Catalogue of Post Graduate Courses

AGRICULTURE

2010

ACHARYA N.G. RANGA AGRICULTURAL UNIVERSITY

Rajendranagar, Hyderabad - 500 030

CATALOGUE OF
POST GRADUATE COURSES

AGRICULTURE

2010

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FOREWORD

Agriculture education has to evolve in tune with fast changing national and international scenario mainly due to new areas of specialization, stakeholders' expectations especially for utilization mode, new cutting edge technologies such as biotechnology, genomics, nanotechnology etc, improved tools of content delivery including ICT's globalization of education etc. For upgrading the knowledge, skill aptitude of our agricultural graduates and reorientation of courses is essential. Recognizing the need, ICAR embarked upon an endurous task of restructuring the post graduate(master's and doctoral) course curricula and syllabi of agriculture and allied sciences at the national level. ICAR also allowed the flexibility of 25% to modify the approved course contents to accommodate the learning needs of the local agricultural and farming situations. More emphasis is also given on practical. The new course programmes are more inclined to agriculture and industry and have been designed in accordance to recent developments in the subjects concerned, hence will be helpful to fetch teaching, research and R&D jobs in colleges/universities, research institutes and industries.

I wish to compliment Dr. Shaik Mohammad, Dean of Post Graduate studies for his efforts in bringing the revised curricula and syllabi in a comprehensive manner. I hope the revised course contents of this catalogue will improve the qualify of graduates passing out from this university in terms of their knowledge, skill and entrepreneurship.

March, 2010

(POLI RAGHAVA REDDY)

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Dr. Shaik Mohammad
Dean- Post Graduate Studies

PREFACE

Agriculture is the prime occupation for about two-thirds of the Indian population. The systematic approach of establishing agricultural universities since 1950s was a mile stone in turning the destiny of the nation from the status of importing food grains to self sufficiency. The land marks in several frontiers of food grains, oilseeds and pulses, fruits and vegetables, fish and poultry, milk and meat through concerted research of the scientists and the adoption of technologies by the farmers are incredible. The food requirement of 385 M inhabitants was obtained through the traditional technologies. The net work of education expansion through the establishment of agricultural universities unveiled the signs of science and exploded agricultural and live stock production. The country witnessed the green revolution in the mid 1960s. The present day gene revolution is likely to herald another leap in production and quality. Today, India is comfortable to sustain the requirement of 120 M people. Education is the engine of human progress. Man is now exploring the nano technology to open new vistas in the history to make agriculture simple, benign to environment, more productive and qualitative for safe health of man and animals than ever before. The civilization of any nation is measured through the educated population. Quality of education is now widely recognized worldwide. The national seminar on revitalizing higher agricultural education in India: prospects and challenges conducted on 24-26 February 2010 at then National Academy of Agricultural Sciences, Rajendranagar is a testimony to the increasing awareness to keep pace with the progress and developmental needs of the future generations.

The state of Andhra Pradesh is next to none in education, research and extension of agriculture. The agricultural university was established in 1964. The post graduation courses for M.Sc.(Ag.) and Ph.D are offered in 3 colleges at Rajendranagar, Bapatla and Tirupati. The Masters' programme is under extension initially for few subjects in 3 more colleges at Ashwaraopet, Mahanandi and Naira from the academic year 2010. About 150 post graduate students in Agriculture are awarded the degrees every year. The quality of education is attracting brilliant students competing at the national level and also from several countries of the world. The credit goes to the dedication of every teacher. The courses are revised with the latest knowledge and research findings available. They were documented as course catalogues.

There has been a continuous revision at reasonable interval of time. The originally conceived PG regulations and programmes during 1980 were modified in 1983. The revision was taken up in 1989 and then in 2001. The catalogues were printed. Every university had its own syllabus for various subjects. The ICAR recognized the need to make vital reforms in agricultural education to make the students more competitive and expose them to wider horizons. It developed strong academic linkages with different Institutions and experts in the country and assigned the responsibility to the national core group to restructure the PG academic programme with the help of 18 Broad Subject Matter Area Committees. The revised syllabus and course curriculum are of high standard, practical oriented, qualitative, competitive and uniform throughout the country. The guidelines were ready by January, 2009 and ANGRAU adopted it immediately from the academic year in August, 2009. The freedom to alter up to about 25% of the course content to meet the local needs was discussed with the faculty several times and finally approved in the faculty board, academic council and the board of management in 2009. The finalized syllabus for M.Sc.(Ag) and Ph.D is documented in this book to serve as a ready reference for the faculty and students.

The efforts made by Dr. G. Swarajya Lakshmi, Professor and Univ. Head, Department of Bio resources Management as convener and Dr. K. Manorama, Professor, Dept. of Biotechnology, Ch.V. Durga Rani, Assoc. Professor, Dept. of Biotechnology as committee members in getting the information compiled and editing are highly appreciated. The efforts of Dr. P. Chandrasekhar Rao, Professor - education with the assistance of Mr. Mohammad Afsar Khan and Mrs. J. Shyamala, Senior Assistants of this office in the preparation of the book are also gratefully acknowledged.

April, 2010

(SHAIK MOHAMMAD)

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AGRICULTURAL ECONOMICS
Course Structure – at a Glance

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AG ECON 502*	MACRO ECONOMICS AND POLICY	2+0
AG ECON 503*	EVOLUTION OF ECONOMIC THOUGHT	1+0
AG ECON 504*	AGRICULTURAL PRODUCTION ECONOMICS	1+1
AG ECON 505*	AGRICULTURAL MARKETING & PRICE ANALYSIS	2+1
AG ECON 506*	RESEARCH METHODOLOGY FOR SOCIAL SCIENCES	1+1
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AG ECON 606**	ADVANCED AGRICULTURAL MARKETING AND PRICE ANALYSIS	2+1

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AG ECON 609	NATURAL RESOURCE MANAGEMENT	1+1
AG ECON 610	ENVIRONMENTAL ECONOMICS	2+1
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* Compulsory for Master's programme;

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PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1
PGS 505	AGRICULTURAL RESEARCH, RESEARCH	1+0
(e-course)	ETHICS AND RURAL DEVELOPMENT PROGRAMMES	
PGS 506	DISASTER MANAGEMENT	1+0
(e-course)		

AG ECON 501 MICRO ECONOMIC THEORY AND APPLICATIONS 2+0

Objective

This course is intended to provide an overview of microeconomic theory and its applications. The course starts with the theory of consumer behaviour consisting of consumer's utility maximization problem and demand theory. It intends to provide fundamental concepts and models in the theory of production and costs and sets out to provide a basic understanding of price and / or output determination under different types of market structures including factor markets. This course will also expose the students to the theory of general equilibrium and welfare economics.

Theory

UNIT I

Theory of Consumer Behaviour - Cardinal Utility Approach - Ordinal Utility Approach – Income effect and substitution effect – Applications of Indifference curve approach - Revealed Preference Hypothesis – Consumer surplus - Derivation of Demand curve – Elasticity of demand.

UNIT II

Theory of Production - Production functions – Returns to scale and economies of scale – Technical progress – Theory of Costs – Cost curves– Profit maximization and cost minimization – Derivation of supply curve – Law of Supply – Producers' surplus.

UNIT III

Market Equilibrium - Behavior of Firms in Competitive Markets - Perfect Competition- Effect of Taxation and Subsidies on market equilibrium - Monopoly- Monopolistic - Oligopoly- Theory of Factor Markets.

UNIT IV

General Equilibrium Theory - Welfare Economics - Pareto Optimality –Social welfare criteria - Social Welfare functions.

Suggested Readings

David M Kreps 1990. *A Course in Microeconomic Theory.* Princeton University Press.

Dewitt KK. 2002. *Modern Economic Theory.* Sultan Chand & Co.

Henderson JM & Quandt RE. 2000. *Microeconomic Theory: A Mathematical Approach.* McGraw-Hill.

Koutsoyiannis A. 2003. Modern Microeconomics. The Macmillan Press.

Silberberg E & Suen W. 2001. *The Structure of Economics – A Mathematical Analysis.* McGraw-Hill.

Varian Hal R. 1999. *Intermediate Microeconomics.* Affiliated East-West Press.

AG ECON 502 MACRO ECONOMICS AND POLICY 2+0

Objective

Macro economics and Policy course is intended to expose the students to macroeconomic concepts and theory, the application of the macro economic theory, and implication of the macroeconomic policies.

Theory

UNIT I

Nature and Scope of Macro Economics - Methodology and Keynesian Concepts National Income - Concepts and measurement- Classical theory of Employment and Say's Law-Modern theory of Employment and Effective Demand.

UNIT II

Consumption function- Investment and savings - Concept of Multiplier and Accelerator - Output and Employment - Rate of interest - Classical, Neo classical and Keynesian version-Classical theory Vs Keynesian theory - Unemployment and Full employment.

UNIT III

Money and classical theories of Money and Price - Keynesian theory of money and Friedman Restatement theory of money - Supply of Money - Demand for Money -Inflation: Nature, Effects and control.

UNIT IV

IS & LM frame work - General Equilibrium of product and money markets -Monetary policy - Fiscal policy- Effectiveness of Monetary and Fiscal policy - Central banking.

UNIT V

Business cycles - Balance of Payment - Foreign Exchange Rate determination.

Suggested Readings

Ahuja HL. 2007. *Macroeconomics: Theory and Policy.* S. Chand & Co.

Eugene A Diulio 2006. *Macroeconomics.* 4th Ed. Schaums' Outlines.

Gardner Ackely 1987. *Macro Economic: Theory and Policy.* Collier Macmillan.

Dornbusch. 2006. *Macroeconomics.* McGraw Hill Publication

AG ECON 503 EVOLUTION OF ECONOMIC THOUGHT 1+0

Objective

To introduce the students to the evolution of economic thought over a period of time, the background of emanation of thoughts and approaches, as acts of balancing and counter balancing events and criticisms. The course will also in a comprehensive way help the students to know and appreciate the contributions of the Galaxy of Economists.

Theory

UNIT 1

Approaches for the study of history of economic thought – Absolutist vs. Relativist approaches – Evolution of Economic Thought vs. Economic History. Ancient economic thought – medieval economic thought – mercantilism – physiocracy – Forerunners of Classical Political Economy.

UNIT II

Development of Classical Thoughts (Adam Smith, Robert Malthus and David Ricardo) – Critics of Classical Thoughts- Socialist critics – Socialist and Marxian Economic Ideas – Austrian School of Thought – Origins of Formal Microeconomic Analysis – William Stanley Jevons. Cournot and Dupuit.

UNIT III

The birth of neoclassical economic thought – Marshall and Walras – General Equilibrium Theory - Welfare Theory – Keynesian economics.

UNIT IV

The Era of globalization – Experiences of developing world - Rigidity of the past vs. emerging realism – The changing path of international Institutions to economic growth and development approaches.

UNIT V

Economic Thought in India – Naoroji and Gokhale – Gandhian Economics - Economic thought of independent India – Nehru's economic philosophy - Experiences of the Structural adjustment programmes of the post liberalization era.

Suggested Readings

Blaug M. 1964. *Economic Theory in Retrospect.* Heineman.

Blaug M. 1986. *Economic History and the History of Economic Thought.*

Wheatsheaf Books, Brighton.

Ekelund RB & Hebert RF. 1975. *A History of Economic Theory and Methods.* McGraw-Hill.

John Mills A. 2002. *Critical History of Economics: Missed Opportunities.* Palgrave Macmillan.

Screpanti E & Zamagni S. 1995. *An Outline of the History of Economic Thought.* Clarendon Press, Oxford.

AG ECON 504 AGRICULTURAL PRODUCTION ECONOMICS 1+1

Objective

To expose the students to the concept, significance and uses of agricultural production economics.

Theory

UNIT I

Nature, scope and significance of agricultural production economics- Agricultural Production processes, character and dimensions-spatial, temporal - Centrality of production functions, assumptions of production, functions, commonly used forms - Properties, limitations, specification, estimation and interpretation of commonly used production functions.

UNIT II

Factors of production, classification, interdependence, and factor substitution -Determination of optimal levels of production and factor application -Optimal factor combination and least cost combination of production - Theory of product choice; selection of optimal product combination.

UNIT III

Cost functions and cost curves, components, and cost minimization - Duality theory – cost and production functions and its applications - Derivation of firm's input demand and output supply functions -Economies and diseconomies of scale.

UNIT IV

Technology in agricultural production, nature and effects and measurement - Measuring efficiency in agricultural production; technical, allocative and economic efficiencies - Yield gap analysis-concepts-types and measurement - Nature and sources of risk, modeling and coping strategies.

Practical

Different forms of production functions - specification, estimation and interpretation of production functions – returns to scale, factor shares, elasticity of production - physical optima-economic optima-least cost combination- optimal product choice- cost function estimation, interpretation-estimation of yield gap - incorporation of technology in production functions- measuring returns to scale-risk analysis through linear programming.

Suggested Readings

Beattie BR & Taylor CR. 1985. *The Economics of Production*. John Wiley & Sons.

Doll JP & Frank O. 1978. *Production Economics - Theory and Applications*. John Wiley & Sons.

Gardner BL & Rausser GC. 2001. *Handbook of Agricultural Economics*.

Vol. I. *Agricultural Production*. Elsevier.

Heady EO. *Economics of Agricultural Production and Resource Use*.

Prentice-Hall.

Sankayan PL. 1983. *Introduction to Farm Management*. Tata Mc Graw Hill.

AG ECON 505 AGRICULTURAL MARKETING AND PRICE ANALYSIS 2+1

Objective

To impart adequate knowledge and analytical skills in the field of agricultural marketing issues, and enhance expertise in improving the performance of the marketing institutions and the players in marketing of agricultural commodities.

Theory

UNIT I

Review of Concepts in Agricultural Marketing - Characteristic of Agricultural product and Production – Problems in Agricultural Marketing from Demand and Supply and Institutions sides. Market intermediaries and their role - Need for regulation in the present context - Marketable & Marketed surplus estimation. Marketing Efficiency - Structure Conduct and Performance analysis - Vertical and Horizontal integration - Integration over space, time and form-Vertical co-ordination.

UNIT II

Marketing Co-operatives – APMC Regulated Markets - Direct marketing, Contract farming and Retailing - Supply Chain Management - State trading, Warehousing and other Government agencies -Performance and Strategies - Market infrastructure needs, performance and Government role - Value Chain Finance.

UNIT III

Role of Information Technology and telecommunication in marketing of agricultural commodities - Market research-Market information service - electronic auctions (e-bay), e-Chaupals, Agmarket and Domestic and Export market Intelligence Cell (DEMIC) – Market extension.

UNIT IV

Spatial and temporal price relationship – price forecasting – time series analysis – time series models – spectral analysis. Price policy and economic development – non-price instruments.

UNIT V

Theory of storage - Introduction to Commodities markets and future trading - Basics of commodity futures - Operation Mechanism of Commodity markets – Price discovery - Hedging and Basis - Fundamental analysis - Technical Analysis - Role of Government in promoting commodity trading and regulatory measures.

Practical

Supply and demand elasticities in relation to problems in agricultural marketing. Price spread and marketing efficiency analysis. Marketing structure analysis through concentration ratios. Performance analysis of Regulated market and marketing societies. Analysis on contract farming and supply chain management of different agricultural commodities, milk and poultry products. Chain Analysis - quantitative estimation of supply chain efficiency - Market Intelligence – Characters, Accessibility, and Availability Price forecasting. Online searches for market information sources and interpretation of market intelligence reports – commodity outlook - Technical Analysis for important agricultural commodities - Fundamental Analysis for important agricultural commodities - Presentation of the survey results and wrap-up discussion.

Suggested Readings

Purecell WD & Koontz SR. 1999. *Agricultural Futures and Options:*

Principles and Strategies. 2nd Ed. Prentice-Hall.

Rhodes VJ. 1978. *The Agricultural Marketing System*. Grid Publ., Ohio.

Shepherd SG & Gene AF. 1982. *Marketing Farm Products*. Iowa State Univ. Press.

Singhal AK. 1986. *Agricultural Marketing in India*. Annual Publ., New Delhi.

AG ECON 506 RESEARCH METHODOLOGY FOR SOCIAL SCIENCES 1+1

Objective

To expose the students to research methodology used in social sciences. The focus will be on providing knowledge related to research process, data collection and data analysis etc.

Theory

UNIT I

Importance and scope of research in agricultural economics. Types of research - Fundamental vs. Applied. Concept of researchable problem – research prioritization – selection of research problem. Approach to research – research process.

UNIT II

Hypothesis – meaning - characteristics - types of hypothesis – review of literature – setting of Course Objective and hypotheses - testing of hypothesis.

UNIT III

Sampling theory and sampling design – sampling error - methods of sampling – probability and non-probability sampling methods - criteria to choose. Project proposals – contents and scope – different types of projects to meet different needs – trade-off between scope and cost of the study. Research design and techniques – Types of research design.

UNIT IV

Data collection – assessment of data needs – sources of data collection – discussion of different situations. Mailed questionnaire and interview schedule – structured, unstructured, open ended and closed-ended questions. Scaling Techniques. Preparation of schedule – problems in measurement of variables in agriculture. Interviewing techniques and field problems - methods of conducting survey – Reconnaissance survey and Pre testing.

UNIT V

Coding editing – tabulation – validation of data. Tools of analysis – data processing. Interpretation of results – Preparing research report / thesis – Universal procedures for preparation of bibliography – writing of research articles.

Practical

Exercises in problem identification. Project proposals – contents and scope. Formulation of Objective and hypotheses. Assessment of data needs – sources of data – methods of collection of data. Methods of sampling – criteria to choose – discussion on sampling under different situations. Scaling Techniques – measurement of scales. Preparation of interview schedule - Field testing. Method of conducting survey. Exercise on coding, editing, tabulation and validation of data. Preparing for data entry into computer. Hypothesis testing – Parametric and Non-Parametric Tests. Exercises on format for Thesis / Report writing. Presentation of the results.

Suggested Readings

Black TR. 1993. *Evaluating Social Science Research - An Introduction.* SAGE Publ.

Creswell JW. 1999. *Research Design - Qualitative and Quantitative Approaches.* SAGE Publ.

Dhondyal SP. 1997. *Research Methodology in Social Sciences and Essentials of Thesis Writing.* Amman Publ. House, New Delhi.

Kothari CR. 2004. *Research Methodology - Methods and Techniques.*

Wishwa Prakashan, Chennai.

Rao KV. 1993. *Research Methodology in Commerce and Management.* Sterling Publ., New Delhi.

Singh AK. 1993. *Tests, Measurements and Research Methods in Behavioural Sciences.* Tata McGraw-Hill.

Venkatasubramanian V. 1999. *Introduction to Research Methodology in Agricultural and Biological Sciences.* SAGE Publ.

AG ECON 507 **ECONOMETRICS** **2+1**

Objective

The objective of the course is to impart knowledge on econometric, tools to the students of agricultural economics. Training in econometrics, will help the student to analyze the economic problem by applying, quantitative techniques.

Theory

UNIT I

Introduction – relationship between economic theory, mathematical, economics, models and econometrics, methodology of econometrics regression analysis.

UNIT II

Basic two variable regression model - assumptions estimation and interpretation approaches to estimation - OLS, MLE and their properties - extensions to multi variable models-multiple regression estimation and interpretation.

UNIT III

Violation of assumptions – identification, consequences and remedies for Multicollinearity, heteroscedasticity, autocorrelation – data problems and remedial measures - model misspecification.

UNIT IV

Use of dummy variables-limited dependent variables – specification, estimation and interpretation.

UNIT V

Simultaneous equation models – structural equations - reduced form equations - identification and approaches to estimation.

Practical

Single equation two variable model specification and estimation - hypothesis testing-transformations of functional forms and OLS application-estimation of multiple regression model - hypothesis testing - testing and correcting specification errors - testing and managing Multicollinearity - testing and managing heteroscedasticity - testing and managing autocorrelation - estimation of regressions with dummy variables - estimation of regression with limited dependent variable - identification of equations in simultaneous equation systems.

Suggested Readings

Gujarati DN. 2003. *Basic Econometrics.* McGraw Hill.

Johnson AG Jr., Johnson MB & Buse RC. 1990. *Econometrics - Basic and Applied.* MacMillan.

Kelejan HH & Oates WE. 1994.*Introduction to Econometrics Principles and Applications.* Harper and Row Publ.

Koutsoyianis A. 1997. *Theory of Econometrics.* Barner & Noble.

Maddala GS. 1992. *Introduction to Econometrics.* MacMillan.

Maddala GS. 1997. *Econometrics.* McGraw Hill.

Pindyck RS & Rubinfeld DL. 1990. *Econometrics Models and Econometric Forecasts.* McGraw Hill.

AG ECON 508 LINEAR PROGRAMMING 1+1

Objective

The objective of the course is to impart knowledge of Linear programming techniques and their applications.

Theory

UNIT I

Decision Making- Concepts of decision making, introduction to quantitative tools, introduction to linear programming, uses of LP in different fields, graphic solution to problems, formulation of problems.

UNIT II

Simplex Method: Concept of simplex method, solving profit maximization and cost minimizations problems. Formulation of farm and non farm problems as linear programming models and solutions.

UNIT III

Extension of Linear Programming models: Variable resource and price programming, transportation problems, recursive programming, dynamic programming.

UNIT IV

Game Theory- Concepts of game theory, two person constant sum, zero sum game, saddle point, solution to mixed strategies, the rectangular game with saddle point.

Practical

Graphical and algebraic formulation of Linear Programming models. Solving of maximization and minimization problems by simplex method. Formulation of the simplex matrices for typical farm situations.

Suggested Readings

Dorfman R. 1996. *Linear Programming & Economic Analysis.* McGrawHill.

Loomba NP.2006. *Linear Programming.* Tata McGraw Hill.

Shenoy G. 1989. *Linear Programming-Principles & Applications.* Wiley Eastern Publ.

Vaserstein. 2006. *Introduction to Linear Programming.* Pearson Education Publication

AG ECON 509 AGRICULTURAL FINANCE AND PROJECT MANAGEMENT 2+1

Objective

The objective of the course is to impart knowledge on issues related to lending to priority sector credit management and financial risk management. The course would bring in the various appraisal techniques in project - investment of agricultural projects.

Theory

UNIT I

Role and Importance of Agricultural Finance. Financial Institutions and credit flow to rural/ priority sector. Agricultural lending – Direct and Indirect Financing - Financing through Co-

operatives, NABARD and Commercial Banks and RRBs. District Credit Plan and lending to agriculture/priority sector. Micro-Financing and Role of MFI's - NGO's, and SHG's.

UNIT II

Lending to farmers – The concept of 3 R's, 3 C's, 7 P's of credit. Estimation of Technical feasibility, Economic viability and repaying capacity of borrowers and appraisal of credit proposals. Understanding lenders and developing better working relationship and supervisory credit system. Credit inclusions – credit widening and credit deepening.

UNIT III

Financial Decisions – Investment, Financing, Liquidity and Solvency. Preparation of financial statements - Balance Sheet, Cash Flow Statement and Profit and Loss Account. Ratio Analysis and Assessing the performance of farm/firm.

UNIT IV

Project Approach in financing agriculture. Financial, economic and environmental appraisal of investment projects. Identification, preparation, appraisal, financing and implementation of projects. Project Appraisal techniques – Undiscounted measures. Time value of money – Use of discounted measures - B-C ratio, NPV and IRR. Agreements, supervision, monitoring and evaluation phases in appraising agricultural investment projects. Net work Techniques – PERT and CPM.

UNIT V

Risks in financing agriculture. Risk management strategies and coping mechanism. Crop Insurance programmes – Review of different crop insurance schemes - Yield loss and weather based insurance and their applications.

Practical

Development of Rural Institutional Lending - Branch expansion, demand and supply of institutional agricultural credit and Over dues and Loan waiving- : An overview, Rural Lending Programmes of Commercial Banks, Lead Bank Scheme- Preparation of District Credit Plan, Rural Lending Programmes of Co-operative Lending Institutions, Preparation of financial statements using farm/firm level data, Farm credit appraisal techniques and farm financial analysis through financial statements, Performance of Micro Financing Institutions - NGO's and Self-Help Groups, Identification and formulation of investment projects, Project appraisal techniques – Undiscounted Measures and their limitations. Project Appraisal Techniques – Discounted Measures, Network techniques – PERT and CPM for project management, Case Study analysis of an Agricultural project, Financial Risk and risk management strategies – Crop Insurance Schemes, Financial instruments and methods – E banking, Kisan Cards and core banking.

Suggested Readings

Dhubashi PR. 1986. *Policy and Performance - Agricultural and Rural Development in Post Independent India.* Sage Publ.

Gittinger JP 1982. *Economic Analysis of Agricultural Projects.* The Johns Hopkins Univ. Press.

Gupta SC. 1987. *Development Banking for Rural Development.* Deep & Deep Publ.

Little IMD & Mirlees JA. 1974. *Project Appraisal and Planning for Developing Countries.* Oxford & IBH Publ.

Muniraj R. 1987. *Farm Finance for Development.* Oxford & IBH Publ.

AG ECON 510 INTERNATIONAL ECONOMICS 1+1

Objective

The expected outcome of this course will be creating awareness among the students about the role of International Economics on National welfare.

Theory

UNIT I

Scope and Significance of International Economics - The role of trade- General Equilibrium in a Closed Economy (Autarky Equilibrium) – Equilibrium in a Simple Open Economy - Possibility of World Trade - Trade gains and Trade Equilibrium.

UNIT II

Tariff, Producer Subsidy, Export Subsidy, Import Quota and Export Voluntary Restraints- The Case of Small Country and Large Country Case.

UNIT III

Ricardian Model of Trade- Specific Factors Model- Heckscher - Ohlin Model - Trade Creation and Trade Diversion – Offer Curve - Export Supply Elasticity and Import Demand Elasticity - Comparative Advantage and Absolute Advantage.

UNIT IV

Official Exchange Rate and Shadow Exchange Rate - Walra's Law and Terms of Trade – Trade Blocks.

UNIT V

IMF, World Bank, IDA, IFC, ADB – International Trade agreements – Uruguay Round – GATT – WTO.

Practical

Producer's Surplus, Consumer's Surplus, National Welfare under Autarky, and Free Trade Equilibrium with small and large country assumption- Estimation of Trade Gains- Estimation of competitive and comparative measures like NPC, EPC, ERP and DRC- Estimation of Offer Curve Elasticity- Estimation of Effect of Tariff, Export Subsidy, Producer Subsidy, Import Quota and Export Voluntary Restraints on National, Welfare- Estimation of Ricardian Model - Estimation of Effect of Trade under Specific Factor Model- Estimation of trade Equilibrium under, Heckscher -Ohlin model - Trade Creation and Diversion.

Suggested Readings

Apple Yard DR & Field AJ Jr. 1995. *International Economics - Trade, Theory and Policy*. Irwin, Chicago.

Cherunilam F. 1998. *International Economics*. Tata McGraw Hill.

Krugman PR & Obstfeld M. 2000. *International Economics – Theory and Policy*. Addison-Wesley.

AG ECON 511 AGRICULTURAL DEVELOPMENT AND POLICIES 2+0

Objectives

To provide orientation to the students regarding the concepts and measures of economic development. To provide orientation on theories of economic growth and relevance of theories in developing countries. To make them to understand the agricultural policies and its effect on sustainable agricultural development. To make them understand the globalization and its impact on agricultural development.

Theory

UNIT I

Development Economics – Scope and Importance - Economic development and economic growth - divergence in concept and approach - Indicators and Measurement of Economic Development – GNP as a measure of economic growth – New Measures of Welfare – NEW and MEW – PQLI – HDI – Green GNP - Criteria for under development – Obstacles to economic development – Economic and Non-Economic factors of economic growth.

UNIT II

Economic development – meaning, stages of economic development, determinants of economic growth. Theories of economic growth – Ricardian growth model – The Harrod – Domar Model – The Neo classical Model of Growth – The Kaldor Model – Optimal Economic Growth – Recent Experiences of developing country economies in transition – Role of state in economic development – Government measures to promote economic development. Introduction to development planning.

UNIT III

Role of agriculture in economic / rural development – theories of agricultural development – Population and food supply - need for sound agricultural policies – resource policies – credit policies – input and product marketing policies – price policies.

UNIT IV

Development issues, poverty, inequality, unemployment and environmental degradation – Models of Agricultural Development – Induced Innovation Model - policy options for sustainable agricultural development.

UNIT V

Globalization and the relevance of development policy analysis – The dilemma of free trade? – Free trade versus Protectionism- Arguments for protection. Arguments against protection. Role of protection in Developing Countries. WTO – Agreement on Agriculture - Contradictions of free trade - proponents and opponents policies in vulnerable sectors like agriculture – Lessons for developing countries.

Suggested Readings

Chakaravathi RM. 1986. *Under Development and Choices in Agriculture.* Heritage Publ., New Delhi.

Diwett KK. 2002. *Modern Economic Theory.* S. Chand & Co.

Eicher KC & Staatz JM. 1998. *International Agricultural Development.* Johns Hopkins Univ. Press.

Frank E. 1992. *Agricultural Polices in Developing Countries.* Cambridge Univ. Press.

Ghatak S & Ingersent K. 1984. *Agriculture and Economic Development.*

Select Book Service Syndicate, New Delhi.

Jhingan ML. 1998. *The Economics of Development and Planning*. Vrinda Publ.

Jules PN. 1995. *Regenerating Agriculture – Polices and Practice for Sustainability and Self Reliance*. Vikas Publ. House.

Naqvi SNH. 2002. *Development Economics – Nature and Significance*. Sage Publ.

AG ECON 512 INSTITUTIONAL ECONOMICS 1+0

Objective

The course exposes the students to the institutional problems and remedies.

Theory

UNIT I

Old and New Institutional Economics - Institutional Economics Vs Neoclassical Economics. Definition of institutions – Distinction between institutions and organizations - Institutional evolution.

UNIT II

Institutional change and economic performance - national and international economic institutions. Transaction cost economics – Transaction costs and the allocation of resources. Transaction costs and efficiency. Asymmetric information - Moral hazard and Principal-Agent problem.

UNIT III

Free rider problem – path dependency – Interlinked transactions. Collective action and the elimination of free-rider problem - The logic of collective action and its role in reducing free rider problem – theory of Groups. Rent seeking – interest groups and policy formulation.

UNIT IV

Economic analysis of property rights- property rights regimes – private property – State Property - Common Property Resources (CPRs) – public goods and club goods.

UNIT V

Special features of institutional arrangements in agriculture – Transaction costs in agriculture - Case Studies - Theories of agrarian institutions - tenancy institutions.

Suggested Readings

Barzel, Y. 1990. *Economic Analysis of Property Rights*. Cambridge Univ. Press.

Bhardhan P. (Ed.). 1989. *The Economic Theory of Agrarian Institutions*. Clarendon Press, Oxford.

Bromley DW. 1989. *Economic Interests and Institutions: The Conceptual Foundations of Public Policy*. Basil Blackwell, Cambridge.

Eggertsson T. 1990. *Economic Behaviour and Institutions*. Cambridge Univ. Press.

Greif A. 2006. *Institutions and the Path to the Modern Economy: Lessons* from Medieval Trade (Political Economy of Institutions & *Decisions)*. Cambridge Univ. Press.

Neelakandan S. 1992. *New Institutional Economics and Agrarian Change – A Primer*. Indian Economic Association Trust for Research and Development, New Delhi.

North DC. 1990. *Institutions, Institutional Change and Economic Performance.* Cambridge Univ. Press.

Ostrom E. 1990. *Governing the Commons: The Evolutions of Institutions for Collective Actions.* Cambridge Univ. Press

AG ECON 513 NATURAL RESOURCE AND ENVIRONMENTAL ECONOMICS 1+1

Objectives

To introduce economics principles related to natural resource and environmental economics To explore the concept of efficiency and the efficient allocation of natural resources To understand the economics of why environmental problems occur. To explore the concept of efficiency and the efficient allocation of pollution control and pollution prevention decisions. To understand the environmental policy issues and alternative instruments of environmental policies

Theory

UNIT I

Concepts, Classification and Problems of Natural Resource Economics – Economy - Environment interaction – The Material Balance principle, Entropy law- Resources Scarcity - Limits to Growth - Measuring and mitigating natural resource scarcity – Malthusian and Recardian scarcity – scarcity indices - Resource Scarcity and Technical Change.

UNIT II

Theory of optimal extraction renewable resources –economic models of oil extraction-efficiency - time path of prices and extraction - Hotelling's rule, Solow-Harwick's Rule. Theory of optimal extraction exhaustible resources –economic models of forestry and fishery.

UNIT III

Efficiency and markets – market failures - externalities – types - property rights – transaction costs – Coase's theorem and its critique - public goods - common property and open access resource management - Collective action.

UNIT IV

Environmental perspectives - biocentrism, sustainability, anthropocentrism - Environmental problems and quality of environment - Sources and types of pollution -air, water, solid waste, land degradation – environmental and economic impacts - Economics of pollution control - efficient reduction in environmental pollution.

UNIT V

Environmental regulation – economic instruments - pollution charges - Pigovian tax - tradable permits – indirect instruments - environmental legislations in India.

UNIT VI

Concept of sustainable development - Economic Perspective - Indicators of sustainability Relation between development and environment stress- Environmental Kuznet's curve Environmental Accounting – resource accounting methods - International Environmental Issues – climate change – likely impacts -mitigation efforts and international treaties.

Practical

Exhaustible resource management –optimum rate of oil extraction. Renewable resource management – optimum harvest of Forestry/fishery. Exercise on pollution abatement –I. Exercise

on pollution abatement –II. Concepts in valuing the environment. Taxonomy of valuation techniques. Productivity change method – substitute cost method - Hedonic price method - Travel cost method -Contingent valuation methods. Discount rate in natural resource management. Environment impact assessment Visit to Pollution Control Board.

Suggested Readings

Ahmad Y, El Serafy S & Lutz E. (Eds.). 1989.Environmental Accounting for Sustainable Development. World Bank.

Freeman AM. 1993. *The Measurement of Environmental and Resource Values*. Resources for the Future Press, Baltimore.

Hackett SC. 2001. *Environmental and Natural Resource Economics: Theory, Policy, and the Sustainable Society*. M. E. Sharpe, Armonk, NY.

Hartwick JM & Olewiler ND. 1998. *The Economics of Natural Resource Use*. 2nd Ed. Addison-Wesley Educational Publ.

Kerr JM, Marothia DK, Katar Singh, Ramasamy C & Bentley WR. 1997 Natural Resource Economics: Theory and Applications in India. Oxford & IBH.

Kolstad CD. 2000. Environmental Economics. Oxford Univ. Press.

Pearce DW & Turner K. 1990. *Economics of Natural Resources and the Environment*. John Hopkins Univ. Press.

Prato T. 1998. *Natural Resource and Environmental Economics*. Iowa State Univ. Press.

Sankar U. 2001. Environmental Economics. Oxford Univ. Press.

Sengupta R. 2000. *Ecology and Economy, an Indian Perspective*. Oxford Univ. Press.

Tietenberg T. 2003. *Environmental and Natural Resource Economics*. 6th Ed. Addison Wesley.

AG ECON 514 INTELLECTUAL PROPERTY MANAGEMENT 1+0

Objective

The objective of the course is to create awareness about intellectual property rights in agriculture. The course deals with management of patents, trademark, geographical indications, copy rights, designs, plant variety protection and bio-diversity protection. The students will be taught on the Marketing and Commercialization of Intellectual Properties.

Theory

UNIT I

World Trade Organization- Agreement on Agriculture (AoA) and Intellectual Property Rights (IPR) - Importance of Intellectual Property Management - IPR and Economic growth- IPR and Bio diversity -Major areas of concern in Intellectual Property Management -Technology Transfer and Commercialization-Forms of different Intellectual Properties generated by agricultural research.

UNIT II

Discovery *versus* Invention - Patentability of Biological Inventions - Method of Agriculture and Horticulture- procedure for patent protection: Preparatory work. Record keeping, writing a patent document, filing the patent document -Types of patent application-patent application under the Patent cooperation treaty (PCT).

UNIT III

Plant genetic resources -Importance and conservation - Sui Generic System -Plant Varieties Protection and Farmers Rights Act- Registration of Extant varieties - Registration and protection of New Varieties / Hybrids / Essentially Derived Varieties - Dispute prevention and settlement -Farmers' Rights.

UNIT IV

Trademark- Geographical Indications of Goods and Commodities – Copy rights-Designs – Biodiversity Protection.

UNIT V

Procedures for commercialization of technology - Valuation, Costs and Pricing of Technology- Licensing and implementation of Intellectual Properties- Procedures for commercialization – Exclusive and non exclusive marketing rights-Research Exemption and benefit sharing.

Suggested Readings

Ganguli P. 2001. *Intellectual Property Rights –Unleashing the Knowledge Economy.* Tata McGraw Hill.

Gupta AK. 2003. *Rewarding Conservation of Biological and Genetic* Resources and Associated Traditional Knowledge and

Contemporary Grass Roots Creativity. Indian Institute of Management, Ahmedabad.

Khan SA & Mashelkar R. 2004. *Intellectual Property and Competitive Strategies in the 21st Century.* Kluwer Law International, The Hague.

AG ECON 515 RURAL MARKETING 2+0

Objective

To provide understanding regarding issues in rural markets like marketing environment, consumer behaviour, distribution channels, marketing strategies, etc.

Theory

UNIT I

Concept and scope of rural marketing, nature and characteristics of rural markets, potential of rural markets in India.

UNIT II

Environmental factors - socio-cultural, economic and other environmental factors affecting rural marketing.

UNIT III

Rural consumer's behaviour - behavior of rural consumers and farmers; buyer characteristics and buying behaviour; Rural v/s urban markets.

UNIT IV

Rural marketing strategy - Marketing of consumer durable and non-durable goods and services in the rural markets with special reference to product planning; product mix, pricing Course Objective, pricing policy and pricing strategy.

UNIT V

Product promotion - Media planning, planning of distribution channels, and organizing personal selling in rural market in India.

Suggested Readings

Krishnamacharyulu CSG & Ramakrishan L. 2002. *Rural Marketing.* Pearson Edu.

Ramaswamy VS & Nanakumari S. 2006. *Marketing Management.* 3rd Ed. MacMillan.

Singh AK & Pandey S. 2005. *Rural Marketing.* New Age.

Singh Sukhpal. 2004. *Rural Marketing.* Vikas Publ. House.

Lofton T. 1993. *Getting Started in Futures.* 3rd Ed. John Wiley & Sons, 1993.

Purcell WD. 1991. *Agricultural Futures and Options: Principles and Strategies.* Macmillan Publ.

Wasendorf RR & McCafferty 1993. *All about Commodities from the Inside Out.* McGraw-Hill.

AG ECON 516 COMMODITY FUTURES TRADING 2+0

Objective

This course is aimed at providing the basic understanding and the mechanics and value of futures markets for speculators and hedgers who in turn will serve as price risk management activities of agribusiness firms.

Theory

UNIT I

History and Evolution of commodity markets – Terms and concepts: spot, forward and futures Markets – factors influencing spot and future markets. Speculatory mechanism in commodity futures.

UNIT II

Transaction and settlement – delivery mechanism - role of different agents - trading strategies - potential impact of interest rate, Foreign Exchange, FDI in Commodity Markets.

UNIT III

Risk in commodity trading, importance and need for risk management measures - managing market price risk: hedging, speculation, arbitrage, swaps - pricing and their features.

UNIT IV

Important global and Indian commodity exchanges - contracts traded – special features - Regulation of Indian commodity exchanges - FMC and its role.

UNIT V

Fundamental Vs Technical analysis – construction and interpretation of charts and chart patterns for analyzing the market trend – Market indicators – back testing. Introduction to technical analysis software – analyzing trading pattern of different commodity groups.

Suggested Readings

Kaufman PJ. 1986. *The Concise Handbook of Futures Markets.* John Wiley & Sons.

Leuthold RM, Junkus JC & Cordier JE. 1989. *The Theory and Practice of Futures Markets.* Lexington Books.

AG ECON 601 **ADVANCED MICRO ECONOMIC ANALYSIS** **1+1**

Objectives

The objective of this course is to introduce the theoretical models and applications of microeconomic theory. In particular, the basic comparative statistical techniques and the more modern duality theory will be developed and applied to the models of maximization, unconstrained and constrained utility maximization, expenditure minimization, constrained profit maximization, and cost and expenditure minimization. These mathematical structures form the basic building blocks of neoclassical economics; this course will stress the development and application of these important models. We follow a calculus rather than a graphical approach to the theory. In the subsequent sections of the course, we provide a fairly rigorous exposure to price determination under different market situations, general equilibrium theory, causes and consequences of market failure and welfare economics including the theory of public choice.

Theory

UNIT I

Theory of consumer behaviour – Duality in consumer theory - expenditure function and indirect utility function - Measurement of Income Effect and Substitution Effect. Measurement of Changes in Consumers' Welfare – Consumer's Surplus, Compensating Variation and Equivalent Variation - Dynamic versions of demand functions – Integrability of demand functions. Demand Models – Linear Expenditure System, Almost Ideal Demand System. Applications of consumer theory – Household model and time allocation – Labour supply decisions by households.

UNIT II

Perfect competition – Monopoly, monopolistic competition and oligopoly. Oligopoly models – collusive and non-collusive models of oligopoly - Cournot model, Chamberlin model, Stackleberg solution.

UNIT III

General equilibrium theory – Conceptual overview - General equilibrium conditions with Production and Consumption. Existence, Uniqueness and Stability of general competitive equilibrium. Walrasian general equilibrium – Mathematical derivation of conditions for general equilibrium.

UNIT IV

Market failure - Incomplete markets - Asymmetric information – Principal- Agent problem, adverse selection and moral hazard. Externalities – Network externalities - Public goods – Optimal provision of public goods.

UNIT V

Welfare Economics - Concepts, problems, approaches and limitations of Welfare Economics, Pareto conditions of maximum welfare – Criteria for social welfare - Social Welfare functions, Social versus Private costs and benefits.

Practical

Problems in consumer utility maximization – Estimation of income and substitution effects; Estimation and comparison of Consumer's surplus, equivalent variation and compensating variation. Estimation of demand models – Derivation and estimation of labour supply equations from household models comparative static analysis in consumption. Advanced problem solving in price determination under perfect competition, monopoly, oligopoly and monopolistic competition. Game theory models. Problems solving in General Equilibrium Theory and Welfare Economics. Problems in public goods provision.

Suggested Readings

Chiang AC. 1981. *Fundamental Methods of Mathematical Economics*. McGraw-Hill.

Henderson JM & Quandt RE. *Microeconomic Theory: A Mathematical Approach*. McGraw-Hill.

Koutsoyiannis A. 2003. Modern Microeconomics. The Macmillan Press.

Kreps DM. 1990. *A Course in Microeconomic Theory*. Princeton Univ. Press.

Silberberg E & Suen W. 2001. *The Structure of Economics - A Mathematical Analysis*. McGraw-Hill.

Varian HR. 1992. *Microeconomic Analysis*. WW Norton & Co

Varian HR. 1999. *Intermediate Microeconomics*. Affiliated East-West Press.

AG ECON 602 ADVANCED MACRO ECONOMICS ANALYSIS 2+0

Objective

Advanced macroeconomics course will be offered to PhD students of Agricultural Economics with the following course objective: to understand the macroeconomic theory to examine the macroeconomic Policy issues to analyze the macroeconomic Policy implications

Theory

UNIT I

Review of Macro Economics concepts-Comparative statics - Keynesian theory-Consumption Function and Theories of Consumption -Saving Function and Theories of Saving.

UNIT II

Theories of Investment-Savings and Investment Equality - IS - LM Framework and equality of demand for many and Supply of Money-Monetary Policy in the static model – Inflation.

UNIT III

Stagflation and Supply side Economics - Theory of Unemployment - Phillips Curve controversy - Inflation, Productivity and distribution - Fiscal policy: Effectiveness and Problems.

UNIT IV

Social Accounting Matrix Framework - General Equilibrium Analysis - Neo classical Macro Economics - Stochastic Macro Economics.

Practical

Estimation of multiple regression model - GLS estimation methods - testing misspecification errors – Testing and Managing multicollinearity, heteroscedasticity and autocorrelation - estimation of LPM, Logit and Probit models - comparing two regressions - Chow test - estimation of distributed lag models – panel data random and fixed effects models - Indirect least squares 2SLS, SURE, 3SLS, estimation of simultaneous equation models

Suggested Readings

Greene WH. 2002. *Econometric Analysis*. Pearson Edu.

Johnston J & Dinardo J. 2000. *Econometric Methods*. McGraw-Hill.

Kelejan HH & Oates WE. 2001. *Introduction to Econometrics Principles and Applications*. Harper & Row.

Maddala GS. 2002. *Econometrics*. McGraw Hill.

AG ECON 604 ADVANCED PRODUCTION ECONOMICS 2+1

Objective

To expose the students to the concept, significance and uses of advance production economics.

Theory

UNIT I

Agricultural Production process – Relationship between farm planning and production economics-scope of agricultural production and planningmethods/ procedures in agro-economic research and planning.

UNIT II

Production functions, components, assumptions, properties and their economic interpretation - Concepts of homogeneity, homotheticity, APP, MPP, elasticities of substitution and their economic relevance – Production relations –Optimality-Commonly used functional forms, nature, properties, limitations, estimation and interpretation -linear, Spillman -Cobb Douglas, Quadratic, multiplicative (power) functional forms - Translog, and Transcendental functional forms -CES, production functional forms- Conceptual and empirical issues in specification, estimation and application of production functions- Analytical approaches to economic optimum - Economic optimum – Determination of economic optimum with constant and varying input and output prices- Economic optimum with production function analysis - input use behaviour.

UNIT III

Decision making with multiple inputs and outputs – MRT and product relationship-cost of production and adjustment in output prices-single input and multiple product decisions- Multi input, and multi product production decisions - Decision making with no risk -Cost of wrong decisions - Cost curves – Principles and importance of duality theory - Correspondence of production, cost, and profit functions - Principles and derivation of demand and supply functions

UNIT IV

Technology, input use and factor shares -effect of technology on input use decomposition analysis-factor shares-estimation methods- Economic efficiency in agricultural production

UNIT V

BOP & Adjustment Policies - Foreign Exchange Policy - Foreign sector : Capital and Current Account - Impact of WTO on Indian Economy - Impact of IMF & IBRD on Indian Economy - Review of Macro Economic Policies in India.

Suggested Readings

Diulio EA. 2006. *Macroeconomics.* 4th Ed. Schaums' Outlines.

Frogen RT. 1999. *Macro Economic: Theory and Policies.* 6th Ed. Prentice Hall.

Samuelson PA & Nordhaus WD. 2004. *Economics.* McGraw-Hill.

Shapiro E. 1989. Macro Economic Analysis. Galgotia Publ.

AG ECON 603 ADVANCED ECONOMETRICS 2+1

Objective

The objective of the course is to impart knowledge on advanced econometric tools to the research scholars of agricultural economics. Training in advanced econometrics will help the research scholars to analyze the economic problems by applying quantitative techniques.

Theory

UNIT I

Review of classical regression model – review of hypothesis testing – restrictions on parameters – single equation techniques.

UNIT II

Ordinary least squares – weighted least squares - generalized least squares –method of principal components – instrumental variables method - maximum likelihood method - errors in variables, non-linearity and specification tests – non spherical error terms.

UNIT III

Dummy variables - Qualitative and truncated dependent variables - limited dependent variables –LPM, probit and logit models, their multinomial extensions.

UNIT IV

Autoregressive distributed lag models – panel data fixed and random effects models and their extensions.

UNIT V

Simultaneous equation methods –identification – estimation by indirec, least squares 2SLS, PIML, SURE, 3SLS. Practical Estimation of multiple regression model - GLS estimation methods - testing misspecification errors – Testing and Managing multicollinearity, heteroscedasticity and autocorrelation - estimation of LPM, Logit and Probit models - comparing two regressions - Chow test - estimation of distributed lag models – panel data random and fixed effects models - Indirect least squares 2SLS, SURE, 3SLS, estimation of simultaneous equation models

– technical, allocative and economic efficiency – measurement -Yield gaps analysis – concepts and measurement - Risk and uncertainty in agriculture – incorporation of risk and uncertainty in decision making – risk and uncertainty and input use level-risk programming.

UNIT V

Simulation and programming techniques in agricultural production- Multiple Course Objective Programming – Goal programming and Compromise programming – applications.

Practical

Estimation of different forms of production functions- Optimal input and product choice from estimated functions-Derivation of demand and supply functions and estimation-Estimation of cost function and interpretations- Optimal product and input choice under multi input and output system- Estimation of factor shares from empirical functions estimated-Estimating production functions incorporating technology changes: Decomposition analysis and incorporation of technology-Estimation of efficiency measures – Stochastic, probabilistic and deterministic frontier production functions- Risk programming – MOTAD-Quadratic programming-Simulation models for agricultural production decisions-Goal programming – Weighted, lexicographic and fuzzy goal programming-Compromise programming.

Suggested Readings

Chambers RG. 1988. *Applied Production Analysis.* Cambridge Univ. Press.

Gardner BL & Rausser GC. 2001. *Handbook of Agricultural Economics.*

Vol. IA *Agricultural Production.* Elsevier.

Palanisami KP, Paramasivam & Ranganathan CR. 2002. *Agricultural Production Economics: Analytical Methods and Applications.* Associated Publishing Co.

AG ECON 605 QUANTITATIVE DEVELOPMENT POLICY ANALYSIS 1+1

Objective

The course trains the scholars in the art of informed decision making and helps them to appreciate the value of the analytical basis in policy decisions. They are given hands on training on the estimation and use of various criteria such as elasticities in making QDPA more meaningful The scholars make extensive reviews to get acquainted with the analytical relevance and in drawing inferences.

Theory

UNIT I

Policy framework – goals, value, beliefs and welfare maximization. Market – Policy and State – State vs. Market – Failure of Policy – Failure of Markets - Rationale for Government Intervention. Role of Quantitative Policy Analysis.

UNIT II

Demand analysis for policymaking – Alternative approaches to demand analysis – Policy implications. Supply response – Alternative approaches to measurement of supply response – Nerlovian models of supply response – Policy implications.

UNIT III

Household behaviour and policy analysis – Household models.

UNIT IV

Partial Equilibrium analysis – Concept of reference prices – Price distortions – indicators and impact. Transaction costs – Implications for efficiency and productivity – Institutional solutions - Multi market approach to policy analysis.

UNIT V

Social Accounting Matrices and multipliers — Computable General Equilibrium models to assess economy wide impact of policy changes. Practical Review of criteria for policy evaluation – Estimation of price elasticities – Review of estimation of complete demand systems – Estimation of Nerlovian supply Response model – Review of Household models – Specification and estimation of household models – Partial equilibrium analysis – Input–output table – Social Accounting Matrix – Construction of a SAM – computation of Multipliers – Multi Market Analysis – Review of Computable General Equilibrium Models.

Practical

Review of criteria for policy evaluation – Estimation of price elasticities – Review of estimation of complete demand systems – Estimation of Nerlovian supply Response model – Review of Household models – Specification and estimation of household models – Partial equilibrium analysis – Input–output table – Social Accounting Matrix – Construction of a SAM – computation of Multipliers – Multi Market Analysis – Review of Computable General Equilibrium Models.

Suggested Readings

Chenery H & Srinivasan TN. (Eds.). 1988. *Hand book of Development Economics*. North-Holland.

Eicher KC & Staatz JM. 1998. *International Agricultural Development*. Johns Hopkins Univ. Press.

Fischer G, Miller J & Sidney MS. (Eds.). 2007. *Handbook of Public Policy Analysis: Theory, Politics and Methods*. CRC Press.

Frank E. 1992. *Agricultural Polices in Developing Countries*. Cambridge Univ. Press.

Ghatak S & Ingersent K. 1984. *Agriculture and Economic Development*. Select Book Service Syndicate.

Kindleberger PC. 1977. Economic Development. McGraw Hill.

Meier MG & Stigilitz JE. 2001. *Frontiers of Development Economics- the Future Perspective*. Oxford Univ. Press.

Sadoulet E & de Janvry A. 1995. *Quantitative Development Policy Analysis*. (London: John Hopkins Univ. Press.

Shoven Neck R, Christian R & Mooslechner P. (Eds.). 2008. *Quantitative* Economic Policy Essays in Honour of Andrew Hughes Hallett.

AG ECON 606 ADVANCED AGRICULTURAL MARKETING AND PRICE ANALYSIS 2+1

Objective

The main objective of this course is to critically analyze the important marketing concepts, models, properties of agricultural commodity prices and forecasting, data collection and analysis using current software etc., in order to make them policy decisions in the field of agricultural marketing.

Theory

UNIT I

Importance of market analysis in the agricultural system - types of marketing- advantages and disadvantages - quantitative estimation - the distinguishing characteristics and role of agricultural prices - data sources for agricultural products and prices - softwares used in market analysis.

UNIT II

Role of various formal institutions in agricultural marketing - and functions - measuring their efficiency - public - private partnership - institutional arrangements. Successful case studies.

UNIT III

Multi market estimation, supply response models. Market integration and price transmission - supply / value chain management. GAP analysis. Current trends in information in the changing agrifood system.

UNIT IV

Agricultural commodity marketing - spot and futures- marketing of derivatives-speculation, hedging, swap, arbitrage etc. commodity exchanges - price discovery and risk management in commodity markets- Regulatory mechanism of futures trading.

UNIT V

Lag operators and difference equations; stationary and stochastic processes; UNIT roots and cointegration; conditional heteroscedasticity: ARCH and GARCH models - forecast evaluation; methods of forecasting. price indices and econometric estimation and simulation.

Practical

Estimation of demand/ supply forecasting, supply chain / value chain analysis for different commodities - Commodity modelsmulti market estimation- time series analysis - market integration studies- price discovery price volatility estimation - commodity price forecasting using econometric softwares.

Suggested Readings

Ferris JN. 1998. *Agricultural Prices and Commodity Market Analysis.* McGraw-Hill.

Goodwin JW. 1994. *Agricultural Price Analysis and Forecasting.* Wiley.

Hallam D. 1990. *Econometric Modeling of Agricultural Commodity Markets.* New Routledge.

Martimort D. (Ed.). 1996. *Agricultural Markets: Mechanisms, Failures, and Regulations.* Elsevier.

Schrimper RA. 2001. *Economics of Agricultural Markets.* Pearson.

Timmer CP. 1986. *Getting Prices Right.* Cornell University Press.

Tomek WG & Robinson KL. 2003. *Agricultural Product Prices.* 4th Ed. Cornell University Press.

AG ECON 608 COMMODITY FUTURES TRADING 2+0

Objective

This course is aimed at providing the basic understanding and the mechanics and value of futures markets for speculators and hedgers which in turn will serve as price risk management activities of agribusiness firms.

Theory

UNIT I

History and Evolution of commodity markets – Terms and concepts: spot, forward and futures Markets – factors influencing spot and future markets. Speculatory mechanism in commodity futures.

UNIT II

Transaction and settlement – delivery mechanism - role of different agents - trading strategies - potential impact of interest rate, Foreign Exchange, FDI in Commodity Markets.

UNIT III

Risk in commodity trading, importance and need for risk management measures - managing market price risk: hedging, speculation, arbitrage, swaps - pricing and their features.

UNIT IV

Important global and Indian commodity exchanges - contracts traded – special features - Regulation of Indian commodity exchanges - FMC and its role.

UNIT V

Fundamental Vs Technical analysis – construction and interpretation of charts and chart patterns for analyzing the market trend – Market indicators – back testing. Introduction to technical analysis software – analyzing trading pattern of different commodity groups.

Suggested Readings

Kaufman PJ. *1986. The Concise Handbook of Futures Markets.* John Wiley & Sons.

Leuthold RM, Junkus JC & Cordier JE. 1989. *The Theory and Practice of Futures Markets.* Lexington Books.

Lofton T. 1993. *Getting Started in Futures.* 3rd Ed. John Wiley & Sons.

Purcell WD. 1991. *Agricultural Futures and Options: Principles and Strategies.* Macmillan Publ.

Wasendorf RR & McCafferty. 1993. *All about Commodities from the Inside Out.* McGraw-Hill.

AG ECON 609 NATURAL RESOURCE MANAGEMENT 1+1

Objectives

This is an applied economics course that focuses on the economic analysis of natural resources, and seeks to identify and solve natural resource management problems via mathematical approach using dynamic optimization techniques. During the course, we will encounter bioeconomic models of natural resources including the classic and more recent forestry and fisheries models, models of land and water use and extraction of non-renewable resources (such as from a mineral deposit). We will focus on intuition and understanding of the economic analysis rather than complicated mathematical models in this class. That natural resource problems are inherently dynamic, so some mathematical modeling of biophysical and economic processes will be required. Using computers as an aid to understanding the models will be an important part of the class. The primary tool will be Microsoft Excel, which is the easiest introduction to computational optimization and graphical representation of the results.

Theory

UNIT I

Natural resources - definition - characteristics and classification. Stock dynamics of renewable and non-renewable resources. Equation of motion for renewable and non-renewable resources. Fundamental equation of renewable resources.

UNIT II

Growth curves of fishery and forest resources. The role of time preference in natural resource use. Simple two-period model of optimal use of renewable and non-renewable resources. Advanced models of optimal resource use – Static Vs. dynamic efficiency in natural resource use Applications of dynamic programming and optimal control.

UNIT III

Economics of groundwater use - optimal extraction of groundwater. Analytical and numerical solutions for optimal inter-temporal allocation of natural resources. Optimal harvesting of single rotation and multiple rotation forests. Optimal management of fishery.

UNIT IV

Property rights in natural resources and their implication for conservation and management of natural resources. Management of common property natural resources – Institutional arrangements for conservation and management of common pool fishery, groundwater and forestry resource.

UNIT V

Resource scarcity – Natural resource degradation – Poverty and resource degradation – Natural resource accounting - Pricing and valuation of natural resources – Natural resources policy.

Practical

Derivation of the fundamental equation of renewable resources-Estimation of growth curves and stock dynamics for fishery and forestry resources. Simple two period problem of optimal resource use – Numerical solution for simple two-period model of dynamic efficiency in natural resource extraction. Multi-period dynamic efficiency – Using Excel Solver in solving dynamic natural resource harvesting problems. Using analytical solution procedures for solving natural resource management problems – Optimal control.

Suggested Readings

Baland J-M & Platteau JP. 1996. *Halting Degradation of Natural Resources: Is There a Role for Rural Communities?* Clarendon Press and FAO.

Carlson GA, Miranowski J & Zilberman D. 1998. *Agricultural and Environmental Resource Economics.* Oxford Univ. Press.

Chiang AC. 1992. *Elements of Dynamic Optimization.* Waveland Press.

Clark CW. 1976. *Mathematical Bioeconomics: The Optimal Management of Renewable Resources.* John Wiley and Sons.

Conrad JM & Clark CW. 1997. *Natural Resource Economics: Notes and Problems.* Cambridge Univ. Press.

Conrad JM. 1999. *Resource Economics.* Cambridge University Press.

Fisher AC. 1981. *Resource and Environmental Economics*. Cambridge Univ. Press.

Prato T. 1998. *Natural Resource and Environmental Economics*. Iowa State Univ. Press.

Sterner T. 2003. Policy Instruments for Environmental and Natural Resource Management. Resources for the Future, Washington DC.

AG ECON 610 **ENVIRONMENTAL ECONOMICS** **2+1**

Objective

The main objective of this course is to provide an advanced treatment of the economic theory of environmental management and policy, externalities and market and non-market approaches to environmental improvement. Topics in economic growth and environmental problems, poverty and environmental degradation, conservation and sustainable economic growth, intergenerational and global environmental problems, policy issues in environmental regulation and management will be covered at a sufficient depth so as to equip the students with the recent developments in the field.

Theory

UNIT I

Environmental pollution as a consequence of market failure - Causes and consequences of market failure - Externalities - Public goods and externalities - Economics of pollution – Private vs. Social cost of environmental pollution – Property rights, environment and development – Theory of environmental policy.

UNIT II

Environmental cost benefit analysis - Environmental impact assessment techniques - Non-market valuation of environmental resources (WTP / WTA) - Environment, market and social welfare.

UNIT III

Economic growth and environmental cost - Growth oriented economic policies and their environmental impacts - Population and environmental quality - poverty and environmental degradation – Sustainable development – Indicators of sustainable development – Issues in sustainable development.

UNIT IV

Environment, ecology and environmental accounting - Environmental pollution with respect to water and air - Land and forest resources related environmental pollution - Coastal externalities - Urbanization and environment - Basic approaches to environmental policy (Tax, subsidy, pollution permits etc.) Green taxes - Political economy of environmental regulation and management.

UNIT V

Transboundary environmental problems - Economics of global warming, climate change and emission trading - Environment, international trade and development.

Practical

Contemporary global environmental issues, movement, policies, programmes, laws and other regulatory mechanisms - Criteria for evaluating the environment related projects and review of

Environmental Impact Assessment (EIA) techniques - Recreation demand models of environmental valuation - Contingent valuation techniques - Environmental Resource Accounting Techniques - Discussion on the techniques dealing with air pollution and review of case studies on air pollution and its impacts - forest environment and wild life conservation - Green GDP and Green house insurance - Practical considerations and comparison of instruments of environmental policy - Non-point source pollution control methodologies - Environment in macroeconomic modeling - Meta-analysis, economic valuation and environmental economics - Multi-criteria methods for quantitative, qualitative and fuzzy evaluation problems related to environment - Input output analysis, technology and the environment - Computable general equilibrium models for environmental economics and policy analysis.

Suggested Readings

Carlson GA, Miranowski J & Zilberman D. 1998. *Agricultural and Environmental Resource Economics*. Oxford Univ. Press.

Hanley N, Shogren J & White B. 2007. *Environmental Economics : Theory and Practice*. Palgrave, London.

Kolstad C. 1999. *Environmental Economics*. Oxford Univ. Press.

Prato T. 1998. *Natural Resource and Environmental Economics* :Iowa State Univ. Press.

Sterner T. 2003. *Policy Instruments for Environmental and Natural Resource Management. Resources for the Future*. The World Bank and SIDA.

List of Journals

Agricultural Economics Research Review
Agricultural Finance Review
Agricultural Marketing
Agriculture and Agro-industries Journal
Agriculture Statistics at a Glance
APEDA Trade yearbook
Asian Economic and Social Review (Old Series)
Bulletin of Agricultural Prices
Economic and Political Weekly
Economic Survey of Asia and Far East
FAO Commodity Review and Outlook
FAO Production Year book
FAO Trade year book
Indian Cooperative Review
Indian Economic Journal
Indian Journal of Agricultural Economics
Indian Journal of Agricultural Marketing
Indian Journal of Economics
International Food Policy Research Institute Research Report
Journal of Agricultural Development and Policy
Journal of Agricultural Economics
Journal of Agricultural Economics and Development
Journal of Farm Economics

Land Economics
Productivity
Reserve Bank of India Bulletin
Rural Economics and Management
World Agricultural Economics and Rural Sociology Abstracts
World Agricultural Production and Trade: Statistical Report
Yojana
Agricultural Situation in India

e- Resources

www.pearsoned.com (Pearson Education Publication)
www.mcgraw-hill.com (McGraw-Hill Publishing Company)
www.oup.com (Oxford University Press)
www.emeraldinsight.com (Emerald Group Publishing)
www.sagepub.com (*S*age publications)
www.isaeindia.org (Indian Society of Agricultural Economics)
www.macmillanindia.com (Macmillan Publishing)
www.icar.org.in (Indian Council of Agricultural Research)
www.khoj.com (Directory for Agricultural Economics)
www.ncap.res.in (National Centre for Agricultural Economics and Policy Research)
www.ncdex.com (National Commodity & Derivatives Exchange Limited)
www.phdcci.in (PHD Chamber of Commerce and Industry)
www.ficci.com (Federation of Indian Chambers of Commerce and Industry)
www.assocham.org (Associated Chambers of Commerce and Industry of India)
www.apeda.com (Agricultural and Processed Food Products Export Development Authority)
www.mpeda.com (Marine Products Export Development Authority)

Suggested Broad Topics for Master's and Doctoral Research

Economics of Irrigation water in different agro-climatic conditions
Potential of exports of agri-products
Potential domestic as well as international markets for value added agriproducts
Demand & supply gap of different agri-products and agri-inputs
Economic analysis of new agri-technologies
Input use efficiency in different agro-climatic conditions
Income and expenditure pattern in rural areas
Saving and investment pattern in rural areas
Return from investment in agriculture research
Marketing of agri-products in WTO regime
Impact of WTO on agricultural economy
Impact of Agricultural credit on socio-economic condition of the farmers
Optimization of production process to reduce the cost of production
Economic analysis of diversification, processing and value addition in agriculture sector
Emerging international marketing scenario of agri-products
Extent of farmers' indebtedness in different agro-climatic conditions

AGRICULTURAL EXTENSION

Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
EXT 501*	DEVELOPMENT PERSPECTIVES OF EXTENSION EDUCATION	1+1
EXT 502*	DEVELOPMENT COMMUNICATION AND INFORMATION MANAGEMENT	2+1
EXT 503*	DIFFUSION AND ADOPTION OF INNOVATIONS	2+1
EXT 504*	RESEARCH METHODS IN BEHAVIORAL SCIENCES	2+1
EXT 505*	e-EXTENSION	2+1
EXT 506*	ENTREPRENEURSHIP DEVELOPMENT AND MANAGEMENT IN EXTENSION	2+1
EXT 507*	HUMAN RESOURCE DEVELOPMENT(HRD)	2+1
EXT 508	VISUAL COMMUNICATION	2+1
EXT 509	PARTICIPATORY METHODS FOR TECHNOLOGY DEVELOPMENT AND TRANSFER	1+1
EXT 510	GENDER SENSITIZATION FOR DEVELOPMENT	1+1
EXT 511	PERSPECTIVES OF DISTANCE EDUCATION	1+1
EXT 512	MARKET-LED EXTENSION MANAGEMENT	1+1
EXT 591	MASTER'S SEMINAR	1+0
EXT 599	MASTER'S RESEARCH	20
EXT 601**	ADVANCES IN AGRICULTURAL EXTENSION	2+1
EXT 602**	ADVANCED DESIGNS AND TECHNIQUES IN SOCIAL SCIENCE RESEARCH	2+1
EXT 603**	ADVANCES IN TRAINING TECHNOLOGY	2+1
EXT 604**	ORGANIZATIONAL DEVELOPMENT	2+1
EXT 605**	ADVANCED INSTRUCTIONAL TECHNOLOGY	2+1
EXT 606	THEORY CONSTRUCTIONS IN SOCIAL SCIENCES	2+0
EXT 607	ADVANCED MANAGEMENT TECHNIQUES	2+1
EXT 608	MEDIA MANAGEMENT	2+1

CODE	COURSE TITLE	CREDITS
EXT 609	TRANSFER OF TECHNOLOGY IN AGRICULTURE	2+1
EXT 691	DOCTORAL SEMINAR I	1+0
EXT 692	DOCTORAL SEMINAR II	1+0
EXT 699	DOCTORAL RESEARCH	45

* Compulsory for Master's programme;

** Compulsory for Doctoral programme

Minor Departments **9**

Agronomy

Agricultural Economics

Seed Science & Technology

Plant Pathology

Entomology

Supporting Departments **5**

Statistics & Mathematics

Non credit compulsory courses

CODE	COURSE TITLE	CREDITS
PGS 501	LIBRARY AND INFORMATION SERVICES	0+1
PGS 502	TECHNICAL WRITING AND COMMUNICATION SKILLS	0+1
PGS 503 (e-course)	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1+0
PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1
PGS 505 (e-course)	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1+0
PGS 506 (e-course)	DISASTER MANAGEMENT	1+0

EXT 501 **DEVELOPMENT PERSPECTIVES OF EXTENSION EDUCATION** 1+1

Objective

The course is intended to orient the students with the concept of extension education and its importance in Agriculture development and also to expose the students with various Rural development programmes aimed at poverty alleviation and to increase employment opportunites and their analysis. Besides, the students will be learning about the new innovations being brought into the Agricultural Extension in India.

Theory

UNIT I

Extension Education – Meaning, objectives, concepts, principles and philosophy, critical analysis of definitions – Extension Education as a Profession – Adult Education and Distance Education.

UNIT II

Pioneering Extension efforts and their implications in Indian Agricultural Extension – Analysis of Extension systems of ICAR and SAU – State Departments Extension system and NGOs – Role of Extension in Agricultural University.

UNIT III

Poverty Alleviation Programmes – SGSY, SGRY, PMGSY, DPAP, DDP, CAPART – Employment Generation Programmes – NREGP, Women Development Programmes – ICDS, MSY, RMK, Problems in Rural Development.

UNIT IV

Current Approaches in Extension: Decentralised Decision Making, Bottom up Planning, Farming System Approach, Farming Situation Based Extension, Market – Led – Extension, Farm Field School, ATIC, Kisan Call Centres, NAIP.

Practical

Visit to Gram Panchayat to study on-going Rural Development Programmes, Visit to KVK, NGO and Extension centers of State Agricultural University and State Departments, Bottom up planning, Report preparation and presentations.

Suggested Readings

Chandrakandan KM, Senthil Kumar & Swatilaxmi. PS. 2005. *Extension Education What? And What Not ?* RBSA Publ.

Gallagher K. 1999. *Farmers Field School (FFS) – A Group Extension Process based on Non-Formal Education Methods.* Global EPM Facility, FAO.

Ganesan R, Iqbal IM & Anandaraja N. 2003. *Reaching the Unreached:*

Basics of Extension Education. Associated Publishing Co.

Jalihal KA & Veerabhadraiah V. 2007. *Fundamentals of Extension Education and Management in Extension.* Concept Publ.

Khan PM. 2002. *Textbook of Extension Education.* Himalaya Publ.

Ray GL. 2006. *Extension Communication and Management.* Kalyani Publ.

Van Den Ban AW & Hawkins HS. 1998. *Agricultural Extension* .2nd Ed. CBS.

Viswanathan M. 1994. *Women in Agriculture and Rural Development.* Printwell Publ.

EXT 502 DEVELOPMENT COMMUNICATION AND INFORMATION MANAGEMENT 2+1

Objective

In this course, students will learn about the concept, meaning and process of communication and various methods and modern media of communication. Besides, the students will also learn the information management and journalistic writing of various information materials and also study their readability.

Theory

UNIT I

Communication process – concept, elements and their characteristics – Models and theories of communication – Communication skills– fidelity of communication, communication competence and empathy, communication effectiveness and credibility, feedback in communication, social networks and Development communication – Barriers in communication, Message – Meaning, dimensions of a message, characteristics of a good message, Message treatment and effectiveness, distortion of message.

UNIT II

Methods of communication – Meaning and functions, classification. Forms of communication – Oral and written communication, Non-verbal communication, interpersonal communication, organizational communication. Key communicators – Meaning, characteristics and their role in development.

UNIT III

Media in communication – Role of mass media in dissemination of farm technology, Effect of media mix for Rural People. Modern communication media – Electronic video, Tele Text, Tele conference, Computer Assisted Instruction, Computer technology and its implications.

UNIT IV

Agricultural Journalism as a means of mass communication, Its form and role in rural development, Basics of writing – News stories, feature articles, magazine articles, farm bulletins and folders. Techniques of collection of materials for news stories and feature articles; Rewriting Art of clear writing, Readability and comprehension testing procedures; photo journalism, communicating with pictures, Radio and TV Journalism, Techniques of writing scripts for Radio and TV.

PRACTICAL

Identification of key communicators and communication networks in a selected village Simulated exercise on distortion of messages at different levels of communication Visit to extension organization to study the organizational communication Exercise on Writing for Print Media –

Writing News Exercise on Writing for Print Media – Success Stories Writing Feature articles for different topics related to Agriculture and allied fields Visit to AIR and TV centre Exercise on Script writing for Radio, Exercise on Script writing for TV, Exercise on Readability and comprehension testing procedures Participation and Interaction through Video conference Exercise on Computer Assisted Instruction Developing communication Strategy for diffusion of modern farm technology in villages

Suggested Readings

Dahama OP & Bhatnagar OP. 2005. *Education and Communication for Development.* Oxford & IBH.

Grover I, Kaushik S, Yadav L & Varma SK. 2002. *Communication and Instructional Technology.* Agrotech Publ. Academy.

Jana BL & Mitra KP. 2005. *Farm Journalism.* Agrotech Publ. Academy.

Ray GL. 2006. *Extension Communication and Management.* Kalyani Publ.

Rayudu CS.2002. *Communication.* Himalaya Publ. House.

Reddy AA. 1987. *Extension Education.* Sree Lakshmi Press, Bapatla.

Sandhu AS. 2004. *Textbook on Agricultural Communication Process and Methods.* Oxford & IBH.

EXT 503 DIFFUSION AND ADOPTION OF INNOVATIONS 2+1

Objective

The students will learn how the agricultural innovations spread among the farmers in the society by getting into the insights of diffusion concept and adoption process, stages of adoption and innovation decision process, adopter categories and their characteristics, opinion leaders and their characteristics, attributes of innovations, and factors influencing adoption. In addition, the students would be learning various concepts related to diffusion and adoption of innovations.

Theory

UNIT I

Diffusion – concept and meaning, elements; traditions of research on diffusion; the generation of innovations; innovation-development process; tracing the innovation-development process, converting research into practice.

UNIT II

The adoption process- concept and stages, dynamic nature of stages, covert and overt processes at stages, the innovation-decision process – a critical appraisal of the new formulation.

UNIT III

Adopter categories – Innovativeness and adopter categories, adopter categories as ideal types, characteristics of adopter categories; Perceived attributes of Innovation and their rate of adoption, factors influencing rate of adoption.

UNIT IV

Diffusion effect and concept of over adoption, opinion leadershipmeasurement and

characteristics of opinion leaders, monomorphic and polymorphic opinion leadership, multi-step flow of innovation; concepts of homophily and heterophily and their influence on flow of innovations; Types of innovation-decisions – Optional, Collective and Authority and contingent innovation decisions; Consequences of Innovation-Decisions – Desirable or Undesirable, direct or indirect, anticipated or unanticipated consequences; Decision making – meaning, theories, process, steps, factors influencing decision – making.

Practical

Case studies in individual and community adoption process, content analysis of adoption studies, Identification of adopter categories on a selected technology, study of attributes of current farm technologies, Identification of opinion leaders, Sources of information at different stages of adoption on a selected technology, study of factors increasing or retarding the rate of adoption, presentation of reports on adoption and diffusion of innovations.

Suggested Readings

Dasgupta. 1989. *Diffusion Agricultural Innovations in Village India.* Wiley Eastern.

Jalihal KA & Veerabhadraiah V. 2007. *Fundamentals of Extension Education and Management in Extension.* Concept Publ. Co.

Ray GL. 2005. *Extension Communication and Management.* Kalyani Publ.

Reddy AA. 1987. *Extension Education.* Sree Lakshmi Press, Bapatla.

Rogers EM. 2003. Diffusion of Innovations. 5th Ed. The Free Press, New York.

EXT 504 RESEARCH METHODS IN BEHAVIOURAL SCIENCES 2+1

Objective

This course is designed with a view to provide knowledge and skills in methods of behavioural sciences research and student will learn the Statistical Package for Social Sciences (SPSS) for choosing appropriate statistics for data analysis.

Theory

UNIT I

Research – Meaning, importance, characteristics. Behavioural sciences research – Meaning, concept and problems in behavioural sciences research. Types and methods of Research – Fundamental, Applied and Action research, Exploratory, Descriptive, Diagnostic, Evaluative, Experimental, Analytical, Historical, Survey and Case Study. Review of literature – Need, Search Procedure, Sources of literature, Planning the review work. Research problem – Selection and Formulation of research problem and guiding principles in the choice of research problem, Factors and criteria in selection of research problem, Statement of research problem and development of theoretical orientation of the research problem.

UNIT II

Objectives – Meaning, types and criteria for judging the objectives. Concept and Construct – Meaning, role of concepts in research and Conceptual frame work development in research. Variable – Meaning, types and their role in research. Definition – Meaning, characteristics of workable definitions, types and their role in research. Hypothesis – Meaning, importance and functions of hypothesis in research, Types of hypothesis, linkages, sources, problems in formulation and criteria for judging a workable hypothesis.

Measurement – Meaning, postulates and levels of measurement, Use of appropriate statistics at different levels of measurement, criteria for judging the measuring instrument and importance of measurement in research. Validity – Meaning and methods of testing. Reliability – Meaning and methods of testing. Sampling – Universe, Sample and Sampling-Meaning, basis for sampling, advantages and limitations, size and factors affecting the size of the sample and sampling errors – Methods of elimination and minimizing, Maximinicon Principle, Sampling – Types of sampling and sampling procedures.

UNIT III

Research Designs – Meaning, purpose and criteria for research design, Types, advantages and limitations of each design. Experimental design – Advantages and limitations. Data Collection devices - Interview – Meaning, purpose, types, techniques of interviewing and advantages and limitations. Enquiry forms and Schedules – Meaning, types of questions used, steps in construction and advantages and limitations in its use. Questionnaires – Meaning, difference between schedule and questionnaire, types of questions to be used, pre – testing of the questionnaires or schedules and advantages and limitations. Check lists – Meaning, steps in construction, advantages and limitations in its use. Rating scales – Meaning, types, limits in construction, advantages and limitations in its use. Observation – Meaning, types, tips in observation, advantages and limitations in its use. Case studies – Meaning, types, steps in conducting, advantages and limitations in its use. Social survey – Meaning, objectives, types and steps in conducting, advantages and limitations.

UNIT IV

Data processing – Meaning, coding, preparation of master code sheet, analysis and tabulation of data, Statistical Package for Social Sciences (SPSS) choosing appropriate statistics for data analysis based on the level of measurement of variables. Report writing – Meaning, guidelines to be followed in scientific report writing, References in reporting.

Practical

Selection and formulation of research problem - Formulation of objectives and hypothesis-Selection of variables based on objectives-Developing the conceptual framework of research. Operationally defining the selected variables-Development of data collection devices.-Testing the validity and reliability of the data collection instruments.- Pre-testing of the data collection instrument-Techniques of interviewing and collection of data using the data collection instruments-Data processing, hands on experiences on SPSS, coding, tabulation and analysis. Formulation of secondary tables based on objectives of research.Writing report, Writing of thesis and research articles-Presentation of reports.

Suggested Readings

Chandrakandan K, Venkatapirabu J, Sekar V & Anand Kumar V. 2000. *Tests and Measurements in Social Research.* APH Publ.

Kerlinger FN. 1973. *Foundations of Behavioural Research.* Holt Rhinehart.

Kothari CR.1984. *Research Methodology, Methods and Techniques.* Chaitanya Publ. House, Allahabad.

Krishnaswami OR & Ranganatham M. 2005. *Methodology of Research in Social Sciences.* Himalaya Publ. House.

Mulay S & Sabaratnam VE.1983. *Research Methods in Extension Education.* Manasavan, New Delhi

Ranjit Kumar. 1999. *Research Methodology - A Step by Step Guide for Beginners.* Sage Publ.

Ray GL & Sagar Mondal. 1999. *Research methods in Social Sciences and Extension Education.* Naya Prakash, Calcutta

Wilkinson TS & Bhandarkar PC.1993. *Methodology and Techniques of* Social *Research.* Himalaya Publ.Home.

EXT 505 **e-EXTENSION** **2+1**

Objective

Students will gain knowledge and skills in understanding the concepts of Information and communication technologies and how these ICT tools can be used for Agricultural Extension. Besides, he studies various ICT projects which are successful in delivering the services to the clientele fulfilling the objective of Transfer of Technology i.e. Reaching the unreached.

Theory

UNIT I

ICTs- Concept, definition, tools and application in extension education. Reorganizing the extension efforts using ICTs, advantages, limitations and opportunities.

UNIT II

ICTs projects, case studies in India and developing world. Different approaches (models) to ICTs. ICT use in field of extension- Expert systems on selected crops and enterprises; Self learning CDs on package of practices, diseases and pest management, Agricultural web sites and portals related crop production and marketing etc.

UNIT III

Community Radio, Web, Tele, and Video conferencing. Computer Aided Extension. Knowledge management, Information kiosks, Multimedia. Online, Offline Extension. Tools-Mobile technologies, e-learning concepts.

UNIT IV

ICT Extension approaches-pre-requisites, information and science needs of farming community. Need integration. Human resource information. Intermediaries. Basic e-extension training issues. ICT enabled extensionpluralism. Emerging issues in ICT.

Practical

Agril.content analysis of ICT Projects. Handling of ICT tools. Designing extension content. Online extension service. Project work on ICT enabled extension. Creation of extension blogs. Visit to ICT extension projects.

Suggested Readings

Batnakar S & Schware R. 2000. *Information and Communication Technology in Development-Cases from India.* Sage Publ.

Meera SN. 2008. *ICTs in Agricultural Extension: Tactical to Practical.*

Ganga-Kaveri Publ. House. JangamWadiMath, Varanasi.

Willem Zip. 1994. *Improving the Transfer and Use of Agricultural Information - A Guide to Information Technology.* The World Bank, Washington.

EXT 506 ENTREPRENEURSHIP DEVELOPMENT AND MANAGEMENT IN EXTENSION 2+1

Objective

The first part of the course is intended to provide overall picture of planning and development of enterprises for extending sustainable livelihoods for rural people. The second part of the course is structured to help the students to gain knowledge and skills in different concepts and techniques of management in extension organizations.

Theory

UNIT I

Entrepreneurship – Concept, characteristics, Approaches, Theories, Need for enterprises development. Agri – entrepreneurship – Concept,characteristics, Nature and importance for sustainable Livelihoods. Traits of entrepreneurs – Risk taking, Leadership, Decision making, Planning, Organising, Coordinating and Marketing, Types of Entrepreneurs. Stages of establishing enterprise – Identification of sound enterprise, steps to be considered in setting up an enterprise, feasibility report, product selection, risk and market analysis, legal requirements. Project Management and Appraisal – Market, Technical, Financial, Social Appraisal of Projects.

UNIT II

Micro enterprises – Profitable Agri enterprises in India – Agro Processing, KVIC industries. Micro financing – meaning, Sources of Finance, Banks, Small scale industries development organizations. Marketing for enterprises – Concept, planning for marketing, target marketing, Competition, market survey and strategies, Product sales and promotion. Gender issues in entrepreneurship development – Understanding gender and subordination of women, Gender as a development tool, Policy approaches for women entrepreneurship development. Success and Failure stories for enterprises – Issues relating to success and failure of enterprises – Personal, Production, Finance, Social, Marketing.

UNIT III

Management – Meaning, concept, nature and importance, Approaches to management, Levels of management, Qualities and skills of a manager. Extension Management – Meaning, Concept, Importance, Principles of management, Classification of Functions of Management. Planning – Concept, Nature, Importance, Types, Making planning effective. Change Management – factors, process and procedures. Decision making – Concept, Types of decisions, Styles and techniques of decision making, Steps in DM Process, Guidelines for making effective decisions. Organizing – Meaning of Organization, Concept, Principles, Organizational Structure, Span of Management, Departmentalization, Authority and responsibility, Delegation and decentralization, line and staff relations.

UNIT IV

Coordination – Concept, Need, Types, Techniques of Coordination. Interpersonal relations in the organization. Staffing – Need and importance, Manpower planning, Recruitment, Selection, Placement and Orientation, Training and Development – Performance appraisal – Meaning, Concept, Methods. Direction – Concept, Principles, Requirements of effective direction, Giving orders, Techniques of direction. Leadership – Concept, Characteristics, Functions, Approaches to leadership, Leadership styles. Organizational Communication – Concept, Process, Types, Net Works, Barriers to Communication. Managing work motivation

– Concept, Motivation and Performance, Approaches to motivation. Supervision – Meaning, Responsibilities, Qualities and functions of supervision, Essentials of effective supervision. Managerial Control – Nature, Process, Types, Techniques of Control, Budgeting, Observation, PERT and CPM, MIS.

Practical

Field visit to Successful enterprises-Study of Characteristics of Successful entrepreneurs Development of Project Proposal -Case Studies of Success / Failure enterprises-Exercise on Market Survey-Field visit to Financial institutions-Simulated exercise to understand management process-Field visit to extension organizations to understand the functions of management - Group exercise on development of short term and long term plan-Simulated exercise on techniques of decision making-Designing organizational structure -Group activity on leadership development skills.

Suggested Readings

Gupta CB. 2001. *Management Theory and Practice.* Sultan Chand & Sons.

Indu Grover. 2008. *Handbook on Empowerment and Entrepreneurship.* Agrotech Public Academy.

Khanka SS. 1999. *Entrepreneurial Development.* S. Chand & Co.

Singh D. 1995. *Effective Managerial Leadership.* Deep & Deep Publ.

Tripathi PC & Reddy PN. 1991. *Principles of Management.* Tata McGraw Hill.

Vasanta Desai. 1997. *Small Scale Industries and Entrepreneurship.* Himalaya Publ. House.

EXT 507 HUMAN RESOURCE DEVELOPMENT (HRD) 2+1

Objective

To orient the students about key concepts, importance, scope & conceptual frame work, growth & development of Human Resource Development, Subsystems of Human Resource Development for extension organizationand process of HRD.

Theory

UNIT I

Human Resource Development – Definition, Meaning, Importance, Scope and Need for HRD; Conceptual frame work, inter disciplinary approach, function systems and case studies in HRD; HRD Interventions – Different Experiences; Selection, Development & Growth-Selection, Recruitment, Induction Staff Training and Development, Career planning; Social and Organizational Culture: Indian environment perspective on cultural process and social structure, society in transition; Organizational and Managerial values and ethics, organizational commitment ; Motivation productivity - job description – analysis and evaluation; Performance Appraisal.

UNIT II

Human Resource management: Collective bargaining, Negotiation skills; Human Resource Accounting (HRA): What is HRA? Why HRA? Information Management for HRA and Measurement in HRA; Intra personal processes: Collective behaviour, learning, and perception ; Stress and coping mechanisms; Inter-Personal Process, Helping Process –

communication and Feedback and interpersonal styles; Group & Inter group process: group information and group processes; Organizational communication, Team building Process and functioning, Conflict management, Collaboration and Competition; HRD & Supervisors: Task Analysis; Capacity Building – Counseling and Mentoring; Role of a Professional Manager: Task of Professional Manager – Responsibility of Professional Manager; Managerial skills and Soft Stills required for Extension workers; Decision Making: Decision Making models, Management by Objectives; Behavioural Dynamics :Leadership styles – Group dynamics.

UNIT III

Training – Meaning, determining training need and development strategies – Training types, models, methods and evaluation; Facilities for training – Trainers training – techniques for trainees participation; Research studies in training extension personnel; Main issues in HRD: HRD culture and climate – organizing for HRD – emerging trends and Prospective.

Practical

Visit to different training organizations to review on going activities & facilities; Analysis of Training methods followed by training institutions for farmers and extension workers Studies on evaluation of training programmes; Study of HRD in organization in terms of performance, organizational development, employees welfare and improving quality of work life and Human resource information, Presentation of reports.

Suggested Readings

Agochiya D. 2002. *Every Trainer's Handbook*. Sage Publ.

David Gross. 1997. *Human Resource Management - The Basics*. TR Publ.

Davis Keth & Newston W John 1989. Human Behaviour at Work. 8th Ed. McGraw-Hill.

Hersey Paul & Balanchard H Kenneth. 1992. *Management of* Organizational *Behaviour Utilizing Human Resource*. 5th Ed. Prentice-Hall of India.

Koontz Harold & Weihhrich Heinz 1990. *Essentials of Management*. 5th Ed. McGraw-Hill.

Lynton RP & Pareek U. 1993. *Training for Development*. DB.

Taraporewale Sons & Co.

Punna Rao P & Sudarshan Reddy M. 2001. *Human Resource Development Mechanisms for Extension Organization*. Kalyani Publ.

Rao TV. 2003. *Readings in Human Resource Development*. Oxford Publ. Co.

Silberman Mel. 1995. *Active Training*. Press Johnston Publ. Co., New Delhi.

Singh RP. 2000. *Management of Training Programmes*. Anmol Publ.

Subba Rao P. 2005. *Management & Organizational Behaviour*. Himalaya Publ. House.

Sundaram RM, Gupta V, George SS. 2006. *Case Studies in Human Resource Management*. ICFAI, Hyderabad.

Tripati & Reddy. 2004. *Principles of Management*. Tata McGraw-Hill.

Wayne MR & Robert MN. 2005. *Human Resource Management*.

International Ed. Pearson Prentice Hall.

EXT 508 VISUAL COMMUNICATION 2+1

Objective

This course is intended to give a clear perspective about the importance of visuals and graphics in communication. The course starts with the delineating about the characteristics of visuals and graphics followed by its main functions, theories of visual perception and its classification and selection. Further, the course deals with the designing the message, graphic formats and devices and presentation of data. It makes the students to understand, prepare and present the scientific data effectively by using low cost visuals. The course also exposes the students to various Digitized video material in multimedia and also enable to design visuals for print, TV and know-how about scanning of visuals.

Theory

UNIT I

Role of visuals & graphics in Communication. Characteristics of visuals & graphics. Functions of visuals and graphics. Theories of visual perception. Classification and selection of visuals. Concepts of multimedia in communication Basics of computers in relation to visuals, Modes of presentation of visuals in computers

UNIT II

Designing message for visuals, Graphic formats and devices. Presentation of Scientific data. Principles and procuction of low cost visuals.

UNIT III

Photographs- reprographic visuals. PC based visuals. Degitized video material in multimedia production. Designing visuals for print and TV and video.

UNIT IV

Pre-testing and evaluation of visuals. Scanning of visuals.

Practical

Preparation of low cost projected and Non-Projected visuals. Designing and layout of charts, posters, flash cards etc. Power point presentations. Generating computer aided presentation graphics. Scanning and evaluation of visuals.

Suggested Readings

Bhatia A. 2005. *Visual Communication.* Rajat Publications, New Delhi.

Edgar Dale 1970. *Audio Visual methods in Teaching.* Holt, Rinehart & Winston.

James WB, Richard BL, Fried F Harcleroad. 1952. *A.V. Instructional Material & Methods.* Mc.Graw Hill.

Reddy YN. 1998. *Audio Visual Aids in Teaching, Training and Extension.* Haritha Publ. House, Hyderabad.

EXT 509 PARTICIPATORY METHODS FOR TECHNOLOGY DEVELOPMENT AND TRANSFER 1+1

Objective

This course is intended to orient the students with the key concepts, principles process of different participatory approaches for technology development and transfer and also to expose the students with various participatory tools and techniques like space related, time related, relation oriented methods. Besides the students will be learning the preparation of action plans, participatory monitoring and evaluation.

Theory

UNIT I

Participatory extension – Importance, key features, principles and process of participatory approaches; Different participatory approaches (RRA, PRA, PLA, AEA, PALM, PAR, PAME, ESRE, FPR) and successful models.

UNIT II

Participatory tools and techniques. Space Related Methods : village map (social & resource), mobility services and opportunities map and transect; Time related methods : time line, trend analysis, seasonal diagram. Daily activity schedule, dream map; Relation oriented methods : cause and effect diagram (problem tree), impact – diagram, well being ranking method, Venn diagram, matrix ranking, livelihood analysis.

UNIT III

Preparation of action plans, concept and action plan preparation; Participatory technology development and dissemination; Participatory planning and management, phases and steps in planning and implementation aspects; Process monitoring, participatory evaluation.

Practical

Simulated exercises on space related methods, time related method and relation oriented methods; Documentation of PTD and dissemination; Preparation of action plan; Participatory monitoring and evaluation of developmental programmes.

Suggested Readings

Adhikary. 2006. *Participatory Planning and Project Management in Extension Science.* Agrotech Publ. Academy.

Mukharjee N. 2002. *Participatory Learning and Action.* Concept Publ. Co.

Singh BK. 2008. *PRA/PLA and Participatory Training.* Adhyayan Publ. & Distr.

Somesh Kumar. 2002. *Methods for Community Participation.* Vistaar Publ.

EXT 510 GENDER SENSITIZATION FOR DEVELOPMENT 1+1

Objective

In this course the students will learn about an overview of the concept of gender and gender balance on development and develop skills of identifying gender roles, rights, responsibilities and relationships on development. Besides the students will also learn the attitudinal change to internalize gender equity concerns as fundamental human rights and also enhance the capability for identifying and analyzing gender issues in agriculture and allied sectors.

Theory

UNIT I

Gender concepts, issues and challenges in development; Gender roles, gender balance, status, need and scope; Gender analysis tools and techniques.

UNIT II

National policy for empowerment of women since independence; Developmental programmes for women; Gender mainstreaming in agriculture and allied sectors –need and relevance; Gender budgeting – A tool for empowering women.

UNIT III

Women empowerment –Dimensions; Women empowerment through SHG approach; Women entrepreneurship and its role in economic development; Public Private Partnership for the economic empowerment of women; Building rural institution for women empowerment; Women human rights ; Action plans for gender mainstreaming.

Practical

Visits to rural institutions of women for studying in the rural institutions engaged in Women empowerment; Visits to entrepreneurial unit of women for studying the ways and means of establishing entrepreneurship units for Women and their development and also SWOT analysis of the Unit; Visit to Center for women development - NIRD to study the different activities related to projects and research on gender; Visit to gender cell, Office of the Commissioner and Director of Agriculture, Hyderabad, to study the mainstreaming of gender concerns and gender budget of the department.

Suggested Readings

Grover I & Grover D. 2002. *Empowerment of Women.* Agrotech Publ. Academy.

Porter F, Smyth I & Sweetman C.1999. *Gender Works: Oxfarm*

Experience in Policy and Practice. Oxfarm Publ.

Raj MK. 1998. *Gender Population and Development.* Oxford Univ. Press.

Sahoo RK & Tripathy SN. 2006. *SHG and Women Empowerment.* Anmol Publ.

Sinha K. 2000. *Empowerment of Women in South Asia.* Association of Management Development Institution in South Asia, Hyderabad.

Thakur Joshi S. 1999. *Women and Development.* Mittal Publ.

Vishwanathan M. 1994. *Women in Agriculture & RD.* Rupa Books.

EXT 511 PERSPECTIVES OF DISTANCE EDUCATION 1+1

Objective

The course is intended to orient the students with the concept of Distance Education, Characteristics of Distance Education, Evolution, Methods of Distance Education, Different Approaches in Planning Distance Education, Educational Technology in Distance Education, Management of Resources for distance education, Strategies for maximizing the reach and programme evaluation and quality assessment.

Theory

UNIT I

Distance Education – Introduction Meaning, Concept, Philosophy and its work ethics, characteristics of Distance Education – Evolution and Historical view of Distance Education – Theory Methodology, and Epistemology. Dimensions of Distance Education, Scope and difficulties. Open Education – Non-formal Education, Continuing Education, Education by correspondence.

UNIT II

Forms and systems of Distance and Open Education, Modes of Teaching and Learning in Distance Education, Methods of Distance Education, Significance of Distance Education in Teacher Education.

UNIT III

Planning Distance Education – A Systems Approach Student Learning – Course Planning, The target groups – Barriers to learning in Distance Education – Planning and Management of Networked Learning.

UNIT IV

Educational Technology in Distance Education Application of information and Educational Technologies in Distance Education, Development of Course and Course material, Management of resources, processes, Forms of Instructional material in Distance Education and Media Development and Production in Distance Education - Video Classroom Strategy in Distance Education – Strategies for maximizing the reach – services to students, programme Evaluation - performance indicators and Quality Assessment.

Practical

Visit to the University which is implementing the Distance Education Programmes. Detailed Study of their programme in relation to Educational Technology, Methodology, Curriculum Development, Evaluation and Assessment. Exercise on development of curriculum for Distance Education exclusively for farming community.

Suggested Readings

Holmberg B. 1995. *Theory and Practice of Distance Education.* Routiedge Publ..

Lakshmi Reddy MV. 2001. *Towards Better Practices in Distance Education.* Kanishka Publ.

More MG. 2003. *Hand Book of Distance Education.*Lawrence Erlbaum Associates Publ.

Panda.S. 2003. *Planning & Management in Distance Education.* Kogan Page Publ.

Pathak CK. 2003. *Distance Education: Prospects and Constraints.* Rajat Publ.

Sharma DC. 2005. *Management of Distance Education.* Anmol Publ.

Sharma M. 2006. *Distance Education: Concepts and Principles.* Kanishka Publ.

EXT 512 MARKET - LED EXTENSION MANAGEMENT 1+1

Objective

The student will learn the significance of post harvest management& value addition in present market environment and the challenges and future strategy for market led extension management. Also identifies the information sources and develop strategy for market intelligence and the marketing infrastructure, multilevel marketing and linkages for market led extension. In addition the students would be learning the public private partnerships for market led extension management, the features of contract farming, WTO its implications on agriculture and Understanding the role of IT for market intelligence.

Theory

UNIT I

Agricultural extension at cross roads; Changing scenario of agricultural extension at the national level; Market led extension – emerging perspectives; Market led extension – issues and challenges; Dimensions of market led extension.

UNIT II

Agricultural marketing an overview; Development of a marketing plan, pricing concepts and pricing strategy; Consumer behaviour; Marketing communication and promotional strategies; The marketing research process; Agricultural trade liberalization and its impact; International marketing opportunities; Implications of AOA, TRIPS and IPRs agreements on agriculture; Agreement on SPS and TBT - an over view; Commodity features marketing.

UNIT III

Public private linkages in market led extension; Role of SHG in market led extension; Contract farming – a viable approach to meet market challenges; IT enabled approaches for market led extension and communication; Weather service and crop modeling – An effective tool in market led extension.

Practical

Identification and analysis of different marketing sources for agricultural commodities. Development of strategy for an effective market intelligence system; Development of suitable marketing plan to suite rural situation; Visit to APEDA, Rythu Bazaars to study the processes and procedures related to market-led extension.

Suggested Readings

Kaleel FMH & Krisnamurthy J. 2007. *Market Led Extension Dimensions and Tools.* Agro Tech Publ. Academy.

Rajmanohar TP & Kumaravel KS. 2006. *Contract Farming in India.* ICFAI Univ. Press, Hyderabad.

Subbalakshmi V. 2005. *Globalization - Indian Experience.* ICFAI Univ. Press, Hyderabad.

Suresh K. 2005. *Rural Markets - Emerging Opportunities.* ICFAI Univ. Press, Hyderabad

EXT 601 ADVANCES IN AGRICULTURAL EXTENSION 2+1

Objective

By the End of the course student will be able to Critically analyze different Agricultural Extension approaches Understand Agricultural Knowledge Information System (AKISs) ITK Understand Advances in Extension - Cyber extension, ICT enabled extension services; Market Led Extension, Public Private Partnership, Mainstreaming gender in extension organizational Innovations. Visualize implications of WTO - AOA and develop extension strategies. Understand extension reforms and Farmer Field Schools Decentralized Decision Making, bottom up planning, ATMA, FSBE & CIGs etc., ATIC, IVLP & Kisan Call Centres

Theory

UNIT I

Approaches of Agricultural Extension: A critical analysis of different approaches of agricultural extension. Importance and relevance of indigenous knowledge system, identification and documentation of ITK, Integration of ITK system in research formulation, Concept of Agricultural Knowledge and Information System, Training of Stakeholders of AKIS.

UNIT II

Cyber Extension - Concept of cyber extension, national and international cases of extension projects using ICT and their impact of agricultural extension, alternative methods of financing agricultural extension - Scope, limitations and experience and cases. Research - Extension -Farmer - Market linkage: Importance, Scope, Implications etc., Market - Led Extension, Farmer - Led Extension, Concept of Farm Field School, Farm School, Public - Private Partnership: Meaning, Models, Identification of various areas for partnership. Stakeholder's analysis in Extension. Main streaming gender in Extension - Issues and Prospects.

UNIT III

Implications of WTO - AOA for extension services, re-orientation of extension services for agri-business and marketing activities, GOI-NGO collaboration to improve efficiency of extension.

UNIT IV

Extension and contemporary issues: Extension and issues related to rural poverty. Privatization of Extension. Intellectual Property Rights (IPRs). Extension Reforms in India - Decentralized decision making, Bottom up planning, Farming System and Situation based Extension Delivery System, Extension delivery through Commodity Interest Groups. Organization innovations in Extension - ATIC, IVLP, Kisan Call Centres.

Practical

Analysis of ITK systems, cases on integration of ITK and formal research system, Analysis of cases on cyber extension and privatization of extension. Analysis of ATMA and SREP. Practicing bottom up planning. Visit to Public-Private -Farmer partnership. Learnings from Food and Nutritional Security and bio-diversity Projects and Programmes.

Suggested Readings

Bagchi J. 2007. *Agriculture and WTO Opportunity for India.* Sanskruti. Chambers R, Pacy A & Thrupp LA. 1989. *Farmers First.* Intermediate Technology Publ.

Crouch BR & Chamala S. 1981. *Extension Education and Rural Development.* Macmillan.

John KC, Sharma DK, Rajan CS & Singh C. 1997. *Farmers Participation in Agricultural Research and Extension Systems.* MANAGE, Concept Publ. Co.

Khan PM. 2002. *Text Book of Extension Education.* Himanshu Publ.

Narasaiah ML. 2005. *Agricultural Development and World Trade Organization.* Discovery Publ.

Talwar S. 2007. *WTO Intellectual Property Rights.* Serials Publ.

Van den Ban BW & Hawkins BS. 1998. *Agricultural Extension.* S.K. Jain Publ.

Venkaiah S. 2001. *New Dimensions of Extension Education.* Anmol Publ.

EXT 602 ADVANCED DESIGNS AND TECHNIQUES IN SOCIAL SCIENCE RESEARCH 2+1

Objective

By the end of the course student will be able to • Develop & Standardize Attitude scale using different techniques of attitude scale construction. • Develop skills of using Projected & Semi Projected & Critical Incident techniques, Computer Package analysis and PRA Tools in Extension Research.

Theory

UNIT I

Scaling technique - meaning, types, principles, steps and quality, techniques of attitude scale construction - Paired comparison, Equal appearing intervals, Successive Intervals, Summated ratings, Scalogram analysis, Scale discrimination technique, Reliability and Validity of Scales. Sociometrics, content analysis, case studies, Q-sort techniques, Semantic different technique.

UNIT II

Projective and Semi projective techniques, Critical incident techniques, Computer packages for analysis - usage in Extension Research. Knowledge scale measurement. Participatory tools and techniques in behaviour Research - Data collection and Evaluation. Impact analysis, e-data collection and information analysis.

Practical

Practice in constructing a scale and use of scale in various situations. Reliability and validity of the scales developed, Application of Semi Projective and Projective techniques. Content analysis, case studies. Practicing participatory tools and techniques. Hands on experience on Computer Preparation and Data Collection instruments, review of previous studies.

Suggested Readings

Burns RB. 2000. *Introduction to Research Methods.* Sage Publ.

Chandrakandan K & Karthikeyan C. 2004. *Behavioral Research Methodology.* Classical Publ.

Daivadeenam P. 2002. *Research Methodology in Extension Education.* Agro-Tech Publ. Academy.

Kerlinger N Fred. 2002. *Foundations of Behavioural Research.* Surjeet Publ.

Kothari CR. 2000. *Research Methodology Methods & Techniques.* 2nd Ed. Wishwa Prakasham.

Ray GL & Mondal S. 1999. *Research Methods in Social Science and Extension Education.* Naya Prokash.

Roger L & Domino WSK. 1980. *Research Methods.* Prentice Hall.

Sadhu AM & Singh A. 2003 *Research Methodology in Social Science.* Himalaya Publ. House.

Sarantakos S. 1998. *Social Research.* 2nd Ed. Macmillan.

Sinha SC & Dhiman AK. 2002. *Research Methodology.* ESS Publ.

Verma RK & Verma G. 2002. *Research Methodology.* Commonwealth Publ.

Walizer MH & Panl L. 2002. *Research Methods & Analysis; Searching for Relationships.* Wiemil Harper & Row.

Wilkinson TS & Bhandarkar PL. 2002. *Methodology and Techniques of Social Research.* Himalaya Publ. House.

EXT 603 ADVANCES IN TRAINING TECHNOLOGY 2+1

Objective

By the end of the course student will be able to plan and design a training programme, Plan & Develop effective training sessions, Manage difficult situations while organizing training programmes, Use different advanced participatory training methods.

Theory

UNIT I

Paradigm shift in training - learning scenario, Training Approaches - Experiential learning - laboratory - organization development (system) approaches; Training Design, Designing an effective training programme, Harmonizing training needs, Course Objective, content and methods.

UNIT II

Designing an effective training session - the semantics involved, Designing experiential training sessions, simulation exercises, and openness in training transaction - managing dilemmas, ambivalence and conflicts and confusion (for both trainers and trainees).

UNIT III

Recent Training Techniques for understanding and facilitation team building, group dynamics, motivation and empowerment, laboratory methods: micro-lab process work, and sensitivity training, Psychological instruments as training tools: TAT, Inventories, Cases, etc.

UNIT IV

Participatory Training Techniques - Lecture, Brainstorming, Group discussion and Training Games. Role Play, Psycho-drama, Coaching, Counseling, etc., Trainer's roles and dilemmas, Factors Effecting Training Effectiveness and Training Evaluation.

Practical

Techniques of participatory training need assessment. Formulation of Course Objective, design of training programmes. Simulation exercises. Participatory training methods - Role Play & Brainstorming, Group discussion and Counseling and Conducting experiential learning sessions. Training evaluation - Techniques of Knowledge, Skill & Attitude evaluation. Visit to training institutions and study of training technologies followed.

Suggested Readings

Agochiya D. 2002. *Every Trainer's Handbook.* Sage Publ.

Alan B & Calardy 2004. *Five Case Studies in Management Training.* Jaico Publ.

Kumar A. 2000. *Management Training Process.* Anmol Publ.

Leslie Rae. 1998. *Techniques of Training.* Jaico Publ.

Lynton RP & Pareek U. 1999. *Training for Development.* 2nd Ed. Vistar Publ.

Reid MA. 1997. *Training Interventions, Managing Employee Development.* Jaico. Publ.

Samanta RK. 1993. *Training Methods for Management and Development.* M.D. Publ.

Sethy ED. 2003. *A Practical Hand Book on Training.* Anmol Publ.

EXT 604 **ORGANIZATIONAL DEVELOPMENT** **2+1**

Objective

By the end of the course student will be able to Understand & Study the Organization in terms of types, Characteristics, Needs, Motives, Organization behaviour, Organization Communication, Organization development and Individual behaviour in organization. To anlayse the factors

effecting organizational effectiveness and distinguish between functional and non functional organization.

Theory

UNIT I

Introduction to organizations: Concept and Characteristics of organizations, Organizational Behvaiour - Context and concept - levels of organizations - formal and informal organizations, Theories of organizations: Nature of organizational theory - classical theories - features of Bureaucracy - administrative theory and Scientific management - Neo-classical theories - the human relations movement - modern theory.

UNIT II

Systems approach to study organization needs and motives - Attitude, values and ethical behaviour - alienation and work - work motivation - communication and interpersonal behaviour - organization communication - leadership behaviour - decision making, problem solving techniques - organizational climate - change proneness and resistance to change, Organizational change, Organizational structure - Process in organizing - Dimension of Motivation Climate.

UNIT III

Departmentation - Span of Management - Delegation of authority - Centralization and decentralization - line and staff organization - functional organization - divisonalisation - Project organization - Matrix organization - free form organization - top management structure.

UNIT IV

Individual behaviour in organization. Fundamentals of Human relations and Organizational behaviour, Groups and teams - Organisational culture and performance. Dynamics of Organization behaviour - leadership conflict situations and inter group behavior- Organisational Development - Factors effecting organization effectiveness. Creativity, leadership, motivation and organization development.

Practical

Analysis of organization in terms of process - attitudes and values, motivation, leadership. Simulation exercises on problem-solving - Study of organizational climate in different organizations. Study of organizational structure of development departments, Study of departmentalization, span of control delegation of authority, decisions making patterns, Study of individual and group behaviour at work in an organization. Conflicts and their management in an organization. Comparative study of functional and non-functional organsiations and drawing factors for organizational effectiveness.

Suggested Readings

Ancona, Kochaw, Scully, Van Maanen, Westney 1999. *Organizational Behaviour and Processes.* South Western College Publ., New York.

Banerjee M. 1984. *Organizational Behaviour.* Allied Publ.

Deka GC. 1999. *Organizational Behaviour - A Conceptual Applicational Approach.* Kanishka Publ.

Dwivedi RS. 2006. *Human Relations and Organization Behaviour- A Global Perspective.* 5th Ed. Macmillan.

Kumar A. 2000. *Organizational Behaviour Theory and Practice*. Anmol Publ.

Luthans F. 1998. *Organizational Behavior*. Tata McGraw Hill.

Luthans F. 2001. *Organizational Behaviour*. McGraw Hill.

Newstrom JW & Davis K. 1997. *Human Behaviour at Work*. Tata McGraw Hill.

Robbins SP. 2007. *Organizational Behaviour*. Prentice Hall.

Shaun T & Jackson T. 2003. *The Essence of Organizational Behaviour*. Practice Hall of India.

Stephen RR. 1999. *Organizational Behaviour*. 5th Ed. Practice Hall of India.

EXT 605 ADVANCED INSTRUCTIONAL TECHNOLOGY 2+1

Objective

By the end of the course student will be able to Understand Agricultural Education Scenario in the country and Curriculum development process, Plan & Prepare and present course outline, Lesson Plan & Skill plan, Develop appropriate teaching & learning Styles, Use innovative instructional aids & methods.

Theory

UNIT I

Concepts in Instructional Technology, Scope of Instructional Technology. History of agricultural education in India. Guidelines for curriculum development in Agricultural Universities. Curriculum design development.

UNIT II

Course outline, Lesson plans for theory and practicals. Teaching and learning styles. Theories of learning. Cognitive levels. Instructional Course Objective. Motivation of students.

UNIT III

Instructional Methods. Experiential learning cycle. Innovative Instructional Aids. Computer Assisted Instruction. Programmed instruction technique. Team Teaching. E-Learning, Art of Effective Communication. Distance education. Student evaluation - Question Bank. Appraisal of Teacher Performance. Review of research in Instructional Technology.

Practical

Formulation of instructional Course Objective. Development and presentation of course outlines. Preparation & presentation of lesson plans for theory & practical with CAI design. Preparation of innovative low cost instructional aids. Development of model question bank. Preparation of schedule for teacher evaluation. Visit to Distance Education centre. Study of research reviews and Presentation of reports.

Suggested Readings

Agarwal JC. 2007. *Essentials of Educational Technology Innovations in Teaching – Learning*. 2nd Ed. Vikas Publ. House.

Agarwal R. 2000. *Educational Technology and Conceptual understanding*. Anmol Publ.

Dayal BK. 2005. *Educational Planning and Development*. Dominant Publ.

Grover I, Kaushik S, Yadav L & Varma SK. 2002. *Communication and Instructional Technology*. Agro Tech Publ. Academy.

Jacobsen D, Eggen P & Kauchak D. 1985. Methods for Teaching - A Skills Appraoch. 2nd Ed. Charles E. Merrill Publ.

Joyee B & Well M. 1980. *Models of Teaching.* 2nd Ed. Prentice Hall.
Khan PM. 2002. *Text Book of Extension Education.* Himanshu Publ.
Rush N. 1987. *Technology Based Learning - Selected Readings.* London Publ. Co., New York.
Tara Chand 1999. *Educational Technology.* Anmol Publ.

EXT 606 THEORY CONSTRUCTIONS IN SOCIAL SCIENCES 2+0

Objective

By the end of the course student will be able to develop skills of theory building and scientific application of theoretical concept in Social Sciences by applying appropriate statistical tests.

Theory

UNIT I

Importance of theory constructions in social science. Theory: Meaning, elements, Ideal Criteria, Functions, Types. Definitions: Meaning, types and Rules.Generalizations: Meaning, Classification. Relationship: Meaning Types.

UNIT II

Terminologies used in theory constructions: Axiom, Postulate, Proposition, Theorem, Fact, Concept, Construct, Probability and Measurement Basic Derived. Steps in theory building - Axiomatic Techniques, Historical approaches. Scientific application Theoretical concept in Social Sciences. Test of Theory: Applying appropriate statistical tests.

Suggested Readings

Blalock HM. *Theory Construction: Form verbal to Mathematical Formulations.* Prentice Hall.
Dubin R. *Theory Building.* The Free Press, New York.
Gibbs JP. *Sociological Theory Construction.* The Dryden Press, Illionis.
Hage J. *Techniques and Problems of Theory Constructions in Sociology.*
John Wiley & Sons
Stinchombe AL. *Construction of Sociological Theories.* Harcourt, Brace & World.
Wionton CA. *Theory and Measurement in Sociology.* John Wiley & Sons.

EXT 607 ADVANCED MANAGEMENT TECHNIQUES 2+1

Objective

By the end of the course student will be able to Develop understanding on concept of MIS, its scope in Agriculture Extension Organization. Understand, Develop and Evaluate the MBO System To cope up with stress, Resolve conflicts and develop effective inter personal communication skills using Transactional analysis. To plan & use, DSS, AI, ES, PERT, CPM

Theory

UNIT I

Management Information System (MIS): Basic concepts, types of information needed at various levels, design of MIS in an agricultural extension organization. Scope for computerization, system alternatives and Evaluation. Implementation, operation and maintenance of the system.

UNIT II

Management By Objectives (MBO): Elements of the MBO system. The Process of MBO. Making MBO effective. Evaluation of the MBO system - strengths and weaknesses. Transactional Analysis (TA): Ego states, transactions, inter relationships, strokes, stamps.

UNIT III

Managing Organizational Stress: Sources of stress in organization, effect of stress. Coping mechanisms and managing stress, Stress management, Team Building Process: Types of teams. Steps in teamwork, Facilitators and barriers to effective relationships, nature of prejudice, tips in reducing interpersonal conflicts, inter-group conflict, resolving techniques. Confect management, tips in reducing interpersonal conflicts.

UNIT IV

Decision Support Systems (DSSs): Basic information about Artificial Intelligence (AI) Expert System (ESs), their future applications in extension system. Forecasting techniques - time series analysis and Delphi, decision making and talent management PERT, CPM techniques and Time management.

Practical

Managements Information system, in research & development organizations. Study of Management By Objectives in an organization. Transactional Analysis, exercises on Team building process, coping skills with organizational stress, exercises on Decision Support Systems (DSSs). Practicals exercise on forecasting techniques, Visit to Management organizations.

Suggested Readings

Chaudhary AK. 1999. *Encyclopedia of Management Information System.* Vols. I, II. Anmol Publ.

Hari Gopal K. 1995. *Conflict Management - Managing Interpersonal Conflict.* Oxford & IBH.

James O'Brien 1999. *Management Information System.* Tata McGraw-Hill.

Koontz H & Welhrich H. 2004. *Essentials of Management.* 5th Ed. Tata. McGraw- Hill.

Lauden & Lauden 2003. *Management Information System.* Pearson Edu.

Maheswari BL. 1980. *Organizational Decision Styles & Orgul Effectiveness.* Vikas Publ.

McGrath SJEH. 2007. *Basic Management Skills for All.* 7th Ed. Prentice Hall of India.

West JD & Leevy FK. 1998. *A Management Guide to PERT / CPM with GERT / PDM / DCPM and Other Networks.* Prentice Hall of India.

EXT 608 MEDIA MANAGEMENT 2+1

Objective

To familiarize the students with the working of print, electronic, New Media & Traditional folk media. To develop working skills needed for Print, Radio and T.V. Journalism to reach farming community. To develop in students an understanding on Mass Communication Process and Media Management its impact on the society. To develop writing skills for different media.

Theory

UNIT I

Media Management – Introduction, Definition, Principles and Significance of Management. Media Ownership patterns in India – Proprietorship, Partnership, private Ltd, Public companies, Trusts, Co-operatives, Religious Institutions (Societies) & Franchisees (Chains). Marketing Function – Product, Price, and Placement & Promotions.

UNIT II

Mass Communication – Meaning, Concept, Definition and Theories of Mass Communication. The Mass Media – History, functions, uses and Theories of Media. Journalism – Meaning, definition, Scope, functions and different types of Journalism. Journalism as communication tool. Farm Journalism – meaning and Developments in Farm Journalism in India. Different problems with Farm Journalism. Print Media – History, the role of the press, news, Types of News, electronics of News and Sources of News, the making of newspaper & magazines, press codes and ethics, Media Laws. News story – Principles of writing, structure a news story,

procedure in writing the news story and the elements of style. Success stories & feature articles – writing for success & feature articles, Types of Feature articles. Information materials – Types of information materials and user. Techniques in book Publishing. Editing – Principles, Tools & Techniques and art of Proof Reading – Techniques, Measuring Readability of writing.

UNIT III

Electronic Media-Role and Importance of Radio -History, Radio Role in TOT, writing and presentation techniques, Different Programmes of Farm Broadcast, developing content for farm broadcast, Role of FM Radio in Agriculture, Ethics of Broad casting, Broadcasting Policy and code. Community Radio – Concept, meaning, role in TOT, Cases of Community radio. Television – History - Role in TOT , Fundamentals of Television Production, Techniques of Script writing for TV, Visual Thinking, language & Style, Farm Telecast programmes, cable and satellite TV and their impact, Ethics of Telecasting, policy and code. Video Production Technology – Potential and its utilization, Typology of farm Video production, Types of Video Production and equipment used in the production, Procedure or Technique of video production. Cassette Technology – Role in TOT, Techniques of production of cassettes for the farming community. Traditional Media – Role of Folk Media in TOT and integration with electronic media.

UNIT IV

Advances in communication Technology – Management of Agricultural Information System (MAIS). Use of computers in Agriculture – Application of IT in Agriculture. Use of Modern Communication Medium- Electronic Video, Teletext, tele conference, Computer assisted instruction, Video conferencing, - Features, Advantages, Limitations and risk factory involved in New Media. Designing and developing of communication and media strategy for developmental programmes. Online journalism scope & importance.

Practical

Exercise on Writing for Print Media – Writing News / Success Stories / Feature articles for different topics related to Agriculture & allied fields. Exercise on editing & proof reading the Farm News for News papers – different types of intro and leads. Exercise on Writing for Radio, TV, Preparation of story board for farm Video Production – Script writing for Radio and T.V. Visit to media management organizations for studying the principles, procedures and processes in managing the media. Participation and Interaction through video conference. Developing communication & Media Strategy for selected developmental programme / activity.

Suggested Readings

Bhaskaran C, Prakash R & Kishore Kumar N. 2008. *Farm Journalism in Media Management.* Agro-Tech Publ. Academy.

Chattergee PC. 1991. *Broadcasting in India.* Sage Publ.

Chiranjeev A. 1999. *Electronic Media Management.* Authors Press.

D'Souza YK.1998. *Principles and Ethics of Journalism and Mass Communication.* Commonwealth Publ.

Defleur ML & Dennis EE. 2001. *Understanding Mass Communications.* Goyalsaab Publ.

Jain SC. 2006. *International Marketing Management.* CBS Publ.

Keval J Kumar. 2004. *Mass Communication in India.* Jaico Publ.

Malhan PN. 2004. *Communication Media: Yesterday, Today and Tommorow.* Directorate of Publication Division, New Delhi.

Mehta DS. 1992. *Mass Communication and Journalism in India.* Allied Publ.

Panigrahy D. 1993. *Media Management in India.* P. K. Biswasroy (Ed.). Kanishka Publ.

Shrivastava KM. 1995. *News Writing for Radio and TV.* Sterling Publ.

Sinha KK. 2001. *Business Communications.* Galgotia Publ.

EXT 609 TRANSFER OF TECHNOLOGY IN AGRICULTURE 2+1

Objective

By the end of the Course student will be able to Develop thorough understanding on different systems of Technology Transfer Develop appropriate communication & Media Strategy suitable to the System of Technology Transfer Analyse the constraints in Systems of Technology Transfer Technology and Suggest suitable Strategies.

Theory

UNIT I

Technology - Meaning and Concepts - Appropriate technology, transfer of technology - meaning and concepts. Systems of transfer of technology - Knowledge Generating System (KGS) - Knowledge Disseminating System (KDS) - Knowledge Consuming System (KCS) - Input Supplying Agencies System (ISAS).

UNIT II

Appropriateness of communication media in the system of technology transfer. New communication strategy for transfer and adoption of Agricultural technology. Extension training in transfer of technology.

UNIT III

Analysis. Constraints in Transfer of Technology, agencies or departments involved in TOT. Extension professional in TOT. Attributes of Technology and its Relation in TOT process. TOT to resource poor farmers. Role of Key communicators or local leaders in TOT. Private and Public partnership in TOT.

Practical

Analysis of Transferred technology. Analysis of knowledge generation and consuming systems. Formulation of communication strategies, Study of attributes of selected fast spreading technologies and slow technologies, study of constraints in TOT, visit to TOT centres of ICAR and SAU, Identification of key communicators, Case studies of Public-Private Partnerships, Visits to the print and electronic media centres to study their role in TOT.

Suggested Readings

Chaturvedi TN. 1982. *Transfer of Technology among Developing Countries; Need for Strengthening Cooperation.* Gitanjali Publ. House.

Dunn DD. 1978. *Appropriate Technology With a Human Face.* Macmillan Press.

Kapoor SK, Roy PB & Roy AK. 1980. *Role of Information Centres in Technology Transfer.* IASLIC, Kolakata.

Lekhi RK. 1984. *Technological Revolution in Agriculture.* Classical Publ. Co.

Singh SN. 1991. *Transfer of Technology to Small Farmers; An Analysis of Constraints and Experience.* Concept Publ. Co.

Wallender HW. 1980. *Technology Transfer of Management in the Developing Countries.* Ballinger Publ. Co., Cambridge.

List of Journals

Agricultural Extension Review
European Journal of Agricultural Education and Extension
Indian Journal of Social Work
International Journal of Business and Globalization
International Journal of Sustainable Development
Journal of Extension
Journal of Asia Entrepreneurship and Sustainability
Journal of Environmental Extension
Journal of Extension Education
Journal of International Agriculture and Extension Education
Journal of Rural Development
British Journal of Educational Technology
Economic and Political Weekly
Indian Economic Panorama
Indian Journal of Adult Education
Indian Journal of Extension Education
Indian Journal of Human Development
Indian Journal of Open Learning
Indian Journal of Social Development
Indian Journal of Training and Development
Indian Social Science Review
Journal of Extension System
Journal of Development Studies
Journal of Educational Planning and Administration
Journal of Educational Psychology
Journal of Environmental Studies and Policy
Journal of Sustainable Agriculture
The Journal of Entrepreneurship

e- Resources

www.pearsoned.com (Pearson Education Publication)
www.mcgraw-hill.com (McGraw-Hill Publishing Company)
www.oup.com (Oxford University Press)
www.emeraldinsight.com (Emerald Group Publishing)
www.sagepub.com (Sage publications)
www.macmillanindia.com (Macmillan Publishing)
www.krishiworld.com (Agriculture Portal)
www.aiaee.org (The Association for International Agricultural and Extension Education)
www.geogate.org (Agriculture Portal)
www.icar.org.in (Indian Council of Agricultural Research)
www.manage.gov.in (National Institute of Agricultural Extension

Suggested Broad Topics for Master's and Doctoral Research

Agricultural communication
Agricultural Journalism
Agriculture Education
Agro Forestry Extension
Banking & Credit
Commercialization and Diversification in Agriculture
Vegetables
Horticulture
Agri. tourism
Floriculture
Mushroom cultivation
Bee Keeping
Organic Farming
Cropping System/Farming System
Diffusion and Adoption
Dry Farming Technology
Entrepreneurship Development
Extension Administration and Management
Extension Methods and techniques
Extension Trainings
Extension Management and Sustainable Agricultural Development
Indigenous Practices
Rural Organization and Institutions
Scientific Productivity and Human Resource Development
Youth/Women Development
Social Marketing

AGRICULTURAL WATER MANAGEMENT

Course Structure - at a glance

CODE	COURSE TITLE	CREDITS
AWM 501 *	WATER RESOURCES MANAGEMENT	2+1
AWM 502 *	SOIL-WATER-PLANT-ENVIRONMENT SYSTEMS	2+1
AWM 503 *	CROP WATER REQUIREMENTS AND IRRIGATION PLANNING	2+1
AWM 504 *	PRESSURIZED IRRIGATION SYSTEM AND DESIGN	2+1
AWM 505 *	DROUGHT CLIMATOLOGY	2+0
AWM 506 *	SOIL, WATER QUALITY AND POLLUTION	2+1
AWM 507	REMOTE SENSING AND GIS IN WATER MANAGEMENT	2+1
AWM 508	ECONOMICS OF WATER USE	2+0
AWM 509	WATERSHED MANAGEMENT	2+1
AWM 510	ENVIRONMENTAL IMPACT	2+1
AWM 511	ECONOMICAL, SOCIAL AND INSTITUTIONAL PROSPECTS AND ISSUES OF WATER RESOURCES MANAGEMENT	2+0
AWM 591	MASTER'S SEMINAR	1+0
AWM 599	MASTER'S RESEARCH	20

*** Compulsory for Master's programme**

Minor Departments **9**

Agronomy

Soil & Water Engineering

Soil Science

Supporting Departments **5**

Statistics and Mathematics

Agricultural Economics

Plant Physiology

Non credit compulsory courses

CODE	COURSE TITLE	CREDITS
PGS 501	LIBRARY AND INFORMATION SERVICES	0+1
PGS 502	TECHNICAL WRITING AND COMMUNICATION SKILLS	0+1
PGS 503 (e-course)	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1+0
PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1
PGS 505 (e-course)	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1+0
PGS 506 (e-course)	DISASTER MANAGEMENT	1+0

AWM 501 **WATER RESOURCES MANAGEMENT** **2+1**

Objective

To impart knowledge on water status, resources, runoff, ground water assessment for managing the water sources with simulation modeling, optimal allocation and conjunctive use.

Theory

UNIT I

Hydrologic cycle and Hydrologic Processes.

UNIT II

India's water resources and their development.

UNIT III

Water needs for future in different sectors. Water resources data.

UNIT IV

Analysis of rainfall data, soil water balance, runoff estimation.

UNIT V

Ground water concept, porosity, permeability and transmissivity. Basic equations of ground water flow. Identification of recharge zones and boundaries. Assessment of recharge and aquifer system.

UNIT VI

Irrigation water distribution practices in India

UNIT VII

Principles of decision making in water resources, planning and management –systems analysis, identification of objectives, benefits, costs, decision variables, constraints and production functions, use of simulation optimization models and forecasting models.

UNIT VIII

Expert systems, decision support systems for planning and operation, water management projects. Conjuctive use of canal and ground water in irrigation projects. Water quality management models, case studies.

Practical

Analysis of rainfall data, Application of soil water balance by estimating all components of water balance, Estimation of runoff, Estimation of infiltration, Estimation of permeability, Formulation and application of Ground water flow model, Assessment of ground water potential, Use of simulation model for water resources planning, Use of optimization model for optimal water allocation, Use of DSS for water resources management, Use of water quality model, Use of DSS for water resources management and water quality

Suggested Readings

Arora, K.R.1996. *Irrigation, Water power and water resources Engineering.* Standard Publishers distributors, 1705-B, Nai Sarak, Post Box No. 1066, New Delhi-6

Ritzema, H.P. (Editor-in-chief).1994. *Drainage Principles and Applications* –ILRI Publications-16, International Institute for Land Reclamation and Improvement. P.O.Box 45, 670U AA Wageningen, The Netherlands.

Todd D.K.John . 1959. *Ground Water hydrology*. Wiley and sons, New York.

De Vries J.J and Hromadka. T.V. 1992. *Computer models for surface water* – MC Grow Hill, New York

Maidment D.R. (Ed)1992. *Hand book of Hydrology*. MC Grow Hill New York

Andrew Albert Dzurik Rowman and Littlefield .1992. *Water Resources Planning*. MC Grow Hill New York

AWM 502 SOIL WATER PLANT ENVIRONMENT SYSTEMS 2+1

Objective

To have comprehensive understanding of soil-plant-water regimes in relation to climate for planning an efficient irrigation system.

Unit- I: Soil Water Relations

Soil profile and horizon description. Soil physical properties-Texture, structure, bulk density, particle density, pore space, soil depth, soil /plough pan, Adhesion ,Cohesion, capillarity etc,. Water structure, physical properties of water. Energy concept of soil water-redox potential, solute content and its movement in soil. Soil moisture constants. Theories of water availability. Soil hydraulic properties. Soil moisture measurement.

Unit –II: Plant Water relations

Role of water in plant,. Water relationship of cell and whole plant-water and ion uptake and movement mechanism in plant systems. Concept of plat water potential and their measurement. Factors affecting plant water absorption. Plant structure and root development-effective root zone depth-moisture sensitive stages. Water stress and plant growth.

Unit – III: Evapotranspiration

Evapotranspiration (ET)-evaporation, transpiration, factors influencing ET. Measurement of actual ET. Measurement of PET-empirical methods. Weather parameters-solar radiation, air temp., air humidity, wind speed and their measurement. Soil-Water –Plant-Atmosphere Continum (SPAC).Energy balance at crop surface. Control of ET losses. Aridity indices. Crop Co-efficient (Kc). Yield response factor(Ky).

Practical

Study of soil profile and description of soil profile horizons, Estimation of bulky density, Estimation of particle density, Determination of Field capacity by field method, Determination of permanent wilting point by field method, Determination of infiltration rate, Determination of hydraulic conductivity under saturated conditions, Determination of moisture retention characteristics of soil in laboratory by pressure plate apparatus, Determination of soil moisture content by Tensiometer, Measurement of soil moisture content by TDR/Profile probe, Measurement of plant water potential, Working of crop ET problems, Measurement of weather parameters, Study of aridity indices- case studies, Study of influence of water stress on crop yield

Suggested Readings

Panda, S.C. 1996. *Agronomy*. Agro-Bios(India), Jodhpur

Reddy, S.R. 2007. *Irrigation Agronomy.* Kalyani publishers, New Delhi

Michael, A.M. 1992. *Irrigation-Theory and Practice.* Vikas publishers, New Delhi

Misra, R.D. and M.Ahmed. *Manual on Irrigation Agronomy.* Oxford and IBH publishers FAO. *Irrigation and drainage paper* No. 56

Shankara Reddi, G.H.and T.Yellamanda Reddy 2002 *Efficient use of irrigation water.* Kalyani publishers, New Delhi

Mukund Joshi and T.K.Prabhakar Setty. 2006. *Irrigation and water management* Kalyani publishers, New Delhi.

Majumdar, D.K. 2002. *Irrigation Water management-Principles and practice.* PHI Pvt.Ltd, New Delhi.

AWM 503 CROP WATER REQUIREMENTS AND IRRIGATION PLANNING 2+I

Objective

To impart knowledge to students on hydraulics, design of channels, crop water requirement and irrigation planning

Unit I

Properties of fluids, fundamentals of fluid flow, steady flow, uniform flow, equation of continuity, energy equation and momentum equation. Open channel flow, Manning's equation, Chezy's equation, hydraulic jump, normal depth, laminar flow, Reynold's number, turbulent flow, Darcy's Weisbach equation, friction factor.

Unit II

Design of channels, flow in closed conduits, Measurement of irrigation water and empirical equations for water flow, weirs, notches, orifices and empirical equations.

Unit III

Land use capability and soil and land irritability assessment. Factors affecting irrigation water requirement, estimation of seasonal and annual water, land irrigation requirement of crop (s). Estimation of progressive, seasonal and peak consumptive water use and its significance in operation of an irrigation project.

Unit IV

Irrigation scheduling to crops, and different irrigation methods. Crop response functions to irrigation. Matching of net irrigation demand to water supply characteristics through modification of irrigation technology. Cropping pattern and cropping intensity, crop planning in relation to changing scenario of water availability.

Practical

Assessment of types of flow, Design of open channels, Field visit to canal command area, Design of channels based on command area and cropping pattern, Measurement of irrigation water using weirs, Measurement of irrigation water using flumes and current meter, Design of surface irrigation methods, Design of surface irrigation methods – Surdev model, Design of surface irrigation methods - exercises, Calculation of crop water requirement – Kc curve and reference crop ET, Calculation of crop water requirement – Average, peak and seasonal water use, Calculation of Irrigation requirement of important crops and water use efficiency, Estimation of irrigation efficiencies, Study of crop response functions to irrigation, Irrigation scheduling to important crops, Irrigation scheduling to important crops

Suggested Readings

Murthy, V.V.N. 1985. *Land and water management engineering. Kalyani Publications*, New Delhi.

Ven T Chow. 1976. *Open channel hydraulics.* New York, McGrow-Hill

Dilip Kumar Majumdar, 2002. *Irrigation and water management Principles and Practices.* Prentice – Hall of India Private Limited, New Delhi.

Lenka, 2005. *Irrigation and Drainage. Kalyani Publishers*, Hyderabad.

Sankara Reddi, G.H. and Yellamanda Reddy, T. 2002. *Efficient use of irrigation water.* Kalyani Publishers, New Delhi.

Michael. A.M. 1992. *Irrigation Theory and practice.* Vikas Publishing house Private Limited, New Delhi.

Sehgal, J. 1996. Pedology – *concepts and applications.* Kalyani Publications, New Delhi.

AWM 504 PRESSURIZED IRRIGATION SYSTEM AND DESIGN 2+1

Objective

To impart knowledge on importance of Sprinkler and Drip irrigation systems, design consideration of system components for efficient and economical adoption of the system.

Theory

UNIT I

An overview of Sprinkler irrigation, types of systems, components of system, design objectives, uniformity, adequacy and efficiency of application.

UNIT II

Design of different types of sprinklers, Design of pipe lines, laterals manifold, submain and mains, Design of traveler sprinkler system, layout, nose selection, gun sprinklers.

UNIT III

Trickle irrigation overview, types of system, and components of the system.

UNIT IV

Design objectives of Trickle irrigation system, uniformity, adeqnacy and efficiency of application.

UNIT V

Design of Trickle system, layout, emitter selection, lateral design, control head components, filtration and fertigation.

Practical

Study of components of sprinkler irrigation system, Designing of Sprinkler irrigation system for groundnut, Irrigation scheduling procedure for sprinkler irrigation of field crops, Calculating Christiansen's coefficient of uniformity with experimental data, Visit to Sprinkler irrigated cropped field, Study of components of drip irrigation system, Irrigation scheduling procedure for drip irrigation of fruit trees, Irrigation scheduling procedure for drip irrigation of row crops, Designing of drip irrigation system for sugarcane, Designing of drip irrigation system for vegetables, Designing of drip irrigation system for mango, Demonstration of fertigation practice, Evaluation of design emission uniformity, Acid treatment for drip irrigation system, Chlorination of drip irrigation system, Visit to drip irrigated mango & grape orchard

Suggested Readings

1. James, L.G. 1988. *Principles of Farm Irrigation System Design.* John Wiley & Sons Inc., New York 10158
2. Burt, C.M. and Styles, S.W. 1999. *Drip & Microirrigation for Trees, Vines and Row crops.* ITRC, California Polytechnic State University, San Luis Obispo, California
3. Burt, C.M., O'Connor, K. and Ruehr, T. 1998. *Fertigation.* ITRC, California Polytechnic State University, San Luis Obispo, California 93407
4. Benami, A. and Ofen, A. 1993. *Irrigation Engineering – Sprinkler, Trickle, Surface irrigation principles, Designs and Agricultural Practices.* Michlol, Ltd., Haifa, Israel 32000
5. Bucks, D.A., Nakayama, F.S. and Warrick, A.W. 1983. *Trickle irrigation for crop production.* Elsevier Publications, Amsterdam, Netherlands

AWM 505 **DROUGHT CLIMATOLOGY** **2+0**

Objective

To impart the knowledge to the students on climatology of drought, impact and assessment of drought, monitoring and combating of drought

Unit I

Definitions; Causes, climatology of drought, EL Nino and La Nina, Synoptic weather systems during drought, drought indices and characteristics.

Unit II

Significant droughts in India. Impact of climate change on water resources. Agronomic practices during drought. Forest fire and drought, drought impact and assessment,

Unit III

Crop weather forecasting –modification of microclimate through heat evasion and trapping-modification of weather through solar radiation management. Case studies of successful micrometeorological applications.

Unit IV

Drought monitoring, Drought mitigation and advisory services, Drought prediction, appraisal and drought policy. Drought proofing and management .

Unit V

Modern tools including remote sensing and GIS in monitoring and combating droughts.

Suggested Readings

Ramakrishna,Y.S., Rao, G.G.S.N., Sastry, P.S.N. and Rao, V.U.M.(Editors). 2006. *Agricultural drought: Aspects of Micro meteorology 4th SERC School* – DST Sponsored Programme (25th Sep to 15th Oct, 2006). CRIDA, Hyderabad

Ghadekar, S. R. *Meteorology*

Prasada Rao, G.S.L.H.V. *Agricultural Meteorology.*

Anji Reddy, M, 2006. *Text book of Remote sensing and geographical information system.* B.S. Publications.

Chakraborty Sahoo, R.N. 2004. *Fundamentals of Geographic information system.* Viva books

Chang, J.M. 1968. *Climate and Agriculture.* Aldine publications

Lal, D.S.1998. *Climatology.* Sharda pustak bhawan

Thompson, R.1997. *Applied climatology. Principles and practice.* Rout ledge

Ramsastry, A.A. 1984. *Weather and weather forecasting.* Publication division, GOI, New Delhi.

Singh, S.V., Rathore, L.S and Trivedi, M.K.N. 1999. *A guide for Agrometeorological Advisory services. Department of science & Technology*, NCMRWF, New Delhi

AWM 506 SOIL, WATER QUALITY AND POLLUTION 2+1

Objective

To impart knowledge about different indicators of soil and water quality, their impact on soil productivity and their assessment and management. The course also provides insight in to the causes, effects and control of soil and water pollution.

Theory

UNIT I

Soil Quality- Quantitative indicators of soil quality (physical, chemical and microbiological)- minimum data set – Physical: texture, soil depth, infiltration, bulk density, water holding capacity, aggregate stability- Chemical: organic carbon, pH, EC, extractable NPK, Sodium Absorption Ratio - Microbiological: microbial biomass C and N, soil respiration, potentially mineralizable N (anaerobic incubation)- integration of indicators into soil quality index using Soil Management Assessment Framework (SMAF), a tool for quantitative soil quality evaluation method developed by USDA.

UNIT II

Water quality- guidelines and criteria for soil quality evaluation – water quality related problems in irrigated agriculture (salinity, low infiltration, specific ion toxicity and miscellaneous problems) – Salinity: build up of salinity, effect on crops, management, drainage and control by leaching, crop tolerance and cultural methods. Infiltration problems: evaluation, management, soil, water amendments, deep tillage, organic residues, irrigation management – Specific ion toxicity: Effect of Cl, Na, B, management-leaching, crop selection, cultural practices, toxicity effects due to sprinkler irrigation – Miscellaneous problems: excess nitrogen, abnormal pH, scale deposits, clogging in drip irrigation system, metal corrosion. Water quality for live stock -Waste water reuse – case studies.

UNIT III

Soil Pollution – Land application of wastes: bio-solid wastes, industrial effluents, distillery and paper mill effluents, Tannery and textile industrial effluents – Mechanism of interaction of wastes with soil – effect of sewage waste application on soil characteristics and crop responses, excessive use of fertilizers – excessive nitrates – heavy metals contaminants in fertilizers as soil pollutants, pesticides, insecticides, fungicides, herbicides – reducing pesticide levels in soils – potentially toxic elements: Cd, Pb, Hg, Ni, Cr, Se, As – reducing heavy metal pollution in soil – radio nuclides – case studies.

UNIT IV

Water pollution: Indicators of water pollution - Categories of water pollutants: organic matter, pathogens, plant nutrients, sediments, petroleum oil, radioactive materials, heat – Sources

of water pollutants: domestic waste water, infectious agents, plant nutrients, industrial water pollution, Agricultural water pollution, solid waste pollution, thermal and radioactive pollution – Effect of water pollutants on aquatic biota – state of ground water pollution in Indian cities –case studies - purification of water: drinking and sewer water – Legislation – Environment Protection Act and Water (prevention and control of pollution) Act.

UNIT IV

Management and improvement of soil and water quality - improving the crop productivity.

Practical

Collection of soil samples from different ecosystems (Forestry, Agro Forestry, Cultivated fields, Grass lands etc). Entry operations and sample preparation, Visit to pollution affected areas in the city and collection of soil and water samples. Entry operations and sample preparation, Introduction to Soil Management Assessment Framework (SMAF) – a tool for evaluation of soil quality – minimum data set for quantification of soil quality indicators, Estimation of physical soil quality indicators: bulk density, texture, Estimation of Aggregate stability, Soil moisture retention at field capacity and wilting point using pressure membrane apparatus, Infiltration studies in soils under different ecosystems, Microbial biomass carbon and nitrogen estimation, Respiration studies in soils under different ecosystems, Estimation of chemical soil and water quality indicators: Estimation of pH, EC in soil and water samples and organic carbon in soil samples, Estimation of Na, Ca and Mg of soil and water samples and computation of SAR, Estimation of extractable N of soils, Estimation of extractable P and K of soils, Estimation of carbonates, bicarbonates, chlorides (Residual Sodium Carbonate), nitrates and boron in water

Suggested Readings

Ayers, R.S. and Westcot, D.W. 1994. *Water quality for Agriculture*, FAO Irrigation and Drainage Paper 29. Rev. 1.

Chandra Sekhar, M. and Sankara Rao, M. 2004. *Environmental Science.* 5th Edn. The HiTech Publishers, Hyderabad.

ISSS. 2002. *Fundamentals of Soil Science.* Indian Society of Soil Science. IARI. New Delhi.

John W Doran and Alice J Jones. 1996. *Methods of Assessing Soil Quality.* Soil Science Society of America Special Publication No. 49, Inc. Madison, Wisconsin, USA.

Ramesh Chandra and Satish Kumar Singh. 2009. *Fundamental and Management of Soil Quality.* Westville Publishing House, New Delhi.

Susan S Andrew, Douglas L. Karlen and Cynthia A. Cambardella. 2004. *The Soil Management Assessment Frame work. A Quantitative Soil Quality Evaluation method.* Soil Science Society of America Jouranl. Vol. 68, Nov-Dec. pp 1945-1762.

Srivastava, K.P. 2001. *An introduction to environmental study.* Kalyani Publishers, Hyderabad.

Tandon, H.L.S. 1993. *Methods of analysis of soils, plants, waters and fertilizers.* Fertilizer Development and Consultation Organisation. New Delhi.

U.G.C. 2005. *Text Book of Environmental studies for undergraduate courses.* University Grants Commssion. Universities Press (India) Private Ltd.

USDA. 1998. *Soil Quality Test Kit Guide.* United States Department of Agriculture, Agricultural Research Service, Natural Resources Conservation Service. Soil Quality Institute

AWM 507 REMOTE SENSING AND GIS IN WATER MANAGEMENT 2+1

Objective

The course provides an insight into the principles and basic concepts of Remote Sensing, Geographical Information System, techniques of satellite data processing and application of these modern tools for inventory, monitoring and management of different aspects of water management in Agriculture.

Theory

UNIT I

Elements involved in remote sensing, Electromagnetic spectrum, Remote Sensing terminology, Energy Sources, Energy interactions with earth surface features and atmosphere, spectral properties of vegetation, soil and water bodies. Resolution, Sensors and Satellites, Visual Interpretation techniques- Basic elements.

UNIT II

GIS definition and Terminology, GIS categories, Components of GIS, fundamental Operations of GIS, A theoretical Frameworks for GIS, GIS types of data representation, Raster and Vector Data Structures, Comparisons between data Structures.Map language – spatial elements, classification of maps, map scale, map projections. Map referencing system – national and international Satellite data.

UNIT III

Digital Image Processing techniques - Image rectification and registration-Image enhancement-Image classification-Accuracy assessment, Data merging and Data integration.

UNIT IV

Crop inventory – Acreage estimation, Production forecasting and Condition assessment. Land Use/Land cover analysis. Irrigated Land assessment and inventory – Assessment of Irrigation water requirements – Irrigation Scheduling – Assessment of surface water logging. evapotranspiration estimation, Remote sensing based approaches for soil moisture assessment.

UNIT V

Flood plain zoning, Drought assessment and monitoring, Hydrological characterization of watershed, Soil erosion modeling and erosion hazard assessment.

Practical

Acquaintance with instruments used in Remote Sensing, Introduction of RS and GIS software's –Topographic sheets-Map language-Reference system, Study of boarder information of satellite images - Using image processing software (Erda imagine) - Loading of Satellite data and Pre processing geo rectification and registration of toposheets and satellite image and mosaicing, Image enhancement techniques band rationing – image merging, Use of Spectro radiometer – Spectral reflectance of crops and soils, Calculation of spectral indices, Handling of Global position system, Unsupervised classification for land use land cover mapping, Supervised classification techniques, Map preparation – legend – graticules, index, Visit to NRSA, Infrared Thermometer and its use in scheduling irrigation – calculation of various thermal indices like CWRI (Crop Water Stress Index, Visit to AP State Remote Sensing Application Centre (APSRAC) and A P Forestry Academy, Hyderabad, Watershed characterization and runoff assessment using Arc GIS

Suggested Readings

Anji Reddy, M. 2001. *Remote Sensing and Geographical Information Systems.* Second Edition. Book Syndicate Publication, Hyderabad.

David L Verbyla. 1995. *Satellite Remote Sensing of Natural Resources.* Lewis Publishers, New York, Imprint of CRC Press, LLC, Florida, US.

John R Jensen, 1986. *Introductory Image Processing A remote sensing perspective* Second Edition. Printice Hall Series in Geographic Information Science, New Jersey.

Indian Institute of Remote Sensing (IIRS), Dehradun. Lecture notes of PG Diploma in Remote Sensing applications in agriculture

Thomas M Lilles and Ralph W Kiefer. 2001. *Remote Sensing and Image Interpretation.* Fourth Edition, John Wiley & Sons, Inc.New York. / Book Syndicate Publication, Hyderabad (Indian Edition)

Venkataratnam, L. Ravi Sankar, T. and Sudarshana, R. 2004. *Remote Sensing applications, Soils and Crops, status, issues and prospects.* National Remote Sensing Agency, Hyderabad.

AWM 508 **ECONOMICS OF WATER USE** **2+0**

Objective

To impart the knowledge on production functions, optimum allocation of water and economics of water.

Unit I

Crop response to irrigation water and application of production function for optimum utilization of irrigation water.

Unit II

Mathematical models of computer simulation/system analysis to water allocation and management problems.

Unit III

Linear programming, dynamic programming, multi-purpose and multi-objective water resources development, allocation and optimization of irrigation water for increasing returns.

Unit IV

Groundwater economics and conjunctive use plan of water resources.

Unit V

Water trade and water pricing.

Suggested Readings

Alpha C. Chiang. 1984. *Fundamental methods of mathematical economics.* Mc Graco- Hill book company, New Delhi.

Palanisami, K. Paramasicam, P. and Ranganathan, R. 2002. *Agricultural Production economics- Analytical methods and applications.* Associate publishing company, New Delhi.

Heady O Earl and Dillon L. John. 1988. *Agricultural Production Functions.* Kalyani Publishers, New Delhi.

Shenoy, G.1989. *Linear programming – Principles and applications.* Wiley Eastern publications.

Dorfman, R. 1996. *Linear programming and economic analysis.* Mc Graw Hill.

Lomba, N.P. 2006. *Linear programming.* Tata Mc Graw Hill.

Vasertein, 2006. *Introduction to linear programming.* Pearson Education publication

AWM 509 WATERSHED MANAGEMENT 2+1

Objective

To impart the knowledge to students on concepts of watershed and integrated watershed management with community participation

Unit I

Concepts of watershed components, delineation, problem identification, deterioration and priority concepts. Land and water degradation. Land capability and land suitability classification. Hydrological processes.

Unit II

Integrated watershed management, data base generation and management, impact evaluation and assessment. Watershed resources appraisal. Community participation, role of NGO's and political will & support. Watershed management programmes in the country-overview, sustainability aspects, economic evaluation and environmental assessment.

Unit III

Concepts of soil and water conservation, Soil and water conservation measures, Soil erosion. Effective life of dams and water retention structures. Mechanics of wind erosion; types of wind erosion and soil movement; wind erosion control measures.

Unit IV

Analysis of hydrologic data including rainfall, evapotransipration; watershed characteristics; overland flow. Methods of estimation of runoff; peak rate and time distribution of hydrograph; synthetic hydrograph; infiltration process; hydrologic evaluation of land treatment. Erosion control.

Unit V

The role of soil water conservation work, river valley projects; soil conservation department, CADA etc.

Practical

Field visit for studying different types of land uses and land capability units, Field visit for land suitability evaluation for agriculture, Delineation and characterization of different elements of watershed using. toposheet and field, Assessment of soil suitability for irrigation and crops, Visit to under developed and developed watersheds to study their features, Preparation of hydrologic data base for a watershed, Preparation of detailed work plans for watershed development, Contour surveying in a micro watershed using dumpy level, Preparation of countour map, Design of countour and graded bunds and locating the position of countour and graded bunds on the map, Fixing countour lines in the field using land level, Estimation of peak run off rate of a watershed, Exercises in design of water storage structures, Design of grassed waterways, Computation of irrigation needs of crops for life saving irrigation.

Suggested Readings

Khan, M.A. 2006. Watershed Management for Sustainable Agriculture Agrobios, Jodhpur

Oswal, M.C. 1999. Watershed Management (for dryland Agriculture, Associated Publishing Company, New Delhi.

Gunny Honore (Editor). 2002. Principles and practices of integrated watershed management in India. Indo-German Bilateral Project on watershed development, New Delhi.

Murthy, J.V.S. 1994. Watershed management in India, Wiley eastern limited, New Age international limited, Hyderabad

Druvanarayana, V.V., Sastry, G. and Patnaik, U.S. 1990. *Watershed management.* ICAR, New Delhi.

Tideman, E.M. 1996. *Watershed Management – Guidelines for Indian conditions.* Omega scientific Publishers New Delhi

AWM 510 **ENVIRONMENTAL IMPACT** **2+1**

Objective

To impart the knowledge to students on environmental impact of irrigation project and its assessment

Unit I

Nature of environmental impacts of water resources development, environmental impact statement for irrigation and drainage projects, protocols, procedures and regulations in India, use of Geographic Information Systems for assessment and prediction of impacts.

Unit II

Preparation of EIA reports on water resources projects, Social assessment, Risk and uncertainty and matrix methods in EIA. Agricultural non-point pollution sources. Modelling pollutant transport in runoff and sediment; modeling pollutant loadings to ground water. Case studies on EIA of irrigation and drainage projects.

Unit III

Definition, Objectives, activities and basic aspects of diagnostic analysis of irrigation projects. Study and measurement of performance parameters. Interaction of productivity and water use efficiency under different fertility levels. Efficient utilization of irrigation water. Operational management of irrigation and drainage net works. Participatory irrigation water management.

Unit IV

Fundamentals of conceptual framework for performance evaluation of irrigation projects. Evaluation of irrigation projects in relation to basic objectives. Equitable water distribution. Socioeconomic, political and organizational implications in the management of irrigation systems.

Unit V

Pricing of irrigation water. Case studies.

Practical

Preparation of EIA report on water resource projects, Estimation of soil loss and runoff in Agricultural fields, Quantification of pollutants in soil, Quantification of Agriculturally polluted water, Study of flora and fauna at non point source of pollution, Modelling of pollutant transport

in runoff, Calculation of water use efficiency under different soil fertility levels, Identification and quantification of organic chemicals in runoff water by using GC/HPLC, Case study on impact of letout water of Noor Mahabood kunta on surrounding Agricultural fields, Visit to sewage treatment plant/effluent treatment plant.

Suggested Readings

Joshi, L.K. and Rakesh Hooja (Editor). 2000. *Participatory Irrigation Management –Paradigm for the 21st Century.* Pawat Publications, New Delhi.

Bos, M.G., Burton, M.A. and Molden, D.J. 2005. *Irrigation and Drainage performance Assessment-Practical Guidelines.* CABI publishing, UK and USA.

Hosetti, B.B. 1998 *Environmental impact assessment and Management.* Daya Publishing house New Delhi.

Trivedy, R.K. 2004. *Hand book of Environment Laws, Acts, Guidelines, Compliances and standards.* B.S. Publications. Hyderabad

Shansi, U.M. 2000. *GIS applications for water, waste water and storm water systems*, Taylor & Grancis, Newyork

Purohit, S.S. and Agrawal K.A. 2004. *Environmental Pollution causes, effects and control.* Agrobios (India), Jodhpur

Richard Helmer and Ivanildo Hespanbol (Editor) 1997 *Water Pollution Control A guide to the use of water quality management principles.* E & FNSPON, An imprint of Thomas Professional New york, Madras

Kulkarni, V.S., Kaul, S.N. and Trivedy, R.K. 2002. *A Hand book of Environment Impact Assessment.* Scientific Publishers (India), Jodhpur

AWM 511 ECONOMICAL, SOCIAL AND INSTITUTIONAL PROSPECTS AND ISSUES OF WATER RESOURCES MANAGEMENT **2 + 0**

Objective

To impart the knowledge to students on economical, social and institutional issues of water resources management

Unit I

Principles of economics and their application in water resources management. Economic dimensions of irrigation systems appraisal – economic appraisal of irrigation programmes and water harvesting technologies, project feasibility criteria, assessment of costs and benefits and internal rate of return. Water resources pricing: theory and practice.

Unit II

Policy approaches for efficient on-farm water utilization – equity and efficiency in water distribution. Irrigation management alternatives and productivity impact.

Unit III

Institutional framework in canal command and watershed areas. Organizations, their roles and functions. Water users associations and participatory irrigation management; Case studies.

Unit IV

Elements of theory of sampling. Data generation and socio-economic methodological framework for irrigation water management studies.

Unit V.

Water laws, water rights and managing conflicts. Inter-state water disputes. Banking and financing mechanisms in water resources management.

Suggested Readings

Gittinger, J. P. 1982. *Economic analysis of Agricultural projects.* The Johns Hopkins Univ. Press.

Bansil, P.C. 2004. *Water Management in India.* Concept Publishing company, New Delhi

Little I.M.D. and Mirlees J.A. 1974. *Project Appraisal and planning for developing countries.* Oxford & IBH publications.

Kothari, C. R. 2004. *Research Methodolgy-Methods and Techniques.* Wishwa Prakashan, Chennai

Venkata Subramanian, V.1999. *Introduction to Research Methodology in Agricultural and Biological sciences.* SAGE publications

List of Journals

Journal of water management
Indian Journal of Agronomy
Indian Journal of Agricultural Sciences
Agricultural water management
Irrigation and drainage
Irrigation Science
Annals of Arid zone
Agronomy Journal
Field crops Research
Ground water
Hydrology Journal
Indian Journal of water Management
International Journal of water Resources development
Irrigation and Drainage systems
Journal of Agricultural Engineering
Journal of Agricultural water Management
Journal of agriculture and forest Meteorology
Journal of Agro meteorology
Journal of Hydrology
Journal of Indian Water Resources Society
Journal of Irrigation and Power
Journal of Irrigation and Drainage Engineering
Journal of Soil and Water Conservation
Water Research
Water International
Water Policy
Water Resources Management

Water Resources Journal
Water Resources Bulletin
Water Resources Research
Water Science and Technology
Water and Energy International
Water, Air and soil Pollution
Advances in Agronomy
Advances in water Resources
Soil science society of American Journal
Soil Science and plant nutrition
Environment pollution
Journal of Indian Society of Soil Science
Soil Science
Plant and soil
Indian society of Coastal Agricultural Research
Journal of Environment Biology
e-Resources
www.indianjournals.com
www.springerlink.com/journals
www.sciencedirect.com
www.scijournals.com
www.elsevier.com

Suggested Broad topics for Master's Research

Water Resources Assessment and use efficiency through remote sensing and GIS
Water management strategies inn different crops and cropping systems
Modeling soil water relationships
Validation of existing models for crop water requirement
Water quality and pollution remedial measures
Assessment and water management strategies for different irrigation projects
Studies on drought indices
Assessment of Ground Water use and management
Micro irrigation and fertigation
Rain water conservation and management
Approaches for estimation of evapotranspiration
Use of poor quality water for irrigation
Climate change and water management
Management strategies under deficit water situations
Studies on Water saving technologies

AGRONOMY

Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
AGRON 501*	MODERN CONCEPTS IN CROP PRODUCTION	3+0
AGRON 502*	SOIL FERTILITY AND NUTRIENT MANAGEMENT	2+1
AGRON 503*	PRINCIPLES AND PRACTICES OF WEED MANAGEMENT	2+1
AGRON 504*	PRINCIPLES AND PRACTICES OF WATER MANAGEMENT	2+1
AGRON 505	AGROMETEOROLOGY AND CROP WEATHER FORECASTING	2+1
AGRON 506*	AGRONOMY OF MAJOR CEREALS AND PULSES	2+1
AGRON 507*	AGRONOMY OF OILSEED, FIBRE AND SUGAR CROPS	2+1
AGRON 508	AGRONOMY OF MEDICINAL, AROMATIC AND UNDER UTILIZED CROPS	2+1
AGRON 509	AGRONOMY OF FODDER AND FORAGE CROPS	2+1
AGRON 510	AGROSTOLOGY AND AGROFORESTRY	2+1
AGRON 511	CROPPING SYSTEMS AND SUSTAINABLE AGRICULTURE	2+0
AGRON 512*	DRYLAND FARMING AND WATERSHED MANAGEMENT	2+1
AGRON 513	PRINCIPLES AND PRACTICES OF ORGANIC FARMING	2+1
AGRON 591	MASTER'S SEMINAR	1+0
AGRON 599	MASTER'S RESEARCH	20
AGRON 601	CURRENT TRENDS IN AGRONOMY	3+0
AGRON 602	CROP ECOLOGY	2+0
AGRON 603	CROP PRODUCTION AND SYSTEM MODELING	2+1
AGRON 604	ADVANCES IN CROP GROWTH AND PRODUCTIVITY	2+1
AGRON 605	IRRIGATION MANAGEMENT	2+1
AGRON 606	ADVANCES IN WEED MANAGEMENT	2+0
AGRON 607	INTEGRATED FARMING SYSTEMS FOR SUSTAINABLE AGRICULTURE	2+0
AGRON 608	SOIL CONSERVATION AND WATERSHED MANAGEMENT	2+1
AGRON 609	STRESS CROP PRODUCTION	2+1
AGRON 691	DOCTORAL SEMINAR I	1+0
AGRON 692	DOCTORAL SEMINAR II	1+0
AGRON 699	DOCTORAL RESEARCH	45

*Compulsory for Master's programme

Minor Departments **9**

Soil Science

Plant Physiology

Supporting Departments **5**

Soil Science

Plant Physiology

Statistics and Mathematics

Non credit compulsory courses

CODE	COURSE TITLE	CREDITS
PGS 501	LIBRARY INFORMATION SERVICES	0+1
PGS 501	LIBRARY AND INFORMATION SERVICES	0+1
PGS 502	TECHNICAL WRITING AND COMMUNICATION SKILLS	0+1
PGS 503 (e-course)	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1+0
PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1
PGS 505 (e-course)	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1+0
PGS 506 (e-course)	DISASTER MANAGEMENT	1+0

AGRON 501 MODERN CONCEPTS IN CROP PRODUCTION 3+0

Objective

To teach the basic concepts of soil management and crop production.

Theory

UNIT I

Crop growth analysis in relation to environment; Agro-ecological zones of India.

UNIT II

Quantitative agro-biological principles and inverse yield nitrogen law; Mitscherlich yield equation, its interpretation and applicability; Baule unit.

UNIT III

Effect of lodging in cereals; physiology of grain yield in cereals; optimization of plant population and planting geometry in relation to different resources, concept of ideal plant type and crop modeling for desired crop yield.

UNIT IV

Scientific principles of crop production; crop response production functions; concept of soil plant relations; yield and environmental stress.

UNIT V

Integrated farming systems, organic farming, and resource conservation technology including modern concept of tillage; dry farming; determining the nutrient needs for yield potentiality of crop plants, concept of balance nutrition and integrated nutrient management; precision agriculture.

Suggested Readings

Balasubramaniyan, P. & Palaniappan, S.P. 2001. *Principles and Practices of Agronomy.* Agrobios (India), Jodhpur, India.

Fageria, N.K. 1992. *Maximizing Crop Yields.* Marcel Dekker Inc., New York.

Havlin, J.L., Beaton, J.D., Tisdale, S.L. & Nelson, W.L. 2006. Soil Fertility and Fertilizers. 7th Ed., Pearson/Prentice Hall, Upper Saddle River, New Jersey.

Paroda, R.S. 2003. Sustaining our Food Security, Konark Publishers Pvt. Ltd., A-149, Main Vikas Marg, New Delhi.

Reddy, S.R. 2000. Principles of Crop Production. Kalyani Publishers, New Delhi.

Sankaran, S. & Mudaliar, T.V.S. 1997. Principles of Agronomy. The Bangalore Printing & Publishers, Bangalore.

Singh, S.S. 2006. Principles and Practices of Agronomy. Kalyani Publishers, New Delhi.

Yellamanda Reddy, T. & Sankara Reddi, G.H. 2002. Principles of Agronomy, Kalyani Publishers, New Delhi.

AGRON 502 SOIL FERTILITY AND NUTRIENT MANAGEMENT 2+1

Objective

To impart knowledge of fertilizers and manures as sources of plant nutrients and apprise about the integrated approach of plant nutrition and sustainability of soil fertility.

Theory

UNIT I

Soil fertility and productivity - factors affecting; features of good soil management; problems of supply and availability of nutrients; relation between nutrient supply and crop growth; organic farming - basic concepts and definitions.

UNIT II

Criteria of essentiality of nutrients; Essential plant nutrients – their functions, nutrient deficiency symptoms; transformation and dynamics of major plant nutrients.

UNIT III

Preparation and use of farmyard manure, compost, green manures, vermicompost, biofertilizers and other organic concentrates their composition, availability and crop responses; recycling of organic wastes and residue management.

UNIT IV

Commercial fertilizers; composition, relative fertilizer value and cost; crop response to different nutrients, residual effects and fertilizer use efficiency, fertilizer mixtures and grades; agronomic, chemical and physiological methods of increasing fertilizer use efficiency; nutrient interactions.

UNIT V

Time and methods of manures and fertilizers application; foliar application and its concept; relative performance of organic and inorganic manures; economics of fertilizer use; integrated nutrient management; use of vermincompost and residue wastes in crops.

Practical

Determination of soil pH, Determination of EC, Determination of organic Carbon, Determination of total N and available N in soils, Determination of P in soils, Determination of K in soils, Determination of S in soils, Determination of total N in plants, Determination of total P in plants, Determination of total K in plants, Determination of total S in plants, Interpretation of interaction effects, Computation of economic and yield optima

Suggested Readingss

Brady, N.C. & Weil, R.R 2002. The Nature and Properties of Soils. 13th Ed, Prentice Hall, Upper Saddle River, New Jersey.

Havlin, J.L., Tisdale, S.L., Beaton, J.D., & Nelson, W.L. 2006. Soil Fertility and Fertilizers. 7th Ed., Pearson/Prentice Hall, Upper Saddle River, New Jersey..

Prasad, R. & Power J.F. 1997. Soil Fertility Management for Sustainable Agriculture. CRC Press-Lewis, Boca Raton, Florida.

Reddy S.R. 2006. Principles of Crop Production, Kalyani Publishers, New Delhi.

Reedy T.Y. and Reddi, G.H.S. 2002. Principles of Agronomy, Kalyani Publishers, New Delhi, India.

Tandon, H.L.S. 1992. Management of nutrient interactions in Agriculture. FDCO, New Delhi.

Tandon, H.L.S. 1994. Fertilizers, Organic manures, Recyclable wastes and Biofertilizers – Components of Integrated Plant Nutrition. FDCO, New Delhi.

Fageria, N.K., Baligar, V.C. & Jones, C.A. 1991. Growth and Mineral Nutrition of Field Crops. Marcel Dekker Inc., New York

Yawalkar, K.S., Agarwal, J.P. & Bokde, S. 2000. Manures and Fertilizers. Agri-Horti Publishers, Nagpur.

AGRON 503 PRINCIPLES AND PRACTICES OF WEED MANAGEMENT 2+1

Objective

To familiarize the students about the weeds, herbicides and methods of weed control.

Theory

UNIT I

Weed biology and ecology, crop-weed competition including allelopathy; principles and methods of weed control and classification; weed indices.

UNIT II

Herbicides introduction and history of their development; classification based on chemical, physiological application and selectivity; mode and mechanism of action of herbicides.

UNIT III

Herbicide structure - activity relationship; factors affecting the efficiency of herbicides; herbicide formulations, herbicide mixtures; herbicide resistance and management; weed control through bio-herbicides, myco-herbicides and allelochemicals; Degradation of herbicides in soil and plants; herbicide resistance in weeds and crops; herbicide rotation.

UNIT IV

Weed management in major crops and cropping systems; parasitic weeds; weed shifts in cropping systems; aquatic and perennial weed control.

UNIT V

Integrated weed management; cost : benefit analysis of weed management.

Practical

Identification of important weeds of different crops, Preparation of weed herbarium, Weed survey in crops and cropping systems, Study of crop weed competition in on-going research experiments, Preparation of spray solutions of herbicides for high and low volume sprayers , Use of various types of spray pumps and nozzles and calculation of swath width, Economic analysis of weed management practices in different crops and cropping systems, Calculation of herbicide dose requirement, Study of herbicide residue analysis in plants and soils , Bio-assay of herbicide residues

Suggested Readings

Aldrich RJ & Kramer RJ. 1997. *Principles in Weed Management.* Panima Publ.

Ashton FM & Crafts AS. 1981. *Mode of Action of Herbicides.* 2nd Ed. Wiley Inter-Science.

Gupta OP. 2007. *Weed Management – Principles and Practices.* Agrobios.

Mandal RC. 1990. *Weed, Weedicides and Weed Control - Principles and Practices.* Agro-Botanical Publ.

Rao VS. 2000. *Principles of Weed Science.* Oxford & IBH.

Subramanian S, Ali AM & Kumar RJ. 1997. *All About Weed Control.* Kalyani.

Zimdahl RL. 1999. *Fundamentals of Weed Science.* 2nd Ed. Academic Press.

AGRON 504 PRINCIPLES AND PRACTICES OF WATER MANAGEMENT 2+1

Objective

To teach the principles of water management and practices to enhance the water productivity.

Theory

UNIT I

Water and its role in plants; water resources of India, major irrigation projects, extent of area and crops irrigated in India and different states.

UNIT II

Soil water movement in soil and plants; transpiration; soil-water-plant relationships; water absorption by plants; plant response to water stress, crop plant adaptation to moisture stress condition.

UNIT III

Soil, plant and meteorological factors determining water needs of crops; scheduling, depth and methods of irrigation; microirrigation system; fertigation; management of water in controlled environments and polyhouses.

UNIT IV

Water management of the crops and cropping systems; quality of irrigation water and management of saline water for irrigation; water use efficiency.

UNIT V

Excess of soil water and plant growth; water management in problem soils; drainage requirement of crops and methods of field drainage, their layout and spacing.

Practical

Measurement of soil water potential by Tensiometer, Measurement of soil water potential by pressure plate & pressure membrane apparatus , Construction of soil moisture characteristic curves for soils representative to the region, Determination of infiltration rate by double ring infiltrometer method, Determination of saturated and unsaturated hydraulic conductivity, Determination of reference crop evapotranspiration by Modified Penman, Penman Monteith & Pan evaporation method, Construction of crop coefficient curves for important crops of the region, Determination of crop evapotranspiration, effective rainfall, leaching requirements and irrigation requirements, Measurement of irrigation water by 90 V-notch, Parshall flume and water meter, Calculation of irrigation efficiency parameters, Study of sprinkler & drip irrigation system components, Determination of design emission uniformity in drip irrigation, Study of on-going irrigation experiments

Suggested Readings

Lenka D. 1999. *Irrigation and Drainage.* Kalyani

Michael AM. 1978. *Irrigation: Theory and Practice.* Vikas Publ.

Paliwal KV. 1972. *Irrigation with Saline Water.* IARI Monograph, New Delhi.

Panda SC. 2003. *Principles and Practices of Water Management.* Agrobios.

Prihar SS & Sandhu BS. 1987. *Irrigation of Food Crops - Principles and Practices.* ICAR.

Reddy SR. 2000. *Principles of Crop Production.* Kalyani.

Singh Pratap & Maliwal PL. 2005. *Technologies for Food Security and Sustainable Agriculture.* Agrotech Publ.

AGRON 505 AGROMETEOROLOGY AND CROP WEATHER FORECASTING 2+1

Objective

To impart knowledge about agro-meteorology and crop weather forecasting to meet the challenges of aberrant weather conditions.

Theory

UNIT I

Agro meteorology - aim, scope and development in relation to crop environment; composition of atmosphere, distribution of atmospheric

pressure and wind.

UNIT II

Characteristics of solar radiation; energy balance of atmosphere system; radiation distribution in plant canopies, radiation utilization by field crops; photosynthesis and efficiency of radiation utilization by field crops; energy budget of plant canopies; environmental temperature: soil, air and canopy temperature.

UNIT III

Temperature profile in air, soil, crop canopies; soil and air temperature effects on plant processes; environmental moisture and evaporation: measures of atmospheric temperature and relative humidity vapor pressure and their relationships; evapo-transpiration and meteorological factors determining evapotranspiration.

UNIT IV

Modification of plant environment: artificial rain making, heat transfer, controlling heat load, heat trapping and shading; protection from cold, sensible and latent heat flux, controlling soil moisture; monsoon and their origin, characteristics of monsoon; onset, progress and withdrawal of monsoon; weather hazards, drought monitoring and planning for mitigation.

UNIT V

Weather forecasting in India – short, medium and long range; aerospace science and weather forecasting; benefits of weather services to agriculture, remote sensing; application

in agriculture and its present status in India; atmospheric pollution and its effect on climate and crop production; climate change and its impact on agriculture.

Practical

Visit to agro-meteorological observatory and to record sun-shine hours, wind velocity, wind direction, relative humidity, soil and air temperature, evaporation, precipitation and atmospheric pressure, Measurement of solar radiation outside and within plant canopy, Measurement/ estimation of evapo-transpiration by various methods, Measurement/estimation of soil water balance, Rainfall variability analysis, Determination of heat-unit requirement for different crops, Measurement of crop canopy temperature, Measurement of soil temperatures at different depths, Remote sensing and familiarization with agro-advisory service bulletins, Study of synoptic charts and weather reports, working principle of automatic weather station, Visit to solar observatory

Suggested Readings

Chang Jan Hu 1968. *Climate and Agriculture on Ecological Survey*. Aldine Publ.

Critchfield HJ.1995. *General Climatology*. Prentice Hall of India.

Das PK.1968. *The Monsoons*. National Book Trust Publ.

Lal DS.1998. *Climatology*. Sharda Pustak Bhawan.

Lenka D.1998. *Climate, Weather and Crops in India*. Kalyani.

Mavi H.S.1994. *Introduction to Agro-meteorology*. Oxford & IBH.

Mavi HS & Tupper GJ. 2004. *Agrometeorology: Principles and Application of Climate Studies in Agriculture*. Haworth Press.

Menon PA.1991. *Our Weather*. National Book Trust Publ.

Sahu DD. *Agrometeorology and Remote Sensing: Principles and Practices*. Agrobios.

Variraju R & Krishnamurty 1995. *Practical Manual on Agricultural Meteorology*. Kalyani.

Varshneya MC & Balakrishana Pillai P. 2003. *Textbook of Agricultural Meteorology*. ICAR.

AGRON 506 AGRONOMY OF MAJOR CEREALS AND PULSES 2+1

Objective

To teach the crop husbandry of cereals and pulse crops.

Theory

Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality components, handling and processing of the produce for maximum production of

UNIT I

Rabi cereals.

UNIT II

Kharif cereals.

UNIT III

Rabi pulses.

UNIT IV

Kharif pulses

Practical

Planning, seed bed preparation and layout of field experiments, Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities, Intercultural operations in different crops. Phenological studies at different growth stages of crops. Working out growth indices (CGR, RGR, NAR and LAD), LER, aggressivity, relative crowding coefficient, monetary yield advantage and ATER of prominent intercropping systems of different crops. Judging of physiological maturity in different crops. Estimation of crop yield on the basis of yield attributes. Estimation of protein content in pulses. Working out harvest index of various crops. Determination of cost of cultivation of different crops. Study of seed production techniques in various crops. Visit of field experiments on cultural, fertilizer, weed control and water management aspects. Visit to nearby villages for identification of constraints in crop production.

Suggested Readings

Das, N.R. 2007. Introduction to Crops of India. Scientific publishers, Jodhpur, India.

Rajendra Prasad. 2004. Text Book of Field Crop Production. Technical Editor, ICAR, New Delhi.

Reddy, S.R. 2004. Agronomy of Field Crops. Kalyani Publishers, New Delhi.

De Datta, S.K. 1981. Principles and Practices Rice Production., John Willey & Sons, New York.

Jeswani, L.M. & Baldev, B. 1997. Advances in Pulse Production Technology. ICAR, New Delhi.

Yadav D S. 1992. Pulse Crops. Kalyani Publishers, New Delhi.

Gururaj Hunsigi & Krishna, K. R. 1998. Science of Field Crop Production. Oxford & IBH publishing Co., Pvt., Ltd., New Delhi.

Mahendra Pal, Jayanta, D. & Rai, R.K. 1996. Fundamentals of Cereal Crop Production.. Tata McGraw Hill Publishing Co., New Delhi.

Singh, C., Singh, P. & Singh, R. 2003. Modern Techniques of Raising Field Crops. Oxford & IBH Publishing Co., Pvt., Ltd., New Delhi.

AGRON 507 AGRONOMY OF OILSEED, FIBRE AND SUGAR CROPS 2+1

Objective

To teach the crop husbandry of oilseed, fiber and sugar crops.

Theory

Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition quality component, handling and processing of the produce for maximum production of :

UNIT I

Rabi oilseeds – Rapeseed and mustard, linseed, etc.

UNIT II

Kharif oilseeds - Groundnut, sesame, castor, sunflower, soybean etc.

UNIT III

Fiber crops - Cotton, jute, sunhemp etc.

UNIT IV

Sugar crops – Sugar-beet and sugarcane.

Practical

Planning and layout of field experiments, Cutting of sugarcane setts, its treatment and methods of sowing, tying and propping of sugarcane, Determination of cane maturity and calculation on purity percentage, recovery percentage and sucrose content in cane juice phenological studies at different growth stages of crop, Intercultural operations in different crops, Cotton seed treatment, Working out growth indices (LER, CGR, RGR, NAR, LAD) aggressivity, relative crowding coefficient, monetary yield advantage and ATER of prominent intercropping systems, Judging of physiological maturity in different crops and working out harvest index, Working out cost of cultivation of different crops, Estimation of crop yield on the basis of yield attributes, Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities, Determination of oil content in oilseeds and computation of oil yield, Estimation of quality of fibre of different fibre crops, Study of seed production techniques in various crops, Visit of field experiments on cultural, fertilizer, weed control and water management aspects, Visit to nearby villages for identification of constraints in crop production

Suggested Readings

Das NR. 2007. *Introduction to Crops of India*. Scientific Publ.

Das PC. 1997. *Oilseed Crops of India*. Kalyani.

Lakshmikantam N. 1983. *Technology in Sugarcane Growing*. 2nd Ed.
Oxford & IBH.

Prasad, Rajendra. 2002. *Text Book of Field Crop Production*. ICAR.

Singh C, Singh P & Singh R. 2003. *Modern Techniques of Raising Field Crops*. Oxford & IBH.

Singh SS. 1998. *Crop Management*. Kalyani.

AGRON 508 AGRONOMY OF MEDICINAL, AROMATIC AND UNDER-UTILIZED CROPS 2+1

Objective

To acquaint students about different medicinal, aromatic and underutilized field crops, their package of practices and processing.

Theory

UNIT I

Importance of medicinal and aromatic plants in human health, national economy and related industries, classification of medicinal and aromatic plants according to botanical characteristics and uses.

UNIT II

Climate and soil requirements; cultural practices; yield and important constituents of medicinal plants (Isabgol, Rauwolfia, Poppy, *Aloe vera*, Satavar, Stevia, Safed Musli, Kalmegh, Asaphoetida, *Nux vomica*, Rosadle etc).

UNIT III

Climate and soil requirements; cultural practices; yield and important constituents of aromatic plants (Citronella, Palmarosa, Mentha, Basil, Lemon grass, Rose, Patchouli, Geranium etc.).

UNIT IV

Climate and soil requirements; cultural practices; yield of under-utilized crops (Rice bean, Lathyrus, Sesbania, Clusterbean, French bean, Fenugreek, Grain Amaranth, Coffee, Tea and Tobacco).

Practical

Identification of crops based on morphological and seed characteristics, Raising of herbarium of medicinal, aromatic and under-utilized plants, Quality characters in medicinal and aromatic plants, Methods of analysis of essential oil and other chemicals of importance in medicinal and aromatic plants

Suggested Readings

Chadha KL & Gupta R. 1995. *Advances in Horticulture.* Vol. II. *Medicinal and Aromatic Plants.* Malhotra Publ.

Das NR. 2007. *Introduction to Crops of India.* Scientific Publ.

Handa SS. 1984. *Cultivation and Utilization of Medicinal Plants.* RRL, CSIR, Jammu.

Hussain A. 1984. *Essential Oil Plants and their Cultivation.* CIMAP, Lucknow.

Hussain A. 1993. *Medicinal Plants and their Cultivation.* CIMAP, Lucknow.

ICAR 2006. *Hand Book of Agriculture.* ICAR, New Delhi.

Kumar N, Khader Md. Abdul, Rangaswami JBM & Irulappan 1997.

Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants. Oxford & IBH.

Prajapati ND, Purohit SS, Sharma AK & Kumar T. 2003. *A Hand Book of Medicinal Plants: A Complete Source Book.* Agrobios.

Sharma R. 2004. *Agro-Techniques of Medicinal Plants.* Daya Publ. House.

AGRON 509 AGRONOMY OF FODDER AND FORAGE CROPS 2+1

Objective

To teach the crop husbandry of different forage and fodder crops along with their processing.

Theory

UNIT I

Adaptation, distribution, varietal improvement, agro-techniques and quality aspects including anti-quality factors of important fodder crops like maize, *bajra*, *guar*, cowpea, oats, barley, berseem, *senji*, lucerne etc.

UNIT II

Adaptation, distribution, varietal improvement, agro-techniques and quality aspects including anti-quality factors of important forage crops/grasseslime, napier grass, *Panicum, Lasiuras, Cenchrus* etc.

UNIT III

Year-round fodder production and management, preservation and utilization of forage and pasture crops.

UNIT IV

Principles and methods of hay and silage making; chemical and biochemical changes, nutrient losses and factors affecting quality of hay and silage; use of physical and chemical enrichments and biological methods for improving nutrition; value addition of poor quality fodder.

UNIT V

Economics of forage cultivation uses and seed production techniques.

Practical

Practical raining of farm operations in raising fodder crops;, Canopy measurement, yield and quality estimation, viz. crude protein, NDF, ADF, lignin, silica, cellulose etc. of various fodder and forage crops, Anti-quality components like HCN in sorghum and such factors in other crops, Hay and silage making and economics of their preparation

Suggested Readings

Chatterjee BN. 1989. *Forage Crop Production - Principles and Practices.* Oxford & IBH.

Das NR. 2007. *Introduction to Crops of India.* Scientific Publ.

Narayanan TR & Dabadghao PM. 1972. *Forage Crops of India.* ICAR.

Singh P & Srivastava AK. 1990. *Forage Production Technology.* IGFRI, Jhansi.

Singh C, Singh P & Singh R. 2003. *Modern Techniques of Raising Field Crops.* Oxford & IBH.

Tejwani KG. 1994. *Agroforestry in India.* Oxford & IBH.

AGRON 510 AGROSTOLOGY AND AGROFORESTRY 2+1

Objective

To teach crop husbandry of different forage, fodder and agroforestry crops/trees along with their processing.

Theory

UNIT I

Agrostology: definition and importance; principles of grassland ecology: grassland ecology – community, climax, dominant species, succession, biotype, ecological status of grasslands in India, grass cover of India; problems and management of grasslands.

UNIT II

Importance, classification (various criteria), scope, status and research needs of pastures; pasture establishment, their improvement and renovation-natural pastures, cultivated pastures; common pasture grasses.

UNIT III

Agroforestry: definition and importance; agroforestory systems, agrisilviculture, silvipasture, agrisilvipasture, agrihorticulture, aquasilviculture, alley cropping and energy plantation.

UNIT IV

Crop production technology in agro-forestory and agrostology system; silvipastoral system: meaning and importance for wasteland development; selection of species, planting methods and problems of seed germination in agro-forestry systems; irrigation and manuring in agro-forestry systems, associative influence in relation to above ground and underground interferences; lopping and coppicing in agro-forestry systems; social acceptability and economic viability, nutritive value of trees; tender operation; desirable tree characteristics.

Practical

Preparation of charts and maps of India showing different types of pastures and agro-forestry systems, Identification of seeds and plants of common grasses, legumes and trees of economic importance with reference to agro-forestry, Seed treatment for better germination of farm vegetation, Methods of propagation/planting of grasses and trees in silvipastoral system, Fertilizer application in strip and silvipastroal systems, After-care of plantation, Estimation of protein content in loppings of important fodder trees, Estimation of calorie value of wood of important fuel trees, Estimation of total biomass and fuel wood, Economics of agro-forestry, Visit to important agro-forestry research stations

Suggested Readings

Chatterjee BN & Das PK. 1989. *Forage Crop Production. Principles and Practices.* Oxford & IBH.

Dabadghao PM & Shankaranarayan KA. 1973. *The Grass Cover in India.* ICAR.

Dwivedi AP. 1992. *Agroforestry- Principles and Practices.* Oxford & IBH.

Indian Society of Agronomy. 1989. *Agroforestry System in India. Research and Development,* New Delhi.

Narayan TR & Dabadghao PM. 1972. *Forage Crop of India.* ICAR, New Delhi.

Pathak PS & Roy MM. 1994. *Agroforestry System for Degraded Lands.*

Oxford & IBH.

Sen NL, Dadheech RC, Dashora LK & Rawat TS. 2004. *Manual of Agroforestry and Social Forestry.* Agrotech Publ.

Shah SA.1988. *Forestry for People.* ICAR.

Singh Panjab, Pathak PS & Roy MM.1994. *Agroforestry System for Sustainable Use.* Oxford & IBH.

Singh SP. 1994. *Handbook of Agroforestry.* Agrotech Publ.

Solanki KR. 2000. *Multipurpose Tree Species: Research, Retrospect and Prospects.* Agrobios.

Tejwani KG.1994. *Agroforestry in India.* Oxford & IBH.

AGRON 511 CROPPING SYSTEMS AND SUSTAINABLE AGRICULTURE 2+0

Objective

To acquaint the students about prevailing cropping systems in the country and practices to improve their productivity.

Theory

UNIT I

Cropping systems: definition, indices and its importance; physical resources, soil and water management in cropping systems; assessment of land use.

UNIT II

Concept of sustainability in cropping systems and farming systems, scope and objectives; production potential under monoculture cropping, multiple cropping, alley cropping, sequential cropping and intercropping, mechanism of yield advantage in intercropping systems.

UNIT III

Above and below ground interactions and allelopathic effects; competition relations; multi-storied cropping and yield stability in intercropping, role of non-monetary inputs and low cost technologies; research need on sustainable agriculture.

UNIT IV

Crop diversification for sustainability; role of organic matter in maintenance of soil fertility; crop residue management; fertilizer use efficiency and concept of fertilizer use in intensive cropping system.

UNIT V

Plant ideotypes for drylands; plant growth regulators and their role in sustainability.

Suggested Readings

Palaniappan SP & Sivaraman K. 1996. *Cropping Systems in the Tropics; Principles and Management.* New Age.

Panda SC. 2003. *Cropping and Farming Systems.* Agrobios.

Reddy SR. 2000. *Principles of Crop Production.* Kalyani.

Sankaran S & Mudaliar TVS. 1997. *Principles of Agronomy.* The Bangalore Printing & Publ. Co.

Singh SS. 2006. *Principles and Practices of Agronomy.* Kalyani.

Tisdale SL, Nelson WL, Beaton JD & Havlin JL. 1997. *Soil Fertility and Fertilizers.* Prentice Hall.

AGRON 512 DRYLAND FARMING AND WATERSHED MANAGEMENT 2+1

Objective

To teach the basic concepts and practices of dry land farming and soil moisture conservation.

Theory

UNIT I

Definition, concept and characteristics of dry land farming; dry land versus rainfed farming; significance and dimensions of dry land farming in Indian agriculture.

UNIT II

Soil and climatic parameters with special emphasis on rainfall characteristics; constraints limiting crop production in dry land areas; types of drought, characterization of environment for water availability; crop planning for erratic and aberrant weather conditions.

UNIT III

Stress physiology and resistance to drought, adaptation of crop plants to drought, drought management strategies; preparation of appropriate crop plans for dry land areas; mid contingent plan for aberrant weather conditions.

UNIT IV

Tillage, tilth, frequency and depth of cultivation, compaction in soil tillage; concept of conservation tillage; tillage in relation to weed control and moisture conservation; techniques and practices of soil moisture conservation (use of mulches, kinds, effectiveness and economics); antitranspirants; soil and crop management techniques, seeding and efficient fertilizer use.

UNIT V

Concept of watershed resource management, problems, approach and components.

Practical

Seed treatment, Seed germination and crop establishment in relation to soil moisture contents Study of moisture stress effects and recovery behaviour of important crops, Estimation of moisture index and aridity index, Spraying of antitranspirants and their effect on crops, Collection and interpretation of data for water balance equations, Study of water use efficiency in different crops, Preparation of crop plans for different drought conditions, Study of field experiments relevant to dryland farming, Visit to dryland research stations and watershed projects

Suggested Readings

Das NR. 2007. *Tillage and Crop Production.* Scientific Publishers.

Dhopte AM. 2002. *Agrotechnology for Dryland Farming.* Scientific Publ.

Dhruv Narayan VV. 2002. *Soil and Water Conservation Research in India.* ICAR.

Gupta US. (Ed.). 1995. *Production and Improvements of Crops for Drylands.* Oxford & IBH.

Katyal JC & Farrington J. 1995. *Research for Rainfed Farming.* CRIDA.

Rao SC & Ryan J. 2007. *Challenges and Strategies of Dryland Agriculture.*

Scientific Publishers.

Singh P & Maliwal PL. 2005. *Technologies for Food Security and Sustainable Agriculture.* Agrotech Publishing Company.

Singh RP. 1988. *Improved Agronomic Practices for Dryland Crops.* CRIDA.

Singh RP. 2005. *Sustainable Development of Dryland Agriculture in India.*

Scientific Publ.

Singh SD. 1998. *Arid Land Irrigation and Ecological Management.* Scientific Publishers.

Venkateshwarlu J. 2004. *Rainfed Agriculture in India. Research and Development Scenario.* ICAR.

AGRON 513 PRINCIPLES AND PRACTICES OF ORGANIC FARMING 2+1

Objective

To study the principles and practices of organic farming for sustainable crop production.

Theory

UNIT I

Organic farming - concept and definition, its relevance to India and global agriculture and future prospects; land and water management - land use, minimum tillage; shelter zones, hedges, pasture management, agro-forestry.

UNIT II

Organic farming and water use efficiency; soil fertility, nutrient recycling, organic residues, organic manures, composting, soil biota and decomposition of organic residues, earthworms and vermicompost, green manures and biofertilizers.

UNIT III

Farming systems, crop rotations, multiple and relay cropping systems, intercropping in relation to maintenance of soil productivity.

UNIT IV

Control of weeds, diseases and insect pest management, biological agents and pheromones, biopesticides.

UNIT V

Socio-economic impacts; marketing and export potential: inspection, certification, labeling and accreditation procedures; organic farming and national economy.

Practical

Aerobic and anaerobic methods of making compost, Making of vermicompost, Identification and nursery raising of important agro-forestry tress and tress for shelter belts, Efficient use of biofertilizers, Technique of treating legume seeds with *Rhizobium* cultures, Use of *Azotobacter*, *Azospirillum*, and PSB cultures in field, Visit to an organic farm, Quality standards, inspection, certification and labeling and accreditation procedures for farm produce from organic farms

Suggested Readings

Ananthakrishnan TN. (Ed.). 1992. *Emerging Trends in Biological Control of Phytophagous Insects.* Oxford & IBH.

Gaur AC. 1982. *A Manual of Rural Composting*, FAO/UNDP Regional Project Document, FAO.

Lampin N. 1990. *Organic Farming.* Press Books, Ipswitch, UK.

Palaniappan SP & Anandurai K. 1999. *Organic Farming – Theory and Practice.* Scientific Publ.

Rao BV Venkata. 1995. *Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective*:

Publ.3, Parisaraprajna Parishtana, Bangalore.

Reddy MV. (Ed.). 1995. *Soil Organisms and Litter Decomposition in the Tropics*. Oxford & IBH.

Sharma A. 2002. *Hand Book of Organic Farming*. Agrobios.

Singh SP. (Ed.) 1994. *Technology for Production of Natural Enemies*.

PDBC, Bangalore.

Subba Rao NS. 2002. *Soil Microbiology*. Oxford & IBH.

Trivedi RN.1993. *A Text Book of Environmental Sciences*, Anmol Publ.

Veeresh GK, Shivashankar K & Suiglachar MA. 1997. *Organic Farming and Sustainable Agriculture*. Association for Promotion of Organic Farming, Bangalore.

WHO. 1990. *Public Health Impact of Pesticides Used in Agriculture*.

Woolmer PL & Swift MJ. 1994. *The Biological Management of Tropical Soil Fertility*. TSBF & Wiley.

AGRON 601 CURRENT TRENDS IN AGRONOMY 3+0

Objective

To acquaint the students about recent advances in agricultural production.

Theory

UNIT I

Agro-physiological basis of variation in yield, recent advances in soilplant- water relationship.

UNIT II

Globalization of agriculture and WTO, precision agriculture, contract farming, organic farming, marketing and export potential of organic products, certification, labeling and accreditation procedures.

UNIT III

Crop residue management in multiple cropping systems; latest developments in plant management, weed management, cropping systems, grassland management, agro-forestry, allelopathy.

UNIT IV

GIS, GPS and remote sensing for crop management, global warming, GM crops, seed production technology; seed certification, seed multiplication, hybrid seed production etc.

UNIT V

Concepts of system agriculture; holistic approach of farming systems, dryland farming, sustainable agriculture and research methodology in Agronomy.

Suggested Readings

Agarwal RL. 1995. *Seed Technology*. Oxford & IBH.

Dahiya BS & Rai KN. 1997. *Seed Technology*. Kalyani.

Govardhan V. 2000. *Remote Sensing and Water Management in Command Areas: Agroecological Prospectives.* IBDC.

ICAR. 2006. *Hand Book of Agriculture.* ICAR.

Narasaiah ML. 2004. *World Trade Organization and Agriculture.* Sonali Publ.

Palaniappan SP & Annadurai K. 2006. *Organic Farming - Theory and Practice.* Scientific Publ.

Sen S & Ghosh N. 1999. *Seed Science and Technology.* Kalyani.

Tarafdar JC, Tripathi KP & Mahesh Kumar 2007. *Organic Agriculture.*

Scientific Publ.

AGRON 602 **CROP ECOLOGY** **2+0**

Objective

To acquaint the students about the agricultural systems, agro-ecological regions, and adaptation of crops to different agro-climatic conditions.

Theory

UNIT I

Concept of crop ecology, agricultural systems, ecology of cropping systems, principles of plant distribution and adaptation, crop and world food supply.

UNIT II

Ecosystem characteristics, types and functions, terrestrial ecology, flow of energy in ecosystem, ecosystem productivity, biomass, succession and climax concept.

UNIT III

Physiological response of crop plants to light, temperature, CO2, moisture and solar radiation; influence of climate on photosynthesis and productivity of crops; effect of global climate change on crop production.

UNIT IV

Exploitation of solar energy in crops; vertical distribution of temperature; efficiency in crop production.

UNIT V

Competition in crop plants; environmental pollution, ecological basis of environmental management and environment manipulation through agronomic practices; improvement of unproductive lands through crop selection and management.

Suggested Readings

Ambasht RS. 1986. *A Text Book of Plant Ecology.* 9th Ed. Students' Friends & Co.

Chadha KL & Swaminathan MS. 2006. *Environment and Agriculture.*

Malhotra Publ. House.

Dwivedi P, Dwivedi SK & Kalita MC. 2007. *Biodiversity and Environmental Biotechnology.* Scientific Publ.

Hemantarajan A. 2007. *Environmental Physiology.* Scientific Publ.

Kumar HD. 1992. *Modern Concepts of Ecology*. 7th Ed. Vikas.Publ.

Lenka D. 1998. *Climate, Weather and Crops in India*. Kalyani.

Misra KC. 1989. *Manual of Plant Ecology*. 3rd Ed. Oxford & IBH.

Pandey SN & Sinha BK. 1995. *Plant Physiology*. Vikas Publ.

Sharma PD. 1998. *Ecology and Environment*. Rastogi Publ.

Singh J & Dhillon SS. 1984. *Agricultural Geography*. Tata McGraw Hill.

Taiz L & Zeiger E. 1992. *Plant Physiology*. Benjamin/Cummings Publ.

AGRON 603 CROP PRODUCTION AND SYSTEM MODELING 2+1

Objective

To familiarize the students about systems approach and to simulate yields and growth of several crops under varied soil and weather conditions with different management practices and their optimization.

Theory

UNIT I

Systems classification; flow charts, modeling techniques and methods of integration - state, rates and driving variables, feedbacks and relational diagrams.

UNIT II

Elementary models for crop growth based on basic methods of classical growth analysis.

UNIT III

Crop modeling methods for crop-weather interaction, climate change and variability components.

UNIT IV

Potential production: leaf and canopy CO2 assimilation, respiration, dry matter accumulation, crop phenology and dry matter distribution and development in different crops.

UNIT V

Production by moisture availability, potential evapotranspiration, water balance of the soil, and production with nutrient and moisture limitations.

Practical

Simulation of elementary models for crop growth, Simulation of potential production, Simulation with limitations of water and nutrient management options, Sensitivity analysis using different climatic years and crop management practices

Suggested Readings

Gordan G. 1992. System Sim*ulation*. 2nd Ed. Prentice Hall.

Kropff MJ & Vann Laar HH. (Ed.). 1993. *Modelling Crop Weed Interactions*. ISBN.

Mathews RB, Kropff MJ, Bachelet D & Vaan Laar HH. (Eds.). 1993.

Modelling the Impact of Climate Change on Rice Production in *Asia*. CABI.

Penning de Vries FWT & Van Laar HH. (Eds.). 1982. *Simulation of Plant Growth and Crop Production*. Wageningen Centre for Agricultural Publications and Documentation, Netherlands.

Ritchie JT & Hanks J. 1991. *Modelling Plant and Soil Systems*. American Society of Agronomy, Madison.

Zeigler BP. 1976. *Theory of Modeling and Simulation*. John Wiley & Sons.

AGRON 604 ADVANCES IN CROP GROWTH AND PRODUCTIVITY 2+1

Objective

To study the physiology of vegetative and reproductive growth in relation to productivity of different crops in various environments.

Theory

UNIT I

Plant density and crop productivity; plant and environmental factors, yield, plant distribution, strategies for maximizing solar energy utilization; leaf area; interception of solar radiation and crop growth; photosynthesis: the photosynthetic apparatus, factors essential for photosynthesis; difference in photosynthetic rates among and within species; physiological limitations to crop yield; solar radiation concept and agro-techniques for harvesting solar radiation.

UNIT II

Growth analysis: concept, CGR, RGR, NAR, LAI, LAD, LAR; validity and Limitations in interpreting crop growth and development; growth curves: sigmoid, polynomial and asymptotic; root systems; root-shoot relationship; principles involved in inter and mixed cropping systems under rainfed and irrigated conditions; concept and differentiation of inter and mixed cropping; criteria in assessing the yield advantages.

UNIT III

Competitive relationship and competition functions; biological and agronomic basis of yield advantage under intercropping; physiological principles of dry land crop production, constraints and remedial measures; heat unit concept of crop maturity: concept and types of heat units.

UNIT IV

Concept of plant ideotypes: crop physiological and new ideotypes; characteristics of ideotype for wheat, rice, maize, etc.; concept and types of growth hormones; their role in field crop production; efficient use of resources.

Practical

Field measurement of root-shoot relationship in crops at different growth stages, Estimation of growth evaluating parameters like CGR, RGR, NAR, LAI etc., at different stages of crop growth, Computation of harvest index of various crops, Assessment of crop yield on the basis of yield attributing characters, Construction of crop growth curves based on growth analysis data, Computation of competition functions, viz. LER, IER aggressivity competition index etc in intercropping, Senescence and abscission indices, Analysis of productivity trend in un-irrigated areas, Analysis of productivity trend in irrigated areas

Suggested Readings

Chopra VL & Paroda RS. 1984. *Approaches for Incorporation of Drought and Salinity Resistance in Crop Plants.* Oxford and IBH.

Delvin RM & Vitham FH. 1986. *Plant Physiology.* CBS Publ.

Evans LT. 1975. *Crop Physiology.* Cambridge Univ. Press.

Evans LT. 1996. *Crop Evolution, Adaptation and Yield.* Cambridge Univ. Press.

Gupta US. (Ed.). 1995. *Production and Improvement of Crops for Drylands.* Oxford & IBH.

Gupta US. 1988. *Progress in Crop Physiology.* Oxford and IBH.

Kramer PJ & Boyer JS. 1995. *Water Relations of Plant and Soils.*

Academic Press.

Mukherjee S & Ghosh AK. 1996. *Plant Physiology.* Tata McGraw Hill.

Narwal SS, Politycka B & Goswami CL. 2007. *Plant Physiology: Research Methods.* Scientific Publishers.

AGRON 605 IRRIGATION MANAGEMENT 2+1

Objective

To teach students about optimization of irrigation in different crops under variable agroclimatic conditions.

Theory

UNIT I

Water resources of India, irrigation projects; irrigation needs, atmospheric, soil, agronomic, plant and water factors affecting irrigation need; water deficits and crop growth.

UNIT II

Soil-plant-water relationships, transpiration and evapotranspiration, significance of transpiration, energy utilization in transpiration, physiological processes and crop productivity.

UNIT III

Infiltration; water movement under saturated and unsaturated conditions; management practices for improving water use efficiency of crops.

UNIT IV

Application of irrigation water, conveyance and distribution system, irrigation efficiency; agronomic considerations in the design and operation of irrigation projects; characteristics of irrigation and farming systems affecting irrigation management.

UNIT V

Strategies of using limited water supply; factors affecting ET, control of ET by mulching and use of anti-transpirants; fertilizer use in relation to irrigation; optimizing the use of given irrigation supplies.

UNIT VI

Land suitability for irrigation, land irrigability classification; integrated water management in command areas, institution of water management in commands, farmer's participation in command areas; irrigation legislation.

Practical

Determination of water infiltration characteristics and water holding capacity of soil profiles, Moisture extraction pattern of crops, Consumptive use, Water requirement of a given cropping pattern for optimum/variable productivity, Crop planning at the farm and project level, Agronomic evaluation of irrigation projects, Case studies

Suggested Readings

FAO. 1984. *Irrigation Practice and Water Management.* Oxford & IBH.

Michael AM. 1978. *Irrigation: Theory and Practice.*Vikas Publ.

Mishra RR & Ahmad M. 1987. *Manual on Irrigation and Agronomy.* Oxford & IBH.

Panda SC. 2003. *Principles and Practices of Water Management.* Agrobios.

Reddy SR. 2000. *Principles of Crop Production.* Kalyani.

Sankara Reddy GH & Yellamananda Reddy 1995. Efficient Use of Irrigation Water. In: Gupta US. (Ed.). *Production and Improvement of Crops for Drylands.* Oxford & IBH.

Singh SS. 2006. Principles and Practices of Agronomy. In: Gupta US.

(Ed.). *Production and Improvement of Crops for Drylands.* Oxford & IBH.

AGRON 606 ADVANCES IN WEED MANAGEMENT 2+0

Objective

To teach about the changing weed flora, new herbicides, their resistance, toxicity, antidotes and residue management under different cropping systems.

Theory

UNIT I

Crop-weed competition in different cropping situations; changes in weed flora, various causes and affects.

UNIT II

Physiological and biological aspects of herbicides, their absorption, translocation, metabolism and mode of action; selectivity of herbicides and factors affecting them.

UNIT III

Climatic factors and phytotoxicity of herbicides; fate of herbicides in soil and factors affecting them, residue management of herbicides, adjuvants.

UNIT IV

Advances in herbicide application techniques; herbicide resistance; antidotes and crop protection compatibility of herbicides of different groups; compatibility of herbicides with other pesticides.

UNIT V

Development of transgenic herbicide resistant crops; herbicide development, registration procedures.

UNIT VI

Relationship of herbicides with tillage, fertilizer and irrigation; bioherbicides, allelochemical herbicide bioassays.

Suggested Readings

Aldrich RJ & Kramer R.J. 1997. *Principles in Weed Management.* Panama Publ.

Ashton FM & Crafts AS. 1981. *Mode of Action of Herbicides.* 2nd Ed. Wiley-Inter Science.

Gupta OP. 2000. *Weed Management – Principles and Practices.* Agrobios.

Mandal RC. 1990. *Weed, Weedicides and Weed Control - Principles and Practices.* Agro-Botanical Publ.

Rao VS. 2007. *Principles of Weed Science.* Oxford & IBH.

Ross MA & Carola Lembi A. 1999. *Applied Weed Science.* 2nd Ed. Prentice Hall.

Subramanian SAM & Kumar R.J. 1997. *All About Weed Control.* Kalyani.

Zimdahl RL. 1999. *Fundamentals of Weed Science.* 2nd Ed. Academic Press.

AGRON 607 INTEGRATED FARMING SYSTEMS FOR SUSTAINABLE AGRICULTURE 2+0

Objective

To apprise about different enterprises suitable for different agroclimatic conditions for sustainable agriculture.

Theory

UNIT I

Farming systems: definition and importance; classification of farming systems according to type of rotation, intensity of rotation, degree of commercialization, water supply, enterprises.

UNIT II

Concept of sustainability in farming systems; efficient farming systems; natural resources - identification and management.

UNIT III

Production potential of different components of farming systems; interaction and mechanism of different production factors; stability in different systems through research; eco-physiological approaches to intercropping.

UNIT IV

Simulation models for intercropping; soil nutrient in intercropping; preparation of different farming system models; evaluation of different farming systems.

UNIT V

New concepts and approaches of farming systems and cropping systems and organic farming; case studies on different farming systems.

Suggested Readings

Ananthakrishnan TN. (Ed.) 1992. *Emerging Trends in Biological Control of Phytophagous Insects.* Oxford & IBH.

Balasubramanian P & Palaniappan SP 2006. *Principles and Practices of Agronomy.* Agrobios.

Joshi M & Parbhakarasetty TK. 2005. *Sustainability through Organic Farming.* Kalyani.

Lampin N. 1990. *Organic Farming.* Farming Press Books.

Palaniappan SP & Anandurai K. 1999. *Organic Farming - Theory and Practice.* Scientific Publ.

Panda SC. 2004. *Cropping systems and Farming Systems.* Agribios.

Reddy MV. (Ed.). 1995. *Soil Organisms and Litter Decomposition in the Tropics.* Oxford & IBH.

Sharma AK. 2001. *A Hand Book of Organic Farming.* Agrobios.

Singh SP. (Ed) 1994. *Technology for Production of Natural Enemies.* PDBC, Bangalore.

Trivedi RN. 1993. *A Text Book of Environmental Sciences.* Anmol Publ.

Veeresh GK, Shivashankar K & Suiglachar MA. 1997. *Organic Farming and Sustainable Agriculture.* Association for Promotion of Organic Farming, Bangalore.

Venkata Rao BV. 1995. *Small Farmer Focused Integrated Rural*

Development: Socio-economic Environment and Legal Perspective.

Publ. 3. Parisaraprajna Parishtana, Bangalore.

AGRON 608 SOIL CONSERVATION AND WATERSHED MANAGEMENT 2+1

Objective

To teach about different soil moisture conservation technologies for enhancing the agricultural productivity through holistic approach watershed management.

Theory

UNIT I

Soil erosion: definition, nature and extent of erosion; types of erosion, factors affecting erosion.

UNIT II

Soil conservation: definition, methods of soil conservation; agronomic measures - contour cultivation, strip cropping, cover crops; vegetative barriers; improved dry farming practices; mechanical measures - bunding, gully control, bench terracing; role of grasses and pastures in soil conservation; wind breaks and shelter belts.

UNIT III

Watershed management: definition, objectives, concepts, approach, components, steps in implementation of watershed; development of cropping systems for watershed areas.

UNIT IV

Land use capability classification, alternate land use systems; agro-forestry; ley farming; *jhum* management - basic concepts, socio-ethnic aspects, its layout.

UNIT V

Drainage considerations and agronomic management; rehabilitation of abandoned *jhum* lands and measures to prevent soil erosion.

Practical

Study of different types of erosion, Field studies of different soil conservation measures, Run-off and soil loss measurements, Laying out run-off plot and deciding treatments, Identification of different grasses and trees for soil conservation, Visit to a soil conservation research centre, demonstration and training centre

Suggested Readings

Arakeri HR & Roy D. 1984. *Principles of Soil Conservation and Water Management.* Oxford & IBH.

Dhruvanarayana VV. 1993. *Soil and Water Conservation Research in India.* ICAR.

FAO. 2004. *Soil and Water Conservation in Semi-Arid Areas. Soils Bull.,* Paper 57.

Frederick RT, Hobbs J, Arthur D & Roy L. 1999. *Soil and Water Conservation: Productivity and Environment Protection.* 3rd Ed. Prentice Hall.

Gurmel Singh, Venkataraman CG, Sastry B & Joshi P. 1990. *Manual of Soil and Water Conservation Practices.* Oxford & IBH.

Murthy VVN. 1995. *Land and Water Management Engineering.* Kalyani.

Tripathi RP & Singh HP. 1993. *Soil Erosion and Conservation.* Wiley Eastern.

Yellamanda Reddy T & Sankara Reddy GH. 1992. *Principles of Agronomy.* Kalyani.

AGRON 609 STRESS CROP PRODUCTION 2+1

Objective

To study various types of stresses in crop production and strategies to overcome them.

Theory

UNIT I

Stress and strain terminology; nature and stress injury and resistance; causes of stress.

UNIT II

Low temperature stress: freezing injury and resistance in plants, measurement of freezing tolerance, chilling injury and resistance in plants, practical ways to overcome the effect of low temperature tress through, soil and crop manipulations.

UNIT II

High temperature or heat stress: meaning of heat stress, heat injury and resistance in plants, practical ways to overcome the effect of heat stress through soil and crop manipulations.

UNIT III

Water deficit stress: meaning of plant water deficient stress and its effect on growth and development, water deficit injury and resistance, practical ways to overcome effect of water deficit stress through soil and crop, manipulations.

UNIT IV

Excess water or flooding stress: meaning of excess water stress, its kinds and effects on crop plants, excess water stress injury and resistance, practical ways to overcome excess water stress through soil and crop manipulations.

UNIT V

Salt stress: meaning of salt stress and its effect on crop growth, salt stress injury and resistance in plants, practical ways to overcome the effect of salt stress through soil and crop manipulations.

UNIT VI

Mechanical impedance of soil and its impact on plant growth; measures to overcome soil mechanical impedance.

UNIT VII

Environmental pollution: air, soil and water pollution, and their effect on crop growth and quality of produce; ways and means to prevent environmental pollution.

Practical

Determination of electrical conductivity of plant cell sap, Determination of osmotic potential and tissue water potential, Measurement of transpiration rate, Measurement of stomatal frequency, Growing of plants in sand culture under salt stress for biochemical and physiological studies, Studies on effect of osmotic and ionic stress on seed germination and seedling growth, Measurement of low temperature injury under field conditions

Suggested Readings

Baker FWG.1989. *Drought Resistance in Cereals.* Oxon, UK.

Gupta U.S. (Ed.). 1988. *Physiological Aspects of Dryland Farming.* Oxford & IBH.

Kramer PJ.1983. *Water Relations of Plants.* Academic Press.

Levitt J. 1980. *Response of Plants to Environmental Stresses.* Vols. I, II. Academic Press.

Mavi HS.1978. *Introduction to Agro-meteorology.* Oxford & IBH.

Michael AM & Ojha TP.1981. *Principles of Agricultural Engineering.* Vol II. Jain Bros.

Nilsen ET & Orcut DM. 1996. *Physiology of Plants under Stress - Abiotic Factors.* John Wiley & Sons.

Singh K. 2000. *Plant Productivity under Environmental Stress.* Agribios.

Singh KN & Singh RP. 1990. *Agronomic Research Towards Sustainable*

Agriculture. Indian Society of Agronomy, New Delhi.

Somani LL & Totawat KL. 1992. *Management of Salt-affected Soils and Waters.* Agrotech Publ.

Virmani SM, Katyal JC, Eswaran H & Abrol IP.1994. *Stressed Ecosystem and Sustainable Agriculture.* Oxford & IBH.

List of Journals

Advances in Agronomy

Agriculture, Ecosystems and Environment

Agricultural Systems

Agricultural Water Management

Agronomy Journal

Annual Review of Plant Physiology

Applied Ecology and Environment

Research

Australian Journal of Agricultural Research

Australian Journal of Experimental

Agriculture

Crop Protection

Environment and Ecology

European Journal of Agronomy

Fertilizer Research

Field Crops Research

Indian Journal of Agricultural Sciences

Indian Journal of Agronomy

Indian Journal of Ecology

Indian Journal of Weed Science

Irrigation Science

Japanese Journal of Crop Science

Journal of Agronomy

Journal of Applied Ecology

Journal of Experimental Botany

Journal of Farming Systems Research

Journal of Range Management

Journal of Agricultural Science

Cambridge

Journal of Sustainable Agriculture

Netherlands Journal of Agricultural

Sciences

Nutrient Cycling in Agroecosystems

Pesticide Biochemistry and Physiology

Plant and Soil

Plant Production Science

Soil and Tillage Research

Swedish Journal of Agricultural

Research

Tropical Agriculture

Weed Research

Suggested Broad Topics for Master's and Doctoral Research

Crop diversification under different agricultural situations

Development of farming systems for marginal, small and other farmers

Agricultural information at door step/click of mouse

Farm-specific nutrient management

Weed management in different cropping/farming systems

Nutrient studies in different cropping/farming systems

Biodiversity of farming systems for conservation

Organic farming systems for different regions

Modeling for different crop situations

Conservation agriculture for yield sustainability

Role of edaphic factors on weeds proliferation and management

Implications of global warming on weed growth and herbicide behaviour

Ecological implications of using thresholds for weed management

Effect of cultivation practices and herbicides on weed flora shift

GM crops and weed management strategies

Weed management under reduced moisture regime in major summer/*kharif* crops

Avoidance of herbicide resistance using IWM

BIOCHEMISTRY
Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
BIOCHEM 501*^	BASIC BIOCHEMISTRY	2+1
BIOCHEM 502*	INTERMEDIARY METABOLISM	2+1
BIOCHEM 503*	ENZYMOLOGY	2+1
BIOCHEM 504	MOLECULAR BIOLOGY	2+1
BIOCHEM 505*	BIOCHEMICAL TECHNIQUES	1+2
BIOCHEM 506	IMMUNO CHEMISTRY	2+1
BIOCHEM 507	PLANT BIOCHEMISTRY	3+0
BIOCHEM 508	ANIMAL BIOCHEMISTRY	3+0
BIOCHEM 509	FOOD AND NUTRITIONAL BIOCHEMISTRY	2+1
BIOCHEM 510	CARBON AND NITROGEN METABOLISM	2+1
BIOCHEM 591	MASTER'S SEMINAR	1+0
BIOCHEM 599	MASTER'S RESEARCH	20
BIOCHEM 601**	ADVANCED ENZYMOLOGY	2+0
BIOCHEM 602**	ADVANCED MOLECULAR BIOLOGY	3+0
BIOCHEM 603	BIOCHEMISTRY OF BIOTIC AND ABIOTIC STRESS	3+0
BIOCHEM 604**	CURRENT TOPICS IN BIOCHEMISTRY	1+0
BIOCHEM 605	FUNCTIONAL GENOMICS AND METABOLOMICS	3+0
BIOCHEM 606	BIOMEMBRANES	2+0
BIOCHEM 607**	ADVANCED TECHNIQUES IN BIOCHEMISTRY	0+2
BIOCHEM 691	DOCTORAL SEMINAR I	1+0
BIOCHEM 692	DOCTORAL SEMINAR II	1+0
BIOCHEM 699	DOCTORAL RESEARCH	45

*Compulsory for Master's programme;

** Compulsory for Doctoral programme

^ Open for PG students of other discipline

Minor Departments 9

Plant Physiology

Plant Molecular biology and Biotechnology

Supporting Departments 5

Microbiology

Statistics & Mathematics

Soil Science

Non credit compulsory courses

CODE	COURSE TITLE	CREDITS
PGS 501	LIBRARY AND INFORMATION SERVICES	0+1
PGS 502	TECHNICAL WRITING AND COMMUNICATION SKILLS	0+1
PGS 503 (e-course)	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1+0
PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1
PGS 505 (e-course)	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1+0
PGS 506 (e-course)	DISASTER MANAGEMENT	1+0

BIOCHEM 501 **BASIC BIOCHEMISTRY** **2+1**

Objective

To provide elementary knowledge/overview of structure and functions and metabolism of biomolecules.

Theory

UNIT I

Scope and importance of biochemistry in agriculture; Fundamental principles governing life; structure of water; acid base concept and buffers; pH; hydrogen bonding; hydrophobic, electrostatic and Van der Waals forces; General introduction to physical techniques for determination of structure of biopolymers.

UNIT II

Classification, structure and function of carbohydrates, lipids and biomembranes, amino acids, proteins, and nucleic acids.

UNIT III

Structure and biological functions of vitamins, enzymes classification and mechanism of action; regulation, factors affecting enzyme action. Hormones animal plants and insects, Fundamentals of thermodynamic principles applicable to biological processes, Bioenergetics.

UNIT IV

Metabolism of carbohydrates, photosynthesis and respiration, oxidative phosphorylation, lipids, proteins and nucleic acids. DNA replication, transcription and translation; recombinant DNA technology

Practical

Preparation of standard and buffer solutions, Extraction and estimation of sugars, Amino acids,Estimation of Proteins by Lowry's method, Estimation of DNA and RNA by diphenylamine and orcinol methods, Estimation of Ascorbic acid, Separation of biomolecules by TLC and Paper chromatography.

Suggested Readings

Conn EE & Stumpf PK. 1987. *Outlines of Biochemistry*. John Wiley.

Metzler DE. 2006. *Biochemistry*. Vols. I, II. Wiley International.

Nelson DL & Cox MM. 2004. *Lehninger Principles of Biochemistry*. 4th Ed. MacMillan.

Voet D, Voet JG & Pratt CW. 2007. *Fundamentals of Biochemistry*. John Wiley.

BIOCHEM 502 **INTERMEDIARY METABOLISM** **2+1**

Objective

To teach metabolic pathways, their regulation and engineering, and methods used in their elucidation.

Theory

UNIT I

The living cell a unique chemical system, Introduction to metabolism, methods of studying metabolism, transport mechanism, bioenergetics, biological oxidation, signal transduction.

UNIT II

Catabolic and anabolic pathways of carbohydrates, lipids, regulation and their metabolic disorders. Energy transduction and oxidative phosphorylation.

UNIT III

General reactions of amino acid metabolism, Degradative and biosynthetic pathways of amino acids and their metabolic disorders. Sulphur metabolism, Metabolic engineering concepts.

UNIT IV

Compartmentation of metabolic pathways, metabolic profiles of major organs and regulation of metabolic pathways.

Practical

Estimation of glucose, total cholesterol, lipoproteins, triglyceride, urea, protein, albumin & globulin ratio, hemoglobin ,calcium, iron, zinc, Glutamate oxaloacetate transaminase, Glutamate pyruvate transaminase & bile pigments in blood. Estimation of glucose & creatinine in urine.

Suggested Readings

Berg JM, Tymoczko JL, Stryer L & Clarke ND 2000. *Biochemistry*. 5th Ed.

WH Freeman & Co.

Metzler DE. 2006. *Biochemistry*. Vols. I, II. John Wiley.

Voet D, Voet JG & Pratt CW. 2007. *Fundamentals of Biochemistry*. John Wiley.

Zubey GL. 1998. Biochemistry. 4th Ed. WCB London.

BIOCHEM 503 ENZYMOLOGY 2+1

Objective

To impart knowledge about the catalytic role of enzymes, their structure, physico-chemical, kinetic and regulatory properties and mechanism of action.

Theory

UNIT I

Introduction and historic perspective, Enzyme nomenclature and classification, enzyme compartmentalization in cell organelles, isolation and purification of enzymes, measurement of enzyme activity. ribozymes, isozymes, abzymes,

UNIT II

Enzyme structure, enzyme specificity, active site, active site mapping, mechanism of enzyme catalysis. cofactors, coenzymes- their structure and role.

UNIT III

Enzyme kinetics, enzyme inhibition and activation, multienzyme complexes, allosteric enzymes and their kinetics, regulation of enzyme activity.

UNIT IV

Isolation and purification of enzymes, Applications of enzymes in chemical and food industry, enzyme immobilization, biosensors and clinical applications of enzymes.

Practical

Enzyme assay by taking any model enzyme like alpha-amylase or acid phosphatase,isolation and purification of any model enzyme like alpha amylase or acid phosphatase,study of the effect of enzyme and substrate concentrations and determination of Km and Vmax,determination of pH and temperature optima and effect of various inhibitors,determination of the pH and temperature stability of enzyme.

Suggested Readings

Bergmeyer HU. 1983. *Methods of Enzymatic Analysis.* Vol. II. Verlag Chemie, Academic Press.

Dixon M, Webb EC, Thorne CJR & Tipton KF. 1979. *Enzymes*. 3rd Ed. Longman.

Maragoni AG. 2003. *Enzyme Kinetics - A Modern Approach.* John Wiley.

Palmer T. 2001. *Enzymes: Biochemistry, Biotechnology and Clinical Chemistry.* 5th Ed. Horwood Publ.

Price NC & Stevens L. 2003. *Fundamentals of Enzymology.* Oxford Univ. Press.

Wilson K & Walker J. (Eds.). 2000. *Principles and Techniques of Practical Biochemistry.* 5th Ed. Cambridge Univ. Press.

BIOCHEM 504 MOLECULAR BIOLOGY 2+1

Objective

To provide knowledge regarding genes, their functions, expression, regulation and transfer in heterologous systems.

Theory

UNIT I

Historical development of molecular biology, nucleic acids as genetic material, chemistry and structure of DNA and RNA, Genome organization in prokaryotes and eukaryotes, chromatin structure and function.

UNIT II

DNA replication, DNA polymerases, topoisomerases, DNA ligase, reverse transcriptase, repetitive and non-repetitive DNA, satellite DNA; transcription process, RNA editing, RNA processing.

UNIT III

Ribosomes structure and function, organization of ribosomal proteins and RNA genes, genetic code, aminoacyl tRNA synthases' inhibitors of replication, transcription and translation; translation and Post translational modification; nucleases and restriction enzymes, regulation of gene expression in prokaryotes and eukaryotes, molecular mechanism of mutation.

UNIT IV

DNA sequencing, recombinant DNA technology, vectors, isolation of genes, recombinants vector, selection of recombinants, PCR; general features of replication, transcription, site directed mutagenesis and translation in eukaryotes.

Practical

Isolation and purification of DNA and RNA from different sources, check of purity of isolated DNA and RNA, restriction fragmentation and separation of oligos by agarose electrophoresis,RAPD analysis of DNA, cDNA synthesis using PCR, Southern and Northern blotting experiments

Suggested Readings

Adams RLP, Knowler JT & Leader DP. 1992. *The Biochemistry of the Nucleic Acids*. 11th Ed. Chapman & Hall.

Alberts B, Bray D, Lewis J, Raff M, Roberts K & Watson JD 2006. *Molecular Biology of the Cell*. 6th Ed. Garland Publ.

Blackburn GM & Gait MJ. 1996. *Nucleic Acids in Chemistry and Biology*. 2nd Ed. Oxford University Press.

Freifelder D & Malacinski GM. 1996. *Essentials of Molecular Biology*. 3rd Ed. Panima.

Glick BR & Pasternak JJ. 1994. *Molecular Biology: Principles and Applications of Recombinant DNA Technology*. ASM Press.

Lewin B. 2007. *Genes* IX. Oxford University Press.

Lodish H, Berk A, Zipursky SA, Matsudaira P, Baltimore D & Darnell J. 1999. *Molecular Cell Biology*. WH Freeman.

Old RW & Primrose SB. 1989. *Principles of Gene Manipulation*: *An Introduction to Genetic Engineering*. 4th Ed. Blackwell Scientific Publ.

Sambrook J & Russel DW. 2001. *Molecular Cloning: A Laboratory Manual*. Vols. I-III. Cold Spring Harbor.

BIOCHEM 505 BIOCHEMICAL TECHNIQUES 1+2

Objective

To impart practical knowledge about various techniques used in purification and characterization and estimation of cellular constituents.

Theory

UNIT I

Chromatographic and electrophoretic methods of separation, Principles and applications of Paper, Thin layer & HPTLC, Gas, Gas-liquid, Liquid chromatography, HPLC and FPLC; Paper and gel electrophoresis, Different variants of polyacrylamide gel electrophoresis (PAGE) like native and SDS-PAGE, 2D-PAGE, capillary electrophoresis.

UNIT II

Spectrophotometry: Principles and applications UV-Visible, Fluorescence, IR and FTIR, Raman, NMR and FTNMR, ESR and X-Ray spectroscopy.

UNIT III

Hydrodyanmic methods of separation of biomolecules such as viscosity and sedimentation- their principles, variants and applications.

UNIT IV

Tracer techniques in biology: Concept of radioactivity, radioactivity counting methods with principles of different types of counters, concept of a b and g emitters, scintillation counters, g-ray spectrometers, autoradiography, applications of radioactive tracers in biology, principles and applications of phosphor imager.

Practical

Determination of absorption maxima of some important chemicals from their absorption spectra, estimation of biomolecule using spectrophotometer, Separation of carbohydrates and amino acids by paper chromatography, Separation of lipids by thin layer and column chromatography, Separation of proteins by ion exchange and gel filtration chromatography, Electrophoretic techniques to separate proteins and nucleic acids ,Centrifugation- Cell fractionation, Application of GLC, HPLC, FPLC in separation of biomolecules,Use of radioisotopes in metabolic studies.

Suggested Readings

Clark JM. 1977. *Experimental Biochemistry*. 2nd Ed. WH Freeman. Sawhney SK & Singh R. 2000. *Introductory Practical Biochemistry*. 2nd Ed. Narosa.

Willard M, Merritt LL & Dean JA.1981. *Instrumental Methods of Analysis*. 4th Ed. Van Nostrand.

William BL & Wilson K. 1975. *Principles and Techniques of Practical Biochemistry*. Edward Arnold.

Wilson K, Walker J & Walker JM. 2005. *Principles and Techniques of Practical Biochemistry*. Cambridge Univ. Press.

BIOCHEM 506 IMMUNOCHEMISTRY 2+1

Objective

To give an insight into the biochemical basis of immunity.

Theory

UNIT I

History and scope of immunology, antigens, adjuvants, immune system, organs, tissues and cells, immunoglobulins, molecular organization of Immunoglobulin.

UNIT II

Classes of antibodies, Antibody diversity, theories of generation of antibody diversity, Vaccine, Monoclonal antibodies, polyclonal antibodies, Hybridoma, Recombinant antibodies, complement system- classical and alternate.

UNIT III

Cellular interactions in the immune response, major histocompatibility complex, cell mediated immune response, cytokines.

UNIT IV

Immunoregulation, immunological tolerance, hypersensitivity, mechanisms of immunity, innate resistance and specific immunity. Current immunological techniques-ELISA, RIA

Practical

Handling, inoculation and bleeding of laboratory animals, Preparation of antigens and antisera, natural antibodies, Carbon clearance test, lymphoid organs of the mouse, Morphology of the blood leucocytes, separation of lymphocytes from blood, viable lymphocyte count, Antigen-antibody interaction, precipitation, agglutination, direct and indirect haemagglutination, Immunoelectrophoresis, Complement fixation, Quantitation of immunoglobulins by zinc sulphate turbidity and single radial immunodiffusion.

Suggested Readings

Abbas AK & Lichtman AH. 2003. *Cellular and Molecular Immunology*. 5th Ed. WB Saunders.

Goldsby RA, Kindt TJ & Osborne BA. 2003. *Immunology*. 4th Ed. WH Freeman.

Harlow & Lane D. (Eds.) 1988. *Antibodies: A Laboratory Manual*. Cold Spring Harbor Laboratory.

Kuby J. 1996. *Immunology*. 3rd Ed. WH Freeman.

Male D, Brostoff J, Roth DB & Roitt I. 2006. *Immunology*. 7th Ed. Elsevier.

BIOCHEM 507 PLANT BIOCHEMISTRY 3+0

Objective

Detailed information about biochemical and molecular basis of various plant processes and plant growth regulatory substances.

Theory

UNIT I

Scope and importance of biochemistry in Agriculture, Plant cell organelles and their separation, structure and function of cell organelle. Photosynthetic pigments in relation to their functions, photosynthesis, C3, C4 and CAM pathways, photorespiration.

UNIT II

Sucrose-starch interconversion, biosynthesis of structural carbohydrates, storage proteins and lipids. Biochemistry of nitrogen fixation and nitrate assimilation, sulphate reduction and incorporation of sulphur in to amino acids.

UNIT III

Biochemistry of seed germination and development, Biochemistry of fruit ripening, phytohormones and their mode of action, signal transduction.

UNIT IV

Biochemistry and significance of secondary metabolites-cyanogenic glycosides, glucosinolates, phenolic compounds, terpenoids, alkaloids, plant defense system.

Suggested Readings

Buchanan BB, Gruissem W & Jones RL. 2000. *Biochemistry and Molecular Biology of Plants*. 2nd Ed. John Wiley.

Dey PM & Harborne JB. 1997. *Plant Biochemistry*. Academic Press.

Goodwin TW & Mercer EI. 1983. *Introduction to Plant Biochemistry*. Pergamon Press.

Heldt HS. 1997. *Plant Biochemistry and Molecular Biology*. Oxford Univ. Press.

Lea PJ & Leegood RC. 1993. *Plant Biochemistry and Molecular Biology*. 2nd Ed. John Wiley.

BIOCHEM 508 ANIMAL BIOCHEMISTRY 3+0

Objective

To impart knowledge regarding biochemistry of various physiological processes, specialized tissues and hormone action in animal system.

Theory

UNIT I

Digestion and absorption of food, Vitamins,, Detoxification, biochemistry of specialized tissues – connective tissue, skin, muscle, nervous tissue and blood and other body fluids.

UNIT II

Water, electrolyte and acid-base balance, biochemistry of respiration, structure, function and mechanism of major trace elements.

UNIT III

Hormones of thyroid, hypothalamus, pituitary, pancreas, adrenals and sex hormones, Membrane receptors of hormones, signal transduction, biochemistry of reproduction.

UNIT IV

Immune systems, immunoglobulins, monoclonal antibodies, formation of antibody, antibody diversity, complement system – classical and alternate, major histocompatibility complexes, cell mediated immune response, mechanisms of immunity.

Suggested Readings

Devlin TM. 2006. *Text Book of Biochemistry with Clinical Correlations.* 6th Ed. John Wiley.

Goldsby RA, Kindt TJ, Kuby J & Osborne BA. 2003. *Immunology.* 4th Ed. WH Freeman. & Co.

Harper H. A. 2000. *Physiological Chemistry.* MacMillan.

Buchanan BB, Gruissem W & Jones RL. 2000. *Biochemistry and Molecular Biology of Plants.* 2nd Ed. John Wiley.

BIOCHEM 509 FOOD AND NUTRITIONAL BIOCHEMISTRY 2+1

Objective

To impart knowledge regarding the biochemical aspects of various nutrients and their interactions in foods during processing, storage and deterioration.

Theory

UNIT I

Fundamentals of humam nutrition, concept of balanced diet, biochemical composition, energy and food value of various food grains (including cereals, pulses, oilseeds), fruits and vegetables. Physico-chemical, functional and nutritional characteristics of carbohydrates, proteins and fats and their interactions (emulsions, gelation, browning etc.).

UNIT II

Biochemical and nutritional aspects of vitamins, minerals Nutraceuticals, antinutritional factors, biochemistry of post harvest storage.

UNIT III

Effect of cooking, processing and preservation of different food products on nutrients, biochemical aspects of food spoilage, role of lipase and lipoxygenase, oxidative rancidity and antioxidants.

UNIT IV

Enzymes in food industry, food additives (coloring agents, preservatives etc.), biogenesis of food flavours and aroma, nutritional quality of plant, dairy, poultry and marine products.

Practical

Estimation of starch, lipid/oil, phenols in plant tissue/sample, Estimation of carotenoids, Estimation of Trypsin and chymotrypsin inhibitor activities in seeds, Estimation of Vitamin C in fruits,Reducing & non reducing sugar in fruits, Estimation of protein contents, Estimation of dietary fibre, Determination of limiting amino acids, Estimation of Phytate/Oxalate.

Suggested Readings

Alais C & Lindel G. 1995. *Food Biochemistry*. Amazon Springer.

DeMan JM. 1999. *Principles of Food Chemistry*. 3rd Ed. Springer.

Fennema OR. 1996. *Food Chemistry*. 3rd Ed. CRC Press.

Hulme AC. (Ed.). 1970. *Biochemistry of Fruits and Vegetables and their Products*. Vols. I, II. Academic Press.

Ranganna S. (Ed.). 1986. *Handbook of Analysis and Quality for Fruits and Vegetable Products*. Tata McGraw Hill.

Robinson DS. 1987. *Food Biochemistry and Nutritional Value*. Longman.

BIOCHEM 510 CARBON AND NITROGEN METABOLISM 2+1

Objective

To impart knowledge of general carbon and nitrogen metabolism in plants with special reference to starch and cell wall polysaccharides and biological nitrogen fixation and assimilatory pathways.

Theory

UNIT I

Carbon metabolism: Synthesis of sucrose, Regulation of sucrose phosphate synthesis, Transport of sucrose, phloem loading and unloading, synthesis of starch in leaves and seeds, concept of transitory starch.

UNIT II

Synthesis of fructose, galactomannans raffinose series oligosaccharides and trehalose.

UNIT III

Nitrogen cycle- Biochemistry of nitrate assimilation and its regulation, GS/GOGAT and GDH pathway, ureides and amides as nitrogen transport compounds, chemoautotrophy in denitrifying bacteria.

UNIT IV

Biological nitrogen fixation; structure function and regulation of nitrogenase; nif genes and their regulation; biochemical basis of legume- Rhizobium symbiosis, genes involved in synthesis.

Practical

Estimation of nitrite content, Estimation of protein by Lowry's method, Estimation of starch, Estimation of nitrate content by hydrazine sulphate reduction method, i*n vivo* assay of nitrate reductase activity, *in vitro* assay of nitrate reductase activity, *in vitro* assay of nitrite reductase activity, *in vitro* assay of glutamine synthetase activity, *in vitro* assay of glutamate synthase and glutamate dehydrogenase activity, Estimation of ureides and amides, Assay of nitrogenase activity by acetylene reduction method, Estimation of hydrogen evolution by legume nodules.

Suggested Readings

Beevers L. 1979. *Nitrogen Metabolism in Plants.* Gulab Vazirani for Arnold-Heinermann.

Bergersen FJ. (Ed.). 1980. *Methods for Evaluating Biological Nitrogen Fixation.* John Wiley & Sons.

Bray CM. 1983. *Nitrogen Metabolism in Plants.* Longman Buchanan BB, Gruissem W & James RL. (Eds.). 2000. *Biochemistry and*

Molecular Biology of Plants. American Society of Plant Physiologists.

Mehta SL, Lodha ML & Sane PV. (Eds.). 1993. *Recent Advances in Plant Biochemistry.* ICAR.

BIOCHEM 601 ADVANCED ENZYMOLOGY 2+0

Objective

To provide advanced knowledge about the structure, mechanism, kinetics and regulation of enzymes and their use as biosensors.

Theory

UNIT I

Theory of enzymatic catalysis, specificity, concept of active site and enzyme substrate complex, active site mapping, acid-base and covalent catalysis, factors associated with catalytic efficiency, proximity and orientation, distortion and strain, induced fit hypothesis, Mechanism of enzyme reactions.

UNIT II

Effect of different factors affecting enzyme activity, transition state theory, Arrhenius equation, Determination of energy of activation, kinetics of pH and temperature and determination of pKa and ▯H of active site amino acids.

UNIT III

Kinetics of bisubstrate reactions, mechanism determination by radioisotope exchange, kinetics of mixed inhibitions, substrate and product inhibition.

UNIT IV

Role of enzymes in regulation of metabolism, allosteric enzymes and their kinetics, enzyme engineering, Bifunctional enzymes, enzyme engineering,

Suggested Readings

Dixon M & Web EC. 1979. *Enzymes*. 3rd Ed. Longmans Green.

Seigel IH. 1975. *Enzyme Kinetics*. John Wiley.

Selected reviews and articles from journals.

BIOCHEM 602 ADVANCED MOLECULAR BIOLOGY 3+0

Objective

To impart latest information on the molecular biochemistry of isolation, transfer and expression of genes in plants and biochemical approaches employed in gene therapy.

Theory

UNIT I

Organization of prokaryotic genome, nuclear and organelle genes, concept of genome mapping, molecular evolution, cell development and differentiation.

UNIT II

Prokaryotic and eukaryotic gene regulation, RNA editing, molecular biology of viruses.

UNIT III

Methods of gene isolation and transfer in plants and animals, molecular basis of male sterility, Application of genetic engineering in different fields.

UNIT IV

Site directed mutagenesis, gene targeting and gene therapy, bioethics and biosafety guidelines and IPR in recombinant DNA research.

Suggested Readings

Alberts B, Bray D, Lewis J, Raff M, Roberts K & Watson JD. 2006.

Molecular Biology of the Cell. 6th Ed. Garland Publ.

Lewin B. 2007. *Gene IX*. 9th Ed. Pearson Publ.

Selected articles from journals.

BIOCHEM 603 BIOCHEMISTRY OF BIOTIC AND ABIOTIC STRESSES 3+0

Objective

To impart latest development about biochemistry of biotic and abiotic stresses in plants.

Theory

UNIT I

Plant-pathogen interaction and disease development; molecular mechanisms of fungal and bacterial infection in plants; changes in metabolism, cell wall composition and vascular transport in diseased plants.

UNIT II

Plant defence response, antimicrobial molecules; genes for resistance, hypersensitive response and cell death; systemic and acquired resistance.

UNIT III

Plant viruses, host-virus interactions, disease induction, virus movement, and host range determination; viroids, pathogen-derived resistance.

UNIT IV

Biochemical basis of abiotic stresses namely osmotic (drought, salinity), temperature, heavy metals, air and water pollutants, synthesis and functions of proline and glycine betaine in stress tolerance interaction between biotic and abiotic stresses; stress adaptation.

UNIT V

Reactive oxygen species and biotic and abiotic stress, antioxidants, enzymes defense system. Role of calcium, nitric oxide and salicylic acid in plant development. Molecular strategies for imparting tolerance against biotic and abiotic stress.

Suggested Readings

Basra AS. 1997. *Stress Induced Gene Expression in Plants*. Harwood Academic Publ.

Chessin M, DeBorde D & Zipf A. 1995. *Antiviral Proteins in Higher Plants*. CRC Press.

Crute IR, Burdon JJ & Holub EB. (Eds.). 1997. *Gene-for-Gene Relationship in Host-Parasite Interactions*. CABI.

BIOCHEM 604 CURRENT TOPICS IN BIOCHEMISTRY 1+0

Objective

To acquaint the students with the advanced developments in the field of biochemistry and to inculcate the habit of searching and reading the topics of current importance.

Theory

UNIT I

Advanced topics related to Nutrition and metabolism.

UNIT II

Advanced topics related to enzymology and industrial biochemistry.

UNIT III

Advanced topics related to molecular biochemistry and immunology.

UNIT IV

Advanced topics related to metabolic engineering and bioprospecting.

Suggested Readings

Selected articles from journals.

BIOCHEM 605 FUNCTIONAL GENOMICS AND METABOLOMICS 3+0

Objective

To impart knowledge in the upcoming areas of biochemistry. and to acquaint the students with the recent developments of job opportunities in pharmaceutical and other industries.

Theory

UNIT I

Protein and nucleic acid sequencing: Various methods of sequencing including automated sequencing and microarrays, whole genome sequence analysis.

UNIT II

Comparative genomics, functional genomics, transcriptomics, gene identification, gene annotation, pairwise and multiple alignments, application of genomics, Quantitative PCR, SAGE, MPSS, microarray.

UNIT III

Proteome technology- 2D-PAGE, MSMS, MALDI-TOF, protein microarray, comparative proteomics and structural proteomics.

UNIT IV

Metabolic pathway engineering, vitamin A engineering in cereals, microarray analysis, role of bioinformatics in functional genomics.

Suggested Readings

Baxevanis AD & Ouellette BFF. 2004. *Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins.* 3rd Ed. Wiley InterScience.

Dale JW & Schantz MV. 2002. *From Genes to Genomes.* John Wiley.

Lieber DC. 2002. *Introduction to Proteomics - Tools for the New Biology.* Humana Press.

Suhai S. 2002. *Genomics and Proteomics - Functional and Computational Aspects.* Kluwer.

BIOCHEM 606 BIOMEMBRANES 2+0

Objective

To teach structure and functions of biomembranes, structure-function relationships, membrane biogenesis.

Theory

UNIT I

Concept of biomembranes and their classification based on cellular organelles; physico-chemical properties of different biological and artificial membranes, cell surface receptors and antigen.

UNIT II

Membrane biogenesis and differentiation; membrane components-lipids, their distribution and organization; proteins, intrinsic and extrinsic, their arrangement; carbohydrates in membranes and their function.

UNIT III

Various membrane movements; transport across membrane and energy transduction.

UNIT IV

Role of membrane in cellular metabolism, cell recognition and cell –to – cell interaction; signal transduction, recent trends and tools in membrane research.

Suggested Readings

Lodish H, Berk A, Zipursky SA, Matsudaira P, Baltimore D & Darnel J. 1999. *Molecular Cell Biology*. WH Freeman.

Nelson DL & Cox MM. 2000. *Lehninger Principles of Biochemistry*. 3rd Ed. Printed in India by Replika Press Pvt. Ltd., New Delhi for Worth Publ., New York.

Smallwood M, Knox JP & Bowls BJ. 1996. *Membranes: Specialized Functions in Plants*. Bros. Scientific Publ.

BIOCHEM 607 ADVANCED TECHNIQUES IN BIOCHEMISTRY 0+2

Objective

To impart students a hands on training of techniques of biochemistry and molecular biology.

Practical

Isolation and purification of protein from microbial/plant/animal source. Electrophoretic separation of protein. Determination of molecular weight of protein using PAGE/ gel filtration method. Experiments on DNA: Isolation, agarose gel electrophoresis and restriction analysis of DNA. Isolation of chloroplast and mitochondria by differential centrifugation and their purification by density gradient centrifugation. Isolation and purification of enzymes, isozymic analysis and enzyme immobilization

Suggested Readings

Kolowick NP & Kaplan NP. *Methods in Enzymology*. Academic Press (Series).

Plummer DT. 1998. *An Introduction to Practical Biochemistry*. 3rd Ed. Tata McGraw Hill.

Rickwood D. (Ed.). 1984. *Practical Approaches in Biochemistry*. 2nd Ed. IRL Press, Washington DC.

Wilson K & Goulding KH. 1992. *A Biologist's Guide to Principles and Techniques of Practical Biochemistry*. 3rd Ed. Cambridge Univ. Press.

Wilson K & Walker J. 2000. *Principles and Techniques of Practical Biochemistry*. 5th Ed. Cambridge Univ. Press.

List of Journals

Annual Review of Biochemistry

Annual Review of Genetics

Annual Review of Plant Physiology and Plant Molecular Biology

Biochemical and Biophysical Research Communication

Biochemical Journal

Biochim. Biophysic Acta

Cell

Current Science

Federation of European Biochemical Society

Indian Journal of Experimental Biology

Journal of Biological Chemistry

Journal of Immunology

Journal of Molecular Modeling

Journal of Plant Biochemistry and Biotechnology

Nature

Physiologia Plantarum

Plant Physiology

Plant Science

Planta

Proceedings of National Academy of Sciences, USA

Protein Science

RNA

Science

Scientific American

Trends in Biochemical Sciences

Trends in Biotechnology

Trends in Plant Sciences

e-Resources

www.unixl.com/dir/molecular_sciences/biochemistry/biochemistry_jobs/

www.unixl.com/dir/medical_sciences/

http://www.ncbi.nlm.nih.gov/

http://us.expasy.org

http://us.expasy.org/spdbv/

http://www.brenda.uni-koeln.de/

http://www.worthington-biochem.com

http://www.cefotaxime.net

http://home.123india.com/nbsc/

http://www.biochemist.org

http://www.gwu.edu/~mpb

Suggested Broad Topics for Master's and Doctoral Research

Immobilization of industrially important enzymes

Manipulation of metabolic pathways for reserve biosynthesis and utilization.

Biochemistry and molecular biology of biotic and abiotic stresses in plants.

Biochemistry of fruits and vegetables during ripening and post ripening.

Manipulation of metabolic pathways at molecular level to increase shelf life of fruits and to increase contents of alkaloids, flavones and isoflavones, PUFA etc.

Use of molecular markers for identification and improvement of crop plants.

Enzyme engineering and functional genomics/proteomics.

Biochemical and molecular evaluation of varieties for quality improvement.

Use of biomolecules as biosensors.

Study of metabolome and elucidation of metabolic pathway of secondary metabolites.

COMPUTER APPLICATIONS

Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
MCA 501	Computers Fundamentals and Programming	2+1
MCA 502	Introduction to Networking and Internet Applications	1+1

MCA 501 COMPUTER FUNDAMENTALS AND PROGRAMMING 2+1

Objective

This course builds an understanding of the structure of computers, execution of programmes, data representation and computer arithmetic. The course also provides exposure to developing problem-solving strategies, techniques and skills.

Theory

UNIT I

Computer Fundamentals - Number systems: decimal, octal, binary and hexadecimal; Representation of integers, fixed and floating point numbers, character representation; ASCII, EBCDIC.

UNIT II

Functional units of computer: I/O devices, primary and secondary memories.

UNIT III

Programming fundamentals with C - Algorithm, techniques of problem solving, flowcharting, stepwise refinement; Representation of integer, character, real, data types; Constants and variables; Arithmetic expressions, assignment statement, logical expression.

UNIT IV

Sequencing, alteration and iteration; Arrays, string processing.

UNIT V

Sub-programs, recursion, pointers and files

UNIT VI

Program correctness, Debugging and testing of programs

Practical

Conversion of different number types; Creation of flow chart, conversion of algorithm/flowchart to program; Mathematical operators, operator precedence; Sequence, control and iteration; Arrays and string processing; Pointers and File processing.

References

Balaguruswamy E. 1998. *Programming with ANSI C.* Tata McGraw Hill.

Gottfried B. 1999. *Programming with C, Schaum Outline Series.* Tata McGraw Hill.

Kanetkar Y. 1999. *Let Us C.* BPB Publ.

Malvino AP & Brown JA. 1999. *Digital Computer Electronics.* Tata McGraw Hill.

Mano MM. 1999. *Digital Logic and Computer Design.* Prentice Hall of India.

MCA 502 **INTRODUCTION TO NETWORKING AND INTERNET APPLICATIONS** 1+1

Objective

The course is aimed at providing fundamentals of networking and application protocols with emphasis on web based applications.

Theory

UNIT I

Networking fundamentals, types of networking, network topology; Introduction to File Transfer Protocol (FTP), Telnet, Simple Mail Transfer Protocol (SMTP)

UNIT II

World Wide Web (WWW), working with Internet; Web pages, web sites, web servers; Web Applications

UNIT III

Hyper Text Markup Language (HTML), DHTML, web based application development.

Practical

Network and mail configuration; Using Network Services; Browsing of Internet; Creation of web pages; Creation of websites using HTML and Creation of websites using DHTML.

References

Buyens J. 2002. *Microsoft FrontPage -Inside Out.* Microsoft Press.

Cox V, Wermers L & Reding EE. 2006. *HTML Illustrated Complete.* 3rd Ed. Course Technology.

Niederst J. 2001. *Web Design in a Nutshell.* O'Reilly Media.

Tanenbaum AS. 2003. *Computer Networks.* Prentice Hall of India.

ENTOMOLOGY
Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
ENT 501*	INSECT MORPHOLOGY	1+1
ENT 502*	INSECT ANATOMY, PHYSIOLOGY AND NUTRITION	2+1
ENT 503	PRINCIPLES OF TAXONOMY	2+0
ENT 504*	CLASSIFICATION OF INSECTS	2+1
ENT 505*	INSECT ECOLOGY	1+1
ENT 506	INSECT PATHOLOGY	1+1
ENT 507*	BIOLOGICAL CONTROL OF CROP PESTS AND WEEDS	1+1
ENT 508*	TOXICOLOGY OF INSECTICIDES	2+1
ENT 509	PLANT RESISTANCE TO INSECTS	1+1
ENT 510*	PRINCIPLES OF INTEGRATED PEST MANAGEMENT	1+1
ENT 511*#	PESTS OF FIELD CROPS	1+1
ENT 512*#	PESTS OF HORTICULTURAL AND PLANTATION CROPS	1+1
ENT 513	STORAGE ENTOMOLOGY	1+1
ENT 514	INSECT VECTORS OF PLANT VIRUSES AND OTHER PATHOGENS	1+1
ENT 515	GENERAL ACAROLOGY	1+1
ENT 516	SOIL ARTHROPODS AND THEIR MANAGEMENT	1+1
ENT 517	VERTEBRATE PEST MANAGEMENT	1+1
ENT 518*	TECHNIQUES IN PLANT PROTECTION	0+1
ENT 519	COMMERCIAL ENTOMOLOGY	1+1
ENT 520	PLANT QUARANTINE	2+0
ENT 591	MASTER'S SEMINAR	1+0
ENT 599	MASTER'S RESEARCH	20
ENT 601	ADVANCED INSECT SYSTEMATICS	1+2
ENT 602	IMMATURE STAGES OF INSECTS	1+1
ENT 603	ADVANCED INSECT PHYSIOLOGY	2+0
ENT 604	ADVANCED INSECT ECOLOGY	1+1
ENT 605	INSECT BEHAVIOUR	1+1
ENT 606	RECENT TRENDS IN BIOLOGICAL CONTROL	1+1
ENT 607	ADVANCED INSECTICIDE TOXICOLOGY	2+1
ENT 608	ADVANCED HOST PLANT RESISTANCE	1+1
ENT 609	ADVANCED ACAROLOGY	1+1

CODE	COURSE TITLE	CREDITS
ENT 610	AGRICULTURAL ORNITHOLOGY	1+1
ENT 611**	MOLECULAR APPROACHES IN ENTOMOLOGICAL RESEARCH	1+1
ENT 612**	ADVANCED INTEGRATED PEST MANAGEMENT	2+0
ENT 613/ PL. PATH 606$	PLANT BIOSECURITY AND BIOSAFETY	2+0
ENT 691	DOCTORAL SEMINAR 1	1+0
ENT 692	DOCTORAL SEMINAR II	1+0
ENT 699	DOCTORAL RESEARCH	45

* Compulsory for Master's programme

** Compulsory for Ph.D. programme

One out of 511 or 512 is compulsory

$ Cross-listed with Plant Pathology

Minor Departments **9**

Plant Pathology

Supporting Departments **5**

Statistics and Mathematics

Biochemistry

Non credit compulsory courses

CODE	COURSE TITLE	CREDITS
PGS 501	LIBRARY AND INFORMATION SERVICES	0+1
PGS 502	TECHNICAL WRITING AND COMMUNICATION SKILLS	0+1
PGS 503 (e-course)	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1+0
PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1
PGS 505 (e-course)	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1+0
PGS 506 (e-course)	DISASTER MANAGEMENT	1+0

ENT 501 **INSECT MORPHOLOGY** **1+1**

Objective

To acquaint the students with external morphology of the insect's body i.e., head, thorax and abdomen, their appendages and functions.

Theory

UNIT I

Importance of morphology, evolution of insects; insect body wall- structure, cuticular outgrowths, colouration and special integumentary structures in insects; body tagmata, sclerites and segmentation.

UNIT II

Head- Origin, structure and modifications; types of mouthparts and antennae, tentorium and neck sclerites.

UNIT III

Thorax- Areas and sutures of tergum, sternum and pleuron, pterothorax; Wings- structure and modifications, venation, wing coupling apparatus and mechanism of flight; Legs- structure and modifications.

UNIT IV

Abdomen- Segmentation and appendages; Genitalia and their modifications; Embryonic and post-embryonic development; Types of metamorphosis; Insect sense organs (mechano photo, auditory - and chemoreceptors).

Practical

Preparation of permanent slides. Measurements of microstructures using micrometry. Camera lucida drawings, Study of structure and types of eggs, larvae and pupae. Study of Structure of Head in Cockroaches, Grasshoppers and Plant bugs. Study of Structure of Head in Lepidoptera and Coleoptera Study of Structure of Head in Diptera and Hymenoptera. Study of mouthparts in Grasshoppers , Moths and Plant bugs, Study of mouthparts in Honeybees and Houseflies. Study of structure of thorax in Grasshoppers and Beetles. Study of modifications of antennae and legs in different insects. Study of modifications of wings and wing coupling organs in insects. Study of the structure of the abdomen in Orthopterans, Coleopterans & Hymenopterans. Study of the structure of female genitalia of insects Study of structure of male genitalia of insects, Evaluation.

Suggested references

Chapman RF. 1998. *The Insects: Structure and Function.* Cambridge Univ. Press, Cambridge.

David BV & Ananthkrishnan TN. 2004. *General and Applied Entomology.* Tata-McGraw Hill, New Delhi.

Duntson PA. 2004. *The Insects: Structure, Function and Biodiversity.* Kalyani Publ., New Delhi.

Evans JW. 2004. *Outlines of Agricultural Entomology.* Asiatic Publ., New Delhi.

Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology.* 10th Ed. Chapman & Hall, London.

Saxena RC & Srivastava RC. 2007. *Entomology: At a Glance.* Agrotech Publ. Academy, Jodhpur.

Snodgross RE. 1993. *Principles of Insect Morphology.* Cornell Univ. Press, Ithaca.

ENT 502 INSECT ANATOMY, PHYSIOLOGY AND NUTRITION 2+1

Objective

To impart knowledge to the students on basic aspects of anatomy of different insect systems, elementary physiology, nutritional physiology and their application in entomology.

Theory

UNIT I

Scope and importance of insect anatomy and physiology.

UNIT II

Structure, modification and physiology of different systems- digestive, circulatory, respiratory, excretory, nervous, sensory, reproductive, muscular, endocrine and exocrine glands.

UNIT III

Thermodynamics; physiology of integument, moulting, growth, metamorphosis and diapause.

UNIT IV

Insect nutrition- role of vitamins, proteins, amino acids, carbohydrates, lipids, minerals and other food constituents; extra and intra-cellular microorganisms and their role in physiology; artificial diets.

Practical

Dissection of grasshoppers/ cockroaches to study the digestive, reproductive systems and other systems – preparation of permanent mounts of internal systems. Estimation of free amino acids in haemolymph – chromatographic analysis, Estimation of chitin in insect cuticle, ,Haemocytes staining and counting, Determination of respiratory quotient , Preparation of various artificial diets and its evaluation, Classification and determination of growth ratios in insects, Consumption, utilization and digestion of natural and artificial diets.

Suggested Readings

Chapman RF.1998. *Insects: Structure and Function.* ELBS Ed., London.

Duntson PA. 2004. *The Insects: Structure, Function and Biodiversity.* Kalyani Publ., New Delhi.

Kerkut GA & Gilbert LI. 1985. *Comprehensive Insect Physiology, Biochemistry and Pharmacology.* Vols. I-XIII. Pergamon Press, New York.

Patnaik BD. 2002. *Physiology of Insects.* Dominant, New Delhi.

Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology.* 10th Ed. Vol. 1. *Structure, Physiology and Development.* Chapman & Hall, New York.

Saxena RC & Srivastava RC. 2007. *Entomology at a Glance.* Agrotech Publ. Academy, Jodhpur.

Wigglesworth VB.1984. *Insect Physiology*. 8th Ed. Chapman & Hall, New York

Pant N.C. and Ghai, S .1981.Insect physiology and anatomy, ICAR, New Delhi

Gour, T.B. and Sriramulu, M. 2004. Insect Physiology principles and concepts. Kalyani Publishers, Hyerabad. 187p

ENT 503 **PRINCIPLES OF TAXONOMY** **2+0**

Objective

To sensitize the students on the theory and practice of classifying organisms and the rules governing the same.

Theory

UNIT I

Introduction to history and principles of systematics and importance. Levels and functions of systematics. Identification, purpose, methodscharacter matrix, taxonomic keys. Descriptions- subjects of descriptions, characters, nature of characters, analogy vs homology, parallel vs convergent evolution, intraspecific variation in characters, polythetic and polymorphic taxa, sexual dimorphism.

UNIT II

Classification of animals: Schools of classification- Phenetics, Cladistics and Evolutionary classification. Components of Biological Classification: Hierarchy, Rank, Category and Taxon. Species concepts, cryptic, sibling and etho-species, infra-specific categories. Introduction to numerical, biological and cytogenetical taxonomy.

UNIT III

Nomenclature: Common vs Scientific names. International Code of Zoological Nomenclature, criteria for availability of names, validity of names. Categories of names under consideration of ICZN. Publications, Principles of priority, and homonymy, synonymy, type concept in zoological nomenclature. Speciation, anagenesis vs cladogenesis, allopatric, sympatric and parapatric processes.

Suggested Readings

Blackwelder RE. 1967. *Taxonomy - A Text and Reference Book*. John Wiley & Sons, New York.

International commission on zoological nomenclature 1999 international code of zoological . nomenclature .IV the d, international trust for zoological nomenclature. London.

Kapoor V C 1998 Theory and practice of animal taxonomy, oxford and IBM publishing co. Pvt. Ltd. New Delhi.

Kapoor VC. 1983. *Theory and Practice in Animal Taxonomy*. Oxford & IBH, New Delhi.

Mayr E. 1971. *Principles of Systematic Zoology*. Tata McGraw-Hill, New Delhi.

Quicke DLJ. 1993. *Principles and Techniques of Contemporary Taxonomy*. Blackie, London.

ENT 504 **CLASSIFICATION OF INSECTS** **2+1**

Objective

To introduce the students to the classification of insects up to the level of families with hands-on experience in identifying the families of insects.

Theory

UNIT I

Brief evolutionary history of Insects- introduction to phylogeny of insects and major Classification of Superclass Hexapoda – Classes – Ellipura (Collembola, Protura), Diplura and Insecta- Orders contained. Kinds and systems of classification, Importance of taxonomy in applied science, Concepts of species, International Code of Zoological Nomenclature, Binomial nomenclature, Common terms used in taxonomical literature and their definitions

UNIT II

Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them. Collembola, Protura, Diplura. Class Insecta: Subclass Apterygota –Archaeognatha, Thysanura. Subclass: Pterygota, Division Paleoptera –Odonata and Ephemeroptera. Division: Neoptera: Subdivision: Orthopteroid and Blattoid Orders (=Oligoneoptera: Plecoptera, Blattodea, Isoptera, Mantodea, Orthoptera, Phasmatodea), Subdivision: Hemipteroid Orders (=Paraneoptera): Phthiraptera, Thysanoptera and Hemiptera.

UNIT III

Distinguishing characters, general biology, habits and habitats of Insect orders and economically important families contained in them (Continued). Division Neoptera – Subdivision Endopterygota, Section Neuropteroid- Coleopteroid Orders: Strepsiptera, Megaloptera, Raphidioptera, Neuroptera and Coleoptera, Section Panorpoid Orders Mecoptera, Siphonaptera, Diptera, Trichoptera, Lepidoptera, and Section Hymenopteroid Orders: Hymenoptera.

Practical

Study of Orders of insects and their identification using taxonomic keys. Keying out families of insects of different major Orders: Odonata, Orthoptera, Blattodea, Mantodea, Isoptera, Hemiptera, Thysanoptera, Phthiraptera, Neuroptera, Coleoptera, Diptera, Lepidoptera and Hymenoptera. Field visits to collect insects of different orders.

Suggested Readings

CSIRO 1990. *The Insects of Australia: A Text Book for Students and Researchers.* 2nd Ed. Vols. I & II, CSIRO. Cornell Univ. Press, Ithaca.

Freeman S & Herron JC. 1998. *Evolutionary Analysis.* Prentice Hall, New Delhi.

Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology.* 10th Ed. Chapman & Hall, London.

Ross HH.1974. *Biological Systematics.* Addison Wesley Publ. Co. Triplehorn CA & Johnson NF. 1998. *Borror and DeLong's Introduction to the Study of Insects.* 7th Ed. Thomson/ Brooks/ Cole, USA/Australia.

ENT 505 **INSECT ECOLOGY** **1+1**

Objective

To teach the students the concepts of ecology, basic principles of distribution and abundance of organisms and their causes. Study life tables, organization of communities, diversity indicies. Train students in sampling methodology, calculation of diversity indicies, constructing life tables, relating insect population fluctuations to biotic and/or abiotic causes.

Theory

UNIT I

History and Definition. Basic Concepts. Organisation of the Biological world. Plato's Natural Balance vs Ecological Dynamics as the modern view. Abundance and diversity of insects, Estimates and Causal factors. Study of abundance and distribution and relation between the two. Basic principles of abiotic factors and their generalised action on insects. Implications for abundance and distribution of organisms including insects- Law of the Minimum, Law of Tolerance, and biocoenosis, Systems approach to ecology.

UNIT II

Basic concepts of abundance- Model vs Real world. Concepts of Carrying capacity, Environmental Resistance and Optimal yield. Vital Statistics- Life Tables and their application to insect biology. Survivorship curves. Case studies of insect life tables. Population dynamics- Factors affecting abundance- Environmental factors, dispersal and migration, Seasonality in insects. Classification and mechanisms of achieving different seasonality- Diapause (Quiescence) - aestivation, hibernation.

UNIT III

Herbivory, pollination, predation, parasitism. Modes of insect-plant interaction, tri-trophic interactions. Evolution of herbivory, monophagy vs polyphagy. Role of plant secondary metabolites. Host seeking behaviour of parasitoids. Biotic factors- Food as a limiting factor for distribution and abundance, Nutritional Ecology. Food chain- web and ecological succession. Inter and Intra-specific interactions- Basic factors governing the interspecific interactions- Classification of inter and intra- specific interactions - The argument of cost-benefit ratios. Concept of niche ecological homologues, competitive exclusion. Prey-predator interactions- Functional and numerical response. Defense mechanisms against predators/ parasitoids- Evolution of mimicry, colouration, concept of predator satiation; evolution of life history strategies.

UNIT IV

Characterization of insect colonization. k and r Strategies. Community ecology- Concept of guild, Organisation of communities-Hutchinson Ratio, May's *d/w*, Relation between the two and their association with Dyar's Law and Przibram's law. Relative distribution of organisms, Concept of diversity- the Wallacian view. Assessment of diversity. Diversity-stability debate, relevance to pest management. Pest management as applied ecology.

Practical

Study of types of distribution of organisms- Measurement of pattern of distribution (dispersion) of a pest species on a crop - case of random distribution). Study of types of distribution of organisms- Measurement of pattern of distribution (dispersion) of a pest species on a crop - case of highly aggregated distribution, Study of methods of sampling insects- Estimation of

densities of population of two pest species on a crop and understanding the distribution parameters for randomly distributed pest species, Study of methods of sampling insects- Estimation of densities of population of two pest species on a crop and understanding the distribution parameters for aggregated distributed pest species, Study of measures of central tendencies, Poisson distribution, negative binomial distribution of certain insect pest species. Determination of optimal sample size – First method of determining sample unit and its size. Determination of optimal sample size –second method of determining sample unit and its size. Learning to fit basic population growth models and testing the goodness of fit. Fitting Holling's disc equation. Assessment prey-predator densities from natural system and working out the correlation between the two. Assessment and description of niche of some insects (two pest species) of a single guild. Calculation of niche breadth, activity breadth and diagrammatic representation of niches of organisms. Calculation of some diversity indices- Sharnon's, Simpson's and avalanche index and understanding their associations and parameters that affect their values. Problem solving in ecology (Case studies). Field visits to understanding Rice ecosystems and to study insect occurrence , Field visits to understanding Rice ecosystems and to study insect occurrence, Final Practical Exam

Suggested Readings

Chapman JL and Reiss MJ. 2006. *Ecology: Principles & Applications.* 2nd Ed. Cambridge Univ. Press, Cambridge.

Gotelli NJ and Ellison AM. 2004. *A Primer of Ecological Statistics.* Sinauer Associates, Inc., underland, MA.

Gotelli NJ. 2001. *A Primer of Ecology.* 3rd Ed. Sinauer Associates, Inc., Sunderland, MA

Gupta RK. 2004. *Advances in Insect Biodiversity.* Agrobios, Jodhpur.

Krebs CJ. 1998. *Ecological Methodology.* 2nd Ed. Benjamin-Cummings Publ. Co., New York.

Krebs CJ. 2001. *Ecology: The Experimental Analysis of Distribution and Abundance.* 5th Ed. Benjamin-Cummings Publ. Co., New York.

Magurran AE. 1988. *Ecological Diversity and its Measurement.* Princeton Univ. Press, Princeton.

Price PW. 1997. *Insect Ecology.* 3rd Ed. John Wiley, New York.

Real LA and Brown JH. (Eds). 1991. *Foundations of Ecology: Classic Papers with Commentaries.* University of Chicago Press, Chicago.

Southwood TRE and Henderson PA. 2000. *Ecological Methods.* 3rd Ed. Methuen & Co. Ltd., London.

Speight MR, Hunta MD and Watt AD. 2006. *Ecology of Insects: Concepts and Application.* Elsevier Science Publ., The Netherlands.

Wilson EO and William H Bossert WH. 1971. *A Primer of Population Biology.* Harvard University, USA.

Wratten SD and Fry GLA.1980. *Field and Laboratory Exercises in Ecology.* Arnold, London.

ENT 506 INSECT PATHOLOGY 1+1

Objective

To teach the students about various microbes that are pathogenic to insects, factors that affect their virulence; provide hands-on training in identification, isolation, culturing various pathogens and assessing pathogenicity.

Theory

UNIT I

History of insect pathology, infection of insects by bacteria, fungi, viruses, protozoa, rickettsiae, spiroplasma and nematodes.

UNIT II

Epizootiology, symptomatology and etiology of diseases caused by the above and the factors controlling these. Defense mechanisms in insects against pathogens.

UNIT III

Examples of successful instances of exploitation of pathogens for pest management and mass production techniques of pathogens. Safety and registration of microbial pesticides. Use of insect pathogens in integrated management of insect pests.

Practical

Study and familiarization with equipment used in insect pathology laboratory, Identification of different groups of insect pathogens (bacteria, fungi, viruses, protozoa and nematodes) and study of symptoms of their infection, Isolation, culturing, standardization and testing pathogenicity of different groups of pathogens namely bacteria, fungi, viruses, protozoa and nematodes, Testing of Koch's postulates for entomopathogenic facultative pathogens namely bacteria and fungi, Testing of Koch's postulates for entomopathogenic obligate pathogens namely baculoviruses, nematodes and protozoa, Estimation of pathogenic load- Serial dilution and standardization techniques in case of bacteria, fungi, viruses, protozoa and nematodes , Extraction of pathogens from live organisms and soil- bacteria, fungi, viruses and nematodes, Bioassays to determine medilian lethal doses and Mendelian lethal time - Testing of virulence of certain isolates of entomopathogenic bacteria, fungi and viruses, Practical examination

Suggested Readings

Boucias DG & Pendland JC. 1998. *Principles of Insect Pathology.* Kluwer Academic Publisher, Norwel.

Burges HD & Hussey NW. (Eds). 1971. *Microbial Control of Insects and Mites.* Academic Press, London.

Steinhaus EA. 1984. *Principles of Insect Pathology.* Academic Press, London.

ENT 507 BIOLOGICAL CONTROL OF CROP PESTS AND WEEDS 1+1

Objective

To train the students with theory and practice of biological control, mass production techniques and field evaluation of various biological control agents like parasitoids, predators and various entomopathogenic microorganisms.

Theory

UNIT I

History, principles and scope of biological control; important groups of parasitoids, predators and pathogens; principles of classical biological control- importation, augmentation and conservation.

UNIT II

Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects. Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa etc. and their mode of action. Biological control of weeds using insects.

UNIT III

Mass production of quality biocontrol agents- techniques, formulations, economics, field release/application and evaluation. Natural enemies on artificial diet. Commercial insectaries and their maintenance.

UNIT IV

Successful biological control projects, analysis, trends and future possibilities of biological control. Importation of natural enemies-Quarantine regulations, biotechnology in biological control. Semiochemicals in biological control.

Practical

Basic insectary facilities and equipment to promote biological control. Characters of important orders and families of parasitoids, Characters of important orders and families of predators, Description of the principal groups of infectious organisms. Identification of important microbial insecticides, Identification of important weed killers, Visits (only where logistically feasible) to bio-control laboratories to learn rearing and mass production of egg, egg-larval, larval, larval-pupal and pupal parasitoids, common predators, microbes and their laboratory hosts, phytophagous natural enemies of weeds – (2), Collection, preservation, shipment of biotic agents and storage of natural enemies. Field trip for collection of natural enemies.(2), Collection of diseased insects and mites from field and Study of symptoms, Production of NPV of *Helicoverpa armigera* and *Spodoptera litura*–extraction and purification, standardization and storage(2), Counting of PIB and larval equivalents, Formulation of microbial insecticides, Measuring various quality parameters of biopesticides and registration of biopesticides

Suggested Readings

Burges HD & Hussey NW. (Eds). 1971. *Microbial Control of Insects and Mites.* Academic Press, London.

De Bach P. 1964. *Biological Control of Insect Pests and Weeds.* Chapman & Hall, New York.

Dhaliwal GS & Arora R. 2001. *Integrated Pest Management: Concepts and Approaches.* Kalyani Publ., New Delhi.

Gerson H & Smiley RL. 1990. *Acarine Biocontrol Agents – An Illustrated Key and Manual.* Chapman & Hall, New York.

Huffaker CB & Messenger PS. 1976. *Theory and Practices of Biological Control.* Academic Press, London.

Ignacimuthu SS & Jayaraj S. 2003. *Biological Control of Insect Pests.* Phoenix Publ., New Delhi.

Saxena AB. 2003. *Biological Control of Insect Pests.* Anmol Publ., New Delhi.

Van Driesche & Bellows TS. Jr. 1996. *Biological Control.* Chapman & Hall, New York.

ENT 508 TOXICOLOGY OF INSECTICIDES 2+1

Objective

To orient the students with structure and mode of action of important insecticides belonging to different groups, development of resistance to insecticides by insects, environmental pollution caused by toxic insecticides and their toxicological aspects.

Theory

UNIT I

Definition and scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India.

UNIT II

Classification of insecticides and acaricides based on mode of entry, mode of action and chemical nature. Neurobiology and its relation to toxicology. Structure and mode of action of organochlorines, organophosphates, carbamates, pyrethroids, neonicotinoids, oxadiazines, phenyl pyrazoles, insect growth regulators, botanicals, new promising compounds etc.

UNIT III

Principles of toxicology; evaluation of insecticide toxicity; joint action of insecticides-synergism, potentiation and antagonism; factors affecting toxicity of insecticides; insecticide compatibility, selectivity and phytotoxicity.

UNIT IV

Insecticide metabolism; pest resistance to insecticides; mechanisms and types of resistance; insecticide resistance management; Pest resurgence and secondary outbreaks, Insecticide formulations.

UNIT V

Insecticide residues, their significance and environmental implications. Insecticide Act, registration and quality control of insecticides; safe use of insecticides. Diagnosis and treatment of insecticide poisoning.

Practical

Dilution of technical grade insecticide following serial dilution technique, Preparation of E.C. formulation of an insecticide, Determination of acidity/alkalinity and specific gravity of EC/SC formulation. Determination of flash point and stability of EC/SC formulation. Study of various bioassay techniques and testing the contact, stomach and fumigant toxicity of an insecticide (2), Testing the toxicity to beneficial insects, Study of probit analysis (sigmoid and dosage mortality curves), Calculation of LC_{50} of an insecticide following probit analysis, Calculation of LD_{50} of an insecticide following probit analysis, Calculation of LT_{50} of an insecticide following probit analysis, Calculation of ED_{50} of an insecticide following probit analysis, Determination of joint action of insecticide and vegetable oil/ non-toxic chemical, Calculation of PT values of insecticides, Visit to toxicology laboratory, Study of Good Laboratory Practices

Suggested Readings

Chattopadhyay SB. 1985. *Principles and Procedures of Plant Protection.*Oxford & IBH, New Delhi.

Gupta HCL.1999. *Insecticides: Toxicology and Uses.* Agrotech Publ., Udaipur.

Ishaaya I & Degheele (Eds.). 1998. *Insecticides with Novel Modes of Action.* Narosa Publ. House, New Delhi.

Matsumura F. 1985. *Toxicology of Insecticides.* Plenum Press, New York.

Perry AS, Yamamoto I, Ishaaya I & Perry R. 1998. *Insecticides in Agriculture and Environment.* Narosa Publ. House, New Delhi.

Prakash A & Rao J. 1997. *Botanical Pesticides in Agriculture.* Lewis Publ., New York.

ENT 509 PLANT RESISTANCE TO INSECTS 1+1

Objective

To familiarize the students with types, basis, mechanisms and genetics of resistance in plants to insects and role of plant resistance in pest management.

Theory

UNIT I

History and importance of resistance, principles, classification, components, types and mechanisms of resistance.

UNIT II

Insect-host plant relationships; theories and basis of host plant selection in phytophagous insects.

UNIT III

Chemical ecology, tritrophic relations, volatiles and secondary plant substances; basis of resistance. Induced resistance - acquired and induced systemic resistance.

UNIT IV

Factors affecting plant resistance including biotypes and measures to combat them.

UNIT V

Screening techniques; breeding for insect resistance in crop plants; exploitation of wild plant species; gene transfer, successful examples of resistant crop varieties in India and world.

UNIT VI

Role of biotechnology in plant resistance to insects.

Practical

Estimation of insect infestation by absolute methods, Estimation of insect infestation by relative methods, Evaluation of clumped, uniform and random spatial distribution of sampling methods, Screening resistance by artificial infestation of plants with laboratory reared insects, Screening resistance by measuring insect responses to excised plant parts, Measurement of plant

characters and working out their correlations with plant resistance, Measuring resistance in important crops against direct pests, Measuring resistance in important crops against indirect pests, Bioassay of plant extracts of susceptible/resistant varieties, Demonstration of antibiosis, tolerance and antixenosis.

Suggested Readings

Dhaliwal GS & Singh R. (Eds). 2004. *Host Plant Resistance to Insects - Concepts and Applications*. Panima Publ., New Delhi.

Maxwell FG & Jennings PR. (Eds). 1980.*Breeding Plants Resistant to Insects*. John Wiley & Sons, New York.

Painter RH.1951. *Insect Resistance in Crop Plants*. MacMillan, London.

Panda N & Khush GS. 1995. *Plant Resistance to Insects*. CABI, London.

Smith CM. 2005. *Plant Resistance to Arthropods – Molecular and Conventional Approaches*. Springer, Berlin.

ENT 510 PRINCIPLES OF INTEGRATED PEST MANAGEMENT 1+1

Objective

To familiarize the students with principles of insect pest management, including concept and philosophy of IPM. Train students in computation of ETL, implementing IPM programmes.

Theory

UNIT I

History and origin, definition and evolution of various related terminologies.

UNIT II

Concept and philosophy, ecological principles, economic threshold concept, and economic consideration.

UNIT III

Tools of pest management and their integration- legislative, cultural, physical, Host Plant Resistance, Biological and Mechanical methods in Tools of pest management and their integration; pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys; political, social and legal implications of IPM; pest risk analysis; pesticide risk analysis; cost-benefit ratios and partial budgeting; Bio-rational, Biotechnological and other innovative approaches (Mass trapping, mating disruption technique) in IPM, case studies of successful IPM programmes.

Practical

Characterization of agro-ecosystems – rice, cotton ecosystems. Characterization of agro-ecosystems- sugarcane, mango *etc.,* Sampling methods and factors affecting sampling- practical considerations for insect pests of rice, cotton. Sampling methods and factors affecting sampling-practical considerations for insect pests of pulses, oilseeds. Population estimation methods – absolute and relative methods- estimation based on products and effects of insects for key pests of select crops- rice, cotton. Population estimation methods- key pests of select crops-pulses, oilseeds. Crop loss assessment – direct, indirect and potential losses- avoidable and unavoidable losses- in select field crops. Crop loss assessment- in select- horticultural crops.

Estimation of losses in storage due to store grain pests. Computation of EIL and ETL for key pests of field crops. Computation of EIL and ETL for key pests of horticultural crops. Crop modeling – in field crops. Crop modeling – in horticultural crops. Designing and implementing IPM system- rice, cotton. Designing and implementing IPM system- apple, mango. Farmers Field school, concept for dissemination of IPM.

Suggested Readings

Dhaliwal GS & Arora R. 2003. *Integrated Pest Management – Concepts and Approaches.* Kalyani Publ., New Delhi.

Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology.* Kalyani Publ., New Delhi.

Flint MC & Bosch RV. 1981. *Introduction to Integrated Pest Management.*1st Ed., Springer, New York.

Horowitz AR & Ishaaya I. 2004. *Insect Pest Management: Field and Protected Crops.* Springer, New Delhi.

Ignacimuthu SS & Jayaraj S. 2007. *Biotechnology and Insect Pest Management.* Elite Publ., New Delhi.

Metcalf RL & Luckman WH. 1982. *Introduction of Insect Pest Management.* John Wiley & Sons, New York.

Pedigo RL. 2002. *Entomology and Pest Management.* 4th Ed. Prentice Hall, New Delhi.

Norris RF, Caswell-Chen EP & Kogan M. 2002. *Concepts in Integrated Pest Management.* Prentice Hall, New Delhi.

Subramanyam B & Hagstrum DW. 1995. *Integrated Management of Insects in Stored Products.* Marcel Dekker, New York.

ENT 511 **PESTS OF FIELD CROPS** **1+1**

Objective

To familiarize the students about nature of damage and seasonal incidence of insect pests that cause loss to major field crops and their effective management by different methods.

Theory

Systematic position, identification, distribution, host-range, bionomics, nature and extent of damage, seasonal abundance and management of insect and mite pests and vectors.

UNIT I

Insect pests of cereals and millets and their management. Polyphagous pests: grasshoppers, locusts, termites, white grubs, hairy caterpillars, and non-insect pests (mites, birds, rodents, snails, slugs etc.).

UNIT II

Insect pests of pulses, tobacco, oilseeds and their management.

UNIT III

Insect pests of fibre crops, forages, sugarcane and their management.

Practical

Identification and study of important pests of paddy (2), Identification and study of important pests of millets. Identification and study of important pests of sugarcane , Identification and study of important pests of cotton (2), Identification and study of important pests of pulses, Identification and study of important pests of oilseeds. Identification and study of important pests of forage. Study of mites, birds, rodents, snails & slugs, Detection and estimation of insect damage(2), Estimation of losses in different crops(2), Field Visits (2)

Suggested Readings

Atwal AS, Dhaliwal GS & David BV. 2001. *Elements of Economic Entomology.* Popular Book Depot, Chennai.

Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology.* Kalyani Publ., New Delhi.

Dunston AP. 2007. *The Insects: Beneficial and Harmful Aspects.* Kalyani Publ., New Delhi

Evans JW. 2005. *Insect Pests and their Control.* Asiatic Publ., New Delhi.

Nair MRGK. 1986. *Insect and Mites of Crops in India.* ICAR, New Delhi.

Prakash I & Mathur RP. 1987. *Management of Rodent Pests.* ICAR, New Delhi.

Saxena RC & Srivastava RC. 2007. *Entomology at a Glance.* Agrotech Publ. Academy, Jodhpur.

ENT 512 PESTS OF HORTICULTURAL AND PLANTATION CROPS 1+1

Objective

To impart knowledge on major pests of horticultural and plantation crops regarding the extent and nature of loss, seasonal history, their integrated management.

Theory

Systematic position, identification, distribution, host range, bionomics and seasonal abundance, nature and extent of damage and management of insect pests of various crops.

UNIT I

Fruit Crops- mango, guava, banana, jack, papaya, pomegranate, litchi, grapes, ber, fig, citrus, annona, pineapple, apple, peach and other temperate fruits.

UNIT II

Vegetable crops- tomato, potato, radish, carrot, beetroot, cole crops, french beans, chow-chow, brinjal, okra, all gourds, gherkin, drumstick, leafy vegetables etc.

UNIT III

Plantation crop- coffee, tea, rubber, coconut, arecanut, cashew, cocoa etc.; Spices and Condiments- pepper, cardamom, clove, nutmeg, chillies, turmeric, ginger, beetlevine etc.

UNIT IV

Ornamental, medicinal and aromatic plants and pests in polyhouses/protected cultivation.

Practical

Identification of insects and damage symptoms of pests of Mango, Identification of insects and damage symptoms of pests of.citrus, Identification of insects and damage symptoms of pests of grape vine, pomegranate, guava, Identification of insects and damage symptoms of pests of sapota, ber and banana, Identification of insects and damage symptoms of pests of pine apple, custard apple and papaya, Identification of insects and damage symptoms of pests of tomato, Identification of insects and damage symptoms of pests of moringa and leafy vegetables, Identification of insect pests and damage symptoms of bhendi, Identification of insect pests and damage symptoms of cucurbits, Identification of insect pests and damage symptoms of crucifers, Identification of insect pests and damage symptoms of potato, carrot, raddish French bean, Identification of insects and damage symptoms of pests of coconut, oil palm and cacoa, Identification of insects and damage symptoms of pests of cashew, tea and coffee, Identification of insects pests attacking turmeric, ginger and betel vine, Identification of insects and damage symptoms of pests of aromatic crops, medicinal crops and processed products

Suggested Readings

Atwal AS & Dhaliwal GS. 2002. *Agricultural Pests of South Asia and their Management.* Kalyani Publ., New Delhi.

Butani DK & Jotwani MG. 1984. *Insects and Vegetables.* Periodical Expert Book Agency, New Delhi.

Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essential of Agricultural Entomology.* Kalyani Publ., New Delhi.

Srivastava RP.1997. *Mango Insect Pest Management.* International Book Distr., Dehra Dun.

Verma LR, Verma AK & Goutham DC. 2004. *Pest Management in Horticulture Crops : Principles and Practices.* Asiatech Publ., New Delhi.

ENT 513 STORAGE ENTOMOLOGY 1+1

Objective

To focus on requirement and importance of grain and grain storage, to understand the role of stored grain pests and to acquaint with various stored grain pest management techniques for avoiding losses in storage.

Theory

UNIT I

Introduction, history of storage entomology, concepts of storage entomology and significance of insect pests. Post-harvest losses *in toto visà- vis* total production of food grains in India. Scientific and socio-economic factors responsible for grain losses.

UNIT II

Important pests namely insects, mites, rodents, birds and microorganisms associated with stored grain and field conditions including agricultural products; traditional storage structures; association of stored grain insects with fungi and mites, their systematic position, identification, distribution, host range, biology, nature and extent of damage; role of field and cross infestations and natural enemies, type of losses in stored grains and their effect on quality including biochemical changes.

UNIT III

Ecology of insect pests of stored commodities/grains with special emphasis on role of moisture, temperature and humidity in safe storage of food grains and commodities. Stored grain deterioration process, physical and biochemical changes and consequences. Grain storage- types of storage structures i.e., traditional, improved and modern storage structures in current usage. Ideal seeds and commodities; storage conditions.

UNIT IV

Important rodent pests associated with stored grains and their non-chemical and chemical control including fumigation of rat burrows. Role of bird pests and their management. Control of infestation by insect pests, mites and microorganisms. Preventive measures- Hygiene/ sanitation, disinfestation of stores/receptacles, legal methods. Curative measures-Non-chemical control measures- ecological, mechanical, physical, cultural, biological and engineering. Chemical control- prophylactic and curative. Characteristics of pesticides, their use and precautions in their handling with special emphasis on fumigants. Integrated approaches to stored grain pest management.

Practical

Collection, identification and familiarization with the stored grains/seed insect pests (Coleopteran) and nature of damage caused by them, Collection, identification and familiarization with the stored grains/seed insect pests (Lepidopteran) and nature of damage caused by them , Collection, identification and familiarization with the stored grains/seed insect pests (Non insect pests) and nature of damage caused by them, Detection of insect infestation in stored food grains, Estimation of losses in stored food grains, Determination of moisture content in stored food grains, Familiarization of storage structures, Demonstration of preventive and curative measures including fumigation techniques, Treatment of packing materials and their effect on seed quality, Field visits to save grain campaign, Central Warehouse and FCI warehouses and institutions engaged in research or practice of grain storage like CFTRI, IGSMRI, Hapur etc. (only where logistically feasible).

References:

Hall DW. 1970. *Handling and Storage of Food Grains in Tropical andSubtropical Areas.* FAO. Agricultural Development Paper No. 90 and FAO, Plant Production and Protection Series No. 19, FAO, Rome.

Jayas DV, White NDG & Muir WE. 1995. *Stored Grain Ecosystem.*Marcel Dekker, New York.

Khader V. 2004. *Textbook on Food Storage and Preservation.* Kalyani Publ., New Delhi.

Khare BP. 1994. *Stored Grain Pests and Their Management.* Kalyani Publ., New Delhi.

Subramanyam B & Hagstrum DW. 1995. *Interrelated Management of Insects in Stored Products.* Marcel Dekker, New York.

ENT 514 INSECT VECTORS OF PLANT VIRUSES AND OTHER PATHOGENS 1+1

Objective

To teach the students about the different groups of insects that vector plant pathogens, vector-plant pathogen interaction, management of vectors for controlling diseases.

Theory

UNIT I

History of development in the area of insects as vectors of plant pathogens. Important insect vectors and their characteristics; mouth parts and feeding processes of important insect vectors. Efficiency of transmission.

UNIT II

Transmission of plant viruses and fungal pathogens. Relation between viruses and their vectors.

UNIT III

Transmission of plant viruses by aphids, whiteflies, mealy bugs and thrips.

UNIT IV

Transmission of mycoplasma and bacteria by leaf hoppers and plant hoppers.

UNIT V

Transmission of plant viruses by psyllids, beetles and mites. Epidemiology and management of insect transmitted diseases through vector management.

Practical

Identification of common vectors of plant pathogens (field trip)- field collection and identification of important vectors- aphids, leafhoppers, plant hoppers, whiteflies, Field trip- field collection and identification of vectors- thrips, beetles, and nematodes, Preservation of vectors for microscopic study, Techniques in culturing and handling of vectors- aphids, leafhoppers, plant hoppers, Techniques in culturing and handling of vectors- whiteflies and thrips, Field trip: collection and identification of symptoms of insect transmitted plant diseases in field crops, Field trip: collection and identification of symptoms of insect transmitted diseases in horticultural crops, Preservation and study of specimens of insect transmitted plant diseases- wet preservation and dry preservation, Study of mouth parts of important vectors and their role in transmission of plant diseases, Demonstration of virus transmission mechanically and through vectors under green house conditions. – sap inoculation of tobacco mosaic virus or cucumber mosaic virus, Demonstration of virus transmission through leafhoppers- Brinjal little leaf virus, Demonstration of development of hopperburn symptoms in cotton/bhendi (phytotoxemia by leafhoppers), Demonstration of virus transmission through whiteflies- YMV in black gram/ green gram, Demonstration of virus transmission through whiteflies- yellow vein mosaic virus in bhendi.

Suggested readings:

Basu AN, 1995. *Bemisia tabaci* (Gennadius)- crop pest and principal whitefly vector of plant viruses. Oxford & IBH, New Delhi.

Harris KF & Maramarosh K (Eds.). 1980. Vectors of plant pathogens, Academic Press, London.

Maramarosh K & Harris KF. (Eds.). 1979. Leafhopper vectors and plant disease agents. Academic Press, London.

Youdeovei A & Service MW. 1983. Pest and vector management in the tropics. English Language Books Series, Longman, London.

ENT 515 **GENERAL ACAROLOGY** **1+1**

Objective

To acquaint the students with external morphology of different groups of mites, train in identification of commonly occurring families of plant associated mites, provide information about important mite pests of crops and their management.

Theory

UNIT I

History of Acarology; importance of mites as a group; habitat, collection and preservation of mites.

UNIT II

Introduction to morphology and biology of mites and ticks. Broad classification- major orders and important families of Acari including diagnostic characteristics.

UNIT III

Economic importance, seasonal occurrence, nature of damage, host range of mite pests of different crops, mite pests in polyhouses, mite pests of stored products and honeybees. Management of mites using acaricides, phytoseiid predators, fungal pathogens *etc.* Culturing of phytophagous, parasitic and predatory mites.

Practical

Collection of mites from plants, Collection of mites from soil , Collection of mites from animals; Extraction of mites from soil, Extraction of mites from plants, Extraction of mites from stored products; Preparation of mounting media, Preparation of mounting slide mounts, External morphology of mites (Tetrranychidae); External morphology of mites (Tarsonemidae); External morphology of mites (Tenuipalpidae); External morphology of mites (Eriophyidae), External morphology of mites (Phytoseidae); Identification of mites up to family level using keys; Studying different rearing techniques for mites.

References:

Chhillar BS, Gulati R & Bhatnagar P. 2007. *Agricultural Acarology.* Daya Publ. House, New Delhi.

Gerson U & Smiley RL. 1990. *Acarine Biocontrol Agents - An IllustratedKey and Manual.* Chapman & Hall, NewYork.

Gupta SK. 1985. *Handbook of Plant Mites of India.* Zoological Survey of India, Calcutta.

Gwilyn O & Evans GO. 1998. *Principles of Acarology.* CABI, London.

Jeppson LR, Keifer HH & Baker EW. 1975. *Mites Injurious to Economic Plants.* University of California Press, Berkeley.

Krantz GW. 1970. *A Manual of Acarology.* Oregon State Univ. Book Stores, Corvallis, Oregon.

Qiang Zhiang Z. 2003. *Mites of Green Houses- Identification, Biology and Control.* CABI, London.

Sadana GL. 1997. *False Spider Mites Infesting Crops in India.* Kalyani Publ. House, New Delhi.

Walter DE & Proctor HC. 1999. *Mites- Ecology, Evolution and Behaviour.* CABI, London.

ENT 516 **SOIL ARTHROPODS AND THEIR MANAGEMENT** **1+1**

Objective

To impart knowledge about the different groups of arthropods found in soil, interaction between the different groups, and role of soil arthropods in humus formation. Hands-on training in sampling and identification of different groups of soil arthropods.

Theory

UNIT I

Soil arthropods and their classification, habitats and their identification.

UNIT II

Estimation of populations; sampling and extraction methods.

UNIT III

Role of soil arthropods in detritus feeding, litter breakdown and humus formation. Soil arthropods as bio-indicators of habitat qualities. Effect of soil arthropod activity on soil properties.

UNIT IV

Harmful and beneficial soil arthropods and their management, interrelationship among arthropods and other soil invertebrates and soil microorganisms. Anthropogenic effects on soil arthropods.

Practical

Introduction to soil fauna-arthropods, Importance of soil arthropods, Sampling of different types of harmful soil arthropods, Sampling of different types of beneficial soil arthropods, Extraction of harmful soil arthropods, Identification of soil arthropods, Estimation of population of beneficial soil fauna, Estimation of population harmful soil fauna, Assessment of damage by soil arthropods on plants, Assessment of damage by soil arthropods on plants, Assessment of damage by soil arthropods on plants, Techniques of culturing of soil arthropods, Techniques of culturing of soil arthropods, Testing of effect of soil pesticides on beneficial fauna, Data recording for estimation of damage by soil arthropods.

Suggested Readings

Anderson JM & Ingram JSI. 1993. *Tropical Soil Biology and Fertility: A Handbook of Methods.* CABI, London.

Dindal DL. 1990. *Soil Biology Guide.* A Wiley-InterScience Publ., John Wiley & Sons, New York.

Pankhurst C, Dube B & Gupta, V. 1997. *Biological Indicators of Soil Health.* CSIRO, Australia.

Veeresh GK & Rajagopal D.1988. *Applied Soil Biology and Ecology.* Oxford & IBH Publ., New Delhi.

ENT 517 **VERTEBRATE PEST MANAGEMENT** **1+1**

Objective

To impart knowledge on vertebrate pests like birds, rodents, mammals etc., of different crops, their biology, damage they cause and management strategies.

Theory

UNIT I

Vertebrate pests of different crops; biology of vertebrate pests such as rodents, birds and other mammals. Biology of beneficial birds.

UNIT II

Population dynamics and assessment, patterns of pest damage and assessment, roosting and nesting systems in birds.

UNIT III

Management strategies- physical (trapping, acoustics and visual), chemical (poisons, repellents, fumigants and anticoagulants), biological (predators, parasites), cropping practices, alteration of habitats, diversion baiting and other eco-friendly methods- Operational practices- baiting, bioassays (LD50 studies), equipments and educative programmes.

Practical

Identification of Vertebrate Pests in the field based on observation and other physical characteristic features, Methods for estimating population structure of various vertebrate pests in relation to habitats, Nature of damage to different crops by vertebrate pests and their identification, Damage pattern and methods for damage estimation & assessment, Introduction to devices for vertebrate scaring and attraction, Equipments used in vertebrate study, Biostatistics in vertebrate studies, Identification of food , food preference and social behaviour studies in captivity, Field visit to understanding captive breeding in Zoos and visit to a National Park (or) Sanctuary.

Suggested Readings

Fitzwater WD & Prakash I. 1989. *Handbook of Vertebrate Pest Control.* ICAR, New Delhi.

Prakash I & Ghosh *PK.1997. Rodents in Indian Agriculture.* Vol. I. State of Art Scientific Publ., Jodhpur.

Prakash I & Ghosh RP.1987. *Management of Rodent Pests.* ICAR, New Delhi.

Prater SH. 1971. *The Book of Indian Animals.* The Bombay Natural History Society, Bombay.

Ali S. 1965. *The Book of Indian Birds.* The Bombay Natural History Society, Bombay

ENT 518 TECHNIQUES IN PLANT PROTECTION 0+1

Objective

To acquaint the students with appropriate use of plant protection equipments and techniques related to microscopy, computation, pest forecasting, electrophoresis etc.

Practical

Pest control equipments, principles, operation, maintenance, selection, application of pesticides and biocontrol agents, seed dressing, soaking, root-dip treatment, dusting, spraying. Bioassay

by Potter's tower. Aerial spraying, HV/LV/ULV sprays, application through irrigation water. Root feeding technique and stem application technique. Soil sterilization, solarization, deep ploughing, flooding, techniques to check the spread of pests through seed, bulbs, corms, cuttings and cut flowers. Protein isolation from the pest and host plant and its quantification using spectrophotometer. Use of light transmission and scanning electron microscopy. Use of tissue culture techniques in plant protection. Computer application for predicting/forecasting pest attack and identification.

Suggested Readings

Alford DV. 1999. *A Textbook of Agricultural Entomology*. Blackwell Science, London.

Crampton JM & Eggleston P. 1992. *Insect Molecular Science.* Academic Press, London.

ENT 519 COMMERCIAL ENTOMOLOGY 1+1

Objective

To familiarize the students with entrepreneurial opportunities in entomology, provide information on productive insects and their products, as well as insect pests of public health and veterinary importance and their management.

Theory

UNIT I

Bee keeping- Establishment and maintenance of apiaries. General colony management during different seasons. Seasonal management. Managing colonies for honey production and pollination. Artificial queen rearing. Pests and diseases of honey bees. Bee poisoning. Production and marketing of quality honey and value added honey products.

UNIT II

Study of different species of silkworms, characteristic features, moriculture, silk and its uses, pests and diseases of silkworms, rearing and management of silkworms. Lac insect-natural enemies and their management.

UNIT III

Economic and public health importance of insect pests in human habitation and habitats, biology, damage and control of mosquitoes, house flies, bed bugs, ants, termites, cockroaches, flies, silverfish, head and body lice, carpet beetles, cloth moths, crickets, wasps, house dust mites, insect pests of cattle, poultry, pet animals and their management.

UNIT IV

Principles and methods of pest management in residential places and public buildings, insecticides for domestic use and their safety, pre- and post construction termite proofing of buildings, appliances for domestic pest control. Rodent control methods. Organic methods of domestic pest management.

Practical

Preparation of planting material and Raising Mulberry nursery and methods of planting of Mulberry under irrigated and rainfed conditions, Study of Insect pests and diseases of Mulberry, Study of Mulberry silk worms and Non- Mulberry silk worms, Study of diseases and pests of silk worms, Visit to sericulture farm and grainage centre, Study of important species of honey bees, castes and special adaptations, Study of bee hives and other equipment and frame inspection, Honey extraction and processing methods of hive products, Study of insect enemies and diseases of honey bees, Visit to commercial Apiaries, Study of lac insect host trees and crop management technology, Study of processing of lac products and bye products of lac., Assessment of pest status in labs or hostels or canteen and implementation of control measures, To evaluate commercially available domestic pest control products through bioassay, Study of pre and post construction termite proofing methods, Visit to the poultry units and assessing the pest status

Suggested Readings

Aruga H. 1994. *Principles of Sericulture.* Oxford & IBH, New Delhi.

Atwal AS. 2006. *The World of the Honey Bee.* Kalyani Publ., New Delhi.

Ganga G. 2003. *Comprehensive Sericulture.* Vol. II. *Silkworm Rearing and Silk Reeling.* Oxford & IBH, New Delhi.

Partiban S and David BV. 2007. *Management of Household Pests and Public Health Pests.* Namratha Publ., Chennai.

Singh S. 1975. *Beekeeping in India.* ICAR, New Delhi.

ENT 520 PLANT QUARANTINE 2+0

Objective

To acquaint the learners about the principles and the role of Plant Quarantine in containment of pests and diseases, plant quarantine regulations and set-up.

Theory

UNIT I

Definition of pest, pesticides and transgenics as per Govt. notification; relative importance; quarantine – domestic and international. Quarantine restrictions in the movement of agricultural produce, seeds and planting material; case histories of exotic pests/diseases and their status.

UNIT II

Plant protection organization in India. Acts related to registration of pesticides and transgenics. History of quarantine legislations, PQ Order 2003. Environmental Acts, Industrial registration; APEDA, Import and Export of bio-control agents.

UNIT III

Identification of pest/disease free areas; contamination of food with toxigens, microorganisms and their elimination; Symptomatic diagnosis and other techniques to detect pest/pathogen infestations; VHT and other safer techniques of disinfestation/salvaging of infested material.

UNIT IV

WTO regulations; non-tariff barriers; Pest risk analysis, good laboratory practices for pesticide laboratories; pesticide industry; Sanitary and Phytosanitary measures.

Suggested Readings

Rajeev K and Mukherjee RC. 1996. *Role of Plant Quarantine in IPM.* Aditya Books.

Rhower GG. 1991. Regulatory Plant Pest Management. In: *Handbook of Pest Management in Agriculture.* 2nd Ed. Vol. II. (Ed. David Pimental). CRC Press.

ENT 601 ADVANCED INSECT SYSTEMATICS 1+2

Objective

To familiarize the students with different schools of classification, phylogenetics, classical and molecular methods, evolution of different groups of insects. International Code of Zoological Nomenclature. Ethics and procedure for taxonomic publications.

Theory

UNIT I

Detailed study of three schools of classification- numerical, evolutionary and cladistics. Methodologies employed. Development of phenograms, cladograms, molecular approaches for the classification of organisms. Methods in identification of homology. Species concepts and speciation processes and evidences. Zoogeography.

UNIT II

Study of different views on the evolution of insects- alternative phylogenies of insects: Kukalova Peck and Kristensen. Fossil insects and evolution of insect diversity over geological times.

UNIT III

Detailed study of International Code of Zoological Nomenclature, including appendices to ICZN- Ethics.

UNIT IV

Concept of Phylocode and alternative naming systems for animals. A detailed study of selected representatives of taxonomic publications – small publications of species descriptions, revisionary works, monographs, check lists, faunal volumes, etc. Websites related to insect taxonomy and databases. Molecular Taxonomy, barcoding species.

Practical

Collection, curation and study of one taxon of insects, Literature search, compilation of a checklist, study of characters, Development of character table, construction of taxonomic keys for the selected group, Development of descriptions, photographing, writing diagrams, and preparation of specimens for "type like" preservation. Submission of the collections made of the group, Multivariate Analysis techniques for clustering specimens into different taxa, and development of phenograms, Rooting and character polarisation for developing cladograms and use of computer programmes to develop cladograms.

Suggested Readings

CSIRO 1990. *The Insects of Australia: A Text Book for Students and Researchers.* 2nd Ed. Vols. I & II, CSIRO. Cornell Univ. Press, Ithaca.

Dakeshott J & Whitten MA. 1994. *Molecular Approaches to Fundamental and Applied Entomology.* Springer-Verlag, Berlin.

Freeman S & Herron JC. 1998. *Evolutionary Analysis.* Prentice Hall, New Delhi.

Hennig W. 1960. *Phylogenetic Systematics.* Urbana Univ. Illinois Press, USA.

Hoy MA. 2003. *Insect Molecular Genetics: An Introduction to Principles and Applications.* 2nd Ed. Academic Press, New York.

Mayr E & Ashlock PD. 1991. *Principles of Systematic Zoology.* 2ndEd. McGraw Hill, New York.

Mayr E.1969. *Principles of Systematic Zoology.* McGraw-Hill, New York.

Quicke DLJ. 1993. *Principles and Techniques of Contemporary Taxonomy.* Blackie Academic and Professional, London.

Ross HH. 1974. *Biological Systematics.* Addison Wesley Publ. Co., London.

Wiley EO. 1981. *Phylogenetics: The Theory and Practices of Phylogenetic Systematics for Biologists.* Columbia Univ. Press, USA.

ENT 602 IMMATURE STAGES OF INSECTS 1+1

Objective

To impart knowledge on morphology of immature stages of different groups of insects. Train the students in identification of common pest species during their immature stages.

Theory

UNIT I

Types of immature stages in insect orders, morphology of egg, nymph/larva and pupa, identification of different immature stages of crop pests and stored product insects

UNIT II

Comparative study of life history strategies in hemi metabola and holometabola, immature stages as ecological and evolutionary adaptations, significance of immature stages for pest management.

Practical

Collection and preservation of immature forms of insects, Rearing of Immature stages of insects, Study of different types of keys and practicing them, Comparative morphology and identification of immature forms of order Lepidoptera, Comparative morphology and identification of immature forms of order Coleoptera, Comparative morphology and identification of immature forms of order Hymenoptera, Comparative morphology and identification of immature forms of order Diptera, Comparative morphology and identification of immature forms of order Neuroptera.

Suggested Readings

Chu HF. 1992. *How to Know Immature Insects.* William Brown Publ., Iowa.

Peterson A. 1962. *Larvae of Insects.* Ohio University Press, Ohio.

Stehr FW. 1998. *Immature Insects.* Vols. I, II. Kendall Hunt Publ., Iowa.

ENT 603 **ADVANCED INSECT PHYSIOLOGY** **2+0**

Objective

To impart knowledge to the students on detailed physiology of various secretory and excretory systems, moulting process, chitin synthesis, physiology of digestion, transmission of nerve impulses, nutrition of insects, pheromones etc.

Theory

UNIT I

Physiology and biochemistry of insect cuticle and moulting process. Biosynthesis of chitin, chitin-protein interactions in various cuticles, types of sclerotization.

UNIT II

Digestive enzymes, digestive physiology in phytophagous, wood boring and wool feeding insects, efficiency of digestion and absorption, role of endosymbionts in insect nutrition, nutritional effects on growth and development; physiology of excretion and osmoregulation, water conservation mechanisms.

UNIT III

Detailed physiology of nervous system, transmission of nerve impulses, neurotransmitters and modulators. Production of receptor potentials in different types of sensilla, pheromones and other semiochemicals in insect life, toxins and defense mechanisms.

UNIT IV

Endocrine system and insect hormones, physiology of insect growth and development-metamorphosis, polyphenism and diapause. Energetics of muscle contractions.

References :

Kerkut GA & Gilbert LI. 1985. *Insect Physiology, Biochemistry and Pharmacology*. Vols. I-XIII. Pergamon Press, Oxford, New York.

Muraleedharan K. 1997. *Recent Advances in Insect Endocrinology*. Assoc. for Advancement of Entomology, Trivandrum, Kerala.

Murray S. Blum 1985 Fundamentals of Insect physiology. John Wiley & Sons, USA

ENT 604 **ADVANCED INSECT ECOLOGY** **1+1**

Objective

To impart advanced practical knowledge of causal factors governing the distribution and abundance of insects and the evolution of ecological characteristics.

Theory

UNIT I

Characterisation of distribution of insects- Indices of Dispersion, Taylor's Power law. Island Biogeography. Population dynamics- Life tables, Leslie Matrix, Stable age distribution, Population projections. Predator-Prey Models- Lotka-Volterra and Nicholson-Bailey Model. Crop Modeling- an introduction.

UNIT II

Insect Plant Interactions. Fig-figwasp mutualism and a quantitative view of types of Associations. Role of insects in the environment. Adaptations to terrestrial habitats. Evolution of Insect diversity and role of phytophagy as an adaptive zone for increased diversity of insects. Evolution of resource harvesting organs, resilience of insect taxa and the sustenance of insect diversity- role of plants. Herbivory, pollination, predation, parasitism. Modes of insect-plant interaction, tri-trophic interactions. Evolution of herbivory, monophagy vs polyphagy. Role of plant secondary metabolites. Host seeking behaviour of parasitoids. Meaning of stress- plant stress and herbivory. Consequences of herbivory to plant fitness and response to stress. Constitutive and induced plant defenses.

UNIT III

Biodiversity and Conservation- RET species, Ecological Indicators. Principles of Population genetics, Hardy Weinberg Law, Computation of Allelic and Phenotypic frequencies, Fitness under selection, Rates of Evolution under selection. Foraging Ecology- Optimal foraging theory, Marginal Value Theorem, and Patch departure rules, central place foraging, Mean-variance relationship and foraging by pollinators, Nutritional Ecology.

UNIT IV

Reproductive ecology- Sexual selection, Mating systems, Reproductive strategies - timing, egg number, reproductive effort, sibling rivalry and parent-offspring conflict. Agro-ecological vs Natural Ecosystems – Characterisation, Pest Control as applied ecology- case studies.

Practical

Methods of data collection under field conditions. Assessment of distribution parameters, Taylor's power law, Iwao's patchiness index, Index of Dispersion, etc. Calculation of sample sizes by different methods. Fitting Poisson and Negative Binomial distributions and working out the data transformation methods. Hardy-Weinberg Law, Computation of Allelic and Phenotypic Frequencies - Calculation of changes under selection, Demonstration of genetic drift. Assessment of Patch Departure rules. Assessment of Resource size by female insects using a suitable insect model, fruit flies/*Goniozus*/Female Bruchids etc.- A test of reproductive effort and fitness. Construction of Life tables and application of Leslie Matrix – population projections, Stable age distribution. Exercises in development of Algorithms for crop modeling.

Suggested Readings

Barbosa P & Letourneau DK. (Eds.). 1988. *Novel Aspects of Insect-Plant Interactions*. Wiley, London.

Elizabeth BA & Chapman RF. 1994. *Host-Plant Selection by Phytophagous Insects*. Chapman & Hall, New York.

Freeman S & Herron JC.1998. *Evolutionary Analysis*. Prentice Hall, New Delhi.

Gotelli NJ & Ellison AM. 2004. *A Primer of Ecological Statistics*. Sinauer Associates, Sunderland, MA.

Gotelli NJ. 2001. *A Primer of Ecology*. 3rd Ed., Sinauer Associates, Sunderland, MA, USA.

Krebs C. 1998. *Ecological Methodology*. 2nd Ed. Benjamin-Cummings Publ. Co., New York.

Krebs CJ. 2001 *Ecology: The Experimental Analysis of Distribution and Abundance*. 5th Ed. Benjamin-Cummings Publ. Co., New York.

Magurran AE. 1988. *Ecological Diversity and its Measurement*. Princeton University Press, Princeton.

Real LA & Brown JH. (Eds.). 1991. *Foundations of Ecology: Classic Papers with Commentaries.* University of Chicago Press, USA.

Southwood TRE & Henderson PA. 2000. *Ecological Methods.* 3rd Ed. Wiley Blackwell, London.

Strong DR, Lawton JH & Southwood R. 1984. *Insects on Plants: Community Patterns and Mechanism.* Harward University Press, Harward.

Wratten SD & Fry GLA. 1980. *Field and Laboratory Exercises in Ecology.* Arnold Publ., London.

ENT 605 **INSECT BEHAVIOUR** **1+1**

Objective

To acquaint the students with a thorough understanding of how natural selection has led to various survival strategies manifested as behaviour in insects.

Theory

UNIT I

Defining Behaviour- Concept of umwelt, instinct, fixed action patterns, imprinting, complex behaviour, inducted behaviour, learnt behaviour and motivation. History of Ethology- development of behaviorism and ethology, contributions of Darwin, Frisch, Tinbergen and Lorenz; Studying behaviour- Proximate and Ultimate approaches, behavioural traits under natural selection, genetic control of behaviour and behavioural polymorphism.

UNIT II

Orientation- Forms of primary and secondary orientation including taxis and kinesis; Communication- primary and secondary orientation, responses to environmental stimuli, role of visual, olfactory and auditory signals in inter- and intra-specific communication, use of signals in defense, mimicry, polyphenism; evolution of signals.

UNIT III

Reproductive behaviour- mate finding, courtship, territoriality, parental care, parental investment, sexual selection and evolution of sex ratios; Social behaviour- kin selection, parental manipulation and mutualism; Self organization and insect behaviour.

UNIT IV

Foraging- Role of different signals in host searching (plant and insects) and host acceptance, ovipositional behaviour, pollination behaviour, co evolution of plants and insect pollinators. Behaviour in IPM- Concept of super-normal stimuli and behavioural manipulation as potential tool in pest management, use of semio-chemicals, auditory stimuli and visual signals in pest management.

Practical

Quantitative methods in sampling behaviour; training bees to artificial feeders; sensory adaptation and habituation in a fly or butterfly model, physical cues used in host selection in a phytophagous insect, chemical and odour cues in host selection in phytophagous insect (DBM or gram pod borer), colour discrimination in honey bee or butterfly model, learning and memory in bees, role of self-organization in resource tracking by honeybees. Evaluation of different types of traps against fruit flies with respect to signals; Use of honey bees/*Helicoverpa armigera* to understand behavioural polymorphism with respect to learning and response to pheromone mixtures, respectively.

Suggested Readings

Ananthkrishnan TN. (Ed.). 1994. *Functional Dynamics of Phytophagous Insects*. Oxford & IBH, New Delhi.

Awasthi VB. 2001. *Principles of Insect Behaviour*. Scientific Publ., Jodhpur.

Bernays EA & Chapman RF. 1994. *Host-Plant Selection by Phytophagous Insects*. Chapman & Hall, London.

Brown LB. 1999. *The Experimental Analysis of Insect Behaviour*. Springer, Berlin.

Krebs JR & Davies NB. 1993. *An Introduction to Behavioural Ecology*. 3rd Ed. Chapman & Hall, London.

Manning A & Dawkins MS. 1992. *An Introduction to Animal Behaviour*. Cambridge University Press, USA.

Mathews RW & Mathews JR. 1978. *Insect Behaviour*. A Wiley- InterScience Publ. John Wiley & Sons, New York.

ENT 606 RECENT TRENDS IN BIOLOGICAL CONTROL 1+1

Objective

To appraise the students with advanced techniques in handling of different bioagents, modern methods of biological control and scope in cropping system based pest management in agro-ecosystems.

Theory

UNIT I

Scope of classical biological control and augmentative biocontrol; introduction and handling of natural enemies; nutrition of entomophagous insects and their hosts; dynamics of biocontrol agents *vis-à-vis* target pest populations.

UNIT II

Mass culturing techniques, insectary facilities and equipments, basic standards of insectary, viable mass-production unit, designs, precautions, good insectary practices.

UNIT III

Colonization, techniques of release of natural enemies, recovery evaluation, conservation and augmentation of natural enemies, survivorship analysis and ecological manipulations, large-scale production of biocontrol agents, bankable project preparation.

UNIT IV

Scope of genetically engineered microbes and parasitoids in biological control, genetics of ideal traits in biocontrol agents for introgressing and for progeny selections, breeding techniques of biocontrol agents.

Practical

Mass rearing and release of some commonly occurring indigenous natural enemies; assessment of role of natural enemies in reducing pest populations; testing side effects of pesticides on natural enemies; effect of semiochemicals on natural enemies, breeding of various biocontrol

agents, performance of efficiency analyses on target pests; project document preparation for establishing a viable mass-production unit /insectary.

Suggested Readings

Burges HD & Hussey NW. (Eds.). 1971. *Microbial Control of Insects and Mites.* Academic Press, London.

Coppel HC & James WM. 1977. *Biological Insect Pest Suppression.* Springer Verlag, Berlin.

De Bach P. 1964. *Biological Control of Insect Pests and Weeds.* Chapman & Hall, London.

Dhaliwal, GS & Koul O. 2007. *Biopesticides and Pest Management.* Kalyani Publ., New Delhi.

Gerson H & Smiley RL. 1990. *Acarine Biocontrol Agents – An Illustrated Key and Manual.* Chapman & Hall, New York.

Huffakar CB & Messenger PS. 1976. *Theory and Practices of Biological Control.* Academic Press, London.

ENT 607 ADVANCED INSECTICIDE TOXICOLOGY 2+1

Objective

To acquaint the students with the latest advancements in the field of insecticide toxicology, biochemical and physiological target sites of insecticides and pesticide resistance mechanisms in insects.

Theory

UNIT I

Penetration and distribution of insecticides in insect systems; insecticide selectivity; factors affecting toxicity of insecticides.

UNIT II

Biochemical and physiological target sites of insecticides in insects; developments in biorationals, biopesticides and newer molecules; their mode of action and structural – activity relationships; advances in metabolism of insecticides.

UNIT III

Joint action of insecticides; activation, synergism and potentiation.

UNIT IV

Problems associated with pesticide use in agriculture: pesticide resistance mechanisms and resistant management strategies; pest resurgence and outbreaks; persistence and pollution; health hazards and other side effects.

UNIT V

Estimation of insecticidal residues- sampling, extraction, clean-up and estimation by various methods; maximum residue limits (MRLs) and their fixation; insecticide laws and standards, and good agricultural practices.

Practical

Pesticide residues-Definition, Objectives of analysis and tolerance limits, Preparation of standard pesticide solutions, Sampling techniques in insecticide residue estimation, Methods of insecticide

extraction from different samples, Methods of cleanup in insecticide residue estimation, Analysis of insecticide residues by Spectrophotometry, Analysis of insecticide residues by Chromatography, Analysis of insecticide residues by ELISA, Radioisotopes & Mass Spectrometry, Biochemical techniques for detection of insecticide resistance in insects, Biological techniques for detection of insecticide resistance in insects, Visit to toxicology laboratories.

Suggested Readings

Busvine JR. 1971. *A Critical Review on the Techniques for Testing Insecticides.* CABI, London.

Dhaliwal GS & Koul O. 2007. *Biopesticides and Pest Management.* Kalyani Publ., New Delhi.

Hayes WJ & Laws ER. 1991. *Handbook of Pesticide Toxicology.* Academic Press, New York.

Ishaaya I & Degheele (Eds.). 1998. *Insecticides with Novel Modes of Action.* Narosa Publ. House, New Delhi.

Matsumura F. 1985. *Toxicology of Insecticides.* Plenum Press, New York.

O' Brien RD. 1974. *Insecticides Action and Metabolism.* Academic Press, New York.

Perry AS, Yamamoto I, Ishaaya I & Perry R. 1998. *Insecticides in Agriculture and Environment.* Narosa Publ. House, New Delhi.

Prakash A & Rao J. 1997. *Botanical Pesticides in Agriculture.* Lewis Publ.,

ENT 608 ADVANCED HOST PLANT RESISTANCE 1+1

Objective

To familiarize the students with recent advances in resistance of plants to insects and acquaint with the techniques for assessment and evaluation of resistance in crop plants.

Theory

UNIT I

Importance of plant resistance, historical perspective, desirable morphological, anatomical and biochemical adaptations of resistance; assembly of plant species - gene pool; insect sources – behaviour in relation to host plant factors.

UNIT II

Physical and chemical environment conferring resistance in plants, role of trypsin inhibitors and protease inhibitors in plant resistance; biochemistry of induced resistance – signal transduction pathways, methyl jasmonate pathways, polyphenol oxidase pathways, salicylic acid pathways; effects of induced resistance; exogenous application of elicitors.

UNIT III

Biotechnological approaches in host plant resistance- genetic manipulation of secondary plant substances; incorporation of resistant gene in crop varieties; marker-aided selection in resistance breeding.

UNIT IV

Estimation of plant resistance based on plant damage- screening and damage rating; evaluation based on insect responses; techniques and determination of categories of plant resistance; breakdown of resistance in crop varieties.

Practical

Mechanisms of resistance for orientation, feeding, oviposition, Allelochemical base of insect resistance, Macro culturing of test insects such as aphids, Macro culturing of test insects such as leaf/plant hoppers, Macro culturing of test insects such as mites, Macro culturing of test insects such as stored grain insects, Macro culturing of test insects such as lepidopteran insects, Field screening- microplot technique, infester row technique, spreader row technique, Field screening - Plant nursery technique, Determination of antixenosis index, Determination of antibiosis index, Determination of tolerance and plant resistance index

Suggested Readings

Ananthakrishnan, T.N. (Ed.). 1994. *Functional Dynamics of Phytophagous Insects.* Oxford & IBH, New Delhi

Bernays E.A. & Chapman, R.F. 1994. *Host Plant Selection by Phytophagous Insects.* Chapman & Hall, London.

Panda N. 1979. *Principles of Host Plant Resistance to Insects.* Allenheld, Osum & Co., New York.

Rosenthal GA & Janzen DH. (Eds.). 1979. *Herbivores – their Interactions with Secondary Plant Metabolites.* Vol. I, II. Academic Press, New York.

Sadasivam S & Thayumanavan B. 2003. *Molecular Host Plant Resistance to Pests.* Marcel Dekker, New York.

Smith CM, Khan ZR & Pathak MD. 1994. *Techniques for Evaluating Insect Resistance in Crop Plants.* CRC Press, Boca Raton, Florida.

Painter, R.H. 1951. *Insect Resistance in Crop Plants.* MacMillan, NewYork. 520 pp.

ENT 609 ADVANCED ACAROLOGY 1+1

Objective

To acquire a good working knowledge of identification of economically important groups of mites up to the species level, a detailed understanding of the newer acaricide molecules and utilization of predators.

Theory

UNIT I

Comparative morphology of Acari, phylogeny of higher categories in mites, knowledge of commonly occurring orders and families of Acari in India. Diagnostic characteristics of commonly occurring species from families Tetranychidae, Tenuipalpidae, Eriophyidae, Tarsonemidae, Phytoseiidae, Bdellidae, Cunaxidae, Stigmaeidae, Pymotidae, Cheyletidae, Acaridae, Pyroglyphidae, Orthogalumnidae, Argasidae, Ixodidae, Sarcoptidae. Soil mites in India.

UNIT II

Management of economical important species of mites in agriculture, veterinary and public health; storage acarology.

UNIT III

Mites as vectors of plant pathogens; mode of action, structure-activity relationships of different groups of acaricides; problem of pesticide resistance in mites, resurgence of mites.

UNIT IV

Predatory mites, their mass production and utilization in managing mite pests, acaropathogenic fungi- identification, isolation and utilization.

Practical

Identification of commonly occurring mites up to species, preparation of keys for identification. Collection of specific groups of mites and preparing their identification keys. Rearing phytoseiid mites and studying their role in suppression of spider mites. Management of mite pests of crops using acaricides, phytoseiid predators, fungal pathogens *etc.*

Suggested Readings

Evans GO.1992. *Principles of Acarology.* CABI, London.

Gerson H & Smiley RL. 1990. *Acarine Biocontrol Agents- An Illustrated Key and Manual.* Chapman & Hall, New York.

Gupta SK. 1985. *Handbook of Plant Mites of India.* Zoological Survey of India, Calcutta.

Krantz GW. 1970. *A Manual of Acarology.* Oregon State University Book Stores, Corvallis, Oregon.

Sadana GL. 1997. *False Spider Mites Infesting Crops in India.* Kalyani Publ. House, New Delhi.

ENT 610 AGRICULTURAL ORNITHOLOGY 1+1

Objective

To expose the students to the prevalence of birds in agricultural fields, their habitat associations and the beneficial and harmful role played by birds in crop fields and management of pest situations.

Theory

UNIT I

Status of agricultural ornithology in India, groups of birds associated with agro-ecosystems. Habitat associations of birds in both wet and dry agricultural systems. Association of birds with different cultivation practices and crop stages, their seasonality and succession. Pestiferous and beneficial birds associated with different crops, their general biology and ecology. Food and feeding habits of birds in crop fields.

UNIT II

Nature of damage caused by birds in different crops. Foraging ecology of birds in agricultural fields. Birds affecting stored grains in houses and godowns. Beneficial role of birds in agriculture and attracting them to field. Use of bird excreta in agriculture. Management of bird pests in agriculture: physical, cultural, ecological and chemical methods.

Practical

Identification of birds in the field based on direct observation and other characteristic features., Study of methods of sampling birds and their population estimation. Mapping of birds in relation to habitats, Identification of damage species, nature and type of damage, Damage pattern and methods to evolve extent of damage, Introduction to devices for bird scaring and attraction,

Equipments used in field Ornithology, Biostatistics in Ornithology, Trapping, banding, types of nests and nest monitoring, Field visit to understanding captive breeding in Zoos, Methods to study food and feeding habits, Exposure the nest box designs.

Suggested Readings

Dhindsa SR and Parasharya BM. 1998. *Birds in Agricultural Ecosystem*. Society for Applied Ornithology, Hyderabad.

Mehrotra KN and Bhatnagar RK. 1979. *Status of Economic Ornithology in* India- Bird Depredents, Depredations and their Management, ICAR, New Delhi.

Vasudeva Rao and Dubey OP. 2006. Grainivorous Pests and their Management. In: *Vertebrate Pests in Agriculture, The Indian Scenario* (Ed: Sridhara, S.), Scientific Publ., Jodhpur.

ENT 611 MOLECULAR APPROACHES IN ENTOMOLOGICAL RESEARCH 1+1

Objective

To familiarize the students with DNA recombinant techonology, marker genes, transgenic plants, biotechnology in sericulture and apiculture.

Theory

UNIT I

Introduction to molecular biology; techniques used in molecular biology.

UNIT II

DNA and RNA analysis in insects- transcription and translocation mechanisms. DNA recombinant technology, identification of genes/nucleotide sequences for characters of interest. Genetic improvement of natural enemies. Cell lines, genetic engineering in baculoviruses, *Bt* and entomopathogenic fungi.

UNIT III

Genes of interest in entomological research- marker genes for sex identification, neuropeptides, JH esterase, chitinase, CPTI; lectins and proteases. Peptides and neuropeptides, JH esterase, St toxins and venoms, Bt toxin, CPTI; trypsin inhibitors. Transgenic plants for pest resistance and diseases.

UNIT IV

Insect gene transformation; biotechnology in relation to silkworms and honey bees; introduction of lectin genes for pest suppression; DNA finger printing for taxonomy and phylogeny. Genetic improvement of inebriate tolerance of natural enemies.

UNIT V

DNA-based diagnostics; insect immune systems in comparison to vertebrates; molecular basis of metamorphosis; Sf transgenic technology and implications; molecular biology of baculoviruses; insecticide resistance. Resistance management strategies in transgenic crops. Alpha amylase inhibitor, GEAC, Bio-safety considerations

Practical

Isolation of DNA/RNA; purity determinations; base pair estimation; agarose gel electrophoresis; restriction mapping of DNA; demonstration of PCR, RFLP and RAPD techniques.

Suggested Readings

Bhattacharya TK, Kumar P & Sharma A. 2007. *Animal Biotehnology.* 1st Ed., Kalyani Publ., New Delhi.

Hagedon HH, Hilderbrand JG, Kidwell MG & Law JH. 1990. *Molecular Insect Science.* Plenum Press, New York.

Oakeshott J & Whitten MA.. 1994. *Molecular Approaches to Fundamental and Applied Entomology.* Springer Verlag.

Rechcigl JE & Rechcigl NA. 1998. *Biological and Biotechnological Control of Insect Pests.* Lewis Publ., North Carolina.

Roy U & Saxena V. 2007. *A Hand Book of Genetic Engineering.* 1st Ed., Kalyani Publ., New Delhi.

Singh BD. 2008. *Biotechnology (Expanding Horizons).* Kalyani Publ., New Delhi.

Singh P. 2007. *Introductory to Biotechnology.* 2nd Ed. Kalyani Publ., New Delhi.

ENT 612 ADVANCED INTEGRATED PEST MANAGEMENT 2+0

Objective

To acquaint the students with recent concepts of integrated pest management. Surviellance and data base management. Successful national and international case histories of integrated pest management, non conventional tools in pest management.

Theory

UNIT I

Principles of sampling and surveillance; database management and computer programming, simulation techniques, system analysis and modeling.

UNIT II

Case histories of national and international programmes, their implementation, adoption and criticisms and global trade.

UNIT III

Genetic engineering and new technologies- their progress and limitations in IPM programmes, deployment of benevolent alien genes for pest management- case studies; scope and limitations of bio-intensive and ecological based IPM programmes. Application of IPM to farmers' realtime situations.

UNIT IV

Challenges, needs and future outlook; dynamism of IPM under changing cropping systems and climate; insect pest management under protected cultivation; strategies for pesticide resistance management. Push and pull technology, area wide pest management, green pest management.

Suggested Readings

Dhaliwal GS & Arora R. 2003. *Integrated Pest Management – Concepts and Approaches.* Kalyani Publ., New Delhi.

Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology.* Kalyani Publ., New Delhi.

Flint MC & Bosch RV. 1981. *Introduction to Integrated Pest Management.* Springer, Berlin.

Koul O & Cuperus GW. 2007. *Ecologically Based Integrated Pest Management.* CABI, London.

Koul O, Dhaliwal GS & Curperus GW. 2004. *Integrated Pest Management-Potential, Constraints and Challenges.* CABI, London.

Maredia KM, Dakouo D & Mota-Sanchez D. 2003. *Integrated Pest Management in the Global Arena.* CABI, London.

Metcalf RL & Luckman WH. 1982. *Introduction of Insect Pest Management.* John Wiley & Sons, New York.

Norris RF, Caswell-Chen EP & Kogan M. 2002. *Concept in Integrated Pest Management.* Prentice Hall, New Delhi.

Pedigo RL. 1996. *Entomology and Pest Management.* Prentice Hall, New Delhi.

Subramanyam B & Hagstrum DW. 1995. *Integrated Management of Insects in Stored Products.* Marcel Dekker, New York.

ENT 613/ PL PATH 606 **PLANT BIOSECURITY AND BIOSAFETY** **2+0**

Objective

To facilitate deeper understanding on plant biosecurity and biosafety issues in agriculture.

Theory

UNIT I

History of biosecurity, Concept of biosecurity, Components of biosecurity, Quarantine, Invasive Alien Species, Biowarfare, Emerging/resurgence of pests and diseases.

UNIT II

National Regulatory Mechanism and International Agreements/Conventions viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures/World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity.

UNIT III

Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, Issues related to release of genetically modified crops.

Suggested Readings

FAO Biosecurity Toolkit 2008.

www.fao.org/docrep/010/a1140e/a1140e00.htm Laboratory Biosecurity Guidance.

http://www.who.int/csr/resources/publications/biosafety/WHO_CD S_EPR_2006.pdf

Grotto Andrew J & Jonathan B Tucker. 2006. *Biosecurity: A* Comprehensive Action Plan.

http://www.americanprogress.org/kf/biosecurity_a_comprehensive_ action_plan.pdf Biosecurity Australia.

www.daff.gov.au/ba;www.affa.gov.au/biosecurityaustralia *Biosecurity New Zealand.* www.biosecurity.govt.nz

DEFRA.www.defra.gov.uk/animalh/diseases/control/biosecurity/index.htm

Randhawa GJ, Khetarpal RK, Tyagi RK & Dhillon. BS (Eds.). 2001.

Transgenic Crops and Biosafety Concerns. NBPGR, New Delhi.

Khetarpal RK & Kavita Gupta 2006. *Plant Biosecurity in India - Status and Strategy.* Asian Biotechnology and Development Review 9(2): 39-63.

Biosecurity for Agriculture and Food Production.

http://www.fao.org/biosecurity/

CFIA.http://www.inspection.gc.ca/english/anima/heasan/fad/biosecure.sht ml

List of Journals

Agricultural and Forest Entomology- Royal Entomological Society, UK
Annual Review of Entomology- Paloatto, California, USA
Applied Soil Ecology- Elsevier Science, Amsterdam, The Netherlands
Biopesticides International- Koul Research Foundation, Jalandhar
Bulletin of Entomological Research- CAB International, Wallingford, UK
Bulletin of Grain Technology- Food Grain Technologist Res. Association of India, Hapur
Crop Protection- Elsevier's Science, USA
Ecological Entomology -Royal Entomological Society, UK
Entomologia Experimentalis Applicata- Kluwer Academic Publishers, The Netherlands
Entomon- Association for Advancement of Entomology, Kerala
Environmental Entomology- Entomological Society of America, Maryland, USA
Indian Journal of Applied Entomology- Entomological Research Association, Udaipur
Indian Journal of Entomology- Entomological Society of India, New Delhi
Indian Journal of Plant Protection- Plant Protection Society of India, Hyderabad
Indian Journal of Sericulture- Central Silk Board, Bangalore
International Journal of Acarology- Indira Acarology Publishing House, Minessota, USA
International Journal of Pest Management- Taylor and Francis, UK
Journal of Acarology- Acarological Society of India, UAS, Bangalore
Journal of Apiculture Research- IBRA, UK
Journal of Applied Entomology- Blackwell Science Ltd., Oxford, UK

Journal of Biocontrol- Society for Biocontrol Advancement, Bangalore
Journal of Economic Entomology- Entomological Society of America, Maryland, USA
Journal of Entomological Research- Malhotra Publishing House, New Delhi
Journal of Insect Behaviour- Plenum Publishing Corporation, NY, USA
Journal of Insect Physiology- Pergamon Press, UK
Journal of Insect Science- Indian Society for the Advancement of Insect Science, Ludhiana
Journal of Invertebrate Pathology, Elsevier Publ. Corporation, The Netherlands
Journal of Soil Biology and Ecology, Indian Society of Soil Biology and Ecology, UAS, Bangalore
Journal of Stored Products Research- Elsevier's Science, USA
Pesticides Research Journal- Society of Pesticides Science, New Delhi
Pesticide Science – Oxford, London
Pesticide Biochemistry and Physiology- New York, USA
Physiological Entomology- Royal Entomological Society, UK
Review of Applied Entomology- CAB International, Wallingford, UK
Systematic Entomology- Royal Entomological Society, UK

e-Resources

http://www.colostate.edu/Depts/Entomology/
http://www.ent.iastate.edu/list/
http://www.biologybrowser.org/
http://www.teachers.ash.org.au/aussieed/insects.htm
http://entomology.si.edu/
http://www.intute.ac.uk/healthandlifesciences/agriculture/
http://www.agriculture.gov.au/
http://www.gbif.org/
http://www.mosquito.org/
http://www.nysaes.cornell.edu/fst/faculty/acree/pheronet/index.html
http://medent.usyd.edu.au/links/links.htm
http://www.ent.iastate.edu/list/
http://www.ento.csiro.au/index.html
http://www.biocollections.org/lib/listbycat.php?cat=Entomology
http://www.IPMnet.org/DIR/
http://www.nhm.ac.uk/hosted_sites/acarology/
http://www.agnic.org/
http://ars-genome.cornell.edu/
http://www.tulane.edu/~dmsander/garryfavweb.html
http://www.ufsia.ac.be/Arachnology/Arachnology.html
http://www.ippc.orst.edu/IPMdefinitions/home.html
http://www.ent.iastate.edu/list/
http://www.ippc.orst.edu/cicp/pests/vertpest.htm
http://ipmwww.ncsu.edu/cicp/IPMnet_NEWS/archives.html
http://nematode.unl.edu/wormsite.htm

http://www.bmckay.com/
http://ace.ace.orst.edu/info/extoxnet/pips/pips.html
http://www.ifgb.uni-hannover.de/extern/ppigb/ppigb.htm
http://www.ceris.purdue.edu/npirs/npirs.html
http://www.ces.ncsu.edu/depts/pp/bluemold/
http://www.ipm.ucdavis.edu
http://ippc.orst.edu/pestalert/
http://www.orst.edu/Dept/IPPC/wea/
http://www.barc.usda.gov/psi/bpdl/bpdl.html
http://www.nalusda.gov/bic/BTTOX/bttoxin.htm
http://www.nysaes.cornell.edu/ent/biocontrol/
http://entweb.clemson.edu/cuentres/
http://www.agr.gov.sk.ca/Docs/crops/cropguide00.asp
http://www.caf.wvu.edu/kearneysville/wvufarm6.html
http://www.chebucto.ns.ca/Environment/NHR/lepidoptera.html
http://nt.ars-grin.gov/fungaldatabases/databaseframe.cfm
http://www.orst.edu/dept/infonet/
http://www.attra.org/attra-pub/fruitover.html
http://www.ceris.purdue.edu/napis/pests/index.html
http://danpatch.ecn.purdue.edu/~epados/farmstead/pest/src/
http://ipmwww.ncsu.edu/current_ipm/otimages.html
http://nematode.unl.edu/wormhome.htm
http://www.ipm.ucdavis.edu/
http://hammock.ifas.ufl.edu/en/en.html
http://www.rce.rutgers.edu/weeddocuments/index.htm
http://www.agric.wa.gov.au/ento/allied1.htm
http://biology.anu.edu.au/Groups/MES/vide/refs.htm
http://chrom.tutms.tut.ac.jp/JINNO/PESDATA/00database.html
http://agrolink.moa.my/doa/english/croptech/crop.html
http://nbo.icipe.org/agriculture/stemborers/default.html
http://www.bdt.org.br
http://www.bspp.org.uk/fbpp.htm
http://www.elsevier.com/inca/publications/store/3/5/6/
http://www.hbz-nrw.de/elsevier/00207322/
http://ianrhome.uni.edu/distanceEd/entomology/401_801_insectphysio.shtml
www.entsoc.org
http://aprtc.org/
http://www.ipmnet.org/news.html
http://www.pestnet.org/www.fruitfly.org
www.celera.com
www.hgsc.bcm.tmc.edu/drosophila

http://sdb.bio.purdue.edu/fly/aimain/links
http://flybase.bio.indiana.edu/
http://naasindia.org/journals.htm

Suggested Broad Topics for Master's and Doctoral Research

Strengthening of eco-friendly strategies of integrated insect and mite pest management including:
Biological control
Bio-rational pesticides
Host plant resistance
Transgenic crop protection
Judicious use of pesticides
Molecular biosystematics
Investigations on ecological factors including:
Survey and surveillance of insect and mite pests
Forecasting of insect and mite pest population life-tables and predictive models
Insect and mite biology
Population dynamics as influenced by abiotic and biotic factors
Studies on role of pollination including honeybees in increasing crop yields and production of honey and other allied products and management of honeybee diseases and mites
Pesticide resistance and Insecticide Resistance Management strategies
Biotypes of pests
Below ground biodiversity- Bio-indicator of soil health, role in decomposition of litter, soil physico-chemical properties
Bioprospecting for protocols, peptides, genes, insecticidal proteins and antibiotics
Climate change and pests
IPM in protected cultivation
Location specific IPM strategies in different cropping systems
Genetic improvement of natural enemies
Genetic improvement of silkworms
Refinement of silkworm rearing technology for different regions
Management of silkworm pests and diseases
Crop-pest modeling
Insect biochemistry- pheromones, hormones and neuropeptides
Insect physiology- metabolism and regulatory mechanisms.
Indigenous technology
Plants as sources of insecticides
Molecular systematics – finger printing of species
Insect systematics and phylogeny

ENVIRONMENTAL SCIENCE AND TECHNOLOGY
Course Structure - at a glance

CODE	COURSE TITLE	CREDITS
EST 501	ENVIRONMENTAL ECOLOGY	1+1
EST 502*	ENVIRONMENTAL CHEMISTRY	2+1
EST 503*	ENVIRONMENTAL LAWS AND REGULATIONS	2+0
EST 504	DEGRADATION OF CHEMICALS IN ENVIRONMENT	2+1
EST 505*	BIODIVERSITY AND CONSERVATION	1+1
EST 506	AGRICULTURE AND ENVIRONMENT	1+1
EST 507*	WASTE WATER MANAGEMENT	1+1
EST 508*	SOLID WASTE MANAGEMENT	1+1
EST 509	ANALYTICAL AND INSTRUMENTAL TECHNIQUES IN ENVIRONMENTAL SCIENCE	0+2
EST 510	ENVIRONMENTAL IMPACT ASSESSMENT	2+0
EST 511	NATURAL RESOURCE AND ENVIRONMENTAL ECONOMICS	1+1
EST 512*	ENVIRONMENTAL POLLUTION	2+1
EST 513	BIOREMEDIATION	1+1
EST 514	ECOFRIENDLY TECHNOLOGIES IN AGRICULTURE	1+1
EST 515	BIOFUELS FOR GREEN ENVIRONMENT	1+1
EST 516	ENERGY AND ENVIRONMENT	1+1
EST 517	CLIMATE CHANGE AND ENVIRONMENT	1+1
EST 518	ENVIRONMENTAL FORECASTING AND ENVIRONMENTAL SYSTEM ANALYSIS	1+1
EST 519	REMOTE SENSING AND GIS APPLICATIONS IN ENVIRONMENTAL SCIENCE	2+1
EST 520	ENVIRONMENTAL BIOTECHNOLOGY	1+1
EST 591	MASTER'S SEMINAR	1+0
EST 599	MASTER'S RESEARCH	20

*** Compulsory for Master's Programme**

Minor Departments **9**

Microbiology

Agronomy

Plant Physiology

Supporting Departments **5**

Soil Science

Statistics and Mathematics

Non credit compulsory courses

CODE	COURSE TITLE	CREDITS
PGS 501	LIBRARY INFORMATION SERVICES	0+1
PGS 501	LIBRARY AND INFORMATION SERVICES	0+1
PGS 502	TECHNICAL WRITING AND COMMUNICATION SKILLS	0+1
PGS 503 (e-course)	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1+0
PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1
PGS 505 (e-course)	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1+0
PGS 506 (e-course)	DISASTER MANAGEMENT	1+0

EST 501 **ENVIRONMENTAL ECOLOGY** **1+1**

Objective

To impart knowledge to the students of the sum of the relations of the species to surrounding world, address questions about the controls over growth, reproduction, survival abundance and geographical distribution of plants

Theory

UNIT-I

Physical, chemical and Environmental Factors and their relationship with living systems

UNIT- II

Ecological adaptations and dynamics of natural ecosystems.

UNIT-III

Material and energy flow in natural ecosystems. Physical and biological characteristics of ecosystems and their relationships.

UNIT- IV

Major ecosystems. Productivity and Ecological impact Climate change, eutrophication, global warming, acidification and stratospheric ozone depletion.

UNIT –V

Ecosystems damage and restoration.

Practical

Study of microphytes and macrophytes in different ecosystems of hydreozere, mesozere and xeroxere, Study of structure of fragile ecosystems, Identification and energy capture potential of algae and fungi in different ecosystems, Ecological adaptation to environment variable *viz.*, temperature, light, Ecological adaptation to soil condition (water logged/ marshy soil), Species diversity indices in artificial and natural ecosystems, Measurement of micro climate in multistoried crop canopy Vs natural vegetation, Study of growth chambers, glass house and poly house, Effect of pollution- dust, soil and water on plant physiological parameters, Emission of methane from rice paddies, Study the effect of global warming

Suggested Readings

PD Sharma. 2006. *Ecology and environment.* Rastogi publications, Meerut

SK Dubey. 2006. *Ecology.* Dominant publishers and distributors, New Delhi.

William P Cunningham and Mary Ann Cunningham. 2003. *Principles of environmental Science*, inquiry and applications. Tata McGraw Hill, New Delhi.

Y. Anjaneyulu. 2004. *Introduction to environmental science.* BS Publications, Hyderabad.

EST-502 **ENVIRONMENTAL CHEMISTRY** **2+1**

Objective

To acquaint with different chemical changes in the environment.

Theory

UNIT I

Introduction – chemical age, Concept and scope of Environmental Chemistry, Terminology, Environmental segments.

UNIT-II

Biogeochemical cycles of environment – The hydrological cycle, Carbon cycle, oxygen cycle, nitrogen cycle, phosphate cycle and sulphur cycle.

UNIT-III

Chemistry of atmosphere – composition, structure, evolution. Particles, ions and radicals in the atmosphere – chemical processes for formation of organic and inorganic particulate matter. Chemical and photochemical reactions in the atmosphere – oxygen and ozone chemistry, sulphur oxides, nitrogen oxides, organic compounds.

UNIT IV

Atmospheric phenomena – acid rain, global warming, ozone hole, *el nino* .

UNIT V

Chemistry of hydrosphere – water resources, properties of water, gases in water, Complication reactions in water, aquatic chemical and microbial reactions.. Aquatic environment, pollutants, Trace elements in water and their chemistry, eutrophication and its significance.

UNIT VI

Chemistry of lithosphere –composition of soil, soil properties, acid-base and ion exchange reactions in soil. Micro and macro - nutrients in soil - cyclic processes

Practical

Chemistry of soils under aerated and waterlogged conditions, Chemistry of fertilized and unfertilized soils, Effect of organic fertilizers on chemistry of soils, Chemistry of irrigation water-surface/ground/treated, Estimation of gases in troposphere, Estimation of microclimate in different cropping systems using weather tracker

Suggested Readings

Connell, D.W. (1997). *Basic Concepts of Environmental Chemistry*. Springer Publication, The Netherlands

De, A.K. (1992). *Environmental Chemistry*. Wiley Eastern Ltd, New Delhi.

De A.K. 2003. *Environmental Chemistry*. New Age International (p) ltd.

Des W. Connell 2005. *Basic Concepts of Environmental Chemistry*. Taylor & francis

Stanley E Manahan 2000. *Environmental Chemistry* – Sixth edition Lewis Publisher.

EST 503 ENVIRONMENTAL LAWS AND REGULATIONS 2+0

Objective

To identify most widespread pollutants, setting ambient standards, establishing control methods to meet the standards for sustainable development and also mobilize public opinion against environmental pollution by making people aware of its benefits.

Theory

UNIT I

Environmental Laws and regulations. Theory and practice of environmental legislation. Case studies.

UNIT II

Clear Air Act, Resource conservation and Recovery Act.

UNIT III

Indian and International Laws and Regulations.

UNIT IV

Economic implications of environmental pollution. Pollution control policies Cost/Benefit Analysis and other techniques for determining environmental policies. Pollution levies.

UNIT V

National and Global pollution control policies.

UNIT VI

Economic impact of concept of depreciation of natural resources for computing National Wealth.

Suggested Readings

Richard T Wright and Bernard J Nebel. 2004. *Environmental science.* Towards a sustainable future. Prentice Hall of India, New Delhi.

Richard T Wright. 2007. *Environmental science. Towards a sustainable future.* Prentice Hall of India. New Delhi.

Shyam Divan and Armin Rosencranz. 2001. *Environmental law and policy in India. Case materials and statues.* Oxford university press, New Delhi.

EST 504 DEGRADATION OF CHEMICALS IN ENVIRONMENT 2+1

Objective

To impart knowledge on the decomposition of pollutants in the environment by different methods.

Theory

UNIT I

Introduction - Importance. Distribution of chemicals in the environment – two phase partition, processes, fugacity.

UNIT II

Different methods of degradation and their comparison.

UNIT III

Chemical methods – Basics, chemical bonding, properties of electrovalent and covalent compounds, properties of metals and non metals, Oxidation – Reduction – Hydrolytic – Photolytic reactions.

UNIT IV

Oxidation technologies - Ozone/UV radiation/hydrogen peroxide, super critical water oxidation technology. Photo catalytic degradation of pollutants in water and air.

UNIT V

Fenton method for pollutant degradation. Sonochemical degradation of pollutants. Electrochemical methods for degradation of organic pollutants in aqueous media.

UNIT VI

The electron beam process for radiolytic degradation of pollutants. Solvated electron reductions.

UNIT VII

Pesticides degradation in soils. Biological degradation – classification of degradative bacteria. Factors effecting biodegradation kinetics. Enzymatic and nonenzymatic reactions.

UNIT VIII

Degradation of cellulose - under anerobic and aerobic situations. Degradation of lignin, proteins, hydrocarbons, synthetic polymers *etc.*

Practical

Fate of chemicals (fertilizers/pesticides/herbicides) in porous columns Preparation of column, Characterization of porous medium, Analyses of leachates at different intervals for relavent chemical, Analyses of residual soil in the column for relavent chemical

Suggested Readings

Pandey Ed BN 2002. *Eco-Degradation, Biodiversity and Health.* Daya Publishing house, Delhi.

Philip C. Kearney and Terry Roberts 1998. *Pesticide Remediation in soils and water.* John Wiley & sons

EST 505 BIODIVERSITY AND CONSERVATION 1+1

Objective

To understand the variation of the living nature on the planet, manage the genetic diversity by selection to meet the constancy, changing environmental conditions towards sustaining life by meeting the food requirements of increasing population.

Theory

UNIT I

Biodiversity – levels of diversity. Significance of Biodiversity – Speciation. Species abundance and species diversity. Direct and indirect values. Hot spots.

UNIT II

Insurance cover for future. Loss of Biodiversity- cause and remedies. National Biodiversity Authority – functions of authority.

UNIT III

State biodiversity Board. Biological diversity act 2002. International convention on biological diversity (ICBD).

UNIT IV

Biodiversity conservation in India. Principles of conservation -*ex situ* and *in situ*. Natural resources and their valuation, Conservation of natural resources.

UNIT V

Conservation laws and regulations. Peoples bio diversity register. Intellectual property Rights, Plants Breeders Right, Farmers' Right in relation to natural resources conservation.

UNIT VI

Management and Restoration of ecosystems. Restoration of disturbed natural ecosystem, such as Natural water ways, wetlands, forests and grasslands. Regulatory requirements for restoration projects plans for disturbed ecosystems.

Practical

Estimation of species abundance of plants, Estimation of biodiversity index in terrestrial ecosystems, Microbial diversity in terrestrial ecosystems, Mapping biodiversity, Biodiversity in tropical, temperate and sub tropical ecosystems, A mathematical model for biodiversity, Visit to *ex situ* and *in situ* conservation centres, Growth analysis of different plant species in different environments, Classification of ecosystem based vegetation and their distribution in world, Energy flow in ecosystems, Types of ecosystems – terrestrial ecosystems, Estimating the role of abiotic factors in aquatic ecosystems

Suggested Readings

Richard T Wright and Bernard J Nebel. 2004. *Environmental Science. Towards a sustainable future.* Prentice Hall of India. New Delhi.

Richard T Wright. 2007. *Environmental Science. Towards a sustainable future.* Prentice Hall of India. New Delhi.

VS Agarwal. 2001. *Strategies in environmental conservation.* Kalyani Publishers, New Delhi.

Y. Anjaneyulu. 2004. *Introduction to environmental science.* BS Publications, Hyderabad.

EST 506 AGRICULTURE AND ENVIRONMENT 1+1

Objective

To acquaint and equip with contribution of agriculture to environmental pollution and its prevention and control techniques.

Theory

UNIT I

Introduction to agricultural activities. Agriculture as source of pollution. Soil profile - general features.

UNIT II

Soil degradation - Physical degradation: erosion, crusting, hard pan, Conservation of soil & water, Watershed Management; Chemical degradation: salinity, sodicity, acidity. Biological degradation.

UNIT III

Heavy metal contamination – sources, remediation Phytoremediation..

UNIT IV

Impact of agricultural activities – on soil quality, water quality, air quality, and greenhouse gases and carbon trading. Prevention of pollution of the environment caused due to agriculture:

UNIT V

Safe and eco-friendly technologies: INM and Vermicomposting, IPM.

UNIT VI

Ecofriendly farming systems- Organic Agriculture, nature farming, regenerative, integrated intensive farming system (IIFS), Low external input supply agriculture (LEISA).

Practical

Estimation of soil salinity & sodicity, Estimation of soil loss & run off, Land use capability classification and alternate land use systems, Analysis of major fertilizers, Analysis of organic manures, Organic farming – certification procedures, Visit to STL & fertilizer control order laboratory, Visit to pesticides testing / residue analysis laboratory, Visit of Vermicomposting site

Suggested Readings

Control of Soil fertility by Cook

Encyclopedia of Environmental Sciences by P.R.Trivedi and Gurdeep Raj, APH Pub., New Delhi

Fundamentals of Soil Science by Indian Society of Soil Science (ISSS)

Guidelines for Soil Based Technologies to optimize land productivity in Andhra Pradesh by A. Prasad Rao & G. Bhupal Raj by Acharya N.G. Ranga Agricultural university, Rajendranagar, Hyderabad – 30.

Natural Resources Development Methodologies by U. Aswathanarayana published by BS Publications, Hyderabad – 095.

Soil Conditions and Plant Growth by Russel

Soil fertility and fertilization by Tisdale and Nelson

The Nature and Properties of Soils by Harry O. Buckman – Nyle C. Brady published by Eurasia Publishing House (p) Ltd, New Delhi.

Watershed management by Dakshinamurthy

EST - 507 WASTE WATER MANAGEMENT 1+1

Objective

To acquaint and equip with different aspects of waste water quality and its management.

Theory

UNIT I

Sources of Waste Water. Characteristics of waste water from domestic, industrial and live stock production activities.

UNIT II

Effects of waste water - Surface and ground water contamination, ground water recharge. Standards for drinking (potable) and non portable water.

UNIT III

Water treatment Technologies - Sedimentation, Coagulation and flocculation. Sewage water treatment - Primary, Secondary and tertiary treatments.

UNIT IV

Industrial waste water - pollutants and their removal. Bioremediation.

UNIT V

Advanced water treatment practices.

UNIT VI

Agricultural utilization of industrial waste water. Utilization of sewage for Agriculture, Horticulture and Forestry. Use of saline water for agriculture. Impact of irrigation with waste waters.

UNIT VII

Approaches for regulating waste water reuse in Agriculture. Policy issues to promote waste water use in Agriculture.

Practical

Sampling of water and waste water, Physical and physico chemical analysis of waste water, Estimation of COD, BOD & dissolved oxygen, Estimation of Heavy metals, Assay of coli forms in water and waste water, Detection of human pathogens I water and waste water, Visit to common effluent treatment plant-1, Visit to sewage treatment plant.

Suggested Readings

Advances in Industrial Waste Water treatment – P.K. Goel, Techno science Publications (1999).

Advances in Water treatment technologies, R.K. Trivedi (1998), global Science publications, Aligarh, UP India.

Utilization of Waste water in Agriculture & Aquaculture, S.N.kaul & et. al , Scientific Publishers (India), Jodhpur.

Waste Water Engineering – Treatment & Reuse, Metcalf & Eddy – Tata Mc Graw- Hill publishing company Limited (2003).

Waste water treatment, M.N. Rao & A.K Datta – oxford & IBH publishing company Pvt, Ltd, New Delhi & Kolkata.

EST – 508 SOLID WASTE MANAGEMENT 1+1

Objective

To acquaint and equip the students with different methods for management of solid wastes and their importance

Theory

UNIT I

Solid waste: Definition – sources and types – characteristics and classification

UNIT II

Collection, processing and segregation.

UNIT III

Treatment methods for solid wastes. Landfill technology, Incineration, Pyrolysis. Composting-methods of composing, maturity and stability indices. Advanced treatment technologies of solid wastes.

UNIT IV

Recent methods for minimization of waste generation adopted by industries.

UNIT V

Hazardous Wastes - Sources and types of hazardous wastes. Environmental toxicity due to hazardous wastes. Treatment and disposal of hospital waste. Management of industrial wastes.

UNIT VI

Legal accepts of solid waste management. Methods of hazardous waste disposal.

The 3R's Golden Rule of waste management.

Practical

Methods of sample collection under different situations, Physical & physico chemical analysis of solid waste - rural & urban waste, Estimation of essential nutrients in urban & rural waste, Estimation of harmful metals in urban & rural waste, Microbial analysis of urban & rural waste, Visit to solid waste management units, Visit to Waste disposal site –land fill, Visit to PCB

Suggested Readings

Encyclopedia of Environmental Sciences. Vol.16 Solid Waste pollution. P.R. Trivedy & Gurdeepraj by Akashdeep publishing House, New Delhi – 110002

Solid Waste Management by Velma, I.Grover, B.K. Guha, William hogland and Stuart G. McRae published by Oxford & IBH Publishing Co.Pvt. Ltd, New Delhi.

Environmental Studies by Benny Joseph published by Tata McGraw-Hill Publishing Company Limited, New Delhi.

EST 509 ANALYTICAL AND INSTRUMENTAL TECHNIQUES IN ENVIRONMENTAL SCIENCE 0+2

Objective

To acquaint the students about the basics of commonly used analytical techniques in the laboratory.

Practical

Chemistry laboratory – Acquaintance with types of chemicals, glassware and equipment, Preparation of standard solutions – (normality, molarity, mole fraction percent solution, me/l, ppm) - Standardisation of H_2So_4 and $AgNo_3$ Collection and preservation of soil and water

samples Volumetric methods of analysis – Analysis of acidity, alkalinity, hardness of water sample by titration, Organic carbon estimation by wet digestion method Instrumental methods of analysis – advantages – various techniques of instrumental methods, COD and total organic carbon (TOC) analysis, Analysis of pH and EC, relationship between TDS and EC, UV – Visible Spectrophotometer - Determination of P, Determination of phenols by spectrophotometer, Atomic absorption spectrophotometry – Determination of heavy metals by AAS, Flame photometry – Determination of concentration of Na and K., Chromatography (paper /GLC/ HPLC) – separation and identification of phenols, Estimation of air pollutants – analysis of particulate matter in air samples, Estimation of gases in ambient air using gas analyzer, Determination of BOD – titration method and BOD analyzer, Isotopic methods – Techniques, GM counter, Liquids scintillation counter, Mass spectrometer, Enumeration of microorganisms & Bioindicators of pollution, Visits to laboratories for seeing the latest instruments

Suggested Readings

Neelima Rajvaidya and Dillip kumar Markandy 2005. *Environmental analysis* and

Skoog, D.A. and J.J.Leary. 1992. *Principles of Instrumentation Analysis.* Saunders College Publishers, New York

Skoog, D.A., D.M.West and F.J.Holler. 1996. *Fundamentals of Analytical Chemistry.* Saunders College Publishers, New York

Sawyer, C.N., McCarty, P.L. and Parkin, G.F. 1994. *Chemistry for Environmental Engineering.* McGraw Hill Inc. New York. p.658

Instrumentation. A.P.H. Publishing corporation, New Delhi.

EST 510 ENVIRONMENTAL IMPACT ASSESSMENT 2+0

Objective

To asses the effects of human activities due to the use of environmental resources on natural environment and also by the likely adverse effect caused by the environmental changes and pollution, resulting into ecology imbalance and ecosystem disequilibrium.

Theory

Unit I

Environmental Impact Analysis: Basic concepts. EIA methodologies: Introduction, Criteria for selection of EIA methodologies – review.

UNIT II

EIA for construction of a Hydro electric projects, Industrial projects, Land clearing projects, Gas based power stations, Highways and road projects, Coal based power plants and Entertainment parks.

UNIT III

Sewage disposal: Sewage pollution, Diversion of sewage to clean water bodies and land fills.

UNIT IV

Prediction and assessment of impacts on biological, air, noise pollution, and socio-economic impacts.

UNIT V

Collection of data sets for EIA. EIA status in India, Statutory requirements, Conceptual limitations.

Suggested readings

Anjaneyulu Y 2002. *Environmental Impact Assessment.* BS Publications, Hyderabad.

Abbasi SA and Arya Ds. 2004. *Environmental Impact Assessment Available Techniques, Emerging Trends.* Discovery Publishing house, New Delhi.

Manoharchariya – *Principles of Environmental Studies.*

EST 511 NATURAL RESOURCE AND ENVIRONMENTAL ECONOMICS 1+1

Objective

To impart knowledge on relationship between conservation, extraction, and exploration of resources and on economic efficiency of utilizing natural resources

Theory

UNIT I

Natural resources and economic growth

UNIT II

Resource scarcity and environmental degradation – optimum management of resources: land, water forestry, fisheries and minerals

UNIT III

Role of institutions and suitability of technologies – management of energy resources – allocation of natural resources over time

UNIT IV

Common property resources – concept of capacity sharing – investment decisions related to resource development relationship between conservation, extraction and exploration of resources – economic efficiency and maximum social well being – social welfare function and criteria for economic policy.

UNIT V

Environmental and ecological economics – vision and methods – ecological economics of energy

UNIT VI

Environmental problems in developing countries – conflict between technology and environmental protection –

UNIT VII

International trade, foreign investment policies and environmental issues – measurement of environmental impact – cost benefit analysis - environmental protection, legislation, carbon taxes, subsidies and efficient charges.

UNIT VIII

Role of government in resource and environmental management.

Practical

Resource inventory assessment techniques – working out depletion rate of land, water, Fisheries forests and minerals – visit to case areas of resource degradation due to air, Land and water pollution and assessment – Use of biological coefficients in assessment – projection of contingency markets in loss estimation – willingness to pay concept and its quantification – assessment of environmental impact – resource development and social benefit cost analysis – analyzing the trade off on resource development *vis a vis* environmental management – Discussions on environment and poverty – population – development – environment, Tax policies – the context and relevance of the Polluter Pays Principle (PPP) and the User Pays Principle (UPP), The relevance of the economic principle of optimality to environmental sustainability in natural resources use – forecasting future resource base – discounting technique – use of multiple objective criteria in environmental planning – Regulation agencies and strategies in India

Suggested Readings

Aswathanarayana U 2006. *Natural Resources Development Methodologies*. BS Publications, Hyderabad

Jayanta Bagchi 2003. *Agriculture and WTO opportunity for India*. Samskriti, New Delhi.

Misra SK and Puri VK 2005. *Indian Economy*. Himalaya Publishing House.

EST 512 ENVIRONMENTAL POLLUTION 2+1

Objective

To impart knowledge on causes effects and control of different types of pollutions in the environment.

Thery

UNIT I

Clean Air, definition – Causes of air pollution. Particulate and non-particulate matter in air. Air Quality standards. Automobile industrial and agricultural activities in relation to air pollution. Air pollution and its effect on biological systems.

UNIT II

Green house gases, Global warming, Building super Forests for Scrubbing excess CO_2, Ozone depletion and other aberrations – Effects on atmosphere, human, plant and animal life.

UNIT III

Prevention of air pollution – Role of flora and forest stands. Emission standards. Air pollution control technologies.

UNIT IV

Noise pollution – Sources, limits. Sound absorption and insulation. Noise pollution control Technologies.

UNIT V

Water pollution – sources, effects and control measures of water pollution.

UNIT VI

Soil pollution- sources, effects and control of soil pollution.

UNIT - VII

Marine pollution- causes, effects and control measures.

UNIT VIII

Thermal pollution –causes, effects and control measures. Radio active pollution-causes, effects and control measures.

Practical

Estimation of SO_2 & NO_2 in air, Estimation of respirable dust and suspended particulate matter in the air, Estimation of CO_2 and O_2 in air, Determination of noise, Assessment of soil pollution, Assessment of water pollution, Visit to Radio Trace Laboratory

Suggested readings

Air Pollution, S. K. Agarwal by A.P.H. Publishing Corporation New Delhi, 2005.

Text book of environmental engineering. P Venugopal Rao. Prentice hall of India 2002.

Text book of Environmental Science and Technology M. Anji Reddy, B.S publications 2007.

Encyclopaedia of Environmental Sciences, vol-25 Noise pollution by P.R Trivedi and Gurdeep Raj.

Environmental Chemistry by B.K Sharma by Goel Publishing House, Meerut

EST 513 **BIOREMEDIATION** **1+1**

Objective

To acquaint and equip the students with different techniques of controlling of pollution by using biological agents.

Theory

UNIT I

Introduction. Bioremediation –Definition, Needs and limitations, Comparison with other remediation methods. Types of Bioremediation – Microbial and Phyto remediation.

UNIT II

Bioaugmentation of naturally occurring microbial activities: - environmental modification – use of co-substrates, oxygen supplementation (composting and aerobic bioreactors, *in situ* aeration) – Nutrients and fertilizers (N& P, soil fertilization and land treatment for disposal of oily wastes, aquifer nutriation, olephilic fertilizers).

UNIT III

Bioremediation of surface soil and sludges, Bioremediation of subsurface material, bioventing, plumes treatment.

UNIT IV

Organic contaminants and bacteria – biodegradation of hydrocarbons under anaerobic conditions – Petroleum contamination – environments contaminated by polycyclic aromatic hydrocarbons – nitro aromatic compounds – Bioremediation of metals.

Practical

Selection of sites polluted with organics for bioremediation, Assessing the physical, Chemical and biological properties of the selected site of pollution, Growing of appropriate microorganism/ plant sps., Monitoring the changes in the content of pollutant metal

Suggested Readings

Indu sheker thannur 2006. *Environmental Biotechnology – Basic concepts and Application.* IK International Pvt Ltd.

Philip C Kearney and Terry Roberts 1998. *Pesticide Remodiation in Soils and Water.* JohnWiley & Sons

Sharma Ra 2007. *Environmental Biotechnology*, Pointer publisher, Jaipur.

Wise DL 2005. *Global Environmental Biotechnology.* Elsevier

EST 514 ECOFRIENDLY TECHNOLOGIES IN AGRICULTURE 1+1

Objective

To impart knowledge on environmentally safe agricultural technologies.

Theory

UNIT I

Agricultural productivity. Management of Agricultural Ecosystem - Soil erosion Deposition - Water management - Ecologically balanced exploitation of soil, water and air resources.

UNIT II

Integrated nutrient management - Alternate sources for plant nutrients - Biomanure, Vermicompost, Bio fertilizers, Plant Growth Promoting Rhizobacteria (PGPR), Green leaf manure, Soil amendments, slow release formulation - N - lignin.

UNIT III

IPM - Biopesticides, Biocontrol agents, Trap crop for Pest control.

UNIT IV

Waste utilization – Composting technology for organic waste recycling, Biogas production from solid and liquid waste. Utilization of solid and liquid wastes from agriculture to conversion into single cell proteins, fuels, feeds and fertilizers.

UNIT V

Less input agriculture. Organic agriculture – Concepts and Prospects.

Practical

Integrated farming system – Water conservation techniques, Compost making – Vermicompost preparation and analysis of compost, Biofertilizers - PGPR organism usage, Bio pesticide

preparation and usage, Bio control agents handling and usage, Biogas technology for waste utilization – analysis of raw material and post treatment waste, Visit to biofertilizer unit, Visit to Biogas production unit

Suggested Readings

Benjamin wolf and Goerge H. snyder 2004. *Sustainable soils the place of organic matter in sustaining soils and their productivity*. International Book Distributing Co.

Trivedy RK and Arvind Kumar, 1998. *Ecotechnology for pollution control and Environmental Management*. Enviro media, Karad.

EST 515 BIOFUELS FOR GREEN ENVIRONMENT 1+1

Objective

To acquaint and equip the students with different technologies for energy production from biomass.

Theory

UNIT I

Introduction to Bio-fuels and energy scenario of India,

UNIT II

Bio-diesel crops of India. Agronomic management for maximizing yields of bio-diesel crops. Carbon sequestration potential of energy plantations. In-vitro technology and vegetative propagation of bio-fuel crops.

UNIT III

Environmental and economic cost-benefit assessment of bio-diesel crops, Phyto-chemistry of various bio-fuel crops, conversion processes of fatty acid into bio-diesel. Potential of alcohol production from agri-residues, starch and sugar based crops.

UNIT IV

Biophysical technologies for energy production from biomass, Hydrogen fuel production from biomass, its limitations and advantages. Production of Biogas from farm, municipal and industrial wastes.

Practical

Demonstration of bio gas production from cow dung, poultry manure, Alcohol production from molasses, rice grain, sorghum seed, Mass propagation of biofuel plants in vitro, Development of indices to understand the impact of Biofuels plantation, Study of agronomic management of biofuels, Development of package of practices for biofuel plantations, Filed trips to understand the working of commercial plants in biofuel production, Study the viability of farmer participation in taking up biofule plantations

Suggested Readings

Banwari lal and Reddy MRUP. *Wealth from waste*. Teri press, New Delhi.

Satish Kumar Mehla 2007. *Bio fuel Plants – Cultivation Practices & seed bank*. Awishkar Publication, jaipur.

EST 516 ENERGY AND ENVIRONMENT 1+1

Objective

To acquaint and equip the students with energy resources and their impact on environment.

Theory

UNIT I

Energy systems of the biosphere - autotrophy and heterotrophy - CO_2 fixation, respiration, fermentation - energy flow in the ecosystem.

UNIT II

Energy demand and outlook - global and Indian perspectives - forms of energy - potential and kinetic energy - conversion and conservation of energy.

UNIT III

Energy resources - conventional and non -conventional sources - energy from sun, ocean and wind - geothermal and nuclear energy - energy from fossil fuel - energy from bio mass - fuel wood energy.

UNIT I V

National programmes on non -conventional energy sources - chulah, biogas, wind, producer gas, biomass. Effect of energy generation on environment - Contribution to global warming, acid rain etc.

Practical

Study of photosynthetic efficiency of plants, Study of photosynthetic efficiency of blue-green algae and microorganisms, Assay of CO_2 fixation by plants and microorganisms, Hydrogen production by microorganisms, Harnessing wind energy and estimation of wind energy potential, Solar cooker and Solar driers, Energy production through pyrolysis, Smokeless Chulah and energy efficiency, Biogas production from cowdung, CH_4 production efficiency of wastes other than cow dung, Ethanol production and assay, Energy production through fuel cells, Energy efficiency of different fuels like fuel wood, kerosine, LPG, etc., Analysis of exhaust gas from automobiles, Visit to solar energy centre / wind farms, Estimation of energy demand and outlook

Suggested Readings

Fowler, J.M. 1984. *Energy and Environment.* McGraw Hill Co., New York.

Grathwohl, M. *World Energy Supply - Resources, Technologies, perspectives* - 1982. WDEG Publications, New York.

Banwari lal and Reddy MRUP. *Wealth from waste.* Teri press, New Delhi.

EST 517 CLIMATE CHANGE AND ENVIRONMENT 1+1

Objective

To impart knowledge on impact of change if climatic conditions on environment and crop productivity and soil fertility.

Theory

UNIT I

Global climate change, problems and uncertainties in food security – Impact on crop productivity and soil fertility.

UNIT II

Greenhouse gases - CO_2, CH_4, NOx, CFCs *etc.* - Change in Concentration of greenhouse gases in atmosphere , global warming potential, source - sink ratios and atmospheric loading rates *etc.* O_3 depletion and temperature Changes. Mitigation options of greenhouse gases. CO_2 enrichment studies and plant response.

UNIT III

El nino impact on Climatic fluctuations over India, climate change and global desertification process, cyclone - flood – drought – hurricane. Atmospheric brown clouds.

UNIT IV

Forest fire and oil sleek on climate change. Adaptation mechanisms in plants and animals to climate change.

UNIT V

Ongoing efforts on climate change research. Role of Global circulation models in predicting climate change scenarios, assessing global shift in monsoon pattern and its impact on productivity and soil fertility.

Practical

Methodologies for collection and quantification of greenhouse gases (CO_2, CH_4, NOx) in terrestrial and aquatic ecosystems, Methane production and emission potentials., Estimation of aerosol, SO_2 and particulate matter, Qualitative and quantitative assessment of methanogens, methanotrophs, nitrifies, sulfate reducers, CO_2 enrichment and its impact on physiology of plants and food web, Measurements of CFC and O_3 from gas samples, Global circulation models

Suggested Readings

Amrita N Achanta 1993. *The climate change Agenda.* An Indian Prospective. Tata Energy Research Institute

Co_2 Mitigation and the Indian Transport Sector. Tata energy research Institute

Thomas E Lovejoy and Lee Hannah 2005. *Climate Change and Biodiversity.* Teri New Delhi.

EST 518 **ENVIRONMENTAL FORECASTING AND ENVIRONMENTAL SYSTEM ANALYSIS** **1+1**

Objective

To acquaint and equip the students with different methods of environmental forecasting and techniques of analysis of environmental quality management.

Theory

UNIT I

Weather, climate, Agro climatic zones. Observations and tools for environmental forecasting.

UNIT II

Methods of forecasting - synoptic, statistical & numerical. Short, medium and long range weather forecasting. Forewarning of drought forecasting of dust storms, cyclones and other weather related aberrations.

UNIT III

Techniques and systems of analysis for environmental quality management.

UNIT IV

Application of crop simulation models in assessing the impact of climate change scenarios

UNIT V

Weather based agro – advisories. Models for evaluating environmental management alternatives. Application of systems analysis for air, water, soil and hazardous waste management.

Practical

Recording observation in meteorological observatory, Visit to automatic weather station, Analysis of weather data for identifying extreme weather events, Tools in cyclone forecasting, Agro-met advisory, Visit to Met-Centre, Hyderabad, Crop weather models, Methods of application of short range weather forecasting, Methods of application of medium range weather forecasting, Methods of application of long range weather forecasting

Suggested Readings

Anji Reddy 2001. *Remote Sensing and Geographical Information Systems*. BS publication, Hyderabad.

Muralikrishna IV 2001. *Spatial Information Technology – Remote Sensing and Geographical Information System*. BS Publication, Hyderabad.

Padmanabha murthy B 2004. *Environmental Meteorology*. I.K International pvt Ltd. New Delhi

EST 519 REMOTE SENSING AND GIS APPLICATIONS IN ENVIRONMENTAL SCIENCE 2+1

Objective

To acquaint and equip with the techniques of Remote Sensing and application of GIS in environmental science.

Theory

UNIT I

Remote sensing –Terminology; Physics of radiant energy – Electro Magnetic Spectrum, Radiation laws; interaction of electromagnetic radiation with atmosphere and earth surface; resolution – spatial, spectral, radiometric and temporal; typical spectral reflectance properties - vegetation, soil and water;

UNIT II

Indian space programmes and centers; platforms –sun synchronous and geostationary; sensors – active, passive, thermal, microwave; Major IRS missions, LANDSAT series, IKONOS series, SPOT series, ENVISAT, Meteorological satellites– NOAA, INSAT series, Ocean monitoring satellites.

UNIT III

Image interpretation – elements and techniques; spectral charateristics of soils; Digital Image Processing techniques – geometric errors, radiometric errors; Image enhancement techniques – spectral and spatial; image classification-supervised and unsupervised; accuracy assessment; change detection studies.

UNIT IV

GIS- applications, data structures, analytical tasks useful for spatial analysis. Map projection – properties; types; map reference systems -International, Indian and adjacent contries. Cartography –types and classification, symbols, map layout –annotation, scale, lettering, legend, North point, geographical values *etc.*

UNIT V

Application of remote sensing and GIS : Crop inventory- crop identification, acerage estimation, production forecasting, crop condition assessment. Land use/ land cover mapping and monitoring. Soils and land degradation studies. Application in watershed characterization and mapping. Application in weather forecasting and disaster management – droughts, floods *etc.* Application in Industrialization, urbanization, mining etc. Environmental Pollution monitoring.

Practical

Study of spectral signatures of different objects (soils, crops, water body etc) using spectro – radiometer – calculation of spectral indices, Use of infrared thermometer – study of diurnal temperature variations of different objects, Handling of GPS, Study of toposheets – map language – preparation of basemaps using light table, Browsing National Data centre (NDC) web site to select cloud free satellite data of study area, Relation database management for GIS in MS Access, Introduction to remote sensing soft ware (ERDOS/ ENVI/ IDRISI). Importing satellite data & toposheets, Digital image processing (DIP) techniques - Geo rectification, DIP- Image enhancement – Band ratioing filtering techniques, DIP - Unsupervised classification for mapping land use /land cover mapping, DIP - Supervised classification – Accuracy assessment, Introduction to GIS software - Arc GIS / ARC view/ Arc Info., Using arc tool box of Arc GIS, on screen digitization, overlaying analysis etc., Map preparation, legend, graticules, North arrow, scale etc., Visit to NRSA, Visit to APSRAC / JNTU/ AP forest Academy.

Suggested Reading

Anji Reddy M 2002. *Remote Sensing and Geographical Information systems* second edition. B.S Publication, Hyderabad

David Martin 2002. *Geographic information Systems socio economic application*, Routledge, London

Mural Krishna 2001. *Spatial Information Technology – Remote Sensing and Geographical Information systems.* B.S Publication, Hyderabad.

Thomas M. Lillesand and Ralph w. kiefer 2000. *Remote Sensing and Image Interpretation.* John Wiley & Sons, Inc.

EST 520 **ENVIRONMENTAL BIOTECHNOLOGY** **1+1**

Objective

To impart knowledge on role of microbes and genetic engineering in control of environmental pollution.

Theory

UNIT I

Effects of pollutants on physiology and genetics of prokaryotes and eukaryotes.

UNIT II

Aerobic processes: aeration and oxygen transfers – aeration equipment and performance – site and process selection – regionalization and location related to development – energy requirements – odor control – primary settlement – activated sludge – rotary biological contactors – Deep shaft treatment – tertiary treatment – sludge thickening – Dewatering – digestion –

UNIT III

Application to land anaerobic treatment of effluents – process option – Disinfection: use of ozone, hydrogen peroxide, chlorine – other disinfectants –

UNIT IV

Waste water treatment in developing countries – waste stabilization ponds – aerated lagoons, oxidation ditches, biomethanation – industrial treatments

UNIT V

Solid wastes – municipal refuse composition – landfill sites and refuse emplacement strategies – refuse degradation – landfill products and site exploitation – toxic and hazardous wastes and co-disposal – control and optimization and exploitation of landfill gas –

UNIT VI

Composting – agricultural alternatives – straw decomposition – probiotic organisms – role of the lactic acid bacteria in silage additives.

UNIT VII

Mineral leaching with bacteria – microorganisms involved in the sulfide mineral leaching – chemistry of sulfide mineral oxidation by bacteria – exploitation of bacterial sulfide mineral oxidation – dump and heap leaching – *in situ* bacterial leaching of ore – mineral concentrate-leaching - utilization of bacterially generated solvents – heavy metal pollutants removal by bioaccumulation Degradation of toxic wastes –

UNIT VIII

Mechanisms of detoxification - biotechnological remedies - waste recovery - single cell protein - biogas technology.

UNIT IX

Microbial control of environmental pollution: Role of genetic engineering in environmental pollution abatement - Catabolic plasmids as natural vectors – physical and genetic overviews – genetic engineering of genes for augmenting pollution abatement in microbes and plants – use of immobilized microbes for waste recycling – immobilized enzymes in pollution abatement.

Practical

Assessment of the strains for removal of BOD, Assessment of the strains for removal of COD, TOC, Estimation of oxygen mass transfer in waste waters using aerators, Microbial analysis of flocs in activated sludge system, Measurement of specific substrate removal by different microbial system, Influence of bacteria, fungi and actinomycetes on the composting of different farm wastes, Value added products from biological treatment processes, Ethanol production from immobilized process, Biological decolourization using microbial columns, Estimation of the efficiency of bacterial, fungal and actinomycetal strains for absorption of heavy metals, Assessing the survival of plant pathogens during composting, Assessing the survival of animal and human pathogens during composting, Isolation of mineral leaching bacteria from sulphur ores, Differentiation of the strains based on their protein profile, Estimation of changes in the expression of proteins during growth on specific substrates, Extraction and analysis of DNA from microbial strains, Transformation of heavy metal resistance from one strain to another through plasmids.

Suggested Readings

B.D. Singh, *Biotechnology expanding horizons* , Kalyani Publishers 2004.

G.R. Pathade, P.K. Goel, *Biotechnology in Environmental Management*, (2004) ABD Pubisher, Jaipur (India)

R.A. Sharma, 2007, *Environmental Biotechnology*, Pointer Publisher, jaipur – (Raj), India.

R.K. Trivedi & Sadhana sharma, 2005, *Biotechnological Applications in Environmental Management*. BS Publications, Hyderabad (AP), India.

List of Journals

American-Eurasian journal of Agricultural and Environmental Sciences

Annals of Agricultural Research, Down to earth.

Ecology-Environment and Conservation, Enviro Media

Environment International, A journal of environmental science, Risk and Health.

Environmental Health: A global Access Science Source.

Environmental pollution

India Green File ,Centre For Science and Environment.

Indian Journal of Environmental Health

Indian Journal of Environmental Health Protection

International Journal of Environmental Science and Technology.

Journal of Environment biology

Journal of Environmental Quality.

Journal of Environmental Science and Engineering (JESE), NEERI

Journal of Potassium Research ,Potash Research Institute , Gurgoan, Haryana

Journal of the Indian Society of Soil Science.

Journal of Water and Environment Technology.

Pollution Research, Enviro Media.

Research journal of Environmental Sciences.

Science and Culture, Indian Science News Association
Terra Green.
The Open Environmental and Biological Monitoring Journal.
The Open Environmental Engineering Journal.
Water, air and soil pollution

e-resources:

www.agrosbiotech.de
WWW.Elsevier.com
www.seacology.org
www.earthsystems.org
www.enn.com (enn-environmental news network).
www. envirolink.org
www.Greenpeace.org

Suggested Broad topics for Master's Research

Bioremediation

- Phytoremediation
- Microbial remediation

Assessment and management of

- Water Pollution
- Soil Pollution
- Air pollution

Assessment of pollutants through remote sensing and Ggs

Management of solid wastes of

- Muncipalities
- Industries
- Agriculture
- Hazardous

Management of waste water of

- Municpalities
- Industries
- Agriculture

Methodologies for collection and quantification of greenhouse gases interrestrial and aquatic ecosystems

Global circulation models for predicting climate change scenarios

GENETICS AND PLANT BREEDING
Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
GP501*	Principles of Genetics	2+1
GP502*	Principles of Cytogenetics	2+1
GP503*	Principles of Plant Breeding	2+1
GP504*	Principles of Quantitative Genetics	2+1
GP505	Mutagenesis and Mutation Breeding	2+1
GP506	Population Genetics	2+1
GP507	Heterosis Breeding	1+1
GP508*	Cell Biology and Molecular Genetics	2+1
GP509*	Biotechnology for Crop Improvement	2+1
GP510	Breeding for Biotic and Abiotic Stress Resistance	2+1
GP511	Breeding Cereals, Forages and Sugarcane	2+1
GP512	Breeding Legumes, Oilseeds and Fibre Crops	2+1
GP513	Breeding for Quality Traits	2+1
GP514	Gene Regulation and Expression	2+0
GP515	Maintenance Breeding, Concepts of Variety Release and Seed Production	1+1
GP 516$	Germplasm Collection, Exchange and Quarantine	2 +1
GP 517	Data Base Management, Evaluation and Utilization Of PGR	2+1
GP591	Master's Seminar	1+0
GP599	Master's Research	20
GP601	Plant Genetic Resources and Their Utilization	2+0
GP602	Advances in Quantitative Genetics	2+1
GP603**	Genomics in Crop Improvement	2+1
GP604**	Cellular and Chromosomal Manipulations in Crop Improvement	2+0
GP605**	Advanced Plant Breeding Systems	2+0
GP606	Crop Evolution	2+0
GP607	Breeding Designer Crops	2+1
GP608	Advances in Breeding of Major Field Crops	3+0
GP609	Microbial Genetics	2+1
GP610	In Situ and Ex Situ Conservation of Germplasm	2 +1
GP 691	Doctoral Seminar I	1+0
GP 692	Doctoral Seminar II	1+0
GP 699	Doctoral Research	45

Compulsory for Master's programme*; * Compulsory for Ph. D. programme*
$ Cross listed with SST 516

Minor Departments

Plant Molecular Biology and Biotechnology
Biochemistry

Statistics and Mathematics

Entomology

Plant Pathology

Plant physiology

Supporting Departments

Statistics and Mathematics

Entomology

Plant Pathology

Plant physiology

Non credit compulsory courses

CODE	COURSE TITLE	CREDITS
PGS 501	LIBRARY AND INFORMATION SERVICES	0+1
PGS 502	TECHNICAL WRITING AND COMMUNICATION SKILLS	0+1
PGS 503 (e-course)	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1+0
PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1
PGS 505 (e-course)	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1+0
PGS 506 (e-course)	DISASTER MANAGEMENT	1+0

GP 501 **PRINCIPLES OF GENETICS** 2+1

Objective

This course is aimed at understanding the basic concepts of genetics, helping students to develop their analytical, quantitative and problem solving skills from classical to molecular genetics.

Theory

UNIT I

Beginning of genetics; Cell structure and cell division; Early concepts of inheritance, Mendel's laws; Discussion on Mendel's paper, Chromosomal theory of inheritance.

UNIT II

Multiple alleles, Gene interactions. Sex determination, differentiation and sex-linkage, Sex-influenced and sex-limited traits; Linkage-detection, estimation; Recombination and genetic mapping in eukaryotes, Chiasmata and the time of crossing over,

UNIT III

Somatic cell genetics,

UNIT IV

Structural and numerical changes in chromosomes; Variation in chromosome number; Nature, structure and replication of the genetic material; Basic features of DNA replication *in vivo*; DNA modification and restriction; Organization of DNA in chromosomes; Genetic code; Protein biosynthesis; Split genes; Translation and Genetic code.

UNIT V

Regulation of gene activity in prokaryotes; Molecular chaperones and gene expression. Gene regulation in eukaryotes, RNA editing. Gene silencing, Anti-sense RNA and ribozymes; Micro-RNAs (miRNAs)

UNIT IV

Genetic fine structure analysis, Allelic complementation; Transposable genetic elements, overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters.

UNIT V

Molecular mechanism of mutation, repair and suppression – reverse mutations and suppressor mutations.

UNIV VI

Extra chromosomal inheritance – Genetics of mitochondria and chloroplasts

UNIT VII

Population - Mendelian population – Random mating population - Frequencies of genes and genotypes-Causes of change: Hardy-Weinberg equilibrium.

UNIT VIII

Gene isolation, synthesis and cloning, genomic and cDNA libraries, PCR based cloning, positional cloning; Nucleic acid hybridization and immunochemical detection;

UNIT IX

Genomics and proteomics; Functional and pharmacogenomics; Metagenomics.

UNIT X

Concepts of Eugenics, Epigenetics, Genetic disorders and Behavioural genetics.

Practical

Laboratory exercises in probability and chi-square, Demonstration of genetic principles using laboratory organisms, Chromosome mapping using three point test cross, Tetrad analysis, Induction and detection of mutations through genetic tests, DNA extraction and PCR amplification, Electrophoresis – basic principles and running of amplified DNA, Extraction of proteins and isozymes – use of *Agrobacterium* mediated method, Biolistic gun; practical demonstrations, Detection of transgenes in the exposed plant material, Visit to transgenic glasshouse and learning the practical considerations.

Suggested Readings

Gardner EJ & Snustad DP. 1991. *Principles of Genetics*. John Wiley & Sons.

Klug WS & Cummings MR. 2003. *Concepts of Genetics*. Peterson Edu.

Lewin B. 2008. *Genes IX*. Jones & Bartlett Publ.

Russell PJ. 1998. *Genetics*. The Benzamin/Cummings Publ. Co.

Snustad DP & Simmons MJ. 2006. *Genetics*. 4th Ed. John Wiley & Sons.

Strickberger MW. 2005. *Genetics (III Ed)*. Prentice Hall, New Delhi, India

Tamarin RH. 1999. *Principles of Genetics*. Wm. C. Brown Publs.

Uppal S, Yadav R, Subhadra & Saharan RP. 2005. *Practical Manual on Basic and Applied Genetics*. Dept. of Genetics, CCS HAU Hisar.

GP 502 **PRINCIPLES OF CYTOGENETICS** **2+1**

Objective

To provide insight into structure and functions of chromosomes, chromosome mapping, polyploidy and cytogenetic aspects of crop evolution.

Theory

UNIT I

Architecture of chromosome in prokaryotes and eukaryotes – Terminology, euchromatin and heterochromatin; karyotype and techniques for karyotyping; Banding patterns for identification of chromosomes – C value paradox – DNA content (genome size) and adaptability, Split gene; Special types of chromosomes – lamp brush chromosomes, polytene chromosomes B chromosomes and sex chromosomes.

UNIT II

Mitosis cell cycle-significance of mitosis; Meiosis cell cycle-significance of meiosis, Differences between mitosis and meiosis – significance; Crossing over-mechanisms and theories of crossing over.

UNIT III

Recombination models and cytological basis of crossing over; Structural chromosomal aberrations, Deletions – types of deletions, origin and occurrence – meiosis and breeding behaviour of deletion heterozygote, genetics of deletions; Duplications – origin, types of duplications – chromosome pairing and crossing over at meiosis in duplicate heterozygotes, phenotypic effects of duplications; Bridge-breakage – fusion cycle in corn. Role of duplications in plant breeding and evolution; Inversions: origin, types of inversions – meiotic pairing in inversions-detection and uses of pericentric and paracentric inversions; Breeding behaviour of inversion heterozygotes, Role of inversions in evolution and karyotype; Breeding behaviors of translocation heterozygote – Permanent hybrids in *Oenothera* – Robertsonian translocations, detection and uses; Numerical chromosomal aberrations: classification; Euploidy; Haploidy – Terminology and classification of haploids; Origin, occurrence and production of haploids Detection of haploids Phenotypic effects of haploids - Meiosis and Breeding behaviour of haploids. Use of haploids in plant breeding.

UNIT IV

Polyploidy – autopolyploidy, Origin and types of autopolyploids, Meiotic behaviour in autopolyploids – Autotriploids and autotetraloids; Allopolyploidy – segmental allopolyploidy – Genome analysis of allopolyploids – Evolution of important polyploid crops – Wheat, Tobacco, Brassica and Cotton; Aneuploidy – hyperploids – trisomics and tetrasomics; primary trisomics and secondary trisomics, Meiotic behaviour in trisomics and uses; Balanced tertiary trisomics in hybrid seed production – Trisomics in polyploids; tetrasomics; Aneuploidy – hypoploidy-Monosomics and nullisomics – Method of production of monosomics – Meiotic behaviours of monosomics – Monosomics in maize; Production of nullisomics – Meiotic behaviour of nullisomics – nullisomic analysis, use of nulisomics in locating genes on chromosomes; Alien gene transfer through chromosome manipulations – transfer of genome to 4x and 6x wheat – transfer of genome in the genus *Arachis*.

UNIT V

Transfer of individual whole chromosome – alien addition lines – alien substitution lines; Apomixis – Evolutionary and genetic problems in crops with apomixis; Chromosome painting, chromosome walking and chromosome jumping; Artificial chromosome construction and its uses; Reversion of autopolyploids to diploids; Genome mapping in polyploids.

UNIT IV

Fertilization barriers in crop plants at pre-and post-fertilization levels- *In vitro* techniques to overcome the fertilization barriers in crops; Chromosome manipulations in wide hybridization; case studies – Production and use of haploids, dihaploids and doubled haploids in genetics and breeding.

Practical

Learning the cytogenetics laboratory, various chemicals to be used for fixation, dehydration, embedding, staining, cleaning etc. - Microscopy: various types of microscopes - Observing sections of specimen using Electron microscope; Preparing specimen for observation – Fixative preparation and fixing specimen for light microscopy studies in cereals - Studies on the course of mitosis in wheat, pearl millet - Studies on the course of mitosis in onion and *Aloe vera* - Studies on the course of meiosis in cereals, millets and pulses - Studies on the course of meiosis in oilseeds and forage crops - Using micrometers and studying the pollen grain size in various crops -Various methods of staining and preparation of temporary and permanent slides - Pollen germination *in vivo* and *in vitro;* Microtomy and steps in microtomy; Agents employed

for the induction of various ploidy levels; Solution preparation and application at seed, seedling level - Identification of polyploids in different crops - Induction and identification of haploids; Anther culture and Ovule culture – Morphological observations on synthesized autopolyploids – Observations on C-mitosis, learning on the dynamics of spindle fibre assembly – Morphological observations on alloployploids - Morphological observations on aneuploids - Cytogenetic analysis of interspecific and intergeneric crosses - Maintenance of Cytogenetic stocks and their importance in crop breeding - Various ploidy levels due to somaclonal variation ; Polyploidy in ornamental crops-Fluorescence *in situ* hybridization (FISH)- Genome *in situ* hybridization (GISH).

Suggested Readings

Becker K & Hardin. 2004. *The World of Cell*. 5th Ed. Pearson Edu.

Carroll M. 1989. *Organelles*. The Guilford Press.

Charles B. 1993. *Discussions in Cytogenetics*. Prentice Hall. 14

Darlington CD & La Cour LF. 1969. *The Handling of Chromosomes*. Georger Allen & Unwin Ltd.

Elgin SCR. 1995. *Chromatin Structure and Gene Expression*. IRL Press.

Gray P. 1954. *The Mirotomist's Formulatory Guide*. The Blakiston Co.

Gupta PK & Tsuchiya T. 1991. *Chromosome Engineering in Plants: Genetics, Breeding and Evolution*. Part A. Elsevier.

Gupta PK. 2000. *Cytogenetics*. Rastogi Publ.

Johannson DA. 1975. *Plant Microtechnique*. McGraw Hill.

Karp G. 1996. *Cell and Molecular Biology: Concepts and Experiments*. John Wiley & Sons.

Khush GS. 1973. *Cytogenetics of Aneuploids*. Academic Press.

Sharma AK & Sharma A. 1988. *Chromosome Techniques: Theory and Practice*. Butterworth.

Sumner AT. 1982. *Chromosome Banding*. Unwin Hyman Publ.

Swanson CP. 1960. *Cytology and Cytogenetics*. Macmillan & Co.

Singh B D 2006. Genetics. Kalyani Pubnlishers, New Delhi.

Singh B D 2006. Plant Biotechnology, Kalyani Publishers, New Delhi

Strickberger, M.W. Genetics.

GP 503 PRINCIPLES OF PLANT BREEDING 2+1

Objective

To impart theoretical knowledge and practical skills about plant breeding objectives, modes of reproduction and genetic consequences, breeding methods for crop improvement.

Theory

UNIT I

History of Plant Breeding (Pre and post-Mendelian era); Objectives of plant breeding-characters improved by plant breeding; Domestication – Changes in plant species under domestication, patterns of evolution in crop plants; Centres of Origin-biodiversity and its significance. Genetic basis of breeding self- and cross - pollinated crops; Mating systems – significance in plant breeding.

UNIT II

Selection in self and cross pollinated crops-basic principles and implications; Nature of variability-components of variation-heritability and genetic advance-response to selection-implications in plant breeding; General and specific combining ability-types of gene actions and implications in plant breeding; Plant introduction-types-procedure-merits and demerits-germplasm-components of genetic resources-gene banks-role in plant breeding; Mechanism of pollination control in plants-self incompatibility classification-mechanisms-significance in crop improvement. Genotype - environment interaction- significance in plant breeding.

UNIT III

Male sterility – classification-GMS, CMS, C-GMS and chemically induced male sterility – utilization in plant breeding limitations; Mass selection-procedure-merits and demerits – applications and achievements; Pedigree method – procedure – modifications of pedigree method, bulk method-procedure-modifications of bulk method-merits and demerits-achievements-comparison between bulk and pedigree methods; Back cross method – requirements – procedures of back cross method – applications – merits and demerits – achievements – comparison between back cross, pedigree and bulk methods.

UNIT IV

Multiline breeding – differences between multiline and purelines – procedure – merits and demerits – achievements – population breeding approaches (diallel selective mating scheme) – merits and demerits; Breeding methods in cross-pollinated crops-classification of breeding methods-mass selection – ear-to-row method - S1 and S2 progeny testing - progeny selection schemes; Recurrent selection schemes – comparison among different recurrent selection schemes – merits and demerits – achievements; Hybrid breeding – steps / operations in production of hybrid varieties – genetical and physiological basis of heterosis and inbreeding – production of inbreds – procedures; Genetic improvement of inbred lines – breeding approaches – diversification – improvement of CMS lines – approaches – merits and demerits – prediction of hybrid performance-seed production of hybrid and their parent varieties/inbreds.

UNIT V

Synthetic and composite varieties-steps-merits and demerits-factors determining the performance of synthetic varieties-achievements; Breeding methods for asexually / clonally propagated crops-clonal selection – procedure-merits and demerits-achievements-Apomixis classification – merits and demerits – utilization in plant breeding. Concept of plant Ideotype - types of ideotypes - steps in ideotype devbelopment. Role in crop improvement transgressive breeding - approaches - merits and demerits.

UNIT VI

Special breeding techniques – Mutation breeding – procedures for oligogenic and polygenic traits – somatic mutations in vegetatively propagated crops merits and demerits – achievements; Breeding for abiotic stresses – classification of abiotic stresses-mechanisms of drought, salt tolerance, flooding tolerance, cold tolerance crop plants-screening techniques – problems in breeding for abiotic stresses – achievements; Breeding for biotic stresses – disease resistance – mechanisms of disease resistance – genetics of disease resistance – breeding methods for disease resistance-screening techniques – achievements; Breeding for insect resistance – mechanisms – genetics of insect resistance sources-breeding approaches-screening techniques-problems in breeding for insect resistance-achievements.

UNIT V

Cultivar development-testing procedures-release and notification of cultivars-All India Co-ordinated Research Projects-impact on cultivar development in various crops; Maintenance breeding-classical maintenance breeding – New forms of maintenance breeding – Maintenance procedure of crop varieties; Participatory Plant Breeding approaches-steps-implications; Plant breeders' rights-genesis-benefits and drawbacks of PBR system-Plant variety protection and farmers rights-salient features - implications on Indian Agriculture.

Practical

Floral biology, selfing and crossing techniques in Rice, Floral biology, selfing and crossing techniques in Sorghum, Floral biology, selfing and crossing techniques in Maize, Floral biology, selfing and crossing techniques in Bajra, Floral biology, selfing and crossing techniques in Cotton, Floral biology, selfing and crossing techniques in Pulses, Floral biology, selfing and crossing techniques in Oilseeds, Floral biology, selfing and crossing techniques in asexually propagated crops, Selection methods in segregating populations, Pedigree method, Bulk method and Backcross methods, Evaluation of breeding material, Analysis of variance (ANOVA), Estimation of heritability and genetic advance, Maintenance of experimental records, Learning techniques in hybrid seed production using male-sterility in field crops, Production of hybrids in Rice, Sorghum, Maize, Bajra etc., Production of hybrids in oil seed and pulse crops.

Suggested Readings

Allard RW. 1981. *Principles of Plant Breeding.* John Wiley & Sons.

Chopra VL. 2001. *Breeding Field Crops.* Oxford & IBH.

Chopra VL. 2004. *Plant Breeding.* Oxford & IBH.

Gupta SK. 2005. *Practical Plant Breeding.* Agribios.

Pohlman JM & Bothakur DN. 1972. *Breeding Asian Field Crops.* Oxford & IBH.

Roy D. 2003. *Plant Breeding, Analysis and Exploitation of Variation.* Narosa Publ. House.

Sharma JR. 2001. *Principles and Practice of Plant Breeding.* Tata McGraw-Hill.

Simmonds NW. 1990. *Principles of Crop Improvement.* English Language Book Society.

Singh BD. 2006. *Plant Breeding.* Kalyani Publishers.

Singh P. 2002. *Objective Genetics and Plant Breeding.* Kalyani Publishers.

Singh P. 2006. *Essentials of Plant Breeding.* Kalyani Publishers.

Singh S & Pawar IS. 2006. *Genetic Bases and Methods of Plant Breeding.* CBS.

GP 504 PRINCIPLES OF QUANTITATIVE GENETICS 2+1

Objective

To impart theoretical knowledge and computation skills regarding components of variation and variances, scales, mating designs and gene effects.

Theory

UNIT I

Mendelian traits *vs* polygenic traits - nature of quantitative traits and its inheritance - Multiple factor hypothesis - analysis of continuous variation; Variations associated with polygenic

traits - phenotypic, genotypic and environmental - non-allelic interactions; Nature of gene action - additive, dominance, epistatic and linkage effects.

UNIT II

Principles of Anaylis of Varianc (ANOVA) - Expected variance components, random and fixed models; ANOVA, biplot analysis; Comparison of means and variances for significance.

UNIT III

Designs for plant breeding experiments – principles and applications; Genetic diversity analysis – metroglyph, cluster and D^2 analysis - Association analysis - phenotypic and genotypic correlations; Path analysis and Parent - progeny regression analysis; Discriminant function and principal component analyses; Selection indices - selection of parents; Simultaneous selection models- concepts of selection - heritability and genetic advance.

UNIT IV

Generation mean analysis; Mating designs- Diallel, partial diallel, line x tester analysis, NCDs and TTC; Concepts of combining ability and gene action; Analysis of genotype x environment interaction - adaptability and stability; Models for GxE analysis and stability parameters; AMMI analysis – principles and interpretation.

UNIT V

QTL mapping; Strategies for QTL mapping - desired populations for QTL mapping - statistical methods in QTL mapping - QTL mapping in Genetic analysis; Marker assisted selection (MAS) - Approaches to apply MAS in Plant breeding - selection based on marker - simultaneous selection based on marker and phenotype - factors influencing MAS.

Practical

Problems on multiple factors inheritance - Partitioning of variance - Estimation of heritability and genetic advance - Covariance analysis, Metroglyph analysis, D^2 analysis - Grouping of clusters and interpretation- Cluster analysis - Construction of cluster diagrams and dendrograms –Interpretation, Correlation analysis - Path analysis - Parent-progeny regression analysis, Diallel analysis: Griffing's methods I and II, Diallel analysis: Hayman's graphical approach - Diallel interpretation of results - Estimation of heterosis: standard, mid-parental and better-parental heterosis - Estimation of inbreeding depression, Generation mean analysis: Analytical part and Interpretation - Estimation of different types of gene actions, Partitioning of phenotypic variance and co-variance into components due to genotypes, environment and genotype x environment interactions, Construction of saturated linkage maps and QTL mapping - Strategies for QTL mapping; statistical methods in QTL mapping; Phenotype and Marker linkage studies - Working out efficiency of selection methods in different populations and interpretation, Biparental mating, Triallel analysis,Quadriallel analysis and Triple Test Cross (TTC), Use of softwares in analysis and result interpretation, Advanced biometrical models for combining ability analysis, Models in stability analysis-Additive Main Effect and Multiplicative Interaction (AMMI) model - Principal Component Analysis model - Additive and multiplicative model - Shifted multiplicative model, Analysis and selection of genotypes - Methods and steps to select the best model, Selection systems - Biplots and mapping genotypes.

Suggested Readings

Bos I & Caligari P. 1995. *Selection Methods in Plant Breeding*. Chapman & Hall.

Falconer DS & Mackay J. 1998. *Introduction to Quantitative Genetics*. Longman.

Mather K & Jinks JL. 1971. *Biometrical Genetics*. Chapman & Hall.

Mather K & Jinks JL. 1983. *Introduction to Biometrical Genetics*. Chapman & Hall.

Nadarajan N & Gunasekaran M. 2005. *Quantitative Genetics and Biometrical Techniques in Plant Breeding*. Kalyani Publishers.

Naryanan SS & Singh P. 2007. *Biometrical Techniques in Plant Breeding*. Kalyani Publishers.

Singh P & Narayanan SS. 1993. *Biometrical Techniques in Plant Breeding*. Kalyani Publishers.

Singh RK & Choudhary BD. 1987. *Biometrical Methods in Quantitative Genetics*. Kalyani Publishers.

Weir DS. 1990. *Genetic Data Analysis. Methods for Discrete Population Genetic Data*. Sinauer Associates.

Wricke G & Weber WE. 1986. *Quantitative Genetics and Selection in Plant Breeding*. Walter de Gruyter.

GP 505 **MUTAGENESIS AND MUTATION BREEDING** **2+1**

Objective

To impart the knowledge about general principles of radiation and various tests/methods for detection of radiation effects on the living cells, genetic risks involved and perspectives of advances made.

Theory

UNIT I

Mutation and its history - Nature and classification of mutations: spontaneous and induced mutations, micro and macro mutations, pre and post adaptive mutations - Detection of mutations in lower and higher organisms – paramutations.

UNIT II

Mutagenic agents: physical - Radiation types and sources: Ionizing and non-ionizing radiations *viz.*, X rays, γ rays, α and β particles, protons, neutrons and UV rays - Radiobiology: mechanism of action of various radiations photoelectric absorption, Compton scattering and pair production) and their biological effects –RBE and LET relationships.

UNIT III

Effect of mutations on DNA - Repair mechanisms operating at DNA, chromosome, cell and organism level to counteract the mutation effects - Dosimetry - Objects and methods of treatment - Factors influencing mutation: dose rate, acute *vs* chronic irradiation, recurrent irradiation, enhancement of thermal neutron effects - Radiation sensitivity and modifying factors: External and internal sources- Oxygen, water content, temperature and nuclear volume.

UNIT IV

Chemical mutagens- Classification - Base analogues, antibiotics, alkylating agents, acridine dyes and other mutagens: their properties and mode of action - Dose determination and factors influencing chemical mutagenesis - Treatment methods using physical and chemical mutagens – Combination treatments; Other causes of mutation - direct and indirect action, comparative evaluation of physical and chemical mutagens.

UNIT V

Observing mutagen effects in M_1 generation: plant injury, lethality, sterility, chimeras *etc.*, - Observing mutagen effects in M_2 generation - Estimation of mutagenic efficiency and effectiveness – spectrum of chlorophyll and viable mutations — Mutations in traits with continuous variation.

UNIT VI

Factors influencing the mutant spectrum: genotype, type of mutagen and dose, pleiotropy and linkage *etc.* - Individual plant based mutation analysis and working out effectiveness and efficiency in M_3 generation - Comparative evaluation of physical and chemical mutagens for creation of variability in the same species – Case studies.

UNIT VII

Use of mutagens in creating oligogenic and polygenic variations – Case studies - *In vitro* mutagenesis – callus and pollen irradiation; Handling of segregating generations and selection procedures; Validation of mutants; Mutation breeding for various traits (disease resistance, insect resistance, quality improvement,etc) in different crops- Procedures for micromutations breeding/polygenic mutations- Achievements of mutation breeding- varieties released across the world- Problems associated with mutation breeding.

UNIT VIII

Use of mutagens in genomics, allele mining, Tilling.

Practical

Learning the precautions on handling of mutagens; Dosimetry - Studies of different mutagenic agents: Physical mutagens - Studies of different mutagenic agents: Chemical mutagens - Learning on Radioactivity – Production of source and isotopes at BRIT, Trombay - Learning about gamma chamber; Radiation hazards - Monitoring – safety regulations and safe transportation of radioisotopes - Visit to radio isotope laboratory ; learning on safe disposal of radioisotopes - Hazards due to chemical mutagens - Treating the plant propagules at different doses of physical and chemical mutagens - Learning combined mutagenic treatments; Raising the crop for observation - Mutagenic effectiveness and efficiency; Calculating the same from earlier literature - Study of M_1 generation – Parameters to be observed; Study of M2 generation – Parameters to be observed; Mutation breeding in cereals and pulses – Achievements made and analysis - Mutation breeding in oilseeds and cotton – Achievements and opportunities - Mutation breeding in forage crops and vegetatively propagated crops; Procedure for detection of mutations for polygenic traits in M_2 and M_3 generations.

Suggested Readings

Alper T. 1979. *Cellular Radiobiology*. Cambridge Univ. Press, London. 19

Chadwick KH & Leenhouts HP. 1981. *The Molecular Theory of Radiation Biology*. Springer-Verlag. Cotton RGH, Edkin E & Forrest S. 2000. *Mutation Detection: A Practical Approach*. Oxford Univ. Press.

International Atomic Energey Agency. 1970. *Manual on Mutation Breeding*. International Atomic Energey Agency, Vienna, Italy.

Singh BD. 2003. *Genetics*. Kalyani.

Strickberger MW. 2005. *Genetics*. 3rd Ed. Prentice Hall.

GP 506 **POPULATION GENETICS** **2+1**

Objective

To impart knowledge on structure, properties and their breeding values of different populations.

Theory

UNIT I

Introduction – Population – Characteristics of population - Random mating population – Characters – Natural population – Controlled experiments – Differences between RMP and Natural populations – Definition of population genetics-History of population genetics – Biometricians *vs* Mendelians – Population geneticists – Wright, Kimura – Fisher, Galton Population genetics – Approaches – Experimental, Empirical, Theoretical – Importance of Lewontin's theory – Empirical tool – Allozyme variation – Documentation of Gene and genotype frequencies – Gene pool – Conservation of gene frequencies – Equilibrium

UNIT II

The Hardy Weinberg principle (Law) – Definition – Factors effecting HWL – Numerical proof – Gene frequencies of particular generation depend on gene frequencies of previous generation but not on genotype frequencies - HWL – Two alleles – Autosomal – Complete dominance – Mating combinations – Offspring produced – Attainment of equilibrium – $p + q = 1$ and $p^2 + 2pq + q^2 = 1$- HWL – Assumptions – Deviations from HWF – Biological processes – The implications of HWE – Consequences of HWE. HWL – Multiple alleles – Three alleles – Six genotypes – General model – Specific ABO Blood group example – Calculation of gene frequencies- Estimation of Equilibrium frequencies – Co dominance in natural populations – Dominance in natural populations – Assuming population reached HWF

UNIT III

Estimation of Equilibrium frequencies – Estimation of recessive homozygotes – Carrier heterozygotes - Estimation of Equilibrium frequencies – Test for getting two population ratios – Synder's ratios – Example – Effect over random mating on succeeding generations - Estimation of Equilibrium frequencies – Different frequencies between sexes – Autosomal genes – Derivation of formula - Estimation of Equilibrium frequencies – Different frequencies between sexes – Sex linked genes – Derivation of formula - Estimation of Equilibrium frequencies – Attainment of equilibrium at two or more Loci – All four gametes equal frequency – Coupling and Repulsion phase gametes equal – Linkage equilibrium – Theoretical considerations.

UNIT IV

Estimation of Equilibrium frequencies – Attainment of equilibrium at two or more Loci – Coupling and Repulsion phase gametes unequal – Linkage disequilibrium – Theoretical considerations. Gene and genotypic frequencies – Changes due to mutation - Non recurrent and recurrent mutation – Effects of forward mutation – Compensation by backward mutation – Mutation as a source of variability. Gene and genotypic frequencies – Selection – Manifestations - Strength of selection – Selection against recessives Gene and genotypic frequencies – Survival of recessives and deleterious alleles in populations

UNIT V

Gene and genotypic frequencies – Selection against an allele in the absence of dominance – Heterozygote superiority Polymorphism – Types of Polymorphism – Genetic effects – Balanced and Non balanced polymorphism

UNIT IV

Fisher's fundamental theorem of natural selection. Factors effecting gene and genotypic frequencies – Migration – The founder principle. Factors effecting gene and genotypic frequencies – Meiotic drive – SD locus in Drosophila. Joint effects of Mutation and Migration – Mutation and Selection – Migration and Selection

UNIT VII

Genetic load – Types of Genetic load – Mutational load – Segregation load - Non random mating – Selfing – Inbreeding coefficient – Effects on population - Effect of Inbreeding and sibbing in cross pollinated crops - Change of Gene frequency in small populations – Introduction – Random genetic drift – Effect of population size - Change of Gene frequency in small populations – Random genetic drift – Process of genetic drift - Change of Gene frequency in small populations – Genetic slippage Co-adapted Gene complexes Homeostasis – Adaptive organization of gene pools.

Practical

Laws of the probability – Mutually Exclusive Events – Independent events, Laws of the probability – Binomial expansion – Multinomial distribution, Laws of the probability – Problems on theory of probability, Estimation of Gene and Genotype frequency – Autosomal loci with two alleles in Random mating population, Estimation of Gene and Genotype frequency – Autosomal loci with two alleles in Random mating population Sex Influenced genes, Estimation of gene and genotype frequency – Sex linked genes, Estimation of gene and genotype frequency – Multiple alleles, Testing a gene locus for equilibrium through Chi square test, Factors affecting gene frequency – Selection , Factors affecting gene frequency – Mutation, Factors affecting gene frequency – Random genetic drift, Estimation of inbreeding coefficient of progeny under different kinds of mating, Estimation of inbreeding coefficient of progeny under different kinds of mating

Suggested Readings

Chawla V & Yadava RK. 2006. *Principles of Population Genetics - A Practical Manual.* Dept. of Genetics, CCS HAU Hisar.

Falconer DS & Mackay J.1996. *Introduction to Quantitative Genetics.* Longman.

Jain JP, Jain J & Parbhakaran, VT. 1992. *Genetics of Populations.* South Asia Books.

Li CC. 1955. *Population Genetics.* The Univ. of Chicago Press.

Mather K & Jinks JL. 1982. *Biometrical Genetics.* Chapman & Hall.

Sorrens D & Doniel G. 2007. *Methods in Quantitative Genetics.* Series:

Statistics for Biology and Health. Likelihood.

Tomar SS. 1992. *Text Book of Population Genetics.* Universal Publication.

GP 507 **HETEROSIS BREEDING** **1+1**

Objective

To provide understanding about mechanisms of heterosis and its exploitation for yield improvement through conventional and biotechnological approaches.

Theory

UNIT I

Historical aspect of heterosis - Nomenclature and definitions of heterosis - Heterosis in natural population and inbred population; Evolutionary aspects - Genetic consequences of selfing and crossing in self-and cross-pollinated and asexually propagated crops.

UNIT II

Pre-Mendelian and Post-Mendelian ideas - Genetic theories of heterosis – Physiological, Biochemical and molecular factors underlining heterosis; theories and their estimation; - Evolutionary concepts of heterosis.

UNIT III

Prediction of heterosis from various crosses- Inbreeding depression, frequency of inbreeding and residual heterosis in F_2 and segregating populations, importance of inbreeding in exploitation of heterosis – case studies. - Relationship between genetic distance and expression of heterosis – case studies; Divergence and Genetic Distance analyses- morphological and molecular genetic distance in predicting heterosis, Development of heterotic pools in germplasm/genetic stocks and inbreds, their improvement for increasing heterosis.

UNIT IV

Types of male sterility and use in heterosis breeding; Maintenance, transfer and restoration of different types of male sterility; Use of selfincompatibility in development of hybrids; Hybrid seed production system: 3-line, 2-line and 1-line system; Development of inbreds and parental lines- A, B and R lines – functional male sterility; Commercial exploitation of heterosis- maintenance breeding of parental lines in hybrids.

UNIT V

Fixation of heterosis in self, cross and often cross pollinated crops, asexually/clonally propagated crops; Male sterile line creation and diversification in self pollinated, cross pollinated and asexually propagated 21 crops; problems and prospects; Apomixis in fixing heterosis-concept of single line hybrid.

UNIT VI

Organellar heterosis and complementation - Creation of male sterility through genetic engineering and its exploitation in heterosis.

UNIT VII

Heterosis breeding in wheat, rice, cotton, maize, pearl millet, sorghum and oilseed crops.

Practical

Selection indices and selection differential – Calculations and interpretations - Male sterile line characterization in millets; Using morphological descriptors; Restorer line identification and diversification of male sterile sources - Male sterile line creation in dicots comprising oilseeds,

pulses and cotton ; problems in creation of CGMS system; Ways of overcoming them - Male sterile line creation, diversification and restoration in forage crops; Understanding the difficulties in breeding apomicts; Estimation of heterotic parameters in self, cross and asexually propagated crops - Estimation from the various models for heterosis parameters -Hybrid seed production in field crops – an account on the released hybrids; their potential; Problems and ways of overcoming it; hybrid breeding at National and International level; Opportunities ahead.

Suggested Readings

Proceedings of *Genetics and Exploitation of Heterosis in Crops* – An International Symposium CIMMYT, 1998.

Akin E. 1979. *The Geometry of Population Genetics.* Springer-Verlag.

Ben Hiu Lin. 1998. *Statistical Genomics – Linkage, Mapping and QTL Analysis.* CRC Press.

De Joung G. 1988. *Population Genetics and Evolution.* Springer-Verlag.

Hartl DL. 2000. *A Primer of Population Genetics.* 3rd Ed. Sinauer Assoc.

Mettler LE & Gregg TG. 1969. *Population Genetics and Evolution.* Prentice-Hall.

Montgomery DC. 2001. *Design and Analysis of Experiments.* 5th Ed. Wiley & Sons.

Richards AJ. 1986. *Plant Breeding Systems.* George Allen & Unwin.

Srivastava S & Tyagi R. 1997. *Selected Problems in Genetics.* Vols. I, II. Anmol Publ.

GP 508 CELL BIOLOGY AND MOLECULAR GENETICS 2+1

Objective

To impart knowledge in theory and practice about cell structure, organelles and their functions, molecules like proteins and nucleic acids.

Theory

UNIT I

Introduction – Definition of cell biology and molecular genetics – History of cell biology. Ultra structure of the cell – Differences between eukaryotic and prokaryotic cells and examples. Structure and function of cell wall - Origin and growth of cell wall, plasma membrane structure, evolution and experimental evidence in support of Fluid – Mosaic model of plasma membrane – Functions of plasma membrane, Cellular Organelles - Structure and functions of Nucleus. Interphase nucleus- Structure chemical composition and Hammerlings experiment - Plastids - Structure, types of plastids-Chloroplast – Chromoplast and other photosynthetic organelles and their functions.

UNIT II

Mitochondria Ultra structure and function. Endoplasmic reticulum Structure, types of endoplasmic reticulum – Smooth and rough endoplasmic reticulum and functions of endoplasmic reticulum - Golgi complex, lysosomes, peroxisomes, structure and function and macro molecules Cell division – Mitosis general events of interphase, prophase, metaphase, telophase – Cytokinesis – Physiology of cell cycle – significance of mitosis. Cell division – Meiosis and its significance – Comparison of mitosis and meiosis - Historical background of Molecular genetics.

UNIT III

Genetic material in organisms – Evidence for DNA as the genetic material experiment by Griffiths – Avery, McLeod and Mc Carty – Hershey and Chase to prove DNA as genetic material - Evidences for RNA as the genetic material Cornat and Singer's experiment - Structure and properties of nucleic acid, DNA – Watson and Crick's model – Different forms of DNA - RNA – Types of RNA - DNA transcription and its regulation – Mechanisms of Transcription in prokaryotes –and eukaryotes - DNA regulation – Regulation of Transcription – Promoters – Enhancers – Silencers – Terminators – Transcription factors and their role.

UNIT IV

Processing of RNA Genetic code – Cracking of genetic code - properties of genetic code, Exceptions to genetic code - Regulation of protein synthesis in prokaryotes – Translation – Components of translation – mRNA, tRNA Ribosomes – Amino acids – Translation factors – Translation in prokaryotes. Regulation of protein synthesis in eukaryotes – differences between protein synthesis in prokaryotes and eukaryotes. Transposable elements – Characteristics of Transposable elements – Types of Transposable elements and example Ac – Ds system in maize.

UNIT V

Mechanisms of recombination in prokaryote (bacteria and viruses) DNA organization in eukaryotic chromosomes - models of chromosome - Nucleosome and solenoid model. DNA content variation – C value paradox Types of DNA sequences – Unique and repetitive sequences Organelle genomes – Chloroplast DNA, Mitochondrial DNA Gene amplification and its significance Proteomics and protein-protein interaction Signal transduction – Genes in development – Cancer and cell ageing.

Practical

Morphological and Gram staining of natural bacteria, Cultivation of bacteria in synthetic medium, Determination of growth rate and doubling time of bacterial cells in culture, Demonstration of bacteriophage by plaque assay method, Determination of soluble protein content in a bacterial culture, Isolation, purification and raising clonal population of a bacterium, Biological assay of bacteriophage, Determination of phage population in lysate, Study of lytic cycle of bacteriophage by one step growth experiment, Determination of latent period and burst size of phages per cell, Quantitative estimation of DNA, Quantitative estimation of RNA, Quantitative estimation of protein in an organism, Numericals: problems and assignments

Suggested Readings

Bruce A.2004. *Essential Cell Biology*. Garland.

Karp G.2004. *Cell and Molecular Biology: Concepts and Experiments*. John Wiley.

Klug WS & Cummings MR 2003. *Concepts of Genetics*. Scot, Foreman & Co.

Lewin B. 2008. *IX Genes*. John Wiley & Sons

Lodish H, Berk A & Zipursky SL. 2004. *Molecular Cell Biology*. 5th Ed. WH Freeman.

Nelson DL & Cox MM. 2005. *Lehninger's Principles of Biochemistry*. WH Freeman & Co.

Russell PJ. 1996. *Essential Genetics*. Blackwell Scientific Publ.

Schleif R.1986. *Genetics and Molecular Biology*. Addison-Wesley Publ. Co.

Singh B D. 2006 *Genetics* Kalyani Publishers, New Delhi

Verma P.S. and Agarwal V.K. 2005 – *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology* S Chand and company limited New Delhi

GP 509 BIOTECHNOLOGY FOR CROP IMPROVEMENT 2+1

Objective

To impart knowledge and practical skills to use biotechnological tools in crop improvement.

Theory

UNIT I

Biotechnology and its relevance in agriculture; Definitions, terminologies and scope in plant breeding

UNIT II

Tissue culture - History, callus, suspension cultures, cloning; Rgeneration; Somatic embryogenesis; Anther culture; somatic hybridization techniques; Meristem, ovary and embryo culture; cryopreservation

UNIT III

Techniques of DNA isolation, quantification and analysis; Genotyping; Sequencing techniques; Vectors, vector preparation and cloning, Biochemical and Molecular markers: morphological, biochemical and DNA-based markers(RELP, RAPD, AFLP, SSR, SNPs, Ests etc.) mapping populations(F_2s, back crosses, RILs, NILs and DH).

UNIT IV

Molecular mapping and tagging of agronomically important traits. Statistical tools in marker analysis, Robotics; Marker- Assisted Selection for qualitative and quantitative traits; QTLs analysis in crop plants, Gene pyramiding.

UNIT V

Marker Assisted Selection and molecular breeding; Genomics and genoinformatics for crop improvement; Integrating functional genomics information on agronomically/ economically important traits in plant breeding; Marker- assisted backcross breeding for rapid introgression, Generation of EDVs.

UNIT VI

Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector- mediated gene transfer, physical methods of gene transfer. Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases.

UNIT VII

Biotechnology applications in male sterility/hybrid breeding, molecular farming.

UNIT VIII

MOs and related issues(risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights.

UNIT IX

Bioinformatics & Bioinformatics tools.

UNIT X

Nanotechnology and its applications in crop improvement programmes.

Practical

Requirements for Plant Tissue Culture Laboratory, Techniques in Plant Tissue Culture, Media components and media preparation- Aseptic manipulation of various explants; observations ohn the contaminants occurring in media - interpretations - Inoculation of explants; Callus induction and plant regeneration - Plant regenerations; Standardizing the protocols for regeneration; Hardening of regenerated plants; Establishing a greenhouse and hardening procedures - Visit to commercial micropropagation unit. Transformation using *Agrobacterium* strains, GUS assay in transformed cells/ tissues. DNA isolation, DNA purity and quantification tests, gel electrophoresis of proteins and isozymes, PCR- based DNA markers, gel scoring and data analysis for tagging and phylogenetic relationship, construction of genetic linkage maps using computer software.

Suggested Readings

Singh BD. 2005. *Biotechnology, Expanding Horizons*. Kalyani Publishers, Ludhiana.

Chawla H.S. 2003 *Introduction to Plant Biotechnology*. Oxford & IBH Publishing Co. New Delhi

Gupta PK. 1997. *Elements of Biotechnology*. Rastogi Publ.

Chopra VL & Nasim A. 1990. *Genetic Engineering and Biotechnology: Concepts, Methods and Applications*. Oxford & IBH.

Hackett PB, Fuchs JA & Messing JW. 1988. *An Introduction to Recombinant DNA technology - Basic Experiments in Gene Manipulation*. 2nd Ed. Benjamin Publ. Co.

Sambrook J & Russel D. 2001. *Molecular Cloning* - a Laboratory Manual. 3rd Ed. Cold Spring Harbor Lab. Press.

GP 510 BREEDING FOR BIOTIC AND ABIOTIC STRESS RESISTANCE 2+1

Objective

To apprise about various abiotic and biotic stresses influencing crop yield, mechanisms and genetics of resistance and methods to breed stress resistant varieties.

Theory

UNIT I

Importance of plant breeding with special reference to biotic and abiotic stress resistance; Classification of biotic stresses – major pests and diseases of economically important crops - Concepts in insect and pathogen resistance; Analysis and inheritance of resistance variation; Host defence responses to pathogen invasions- Biochemical and molecular mechanisms; Acquired and induced immunity and systemic acquired resistance (SAR); Host-pathogen interaction, gene-for-gene hypothesis, molecular evidence for its operation and exceptions; Concept of signal transduction and other host-defense mechanisms against viruses and bacteria.

UNIT II

Types and genetic mechanisms of resistance to biotic stresses –Horizontal and vertical resistance in crop plants. Quantitative resistance/Adult plant resistance and Slow rusting resistance - Classical and molecular breeding methods - Measuring plant resistance using plant fitness; Behavioural, physiological and insect gain studies.

UNIT III

Phenotypic screening methods for major pests and diseases; Recording of observations; Correlating the observations using marker data – Gene pyramiding methods and their implications.

UNIT IV

Classification of abiotic stresses - Stress inducing factors –moisture stress/drought and water logging & submergence; Acidity, salinity/alkalinity/sodicity; High/low temperature, wind, etc. Stress due to soil factors and mineral toxicity; Physiological and Phenological responses; Emphasis of abiotic stresses in developing breeding methodologies.

UNIT V

Genetics of abiotic stress resistance; Genes and genomics in breeding cultivars suitable to low water regimes and water logging & submergence, high and low/freezing temperatures; Utilizing MAS procedures for identifying resistant types in important crops like rice, sorghum, wheat, cotton etc; Breeding for resistance to stresses caused by toxicity, deficiency and pollutants/contaminants in soil, water and environment.

UNIT VI

Exploitation of wild relatives as a source of resistance to biotic and abiotic factors in major field crops - Transgenics in management of biotic and abiotic stresses, use of toxins, protease inhibitors, lectins, chitnases and Bt for diseases and insect pest management- Achievements.

Practical

Phenotypic screening techniques for sucking pests and chewing pests – Traits to be observed at plant and insect level - Phenotypic screening techniques for nematodes and borers; Ways of combating them; Breeding strategies - Weeds – ecological, environmental impacts on the crops; Breeding for herbicide resistance - Evaluating the available populations like RIL, NIL etc. for pest resistance; Use of standard MAS procedures - Phenotypic screening methods for diseases caused by fungi and bacteria; Symptoms and data recording; use of MAS procedures - Screening forage crops for resistance to sewage water and tannery effluents; Quality parameters evaluation - Screening crops for drought and flood resistance; factors to be considered and breeding strategies - Screening varieties of major crops for acidity and alkalinity- their effects and breeding strategies; Understanding the climatological parameters and predisposal of biotic and abiotic stress factors- ways of combating them.

Suggested Readings

Blum A. 1988. *Plant Breeding for Stress Environments.* CRC Press.

Christiansen MN & Lewis CF. 1982. *Breeding Plants for Less Favourable Environments.* Wiley International.

Fritz RS & Simms EL. (Eds.). 1992. *Plant Resistance to Herbivores and Pathogens: Ecology, Evolution and Genetics.* The University of Chicago Press.

Li PH & Sakai A. 1987. *Plant Cold Hardiness.* Liss, New York

Luginpill P. 1969. *Developing Resistant Plants - The Ideal Method of Controlling Insects.* USDA, ARS, Washington DC.

Maxwell FG & Jennings PR. (Eds.). 1980. *Breeding Plants Resistant to Insects.* John Wiley & Sons.

Painter RH. 1951. *Insect Resistance in Crop Plants.* MacMillan, New York.

Russel GE. 1978. *Plant Breeding for Pest and Disease Resistance.* Butterworths.

Sakai A & Larcher W. 1987. *Frost Survival in Plants.* Springer-Verlag.

Turener NC & Kramer PJ. 1980. *Adaptation of Plants to Water and High Temperature Stress.* John Wiley & Sons.

Van der Plank JE. 1982. *Host-Pathogen Interactions in Plant Disease.* Academic Press.

GP 511 BREEDING CEREALS, FORAGES AND SUGARCANE 2+1

Objective

To provide insight into recent advances in improvement of cereals and forage crops and sugarcane using conventional and modern biotechnological approaches.

Theory

UNIT I

Rice: Evolution and distribution of species and forms - wild relatives and germplasm; Genetics – cytogenetics and genome relationship – Breeding objectives- yield, quality characters, biotic and abiotic stress resistance *etc.* – Hybrid rice breeding- potential and outcome - Aerobic rice, its implications and drought resistance breeding.

UNIT II

Wheat: Evolution and distribution of species and forms - wild relatives and germplasm; cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress resistance, exploitation of heterosis etc; Sorghum: Evolution and distribution of species and forms - wild relatives and germplasm - cytogenetics and genome relationship - Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc; Pearl millet: Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress resistance, etc.

UNIT III

Maize: Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance etc - QPM and Bt maize – strategies and implications - Heterosis breeding attempts taken in Sorghum, Pearl Millet and Maize; Minor millets: Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship - Minor millets: breeding objectives yield, quality characters, biotic and abiotic stress resistance, etc.

UNIT IV

Sugarcane: Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship – Breeding objectives- yield, quality characters, biotic and abiotic stress resistance, etc - Forage grasses: Evolution and distribution of species and forms – Wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters and palatability studies; Biotic and abiotic stress resistance etc., synthetics, composites and apomixes.

UNIT V

Forage legumes: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc - Tree fodders: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress resistance, *etc*, palatability studies.

UNIT VI

Distinguishing features of popular released varieties in Rice and Sorghum - Wheat, Pearl millet, Maize and other millets - Sugarcane, forage grasses and legumes and their application to DUS testing - Maintenance of seed purity - Nucleus and Breeder Seed Production.

Practical

Floral biology – emasculation - pollination techniques ; Study of range of variation for yield and yield components – Study of segregating populations and their evaluation - Trait based screening for stress resistance in crops of importance– Use of descriptors for cataloguing Germplasm maintenance; learning on the Standard Evaluation System (SES) and descriptors; Use of softwares for database management and retrieval.Practical learning on the cultivation of fodder crop species on sewage water; analysing them for yield components and palatability; Laboratory analysis of forage crops for crude protein, digestibility percent and other quality attributes; Visit to animal feed producing factories, learning the practice of value addition; visiting the animal husbandry unit and learning the animal experiments related with palatability and digestibility of fodder.

Suggested Readings

Agarwal RL. 1996. *Identifying Characteristics of Crop Varieties*. Oxford & IBH.

Bahl PN & Salimath PM. 1996. *Genetics, Cytogenetics and Breeding of Crop Plants*. Vol. I. *Pulses and Oilseeds*. Oxford & IBH.

Chandraratna MF. 1964. *Genetics and Breeding of Rice*. Longmans.

Chopra VL & Prakash S. 2002. *Evolution and Adaptation of Cereal Crops*. Oxford & IBH.

Gill KS. 1991. *Pearl Millet and its Improvement*. ICAR.

IRRI. 1964. *Rice Genetics and Cytogenetics*. Elsevier.

IRRI. 1986. *Rice Genetics*. Proc. International Rice Genetics Symposium.

IRRI, Los Banos, Manila, Philippines.

IRRI. 1991. *Rice Genetics II*. Proc. International Rice Genetics

Symposium. IRRI, Los Banos, Manila, Philippines.

IRRI. 1996. *Rice Genetics III*. Proc. International Rice Genetics

Symposium. IRRI, Los Banos, Manila, Philippines.

IRRI. 2000. *Rice Genetics IV*. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.

Jennings PR, Coffman WR & Kauffman HE. 1979. *Rice Improvement*. IRRI, Los Banos, Manila, Philippines.

Kannaiyan S, Uthamasamy S, Theodore RK & Palaniswamy S. 2002. *New Dimensions and Approaches for Sustainable Agriculture.*

Directorate of Extension Education, TNAU, Coimbatore.

Murty DS, Tabo R & Ajayi O. 1994. *Sorghum Hybrid Seed Production and Management.* ICRISAT, Patancheru, India.

Nanda JS. 1997. *Manual on Rice Breeding.* Kalyani Publishers.

Ram HH & Singh HG. 1993. *Crop Breeding and Genetics.* Kalyani Publishers.

Singh HG, Mishra SN, Singh TB, Ram HH & Singh DP. (Eds.). 1994. *Crop Breeding in India.* International Book Distributing Co.

Slafer GA. (Ed.). 1994. *Genetic Improvement of Field Crops.* Marcel Dekker.

Walden DB. 1978. *Maize Breeding and Genetics.* John Wiley & Sons.

GP 512 BREEDING LEGUMES, OILSEEDS AND FIBRE CROPS 2+1

Objective

To provide insight into recent advances in improvement of legumes, oilseeds and fibre crops using conventional and modern biotechnological approaches.

Theory

UNIT I

Pigeonpea: Evolution and distribution of species and forms; Wild relatives and germplasm; Genetics, cytogenetics and genome relationship; Morphological and molecular descriptors used for differentiating the accessions; Breeding objectives- yield, quality characters, biotic and abiotic stress, *etc* - Hybrid technology; maintenance of male sterile, fertile and restorer lines, progress made at ICRISAT and other Institutes.

UNIT II

Chickpea: Evolution and distribution of species and forms - Wild relatives and germplasm - cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress, etc; Protein quality improvement; Conventional and modern plant breeding approaches, progress made - Breeding for anti nutritional factors.

UNIT III

Other pulses: Greengram, blackgram, fieldpea, lentil,, lathyrus, cowpea, lablab, mothbean: Evolution, cytogenetics and genome relationship; Learning the descriptors; Breeding objectives- yield, quality characters, biotic and abiotic stress, etc; Interspecific crosses attempted and its implications, reasons for failure, ways of overcoming them.

UNIT IV

Groundnut: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; Pod and kernel characters; Breeding objectives- yield, quality characters, biotic and abiotic stress, etc.

UNIT V

Rapeseed and Mustard: Breeding objectives, utilization of wild relatives for yield and quality improvement, biotic and abiotic stress, etc; Oil quality – characteristics in different oils;

Evolution and distribution of species and forms; Wild relatives and germplasm; Genetics, cytogenetics and genome relationship.

UNIT VI

Soybean: Breeding objectives, utilization of wild relatives for yield and quality improvement, biotic and abiotic stress, etc. - Oil quality – characteristics; Evolution and distribution of species and forms; Wild relatives and germplasm; Genetics, cytogenetics and genome relationship.

UNIT VII

Other oilseed crops: Sunflower, sesame, safflower, niger: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; breeding objectives- yield, quality characters, biotic and abiotic stress; Sunflower: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship, hybrid sunflower, constraints and achievements.

UNIT VIII

Castor: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship, breeding objectives- yield, quality characters, biotic and abiotic stress, *etc* - Hybrid breeding in castor – opportunities, constraints and achievements.

UNIT IX

Cotton: Evolution of cotton; Breeding objectives- yield, quality characters, biotic and abiotic stress, etc; Development and maintenance of male sterile lines – Hybrid development and seed production – Scenario of Bt cottons, evaluation procedures for Bt cotton. Jute: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; breeding objectives- yield, quality characters, biotic and abiotic stress etc; Mesta and minor fibre crops: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; breeding objectives- yield, quality characters, biotic and abiotic stress, etc.

UNIT X

Distinguishing features of the released varieties in pulses, oilseeds and cotton; Maintenance of seed purity and seed production.

Practical

Use of descriptors for cataloguing – Floral biology - emasculation – pollination techniques; Study of range of variation for yield and yield components - Study of segregating populations in Redgram, Greengram, Blackgram and other pulse crops; Attempting crosses between blackgram and greengram. Use of descriptors for cataloguing – Floral biology, emasculation, pollination techniques of oilseed crops like Sesame, Groundnut, Sunflower and Castor, Cotton: Use of descriptors for cataloguing – Floral biology - Learning on the crosses between different species - Cotton: Study of range of variation for yield and yield components - Study of segregating populations - evaluation - Trait based screening for stress resistance - Cotton fibre quality evaluation – conventional and modern approaches; analysing the lint samples of different species, interspecific and interracial derivatives for fibre quality and interpretation –Development and maintenance of male sterile lines Evaluation of cotton cultures of different species for insect and disease resistance – Learning the mechanisms of resistance, quantifying the resistance using various parameters; Evaluating the germplasm of cotton for yield, quality and

resistance parameters – learning the procedures on development of Bt cotton - Visit to Cotton technology laboratory and spinning mills – Learning on cotton yarn production, its quality evaluation and uses.

Suggested Readings

Agarwal RL. 1996. *Identifying Characteristics of Crop Varieties*. Oxford & IBH.

Bahl PN & Salimath PM. 1996. *Genetics, Cytogenetics and Breeding of Crop Plants*. Vol. I. *Pulses and Oilseeds*. Oxford & IBH.

Chahal GS & Ghosal SS. 2002. *Principles and Procedures of Plant Breeding - Biotechnological and Conventional Approaches*. Narosa Publ.

Chopra VL. 1997. *Plant Breeding*. Oxford & IBH.

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Nigam J. 1996. *Genetic Improvement of Oilseed Crops*. Oxford & IBH.

Ram HH & Singh HG. 1993. *Crop Breeding and Genetics*. Kalyani Publishers.

Singh DP. 1991. *Genetics and Breeding of Pulse Crops*. Kalyani Publishers.

Singh HG, Mishra SN, Singh TB, Ram HH & Singh DP. (Eds.). 1994. *Crop Breeding in India*. International Book Distributing Co.

Smartt J. 1994. *The Groundnut Crop - A Scientific Basis for Improvement*. Chapman & Hall.

GP 513 BREEDING FOR QUALITY TRAITS 2+1

Objective

To provide insight into recent advances in improvement of quality traits in rice, millets, legumes, oilseeds and forage crops and for physiological efficiency using conventional and modern biotechnological approaches.

Theory

UNIT I

Introduction - Importance of Breeding for quality traits - Recent advances in improvement of quality traits in rice, millets, legumes, oilseeds and forage crops and for physiological efficiency using conventional and modern biotechnological approaches. Developmental biochemistry and genetics of carbohydrates, proteins, fats, Developmental biochemistry and genetics of vitamins, aminoacids and anti-nutritional factors. Nutritional improvement - A human perspective Breeding for grain quality parameters in rice and its analysis Golden rice and aromatic rice breeding strategies, achievements and application in Indian context.

UNIT II

Molecular basis of quality traits and their manipulation in rice Post harvest manipulation for quality improvement.Breeding for baking qualities in wheat Characters to be considered and breeding strategies in wheat.

UNIT III

Molecular and cytogenetic manipulation for quality improvement in wheat, Breeding for quality improvement in barley, Breeding for quality improvement in oats. Breeding for quality

improvement in Sorghum, Breeding for quality improvement in pearl millet, Quality protein maize QPM Concept and breeding strategies.

UNIT IV

Breeding for quality improvement in forage crops Genetic resource management for sustaining nutritive quality in crops. Breeding for quality in pulses, Breeding for quality in groundnut, Breeding for quality in sesame, Breeding for quality in sunflower.

UNIT V

Breeding for quality in minor oilseeds, Molecular basis of fat formation and manipulation to achieve more PUFA in oil crops, Genetic manipulation for quality improvement in cotton. Genetic engineering protocols for quality improvement – Achievements Value addition in crops Classification and importance – Nutritional genomics Second generation transgenics.

Practical

Grain quality evaluation in rice, Correlating ageing and quality improvement in rice, Quality analysis in millets, Estimation of antinutritional factors like tannins in different varieties, Estimation of antinutritional factors like tannins in different hybrids, A comparison of varieties and hybrids Quality parameters evaluation in wheat, Quality parameters evaluation in pulses, Quality parameters evaluation in oilseeds, Value addition in crop plants, Post harvest processing of major field crops I, Post harvest processing of major field crops II, Post harvest processing of major field crops III, Quality improvement in crops through tissue culture techniques, Evaluating the available populations like RIL for quality improvement using MAS procedures, Evaluating the available populations like NIL for quality improvement using MAS procedures.

Suggested Readings

Chahal GS & Ghosal SS. 2002. *Principles and Procedures of Plant Breeding - Biotechnological and Conventional Approaches*. Narosa Publ.

Chopra VL. 1997. *Plant Breeding*. Oxford & IBH.

FAO 2001. *Speciality Rices of the World - Breeding, Production and Marketing*. Oxford & IBH.

Ghosh P. 2004. *Fibre Science and Technology*. Tata McGraw Hill.

Hay RK. 2006. *Physiology of Crop Yield*. 2nd Ed. Blackwell.

Nigam J. 1996. *Genetic Improvement of Oilseed Crops*. Oxford & IBH.

Singh BD. 1997. *Plant Breeding*. Kalyani Publishers.

Singh RK, Singh UK & Khush GS. 2000. *Aromatic Rices*. Oxford & IBH.

GP 514 GENE REGULATION AND EXPRESSION 2+0

Objective

To provide insight into recent advances in the phenomenon of gene regulation and mechanisms by which plants and microbes express different traits and how these are modified during different stages.

Theory

UNIT I

Gene regulation - introduction purpose, Prokaryotes – processes and mechanisms – Induction and repression, Prokaryotes – Operon models – Lac and HIS operons Eukaryotes – Control of gene expression – Differentiation – Lambrush chromosomes, Eukaryotes – Hormonal control – Britton – Davidson model, Coordinated genetic regulation – Heterochromatnization – Human beings

UNIT II

Coordinated genetic regulation – Heterochromatnization – Drosophila, Maize – Activator – Ac – Ds systems, Maize – Suppressor – Mutator control systems Gene expression – Transposons – Insertion sequences – Composite transposons, Gene expression – Transposons – Rearrangement of DNA – Replicative and Non Replicative transposons, Gene expression – Transposons – Maize – Controlling elements

UNIT III

Gene expression – Transposons – Maize – Spm – Mutants Gene expression – Transposons – Arabidopsis – Mutants Paramutation – R^r allele in Maize paramutation – Imprinting of genes and genomes, Transgene expression – Mechanisms, Gene silencing – Mechanisms, Regulating genes – Horizontal homology

UNIT IV

Regulating genes – Vertical homology, Transformation – Regulatory genes as visible markers Reporter systems to study gene expression Eukaryotic - Transcriptional control, Eukaryotic - Translational regulation

UNIT V

Eukaryotic – Post translational regulation - Signal transduction - Stress induced gene expression Gene traps and Enhancer traps

Suggested Readings

Lewin B. 2008. *Genes IX*. John Wiley & Sons.

Schleif R.1986. *Genetics and Molecular Biology*. Addison-Wesley.

Russell PJ. 1996. *Essential Genetics*. Blackwell Scientific Publ.

Brown TA. 2002. *Genomes*. Bios Scientific Publ.

Tamarin RH. 1999. *Principles of Genetics*. Wm C Brown Publ.

Griffiths AJF. 2000. *An Introduction to Genetic Analysis*. WH Freeman.

Hexter W & Yost HT. 1976. *The Science of Genetics*. Prentice Hall.

Singer M & Berg P.1991. *Genes and Genomes*. John Wiley & Sons. 32

Hartl DL & Jones EW. 1998. *Genetics Principles and Analysis*. Jones & Barlett Publ.

Micklos DA & Freyer G. 2003. *DNA Science - A First Course*. CPL Scientific Publ.

Brooker RJ. 2004. *Genetics Analysis and Principles*. Addison-Wesley Longman.

Watson JD. 2004. *Molecular Bilology of the Gene*. Pearson Edu.

GP 515 **MAINTENANCE BREEDING, CONCEPTS OF VARIETY RELEASE AND SEED PRODUCTION** **1+1**

Objective

To apprise the students about the variety deterioration and steps to maintain the purity of varieties & hybrids and principles of seed production in self & cross pollinated crops.

Theory

UNIT I

Variety development and maintenance; Definition- variety, cultivar,extant variety, essentially derived variety, independently derived variety, reference variety, farmers' variety, hybrid and population; Variety testing, release and notification systems in India and abroad.

UNIT II

DUS testing- DUS Descriptors for major crops; Genetic purity concept and maintenance breeding.

UNIT III

Factors responsible for genetic deterioration of varieties - safeguards during seed production; Maintenance of varieties in self and cross-pollinated crops- isolation distance; Principles of seed production; Methods of nucleus and breeder seed production.

UNIT IV

Generation system of seed multiplication -nucleus, breeder, foundation, certified, - Quality seed production technology of self and cross-pollinated crop varieties *viz.* cereals & millets (wheat, barley, paddy, pearlmillet, sorghum, maize and ragi etc.); Pulses (greengram, blackgram, cowpea, pigeonpea, chickpea, fieldpea, lentil); Oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); fibres (cotton, jute) and forages (guar, forage sorghum, teosinte, oats, berseem, lucerne).; Seed certification procedures; Seed laws and plant variety protection regulations in India and international systems.

Practical

Identification of suitable areas/locations for seed production; Ear-to-row method and nucleus seed production - Main characteristics of released and notified varieties, hybrids and parental lines; Identification of important weeds/objectionable weeds; Determination of isolation distance and planting ratios in different crops; Seed production techniques of varieties in different crops; Hybrid seed production technology of important crops.

Suggested Readings

Agarwal RL. 1997. *Seed Technology*. 2nd Ed. Oxford & IBH.

Chhabra AK. 2006. *Practical Manual of Floral Biology of Crop Plants.*

Department of Plant Breeding. CCS HAU Hisar.

Kelly AF. 1988. *Seed Production of Agricultural Crops.* Longman.

McDonald MB Jr & Copeland LO. 1997. *Seed Production: Principles and Practices*. Chapman & Hall.

Musil AF. 1967. *Identification of Crop and Weed Seeds.* Handbook No. 219, USDA, Washington, DC.

Poehlman JM & Borthakur D. 1969. *Breeding Asian Field Crops.* Oxford & IBH.

Singh BD. 2005. *Plant Breeding: Principles and Methods.* Kalyani Publishers.

Thompson JR. 1979. *An Introduction to Seed Technology.* Leonard Hill.

Tunwar NS & Singh SV. 1985. *Handbook of Cultivars.* ICAR.

GP 516 **GERMPLASM COLLECTION, EXCHANGE AND QUARANTINE** **2+1**

Objective

To provide information about collection, germplasm exchange, quarantine, maintenance and use of plant genetic resources including genetically modified plants.

Theory

UNIT I

History and importance of germplasm exploration; Distribution and extent of prevalent genetic diversity; Phyto-geographical regions/ecological zones and associated diversity; Mapping eco-geographic distribution of diversity, threatened habitats, use of flora.

UNIT II

Concept of population and gene pool; Variations in population and their classification; Gene frequencies in populations, rare and common alleles; Gene pool sampling in self and cross pollinated and vegetatively propagated species; Non-selective, random and selective sampling strategies; Strategies and logistics of plant exploration and collection; Coarse and fine grid surveys; Practical problems in plant exploration; Use of *in vitro* methods in germplasm collection.

UNIT III

Ethnobotanical aspects of PGR; Crop botany, farming systems, collecting wild relatives of crop plants; Collection and preservation of specimens; Importance and use of herbaria and preparation of herbarium specimens.

UNIT IV

Post-exploration handling of germplasm collections; Present status and future strategies in collection of major crops of Indian origin such as rice, maize, sorghum, sesame, *Brassica*, okra, eggplant, cotton, mango, etc; approaches for collection including indigenous knowledge.

UNIT V

History, principles, objectives and importance of plant introduction; Prerequisites, conventions, national and international legislations and policies on germplasm collection and exchange; Documentation and information management; Plant quarantine- introduction, history, principles, objectives and relevance; Regulations and plant quarantine set up in India; Pest risk analysis, pest and pathogen information database; Quarantine in relation to integrated pest management; Economic significance of seed-borne pests (insects, mites, non-insect pests, nematodes, fungi, bacteria, viruses, phytoplasma, etc.).

UNIT VI

Detection and identification of pests including use of recent techniques like ELISA, PCR etc., Symptoms of pest damage, salvaging techniques for infested/infected germplasm, post-entry quarantine operation, seed treatment and other prophylactic treatments and facilities; Domestic quarantine; seed certification; International linkages in plant quarantine; weaknesses and future thrust.

UNIT VII

Genetically Modified Organisms (GMOs) or Genetically Engineered Plants (GEPs), Concepts of biosafety, risk analysis and consequences of spread of GE crops on the environment; Treaties and multilateral agreements governing trans-boundary movement of GEPs or GMOs, Indian regulatory system for biosafety.

Practical

Plant exploration and collection; Techniques of coarse and fine grid surveys; Identification of wild relatives of crop plants- Examples of collection, cataloguing and preservation of specimens; Sampling techniques of plant materials; Visiting ports, airports to study the quarantine regulations; Techniques for the detection of insects, mites, nematodes, bacteria, weeds, pathogens and viruses on seed and planting materials and salvaging; Use of visual, qualitative, quantitative, microscopic, molecular and plant growth related techniques(controlled green houses/growth chambers, etc); Detection of GMOs and GEPs; Study of post-entry quarantine operation, seed treatment and other prophylactic treatments.

Suggested Readings

Briggs D. 1997. *Plant Variation and Evolution.* Science Publ.

Cronquist AJ. 1981. *An Integrated System of Classification of Flowering Plants.* Columbia Univ. Press.

Dhillon BS, Varaprasad KS, Kalyani S, Singh M, Archak S, Srivastava U & Sharma GD. 2001. *Germplasm Conservation A Compendium of Achievements.* NBPGR, New Delhi.

di Castri F & Younes T. 1996. *Biodiversity Science and Development:*

Towards New Partnership. CABI & International Union for Biol. Sci. France.

Gurcharan Singh. 2004. *Plant Systematics: An Integrated Approah.* Science Publ.

Lawrence GMH. (Ed.). 1951. *Taxonomy of Vascular Plants.* London.

Paroda RS & Arora RK. 1991. *Plant Genetic Resources Conservation and*

Management Concepts and Approaches. IPGRI Regional office for South and South Asia, New Delhi.

Pearson LC. 1995. *The Diversity and Evolution of Plants.* CRC Press.

Singh BP. 1993. *Principles and Procedures of Exchange of Plant Genetic Resources Conservation and Management.* Indo-US PGR Project Management.

Sivarajan VV. 1991. *Introduction of Principles of Plant Taxonomy.* Science Publ.

Stace CA. *Plant Taxonomy and Biosystematics* 2nd Ed. Cambridge Univ. Press.

Takhrajan A. 1997. *Diversity and Classification of Flowering Plants.* Columbia Univ. Press.

Wiersema JH. 1999. *World Economic Plants: A Standard Reference.* Blanca Leon.

GP 517 DATA BASE MANAGEMENT, EVALUATION AND UTILIZATION OF PGR 2+1

Objective

To train the students in germplasm data base management using modern tools and softwares.

Theory

UNIT I

Statistical techniques in management of germplasm; Core identification, estimation of sample size during plant explorations, impact of sampling on population structure, sequential sampling for viability estimation; Introduction of binomial, normal and negative cumulative normal, use of Probit scales, viability eqations and numograms; Estimation of sample size for storage and viability testing.

UNIT II

Germplasm documentation; Basic of computer and operating ststens; Database management system, use of statistical softwares, pictorial and graphical representation of data; introduction to communication network.

UNIT III

Germplasm management system-global scenario; Genetic variation in crop plants and management of germplasm collection, limitations in use of germplasm collections; necessity of germplasm evaluation; Predictive methods for identification of useful germplasm; Characterization of germplasm and evaluation procedures including specific traits; Gene markers and their use in PGR management.

UNIT IV

Management and utilization of germplasm collections; Concept of core collection, molecular markers and their use in characterization; Evaluation and utilization of genetic resources; Pre-breeding/ genetic enhancement, utilizing wild species for crop improvement; Harmonizing agrobiodiversity and agricultural development crop diversification participatory plant breeding.

Practical

Basic of computer and operating systems; Identification of useful germplasm, evaluation of crop germplasm; Statistical techniques in management of germplasm - estimation of sample size for storage and viability testing; Evaluation procedure and experimental protocols (designs and their analysis), Assessment of genetic diversity; Techniques of Characterization of germplasm; Molecular markers and their use in characterization.

Suggested Readings

Painting KA, Perry MC, Denning RA & Ayad WG. 1993. *Guide Book for Genetic Resources Documentation.* IPGRI, Rome, Italy.

Puzone L & Th. Hazekamp 1996. *Characterization and Documentation of genetic Resources Utilizing Multimedia Database.* NBPGR, New Delhi.

Rana RS, Sapra RL, Agrawal RC & Gambhir R. 1991. *Plant Genetic Resources, Documentation and Information Management.* NBPGR, New Delhi.

GP 601 PLANT GENETIC RESOURCES AND THEIR UTILIZATION 2+0

Objective

To provide information about collection, evaluation, documentation, maintenance and use of plant genetic resources for crop improvement.

Theory

UNIT I

Historical perspectives and need for PGR conservation; Importance of plant genetic resources Taxonomical classification of cultivated plants; Gene pool: primary, secondary and tertiary Centres of origin and global pattern of diversity; Basic genetic resources and transgenes. Principles, strategies and practices of exploration, collection, characterization, evaluation and cataloging of PGR; Plant quarantine and phytosanitary certification; Germplasm introduction and exchange; Principles of *in vitro* and cryopreservation. Germplasm conservation- *in situ, ex situ*, and on-farm; short, medium and long term conservation

UNIT II

Strategies for conservation of orthodox seed and vegetatively propagated crops; Registration of plant genetic resources. PGR data base management; Multivariate and clustering analysis, descriptors; National and international protocols for PGR management; PGR for food and agriculture (PGRFA); PGR access and benefit sharing Role of CGIAR system in the germplasm exchange; PBR, Farmers rights and privileges Seed Act, *sui generis* system; Geographical Indicators, Intellectual property; Patents, copyrights, trademarks and trade secrets. Journey from wild to domestication; Genetic enhancement- need for genetic enhancement

UNIT III

Genetic enhancement in pre-Mendelian era and 21st century; Genetic enhancement and plant breeding, Reasons for failure in genetic enhancement; Sources of genes/ traits- novel genes for quality. Distant Hybridization: Inter-specific, inter-generic hybridization, scope and limitations, techniques to overcome the limitations Gene transfer tools and techniques into cultivated species; Validation of transferred genes and their expression. Post-genomic tools for genetic enhancement of germplasm; Pre-breeding through chromosome manipulation. Application of biotechnology for Genetic enhancement-Achievements. Utilization of genetic resources, concept of core and mini-core collections, genetic enchancement/Pre-breeding for crop improvement including hybrid development.

Suggested Readings

Frankel OH & Bennett E. 1970. *Genetic Resources in Plants – their Exploration and Conservation.* Blackwell.

Gautam PL, Dass BS, Srivastava U & Duhoon SS. 1998. *Plant Germplasm Collecting: Principles and Procedures.* NBPGR, New Delhi.

Painting KA, Perry MC, Denning RA & Ayad WG. 1993. *Guide Book for Genetic Resources Documentation.* IPGRI, Rome, Italy.

Paroda RS & Arora RK. 1991. *Plant Genetic Resources, Conservation and Management. Concepts and Approaches.* IPGRI Regional office for South and South Asia, New Delhi.

Puzone L & Hazekamp TH. 1996. *Characterization and Documentation of Genetic Resources Utilizing Multimedia Database*. NBPGR, New Delhi.

Rana RS, Sapra RL, Agrawal RC & Gambhir R. 1991. *Plant Genetic Resources, Documentation and Information Management*. NBPGR, New Delhi.

Singh RJ & Jauhar PP. 2005. *Genetic Resources, Chromosomal Engineering and Crop Improvement*. Vol. I. *Grain Legumes*, Vol. II. *Cereals*. CRC Press, Taylor & Francis Group, USA.

GP 602 ADVANCES IN QUANTITATIVE GENETICS 2+1

Objective

To impart theoretical knowledge and computation methods for non allelic interactions, mating designs and component analysis and their significance in plant breeding.

Theory

UNIT I

Introduction, Basic principles of Biometrical Genetics, Selection of parents, Advanced biometrical models for combining ability analysis, Simultaneous selection models, Use of Multiple regression analysis in selection of genotypes

UNIT II

Designs and Systems; Selection of stable genotypes. Models in stability analysis - Pattern analysis Additive Main Effect and Multiplicative Interaction (AMMI) analysis, Other related models Principal Component Analysis. Additive and multiplicative model.

UNIT III

Shifted multiplicative model Analysis and selection of genotypes Methods and steps to select the best model, Biplots and mapping genotypes. Genetic architecture of quantitative traits, Conventional analyses to detect gene actions.

UNIT IV

Partitioning of phenotypic/genotypic variance, Construction of saturated linkage maps, Concept of framework map development, QTL mapping - Strategies for QTL mapping - Desired populations, statistical methods.

UNIT V

Marker Assisted Selection (MAS) Approaches to apply MAS in Plant breeding, Selection based on markers, Simultaneous selection based on marker and phenotype, Factors influencing MAS Heritability of the trait Proportion of genetic variance, Linkage disequilibrium between markers and traits and selection methods.

Practical

Working out efficiency of selection methods in different populations and interpretation, Biparental mating – use of softwares in analysis and result interpretation, Triallel analysis– use of softwares in analysis and result interpretation, Quadriallel analysis – use of softwares in analysis and result interpretation, Triple Test Cross (TTC) – use of softwares in analysis and result interpretation, Advanced biometrical models for combining ability analysis, Selection of stable genotypes using stability analysis, Models in stability analysis Additive Main Effect and

Multiplicative Interaction (AMMI) model, Principal Component Analysis model, Additive and multiplicative model, Shifted multiplicative model, Analysis and selection of genotypes, Methods and steps to select the best model, Selection systems - Biplots and mapping genotypes, Construction of linkage maps and QTL mapping - Strategies for QTL mapping, Statistical methods in QTL mapping; Phenotype and Marker linkage studies.

Suggested Readings

Bos I & P Caligari. 1995. *Selection Methods in Plant Breeding.* Chapman & Hall.

Falconer DS & Mackay J. 1996. *Introduction to Quantitative Genetics.* Longman.

Mather K & Jinks L. 1983. *Introduction to Biometrical Genetics.* Chapman & Hall.

Nadarajan N & Gunasekaran M. 2005. *Quantitative Genetics and Biometrical Techniques in Plant Breeding.* Kalyani Publishers.

Singh P & Narayanan SS. 1993. *Biometrical Techniques in Plant Breeding.* Kalyani Publishers.

Singh RK & Choudhary BD. 1987. *Biometrical Methods in Quantitative Genetics.* Kalyani Publishers.

Weir DS. 1990. *Genetic Data Analysis. Methods for Discrete Population Genetic Data.* Sinauer Associates.

Wricke G & Weber WE. 1986. *Quantitative Genetics and Selection in Plant Breeding.* Walter de Gruyter.

GP 603 GENOMICS IN CROP IMPROVEMENT 2+1

Objective

To impart practical skills in advanced molecular techniques in genome mapping, structural / functional genomics and development of transgenic crops.

Theory

UNIT I

Introduction to genomics – Plant nuclear genomes and their molecular description - The chloroplast and mitochondrial genome in plants - Genome size and complexity.

UNIT II

Establishment of plant genome mapping projects – Genome mapping and use of molecular markers in plant breeding; Strategies for mapping genes of agronomic traits in plants - Approaches for mapping quantitative trait loci; Map based cloning of plant genes.

UNIT III

Regulation of Plant gene expression - Functional genomics - Expression Analysis using Microarrays - Transposon tagging and Insertional mutagenesis - methods and significance- Diversity Array Technology.

UNIT IV

Genome sequencing in plants - Principles and Techniques; Applicatins of sequence information in plant genome analyses; Comparative genomics - Genome Comparison Techniques - Classical and advanced approaches.

UNIT V

Detection of Single Nucleotide Polymorphism; TILLING and Eco- TILLING; Role of transcriptomics, proteomics and metabolomics in linking genome and phenome; Importance of understanding the phenotypes for exploiting the outcome of genomic technologies - Knock out mutant studies and high throughput phenotyping.

UNIT VI

Concept of database development, management and bioinformatics; Plant genome projects and application of bioinformatics tools in sturctural and functional genomics.

Practical

Chromosome analysis in major field crops, *Fluorescence in situ* hybridization, Comparative analysis of plant genomes using molecular markers, Genetic map construction using molecular markers, Mapping major genes using molecular markers, QTL mapping in plants, Comparison across mapping populations, Understanding the need for genetic algorithms in QTL mapping, Plant genome databases, Computational tools to explore plant genome databases, Comparative genomics, Comparison of genome sequences using tools of bioinformatics, Advanced genomic technologies: TILLING and Eco-TILLING, DNA array technology, Linking genome sequences to phenotypes: Tools of transcriptomics, proteomics and metabolomics

Suggested Readings

Singh B D. 2006. *Plant Biotechnology*. Kalyani Publishers

Singh B D. 2003. *Genetics*. Kalyani Publishers

Chawla H S.2002 *Introduction to Plant Biotèchnology*. Oxford & IBH Publishing Co. Pvt. Ltd.

Brown TA. 2002. *Genomes*. Wiley-LISS.

Mount DW. 2001. *Bioinformatics. Sequence and Genome Analysis*. Cold Spring Harbor Laboratory Press..

Baxevanis AD & Ouellette BFF. 2001. *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*. Wiley Interscience.

Caetano-Anolles G & Gresshoff PM. 1998. *DNA Markers: Protocols, Applications and Overviews*. Wiley-VCH.

Cantor CR & Smith CL 2004. *Genomics*. Wiley, New York.

Galas DJ & McCormack SJ. 2002. Genomic Technologies: Present and Future. Calster Academic Press.

Jordan BR. 2001. *DNA Microarrays: Gene Expression Applications*. Springer-Verlag.

Liu BH. 1997. *Statistical Genomics: Linkage, Mapping and QTL Analysis*. CRS Press.

Lynch M & Walsh B. 1998. *Genetics and Analysis of Quantitative Traits*. Sinauer Associates.

Palzkill T. 2002. *Proteomics*. Kluwer.

Paterson AH. 1996. *Genome Mapping in Plants*. Academic Press.

Pennington SR & Dunn MJ. 2002. *Proteomics: From Protein Sequence to Function*. Viva Books.

Rampal JB. 2001. *DNA Arrays: Methods and Protocols*. Humana Press.

GP 604 **CELLULAR AND CHROMOSOMAL MANIPULATIONS IN CROP IMPROVEMENT** **2+0**

Objective

This course focuses on the advanced techniques in analyzing chromosome structure and manipulations for genome analysis in crop species.

Theory

UNIT I

Organization and structure of genome - Genome size - Organization of organellar genomes - Nuclear DNA organization - Nuclear and Cytoplasmic genome interactions and signal transduction; Transcriptional and Translational changes, Inheritance and expression of organellar DNA; Variation in DNA content – C value paradox; Sequence complexity-Introns and Exons-Repetitive sequences-Role of repetitive sequence.

UNIT II

Karyotyping - Chromosome banding and chromosome painting; Tracking introgressions using FISH, GISH, loclalization and mapping of genes/genomic segments; Distant hybridization - Role of polyploids in crop evolution and breeding - Auto and allopolyploids.

UNIT III

Applications of cytogenetical methods for crop improvement; Location and mapping of genes on chromosomes: Deficiency method; Interchange genetic consequence, identification of chromosomes involved and gene location; Balanced lethal systems, their maintenance and utility; Multiple interchanges-use in producing inbreds, transfer of genes-linked marker methods; Duplication - production and use Inversions and location of genes; B/A chromosome translocations and gene location.

UNIT IV

Trisomics- types, production, breeding behavior and location of genes, use of balanced tertiary trisomics in hybrid seed production; Monosomics-methods of production, breeding behaviour and location of genes; Intervarietal substitutions-allelic and non-allelic interactions; Telocentric method of mapping.

UNIT V

Barriers to interspecific and intergeneric hybridization- Behaviour of interspecific and intergeneric crosses; Totipotency of cells – Morphogenesis: *in vivo* and *in vitro* Meristem culture, Anther and pollen culture - Ovule, ovary, embryo and endosperm culture - Protoplast isolation and culture – protoplast fusion, Different pathways of *in vitro* morphogenesis - Organogenesis and somatic embryogenesis; *In vitro* mutant/somaclone selection for biotic and abiotic stresses.

Suggested Readings

Clark MS & Wall WJ. 1996. *Chromosomes: The Complex Code*. Chapman & Hall.

Conger BV. (Ed.). 1981. *Cloning Agricultural Plants via in vitro Techniques*. CRC Press.

Constabel F & Vasil IK. (Eds.). 1988. *Cell Culture and Somatic Cell Genetics of Plants*. Vol. V. *Cell Culture and Phytochemicals in Plant Cell Cultures*. Academic Press.

Lal R & Lal S. (Eds.). 1990. *Crop Improvement Utilizing Biotechnology*. CRC Press.

Mantel SH & Smith H. 1983. *Plant Biotechnology*. Cambridge University Press.

Sen SK & Giles KL. (Eds.). 1983. *Plant Cell Culture in Crop Improvement*. Plenum Press.

GP 605 **ADVANCED PLANT BREEDING SYSTEMS** **2+0**

Objective

To impart theoretical knowledge and computation methods for non allelic interactions, mating designs and component analysis and their significance in plant breeding.

Theory

UNIT I

Facts about plant breeding before the discovery of Mendelism; Evolutionary concepts of genetics and plant breeding - Flower development and its importance; genes governing the whorls formation and various models proposed; Mating systems and their exploitation in crop breeding; Types of pollination, mechanisms promoting cross pollination.

UNIT II

Self- incompatability and sterility – Types of self incompatability: Homomorphic (sporophytic and gametophytic) and heteromorphic - Breakdown of incompatibility - Floral adaptive mechanisms - Spatial and temporal - Genetic and biochemical basis of self incompatibility; Sterility: male and female sterility – Types of male sterility: genic, cytoplasmic and cytoplasmic-genic; Exploitation in monocots and dicots, difficulties in exploiting CGMS system in dicots – Case studies and breeding strategies; Nucleocytoplasmic interactions with special reference to male sterility – Genetic , biochemical and molecular bases.

UNIT III

Population formation by hybridization - Types of populations – Mendelian population, gene pool, composites, synthetics, etc.; Principles and procedures in the formation of a complex population; Genetic basis of population improvement.

UNIT IV

Selection in self fertilizing crops; Creation of genetic variability, selection methods - Selection methods: mass selection, pureline selection, pedigree method (selection in early generations *vs* advanced generations); Backcross, polycross and test cross.

UNIT V

Selection in cross fertilizing crops – Polycross and topcross selections, Mass and recurrent selection methods and their modifications – Mass selection: grided mass selection, ear to row selection, modified ear to row selection; Convergent selection, divergent selection; Recurrent selection: Simple recurrent selection and its modifications (restricted phenotypic selection, selfed progeny selection and full sib recurrent selection) - Recurrent selection for general combining ability (GCA) – Concepts and utilization - Recurrent selection for specific combining ability (SCA) – usefulness in hybrid breeding programmes - Reciprocal recurrent selection (Half sib reciprocal recurrent selection, Half sib reciprocal recurrent selection with inbred tester and Full sib reciprocal recurrent selection); Selection in clonally propagated crops – Assumptions and realities.

UNIT VI

Genetic engineering technologies to create male sterility; Prospects and problems - Use of self- incompatability and sterility in plant breeding – case studies; - Fertility restoration in male sterile lines and restorer diversification programmes - Conversion of agronomically ideal genotypes into male steriles – Concepts and breeding strategies; Case studies -

Generating new cytonuclear interaction system for diversification of male steriles - Stability of male sterile lines – Environmental influence on sterility– Environmentally Induced Genic Male Sterility (EGMS) – Types of EGMS; Influence on their expression, genetic studies; Photo and thermo sensitive genetic male sterility and its use in heterosis breeding - Temperature sensitive genetic male sterility and its use heterosis breeding - Apomixis and its use in heterosis breeding - Incongruity – Factors influencing incongruity - Methods to overcome incongruity mechanisms.

Suggested Readings

Agarwal RL. 1996. *Fundamentals of Plant Breeding and Hybrid Seed Production.* Oxford & IBH.

Allard RW. 1966. *Principles of Plant Breeding.* John Wiley & Sons.

Briggs FN & Knowles PF. 1967. *Introduction to Plant Breeding.* Reinhold.

Fehr WR. 1987. *Principles of Cultivar Development: Theory and Technique.* Vol I. Macmillan.

Hayes HK, Immer FR & Smith DC. 1955. *Methods of Plant Breeding.* McGraw-Hill.

Mandal AK, Ganguli PK & Banerji SP. 1995. *Advances in Plant Breeding.* Vol. I, II. CBS.

Richards AJ. 1986. *Plant Breeding Systems.* George Allen & Unwin.

Sharma JR. 1994. *Principles and Practice of Plant Breeding.* Tata McGraw-Hill.

Simmonds NW. 1979. *Principles of Crop Improvement.* Longman.

Singh BD. 1997. *Plant Breeding: Principles and Methods.* 5th Ed., Kalyani Publishers.

Singh P. 1996. *Essentials of Plant Breeding.* Kalyani Publishers.

Welsh JR. 1981. *Fundamentals of Plant Genetic and Breeding.* John Wiley.

Williams W. 1964. *Genetical Principles and Plant Breeding.* Blackwell.

GP 606 **CROP EVOLUTION** **2+0**

Objective

To impart knowledge on crop evolutionary aspects and manipulation at ploidy level for crop improvement.

Theory

UNIT I

Introduction – Brief idea – Origin of variation in crop plants – Individual variation – The nature of species. Charles Darwin and Alfred Wallace ideas of Variation – Evolution over time – Phylogeny – Brief idea of molecular evolution. Evolution – Some general considerations – The fossil record – Rates of evolution and the origin of Angiosperms – Evolution of sex in plants. Polyploid evolution and apomixes – The domestication of plants – Variety of patterns of evolution – Genetic variation in natural populations – Variation in phenotype – Chromosome structure – Protein structure – Nucleotide sequence

UNIT II

Centers of diversity / Origin, diffused centers – Time and place of domestication – Domestication and Uniformity – Characteristics – Early domestication and Changes. Concept

of Gene pools – Recent advances of genecology – Phenotypic plasticity. Population variation – Selection – Consequences of selection Population variation – Random Genetic drift – Effects of chance in populations. Species and speciation – Species concept – Gradual speciation – Abrupt speciation

UNIT III

Reproduction isolation barriers – Genetic differentiation during speciation Hybridization – Gradual speciation and extinction, Exploitation of natural variation – Early attempts to increase variation, Intraspecific variation and ecotype concept – Some pioneer studies, Distant hybridization and introgression – Scope and limitations – Techniques to overcome these limitations

UNIT IV

Distant hybridization and introgression – Gene transfer into cultivated species – Tools and Techniques, Distant hybridization and introgression – Validation of transferred genes and their expression: Controlled expressions; Polyploidy – Auto and allopolyploids – Properties – Delimitation of taxonomic species, Polyploidy – Cytogenetic and genetic stabilization of polyploids, Polyploidy – Evolutionary significances, Polyploidy – Evolution of crop plants through ploidy manipulation

UNIT V

Allopolyploids – Synthesis of new crops, Genomic organization – Transgenesis in crop evolution, Multifactorial genome – Intragenomic and intergenomic interaction – Genome introgression Crop evolution – Allozyme variation, DNA markers – Genome analysis and comparative genomics Crop evolution – Case studies : Introduction – Cytotaxonomic background - Early history – Recent history – Prospects – Rice Crop evolution – Case studies : Introduction – Cytotaxonomic background early history – Recent history – Prospects – Wheat Crop evolution – Case studies : Introduction – Cytotaxonomic background early history – Recent history – Prospects – Cotton

Suggested Readings

Briggs, D and Walters, S.M. 1986. *Plant Variation and Evolution*

Hancock JF. 2004. *Plant Evolution and the Origin of Crop Species.* 2nd Ed.CABI.

Ladizinsky G. 1999. *Evolution and Domestication.* Springer.

Miller AJ. 2007. *Crop Plants: Evolution.* John Wiley & Sons.

Smartt J & Simmonds NW. 1995. *Evolution of Crop Plants.* Blackwell.

GP 607 BREEDING DESIGNER CROPS 2+1

Objective

To impart theoretical knowledge and practical know-how towards physiological efficiency, nutritional enhancement, biofortification and industrial/pharma applications in plant breeding.

Theory

UNIT I

Breeding of crop ideotypes, Genetic manipulations through recombination breeding, Genomics and transgenics for physiological efficiency, Nutritional enhancement, Special compounds-proteins, Vaccines

UNIT II

Gums, Starch and fats. Physiological efficiency as a concept, Parametric and whole plant physiology in integrated mode, Physiological mechanism of improvement in nutrient use efficiency, Water use efficiency

UNIT III

Osmotic adjustment, Photosynthetic efficiency, Stay green trait and its significance in crop improvement. Improvement in yield potential under sub-optimal conditions by manipulating source and sink, Canopy architecture, Plant-water relationships

UNIT IV

Effect of suboptimal conditions on cardinal plant growth and development processes, Enhancing input use efficiency through genetic manipulations. Breeding for special traits *viz.* oil Breeding for special traits, Protein Breeding for special traits, vitamins. Breeding for special traits, amino acids, etc.

UNIT V

Concept of biopharming and development of varieties producing targeted compounds, Nutraceuticals Industrial products, Success stories in vaccines Modified sugars, gums and starch through biopharming, Biosafety management Segregation and isolation requirements in designer crop production, Segregation and isolation requirements in post-harvest management

Practical

Demonstration of plant responses to Stresses through recent techniques (3), Water use efficiency, Transpiration efficiency, Screening techniques Under stress conditions such as , Electrolyte leakage, TTC, Chlorophyll fluorescence, Canopy temperature depression (2), Stomatal conductance, Chlorophyll estimation, Heat/drought/salt shock proteins. (3)

Suggested Readings

Balint A. 1984. *Physiological Genetics of Agricultural Crops.* AK Ademiaikiado.

Hay RK. 2006. *Physiology of Crop Yield.* 2nd Ed. Blackwell.

Pessarakli M. 1995. *Handbook of Plant and Crop Physiology.* Marcel Dekker.

Taiz L & Zeiger E. 2006. *Plant Physiology.* 4th Ed. Sinauer Associates.

GP 608 ADVANCES IN BREEDING OF MAJOR FIELD CROPS 3+0

Objective

To provide insight into recent advances in improvement of cereals, millets and non cereal crops using conventional and modern biotechnological approaches.

Theory

UNIT I

History, description, classification, origin and phylogenetic relationship, genome status in cultivated and alien species – Rice. History, description, classification, origin and

phylogenetic relationship, genome status in cultivated and alien species – Wheat. History, description, classification, origin and phylogenetic relationship, genome status in cultivated and alien species – Maize

UNIT II

History, description, classification, origin and phylogenetic relationship, genome status in cultivated and alien species – Pearlmillet. History, description, classification, origin and phylogenetic relationship, genome status in cultivated and alien species – Sorghum. History, description, classification, origin and phylogenetic relationship, genome status in cultivated and alien species – Pulses – Red gram

UNIT III

History, description, classification, origin and phylogenetic relationship, genome status in cultivated and alien species – Pulses – Black gram and Green gram. History, description, classification, origin and phylogenetic relationship, genome status in cultivated and alien species – Oilseeds – Ground nut. History, description, classification, origin and phylogenetic relationship, genome status in cultivated and alien species – Oil seeds – Sunflower and Castor

UNIT IV

History, description, classification, origin and phylogenetic relationship, genome status in cultivated and alien species – Cotton. History, description, classification, origin and phylogenetic relationship, genome status in cultivated and alien species – Sugarcane. History, description, classification, origin and phylogenetic relationship, genome status in cultivated and alien species – Breeding objectives – ARID Legumes, Breeding objectives in rice, Breeding objectives in wheat

UNIT V

Breeding objectives in Maize, Breeding objectives in Pearlmillet, Breeding objectives in Sorghum, Breeding objectives in Pulses – Red gram, Breeding objectives in Pulses – Green gram and Black gram. Breeding objectives in Oilseeds – Groundnut, Breeding objectives in Oilseeds – Sunflower and Castor, Breeding objectives in Cotton, Breeding objectives in Sugarcane, Breeding for value addition, Breeding for resistance to abiotic and biotic stresses.

UNIT VI

Conventional Plant Breeding – Line breeding, Conventional Plant Breeding – Population improvement, Conventional Plant Breeding – Hybrids. Other approaches – DH Populations, Other approaches Marker Assisted Breeding Development of new male sterility systems, Transgenics. National and International accomplishments in genetic improvement of Rice, Wheat, Maize, Pearlmillet and Sorghum

UNIT VII

National and International accomplishments in genetic improvement of Pulses, Oilseeds and Cotton, National and International accomplishments in genetic improvement of Sugarcane, National and International accomplishments in genetic improvement of ARID legumes

Suggested Readings

Chopra VL. 2001. *Breeding Field Crops - Theory and Practice.* Oxford & IBH.

Davis DD.1978. *Hybrid Cotton Specific Problems and Potentials.* Adv. Agron. 30: 129-157.

Heyne EG. 1987. *Wheat and Wheat Improvement*. 2nd Ed. ASA, CSSA, SSSA Inc Publ.

Khairwal, IS, Rai KN & Harinaryanan H. (Eds.). 1999. *Pearl Millet Breeding*. Oxford & IBH.

Khairwal I, Ram C & Chhabra AK. 1990. *Pearl Millet Seed Production and Technology*. Manohar Publ.

Nagarajan S, Singh G & Tyagi BS. 1998. *Wheat Research Needs Beyond 2000 AD*. Narosa.

Nanda JS. 2000. *Rice Breeding and Genetics - Research Priorities and Challenges*. Oxford & IBH.

Rao VS, Singh G & Misra SC. 2004. *Wheat: Technologies for Warmer Areas*. Annamaya Publ.

Reynolds MP, Rajaram S, McNab A. 1996. *Increasing Yield Potential in Wheat: Breaking the Barriers*. Proc. Workshop held in Ciudad, Obregon, Sonora, Mexico.

Seth BL, Sikka SM, Dastur RH, Maheshwari P, Rangaswamy NS & Josi

AB. 1960. *Cotton in India – A Monograph*. Vol. I. ICAR.

Singh BD. 2006. *Plant Breeding - Principles and Methods*. Kalyani Publishers.

Singh P & Singh S. 1998. *Heterosis Breeding in Cotton*. Kalyani Publishers.

Singh P. 1998. *Cotton Breeding*. Kalyani Publishers.

Singh S & Singh P. 2006. *Trends in Wheat Breeding*. Kalyani Publ.

GP 609 **MICROBIAL GENETICS** **2+1**

Objective

The objective of this course is to apprise the students of molecular processes at DNA and RNA level in different microorganisms, especially bacteria and viruses.

Theory

UNIT I

Introduction, importance of Microbial Genetics, Genetic material in prokaryotes especially bacteria and viruses. Nature of bacterial variation - Episomes - Plasmids - Gene mapping in bacteria.

UNIT II

Life cycle of bacteriophages - Genetic fine analysis of rII locus - Circular genetic map - of phage T4 Transposable elements - Gene manipulation - Biochemical genetics of *Neurospora* - Biochemical genetics of *Sacharomyces*.

UNIT III

One gene - one enzyme hypothesis. Regulation of gene activity in prokaryotes Molecular aspects of mutation. Molecular mechanisms of mutation. Molecular mechanisms of Repair and suppression Molecular chaperones and gene expression.

UNIT IV

Genetic basis of apoptosis. Transgenic bacteria and bioethics Genetic basis of nodulation Genetic basis of nitrogen fixation and competition by rhizobia Genetic regulation of nitrogen fixation and quorum sensing in rhizobia; Genetics of mitochondria. Genetics of chloroplasts.

Practical

Preparation and sterilization of liquid Bacterial nutrient media, Preparation and sterilization of Agar Bacterial nutrient media, Assessment of generation time in the log-phage bacterial cultures, Handling of microorganisms for genetic experiments, Isolation of rhizobia from nodules, Gram staining of rhizobial cells, Examination of polyhydroxy butyrate (PHB) production in rhizobia, Demonstration of N2-fixing nodules/bacterial inoculation in the legume- *Rzhizobium* symbiotic system, Induction, isolation and characterization of auxotrophic and drug resistant mutants in bacteria, Determination of spontaneous and induced mutation frequencies, Discrete bacterial colony counts for the preparation of survival curves, Determination of LD_{50} of a mutagen, Tn-mediated mutagenesis, Analysis and isolation of plasmid DNA, Curing of plasmids.

Suggested Readings

Brooker RJ. 2004. *Genetics Analysis and Principles.* Addison-Wesley Longman.

Brown TA. 2002. *Genomes.* Bios Scientific Publ.

Griffiths AJF. 2000. *An Introduction to Genetic Analysis.* WH Freeman.

Hexter W & Yost HT 1976. *The Science of Genetics.* Prentice Hall.

Karp G. 2004. *Cell and Molecular Biology: Concepts and Experiments.* John Wiley.

Lewin B. 2008. *Genes IX.* John Wiley & Sons.

Russell PJ. 1996. *Essential Genetics.* Blackwell Scientific Publ.

Russell PJ. 1996. *Essential Genetics.* Blackwell Scientific Publ.

Schleif R.1986. *Genetics and Molecular Biology.* Addison-Wesley Publ. Co.

Tamarin RH. 1999. *Principles of Genetics.* Wm C Brown Publ.

Watson JD. 2004. *Molecular Bilology of the Gene.* Pearson Edu.

Yadav AS, Vasudeva M, Kharab P & Vashishat RK. 2002. *Practical Manual on Microbial and Molecular Genetics.* Dept. of Genetics, CCS HAU Hisar.

GP 610 IN SITU AND EX SITU CONSERVATION OF GERMPLASM 2+1

Objective

To impart knowledge on the methods of germplasm conservation.

Theory

UNIT I

Concept of natural reserves and natural gene banks, *In situ* conservation of wild species in nature reserves: *in situ* conservation components, factors influencing conservation value, national plan for *in situ* conservation; *in situ* conservation of agro-biodiversity on-farm; scientific basis of *in situ* conservation on-farm, building on-farm conservation initiatives, implementation of on-farm conservation, management of *in situ* conserved genetic diversity on-farm, enhancing benefits for farmers from local crop diversity.

UNIT II

Ex situ conservation: components, plant genetic resources conservation in gene banks, national gene banks, gene repositories, preservation of genetic materials under natural conditions, *perma-frost* conservation, guidelines for sending seeds to network of active/ working collections, orthodox, recalcitrant seeds- differences in handling ,clonal repositories, genetic stability under long term storage condition.

UNIT III

In vitro storage, maintenance of *in vitro* culture under different conditions, *in vitro* bank maintenance for temporate and tropical fruit crop species, spices, tubers, bulbous crops, medicinal and endangered plant species, conservation of embryos and ovules, cell/ suspension cultures, protoplast and callus cultures, pollen culture, micropropagation techniques, problems, prospects of *in vitro* gene bank.

UNIT IV

Cryopreservation- procedure for handling seeds of orthodox and recalcitrants-cryoprotectants,dessication, rapid freezing, slow freezing, vitrification techniques, encapsulation/dehydration techniques, national facilities, achievements, application of cryopreservation in agriculture, horticulture and forestry crops.Problems and prospects; challenges ahead.

Practical

In situ conservation of wild species –case studies at national and international levels- *ex situ* techniques for active and long-term conservation of collections- Preparation and handling of materials, packaging, documentation; design of cold storage modules- Conservation protocols for recalcitrant and orthodox seeds; Cytological studies for assessing genetic stability, *in vitro* cultures- embryo,cell/suspension cultures,pollen cultures, study of cryotank facility and vitrification techniques, visit to NBPGR/NBAGR -study using fruit crops and other horticultural crops.

Suggested Readings

Ellis RH & Roberts EH & White Head J. 1980. *A New More Economic and Accurate Approach to Monitor the Viability of Accessions. During Storage in Seed Banks.* FAO / IBPGR Pl. Genet. Resources News 41-3-18.

Frankel OH & Hawkes JG. 1975. *Crop Genetic Resources for Today and Tomorrow.* Cambridge University Press, Cambridge.

Simmonds, N.W. 1979. *Principles of Crop Improvement* Longman.

Westwood MN. 1986. *Operation Manual for National Clonal Germplasm*

Repository Processed Report. USDA-ARS and Orgon State Univ. Oregon, USA.

Withers LA. 1980. *Tissue Culture Storage for Genetic Conservation.* IBPGR Tech. Rep. IBPGR, Rome, Italy.

List of Journals

Australian Journal of Biological Sciences, Australia

Australian Journal of Agricultural Research, Australia

Biometrics, UK

BioTechniques

Cereal Research Communication, Hungary

Cotton Research and Development, Hisar, India

Crop Improvement, Ludhiana

Crop Science, USA

Current Science, Bangalore

Critical Reviews in Plant Sciences
Czech Journal of Plant Breeding Genetics, Prague,
Electronic Journal of Biotechnology
Euphytica, The Netherlands
FABIS Newsletter
Forage Research, Hisar, India
Genetics, USA
Genome, Canada
Genetic resources and crop evolution, Netherlands
Haryana Agricultural University Journal of Research, Hisar, India
Heredity
Hilgardia, Sweden,
Indian Journal of Agricultural Research, New Delhi
Indian Journal of Genetics and Plant Breeding, New Delhi
Indian Journal of Plant Genetic Resources, New Delhi
International Chickpea, Newsletter, ICRISAT
International Rice Research Notes, IRRI, Philippines
Journal of Agricultural Research, U.K.
Journal of Biochemistry and Biotechnology, New Delhi
Journal of Genetics and Breeding, Italy
Journal of Heredity
Journal of Pulses Research, Kanpur
Legume Research, Karnal
MILWAI Newsletter
Madras Agricultural Journal, Coimbatore, India
Molecular Breeding, USA
Mutation Research
National Journal of Plant Sciences, Hisar, India
Nucleic Acids Research, USA
Oryza, Cuttack, India
PGR Newsletter, Syria
Plant Breeding, Germany
Plant Molecular Biology, The Netherlands
Rachis, Syria
Sorghum and Millet Newsletter, ICRISAT
Theoretical and Applied Genetics, Germany
Wheat Research, Japan

e-Resources

Name of the Journal URL
Agronomy Research http://www.eau.ee/~agronomy/
Asian Journal of Plant Sciences http://ansijournals.com/3/c4p.php?id=1&theme=3&jid=ajps

Breeding Science http://www.jstage.jst.go.jp/browse/jsbbs

Current Science http://www.ias.ac.in/currsci/index.html

International Journal of Botany http://ansijournals.com/3/c4p.php?id=1&theme=3&jid=ijb

International Journal of Sociology
of Agriculture and Food http://www.csafe.org.nz/ijsaf/

Japan Agricultural Research Quarterly
http://ss.jircas.affrc.go.jp/english/publication/jarq/index.htm

Japanese Journal of Crop Sc. http://www.jstage.jst.go.jp/browse/jcs

Journal of Agronomy http://ansijournals.com/3/c4p.php?id=1&theme=3&jid=ja

Journal of Biosciences http://www.ias.ac.in/jbiosci/index.html

Journal of Cotton Science http://www.cotton.org/journal/

Journal of Genetics http://www.ias.ac.in/jgenet/index.html

Plant Biotechnology http://www.jstage.jst.go.jp/browse/plantbiotechnology

Plant Production Science http://www.jstage.jst.go.jp/browse/pps

Scientia Agraria http://calvados.c3sl.ufpr.br/ojs2/index.php/agraria

Tropicultura http://www.bib.fsagx.ac.be/tropicultura/

Turkish Journal of Agriculture and Forestry Sciences http://journals.tubitak.gov.tr/agriculture/index.php

Suggested Broad Areas for Master's and Doctoral Research

Studies on introgressions, gene transfers, gene identification, location and localization with the application of technologies such as, *in situ* hybridization, chromosome identification like FISH (Fluorescent *In Situ* Hybridization), GISH (Genomic *In Situ* Hybridization), Spectral Karyotyping (SKY) and Multiplex Fluorescence *In Situ* Hybridization (M-FISH) etc.

Studies on stay-green traits in relation to genes affecting efficiency of photosynthethesis, biotic/abiotic stress tolerance

Genetics of AGP system for better photosynthesis and translocation

Identification of genes/QTLs for NUE and WUE

Molecular markers tagged to genes/QTLs identified for improvement of nutrient use efficiency, water use efficiency

MAS based mobilization of transgenes for tolerance to biotic and abiotic stresses into desirable agronomic backgrounds

Breeding methologies to enhance selection efficiency

Component approaches and development of selection criteria for quantitiative trait improvement

Stability analyses and methods to estimate the G X E components in breeding materials

Relative efficiency analyses of genetic component estimation for reliable use in developing selection criteria in crop plants

Distance and divergence statistics for identification of similarity assessment among genetic stocks and parental genetic material

Linear and quadratic distance measures to identify relative contribution of component traits for complex traits

Studies on genetic and molecular bases of stress tolerance to develop molecular diagnostics for screening/identification of stress tolerant genotypes

Use of aneuploids for gene location and source for transfer through wild species

Development and trisomic and monosomic series in diploids and polyploids

Dependable marker systems for detection of introgression in wide crosses with minimized linkage drag

Analysis of Resistance Gene analogues and their use in MAS with enhanced disease resistance

Analysis of Gene analogues and expression synteny and their use in MAS with enhanced quality and trait expression

Refinements in embryo rescue and consequent diplodization for production of double haploids

Use of molecular markers in phylogenetic analysis

Breeding through distant hybridization route for New Plant Type for breaking yield barriers

Genetics of durable, quantitative resistance and adult plant resistance in major crops against known pathogens

Development of tools and methodologies for identification of genes responsible for resistance against polyphagus insects

Development of alien addition lines and telocentric lines in crops

Microarray technique and robotics for identification of useful genes in crops

Characterization of germplasm through molecular and serological techniques

Induction of novel variation through mutagenesis tools and identify novel genes for different traits

Development of heterotic pools for maximized heterosis in cross and self pollinated crops where hybrid seed production tools are available

Genetics and traits responsible for terminal and initial heat tolerance in wheat, maize and mustard

Genetics of cold tolerance related traits in maize, rice and pigeonpea

Widening the QPM base in maize and prebreeding to add value to the genetic stocks of QPM

Comparison of relative efficiency of different softwares in analysis of quantitative trait loci and linkages

Biochemical and molecular bases of signal transduction in host-pathogen interactions

Metal binding proteins for identification of phytoremediators

Crop improvement for biomass energy and industrial use

Development of cytogenetic stocks through varietal/alien chromosome substitutions

MICROBIOLOGY
Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
MICRO 501*	PRINCIPLES OF MICROBIOLOGY	3+1
MICRO 502*	MICROBIAL PHYSIOLOGY AND METABOLISM	3+1
MICRO 503*	MICROBIAL GENETICS	2+1
MICRO 504*#	SOIL MICROBIOLOGY	2+1
MICRO 505*@	MICROBIAL BIOTECHNOLOGY	2+1
MICRO 506*	FOOD AND DAIRY MICROBIOLOGY	2+1
MICRO 507	BACTERIOPHAGES	1+1
MICRO 508	ENVIRONMENTAL MICROBIOLOGY	2+1
MICRO 509**	PLANT-MICROBE INTERACTIONS	3+0
MICRO 510	INDUSTRIAL MICROBIOLOGY	2+1
MICRO 511	BIOFERTILIZER TECHNOLOGY	1+1
MICRO 512	CYANOBACTERIAL AND ALGAL BIOTECHNOLOGY	2+0
MICRO 591	MASTER'S SEMINAR	1+0
MICRO 599	MASTER'S RESEARCH	20
MICRO 601**	ADVANCES IN FERMENTATION	2+1
MICRO 602**	ADVANCED MICROBIAL PHYSIOLOGY	2+0
MICRO 603**	REGULATION OF MICROBIAL BIOSYNTHESIS	2+0
MICRO 604**	CURRENT TOPICS IN SOIL MICROBIOLOGY	2+0
MICRO 691	DOCTORAL SEMINAR I	1+0
MICRO 692	DOCTORAL SEMINAR II	1+0
MICRO 699	DOCTORAL RESEARCH	45

*Compulsory for Master's programme;

**Compulsory for Doctoral programme

#Can be cross-listed with Soil Science;

@Can be cross-listed with Biotechnology

Minor Departments 9

Plant Molecular Biology and Biotechnology

Biochemistry

Soil Science

Plant Pathology

Entomology

Supporting Deparments 5

Statistics and Mathematics

Plant Molecular Biology and Biotechnology

Biochemistry

Soil Science

Plant Pathology

Entomology

Non credit compulsory courses

CODE	COURSE TITLE	CREDITS
PGS 501	LIBRARY AND INFORMATION SERVICES	0+1
PGS 502	TECHNICAL WRITING AND COMMUNICATION SKILLS	0+1
PGS 503 (e-course)	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1+0
PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1
PGS 505 (e-course)	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1+0
PGS 506 (e-course)	DISASTER MANAGEMENT	1+0

MICRO 501 PRINCIPLES OF MICROBIOLOGY 3+1

Objective

To teach the students about basics in development of microbiology, differences in prokaryotes and eukaryotic cell and classification of prokaryotes.

Theory

UNIT I

Development of Microbiology in the 18th and 19th century. Morphology, structure and function of prokaryotic and eukaryotic cell. Archea. Classification of prokaryotes – Basic principles and techniques used in bacterial classification.

UNIT II

Evolutionary relationship among prokaryotes. Phylogenetic and numerical taxonomy. Use of DNA and r-RNA sequencing in classifications.

UNIT III

Study of major groups of bacteria belonging to Gracilicutes, Firmicutes, Tenericutes and Mendosicutes.

UNIT IV

Viruses – morphology, classification and replication of plant, animal and bacterial viruses. Cultivation methods of viruses. Immune response – specific and non-specific resistance. Normal microflora of human body; some common bacterial and viral diseases of humans and animals.

Practical

Preparation of different media, evaluation of different sterilization methods, isolation of microorganisms from air, water, milk, food and soil. Purification and maintenance of microorganisms isolated from water, milk, food, soil and air. Enrichment culture technique, Isolation of nitrogen fixing bacteria, photosynthetic bacteria. Use of selective media for isolation of auxotrophs and antibiotic producing microorganisms. Morphological characterization of bacteria. Biochemical tests for identification of bacteria.

Suggested Readings

Brock TD. 1961. *Milestones in Microbiology*. Infinity Books.

Pelczar MJ, Chan ECS & Kreig NR. 1997. *Microbiology: Concepts and Application*. Tata McGraw Hill.

Stainier RY, Ingraham JL, Wheelis ML & Painter PR. 2003. *General Microbiology*. MacMillan.

Tauro P, Kapoor KK & Yadav KS. 1996. *Introduction to Microbiology*. Wiley Eastern.

MICRO 502 **MICROBIAL PHYSIOLOGY AND METABOLISM** **3+1**

(Pre-requisite Micro 501)

Objective

To teach students about cell cycle, growth and practical training on methods to determine microbial growth.

Theory

UNIT I

Structure, function, biosynthesis and assembly of various cellular components of prokaryotes. Archea and fungi. Transport of solutes across the membrane.

UNIT II

Microbial growth. Cell cycle and cell division. EMP, HMP, ED, TCA pathways, Aerobic and anaerobic respiration. Fermentative metabolism. Biosynthesis of macromolecules. Regulation of microbial metabolism.

UNIT III

Effect of chemicals and other environmental factors on growth. Morphogenesis and cellular differentiation.

UNIT IV

Important metabolic patterns in photoautotrophs, photoheterotrophs, chemoautotrophs and chemoheterotrophs.

Practical

Use of simple techniques in laboratory (Colorimetry, Centrifugation, Electrophoresis and GLC), Determination of viable and total number of cells, Measurement of cell size, Gross cellular composition of microbial cell, Growth – Factors affecting growth, Sporulation and spore germination in bacteria. Protoplasts formation. Induction and repression of enzymes.

Suggested Readings

Doelle HW. 1969. *Bacterial Metabolism.* Academic Press.

Gottschalk G. 1979. *Bacterial Metabolism.* Springer Verlag.

Moat AG. 1979. *Microbial Physiology.* John Wiley & Sons.

Sokatch JR. 1969. *Bacterial Physiology and Metabolism.* Academic Press.

MICRO 503 **MICROBIAL GENETICS** **2+1**

(Pre-requisite Micro 501)

Objective

To acquaint the learners regarding molecular concepts of bacteria and viruses and impact of gene cloning on human welfare.

Theory

UNIT I

Prokaryotic, eukaryotic and viral genome. Replication of Eukaryotic, Prokaryotic and Viral DNA. Structure, classification and replication of plasmids.

UNIT II

Molecular basis of mutation. Biochemical genetics and gene mapping by recombination and complementation. Fine gene structure analysis. Fungal genetics.

UNIT III

Gene transfer in bacteria through transformation, conjugation and transduction; gene mapping by these processes. Transposable elements.

UNIT IV

Gene cloning and gene sequencing. Impact of gene cloning on human welfare. Regulation of gene expression. Recent advances in DNA repair and mutagenesis, Genetic basis of Cancer and cell death.

Practical

Inactivation of microorganisms by different mutagens. Production, isolation and characterization of mutants. Determination of mutation rate. Isolation, characterization and curing of plasmids. Transfer of plasmid by conjugation, electroporation. Tetrad and random spore analysis.

Suggested Readings

Birge EA. 1981. *Bacterial and Bacteriophage Genetics.* Springer Verlag.

Gardner JE, Simmons MJ & Snustad DP. 1991. *Principles of Genetics.*

John Wiley& Sons.

Lewin B.1999. *Gene.* Vols. VI-IX. John Wiley & Sons.

Maloy A & Friedfelder D. 1994. *Microbial Genetics.* Narosa.

Scaife J, Leach D & Galizzi A 1985. *Genetics of Bacteria.* Academic Press.

William Hayes 1981. *Genetics of Bacteria.* Academic Press.

MICRO 504 SOIL MICROBIOLOGY 2+1

Objective

Objective of this course is to teach students regarding basics of microbiology related to soil including biogeochemical cycles, plant growth promoting rhizobacteria, microbial interactions in soil and other soil activities.

Theory

UNIT I

Soil biota, Soil microbial ecology, types of organisms in different soils; Soil microbial biomass; Microbial interactions: unculturable soil biota.

UNIT II

Microbiology and biochemistry of root-soil interface; phyllosphere, Biofertilizers, soil enzyme activities and their importance.

UNIT III

Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil. Siderophores and antimicrobials. Biochemical composition and biodegradation of soil organic matter and crop residues.

UNIT IV

Biodegradation of pesticides, Organic wastes and their use for production of biogas and manures: Biotic factors in soil development.

Practical

Determination of soil microbial population; Soil microbial biomass; Decomposition studies in soil, Soil enzymes; Measurement of important soil microbial processes such as ammonification, nitrification. N_2 fixation, S oxidation, P solubilization and mineralization of other micro nutrients; Study of rhizosphere effect.

Suggested Readings

Martin Alexander 1977. *Soil Microbiology*. John Wiley.

Paul EA. 2007. *Soil Microbiology, Ecology and Biochemistry*. 3rd Ed. Academic Press.

Sylvia *et al.* 2005. *Principles and Applications of Soil Microbiology*. 2nd Ed. Pearson Edu.van

Elsas JD, Trevors JT & Wellington EMH. 1997. *Modern Soil Microbiology*. Marcel Dekker.

MICRO 505 **MICROBIAL BIOTECHNOLOGY** **2+1**

(Pre-requisite Micro 501)

Objective

To teach students about industrially useful microorganisms and use of fermentor for the production of various primary and secondary metabolites.

Theory

UNIT I

Introduction, scope and historical development; Isolation, screening and genetic improvement of industrially important microorganisms.

UNIT II

Types of fermentation systems; production of various primary and secondary metabolities, e.g. amino acids, organic acids, alcohols, enzymes, organic solvents, antibiotics, etc.

UNIT III

Process scale up steps: laboratory, pilot plant and industrial scales. Down stream processing; Over-production of metabolities; Bioreactor operations, process control.

UNIT IV

Fermented beverages; Production of single cell protein; Steroid transformation; Immobilization of cells/enzymes; Silage production; Waste water treatment.

UNIT V

Use of genetically-engineered microorganisms in biotechnology; Bioinsecticides, biofertilizers, etc. Microbiologically-produced food colours and flavours. Retting of flax.

Practical

Isolation and Maintenance of industrially important microorganisms, Improvement of industrially important microorganisms, Production of (industrial compounds such as) alcohol, beer, wine,

citric acid and lactic acid and recovery, Study of types of bio-reactors and their operation , Production of bacterial biofertilizers:, Production of algal biofertilizer, Visit to Biofertilizer industries

Suggested Readings

Cruger W & Cruger A. 2004. *Biotechnology - A Textbook of Industrial Microbiology.* 2nd Ed. Panima.

Ward OP. 1989. *Fermentation Biotechnology.* Prentice Hall.

Wiseman A. 1983. *Principles of Biotechnology.* Chapman & Hall.

MICRO 506 **FOOD AND DAIRY MICROBIOLOGY** **2+1**

(Pre-requisite, Micro 501)

Objective

To familiarize the students with recent advances in food microbiology including fermented foods, dairy, food preservation, detection of foodborne diseases, their control measures.

Theory

UNIT I

Introduction and scope; Food Microbiology – A many faceted science; Interrelationship of food microbiology with other sciences; Perspectives on food safety and Food Biotechnology.

UNIT II

Factors of special significance in Food Microbiology – Principles influencing microbial growth in foods; Spores and their significance; Indicator organisms and Microbiological criteria; Microbial spoilage of foods- meat, milk, fruits, vegetables and their products; Food poisoning and food-borne pathogenic bacteria.

UNIT III

Food fermentation; Fermented dairy, vegetable, meat products; Preservatives and preservation methods – physical methods, chemical preservatives and natural antimicrobial compounds. Bacteriocins and their applications; Biologically based preservation systems and probiotic bacteria.

UNIT IV

Advanced techniques in detecting food-borne pathogens and toxins. Hurdle technology and Hazard analysis. Critical control point systems in controlling microbiological hazards in foods.

Practical

Statutory, recommended and supplementary tests for microbiological analysis of Baby foods, Microbiological analysis of canned foods, Microbiological analysis milk and dairy products, Microbiological analysis of eggs and meat, Microbiological analysis of vegetables, fruits and cereals, Microbiological analysis of surfaces and containers in a food processing unit and environment in a food processing area, Microbiological analysis of water, Visit to Food & Dairy industry

Suggested Readings

Bibek Ray.1996. *Fundamentals of Food Microbiology*. CRC Press.

Frazier WC & Westhoff DC. 1991. *Food Microbiology*. 3rd Ed. Tata McGraw Hill.

George J Banwart. 1989. Basic Food Microbiology. AVI.

James M Jay. 1987. Modern Food Microbiology. CBS.

Peppler HJ & Perlman D.1979. *Microbial Technology*. 2nd Ed. Academic Press.

MICRO 507 BACTERIOPHAGES 1+1

Objective

To familiarize students about phages and phage- bacterial interactions.

Theory

UNIT I

Historical developments and classification of bacteriophages.

UNIT II

Physiology, biochemistry, enzymology and molecular biology of phagebacterial interactions.

UNIT III

Structure, functions and life cycles of different DNA, RNA, lytic and lysogenic phages.

UNIT IV

Phages in the development of molecular biology and genetic engineering.

Practical

Titration of phages and bacteria Absorption of phages, Preparation of phage stocks, Isolation of new phages and phage resistant bacteria, One step growth curve, phage bursts, Induction of lambda. Complementation of T4 *rII* mutants etc.

Suggested Readings

Birge EA. 2000. *Bacterial and Bacteriophage Genetics.* Springer-Verlag.

Mathew CK. 1972. *Bacteriophage Biochemistry*. Am. Chemical Soc.

Mathew CK, Kutter EM, Mosig G & Berget P. 1988. *Bacteriophage T4*. Plenum Press.

Nancy T & Trempy J. 2004. *Fundamental Bacterial Genetics*. Blackwell.

Stent SG. 1963. *Molecular Biology of Bacterial Viruses*. WH Freeman.

Winkler J, Ruger W & Wackernagel W. 1979. *Bacterial, Phage and Molecular Genetics - An Experimental Course.* Narosa.

Winkler U & Ruhr W. 1984. *Bacteria, Phage and Molecular Genetics*. ALA.

MICRO 508 ENVIRONMENTAL MICROBIOLOGY 2+1

(Pre-requisite Micro 502)

Objective

To teach and create awareness regarding environment, water, soil, air pollution and bioremediation.

Theory

UNIT I

Scope of environmental microbiology. An overview of microbial niches in global environment and microbial activities. Microbiology of air, outdoor and indoor environment in relation to human, animal and plant health and economic activities.

UNIT II

Microbiology of natural waters. Environmental pollution – Deleterious and beneficial role of microorganisms. Environmental microbiology in public health. Microorganism in extreme environments, Environmental determinants that govern extreme environment- Air water interface, extreme of pH, Temperature, Salinity, Hydrostatic pressure.

UNIT III

Microbial technology in pollution abatement, waste management and resource recovery in metal, petroleum and bioenergy fields. Biofuels. Global environmental problems

UNIT IV

Microbial upgradation of fossil fuels and coal gas. Microbial interaction in rumen and gastrointestinal tract. Biodeterioration and Bioremediation. Biodegradation and xenobiotic compounds

Practical

Analysis of natural waters, waste waters and organic waste in relation to water pollution assessment, pollution strength and resource quantification; Quality control tests, waste treatment and anaerobic digestion; Demonstration of waste water treatment processes such as activated sludge processes, biofilter and fluidized bed process. Visit to water / effluent treatment plants

Suggested Readings

Campbell R. 1983. *Microbial Ecology*. Blackwell.

Hawker LE & Linton AH. 1989. *Microorganisms Function, Form and Environment*. 2nd Ed. Edward Arnold.

Mitchell R. 1992. *Environmental Microbiology*. John Wiley & Sons.

Richards BN. 1987. *Microbes of Terrestrial Ecosystem*. Longman.

MICRO 509 PLANT- MICROBE INTERACTIONS 3+0

(Open for: Microbiology, Biotechnology & Molecular Biology, Genetics, Pl. Physiology, Biochemistry, Plant Breeding & Plant Pathology students; Pre-requisite Micro503/Equiv., Micro 504)

Objective

To familiarize the students with the biochemical and biophysical mechanisms, genetics, genomics, proteomics and advanced microscopy, spectroscopy of different interfaces of beneficial and pathogenic plant microbe interactions. Molecular analysis of relevant factors in the plant and microbes, and components that modulate plant-microbe interactions for soil and plant health for sustaining crop productivity.

Theory

UNIT I

Different interfaces of interactions - Plant-microbe, microbe-microbe, soil - microbe, soil-plant-microbe interactions leading to symbiotic (rhizobial and mycorrhizal), associative, endophytic and pathogenic interactions. Types of ecosystems: Concept and dynamics of ecosystem, Food chain and energy flow, Microbial communities in the soil. Community dynamics and population interactions employing DGGE, TGGE, T-RFLP.

UNIT II

Quorum-sensing in bacteria, flow of signals in response to different carbon or other substrates and how signals are recognized.

UNIT III

Methodology/resources to study plant-microbe interaction, recombinant inbred lines, biosensors, transcriptome profiling, metabolic profiling, genomics, proteomics and advanced microscopy, spectroscopy of different interfaces.

UNIT IV

Plant and microbial gene expression and signal exchange, global and specific regulators for different interactions. Molecular diversity of microbes, plants and their interactions including transgenic microbes and plants.

Suggested Readings

Kosuge T & Nester EW. 1989. *Plant-Microbe Interactions: Molecular and Genetic Perspectives.* Vols I-IV. McGraw Hill.

Verma DPS & Kohn TH. 1984. *Genes Involved in Microbe-Plant Interactions.* Springer Verlag.

Molecular Plant-Microbe Interactions. Journal Published by APS.

MICRO 510 INDUSTRIAL MICROBIOLOGY 2+1

(Open for: Microbiology, Biotechnology, Biochemistry, Soil Science, Agronomy, Plant Pathology, Horticulture students; prerequisite Micro 504, Micro 506)

Objective

To expose the students to the commercial exploitation of microorganisms for production of useful products. Focus will be on understanding of the techniques involved and the application of microorganisms for agribusiness purpose.

Theory

UNIT I

Biofermentor; Production of wine, beer, lactic acid, acetic acid (vinegar), citric acid, antibiotics, enzymes, vitamins and single cell proteins. Biofuels: Production of ethanol, biogas and hydrogen production.

UNIT II

Brief introduction to bacterial, fungal and insect diseases, Types of chemicals/pesticides used for disease control. Vaccines. Bioagents and Biopesticides Biocontrol agents and their scope in control of plant diseases, nematodes and insect pests.

UNIT III

Bioplastics and biopolymers: Microorganisms involved in synthesis of biodegradable plastics, other pigments, Biosensors: Development of biosensors to detect food contamination and environment pollution.

UNIT IV

Biofertilizers, Genetic engineering of microbes for enhanced pesticide degradation Mechanisms of pesticide degradation by microbes. Biomining: Coal, mineral and gas formation, prospecting for deposits of crude, oil and gas, recovery of minerals from low-grade ores.

Practical

Production of industrial compounds such as alcohol, beer, citric acid, lactic acid and their recovery. Detection of food-borne pathogens, pesticide degradation, Demonstration of biogas production, Production of biocontrol agents, Visit to industries

Suggested Readings

Alexander M. 1977. *Soil Microbiology*. John Wiley.

Hawker LE & Linton AH. 1989. *Microorganisms Function, Form and Environment*. 2nd Ed. Edward Arnold.

James M Jaq 1987. *Modern Food Microbiology*. CBS.

Paul EA. 2007. *Soil Microbiology, Ecology and Biochemistry*. 3rd Ed Academic Press.

Stanbury PF & Whitaker A. 1987. *Principles of Fermentation Technology*. Pergamon Press.

Sylvia DM, Fuhrmann JJ, Hartlly PT & Zuberer D. 2005. *Principles and Applications of Soil Microbiology*. 2nd Ed. Pearson Prentice Hall Edu.

MICRO 511 BIOFERTILIZER TECHNOLOGY 1+1

Objective

To familiarize the students and farmers with mass scale production of different agriculturally important microorganisms which are being used as biofertilizers for maintaining the soil and plant health for sustaining crop productivity and their importance in organic farming.

Theory

UNIT I

Different agriculturally important beneficial microorganisms – free living, symbiotic (rhizobial, actinorhizal), associative and endophytic nitrogen fixers including cyanobacteria, taxonomic classification, nodule formation, competitiveness and quantification of N_2 fixed.

UNIT II

Different agriculturally important beneficial microorganisms – phosphate solubilizing bacteria and fungi, including mycorrhiza.

UNIT III

Different agriculturally important beneficial microorganisms – plant growth promoting rhizobacteria.

UNIT IV

Different agriculturally important beneficial microorganisms – Biocontrol microbial inoculants.

UNIT V

Different agriculturally important beneficial microorganisms for recycling of organic waste and compositing, bioremediators and other related microbes.

UNIT VI

Different agriculturally important beneficial microorganisms - selection, establishment, competitiveness, crop productivity, soil & plant health, mass scale production and quality control of bio inoculants. Biofertilizer inoculation and microbial communities in the soil.

Practical

Isolations of symbiotic, asymbiotic, associative nitrogen fixating bacteria, Development and production of efficient microorganisms, Determination of beneficial properties in important bacteria to be used as biofertilizer, Nitrogen fixing activity, indole acetic acid (IAA), siderophore production etc, Bioinoculant production and quality control, Visit to industty

Suggested Readings

Alexander M. 1977. *Soil Microbiology*. John Wiley.

Bergerson FJ. 1980. *Methods for Evaluating Biological Nitrogen Fixation.*

John Wiley & Sons.

Sylvia DM, Fuhrmann JJ, Hartlly PT & Zuberer D. 2005. *Principles and Applications of Soil Microbiology*. 2nd Ed. Pearson Prentice Hall Edu.

van Elsas JD, Trevors JT & Wellington EMH. 1997. *Modern Soil Microbiology*. CRC Press.

MICRO 512 **CYANOBACTERIAL AND ALGAL BIOTECHN0OLOGY** **2+0**

Objective

To teach students about this upcoming fascinating field of microbes developed at a faster pace, mainly due to photoautotrophic nature of Cyanobacteria, their ability to survive under a variety of habitats and wide diversity of thallus structure and functions. Their importance for mankind is enormous including their role as biofertilizers, nutraceuticals, experimental models, dyes, biofuels and a variety of biochemicals. regarding structure, molecular evolution and properties of cyanobacteria and algae

Theory

UNIT I

Introduction to Cyanobacteria and algae. Definition, occurrence and distribution, thallus structure, reproduction, life cycles, origin and evolution of Cyanobacteria, molecular evolution; role of algae in evolution of land plants and horizontal transfer of genes.

UNIT II

Algal pigments, storage products, carbon metabolism, photosynthesis. Algal culturing and cultivation. Culture types, culture conditions, culture vessels, culture media, sterilization,

culture methods, synchronous cultures, photobioreactors, algal density and growth, seaweed cultivation.

UNIT III

Cyanobacterial and algal fuels, Fine chemicals (restriction enzymes etc) and nutraceuticals from algae; UV absorbing pigments Industrial products from macro algae - seaweed biotechnology, sustainable aquaculture.

Ecology of algae- distribution in soil and water; primary colonizers, carbon sequestration and cycling in soil and water. Cellular differentiation and nitrogen fixation, nitrogen metabolism.

UNIT IV

Algae in pollution - as pollution indicators, eutrophication agents and role in Bioremediation. Cyanobacterial and algal toxins, allelopathic interactions, Algae in global warming and environmental sustainability. Cyanobacteria and selected microalgae in agriculture – biofertilizers & algalization; soil conditioners; reclamation of problem soils.

Suggested Readings

Ahluwalia AS. 2003. *Phycology: Principles, Processes and Applications.* Daya Publ.

Barsanti L & Gualtieri P. 2006. *Algae: Anatomy, Biochemistry and Biotechnology.*

Taylor & Francis, CRC Press.

Carr NG & Whitton BA. 1982. *The Biology of Cyanobacteria.* Blackwell.

Herrero A & Flores E. 2008. *The Cyanobacteria Molecular Biology,*

Genomics and Evolution. Calster Academic Press

Kumar HD. 2005. *Introductory Phycology.* East West Press.

Linda E Graham & Lee W Wilcox. 2000. *Algae.* Prentice Hall.

Robert A Andersen. 2005. *Algal Culturing Techniques.* Academic Press.

Venkataraman LV & Becker EW. 1985. *Biotechnology and Utilization of Algae: the Indian Experience.* DST.

MICRO 601 ADVANCES IN FERMENTATION 2+1

Objective

To teach students regarding fermentation industry using industrially useful microorganisms including yeast technology.

Theory

UNIT I

An overview of fermentation - current status of fermentation industry. Fermentor design, high performance bioreactors, mass and energy transfer in bioreactors. Instrumentation and control in fermentors – on line measurements systems, computer application.

UNIT II

Media for microbial fermentation; Criteria in media formulation. An overview of downstream processing.

UNIT III

New strategies for isolation of industrially important microbes and their genetic manipulations; Microbial production of health care products. Antibiotic fermentation research; steroid transformation.

UNIT IV

Recent developments on production of primary and secondary metabolites, Treatment of biological wastes, microbial inoculants and enzymes for waste treatment.

UNIT V

Yeast technology – classification, genetics, strain improvement for brewing, baking and distilleries and topics of current interest in fermentations.

Practical

Industrially important microbes and their genetic manipulations, Fermentation by improved strains of yeast for production of alcohol and beer, Microbial production of important antibiotics, enzymes and organic acids, Bioremediation of industrial effluents

Suggested Readings

Peppler HJ & Perlman D. 1979. *Microbial Technology*. 2nd Ed. Academic Press.

Reed G. 1987. *Presscott & Dunn's Industrial Microbiology*. 4th Ed. CBS.

Stanbury PF & Whitaker A. 1987. *Principles of Fermentaticn Technology*. Pergamon Press.

Wiseman A. 1983. *Principles of Biotechnology*. Chapman & Hall.

MICRO 602 ADVANCED MICROBIAL PHYSIOLOGY 2+0

(Pre-requisite Micro 502)

Objective

To acquaint students with current topics in molecular microbiology

Theory

UNIT I

Origin, evolution, structure, function and molecular aspects of various cell components.

UNIT II

Differentiation in bacteria, slime molds, yeasts.

UNIT III

Molecular biology of bioluminescence, bacterial virulence. Heat shock response. Extracellular protein secretion in bacteria.

UNIT IV

Topics of current interest in molecular microbiology.

Suggested Readings

Selected articles from journals.

MICRO 603 **REGULATION OF MICROBIAL BIOSYNTHESIS** **2+0**

(Pre-requisite Micro 502, Micro 503)

Objective

Course imparts thorough knowledge about the synthesis of biomolecules in microorganisms by various pathways and their regulation.

Theory

UNIT I

Regulation of initiation, termination and anti-termination of transcription. Global regulation and differentiation by sigma factor. Regulatory controls in bacteria - inducible and biosynthetic pathways.

UNIT II

Ribosomal RNA and ribosomal proteins regulation under stress condition. Specific regulatory systems; SOS regulatory control; Antisense RNA regulation of gene expression.

UNIT III

Oxidative stress control. Fermentative and respiratory regulatory pathways. Regulation of cell cycle. Lytic and lysogenic cascade.

UNIT IV

Global nitrogen control and regulation of nitrogen fixation and other recent topics of regulatory systems of current interest.

Suggested Readings

Selected articles from journals.

MICRO 604 **CURRENT TOPICS IN SOIL MICROBIOLOGY** **2+0**

(Pre-requisite Micro 504)

Objective

To make students learn the latest trends in soil microbiology like diversity, biological control and bioremediation.

Theory

UNIT I

Molecular ecology and biodiversity of soil microorganisms; Survival and dispersal of microorganisms.

UNIT II

Microbial successions and transformation of organic matter; Role of microorganisms in soil fertility.

UNIT III

Bioremediation of polluted soils; Biological control.

UNIT IV

Other topics of current interest.

Suggested Readings

Selected articles from journals.

List of Journals

Advances in Microbial Physiology
Annual Review of Genetics/Biochemistry
Annual Review of Microbiology
Applied and Environmental Microbiology
Biology and Fertility Soils
Indian Journal of Microbiology
Journal of Bacteriology
Journal of Basic Microbiology
Microbiology and Molecular Biology Reviews
Nature/Science/EMBO Journal
Reviews in Microbiology and Biotechnology
Soil Biology and Biochemistry
Trends in Biotechnology
Trends in Microbiology
Trends in Plant Sciences

e-Resources

Books

http://www.aw-bc.com/microplace/
http://www.personal.psu.edu/jel5/micro/index.htm
http://microbiology.ucsc.edu/

Details of sites related to Microbiology

http://www.suite101.com/links.cfm/microbiology
http://www.microbeworld.org/resources/links.aspx
http://www.asm.org/
http://www.microbiologyiworld.com/
http://www.sciencemag.org/cgi/collection
http://www.latrobe.edu.au/microbiology/links
www.uwstout.edu/lib/subjects/microbi
http://www.aemtek.com

Journal related to Microbiology

http://www.fems-microbiology.org/website/nl/default.asp

http://www.blackwellpublishing.com/journal

http://www.springer.com/

http://www.e-journals.org/microbiology/

http://pubs.nrc-cnrc.gc.ca/

http://www.elsevier.com/

http://www.academicjournals.org/ajmr/

http://www.horizonpress.com/gateway/journals.html

http://www.scielo.br/bjm

http://www.jmb.or.kr/

Latest in microbiology- Microbiology News

http://microbiologybytes.wordpress.com/

http://www.topix.net/science/microbiolog

Suggested Broad Topics for Master's and Doctoral Research

Molecular Microbiology

Microbial diversity

Meta genomics

Improvement of beneficial microorganisms

(Nitrogen fixers, Phosphate solubilizers etc.)

Environmental Microbiology

Biocontrol

PGPR, Termite control, Pathogenic fungi control

Biofuels

Biogas, alcohol production

Bioremediation

Waste management, Bioremediation of industrial effluents and

agrochemicals

Composting

Microbial Biotechnology

Biofertilizers

(Nitrogen fixers, Phosphate solubilizers, PGPR, BGA, composting etc)

Secondary metabolites including industrially important enzymes, amino acids

Citric acid and lactic acid fermentations

Food Microbiology

Improvenment and industrial exploitation of microorganisms

Fermented foods

PLANT PATHOLOGY

Course Structure – at a Glance

CODE	COURSE TITLE	CREDITS
PL PATH 501*	MYCOLOGY	2+1
PL PATH 502*	PLANT VIROLOGY	2+1
PL PATH 503*	PLANT BACTERIOLOGY	2+1
PL PATH 504*	PRINCIPLES OF PLANT PATHOLOGY	3+0
PL PATH 505*	DETECTION AND DIAGNOSIS OF PLANT DISEASES	0+2
PL PATH 506	PRINCIPLES OF PLANT DISEASE MANAGEMENT	2+1
PL PATH 507	DISEASES OF FIELD AND MEDICINAL CROPS	2+1
PL PATH 508	DISEASES OF FRUITS, PLANTATION AND ORNAMENTAL CROPS	2+1
PL PATH 509	DISEASES OF VEGETABLE AND SPICES CROPS	2+1
PL PATH 510	SEED HEALTH TECHNOLOGY	2+1
PL PATH 511	CHEMICALS IN PLANT DISEASE MANAGEMENT	2+1
PL PATH 512	ECOLOGY OF SOIL-BORNE PLANT PATHOGENS	2+1
PL PATH 513	DISEASE RESISTANCE IN PLANTS	2+0
PL PATH 514/ ENT 514$	INSECT VECTORS OF PLANT VIRUSES AND OTHER PATHOGENS	1+1
PL PATH 515	BIOLOGICAL CONTROL OF PLANT DISEASES	2+1
PL PATH 516	INTEGRATED DISEASE MANAGEMENT	2+1
PL PATH 517	MUSHROOM PRODUCTION TECHNOLOGY	2+1
PL PATH 518	EPIDEMIOLOGY AND FORECASTING OF PLANT DISEASES	2+1
PL PATH 519	POST HARVEST DISEASES	2+1
PL PATH 520/ ENT 520$	PLANT QUARANTINE	2+0
PL PATH 591	MASTER'S SEMINAR	1+0
PL PATH 599	MASTER'S RESEARCH	20
PL PATH 601	ADVANCED MYCOLOGY	2+1
PL PATH 602	ADVANCED VIROLOGY	2+1
PL PATH 603	ADVANCED BACTERIOLOGY	2+1
PL PATH 604**	MOLECULAR BASIS OF HOST-PATHOGEN INTERACTION	2+1
PL PATH 605	PRINCIPLES AND PROCEDURES OF CERTIFICATION	1+0
PL PATH 606	PLANT BIOSECURITY AND BIOSAFETY	2+0
PL PATH 691	DOCTORAL SEMINAR I	1+0
PL PATH 692	DOCTORAL SEMINAR II	1+0
PL PATH 699	DOCTORAL RESEARCH	45

* Compulsory for Master's programme
** Compulsory for Ph. D. programme
S Cross listed with Entomology

Minor Departments **9**

Entomology

Microbiology

Supporting Departments **5**

Statistics and Mathematics

Biochemistry

Plant Molecular Biology and Biotechnology

Seed Science and Technology

Non credit compulsory courses

CODE	COURSE TITLE	CREDITS
PGS 501	LIBRARY AND INFORMATION SERVICES	0+1
PGS 502	TECHNICAL WRITING AND COMMUNICATION SKILLS	0+1
PGS 503 (e-course)	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1+0
PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1
PGS 505 (e-course)	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1+0
PGS 506 (e-course)	DISASTER MANAGEMENT	1+0

PL PATH 501 **MYCOLOGY** **2+1**

Objective

To study the nomenclature, classification and characteristics of fungi.

Theory

UNIT I

Introduction: Scope and importance of Mycology in Agriculture – Plant and animal diseases, biodegradation, mycorrhizae, biological control.

Terms and basic concepts: Fungus, thallus, septate and aseptate forms, dolipore septum, holocarpic and eucarpic mycelium, fungal tissue, modifications of mycelium. Asexual reproductive spores – zoospores, sporangiospores, conidia, arthrospores, blastospores and chlamydospores. Sexual spores – oospores, zygospores, ascospores and basidiospores. Monoecious, Dioecious and sexually undifferentiated forms. Homothallism and heterothallism. Anamorphs and teleomorphs. Parasitism.

UNIT II

Relation of fungi to human affairs: Beneficial and harmful effects of fungi

History of mycology: Ancient history – Greek and Roman periods. Middle ages – Albert Magnus, B. Angleus, Pre de Baryan period (17th – mid 18th century) - Clusius, Bauhin, Robert Hooke, van Sterbeek, Tournefort, Micheli, Linneaus, Persoon, Fries. Post de Baryan period (mid 19th century to date) – de Bary, Saccardo, Tulasne brothers, Berkeley.

History of mycology in India: Kirthikar, Cunnigham, Barclay, Butler, Dastur, Mundkur, Thirumalachar and Vasudeva.

UNIT III

Fungal Biodiversity – Distribution of fungal species in different habitats and their number.

Reproduction – Methods of asexual reproduction. Asexual fruiting bodies – Pycnidium, acervulus, synnemma, sporodochium. Methods of sexual reproduction. Sexual fruiting bodies- ascocarps and basidiocarps.

Ultrastructures – fungal cell and cell wall composition in different fungal groups.

Nomenclature: Binomial nomenclature – rules governing nomenclature, ICBN, nomenclatural filter.

Classification – classification of fungi according to Ainsworth 1973

UNIT IV

Important characteristics of different fungal groups – division, sub-division, class, order, family, genus

Division Myxomycota - Classes Acrasiomycetes, Myxomycetes and Plasmodiophoromycetes - Order Plasmodiophorales – Family Plasmodiophoraceae - Genus *Plasmodiophora*

Division Eumycota: Sub divisions – Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina.

Sub division Mastigomycotina – Class Chytridiomycetes - order Chytridiales – Genus *Synchytrium.* Class Oomycetes - Orders Saprolegniales, Leptomitales, Lagenidiales and

Peronosporales – Families Pythiaceae, Albuginaceae, Peronosporaceae - Genera *Pythium, Phytophthora, Albugo, Sclerospora, Peronospora, Plasmopara, Bremia, Bremiella Basidiophora, Pseudoperonospora, Sclerophthora, Pernosclerospora*

Subdivision Zygomycotina - Class Zygomycetes - Order Mucorales – Family Mucoraceae -Genus *Rhizopus*. Family Choanephoraceae - Genus *Choanephora*

Subdivision Ascomycotina - Classes Hemiascomycetes, Plectomycetes, Pyrenomycetes, Discomycetes and Loculoascomycetes

Class: Hemiascomycetes - Orders Endomycetales, Taphrinales and Protomycetales. Genera: *Taphrina* and *Protomyces*

Class Plectomycetes - Order Erysiphales – Family Erypsiphaceae - *Genera - Erysiphae, Leveillula, Phyllactinia, Uncinula, Sphaerotheca, Podosphaera* and *Microsphaera*. Order Eurotiales – Family Eurotiaceae – Genera *Eurotium, Sartorya, Emericella, Hemicarpenteles, Eupenicillium* and *Talaromyces* Class Pyrenomycetes – Order Hypocreales – Family Claviceptaceae – Genus *Claviceps* – Family Nectriaceae – Genus *Nectria*. Order Phyllochorales – Genera *Glomerella, Phyllochora, Polystigma*. Order Ophiostomatales – Genus *Ophiostoma*. Order Diaporthales – Genera *Diaporthe, Magnaporthe, Gaeumannomyces*. Order Xylariales – Genus *Rosellina*. Order Microascales – Genus *Ceratocystis*. Order Sordariales - Genera *Neurosopra* and *Chaetomium*

Class Discomycetes – Order Pezizales – Family Pezizaceae – Genus *Peziza*. Family Morchellaceae – Genus *Morchella*. Family Helvellaceae – Genus *Helvella*. Order Helotiales – Family Sclerotiniaceae – Genus *Monilinia*. Order Tuberales – Genus *Tuber*

Class Loculoascomycetes – Order Myriangiales – Family Myriangiaceae – Genus *Elsinoe*. Order Dothidiales – Family Dothidiaceae – Genus *Mycosphaerella*. Order Pleosporales – Families Pleosporaceae and Venturiaceae Genera *Pleospora, Cochliobolus* and *Venturia*

Subdivision Basidiomycotina - Class Teliomycetes, Order Uredinales – Family Pucciniaceae - Genera *Puccinia, Uromyces, Hemileia* and *Gymnosporangium*. Family Melampsoraceae – Genus *Melampsora*. Order Ustilaginales – Family Ustilaginaceae – Genera *Usitlago, Spacelotheca, Tolyposporium, Melanopsichium*. Family Tilletiaceae – Genera *Tilletia, Neovossia, Entyloma* and *Urocystis*

Class Hymenomycetes – Sub class Holobasidiomycetidae – Order Agaricales – Family Agaricaceae – Genus *Agaricus*. Order Aphyllophorales – Family Polyporaceae – Genera *Polyporus, Fomes* and *Poria*. Family Ganodermataceae – Genus *Ganoderma*. Sub class Phragmobasidiomycetidae Orders Tremellales, Auriculariales and Septobasidiales – Genera *Exidia, Auricularia* and *Septobasidium*

Class Gasteromycetes – Orders Lycoperdales, Phallales, Nidulariales and Sclerodermatales.

Subdivision Deuteromycotina – Class Coelomycetes – Order Sphaeropsidales – Genera *Phoma, Macrophoma, Phomopsis, Macrophomina* and *Ascochyta*. Order Melanconiales – Genera *Colletotrichum, Pestalotia* and *Pestalotiopsis*

Class Hyphomycetes – Order Hyphomycetales – Family Moniliacae – Genera *Pyricularia* and *Verticillium*. Family Dematiaceae – Genera *Alternaria, Helminthosporium, Drechslera, Bipolaris* and *Curvularia*. Order Stilbellales – Genus *Graphium*. Order Tuberculariales - Genus *Fusarium*. Order Agonomycetales – Genera – *Sclerotium* and *Rhizoctonia*

Fungal genetics – fungal genome – chromosomal genes, mitochondrial genes, plasmids and transposans. Haploid forms

Fungal variability – nonsexual variability – heterokaryosis, mutations and parasexuality. Sexual variability

Lichens – Symbiotic association between fungi and fungi-Mycobiont and Photobiont-different groups of lichen forming fungi – importance of lichens

Practical

Outline classification of fungi, General methods to study fungi, Study of somatic structures in fungi, Study of myxomycotina-Acrasiomycetes(*Dictyostelium*), Myxomycetes (*Ceratiomyxa,Physarum,Stemonitis, Hemitrichia. Lycogala*) and Plasmodiophoromycetes(*Plasmodiophora*), Study of Mastigomycotina- study of Chytridiomycetes (*Synchytrium, Physoderma, Allomyces*), Study of Masigomycotina – study of oomycetes(*Pythium, Phytophthora, Albugo*), Albugo of Mastigomycotina – study of Oomycetes (*Peronospora, Bremia, Plasmopara, Sclerospora*), Study of Zygomycotina- Study of Zygomycetes(*Mucor, Absidia, Rhizopus, Circinella, Thamnosylum, Choanephora, Cunninghamella, Syncephalastrium*), Ascomycotina – Types of Ascocarps of the sub-division and study of Hemiascomycetes. Study of Eurotiales and Erysiphales, Ascomycotina – Study of Sphaeriales and Hypocreales, Ascomycotina – Study of Discomycetes and Loculoascomycetes, Basidiomycotina – Study of Teliomycetes - Uredinales, Basidiomycotina - Study of Teliomycetes – Ustilaginales and Gasteromycetes, Deuteromycotina – study of Hyphomycetes, Deuteromycotina – study of Hyphomycetes,Deuteromycotina – Study of Coelomycetes

Suggested Readings

Ainsworth G C, Sparrow F K & Susman H S. 1973. *The Fungi – An Advanced Treatise.* Vol. IV (A & B). Academic Press, New York.

Alexopoulos C J, Mims C W & Blackwell M.2000. *Introductory Mycology.* 5th Ed. John Wiley & Sons, New York.

Mehrotra R S & Aneja K R. 1990. *An Introductory Mycology.* Wiley Eastern, New Delhi.

Sarbhoy A K. 2000. *Text book of Mycology.* ICAR, New Delhi.

Singh R S. 1982. *Plant Pathogens – The Fungi.* Oxford & IBH, New Delhi.

Webster J. 1980. *Introduction to Fungi.* 2nd Ed. Cambridge Univ. Press, Cambridge, New York.

PL PATH 502 PLANT VIROLOGY 2+1

Objective

To acquaint with the structure, virus-vector relationship, biology and management of plant viruses.

Theory

Unit I

- History of plant viruses-Introduction-historical background-contribution of different scientists to the development of science of virology-Mayer, Beijerinck, Baur, Ivanowski, Purdy, Stanley, Bawden and Pierie, Rawlins, Best, Ruska, Fukushi, Kunkel, Kausche et al., Williams & Wycoff, Markham & Smith, Hershey & Chase,Gierer & Schram, Fraenkel-Conrat, Caspar & Klug, Anderer et al., Wittaman, Nishimura Kassanis, Brakke, Takabe, Clarks & Adam, Kohler & Milstein, Dietzen &Sanderer, Teakle, Doi et al., Diener & Raymer, Shepherd et al., Harrison et al., Beale, Gratia

- Definition of virus- they are living / non living with evidence; how plant viruses differ from animal viruses broadly
- **Composition of plant viruses**
- Viral nucleic acid (ss /ds RNA, ss/ds DNA, negative / positive/ ambisense , segmentation, circular / linear etc.,) and its genome size with examples, Proteins (structural and non-structural including glycoproteins, End group structures (Cap , VPg , PolyA tail and tRNA like structure), polyamines, lipids, metals and water
- **Virus Structure**

Principles of basic virus structure (explain terms capsid and its formation, structural unit, subunits, nucleocapsid, virion, capsomers -Study of various shapes of viruses.

Unit II

- **Symptomatology**

External symptoms (foliar, stem &root); Internal symptoms (Histological- necrosis, hypo- and hyperplasia; cytological effects- nuclei, mitochondria, chloroplasts); Virus induced structures in cytoplasm (pin-wheel & crystalline inclusions); effect of environment on symptoms.

- **Transmission, host virus interactions and virus-vector relationship**

- Mechanical transmission- vegetative, graft, dodder transmission with examples
- Seed and pollen transmission- plant virus groups transmitted through seed, factors affecting seed transmission, mechanism of seed transmission, localization of virus in seed, reasons for failure of seed transmission (Gemini viruses and others).
- Transmission of plant viruses by insects - explain terms of acquisition feeding period, latent period, inoculation feeding period, retention period, transmission threshold period; Virus – vector relationship- Non-persistent, semi-persistant, bimodal and persistant transmission (circulative with uptake route in vector, and propagative type with evidence for multiplication) with examples.
- Transmission of plant viruses by aphids in non-persistant and persistant mode, mouth parts, Vector – virus relationship-molecular interactions-direct (AMV/CMV) and indirect (PAMV/PVY).
- Plant virus transmission by leaf and plant hoppers-kinds of virus-vector relationship;
- Transmission of viruses by thrips –life cycle and route of virus transmission;
- Transmission of viruses by whiteflies, mealy bugs, beetles, mites— their virus –vector relationship with examples for each.
- Plant virus transmission by fungi- groups of viruses transmitted by fungi, mechanism of virus acquisition and transmission by fungi.
- Plant virus transmission by Nematodes-Groups of viruses transmitted by nematodes-differences among these 2 groups-evidence for nematode transmission and mechanism with examples
- Chemical and physical properties of plant viruses, host virus interaction (R-gene, Avr-gene, recognition phenomenon, hypersensitive response etc.,)

Unit III

- **Virus nomenclature and classification**

Historical aspects of virus nomenclature (Johnson, Johnson and Hoggan, Smith, Holmes, Baltimore and ICTV) ; Descriptors used in virus Taxonomy (Virion properties, Genome organization and replication, antigenic and biological properties);Criteria demarcating different virus taxa (at order, family, genus and species level);-Outline diagram depicting classification of plant viruses (7^{th}/8^{th} report of ICTV)

- **Genome organization**

Genome of typical RNA virus (TMV) and DNA virus (CaMV) and its coding strategies (transcription, translation, ORFs), Proteins /enzymes commonly encoded by plant viruses and their functions, sub genomic RNAs,

Unit IV

- **Replication and Movement of viruses**
- **Isolation and Purification of Viruses**

Replication of Plant virus by taking TMV as an example

Plant virus movement in plant system : long distance and short distance movement. Different movement strategies.

1. Choice of plant material (assay host, propagative host); 2. Extraction of virus in suitable buffer (buffers, pH, ionic strength, reducing agents, additives, enzymes and detergents etc.); 3. Clarification of virus in suitable solvents (chloroform, butanol etc.,); 4. Concentration of virus (Differential centrifugation /PEG/salt precipitation); 5. Final purification (Density gradient centrifugation-isopycnic, rate zonal & equilibrium) and 6. Dialysis and storage

- **Electron Microscopy**

Preparation of samples (leaf dip), Negative staining (principle), trapping with antiserum, observation under EM and particle size calculation.

- **Diagnostics-Protein based diagnostics**

Explanation about antigen, antibody, antiserum, titre, epitope and paratope. ELISA and its variants (DAS, DAC), ISEM, Western blot (explain principle behind each techniques and advantages and disadvantages)

- **Nucleic Acid based diagnostics**

Detection of viruses by nucleic acid hybridization, PCR, RT-PCR, multiplex-PCR (explain principle behind each techniques and advantages and disadvantages)

Unit V

- **Mycoviruses**- discovery, definition, genome properties, hypo virulence, mechanism of biological control

Phytoplasma- structure, classification, diseases, symptoms and transmission

Arbo- and baculoviruses- morphology, size, genome properties, diseases they cause in animals and in insects

Satellite viruses- definition, genome properties, classification (ICTV), diseases they cause in plants

Satellite RNAs- discovery, definition, genome properties, diseases they cause

Phages- discovery, structure of T2phage, classification and its importance

Viroids- définition, structure, réplication, classification, diseases, symptoms Transmission

Prions- discovery- structure- replication- diseases they cause-Principles of working Electron Microscope and ultra microtome

Evolution of viruses- Micro &macro evolution, sequence divergence/ convergence, modular evolution, evidence for virus evolution (sequence comparison and phylogenetic studies)

Unit VI

- **Origin of viruses**- viruses of pro and eukaryotes, viruses infecting photosynthetic eukaryotes below angiosperms (refer latest articles on this topic from website)

Mechanism of resistance and Genetic engineering-a brief introduction to development of transgenics (gene gun / *Agrobacterium* mediated transformation), Protein based resistance (coat and movement protein, replicase & protease); Nucleic acid based protection (RNA mediated,, satellite mediated); detailed mechanism behind coat protein mediated and RNA mediated resistance.

- **Ecology and management of plant viruses**-Removal source of infection, production of virus free seed and vegetative stocks, Propagation and maintenance of virus free stocks, modified planting and harvesting procedure, control or avoidance of vectors, cross protection, Effect of environment on virus-vector –host relation (disease triangle)

Practical

Study of symptoms caused by plant viruses, Transmission of plant viruses - Mechanical Transmission using local lesion host and systemic host, Seed Transmission, Insect transmission (non-persistent transmission by Aphids), Assay of Plant Viruses using local lesion host, Physical properties of plant viruses (DEP, TIP), Purification of Plant Viruses (Purification protocol for TMV), Methods of raising antiserum to plant virus Rearing of rabbit, injection, blood collection, separation of antiserum, testing antiserum titre Serological Tests Oucterlony double diffusion test, Serological tests ELISA (direct), Serological tests ELISA (indirect), Electron Microscopy Preparation of grids for virus observation (leaf dip and purified virus), Ultratomy – taking ultrathin sections of virus infected leaf material, PCR – Acquaintance and its use in plant virology

* experiments that can spread throughout the semester as per convenience

Suggested Readings

Bos L. 1964. *Symptoms of Virus Diseases in Plants.* Oxford & IBH., New Delhi.

Brunt AA, Krabtree K, Dallwitz MJ, Gibbs AJ & Watson L. 1995. *Virus of Plants: Descriptions and Lists from VIDE Database.* CABI, Wallington.

Gibbs A & Harrison B. 1976. *Plant Virology - The Principles.* Edward Arnold, London.

Hull R. 2002. *Mathew's Plant Virology.* 4th Ed. Academic Press, New York.

Noordam D. 1973. *Identification of Plant Viruses, Methods and Experiments.* Oxford & IBH, New Delhi.

PL PATH 503 PLANT BACTERIOLOGY 2+1

Objective

To acquaint with plant pathogenic prokaryote (procarya) and their structure, nutritional requirements, survival and dissemination.

Theory

UNIT I

History and introduction to phytopathogenic procarya, viz., bacteria, MLOs, spiroplasmas and other fastidious procarya. Importance of phytopathogenic bacteria.

UNIT II

Evolution, classification and nomenclature of phytopathogenic procarya and important diseases caused by them.

UNIT III

Growth, nutrition requirements, reproduction, preservation of bacterial cultures and variability among phytopathogenic procarya.

UNIT IV

General biology of bacteriophages, L form bacteria, plasmids and bdellovibrios.

UNIT V

Procaryotic inhibitors and their mode of action against phytopathogenic bacteria.

UNIT VI

Survival and dissemination of phytopathogenic bacteria.

Practical

Isolation, purification, identification and host inoculation of phytopathogenic bacteria, staining methods, biochemical and serological, characterization, isolation of plasmid and use of antibacterial, chemicals/antibiotics. Isolation and purification of phytopathogenic bacteria Eg. *Xanthomonas citri* (or) any other, Host inoculation of Phytopathogenic bacteria – Confirmation of Koch's postulates, Staining Methods : Simple staining, Negative staining, Gram staining, Biochemical characterization : Extraction of total proteins and SDS-PAGE analysis, Serological characterization : Immunodiffusion, Immuno electrophoresis, ELISA , Isolation of plasmids – Isolation and Agarose Gel Electrophoresis, Antibacterial chemicals / Antibiotics : Evaluation of different antibiotics against bacteria by inhibition zone technique and spectrophotometric method, Study of symptoms of bacterial diseases of important crops * , Amplification of 16S rRNA by PCR and Agarose Gel Electrophoresis

Suggested Readings

Goto M. 1990. *Fundamentals of Plant Bacteriology*. Academic Press, New York.

Jayaraman J & Verma JP. 2002. *Fundamentals of Plant Bacteriology*. Kalyani Publ., Ludhiana.

Mount MS & Lacy GH. 1982. *Phytopathogenic Prokaryotes*. Vols. I, II. Academic Press, New York.

Verma JP, Varma A & Kumar D. (Eds). 1995. *Detection of Plant Pathogens and their Management*. Angkor Publ., New Delhi.

Verma JP. 1998. *The Bacteria*. Malhotra Publ. House, New Delhi.

PL PATH 504 PRINCIPLES OF PLANT PATHOLOGY 3+0

Objective

To introduce the subject of Plant Pathology, its concepts and principles.

Theory

Unit-I

Introduction, concept of disease, importance of plant diseases, history (as included in the previous syllabus) and growth of plant pathology, Definitions: etiology, Pathogenicity, Pathogenesis, Inoculum, Inoculum potential, Pathotype, Primary inoculum, Secondary inoculum, Penetration, Infection, Incubation period. Disease development, Symptoms, Signs, Syndrome, Disease cycle, Infectious organism, Infectious disease, Types of parasitism, Virulence, predisposition, Susceptibility, Resistance, Hypersensitivity, Symptomless carrier, Biotype, Immunity, Disease triangle, Disease tetrahedron, Fungitoxic, Fungistatic Fungicidal, classification of plant diseases based on spread or occurrence, Symptoms, host and causal factors.

Unit-II

Pathogenesis – Growth, reproduction, kinds of inoculum, survival and dispersal of important plant pathogens by various agents, infection process – Pre-penetration, Penetration and Post penetration activities of pathogens, development inside host tissue, Role of environment, Effect of temperature, moisture, wind, light, soil pH, soil structure, herbicides, Air pollutants.Effect of host plant nutrition. Effects of pathogens on plant physiological functions : Effect on photosynthesis, translocation of water and nutrients, host plant respiration, permeability of cell membranes, transcription and translation, reproduction.

Unit-III

How pathogens attack plants : Mechanical forces, chemical weapons : Role of enzymes, toxins, growth regulators, Polysaccharides. Defense strategies : Pre-exisitng structural and biochemical defenses, Induced structural and biochemical changes, hypersensitive response, classes of R Gene proteins, Recognition of pathogen Avr proteins by the host – How do R and Avr gene products activate plant responses – Some examples, oxidative bursts, co function of two or more genes, Active oxygen species, lipoxygenases, disruption of cell membranes, PR-proteins, phenolic compounds, phytoalexins. Defense through plantibodies, SAR etc.

Unit-IV

Genetics of Resistance : Vertical and horizontal resistance, Mechanisms of genetic variation in fungi, bacteria, viruses, Apparent resistance, Gene for Gene concept, Pathogenicity genes in plant pathogens, genes involved in pathogenesis and virulence by pathogens, Signal transduction between pathogenicity genes and resistance genes.

Unit-V

Disease management strategies: Cultural methods, Avoidance of the pathogen, methods that exclude the pathogen from the host: Quarantines, Inspection, Eradication methods, Biological methods: Suppressive soils, Antagonistic Microorganism's, weeds, Physical Methods, Chemical methods, Disease control by immunizing or improving the resistance of host, Cross protection, SAR, Use of transgenic plants.

Suggested Readings

Agrios GN. 2005. *Plant Pathology*. 5th Ed. Academic Press, New York.

Heitefuss R & Williams PH. 1976. *Physiological Plant Pathology*. Springer Verlag, Berlin, New York.

Mehrotra RS & Aggarwal A. 2003. *Plant Pathology*. 2nd Ed. Oxford & IBH, New Delhi.

Singh RS. 2002. *Introduction to Principles of Plant Pathology*. Oxford & IBH, New Delhi.

Singh DP & Singh A. 2007. *Disease and Insect Resistance in Plants*. Oxford & IBH, New Delhi.

Upadhyay RK & Mukherjee KG. 1997. *Toxins in Plant Disease Development and Evolving Biotechnology*. Oxford & IBH, New Delhi.

PL PATH 505 DETECTION AND DIAGNOSIS OF PLANT DISEASES 0+2

Objective

To impart training on various methods/techniques/instruments used in the study of plant diseases/pathogens.

Practical

Methods to prove Koch's postulates with biotroph and necrotroph pathogens, pure culture techniques, use of selective media to isolate pathogens. Preservation of plant pathogens and disease specimens, use of haemocytometer, micrometer, centrifuge, pH meter, camera lucida. Microscopic techniques and staining methods, phase contrast system, chromatography, use of electron microscope, spectrophotometer, ultracentrifuge and electrophoretic apparatus, disease diagnostics, serological and molecular techniques for detection of plant pathogens. Evaluation of fungicides, bactericides etc.; field experiments, data collection and preparation of references.

Suggested Readings

Baudoin ABAM, Hooper GR, Mathre DE & Carroll RB. 1990. *Laboratory Exercises in Plant Pathology: An Instructional Kit*. Scientific Publ., Jodhpur.

Dhingra OD & Sinclair JB. 1986. *Basic Plant Pathology Methods*. CRC Press, London, Tokyo.

Fox RTV. 1993. *Principles of Diagnostic Techniques in Plant Pathology*. CABI Wallington.

Mathews REF. 1993. *Diagnosis of Plant Virus Diseases*. CRC Press, Boca Raton, Tokyo.

Pathak VN. 1984. *Laboratory Manual of Plant Pathology*. Oxford & IBH, New Delhi.

Forster D & Taylor SC. 1998. *Plant Virology Protocols: From Virus Isolation to Transgenic Resistance. Methods in Molecular Biology*. Humana Press, ttowa, New Jersey.

Noordam D. 1973. *Identification of Plant Viruses, Methods and Experiments*. Cent. Agic. Pub. Doc. Wageningen.

Trigiano RN, Windham MT & Windham AS. 2004. *Plant Pathology- Concepts and Laboratory Exercises*. CRC Press, Florida.

Chakravarti BP. 2005. *Methods of Bacterial Plant Pathology*. Agrotech, Udaipur.

PL PATH 506 PRINCIPLES OF PLANT DISEASE MANAGEMENT 2+1

Objectives

To acquaint with different strategies for management of plant diseases.

Theory

UNIT I

Principles of plant disease management by cultural, physical, biological, chemical, organic amendments and botanicals methods of plant disease control, integrated control measures of plant diseases. Disease resistance and molecular approach for disease management.

UNIT II

Foliage, seed and soil application of chemicals, role of stickers, spreaders and other adjuvants, health vis-a-vis environmental hazards, residual effects and safety measures.

UNIT III

History of fungicides, bactericides, antibiotics, concepts of pathogen, immobilization, chemical protection and chemotherapy, nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals.

Practical

In vitro and *in vivo* evaluation of chemicals against plant pathogens; ED and MIC values, study of structural details of sprayers and dusters.

Suggested Readings

Fry WE. 1982. *Principles of Plant Disease Management.* Academic Press, New York.

Hewitt HG. 1998. *Fungicides in Crop Protection.* CABI, Wallington.

Marsh RW. 1972. *Systemic Fungicides.* Longman, New York.

Nene YL & Thapliyal PN. 1993. *Fungicides in Plant Disease Control.* Oxford & IBH, New Delhi.

Palti J. 1981. *Cultural Practices and Infectious Crop Diseases.* Springer- Verlag, New York.

Vyas SC. 1993 *Handbook of Systemic Fungicides.* Vols. I-III. Tata McGraw Hill, New Delhi.

PL PATH 507 DISEASES OF FIELD AND MEDICINAL CROPS 2+1

Objective

To educate about the nature, prevalence, etiology, factors affecting disease development and control measures of field and medicinal crop diseases.

Theory

UNIT I

Diseases of Cereal crops- wheat, barley, rice, pearl millet, sorghum and maize.

UNIT II

Diseases of Pulse crops- gram, urdbean, mungbean, lentil, pigeonpea, soybean.

UNIT III

Diseases of Oilseed crops- rapeseed and mustard, sesame, linseed, sunflower, groundnut, castor.

UNIT IV

Diseases of Cash crops- cotton, sugarcane.

UNIT V

Diseases of Fodder legume crops- berseem, oats, guar, lucerne, cowpea.

UNIT VI

Medicinal crops- plantago, liquorice, *mulathi,* rosagrass, sacred basil, mentha, *ashwagandha, Aloe vera.*

Practical

Detailed study of symptoms and host parasite relationship of important diseases of above mentioned crops. Collection and dry preservation of diseased specimens of important crops.

Suggested Readings

Joshi LM, Singh DV & Srivastava KD. 1984. *Problems and Progress of Wheat Pathology in South Asia.* Malhotra Publ. House, New Delhi.

Rangaswami G. 1999. *Diseases of Crop Plants in India.* 4th Ed.. Prentice Hall of India, New Delhi.

Ricanel C, Egan BT, Gillaspie Jr AG & Hughes CG. 1989. *Diseases of Sugarcane, Major Diseases.* Academic Press, New York.

Singh RS. 1998. *Plant Diseases.* 7th Ed. Oxford & IBH, New Delhi.

Singh US, Mukhopadhyay AN, Kumar J & Chaube HS. 1992. *Plant Diseases of Internatiobnal Importance.* Vol. I. *Diseases of Cereals and Pulses.* Prentice Hall, Englewood Cliffs, New Jersey.

PL PATH 508 DISEASES OF FRUITS, PLANTATION AND ORNAMENTAL CROPS 2+1

Objective

To acquaint with diseases of fruits, plantation, ornamental plants and their management.

Theory

UNIT I

Introduction, symptoms and etiology of different fruit diseases. Factors affecting disease development in fruits like apple, pear, peach, plum, apricot, cherry, walnut, almond, strawberry, citrus, mango, grapes, guava, banana, pineapple, papaya, fig, pomegranate, date palm and management of the fruits diseases.

UNIT II

Symptoms, mode of perpetuation of diseases of plantation crops such as tea, coffee, rubber and coconut and their management.

UNIT III

Symptoms and life cycle of pathogens. Factors affecting disease development of ornamental plants such as roses, gladiolus, tulip, carnation, orchids, marigold, chrysanthemum and their management.

Practical

Detailed study of symptoms and host parasite relationship of representative diseases of plantation crops. Collection and dry preservation of diseased specimens of important crops.

Suggested Readings

Gupta V K & Sharma S K. 2000. *Diseases of Fruit Crops*. Kalyani Publ., New Delhi.

Pathak V N. 1980. *Diseases of Fruit Crops*. Oxford & IBH, New Delhi.

Singh R S. 2000. *Diseases of Fruit Crops*. Oxford & IBH, New Delhi.

Walker J C. 2004. *Diseases of Vegetable Crops*. TTPP, India.

PL PATH 509 DISEASES OF VEGETABLE AND SPICES CROPS 2+1

Objective

To impart knowledge about symptoms, epidemiology of different diseases of vegetables and spices and their management.

Theory

UNIT I

Nature, prevalence, factors affecting disease development of bulb, leafy vegetables, crucifers, cucurbits and solanaceaous vegetables. Diseases under protected cultivation.

UNIT II

Symptoms and management of diseases of different root, bulb, leafy vegetables, crucifers, cucurbits and solanaceaous vegetable crops.

UNIT III

Symptoms, epidemiology and management of diseases of different spice crops such as black pepper, saffron, cumin, coriander, turmeric, fennel, fenugreek and ginger.

Practical

Detailed study of symptoms and host pathogen interaction of important, diseases of vegetable and spice crops.

Suggested Readings

Chaube HS, Singh US, Mukhopadhyay AN & Kumar J. 1992. *Plant Diseases of International Importance*. Vol. II. *Diseases of Vegetable and Oilseed Crops*. Prentice Hall, Englewood Cliffs, New Jersey.

Gupta VK & Paul YS. 2001. *Diseases of Vegetable Crops*. Kalyani Publ., New Delhi

Sherf AF & Mcnab AA. 1986. *Vegetable Diseases and their Control*.

Wiley InterScience, Columbia.

Singh RS. 1999. *Diseases of Vegetable Crops*. Oxford & IBH, New Delhi.

Gupta SK & Thind TS. 2006. *Disease Problem in Vegetable Production*. Scientific Publ., Jodhpur.

Walker JC. 1952. *Diseases of Vegetable Crops*. McGraw-Hill, New York.

PL PATH 510 **SEED HEALTH TECHNOLOGY** **2+1**

Objective

To acquaint with seed-borne diseases, their nature, detection, transmission, epidemiology, impacts/loses and management.

Theory

UNIT I

History and economic importance of seed pathology in seed industry, plant quarantine and SPS under WTO. Morphology and anatomy of typical monocotyledonous and dicotyledonous infected seeds.

UNIT II

Recent advances in the establishment and subsequent cause of disease development in seed and seedling. Localization and mechanism of seed transmission in relation to seed infection, seed to plant transmission of pathogens.

UNIT III

Seed certification and tolerance limits, types of losses caused by seed-borne diseases in true and vegetatively propagated seeds, evolutionary adaptations of crop plants to defend seed invasion by seed-borne pathogens. Epidemiological factors influencing the transmission of seed-borne diseases, forecasting of epidemics through seed-borne infection.

UNIT IV

Production of toxic metabolites affecting seed quality and its impact on human, animal and plant health, management of seed-borne pathogen/diseases and procedure for healthy seed production, seed health testing, methods for detecting microorganism.

Practical

Conventional and advanced techniques in the detection and identification of seed-borne fungi, bacteria and viruses. Relationship between seed-borne infection and expression of the disease in the field.

Suggested Readings

Agarwal VK & JB Sinclair. 1993. *Principles of Seed Pathology*. Vols. I & II, CBS Publ., New Delhi.

Hutchins JD & Reeves JE. (Eds.). 1997. *Seed Health Testing: Progress Towards the 21st Century*. CABI, Wallington.

Paul Neergaard. 1988. *Seed Pathology*. MacMillan, London.

Suryanarayana D. 1978. *Seed Pathology*. Vikash Publ., New Delhi.

PL PATH 511 **CHEMICALS IN PLANT DISEASE MANAGEMENT** **2+1**

Objective

To impart knowledge on the concepts, principles and judicious use of chemicals in plant disease management.

Theory

UNIT I

History and development of chemicals; definition of pesticides and related terms; advantages and disadvantages of chemicals.

UNIT II

Classification of chemicals used in plant disease control and their characteristics.

UNIT III

Chemicals in plant disease control, viz., fungicides, bactericides, nematicides, antiviral chemicals and botanicals.

UNIT IV

Formulations, mode of action and application of different fungicides; chemotherapy and phytotoxicity of fungicides.

UNIT V

Handling, storage and precautions to be taken while using fungicides; compatibility with other agrochemicals, persistence, cost-benefit ratio, factor affecting fungicides.

UNIT VI

General account of plant protection appliances; environmental pollution, residues and health hazards, fungicidal resistance in plant pathogens and its management.

Practical

Acquaintance with formulation of different fungicides and plant protection appliances. Formulation of fungicides, Bactericides and nematicides; *in vitro* evaluation techniques, Preparation of different concentrations of chemicals including botanical pesticides based on active ingredients against pathogens; Persistence, Compatibility with other agro-chemicals; Detection of naturally occurring fungicide resistant mutants of pathogen; Methods of application of chemicals.

Suggested Readings

Bindra OS & Singh H. 1977. *Pesticides - An Application Equipment*. Oxford & IBH, New Delhi.

Nene YL & Thapliyal PN. 1993. *Fungicides in Plant Disease Control*. 3rd Ed. Oxford & IBH, New Delhi.

Torgeson DC (Ed.). 1969. *Fungicides*. Vol. II. *An Advanced Treatise*. Academic Press, New York.

Vyas SC. 1993. *Handbook of Systemic Fungicides*. Vols. I-III. Tata McGraw Hill, New Delhi.

PL PATH 512 ECOLOGY OF SOIL-BORNE PLANT PATHOGENS 2+1

Objective

To provide knowledge on soil-plant disease relationship.

Theory

UNIT I

Soil as an environment for plant pathogens, nature and importance of rhizosphere and rhizoplane, host exudates, soil and root inhabiting fungi. Types of biocontrol agents.

UNIT II

Inoculum potential and density in relation to host and soil variables, competition, predation, antibiosis and fungistasis.

UNIT III

Suppressive soils, biological control- concepts and potentialities for managing soil borne pathogens.

Practical

Quantification of rhizosphere and rhizoplane microflora with special emphasis on pathogens; Pathogenicity test by soil and root inoculation techniques, Correlation between inoculum density of test pathogens and disease incidence, Demonstration of fungistasis in natural soils; Suppression of test soil-borne pathogens by antagonistic microorganisms. Isolation and identification of different biocontrol agents.

Suggested Readings

Baker KF & Snyder WC. 1965. *Ecology of Soil-borne Plant Pathogens*. John Wiley, New York.

Cook RJ & Baker KF. 1983. *The Nature and Practice of Biological Control of Plant Pathogens*. APS, St Paul, Minnesota.

Garret SD. 1970. *Pathogenic Root-infecting Fungi*. Cambridge Univ. Press, Cambridge, New York.

Hillocks RJ & Waller JM. 1997. *Soil-borne Diseases of Tropical Crops*. CABI, Wallington.

Parker CA, Rovira AD, Moore KJ & Wong PTN. (Eds). 1983. *Ecology and Management of Soil-borne Plant Pathogens*. APS, St. Paul, Minnesota.

PL PATH 513 DISEASE RESISTANCE IN PLANTS 2+0

Objective

To acquaint with disease resistance mechanisms in plants.

Theory

UNIT I

Introduction and historical development, dynamics of pathogenicity, process of infection, variability in plant pathogens, gene centres as sources of resistance, disease resistance terminology.

UNIT II

Disease escape, disease tolerance, disease resistance, types of resistance, identification of physiological races of pathogens, disease progression in relation to resistance, stabilizing selection pressure in plant pathogens.

UNIT III

Host defence system, morphological and anatomical resistance, preformed chemicals in host defence, post infectional chemicals in host defence, phytoalexins, hypersensitivity and its mechanisms.

UNIT IV

Gene-for-gene concept, protein-for-protein and immunization basis, management of resistance genes. Strategies for gene deployment.

Suggested Readings

Deverall BJ. 1977. *Defence Mechanisms in Plants*. Cambridge Univ. Press, Cambridge, New York.

Mills Dallice et al.1996. *Molecular Aspects of Pathogenicity and Resistance: Requirement for Signal Transduction*. APS, St Paul, Minnesota.

Parker J. 2008. *Molecular Aspects of Plant Diseases Resistance*. Blackwell Publ.

Robinson RA. 1976. *Plant Pathosystems*. Springer Verlag, New York.

Singh BD. 2005. *Plant Breeding – Principles and Methods*. 7th Ed. Kalyani Publ., Ludhiana

Van der Plank JE. 1975. *Principles of Plant Infection*. Academic Press, New York.

Van der Plank JE. 1978. *Genetic and Molecular Basis of Plant Pathogenesis*. Springer Verlag. New York.

Van der Plank JE. 1982. *Host Pathogen Interactions in Plant Disease*. Academic Press, New York.

Van der Plank JE. 1984. *Disease Resistance in Plants*. Academic Press, New York.

PL PATH 514/ ENT 514 — **INSECT VECTORS OF PLANT VIRUSES AND OTHER PATHOGENS** — **1+1**

Objective

To teach the students about the different groups of insects that vector plant pathogens, vector-plant pathogen interaction, management of vectors for controlling diseases.

Theory

UNIT I

History of developments in the area of insects as vectors of plant pathogens. Important insect vectors and their characteristics; mouth parts and feeding processes of important insect vectors. Efficiency of transmission.

UNIT II

Transmission of plant viruses and fungal pathogens. Relation between viruses and their vectors.

UNIT III

Transmission of plant viruses by aphids, whiteflies, mealy bugs and thrips.

UNIT IV

Transmission of mycoplasma and bacteria by leaf hoppers and plant hoppers.

UNIT V

Transmission of plant viruses by psyllids, beetles and mites. Epidemiology and management of insect transmitted diseases through vector management.

Practical

Identification of common vectors of plant pathogens- aphids, leafhoppers, whiteflies, thrips, beetles, Nematodes; Culturing and handling of vectors; Demonstration of virus transmission through vectors- aphids, Leafhoppers and whiteflies.

Suggested Readings

Basu AN. 1995. *Bemisia tabaci (*Gennadius*) - Crop Pest and Principal Whitefly Vector of Plant Viruses.* Oxford & IBH, New Delhi.

Harris KF & Maramarosh K. (Eds.).1980. *Vectors of Plant Pathogens.* Academic Press, London.

Maramorosch K & Harris KF. (Eds.). 1979. *Leafhopper Vectors and Plant Disease Agents.* Academic Press, London.

Youdeovei A & Service MW. 1983. *Pest and Vector Management in the Tropics.* English Language Books Series, Longman, London.

PL PATH 515 BIOLOGICAL CONTROL OF PLANT DISEASES 2+1

Objective: To study principles and application of ecofriendly and sustainable management strategies of plant diseases.

Theory

UNIT I

Concept of biological control, Definitions of Garret (1965), Baker and Cook (1974) and Cook (1987), Importance of biological control in managing soil borne plant pathogens, foliar pathogens, post harvest diseases and role of biocontrol agents in plant growth promotion and induction of resistance in plants. History of biological control – Weindling, Garret, K F Baker, R Cook, Elad, Chet, A N Mukhopadhyay, B L Jalali, Bineeta Sen, K G Mukherjee, Gnanamanickam, R D Prasad. Merits and demerits of biological control of plant pathogens.

UNIT II

Types of biological interactions – neutral, mutual and antagonistic, Antagonistic interactions – Competition - Meaning of Competitive Saprophytic Ability (CSA), qualities of microorganism for high CSA Mycoparasitism – steps in mycoparasitism, enzymes involved in mycoparasitism Hypovirulence – principle and exploitation as a biocontrol tool Rhizosphere colonization – rhizosphere, rhizoplane, exudates of plant roots, rhizosphere effect, beneficial rhizosphere colonizing microbes and Plant growth promotion. Antibiosis – principle, role of antibiosis in biological control of plant pathogens, Agrocin, antibiotics produced by *Trichoderma, Bacillus subtilis, Pseudomonas fluorescens*. Siderophores and their involvement in antibiosis. Induced resistance – concepts of ISR and SAR Mycorrhizae and their involvement in biological control

UNIT III

Factors governing biological control, Role of physical environment – soil moisture, pH, temperature etc., Role of agroecosystem – host – pathogen – antagonist interactions, root exudates, carbon sources on the plant surface, microbial interactions on spermosphere, rhizosphere and phyllosphere in relation to pathogen and antagonist survival and proliferation., Cultural practices – soil solarization, deep summer ploughing, organic and

inorganic amendments, flood fallow / fallow, crop rotation, green manure crops, irrigation practices, Biological control agents, Approaches to biological control – inundative and augmentative, Comparison between biocontrol of plant pathogens using resident and introduced antagonists., Important soil borne and foliar plant pathogens and biocontrol agents used against them. Biological control of post harvest plant diseases.Compatibility of different Bioagents and microbial consortia in biological control

UNIT IV

Commercialization of antagonists.Mass production, Delivery systems and formulations, Monitoring efficacy and population of applied biocontrol agents, Biopesticides (Registered) available in the market for the management of plant diseases, Quality control system of biocontrol formulations, Role of biological control as a componenet in IDM, IPM and organic farming.

Practical

Isolation of rhizosphere and phyllosphere microorganisms of biocontrol potential, Characterization of isolated biocontrol agents based on cultural and morphological features, *In vitro* assay of antagonistic efficacy of isolated BCA against soil borne plant pathogens – dual culture plate technique, *In vitro* assay of antagonistic efficacy of isolated BCA against soil borne plant pathogens – diffusible non volatile metabolites, *In vitro* assay of antagonistic efficacy of isolated BCA against soil borne plant pathogens – volatile metabolites – determination of HCN producing ability of BCA, *In vitro* assay of antagonistic efficacy of isolated BCA against soil borne plant pathogens – mycoparasitism, *In vitro* evaluation of compatibility of fungicides with BCA, Mass multiplication techniques for BCA and formulations, Seed bacterization and biopriming with BCA, *In vivo* evaluation of BCA on soil borne disease, Visit to biocontrol labs and production units

Suggested Readings

Campbell R. 1989. *Biological Control of Microbial Plant Pathogens.* Cambridge Univ. Press, Cambridge.

Cook RJ & Baker KF. 1983. *Nature and Practice of Biological Control of Plant Pathogens.* APS, St. Paul, Minnesota.

Fokkemma MJ. 1986. *Microbiology of the Phyllosphere.* Cambridge Univ. Press, Cambridge.

Gnanamanickam SS (Eds). 2002. *Biological Control of Crop Diseases.* CRC Press, Florida.

Heikki MT & Hokkanen James M (Eds.). 1996. *Biological Control - Benefits and Risks.* Cambridge Univ. Press, Cambridge.

Mukerji KG, Tewari JP, Arora DK & Saxena G. 1992. *Recent Developments in Biocontrol of Plant Diseases.* Aditya Books, New Delhi.

PL PATH 516 INTEGRATED DISEASE MANAGEMENT 2+1

Objective

To emphasize the importance and need of IDM in the management of diseases of important crops.

Theory

UNIT I

Introduction, definition, concept and tools of disease management, components of integrated disease management- their limitations and implications.

UNIT II

Development of IDM- basic principles, biological, chemical and cultural disease management.

UNIT III

IDM in important crops- rice, wheat, cotton, sugarcane, chickpea, rapesee dmustard, pearlmillet, *kharif* pulses, vegetable crops and fruit crops.

Practical

Application of biological, cultural, chemical and biocontrol agents, Their compatibility and integration in IDM; Demonstration of IDM in certain crops as project work.

Suggested Readings

Gupta VK & Sharma RC. (Eds). 1995. *Integrated Disease Management and Plant Health.* Scientific Publ., Jodhpur.

Mayee CD, Manoharachary C, Tilak KVBR, Mukadam DS & Deshpande Jayashree (Eds.). 2004. *Biotechnological Approaches for the Integrated Management of Crop Diseases.* Daya Publ. House, New Delhi.

Sharma RC & Sharma JN. (Eds). 1995. *Integrated Plant Disease Management.* Scientific Publ., Jodhpur.

PL PATH 517 MUSHROOM PRODUCTION TECHNOLOGY 2+1

Objective

To develop mushroom cultivation skills for entrepreneurial activity. Historical development of mushroom cultivation and present status of mushroom industry in India.

Theory

UNIT I

Historical development of mushroom cultivation and present status, taxonomy, classification, food, medicinal value, uses of mushroom, edible and poisonous mushrooms.

UNIT II

Life cycle of cultivated mushrooms, reproduction and strain improvement, maintenance of pure culture, preparation of spawn and facilities required for establishing commercial spawn lab.

UNIT III

Preparation of substrate for mushroom cultivation, long, short and indoor composting methods, formulae for different composts and their computation, qualities and testing of compost, uses of spent mushroom compost/substrate.

UNIT IV

Facilities for setting up mushroom farm for seasonal and environmentally control cultivation, requirement and maintenance of temperature, relative humidity, CO2, ventilation in cropping rooms, cultivation technology of *Agaricus bisporus, Pleurotus* sp., *Calocybe indica, Lentinus edodes* and *Ganoderma lucidum.*

UNIT V

Insect pests, diseases and abnormalities of cultivated mushroom and their management, post harvest processing and value addition, economics of mushroom cultivation, biotechnology and mushroom cultivation.

Practical

Preparation of spawn, Compost, Spawning, Casing, Harvesting and postharvest handling of edible mushroom; Identification of various pathogens, Competitors of various mushroom.

Suggested Readings

Chadha KL & Sharma SR. 2001. *Advances in Horticulture* (*Mushroom*). Vol. XIII. Malhotra Publ. House, New Delhi.

Chang ST & Hays WA. 1997. *The Biology and Cultivation of Edible Mushrooms*. Academic Press, New York.

Chang ST & Miles PG. 2002. *Edible Mushrooms and their Cultivation*. CRC Press, Florida.

Kapur JN. 1989. *Mushroom Cultivation*. DIPA, ICAR, New Delhi.

Dhar BL. 2005. *Cultivation Technology of High Temperature Tolerant White Button Mushroom*. DIPA, ICAR, New Delhi.

PL PATH 518 EPIDEMIOLOGY AND FORECASTING OF PLANT DISEASES 2+1

Objective

To acquaint with the principles of epidemiology and its application in disease forecasting.

Theory

UNIT I

Epidemic concept and historical development, pathometry and crop growth stages, epidemic growth and analysis.

UNIT II

Common and natural logarithms, function fitting area under disease progress curve and correction factors, inoculum dynamics, population biology of pathogens, temporal spatial variability in plant pathogens.

UNIT III

Survey, surveillance and vigilance, crop loss assessment and models.

UNIT IV

Principles and pre-requisites of forecasting, systems and factors affecting various components of forecastings, some early forecasting, procedures based on weather and inoculum potential, modeling disease growth and disease prediction.

Practical

Measuring diseases, Spore dispersal and trapping, Weather recording, Survey, Multiplication of inoculum, Computerized data analysis, Function fitting, Model preparation and validation.

Suggested Readings

Campbell CL & Madden LV. 1990. *Introduction to Plant Disease Epidemiology.* John Wiley & Sons. New York

Cowling EB & Horsefall JG. 1978. *Plant Disease.* Vol. II. Academic Press, New York.

Laurence VM, Gareth H & Frame Van den Bosch (Eds.). *The Study of Plant Disease Epidemics.* APS, St. Paul, Minnesota.

Nagarajan S & Murlidharan K. 1995. *Dynamics of Plant Diseases.* Allied Publ., New Delhi.

Thresh JM. 2006. *Plant Virus Epidemiology.* Advances in Virus Research 67, Academic Press, New York.

Van der Plank JE. 1963. *Plant Diseases Epidemics and Control.* Academic Press, New York.

Zadoks JC & Schein RD. 1979. *Epidemiology and Plant Disease Management.* Oxford Univ. Press, London.

PL PATH 519 POST HARVEST DISEASES 2+1

Objective

To acquaint with post harvest diseases of agricultural produce and their ecofriendly management.

Theory

UNIT I

Concept of post harvest diseases, definitions, importance with reference to environment and health, principles of plant disease management as preharvest and post-harvest, merits and demerits of biological/phytoextracts in controlling post-harvest diseases.

UNIT II

Types of post harvest problems both by biotic and abiotic causes, rhizosphere colonization, competitive, saprophytic ability, antibiosis, induced resistance, microbial associations, concept, operational mechanisms and its relevance in control.

UNIT III

Factors governing post harvest problems both as biotic and abiotic, role of physical environment, agro-ecocystem leading to quiescent infection, operational mechanisms and cultural practices in perpetuation of pathogens, pathogens and antagonist and their relationship, role of biocontrol agents and chemicals in controlling post-harvest diseases, comparative approaches to control of plant pathogens by resident and introduced antagonists. Isolation, characterization and maintenance of pathogens, role of different storage.

UNIT IV

Integrated approach in controlling diseases and improving the shelf life of produce, control of aflatoxigenic and mycotoxigenic fungi, application and monitoring for any health hazard, knowledge of Codex Alimentarious for each product and commodity.

Practical

Isolation characterization and maintenance of pathogens, role of different storage conditions on disease development, application of antagonists against pathogens *in vivo* and *in vitro* conditions. Comparative efficacy of different chemicals, fungicides, phytoextracts and bioagents.

Suggested Readings

Pathak VN. 1970. *Diseases of Fruit Crops and their Control.* IBH Publ., New Delhi.

Chaddha KL & Pareek OP. 1992. *Advances in Horticulture* Vol. IV, Malhotra Publ. House, New Delhi.

PL PATH 520/ ENT 520 **PLANT QUARANTINE** **2+0**

Objective

To acquaint the learners about the principles and the role of Plant Quarantine in containment of pests and diseases, plant quarantine regulations and set-up.

Theory

UNIT I

Definition of pest, pesticides and transgenics as per Govt. notification; relative importance; quarantine – domestic and international. Quarantine restrictions in the movement of agricultural produce, seeds and planting material; case histories of exotic pests/diseases and their status.

UNIT II

Plant protection organization in India. Acts related to registration of pesticides and transgenics. History of quarantine legislations, PQ Order 2003. Environmental Acts, Industrial registration; APEDA, Import and Export of bio-control agents.

UNIT III

Identification of pest/disease free areas; contamination of food with toxigens, microorganisms and their elimination; Symptomatic diagnosis and other techniques to detect pest/pathogen infestations; VHT and other safer techniques of disinfestation/salvaging of infected material.

UNIT IV

WTO regulations; non-tariff barriers; Pest risk analysis, good laboratory practices for pesticide laboratories; pesticide industry; Sanitary and Phytosanitary measures.

Suggested Readings

Rajeev K & Mukherjee RC. 1996. Role of Plant Quarantine in IPM. Aditya Books.

Rhower GG. 1991. Regulatory Plant Pest Management. In: Handbook of Pest Management in Agriculture. 2nd Ed. Vol. II. (Ed. David Pimental). CRC Press.

PL PATH 601 **ADVANCED MYCOLOGY** **2+1**

Objective

To acquaint with the latest advances in Mycology.

Theory

UNIT I

General introduction, historical development and advances in mycology.

UNIT II

Recent taxonomic criteria, morphological criteria for classification. Serological, Chemical (chemotaxonomy), Molecular and Numerical (Computer based assessment) taxonomy.

UNIT III

Interaction between groups: Phylogeny. Micro conidiation, conidiogenesis and sporulating structures of fungi imperfecti. Morphology and reproduction of representative plant pathogenic genera from different groups of fungi. Sexual reproduction in different groups of fungi.

UNIT IV

Population biology, pathogenic variability/vegetative compatibility.

UNIT V

Heterokaryosis and parasexual cycle. Sex hormones in fungi. Pleomorphism and speciation in fungi. Mechanism of nuclear inheritance. Mechanism of extra-nuclear inheritance. Biodegradation.

Practical

Study of conidiogenesis- phialides, porospores, arthroo spores. Study of fruiting bodies in Ascomycotina. Identification of fungi up to species level. Study of hyphal anastomosis. Morphology of representative plant pathogenic genera from different groups of fungi.

Suggested Readings

Alexopoulos CJ, Mimms CW & Blackwell M. 1996. *Introductory Mycology*. John Wiley & Sons, New York.

Dube HC. 2005. *An Introduction to Fungi*. 3rd Ed. Vikas Publ. House, New Delhi.

Kirk PM, Cannon PF, David JC & Stalpers JA. (Eds.). 2001. *Ainswsorth and Bisby's Dictionary of Fungi*. 9th Ed., CABI, Wallington.

Ulloa M & Hanlin RT. 2000. *Illustrated Dictionary of Mycology*. APS, St. Paul, Mennisota.

Webster J & Weber R. 2007. *Introduction to Fungi*. Cambridge Univ. Press, Cambridge.

PL PATH 602 ADVANCED VIROLOGY 2+1

Objective

To educate about the advanced techniques and new developments in the field of Plant Virology.

Theory

UNIT I

Mechanism of virus transmission by vectors, virus-vector relationship, bimodal transmission and taxonomy of vectors and viruses, vector specificity for classes of viruses, virus replication, assembly and architecture, ultrastructural changes due to virus infection, variation, mutation and virus strains.

UNIT II

Immunoglobulin structure and functions of various domains, methods of immunodiagnosis, hybridoma technology and use of monoclonal antibodies in identification of viruses and their strains, Polymerase Chain Reaction.

UNIT III

Genome organization, replication, transcription and translational strategies of pararetroviruses and gemini viruses, satellite viruses and satellite RNA genome organization in tobamo-, poty, bromo, cucummo, ilar and tospoviruses.

UNIT IV

Gene expression and regulation, viral promoters, molecular mechanism of host virus interactions, virus induced gene, molecular mechanism of vector transmission, symptom expression, viroids and prions.

UNIT V

Genetic engineering with plant viruses, viral suppressors, a RNAi dynamics, resistant genes. Viruses potential as vectors, genetically engineered resistance, transgenic plants.

UNIT VI

Techniques and application of tissue culture. Origin, evolution and interrelationship with animal viruses.

Practical

Purification of virus(es), SDS-PAGE for molecular weight determination, Production of polyclonal antiserum, Purification of IgG and conjugate preparation, Serological techniques (i) DAC-ELISA (ii) DAS -ELISA (iii) DIBA (iv) Western blots (v) (ab) 2-ELISA, Vector transmission (one each with aphid, leaf hopper and whitefly), Methods for collecting vectors and their maintenance, Nucleic acid isolation, DOT-blot, southern hybridization, Probe preparation and autoradiography, PCR application and viral genome cloning, Sequencing annotation of genes.

Suggested Readings

Davies 1997. *Molecular Plant Virology: Replication and Gene Expression.* CRC Press, Florida.

Fauquet *et al.* 2005. *Vius Taxonomy.* VIII Report of ICTV. Academic Press, New York.

Gibbs A & Harrison B. 1976. *Plant Virology - The Principles.* Edward Arnold, London.

Jones P, Jones PG & Sutton JM. 1997. *Plant Molecular Biology: Essential Techniques.* John Wiley & Sons, New York.

Khan JA & Dijkstra. 2002. *Plant Viruses as Molecular Pathogens.* Howarth Press, New York.

Maramorosch K, Murphy FA & Shatkin AJ. 1996. *Advances in Virus Research.* Vol. 46. Academic Press, New York.

Pirone TP & Shaw JG. 1990. *Viral Genes and Plant Pathogenesis.* Springer Verlag, New York.

Roger Hull 2002. *Mathew's Plant Virology* (4th Ed.). Academic Press, New York.

Thresh JM. 2006. *Plant Virus Epidemiology.* Advances in Virus Research Academic Press, New York.

PL PATH 603 ADVANCED BACTERIOLOGY 2+1

Objective

To provide knowledge about the latest advances in phytobacteriology.

Theory

UNIT I

Current approaches for the characterization and identification of phytopathogenic bacteria. Ultrastructures and biology of bacteria.

UNIT II

Current trends in taxonomy of phytopathogenic procarya.

UNIT III

Role of enzyme, toxin, expolysaccharide, polypeptide signals in disease development. Mechanism of wilt (*Ralstonia solanacearum*) development, mechanism of soft rot (*Erwinia* spp.) development, mechanism of Crown gall formation (*Agrobacterium tumifaciens*).

UNIT IV

Host-bacterial pathogen interaction, quorum-sensing phenomenon, Type III secretion system, HR/SR reactions, R-genes, Avr-genes, hrp genes, Effector protein.

UNIT V

Molecular variability among phytopathogenic prokayotoes and possible host defense mechanism(s). Genetic engineering for management of bacterial plant pasthogens-gene silencing, RNAi technology.

UNIT VI

Epidemiology in relation to bacterial plant pathogens. Development of diagnostic kit.

UNIT VII

Beneficial prokaryotes- Endophytes, PGPR, phylloplane bacteria and their role in disease management. Endosymbionts for host defence.

Practical

Pathogenic studies and race identification; Plasmid profiling of bacteria; Fatty acid profiling of bacteria; RAPD prolfiling of bacteria and variability status; Endospore, Flagella staining; Test for secondary metabolite production, Cyanides, EPS, Siderophore; Specific detection of phytopathogenic bacteria using species/pathovar specific primers. Basic techniques in diagnostic kit development, molecular tools to identify phytoendosymbionts.

Suggested Readings

Dale JW & Simon P. 2004. *Molecular Genetics of Bacteria.* John Wiley & Sons, New York.

Garrity GM, Krieg NR & Brenner DJ. 2006. *Bergey's Manual of Systematic Bacteriology: The Proteobacteria.* Vol. II. Springer Verlag, New York.

Gnanamanickam SS. 2006. *Plant-Associated Bacteria.* Springer Verlag, New York.

Mount MS & Lacy GH. 1982. *Plant Pathogenic Prokaryotes.* Vols. I, II.

Academic Press, New York.

Sigee DC. 1993. *Bacterial Plant Pathology: Cell and Molecular Aspects.* Cambridge Univ. Press, Cambridge.

Starr MP. 1992. *The Prokaryotes.* Vols. I – IV. Springer Verlag, New York.

PL PATH 604 MOLECULAR BASIS OF HOST-PATHOGEN INTERACTION 2+1

Objective

To understand the concepts of molecular biology and biotechnology in relation to host-pathogen interactions.

Theory

UNIT I

Importance and role of biotechnological tools in Plant Pathology- Basic concepts and principles to study host pathogen relationship.

UNIT II

Molecular basis of host-pathogen interaction- fungi, bacteria and viruses; recognition system, signal transduction.

UNIT III

Induction of defense responses- pathogenesis related proteins, HR, reactiveoxygen species, phytoalexins and systemic acquired resistance, Programmed Cell Death, Viral induced gene silencing.

UNIT IV

Molecular basis of gene-for-gene hypothesis; R-gene expression and transcription profiling, mapping and cloning of resistance genes and marker-aided selection, pyramiding of R genes.

UNIT V

Biotechnology and disease management; development of disease resistance plants using genetic engineering approaches, different methods of gene transfer, biosafety issues related to GM crops.

Practical

Protein, DNA and RNA isolation, Plasmids extraction,PCR analysis, DNA and Protein electrophoresis, bacterial transformation. Isolation and SDS-PAGE analysis of proteins from pathogen infected (Stress) and non-infected plant (Non-stress), Isolation and quantification of Nucleic Acids by Spectrophotometric method and Agarose gel electrophoresis, Isolation of genomic DNA from Bacteria and Agarose gel electrophoresis, Isolation of plasmid from Bacteria, RAPD analysis of plant pathogens like fungi and Bacteria, RAPD analysis of disease resistant plants Vs susceptible plants. (In any crop based on the availability), ITS-PCR analysis of different isolates of fungi, 16s rDNA analysis of Bacterial population Amplification with specific primers, Preparation of competent cells, Cloning of amplified 16s rDNA into plasmid vector, Transformation into Bacteria: Confirmation by restriction digestion and PCR, Sequencing - Comparing the sequence data by using the suitable software programme

Suggested Readings

Chet I. 1993. *Biotechnology in Plant Disease Control.* John Wiley & Sons, New York.

Gurr SJ, Mc Pohersen MJ & Bowlos DJ. (Eds.). 1992. *Molecular Plant Pathology - A Practical Approach.* Vols. I & II, Oxford Univ. Press, Oxford.

Mathew JD. 2003. *Molecular Plant Pathology.* Bios Scientific Publ., UK.

Ronald PC. 2007. *Plant-Pathogen Interactions: Methods in Molecular Biology*. Humana Press, New Jersey.

Stacey G & Keen TN. (Eds.). 1996. *Plant Microbe Interactions*. Vols. I-III.

Chapman & Hall, New York; Vol. IV. APS Press, St. Paul, Minnesota.

PL PATH 605 PRINCIPLES AND PROCEDURES OF CERTIFICATION 1+0

Objective

To acquaint with certification procedures of seed and planting material.

Theory

UNIT I

Introduction to certification. International scenario of certification and role of ISTA, EPPO, OECD etc. in certification and quality control.

UNIT II

Case studies of certification systems of USA and Europe. National Regulatory mechanism and certification system including seed certification, minimum seed certification standards. National status of seed health in seed certification. Methods for testing genetic identity, physical purity, germination percentage, seed health etc.

UNIT III

Fixing tolerance limits for diseases and insect pests in certification and quality control programmes. Methods used in certification of seeds, vegetative propagules and *in vitro* cultures. Accreditation of seed testing laboratories. Role of seed/ planting material health certification in national and international trade.

Suggested Readings

Association of Official Seed Certifying

Agencies.http://www.aosca.org/index.htm.

Hutchins D & Reeves JE. (Eds.). 1997. *Seed Health Testing: Progress Towards the 21st Century*. CABI, UK.

ISHI-v*eg Manual of Seed Health Testing Methods.*

http://www.worldseed.org/enus/

international_seed/ishi_vegetable.html

ISHI-F *Manual of Seed Health Testing Methods.*

http://www.worldseed.org/en-us/international_seed/ishi_f.html

ISTA *Seed Health Testing Methods.* http://www.seedtest.org/en/content— 1—1132—241.html

Tunwar NS & Singh SV. 1988. *Indian Minimum Seed Certification Standards*. Central Seed Certification Board, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi.

US National Seed Health System. http://www.seedhealth.org/

PL PATH 606 PLANT BIOSECURITY AND BIOSAFETY 2+0

Objective

To facilitate deeper understanding on plant biosecurity and biosafety issues in agriculture.

Theory

UNIT I

History of biosecurity, Concept of biosecurity, Components of biosecurity, Quarantine, Invasive Alien Species, Biowarfare, Emerging/resurgence of pests and diseases.

UNIT II

National Regulatory Mechanism and International Agreements/Conventions viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures/World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity.

UNIT III

Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, Issues related to release of genetically modified crops.

Suggested Readings

FAO Biosecurity Toolkit 2008.

www.fao.org/docrep/010/a1140e/a1140e00.htm

Laboratory Biosecurity Guidance.

http://www.who.int/csr/resources/publications/biosafety/WHO_CD S_EPR_2006.pdf

Grotto Andrew J & Jonathan B Tucker. 2006. *Biosecurity: A* Comprehensive Action Plan.

http://www.americanprogress.org/kf/biosecurity_a_comprehensive_ action_plan.pdf

Biosecurity Australia.

www.daff.gov.au/ba;www.affa.gov.au/biosecurityaustralia

Biosecurity New Zealand. www.biosecurity.govt.nz DEFRA.

www.defra.gov.uk/animalh/diseases/control/biosecurity/index.htm

Randhawa GJ, Khetarpal RK, Tyagi RK & Dhillon. BS (Eds.). 2001.

Transgenic Crops and Biosafety Concerns. NBPGR, New Delhi.

Khetarpal RK & Kavita Gupta 2006. *Plant Biosecurity in India - Status and Strategy*. Asian Biotechnology and Development Review 9(2): 39-Biosecurity for Agriculture and Food Production. http://www.fao.org/biosecurity/

CFIA.http://www.inspection.gc.ca/english/anima/heasan/fad/biosecure.sht ml

List of Journals

Annals of Applied Biology – Cambridge University Press, London

Annual Review of Phytopathology – Annual Reviews, Palo Alto, California

Annual Review of Plant Pathology - Scientific Publishers, Jodhpur

Canadian Journal of Plant Pathology - Canadian Phytopathological Society, Ottawa

Indian Journal of Biotechnology - National Institute of Science Communication and Information Resources, CSIR, New Delhi

Indian Journal of Mycopathological Research- Indian Society of Mycology, Kolkata.

Indian Journal of Virology - Indian Virological Society, New Delhi

Indian Phytopathology - Indian Phytopathological Society, New Delhi

Journal of Mycology and Plant Pathology - Society of Mycology and Plant Pathology, Udaipur

Journal of Phytopathology - Blackwell Verlag, Berlin

Mycologia - New York Botanical Garden, Pennsylvania

Mycological Research - Cambridge University Press, London

Physiological Molecular Plant Pathology - Academic Press, London

Phytopathology - American Phytopathological Society, USA

Plant Disease - The American Phytopathological Society, USA

Plant Disease Research – Indian Society of Plant Pathologists, Ludhiana

Plant Pathology - British Society for Plant Pathology, Blackwell Publ.

Review of Plant Pathology - CAB International, Wallingford

Virology- New York Academic Press

e-Resources

www.shopapspress.org

www.apsjournals.apsnet.org

www.apsnet.org/journals

www.cabi_publishing.org

www.springer.com/life+Sci/agriculture

www.backwellpublishing.com

www.csiro.au

www.annual-reviews.org

Suggested Broad Topics for Master's and Doctoral Research

Pathogenesis and characterization of plant pathogens

Survey and surveillance

Induction of resistance using biotic and abiotic elicitors

Variability in plant pathogens

Plant-Virus-Vector relationships

Genome organization of plant pathogens

Dynamics of plant pathogen propagules and their biology

Molecular tools in disease diagnosis

Molecular mechanisms of pathogenesis in crops and seeds

Rhizosphere in pathogenesis of seed-borne plant pathogens

Transgenic resistance

Development of disease prediction models in disease forecasting

Integrated Disease Management

Molecular Taxonomy of different plant pathogens

Development of Rapid Diagnostic methods

Development and Formulation of Improved Biocontrol Agent

PLANT MOLECULAR BIOLOGY AND BIOTECHNOLOGY
Course Structure –at a Glance

CODE	COURSE TITLE	CREDITS
MBB 501*	PRINCIPLES OF BIOTECHNOLOGY	2+1
MBB 502*	FUNDAMENTALS OF MOLECULAR BIOLOGY	3+0
MBB 503*	MOLECULAR CELL BIOLOGY	3+0
MBB 504	PLANT TISSUE CULTURE AND GENETIC TRANSFORMATION	2+1
MBB 505*	TECHNIQUES IN MOLECULAR BIOLOGY 1	0+3
MBB 506	MICROBIAL/INDUSTRIAL BIOTECHNOLOGY	2+1
MBB 507	MOLECULAR MARKERS IN CROP IMPROVEMENT	2+1
MBB 508	GENOMICS & PROTEOMICS	2+0
MBB 509	TECHNIQUES IN MOLECULAR BIOLOGY II	0+3
MBB 510	BIOSAFETY, IPR AND BIOETHICS	2+0
MBB 511	ANIMAL BIOTECHNOLOGY	3+0
MBB 512	IMMUNOLOGY AND MOLECULAR DIAGNOSTICS	2+1
MBB 513	NANO-BIOTECHNOLOGY	3+0
MBB 552 LINKED TO BIOCHEM 501	BASIC BIOCHEMISTRY	2+1
MBB 553 LINKED TO STAT 511	BIOSTATISTICS AND COMPUTERS/STATISTICAL METHODS FOR APPLIED SCIENCES	2+1
MBB 554	PRINCIPLES OF MICROBIOLOGY	3+1
MBB 555	INTRODUCTION TO BIOINFORMATICS	1+1
MBB 556	ENVIRONMENTAL BIOTECHNOLOGY	3+0
MBB 557	PLANT MOLECULAR GENETICS	2+1
MBB 558	ENZYMOLOGY	1+1
MBB 591	MASTER'S SEMINAR	1+0
MBB 599	MASTER'S RESEARCH	20
MBB 601	ADVANCES IN PLANT MOLECULAR BIOLOGY	3+0
MBB 602	ADVANCES IN GENETIC ENGINEERING	3+0
MBB 603	ADVANCES IN MICROBIAL BIOTECHNOLOGY	3+0
MBB 604	ADVANCES IN CROP BIOTECHNOLOGY	3+0
MBB 605	ADVANCES IN FUNCTIONAL GENOMICS AND PROTEOMICS	2+0

CODE	COURSE TITLE	CREDITS
MBB 606	COMMERCIAL PLANT TISSUE CULTURE	2+0
MBB 607	ADVANCES IN ANIMAL BIOTECHNOLOGY	2+0
MBB 608	BIOTECHNOLOGY IN BIODIVERSITY	2+0
MBB 609	TECHNIQUES IN MOLECULAR BIOLOGY II	0+2
MBB 610	ANALYTICAL METHODS IN BIOTECHNOLOGY	2+1
MBB 611	ADVANCES IN BIOINFORMATICS	1+1
MBB 691	DOCTORAL SEMINAR I	1+0
MBB 692	DOCTORAL SEMINAR II	1+0
MBB 699	DOCTORAL RESEARCH	45

* Compulsory for M.Sc. Programme

Minor Departments **9**

Genetics and Plant Breeding

Biochemistry

Statistics

Supporting Departments **5**

Biotechnology

Non credit compulsory courses

CODE	COURSE TITLE	CREDITS
PGS 501	LIBRARY AND INFORMATION SERVICES	0+1
PGS 501	LIBRARY AND INFORMATION SERVICES	0+1
PGS 502	TECHNICAL WRITING AND COMMUNICATION SKILLS	0+1
PGS 503 (e-course)	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1+0
PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1
PGS 505 (e-course)	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1+0
PGS 506 (e-course)	DISASTER MANAGEMENT	1+0

MBB 501 **PRINCIPLES OF BIOTECHNOLOGY** **2+1**

Objective

To familiarize the students with the fundamental principles of Biotechnology, various developments in Biotechnology and its potential applications.

Theory

Unit I

History, scope and importance: DNA structure, function and metabolism, C values and plant genomes, Repetitive and coding sequences

Unit II

Restriction enzymes, DNA modifying enzymes, Vectors, Methods of recombinant DNA technology, Nucleic acid hybridization, Gene libraries, DNA cloning, Applications of rDNA technology

Unit III

Introduction to Molecular markers, Nucleic acid hybridization and RFLP marker, CR based markers (RAPDS, ISSR, SCAR, SSR), AFLP, Single Nucleotide Polymorphism (SNPs), DNA sequencing – methods, Automatic sequencing methods, Genetic engineering and transgenics, Genomics, transcriptomics and proteomics

Unit IV

General application of biotechnology in Agriculture, Medicine, Animal husbandry, Environmental remediation, Energy production and Forensics

Practical

Isolation of genomic and plasmid DNA, Gel electrophoresis techniques, Restriction enzyme digestion, ligation, transformation and screening of transformants, PCR and molecular analysis.

Suggested Readings

Becker JM, Coldwell GA & Zachgo EA. 2007. *Biotechnology - a Laboratory Course*. Academic Press.

Brown CM, Campbell I & Priest FG. 2005. *Introduction to Biotechnology*. Panima Pub.

Brown TA. *Gene Cloning and DNA Analysis*. 5th Ed. Blackwell Publishing.

Dale JW & von Schantz M. 2002. *From Genes to Genomes: Concepts and Applications of DNA Technology*. John Wiley & Sons.

Gupta PK. 2004. *Biotechnology and Genomics*. Rastogi Publications.

Sambrook J, Fritsch T & Maniatis T. 2001. *Molecular Cloning - a Laboratory Manual*. 2nd Ed. Cold Spring Harbour Laboratory Press.

Singh BD. 2007. *Biotechnology Expanding Horiozon*. Kalyani Publishers.

MBB 502 **Fundamentals of Molecular Biology** **3+0**

Objective

To familiarize the students with the basic cellular processes at molecular level.

Theory

Unit I

Historical developments of molecular biology; Nucleic acids as genetic material; Chemistry, structure and properties of DNA and RNA.

Unit II

Genome organization in prokaryotes and eukaryotes; Chromatin structure and function; DNA replication; DNA polymerases, topoisomerases, DNA ligase, etc; Molecular basis of mutations; DNA repair mechanisms.

Unit III

Transcription process; RNA processing; Reverse transcriptase; RNA editing; Ribosomes structure and function; Organization of ribosomal proteins and RNA genes; Genetic code; Aminoacyl tRNA synthases.

Unit IV

Translation and post-translational modifications; Operon concept; Attenuation of *trp* operon; important features of gene regulation in eukaryotes.

Suggested Readings

Lewin B. 2008. *Gene IX*. Peterson Publications/ Panima.

Malacinski GM & Freifelder D. 1998. *Essentials of Molecular Biology*. 3rd Ed. Jones & Bartlett Publishers.

Nelson DL & Cox MM. 2007. *Lehninger's Principles of Biochemistry*.

W.H. Freeman & Co.

Primrose SB. 2001. *Molecular Biotechnology*. Panima.

Watson JD, Bakee TA, Bell SP, Gann A, Levine M & Losick R. 2008.

Molecular Biology of the Gene. 6th Ed. Pearson Education International.

MBB 503 **MOLECULAR CELL BIOLOGY** **3+0**

Objective

To familiarize the students with the cell biology at molecular level.

Theory

Unit I

General structure and constituents of cell; Similarities and distinction between plant and animal cells; Cell wall, cell membrane, structure and composition of biomembranes, cell surface related functions.

Unit II

Structure and function of major organelles: Nucleus, Chloroplasts, Mitochondria, Ribosomes, Lysosomes, Peroxisomes, Endoplasmic reticulum, Microbodies, Golgi apparatus, Vacuoles, etc.

Unit III

Organellar genomes and their manipulation; Ribosomes in relation to cell growth and division; Cyto-skeletal elements.

Unit IV

Cell division and regulation of cell cycle; Membrane transport; Transport of water, ion and biomolecules; Signal transduction mechanisms; Protein targeting.

Suggested Readings

Gupta PK. 2003. *Cell and Molecular Biology*. 2nd Ed. Rastogi Publ.

Lodish H. 2003. *Molecular Cell Biology*. 5th Ed. W.H. Freeman & Co.

Primrose SB. 2001. *Molecular Biotechnology*. Panima.

Alberts B et al; Molecular Biology of the Cell; 4th Ed.

MBB 504 PLANT TISSUE CULTURE AND GENETIC TRANSFORMATION 2+1

Objective

To familiarize the students and provide hands on training on various techniques of plant tissue culture, genetic engineering and transformation.

Theory

Unit I

History of plant cell and tissue culture; Culture media; Various types of culture; callus, suspension, nurse, root, meristem, etc.; *In vitro* differentiation: organogenesis and somatic embryogenesis; Plant growth regulators: mode of action, effects on *in vitro* culture and regeneration; Molecular basis of plant organ differentiation.

Unit II

Micropropagation; Anther and microspore culture; Somaclonal variation; *In vitro* mutagenesis; *In vitro* fertilization; *In vitro* germplasm conservation; Production of secondary metabolites; Synthetic seeds.

Unit III

Embryo rescue and wide hybridization; Protoplast culture and regeneration; Somatic hybridization: protoplast fusion, cybrids, asymmetric hybrids, etc.

Unit IV

Methods of plant transformation; Vectors for plant transformation; Genetic and molecular analyses of transgenics; Target traits and transgenic crops; Biosafety issues, testing of transgenics, regulatory procedures for commercial approval.

Practical

Laboratory set-up, Preparation of nutrient media; handling and sterilization of plant material; inoculation, subculturing and plant regeneration, Anther and pollen culture, Embryo rescue, Suspension cultures and production of secondary metabolites, Protoplast isolation, culture and fusion, Gene cloning and vector construction, Gene transfer using different methods, Reporter gene expression, Selection of transformed tissues/plants, Molecular analysis.

Suggested Readings

Bhojwani SS. 1983. *Plant Tissue Culture: Theory and Practice.* Elsevier.

Christou P & Klee H. 2004. *Handbook of Plant Biotechnology.* John Wiley & Sons.

Dixon RA. 2003. *Plant Cell Culture.* IRL Press.

George EF, Hall MA & De Klerk GJ. 2008. *Plant Propagation by Tissue Culture.* Agritech Publ.

Gupta PK. 2004. *Biotechnology and Genomics.* Rastogi Publ.

Herman EB. 2005-08. *Media and Techniques for Growth, Regeneration and Storage.* Agritech Publ.

Pena L. 2004. *Transgenic Plants: Methods and Protocols.* Humana Press.

Pierik RLM. 1997. *In vitro Culture of Higher Plants.* Kluwer.

Singh BD. 2007. *Biotechnology: Expanding Horiozon.* Kalyani.

MBB 505 TECHNIQUES IN MOLECULAR BIOLOGY -I 0+3

Objective

To provide hands on training on basic molecular biology techniques.

Practical

Good lab practices; Biochemical techniques: Preparation of buffers and reagents, Principle of centrifugation, Chromatographic techniques (Gel Filtration Chromatography, Ion exchange Chromatography, Affinity Chromatography). Gel electrophoresis- agarose and PAGE (nucleic acids and proteins);Growth of bacterial culture and preparation of growth curve; Isolation of plasmid DNA from bacteria; Growth of lambda phage and isolation of phage DNA; Restriction digestion of plasmid and phage DNA; Isolation of high molecular weight DNA and analysis. Gene cloning – Recombinant DNA construction, transformation and selection of transformants; PCR and optimization of factors affecting PCR. Southern hybridization; Northern hybridization; Western blotting and ELISA; Radiation safety and non-radio isotopic procedure.

Suggested Readings

Ausubel FM, Brent R, Kingston RE, Moore DD, Seidman JG, Smith JA & Struhl K. 2002. *Short Protocols in Molecular Biology.* John Wiley.

Kun LY. 2006. *Microbial Biotechnology.* World Scientific.

Sambrook J, Russel DW & Maniatis T. 2001. *Molecular Cloning: a Laboratory Manual.* Cold Spring Harbour Laboratory Press.

MBB 506 MICROBIAL/INDUSTRIAL BIOTECHNOLOGY 2+1

Objective

To familiarize about the various microbial processes/systems/activities, which have been used for the development of industrially important products/processes.

Theory

UNIT I

Introduction, scope and historical developments; Isolation, screening and genetic improvement (involving classical approaches) of industrially important organisms.

UNIT II

Primary metabolism products, production of industrial ethanol as a case study; Secondary metabolites, bacterial antibiotics and non ribosomal peptide antibiotics; Recombinant DNA technologies for microbial processes; Strategies for development of industrial microbial strains with scale up production capacities; Metabolic pathway engineering of microbes for production of novel product for industry.

UNIT III

Microbial enzymes, role in various industrial processes, production of fine chemicals for pharmaceutical industries; Bio-transformations, Bioaugmentation with production of vitamin C as a case study; Bioreactors, their design and types; Immobilized enzymes based bioreactors; Microencapsulation technologies for immobilization of microbial enzymes.

UNIT IV

Industrial biotechnology for pollution control, treatment of industrial and other wastes, biomass production involving single cell protein; Bioremediation of soil; Production of eco-friendly agricultural chemicals, biopesticides, bio-herbicides, bio-fertilizers, bio-fuels, etc.

Practical

Isolation of industrially important microorganisms, Their maintenance and improvement, Production of industrial compounds such as alcohol, beer, citric acid, lactic acid and their recovery, Study of bio-reactors and their operations, Production of biofertilizers, Experiments on microbial fermentation process, Harvesting purification and recovery of end products., Immobilization of cells and enzymes, Studies on its kinetic behavior, Growth analysis and biomass estimation, Determination mass transfer co-efficients.

Suggested Readings

Huffnagle GB & Wernick S. 2007. *The Probiotics Revolution: The Definitive Guide to Safe, Natural Health*. Bantam Books.

Kun LY. 2006. *Microbial Biotechnology*. World Scientific.

Primrose SB. 2001. *Molecular Biotechnology*. Panima.

MBB 507 MOLECULAR MARKERS IN CROP IMPROVEMENT 2+1

Theory

Unit I

DNA marker techniques, PCR and hybridization based methods, Methods of physical mapping – Restriction mapping, DNA fingerprinting and foot printing methods, Southern, Northern and Western Hybridizations, ESTs,

Unit II

Development of sequence based molecular markers - SSRs and SNPs; Advanced methods of genotyping; Mapping genes for qualitative and quantitative traits. Principles of Genetic linkage map construction, Relation between Genetic maps and physical maps

Unit III

QTL mapping using structured populations; AB-QTL analysis; Association mapping of QTL; Fine mapping of genes/QTL; Map based gene/QTL isolation and development of gene based markers; Allele mining by TILLING and Eco-TILLING; Use of markers in plant breeding.

Unit IV

Marker assisted selection (MAS) in backcross and heterosis breeding; Transgenic breeding; Foreground and background selection; MAS for gene introgression and pyramiding: MAS for specific traits with examples.

Practical

Extraction of DNA and quantitation, Restriction Digestion of Genomic DNA, Southern transfer, RFLP Southern Hybridization: Washing of Blots and autoradiography Filter stripping and reuse of the blot, Western blotting, PCR amplification of insert DNA for using as RFLP probe, RAPDs with two arbitrary primers, Set up the PCR reaction with SSR primers, Purity testing of hybrids with mol markers, MAS for BLB resistance, Genotyping and phenotyping data collection, Use of various software like NTSys for data analysis

Suggested Readings

G. Caetano-Anolles and P.M. Gresshoff . DNA Markers, Wiley

R.L. Philips and I.K. Vasil. DNA-based markers in plants, Kluwer

K.Weising, H.Nybom, K.Wolff and W.Meyer. DNA Fingerprinting in plants and fungi, CRC

H.J. Newbury. Plant Molecular Breeding, Blackwell

P.Christou and H.Klee. Handbook of Plant Biotechnology vols 1 & 2, Wiley

MBB 508 GENOMICS AND PROTEOMICS 2+0

Objective

To familiarize the students with recent tools used for genome analysis and their applications.

Theory

UNIT I

Structural genomics: Classical ways of genome analysis, large fragment, genomic libraries; Physical mapping of genomes; Genome sequencing, sequence assembly and annotation; Comparative genomics, etc.

UNIT II

Functional genomics: DNA chips and their use in transcriptome analysis; Mutants and RNAi in functional genomics; Metabolomics and ionomics for elucidating metabolic pathways, etc.

UNIT III

Proteomics - Protein structure, function and purification; Introduction to basic proteomics technology; Bio-informatics in proteomics; Proteome analysis, etc.

UNIT IV

Applications of genomics and proteomics in agriculture, human health and industry.

Suggested Readings

Azuaje F & Dopazo J. 2005. *Data Analysis and Visualization in Genomics and Proteomics*. John Wiley & Sons.

Brown TA. 2007. *Genome III*. Garland Science Publ.

Campbell AM & Heyer L. 2004. *Discovery Genomics, Proteomics and Bioinformatics*. Pearson Education.

Gibson G & Muse SV. 2004. *A Primer of Genome Science*. Sinauer Associates.

Jollès P & Jörnvall H. 2000. *Proteomics in Functional Genomics: Protein Structure Analysis*. Birkhäuser.

Kamp RM. 2004. *Methods in Proteome and Protein Analysis*. Springer.

Primrose SB & Twyman RM. 2007. *Principles of Genome Analysis and Genomics*. Blackwell.

Sensen CW. 2005. *Handbook of Genome Research*. Vols. I, II. Wiley CVH.

MBB 509 TECHNIQUES IN MOLECULAR BIOLOGY-II 0+3

Objective

To provide hands on training on various molecular techniques used in molecular breeding and genomics.

Practical

Construction of gene libraries; Synthesis and cloning of cDNA and RTPCR analysis; Real time PCR and interpretation of data. Molecular markers (RAPD, SSR, AFLP etc) and their analysis; Case study of SSR markers (linkage map, QTL analysis etc); SNP identification and analysis; Microarray studies and use of relevant software. Proteomics (2D gels, mass spectrometry, etc.); RNAi (right from designing of construct to the phenotyping of the plant); Yeast 1 and 2-hybrid interaction. Generation and screening of mutants; Transposon mediated mutagenesis.

Suggested Readings

Ausubel FM, Brent R, Kingston RE, Moore DD, Seidman JG, Smith JA & Struhl K. 2002. *Short Protocols in Molecular Biology*. Wiley.

Caldwell G, Williams SN & Caldwell K. 2006. *Integrated Genomics: A Discovery-Based Laboratory Course*. John Wiley.

Sambrook J, Russel DW & Maniatis T. 2001. *Molecular Cloning: a Laboratory Manual*. Cold Spring Harbour Laboratory Press.

MBB 510 **BIOSAFETY, IPR AND BIOETHICS** **2+0**

Unit I

Biosafety and risk assessment issues; Regulatory framework; National biosafety policies and law, The Cartagena protocol on biosafety, WTO and other international agreements related to biosafety, Cross border movement of germplasm; Risk management issues - containment.

Unit II

General principles for the laboratory and environmental biosafety; Health aspects; toxicology, allergenicity, antibiotic resistance, etc; Impact on environment: gene flow in natural and artificial ecologies; Sources of gene escape, tolerance of target organisms, creation of superweeds/superviruses, etc.

Unit III

Ecological aspects of GMOs and impact on biodiversity; Monitoring strategies and methods for detecting transgenics; Radiation safety and non-radio isotopic procedure; Benefits of transgenics to human health, society and the environment.

Unit IV

The WTO and other international agreements; Intellectual properties, copyrights, trademarks, trade secrets, patents, geographical indications, etc; Protection of plant variety and farmers right act; Indian patent act and amendments, patent filing; Convention on biological diversity; Implications of intellectual property rights on the commercialization of biotechnology products.

Suggested Readings

Singh BD. 2007. *Biotechnology: Expanding Horizon.* Kalyani.

http://patentoffice.nic.in

www.wipo.org

www.dbtindia.nic.in

www.dbtbiosafety.nic.in

MBB 511 **ANIMAL BIOTECHNOLOGY** **3+0**

Objective

Intended to provide an overview and current developments in different areas of animal biotechnology.

Theory

UNIT I

Structure of animal cell; History of animal cell culture; Cell culture media and reagents, culture of mammalian cells, tissues and organs, primary culture, secondary culture, continuous cell lines, suspension cultures, somatic cell cloning and hybridization, transfection and transformation of cells, commercial scale production of animal cells, application of animal cell culture for *in vitro* testing of drugs, testing of toxicity of environmental pollutants in cell culture, application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.

UNIT II

Introduction to immune system, cellular and hormonal immune response, history of development of vaccines, introduction to the concept of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, hybridoma technology, phage display technology for production of antibodies, antigen-antibody based diagnostic assays including radioimmunoassays and enzyme immunoassays, immunoblotting, nucleic acid based diagnostic methods, commercial scale production of diagnostic antigens and antisera, animal disease diagnostic kits, probiotics.

UNIT III

Structure of sperms and ovum, cryopreservation of sperms and ova of livestock, artificial insemination, super ovulation, *in vitro* fertilization, culture of embryos, cryopreservation of embryos, embryo transfer, embryo-spliting, embryo sexing, transgenic manipulation of animal embryos, different applications of transgenic animal technology, animal viral vectors, animal cloning basic concept, cloning from- embryonic cells and adult cells, cloning of different animals, cloning for conservation for conservation endangered species, ethical, social and moral issues related to cloning, *in situ* and *ex situ* preservation of germplasm, *in utero* testing of foetus for genetic defects, pregnancy diagnostic kits, anti-fertility animal vaccines, gene knock out technology and animal models for human genetic disorders.

UNIT IV

Introduction to different breeds of cattle, buffalo, sheep, goats, pigs, camels, horses, canines and poultry, genetic characterization of livestock breeds, marker assisted breeding of livestock, introduction to animal genomics, different methods for characterization of animal genomes, SNP, STR, QTL, RFLP, RAPD, genetic basis for disease resistance, Transgenic animal production and application in expression of therapeutic proteins. Immunological and nucleic acid based methods for identification of animal species, detection of meat adulteration using DNA based methods, detection food/feed adulteration with animal protein, identification of wild animal species using DNA based methods using different parts including 18 bones, hair, blood, skin and other parts confiscated by anti-poaching agencies.

Suggested Readings

Gordon I. 2005. *Reproductive Techniques in Farm Animals*. CABI.

Kindt TJ, Goldsby RA & Osbrne BA. 2007. *Kuby Immunology*. WH Freeman.

Kun LY. 2006. *Microbial Biotechnology*. World Scientific.

Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. 2004. *New Generation Vaccines*. 3rd Ed. Informa Healthcare.

Lincoln PJ & Thomson J. 1998. *Forensic DNA Profiling Protocols*. Humana Press.

Portner R. 2007. *Animal Cell Biotechnology*. Humana Press.

Spinger TA. 1985. *Hybridoma Technology in Biosciences and Medicine*. Plenum Press.

Twyman RM. 2003. *Advanced Molecular Biology*. Bios Scientific.

MBB 512 IMMUNOLOGY AND MOLECULAR DIAGNOSTICS 2+1

Objective

To discuss the application of various immunological and molecular diagnostic tools.

Theory

UNIT I

History and scope of immunology; Components of immune system: organs, tissues and cells, Immunoglobulin chemistry, structure and functions; Molecular organization of immunoglobulins and classes of antibodies.

UNIT II

Antibody diversity; antigens, haptens, antigens- antibody interactions; immuno-regulation and tolerance; Allergies and hypersensitive response; Immunodeficiency; Vaccines; Immunological techniques.

UNIT III

Immunological application in plant science, monoclonal antibodies and their uses, molecular diagnostics. Introduction to the basic principles of molecular technology and techniques used in pathogen detection, Principles of ELISA and its applications in viral detection.

UNIT IV

Basics and procedures of PCR, Real time PCR, PCR based and hybridization based methods of detection, microarrays based detection, multiplexing etc, detection of soil borne and seed born infections, transgene detection in seed, planting material and processed food, molecular detection of varietal impurities and seed admixtures in commercial consignments.

Practical

Preparation of buffers and reagents, Immunoblotting, immunoelectrophoresis and fluorescent antibody test, Enzyme immunoassays including ELISA western blotting, Extraction and identification of DNA/RNA of pathogenic organisms, Restriction hybridoma technique and production of monoclonal antibodies, Immunogenic proteins, expression and immunogenecity studies, Purification of immunogenic protein and immunization of laboratory animals.

Suggested Readings

Bloom BR & Lambert P-H. 2002. *The Vaccine Book*. Academic Press.

Elles R & Mountford R. 2004. *Molecular Diagnosis of Genetic Disease*. Humana Press.

Kindt TJ, Goldsby RA & Osbrne BA. 2007. *Kuby's Immunology*. WH Freeman.

Levine MM, Kaper JB, Rappuoli R, Liu MA & Good MF. 2004. *New Generation Vaccines*. 3rd Ed. Informa Healthcare.

Lowrie DB & Whalen R. 2000. *DNA Vaccines*. Humana Press.

Male D, Brostoff J, Roth DB & Roitt I. 2006. *Immunology*. Elsevier.

Rao JR, Fleming CC & Moore JE. 2006. *Molecular Diagnostics*. Horizon Bioscience.

Robinson A & Cranage MP. 2003. *Vaccine Protocols*. 2nd Ed. Humana Press.

Spinger TA, 1985. *Hybridoma Technology in Biosciences and Medicine*. Plenum Press.

MBB 513 NANO-BIOTECHNOLOGY 3+0

Objective

Understanding the molecular techniques involved in structure and functions of nano-biomolecules in cells such as DNA, RNA and proteins.

Theory

UNIT I

Introduction to Biomacromolecules: The modern concepts to describe the conformation and dynamics of biological macromolecules: scattering techniques, micromanipulation techniques, drug delivery applications etc.

UNIT II

Cellular engineering: signal transduction in biological systems, feedback control signaling pathways, cell-cell interactions etc. Effects of physical, chemical and electrical stimuli on cell function and gene regulation.

UNIT III

Chemical, physical and biological properties of biomaterials and bioresponse: biomineralization, biosynthesis, and properties of natural materials (proteins, DNA, and polysaccharides), structure-property relationships in polymeric materials (synthetic polymers and structural proteins); Aerosol properties, application and dynamics; Statistical Mechanics in Biological Systems,

UNIT IV

Preparation and characterization of nanoparticles; Nanoparticular carrier systems; Micro- and Nano-fluidics; Drug and gene delivery system; Microfabrication, Biosensors, Chip technologies, Nano- imaging, Metabolic engineering and Gene therapy.

Suggested Readings

Nalwa HS. 2005. *Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology*. American Scientific Publ.

Niemeyer CM & Mirkin CA. 2005. *Nanobiotechnology*. Wiley Interscience.

MBB 552/BIOCHEM 501 BASIC BIOCHEMISTRY 2+1

Theory

Unit I

Scope and importance of biochemistry in agriculture; Fundamental principles governing life; structure of water; acid base concept and buffers;pH; hydrogen bonding; hydrophobic, electrostatic and Van der Waals forces; General introduction to physical techniques for determination of structure of biopolymers.

Unit II

Classification, structure and function of carbohydrates, lipids and biomembranes, amino acids, proteins, and nucleic acids.

Unit III

Structure and biological functions of vitamins, enzymes classification and mechanism of action; regulation, factors affecting enzyme action. Fundamentals of thermodynamic principles applicable to biological processes, Bioenergetics.

Unit IV

Metabolism of carbohydrates, photosynthesis and respiration, oxidative phosphorylation, lipids, proteins and nucleic acids, Secondary Metabolites – origin, functions and metabolism

Practical

Preparation of standard and buffer solutions, Extraction and estimation of sugars and amino acids, Estimation of proteins by Lowry's method., Estimation of DNA and RNA by Diphenylamine and orcinol methods, Estimation of ascorbic acid, Separation of biomolecules by TLC and paper chromatography.

Suggested Readings

Conn EE & Stumpf PK. 1987. *Outlines of Biochemistry.* John Wiley.

Metzler DE. *Biochemistry.* Vols. I, II. Wiley International.

Nelson DL & Cox MM. 2004. *Lehninger's Principles of Biochemistry* MacMillan.

Voet D & Voet JG. *Biochemistry.* 3rd Ed. Wiley International.

STAT 511 STATISTICAL METHODS FOR APPLIED SCIENCES 2+1

Theory

UNIT I

Classification, tabulation and graphical representation of data. Box-plot, Descriptive statistics. Exploratory data analysis; Theory of probability. Random variable and mathematical expectation.

UNIT II

Discrete and continuous probability distributions: Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions and their applications. Concept of sampling distribution: chi-square, *t* and *F* distributions. Tests of significance based on Normal, chi-square, *t* and *F* distributions. Large sample theory.

UNIT III

Introduction to theory of estimation and confidence-intervals. Correlation and regression. Simple and multiple linear regression model, estimation of parameters, predicted values and residuals, correlation, partial correlation coefficient, multiple correlation coefficient, rank correlation, test of significance of correlation coefficient and regression coefficients. Coefficient of determination. Polynomial regression models and their fitting. Probit regression analysis by least squares and maximum likelihood methods, confidence interval for sensitivity; Testing for heterogeneity.

UNIT IV

Non-parametric tests - sign, Wilcoxon, Mann-Whitney U-test, Wald Wolfowitz run test, Run test for the randomness of a sequence. Median test, Kruskal- Wallis test, Friedman two-way ANOVA by ranks. Kendall's coefficient of concordance.

UNIT V

Introduction to multivariate analytical tools- Hotelling's T2 Tests of hypothesis about the mean vector of a multinormal population. Classificatory problems and discriminant function, D2-statistic and its applications; Cluster analysis, principal component analysis, canonical correlations and Factor analysis.

Practical

Exploratory data analysis, Box-Cox plots; Fitting of distributions ~Binomial, Poisson, Negative Binomial, Normal;, Large sample tests, testing of hypothesis based on exact sampling distributions ~ chi square, t and F, Confidence interval estimation and point estimation of parameters of binomial, Poisson and Normal distribution, Correlation and regression analysis, fitting of orthogonal polynomial regression; applications of dimensionality reduction and discriminant function analysis; Nonparametric tests.

Suggested Readings

Anderson TW. 1958. *An Introduction to Multivariate Statistical Analysis.*

John Wiley.

Dillon WR & Goldstein M. 1984. *Multivariate Analysis - Methods and* 15 *Applications.* John Wiley.

Goon AM, Gupta MK & Dasgupta B. 1977. *An Outline of Statistical Theory.* Vol. I. The World Press.

Goon AM, Gupta MK & Dasgupta B. 1983. *Fundamentals of Statistics.*

Vol. I. The World Press.

Hoel PG. 1971. *Introduction to Mathematical Statistics.* John Wiley.

Hogg RV & Craig TT. 1978. *Introduction to Mathematical Statistics.*

Macmillan.

Morrison DF. 1976. *Multivariate Statistical Methods.* McGraw Hill.

Siegel S, Johan N & Casellan Jr. 1956. *Non-parametric Tests for Behavior Sciences.* John Wiley.

Learning Statistics: http://freestatistics.altervista.org/en/learning.php.

Electronic Statistics Text Book:

http://www.statsoft.com/textbook/stathome.html

MBB 553 BIOSTATISTICS AND COMPUTERS 2+1

Theory

Unit I

Aims, scope and idea of elementary statistics; Measures of central tendency and dispersion, skewness and kurtosis.

Unit II

Concept of probability and probability laws, mathematical expectation, moments, moments generating function; Standard probability distributions- Binomial, Poisson and Normal distributions.

Unit III

Tests of significance based on Z, ÷2, t and F statistics; Correlation and regression, curve fitting by least squares methods.

Unit IV

Basic principles, organization and operational aspects of computers, operating systems. Introduction to MS-Office, MS-Word, MS-Excel. Statistical Data analysis based on above topics through MS-Excel.

Practical

Data analysis using probability, test of significance, Correlation and regression analysis, Usage of MS-Windows, Exercises on test processing, spreadsheet and DBMS, SPSS.

Suggested Readings

Agarwal BL. 2003. *Basic Statistics*. New Age.

Gupta SP. 2004. *Statistical Methods*. S. Chand & Sons.

Dutta NK. 2002. *Fundamentals of Bio-Statistics*. Kanishka Publ.

MBB 554 PRINCIPLES OF MICROBIOLOGY 3+1

Objective

To acquaint the students with history, classification and role of microbiology in agriculture, food and environment.

Theory

UNIT I

Development of Microbiology in the 18th and 19th century. Morphology, structure and function of prokaryotic and eukaryotic cell. Archea. Classification of prokaryotes – Basic principles and techniques used in bacterial classification.

UNIT II

Evolutionary relationship among prokaryotes. Phylogenetic and numerical taxonomy. Use of DNA and r-RNA sequencing in classifications.

UNIT III

Study of major groups of bacteria belonging to Gracilicutes, Firmicutes, Tanericutes and Mendosicutes.

UNIT IV

Viruses – morphology, classification and replication of plant, animal and bacterial viruses. Cultivation methods of viruses. Immune response – specific and non-specific resistance. Normal microflora of human body; some common bacterial and viral diseases of humans and animals.

Practical

Methods of isolation, purification and maintenance of microorganisms from different environments (air, water, soil, milk and food). Enrichment culture technique – isolation of asymbiotic, symbiotic nitrogen fixing bacteria. Isolation of photosynthetic bacteria, Use of selective media, antibiotic resistance and isolation of antibiotic, producing microorganisms. Morphological, physiological and biochemical characterization of bacteria.

Suggested Readings

Brock TD. 1961. *Milestones in Microbiology*. Infinity Books.

Pelczar ML Jr. 1997. *Microbiology*. Tata McGraw Hill. 23

Stainier RY, Ingraham JL, Wheelis ML & Painter PR. 2003. *General Microbiology*. MacMillan.

Tauro P, Kapoor KK & Yadav KS. 1996. *Introduction to Microbiology*.

Wiley Eastern.

MBB 555 INTRODUCTION TO BIOINFORMATICS 1+1

Theory

Unit I

Introduction, biological databases – Introduction to protein primary structure, secondary structure , Protein structural domains, Ramachandran Plot, Protein structure prediction and modeling, Docking I, Protein and Gene Information Resources – PIR, SWISSPROT, PDB, GenBank, DDBJ. Specialized genomic resources.

Unit II

DNA sequence analysis, cDNA libraries and EST, EST analysis, pairwise alignment techniques, database searching, multiple sequence alignment.

Unit III

Molecular phylogenetics, Molecular clock hypothesis, Building dendrograms, Computer aided drug design, computer aided drug design – basic principles, QSAR.

Unit IV

Analysis packages –PHYLIP, Primer design, web-based analysis tools.

Practical

Usage of NCBI resources, Retrieval of sequence/structure from databases, Visualization of structures, Docking of ligand receptors, BLAST exercises.

Suggested Readings

Attwood TK & Parry-Smith DJ. 2003. *Introduction to Bioinformatics*.

Pearson Education.

Rastogi SC, Mendiratta N & Rastogi P. 2004. *Bioinformatics: Concepts, Skills and Applications*. CBS.

D.W. Mount, Bioinformatics: Sequence and Genome Analysis by Bioinformatics: Sequence and Genome Analysis, CSHL

BMB 556 ENVIRONMENTAL BIOTECHNOLOGY 3+0

Objective

To apprise the students about the role of biotechnology in environment management for sustainable eco-system and human welfare.

Theory

UNIT I

Basic concepts and environmental issues; types of environmental pollution; problems arising from high-input agriculture; methodology of environmental management; air and water pollution and its control; waste water treatment - physical, chemical and biological processes; need for water and natural resource management.

UNIT II

Microbiology and use of micro-organisms in waste treatment; biodegradation; degradation of Xenobiotic, surfactants; bioremediation of soil & water contaminated with oils, pesticides & toxic chemicals, 24 detergents etc; aerobic processes (activated sludge, oxidation ditches, trickling filter, rotating drums, etc); anaerobic processes: digestion, filteration, etc.

UNIT III

Renewable and non-Renewable resources of energy; energy from solid waste; conventional fuels and their environmental impact; biogas; microbial hydrogen production; conversion of sugar to alcohol; gasohol; biodegradation of lignin and cellulose; biopesticides; biofertilizers; composting; vermiculture, etc.

UNIT IV

Treatment schemes of domestic waste and industrial effluents; food, feed and energy from solid waste; bioleaching; enrichment of ores by microorganisms; global environmental problems: ozone depletion, UV-B, greenhouse effects, and acid rain; biodiversity and its conservation; biotechnological approaches for the management environmental problems.

Suggested Readings

Evans GM & Furlong JC. 2002. *Environmental Biotechnology: Theory and Application.* Wiley International.

Jordening H-J & Winter J. 2006. *Environmental Biotechnology: Concepts and Applications.* Wiley-VCH Verlag.

MBB 557 PLANT MOLECULAR GENETICS 2+1

Theory

Unit I

Model systems for understanding molecular genetics- Molecular basis of Mendelian inheritance- Molecular events in cell division- Genome organization in prokaryotes and eukaryotes- Development of gene concept- Gene interactions and biosynthetic pathways- Fine structure analysis of gene

Unit II

Molecular basis of crossing over and genetic recombination- Mechanisms of gene transfer in bacteria- Gene mapping in prokaryotes and eukaryotes- Molecular basis of mutagenesis- DNA repair mechanisms- Molecular basis of structural and numerical chromosomal aberrations

Unit III

Transposable genetic elements in prokaryotes and eukaryotes- Molecular basis of qualitative and quantitative inheritance- Molecular basis of cytoplasmic inheritance- Molecular basis of heterosis-Transfer of genetic information and expression

Unit IV

Regulation of gene expression in prokaryotes and eukaryotes- Differential regulation of gene expression in eukaryotes-Genetics of populations- Molecular changes underlying evolution

Practical

Chromosome staining and visualization by simple microscope and electron microscope, Events in mitosis and meiosis; Problems on Mendelian genetics ; Isolation of genomic and plasmid DNA; Digestion of DNA with restriction enzymes and resolution of fragments by electrophoresis; Construction of recombinant plasmid; Measurement of growth rate; Bacterial transformation; Selection of recombinants; Use of Lambda vector for cloning; Different types of molecular markers - RAPD, RFLP, SSRs, etc.

Suggested Readings

B.D. Singh, *Molecular Genetics*, Kalyani Publishers, New Delhi.

Strickberger MW L.H., *Genetics 3/e,* Prentice Hall.

Hartwell, L.Hood, M.L.Goldberg, A.E. Reynolds, L.M. Silver and R.C. Veres, *Genetics: From Genes to Genomes,* McGraw Hill

B.Lewin, *Genes IX*, Pearson Publishers

MBB 558 **ENZYMOLOGY** **1 +1**

Theory

Unit I

Enzyme nomenclature and classification, General properties of enzymes like effect of pH, temperature ions, etc., Extraction, assay and purification of enzymes

Unit II

Steady state kinetics, Michaelis-Menten, Lineweaver-Buke, Eeadie –Hofstee and Hanes - Wolf equations

Unit III

Enzyme inhibitors, Pre-steady state kinetics, Enzyme specificity, Evidences for enzyme-substrate complexes, Nucleophilic and electrophilic attacks, Role of metal ions in enzyme catalysis, Mechanism of enzyme action e.g. Lysozyme, chymotrypsin, DNA polymerases, RNase, etc., Zymogen and enzyme activation

Unit IV

Allosteric interactions and product inhibition, Enzyme induction and repression, Membrane bound enzymes, Chemical nature and organization – isozymes – catalysis, Chemical and industrial application of enzymes, Immobilization of enzymes and their applications, Ribozymes and their applications, Enzyme engineering , Biotechnology of enzymes – Medical, industrial and analytical application of enzymes, Abzymes

Practical

Enzyme preparation- purification procedures; Experiments on kinetics – effect of pH, and temperature; Determination of V_{max} and K_m ; Detection of isozymes on gel by staining(3) Nitrate reductase activity determination; Assay of Glutamate dehydrogenase/Urease/Alkaline phosphatase; Enzyme immobilization methods

Suggested Readings

Bergmeyer HU. 1983. *Method of Enzymatic Analysis Vol.II*, Verlag Chemie, Academic Press, NY

R.A. Copland Enzymes, Wiley VCH

Fundamentals of Enzymology, N.C. Price C.L.Stevens, Oxford

Biochemistry 5th, Berg JM, Tymoczko JL, Stryer L & Clarke ND - 2000. W.H. Freeman & Co.

MBB 601 ADVANCES IN PLANT MOLECULAR BIOLOGY 3+0

Theory

Unit I

Arabidopsis in molecular biology, Forward and Reverse Genetic Approaches, Transcriptional and post-transcriptional regulation of gene expression, isolation of promoters and other regulatory elements.

Unit II

RNA interference, Transcriptional gene silencing, Transcript and protein analysis, use of transcript profiling to study biological systems.

Unit III

Hormone regulatory pathways: Ethylene, Cytokinin, Auxin and ABA, SA and JA; ABC Model of Floral Development, Molecular basis of self incompatibility, Regulation of flowering: photoperiod, vernalization, circadian rhythms.

Unit IV

Molecular biology of abiotic stress responses: Cold, high temperature, submergence, salinity and drought; Molecular Biology of plant-pathogen interactions, molecular biology of *Agrobacterium* Infection, Molecular biology of *Rhizobium* infection (molecular mechanisms in symbiosis), Programmed cell death in development and defense.

Suggested Readings

Buchanan B, Gruissen W & Jones R. 2000. *Biochemistry and Molecular*

Biology of Plants. American Society of Plant Physiologists, USA.

Lewin B. 2008. *Gene IX*. Peterson Publications/ Panima.

Malacinski GM & Freifelder D. 1998. *Essentials of Molecular Biology*. 3rd

Ed. Jones & Bartlett Publ.

MBB 602 **ADVANCES IN GENETIC ENGINEERING** **3+0**

Theory

Unit I

General overview of transgenic plants; Case studies: Genetic engineering of herbicide resistance, Transgenic plants resistant to insects/pests, Genetic engineering of abiotic stress tolerance, engineering food crops for quality, Genetically engineered pollination control, Induction of male sterility in plants.

Unit II

Molecular farming of plants for applications in veterinary and human medicine systems: Boosting heterologous protein production in transgenics, Rapid production of specific vaccines, High-yield production of therapeutic proteins in chloroplasts.

Unit III

Recent developments in plant transformation strategies; Role of antisense and RNAi-based gene silencing in crop improvement; Regulated and tissue-specific expression of transgenes for crop improvement; Gene stacking; Pathway engineering; Marker-free transgenic development strategies; High throughput phenotyping of transgenic plants.

Unit IV

Field studies with transgenic crops; Environmental issues associated with transgenic crops; Food and feed safety issues associated with transgenic crops; Risk assessment of transgenic food crops.

Suggested Readings

Christou P & Klee H. 2004. *Handbook of Plant Biotechnology*. John Wiley & Sons.

Specific journals mentioned later.

MBB 603 **ADVANCES IN MICROBIAL BIOTECHNOLOGY** **3+0**

Objective

To discuss specialized topics about industrially important microorganisms.

Theory

UNIT I

Fermentative metabolism and development of bioprocessing technology, processing and production of recombinant products; isolation, preservation and improvement of industrially important microorganisms.

UNIT II

Immobilization of enzymes and cells; Batch, plug flow and chemostate cultures; Computer simulations; Fed-batch and mixed cultures; Scale-up principles; Down stream processing etc.

UNIT III

Current advances in production of antibiotics, vaccines, and biocides; Steroid transformation; Bioreactors; Bioprocess engineering; Production of non-microbial origin products by genetically engineered microorganisms.

UNIT IV

Concept of probiotics and applications of new tools of biotechnology for quality feed/food production; Microorganisms and proteins used in probiotics; Lactic acid bacteria as live vaccines; Factors affecting delignification; Bioconversion of substrates, anti-nutritional factors present in feeds; Microbial detoxification of aflatoxins; Single cell protein, Bioinsecticides; Biofertilizers; Recent advances in microbial biotechnology.

Suggested Readings

Specific journals and published references.

MBB 604 ADVANCES IN CROP BIOTECHNOLOGY 3+0

Theory

Unit I

Conventional versus non-conventional methods for crop improvement; Present status and recent developments on available molecular marker, transformation and genomic tools for crop improvement.

Unit II

Genetic engineering for resistance against abiotic (drought, salinity, flooding, temperature, etc) and biotic (insect pests, fungal, viral and bacterial diseases, weeds, etc) stresses; Genetic Engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation and nutrient uptake efficiency; Genetic engineering for quality improvement (Protein, essential amino acids, vitamins, mineral nutrients, etc); edible vaccines, etc.

Unit III

Molecular breeding: constructing molecular maps; integrating genetic, physical and molecular maps; diversity assessment and Phylogenetic analysis; molecular tagging of genes/traits; selected examples on marker assisted selection of qualitative and quantitative traits.

Unit IV

Discussion on application of molecular, transformation and genomic tools for the genetic enhancement in some major field crops such as rice, wheat, cotton, maize, soybean, oilseeds, sugarcane etc.

Suggested Readings

Specific journals and published references.

MBB 605 ADVANCES IN FUNCTIONAL GENOMICS AND PROTEOMICS 2+0

Theory

Unit I

Genome sequencing and functional genomics; Human, animal, plant, bacterial and yeast genome projects; genome annotation; *ab initio* gene discovery; functional annotation and gene family clusters; etc.

Unit II

Functional analysis of genes; RNA-mediated interference; gene knockoffs; Gene traps/ T-DNA insertion lines; homologous recombination; microarray profiling; SAGE; SNPs/variation;

yeast-two hybrid screening; gene expression and transcript profiling; EST contigs; EcoTILLING; allele/gene mining; synteny and comparative genomics; Genome evolution, speciation and domestication etc.

Unit III

Proteomics: protein annotation; protein separation and 2D PAGE; mass spectroscopy; protein microarrays; protein interactive maps; structural proteomics: protein structure determination, prediction and threading, software and data analysis/ management, etc.

Unit IV

Discussion on selected papers on functional genomics, proteomics, integrative genomics etc.

Suggested Readings

Specific journals and published references.

MBB 606 COMMERCIAL PLANT TISSUE CULTURE 2+0

Objective

To discuss the commercial applications of plant tissue culture in agriculture, medicine and industry.

Theory

UNIT I

Micropropagation of commercially important plant species; plant multiplication, hardening, and transplantation; genetic fidelity; scaling up and cost reduction; bioreactors; synthetic seeds; management and marketing.

UNIT II

Production of useful compounds via biotransformation and secondary metabolite production: suspension cultures, immobilization, examples of chemicals being produced for use in pharmacy, medicine and industry.

UNIT III

Value-addition by transformation; development, production and release of transgenic plants; patent, bio-safety, regulatory, environmental and ethic issues; management and commercialization.

UNIT IV

Some case studies on success stories on commercial applications of plant tissue culture. Visits to some tissue culture based commercial units/industries.

Suggested Readings

Specific journals and published references.

MBB 607 ADVANCES IN ANIMAL BIOTECHNOLOGY 2+0

Objective

Intended to provide cutting edge knowledge on advances in different areas of animal biotechnology.

Theory

UNIT I

Advances in animal cell culture technology, suspension culture technology, advances in commercial scale productions of mammalian cells.

UNIT II

Advances in cell cloning and cell hybridization, advances in monoclonal antibody production technology, Advances in diagnostic technology, Computational vaccinology, reverse genetics based vaccines.

UNIT III

Advances in embryo manipulation, knock out and knock in technology, advances in animal cloning technology, stem cell technology, Advances in development of animal models for human diseases using transgenic animal technology.

UNIT IV

Advances in genetic basis for animal disease resistance, Molecular methods for animal forensics, Advances in animal genomics, proteomics

Suggested Readings

Selected articles from journals.

MBB 608 BIOTECHNOLOGY IN BIODIVERSITY 2+0

Theory

Unit I

Plant Genetic resources (PGR) and their importance – Agrobiodiversity and centres of origin – Primary and secondary centres, base for reconstruction and reconstellation of new cultivars – exploration and collection –exploration missions- importance of explorations and case studies , Collection: Patterns of variation and genetic makeup Entering the collected material in gene banks, Handling the site data – Conservation : ex situ conservation, gene pool establishment, in situ conservation, conservation of wild relatives and land races, community based plant conservation, participatory conservation methods,

Unit II

Methods of crop diversity analysis, Characterization- taxonomic, using plant descriptors, biochemical, using isozymes and DNA markers, DNA fingerprinting methods, Utilization-types of collection- PGR exchange, national and international formalities ,

Unit III

MTA, primary and secondary evaluations, crop genetic resources network; International and National, Role of IARCs in PGR conservation, CBD and Caratgena protocol on Biodiversity, National Biodiversity Board and Act, Economic evaluation of biodiversity

Unit IV

Conservation and biodiversity assessment- IPR- issues and concerns, implications of WTO, GATTT and TRIPS , PVR and CBD on PGR, Comparison of plant protection/registration system across the world, SWOT of Indian act, Transgenics and conservation and evaluation,

Suggested Readings

K V Krishnamurthy. An advanced text book on biodiversity, principles and practice: Oxford & IBH Publ.

K C Agrawal .Biodiversity, Agrobios-India

Tangadurai D & T Pullaiah. Genetic resources and biotechnology

Lindsey A. Biotechnology and Plant genetic resources:

Agrawal. Biodiversity:

MBB 609 TECHNIQUES IN MOLECULAR BIOLOGY-II 0+2

Practical

Methods of DNA isolation, Construction of gene libraries; Synthesis of cDNA and cloning methods, Construction of dendrograms based on similarity matrix, Molecular markers (RAPD, SSR, AFLP etc) and their analysis; Case study of SSR markers, Use of NTSys software, DNA star and Biosuite software for DNA sequence analysis. Genotyping and phenotyping for linkage map and QTL analysis etc; Software for linkage map and QTL analysis, SNP identification and analysis, High througput analysis for genotyping using SSRs, Automated DNA sequencing, Basics of Proteomics, Basics of RT PCR and microarray analysis.

Suggested Readings

Ausubel FM, Brent R, Kingston RE, Moore DD, Seidman JG, Smith JA & Struhl K. 2002. *Short Protocols in Molecular Biology*. Wiley.

Caldwell G, Williams SN & Caldwell K. 2006. *Integrated Genomics: A Discovery-Based Laboratory Course*. John Wiley.

Sambrook J, Russel DW & Maniatis T. 2001. *Molecular Cloning: a Laboratory Manual*. Cold Spring Harbour Laboratory Press.

MBB 610 ANALYTICAL METHODS IN BIOTECHNOLOGY 2 + 1

Theory

Unit I

Beer-Lambert law and Spectrophotometry, Flourimetry, Principles of centrifugation - Sedimentation principle and analysis, Ultracentrifugation methods- Cs Cl gradient centrifugation, Setting up of sucrose gradients for centrifugation, Optical rotation and polarimetry, ORD and CD,

Unit II

Principles and Methods of chromatography, affinity chromatography, Gas liquid chromatography(GLC), HPLC, Gel Filtration, Ultra filtration, Principles of Electrophoresis, Pulse Field Gel Electrophoresis, Dialysis, Lyophilization, Flourescence *in situ* hybridization (FISH),

Unit III

Basic aspects of Oligonucleotide synthesis, peptide synthesis, DNA and protein sequencing methods, PCR and Real time PCR, Differential display and subtractive DNA hybridization studies, Basics of Cell sorting

Unit IV

Basics of radioactivity and autoradiography, Safety aspects of radiation, Principles of ELISA and Monoclonal Ab production, Electron Microscopy.

Practical

1. Verification of Beer-Lambert law using spectrophotometer, Subcellular fractionation procedure - Isolation of nuclei, chloroplasts and mitochondria, Identification of the cell organelle, and products of plant cells (2), DNA isolation and quantitation, PCR Methods, ELISA, Microscopy: simple and compound, phase contrast and Electron Microscopy, Affinity chromatography (2), DNA hybridization

Suggested Readings:

New developments to be downloaded from the internet.

MBB 611 ADVANCES IN BIOINFORMATICS 1+1

Theory

Unit I

Bioinformatics and computing for innovative scientific discovery, Data application and management, Databases in biology – DNA and Proteins, BLAST, Multiple sequence alignment, Similarity index

Unit II

Sequencing genomes: physical mapping, genome structure, genome annotation including gene finding tools, understanding the cell / organisms: regulatory pathways and networks, simulations,

Unit III

Molecular Phylogenetic: relations between organisms and evolutionary questions, Phylogenetic trees, Construction of dendrograms, computational models of evolution, Biomolecular computing: DNA Structures, Genome annotation, Gene finding software

Unit IV

Protein structures, protein folding, inverse folding, molecular mechanics,Ramachandran plot, docking Pair-wise alignment, similarity searches, multiple sequence alignment, pattern discovery (motifs etc.), Primer designing, Gene Expression Analysis, HMMs , clustering, tree inference

Practical

Usage of NCBI resources, Retrieval of sequence / structure from database, visualization of structures, Docking of ligand recoptors, BLAST exercises, Primer designing.

Suggested Readings

Attwood TK & Parry-Smith DJ. 2003. *Introduction to Bioinformatics.*

Pearson Education.

Rastogi SC, Mendiratta N & Rastogi P. 2004. *Bioinformatics: Concepts, Skills and Applications.* CBS.

D.W. Mount, Bioinformatics: Sequence and Genome Analysis by Bioinformatics: Sequence and Genome Analysis, CSHL

List of Journals

Advances in Botanical Research

Advances in Enzyme Regulation

Advances in Enzymology

Advances in Genetics

Agricultural and Biological Research

Analytical Biochemistry

Annals of Botany

Archives of Biochemistry and Biophysics

Archives of Microbiology

Biochemical and Biophysical Research Communication

Biochemical Genetics

Biochemistry

Biotechnology and Bioengineering

Critical Reviews in Plant Sciences

Crop Science

EMBO Journal

Euphytica

Genetic and Plant Breeding

Genome

Indian Journal of Genetics and Plant Breeding

Journal of Biotechnology

Journal of Experimental Botany

Journal of General Microbiology

Journal of Heredity

Journal of Plant Biochemistry and Biotechnology

Journal of Plant Biology

Molecular and Cellular Biochemistry

Molecular Breeding

Molecular Genetics and Genomics

Nature

Nature Biotechnology

Plant Cell

Plant Molecular Biology

Plant Physiology

Plant Physiology and Biochemistry

Proceedings of The National Academy of Sciences (USA)

Science

Trends in Biochemical Sciences

Trends in Biotechnology

Trends in Cell Biology

Trends in Food Science and Technology

Trends in Genetics

Trends in Microbiology

Trends in Plant Sciences

e-Resources

National Center for Biotechnology Information

http://www.ncbi.nlm.nih.gov/

The World Wide Web Virtual Library: Biotechnology.

http://www.cato.com/biotech/

The Transgenic/Targeted Mutation Database (TBASE)

http://www.bis.med.jhmi.edu/Dan/tbase/tbase.html

Primer on Molecular Genetics

http://www.bis.med.jhmi.edu/Dan/DOE/intro.html.

Bioportal

http://bioportal.gc.ca/english/BioPortalHome.asp

Access Excellence

http://www.gene.com/ae

BioTech Biosources Database: Indiana University

http://biotech.chem.indiana.edu/

Information Systems for Biotechnology

http://gophisb.biochem.vt.edu/

All About The Human Genome Project (HGP)

http://www.genome.gov/

Human Genome Project at the Sanger Institute

http://www.sanger.ac.uk/HGP/

UCSC Genome Browser

http://genome.ucsc.edu/

Gramene

www.gramene.org/

The Institute for Genomic Research

www.tigr.org

Suggested Broad Topics for Master's and Doctoral Research

Micropropagation of important crop plants, cash crops, ornamentals, forest and horticultural trees, medicinal and aromatic plants.

Development of transgenics in field crops for resistance against biotic and abiotic stresses, and to improve the nutritional quality, etc.

DNA fingerprinting of important plant species and germplasm.

Development of molecular markers (SNP, SSR, transposable elements, etc) and their utilization for genetic diversity and phylogenetic analysis.

Molecular mapping and marker-assisted selection for major-gene traits in crop species.

Value-addition including biopesticides, biofertilizers, biofuels, biodegradable plastics, secondary metabolites, etc.

Genome sequencing and functional analysis of genes of important organisms.

Allele mining, proteomics, genomics and metabolic engineering for crop improvement.

Immobilization of enzymes/microorganisms.

Protein engineering.

To develop crops with improved mineral (Fe, Zn, Vitamin A, etc) bioavailbility.

Biodiversity and conservation of endangered plant species.

Bioprocess engineering and down stream processing.

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PLANT PHYSIOLOGY
Course Structure –at a Glance

CODE	COURSE TITLE	CREDITS
PP 501*	PRINCIPLES OF PLANT PHYSIOLOGY- I : CELL ORGANELLES, WATER RELATIONS AND MINERAL NUTRITION	2+1
PP 502*	PRINCIPLES OF PLANT PHYSIOLOGY- II:METABOLIC PROCESSES AND GROWTH REGULATION	2+1
PP 503*	PLANT DEVELOPMENTAL BIOLOGY – PHYSIOLOGICAL AND MOLECULAR BASIS	2+0
PP 504*	PHYSIOLOGICAL AND MOLECULAR RESPONSES OF PLANTS TO ABIOTIC STRESSES	2+1
PP 505*	HORMONAL REGULATION OF PLANT GROWTH AND DEVELOPMENT	2+1
PP 506*	PHYSIOLOGY OF GROWTH, YIELD AND MODELING	1+1
PP 507	GENOME ORGANIZATION IN HIGHER PLANTS	2+1
PP 508*	MORPHOGENESIS, TISSUE CULTURE AND TRANSFORMATION	1+1
PP 509	PHYSIOLOGY OF CROP PLANTS – SPECIFIC CASE STUDIES	2+0
PP 510	PHYSIOLOGICAL AND MOLECULAR ASPECTS OF PHOTOSYNTHESIS – CARBON AND NITROGEN ASSIMILATION	1+1
PP 511	MINERAL NUTRITION	2+1
PP 591	MASTER'S SEMINAR	1+0
PP 599	MASTER'S RESEARCH	20
PP 601**	FUNCTIONAL GENOMICS AND GENES ASSOCIATED WITH A FEW PHYSIOLOGICAL PROCESSES	2+0
PP 602**	SIGNAL PERCEPTIONS AND TRANSDUCTION AND REGULATION OF PHYSIOLOGICAL PROCESSES	2+0
PP 603**	MOLECULAR APPROACHES FOR IMPROVING PHYSIOLOGICAL TRAITS	2+1
PP 604	TECHNIQUES IN PLANT PHYSIOLOGY	0+2
PP 605	CLIMATE CHANGE AND CROP GROWTH	2+0
PP 606	POST-HARVEST PHYSIOLOGY	2+0
PP 607	WEED PHYSIOLOGY AND HERBICIDE ACTION	1+1
PP 608	SEED PHYSIOLOGY	2+1

CODE	COURSE TITLE	CREDITS
PP 691	DOCTORAL SEMINAR – I	1+0
PP 692	DOCTORAL SEMINAR- II	1+0
PP 699	DOCTORAL RESEARCH	45

*Compulsory for Master's programme; ** Compulsory for Ph. D. programme

Minor Departments **9**

Biochemistry

Genetics & Plant Breeding

Plant Molecular Biology and Biotechnology

Supporting Departments **5**

Statistics and Mathematics

Microbiology

Agronomy

Computer Science.

Non credit compulsory courses

CODE	COURSE TITLE	CREDITS
PGS 501	LIBRARY AND INFORMATION SERVICES	0+1
PGS 502	TECHNICAL WRITING AND COMMUNICATION SKILLS	0+1
PGS 503 (e-course)	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1+0
PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1
PGS 505 (e-course)	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1+0
PGS 506 (e-course)	DISASTER MANAGEMENT	1+0

PP 501 PRINCIPLES OF PLANT PHYSIOLOGY – I : 2+1

CELL ORGANELLES, WATER RELATIONS AND MINERAL NUTRITION

Objective

To impart the students with basic knowledge of cell physiology and plant nutrition with relevance to agriculture .

Theory

UNIT I

Plant cell: structure & function – cell theory, cell organelles, structure and physiological functions of cell wall.

UNIT II

Cell membranes, fluid mosaic model, importance of membranes in cell organelles, role of plasmodesmata.

UNIT III

Endoplasmic reticulum - golgi apparatus – role in metabolism – diverse function in cell cycle and development, Exocystosis and endocystosis – membrane compartments associated with recycling.

UNIT IV

Vacuoles, role of multifunctional compartments - Nucleus , nuclear pore and nucleolus – organization and role in cell functioning.

UNIT V

Plastids - Mitochondria - peroxisomes – organization and role in cell functioning.

UNIT VI

Plant water relations – importance and properties of water – cell water terminology – water potential and its components – growth of cells and water relations - Movement of water in plants mechanism of water uptake and transport – role of roots – factors affecting root growth and proliferation.

UNIT VII

Transpiration – significance – factors affecting transpiration – stomata, structure, function and regulation – WUE and factors affecting WUE – Anti-transpirants.

UNIT VIII

Physiological aspects of water deficit – influence at cell, organ and canopy level – indices of drought resistance in plants - Transpiration efficiency – intrinsic WUE – scope for plant improvement and crop yield.

UNIT IX

Plant nutrition – Role of nutrients in plant metabolism – Criteria of essentiality – classification of plant nutrients.

UNIT X

Mechanism of uptake and transport - Role of membranes in nutrient transport - Symplast and apoplast – carrier concept – phloem mobility.

UNIT XI

Factors influencing the availability and uptake of plant nutrients - Role of mycorrhiza and root exudates in plant nutrition.

UNIT XII

Physiological role of plant nutrients – N, P, K, Ca, Mg, S, Fe, Cu, Mn, Zn, Mo, B, Cl, Na and Si.

UNIT XIII

Plant nutritional disorders – Deficiency and toxicity symptoms in crop plants, reasons and remedial measures.

UNIT XIV

Foliar nutrition – uptake and transport – Factors influencing foliar uptake of nutrients – significance.

Practical

Plant Cell – a general view, Structure of cell organelles, Anatomy of plant roots, Measurement of water status: Relative water content, Measurement of water potential : Chardakov's falling drop method, Scholander's Pressure chamber method, Osmometer method, Measurement of transpiration (steady state porometer or IRGA), Solar energy absorption in plant – leaf level and canopy level, Effect of ABA on stomata, Effect of water stress on seed germination and seedling growth, Mineral nutrients: Development of deficiency symptoms of plant nutrients (2 classes), Development of toxicity symptoms of plant nutrients, Influence of pH and EC on plant growth in solution culture.

Suggested Readings

Barker AB & Pilbeam DJ. 2007. *Handbook of Plant Nutrition*. CRC

Epstein E. 2007. *Mineral Nutrition of Plants*. John Wiley & Sons.

Hopkins WG & Huner NPA. 2004. *Introduction to Plant Physiology*. John Wiley & Sons.

Marschner H. 1995. *Mineral Nutrition of Higher Plants*. Academic Press.

Salisbury FB & Ross C. 1992. *Plant Physiology*. 4th Ed. Wadsworth Pub.

Taiz L & Zeiger E. 2006. *Plant Physiology*. 4th Ed. Sinauer Associates.

PP 502 PRINCIPLES OF PLANT PHYSIOLOGY - II : METABOLIC PROCESSES AND GROWTH REGULATION 2+1

Objective

To acquaint the students with the basic concepts of physiological process and their relationship with growth regulation.

Theory

UNIT I

Introduction – Photosynthesis, translocation and respiration as key processes regulating carbon metabolism and plant growth

UNIT II

Photosynthesis and its importance in bioproductivity – Photosynthetic apparatus – chloroplast and its structure Photochemical reactions – Absorption of light – Fate of excited chlorophyll –Electron and photon transport and bioenergetics

UNIT III

Carbon metabolism: The C_3 photosynthetic carbon reduction cycle – Calvin cycle. Supplemental pathway of carbon fixation in C_4 and CAM plants and its significance – Further modeling of photosynthesis.

UNIT IV

Photosynthesis as a diffusive process (gas & liquid phase diffusion). Effect of environmental factors on photo synthetic rates (CO_2 response curves and light response curves) – Discrimination of carbon isotopes in plants. Photo respiration and its relevance

UNIT V

Synthesis of sucrose, starch, oligo and polysaccherides from triose phosphate generated by the C_3 cycle.

UNIT VI

Translocation of photosynthesis – Apoplastic and symplastic path way – short distance and long distance transport – phloem loading and unloading . Importance of translocation in sink growth.

UNIT VII

Mitochondrial respiration – Introduction – General characteristics of respiration system – respiratory substrates – glycolytic pathway – anaerobic respiration.

UNIT VIII

TCA cycle and HMP pathway – respiration chain (ETS) – Carbon balance – factors influencing respiration- Growth and maintenance respiration, cyanide resistant respiration and its significance

UNIT IX

Nitrogen metabolism; inorganic nitrogen species (N_2, NO_3 & NH_3) and other reduction to amino acids – biological N fixation. Protein synthesis : The components of protein synthesis. The mechanism of protein synthesis and regulation of protein synthesis.

UNIT X

Nucleic acid synthesis – Activation of nucleic acid (DNA & RNA) precursors – splitting of high energy pyrophosphate group – Union of nucleoside monophosphate group

UNIT XI

Lipid metabolism : storage, protective and structural lipids – Their composition and functions- Biosynthesis of fatty acids, diacylglycerol and triacyl glycerol.

UNIT XII

Secondary metabolites (Terpenes, Phenolic compounds and N containing compounds) and their role in plant defense mechanism

UNIT XIII

Growth and differentiation : Hormonal concept of growth and differentiation - Auxins and gibberellins, Cytokinins, ABA and Ethylene -Biosynthesis and Physiological roles - growth regulators and growth retardants, Apical dominance, senescence, fruit growth and abscission

UNIT XIV

Photomorphogenesis and Phytochrome – Phytochrome regulation of morphogenesis – Different types of phytochrome and its biochemical properties.

UNIT XV

Physiology of flowering – photoperiodism – induction and perception of stimulus – classification of plants based on photoperiodic responses – role of phytochrome, Florigen and GA in photoperiodic response – Vernalisation – Vernalisation stimulus – Perception – shoot apex – its importance in flowering

Practical

Radiation energy measurements, Separation and quantification of chlorophylls, Measurement oxygen evolution during photosynthesis, Measurement of respiration rates, Measurement of gas exchange parameters, conductance and photosynthetic rate, Measurement of photorespiration, Estimation of reducing sugars, Estimation of starch, Estimation of Nitrates in the xylem exudates, Estimation of amino acids in the xylem exudates, Quantification of soluble proteins, Bioassays for Auxins & Gibberellins, Bioassays for Cytokinins, Bioassays for ABA, Bioassays for Ethylene, Photoperiodic responses of plants in terms of flowering

Suggested Readings

Kabita Datta 2007. *Plant Physiology*. Mittal Publ.

Hopkins WG & Huner NPA. 2004. *Introduction to Plant Physiology*. John Wiley & Sons.

Salisbury FB & Ross C. 1992. *Plant Physiology*. 4th Ed. Wadsworth Publ.

Srivastava L.M. 2002. *Plant Growth and Development: Hormones and Environment*. Academic Press.

Taiz L & Zeiger E. 2006. *Plant Physiology*. 4th Ed. Sinauer Associates.

Wareing PF & Phillips IDJ. 1981. *Growth and Differentiation in Plants*. 3rd Ed.Pergamon Press.

Wilkins MB. 1969. *Physiology of Plant Growth and Development*. Tata McGraw-Hill.

PP 503 PLANT DEVELOPMENTAL BIOLOGY-PHYSIOLOGICAL AND MOLECULAR BASIS 2+0

Objective

To explain about bsisc physiological and molecular processes concerning various facets of growth and development of plants.

Theory

UNIT I

Plant Biodiversity, Concept of evolution in plants.

UNIT II

General Aspects - Novel features of plant growth and development; Concept of plasticity in plant development; Analysing plant growth

UNIT III

Seed Germination and Seedling Growth - MObilization of food reserves during seed germination; tropisms; hormonal control of seed germination and seedling growth.

UNIT IV

Shoot, Leaf and Root Development - Organization of shoot apical meristem(SAM); Control of cell division and cell to cell communication; Molecular analysis of SAM; Leaf development and differentiation; Organization of root apical meristem(RAM); Root hair and trichome development; Cell fate and lineages.

UNIT V

Floral Induction and Development - Photoperiodism and its significance; Vernalization and hormonal control; Inflorescence and floral determination; Molecular genetics of floral development and floral organ differentiation; Sex determination.

UNIT VI

Seed Development and Dormancy - Embryo and endosperm development; Cell lineages during late embryo development; Molecular and genetic determinants; Seed maturation and dormancy.

UNIT VII

Senescence and Programmed Cell Death (PCD) - Senescence and its regulation; Hormonal and environmental control of senescence; PCD in the life cycle of plnts.

UNIT VIII

Light Control of Plant Development - Discovery of phytochromes and cryptochromes, their structure, biochemical properties and cellular distribution; Molecular mechanisms of light perception, signal transduction and gene regulation; Biological clocks and their genetic and molecular determinants.

UNIT IX

Embryonic Pattern Formation - Maternal gene effects; Zygotic gene effects; Hometic gene effects in Drosophila; Embryogenesis and early pattern formation in plants.

UNIT X

Regeneration and totipotency; Organ differentiation and development; Cell lineages and developmental control genes in maize.

UNIT XI

Special Aspects of Plant Development and Differentiation - Pollen germination and pollen tube guidance; Phloem differentiation; Sex determination in plants;

UNIT XII

Self - incompatibility and its genetic control; Heterosis and apomixis.

Suggested Readings

Kabita Datta 2007, *Plant Physiology,* Mittal Publ.

Srivastava L.M. 2002. *Plant Growth and Development: Hormones and Environment.* Academic Press.

Taiz L & Zeiger E, 2006. *Plant Physiology.* 4th Ed. Sinauer Associates. Wareing PF & Phillips IDJ, 1981. *Growth and Differentiation in Plants.* 3rd Ed. Pergamon Press.

Wilkins MB, 1969, *Physiology of Plant Growth and Development.* Tata McGraw-HIII.

PP 504 PHYSIOLOGICAL AND MOLECULAR RESPONSES OF PLANTS TO ABIOTIC STRESSES 2+1

Objective

To apprise the students regarding abiotic stress to plant and its molecular basis.

Theory

UNIT I

Response of plants to abiotic stresses; Abiotic stresses affecting plant productivity. Basic principles of a crop improvement programme under stress. Interactions between biotic and abiotic stresses.

UNIT II

Drought - characteristic features, Water potential in the soil -Plant air continuum. Development of water deficits, energy balance concept.

UNIT III

Transpiration and its regulation - stomatal functions

UNIT IV

Physiological processes affected by drought, Drought resistance mechanisms: Escape Dehydration postponement (Drought avoidance), Dehydration tolerance and characteristics of resurrectionn plants. Osmotic adjustment, Osmoprotectants, Stress proteins. Water use efficiency as a drought resistant trait.

UNIT V

Molecular responses to water deficit: Stress perception, Expression of regulatory and functional genes and significance of gene products.

UNIT VI

Stress and hormones - ABA as a signaling molecule - Cytokinin as a negative signal. Oxidative stress: Reactive Oxygen Species (ROS). Role of scavenging systems (SOD catalase etc.)

UNIT VII

High temperature stress: Tolerance mechanisms - role of membrane lipids in high temperature tolerance. Functions of HSP's.

UNIT VIII

Chilling stress: Effects on physiological processes. Crucial role of memberane lipids.

UNIT IX

Salinity : Species variation in salt tolerance. Salinity effects at - Cellular and whole plant level, tolerance mechanisms. Salt tolerance in - Glycophytes and halophytes, Breeding for salt resistance.

UNIT X

Heavy metal stress : Aluminium and cadmium toxicity in acid soils. Role of Phytochelatins(heavy metal binding proteins).

Practical

Measurement of water status of plants, determination of osmotic potential by vapour pressure and freezing point depression, Determination of soil water potential and content by psychrometry and other systems. Stress imposition and quantification, Stress - stomatal conductance. Canopy temperature as a reflection of transpiration and root activity, Water use - efficiency, Determination at whole plant and single leaf level, Root - shoot signals - ABA and cytokinin effect on stomatal behavior, Heat tolerance and membrane integrity. Sullivans heat tolerance test, chilling tolerance - Galactolipase and free fatty acid levels as biochemical markers for chilling damage, Cold induced inactivation of O_2 evolution of chloroplasts - as a screening techniques for chilling tolerance.

Suggested Readings

Hopkins WG &Huner NPA, 2004. *Introduction to Plant Physiology,* John Wiley & Sons.

Salisbury FB & Ross C. 1992. Plant Physiology. 4th Ed. Wadsworth Publ.

Taiz L & Zeiger E. 2006. Plant Physiology, 4th Ed. Sinauer Associates.

PP 505 HORMONAL REGULATION OF PLANT GROWTH AND DEVELOPMENT 2+1

Objective

To apprise the students about structure function of plant growth regulator on growth and development of plant.

Theory

UNIT I

Definition and classification of plant growth regulators - Hormones, endogenous growth substances and synthetic chemicals, Endogenous growth regulating substances other than hormones, tricontanol, Phenols - polyamines, jasmonates, concept of death hormone.

UNIT II

Site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth development of individual group of hormones - Auxins, Gibberlins, cytokinins, Abscisic acid and Ethylene Brassinosteroids.

UNIT III

Hormone mutants and transgenic plants in understanding role of hormones.

UNIT IV

Signal perception, transduction and effect at functional gene level of different hormones - Auxins - cell elongation, Gibberellins - germination of dormant seeds, cytokinnis - cell division, Retardation of senescence of plant parts, Abscisic acid - Stomatal closure and induction of drought resistance, Ethylene - fruit ripening.

UNIT V

Interaction of hormones in regulation of plant growth and development processes. Rooting of cuttings - Flowering. Apical dominance, molecular aspects of control of reproductive growth and development.

UNIT VI

Syntheitc growth regulators - Classification, their effect on plant growth and development. Practical utility in agriculture and horticulture.

Practical

Quantification of Hormones - Principles of bioassays, physico chemical techniques and immunoassay, Extraction of hormones from plant tissue. Auxins - bioassays - auxins effect onrooting of cuttings, abscission, apical dominance, Gibberellins - bioassays - GA effect on germination of dormant seeds, cytokinin- bioassays - estimation using immunoassay technique cytokinin effect on apical dormance and senescence, ABA bioassaysestimation using immunoassay technique. ABA effect on somatal movement, Ethylene bioassays, estimation using physico chemical techniques - effect on breaking dormancy in sunflower and groundnut.

Suggested Readings

Hopkins WG & Huner NPA, 2004. *Introduction to Plant Physiology.* John Wiley & Sons.

Salisbury FB & Ross C. 1992. *Plant Physiology.* 4th Ed. Wadsworth Publ. Taiz OL & Zeiger E.2006. *Plant Physiology.* 4th Ed. Sinauer Associates.

PP 506 PHYSIOLOGY OF GROWTH, YIELD AND MODELING 1+1

Objective

To impart knowledge regarding crop growth analysis and different yield prediction models.

Theory

UNIT I

Crop growth analysis, key growth parameters. Analysis of factors limiting crop growth and productivity- the concept of rate limitation

UNIT II

Phenology- Growth stages, internal and external factors influencing flowering. Photoperiodic and thermo-periodic responses and the concept of Degree days and crop growth duration.

UNIT III

Canopy architecture, light interception, energy use efficiency of different canopies. LAI, LAD. concept of optimum LAI.

UNIT IV

Source-sink relationships. Translocation of photosynthates and factors influencing transport of sucrose. Physiological and molecular control of sink activity – partitioning efficiency and harvest index.

UNIT V

Plant growth analysis techniques, yield structure analysis, theoretical and actual yields.

UNIT VI

Plant ideotypes,

UNIT VII

Simple physiological yield models- Duncan's. Monteith's, and Passioura's

UNIT VIII

Crop growth models-empirical models testing and yield prediction.

Practical

Plant sampling for leaf area and biomass estimation; analysis of growth and yield parameters – LAD, NAR. CGR, LAI, LAR, SLA portioning efficiency HI, Measurement of light interception, light extinction coefficient, Energy utilization efficiency based energy intercepted, and realized, Computer applications in plant physiology, Crop productivity and modeling.

Suggested Readings

Gardner FP, Pearce RB & Mitchell RL. 1988. *Physiology of Crop Plants.* Scientific Publ. Goudriaan J & Van Laar HH. 1995. *Modelling Potential Crop Growth*

Processes. (Textbook with Exercises) Series: *Current Issues in Production Ecology.* Vol. II. Kluwer.

Hunt R. *Plant Growth Curve - The Fundamental Approach to Plant Growth Analysis.* Edward Arnold.

John H, Thornley M & Johnson IR. *Plant and Crop Modeling: A Mathematical Approach to Plant and Crop Physiology.* Blackburn Press.

Vos J, Marcelis LFM, Visser PHBD, Struik PC & Evers JB. (Eds.). 2007.

Functional-Structural Plant Modelling in Crop Production. Vol. XXII. Springer.

PP 507 GENOME ORGANIZATION IN HIGHER PLANTS 2+1

Objective

To impart basic concept on genome organization in prokaryotic and eukaryotic system.

Theory

UNIT I

Introduction: Basic discoveries in molecular genetics; basic concepts on genome organization and its replication in prokaryotic systems including cyanobacteria; genome organization in diploids, tetraploids, autoptetraploids and polyploids.

UNIT II

Gene & gene expression: Diversity in DNA polymerases; control of plasmid copy number; Regulation of transcription in prokayotes; Promoters and terminators; Positive and negative control of transcription; Repression and activation-operon concept.

UNIT III

Mitochondrial and chloroplastic genome organization and regulation of gene expression.

UNIT IV

Eukaryotic genome structure: Organization and replication; control of gene expression-transcription and post-transcriptional; promoter analysis; concept of cis elements; transcription factors, function and role of RNA polymerases.

UNIT V

Genetic code and translation-deciphering the genetic code; Codon bias; tRNAs, ribosomes; Initiation and termination of translation; Translational and post-translational controls; Attenuation ; Suppressor tRNAs.

UNIT IV

Mobile genetic elements; Structure and function of transposable elements; Mechanism of transposition; Special features of retroptransposans; Repairand recombination.

Practical

Culturing and transformation of bacteria; genomic DNA and plasmid DNA isolation from bacteria, restriction enzyme digestion and analysis by agarose gel electrophoresis, isolation of genomic DNA and RNA from plants and quantification; Culture of bactriophage; studis on lytic and lysogenic phages.

Suggested Readings

Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith

Roberts & Peter Walter. *Molecular Biology of the Cell.* 3rd Ed. Garland Science.

PP 508 MORPHOGENESIS, TISSUE CULTURE AND TRANSFORMATION 1+1

Objective

To impart knowledge about cellular basic of growth and morphogenesis in plants.

Theory

UNIT I

Morphogenesis: The cellular basis of growth and morphogenesis cytodifferentiation.

UNIT II

The cell cycle-cell division and cell organization, cell structure, tissue and organ differentiation. Control of cell division and differentiation in selected cell types, Introductory history, morphogenesis and cellular totipotency.

UNIT III

Introduction to in vitro methods : Terms and definitions, Use of growth regulators, Beginning of in vitro cultures in our country (ovary and ovule culture , in vitro pollination and fertilization), Embryo culture, embryo rescue after wide hybridization and its application, Endosperm culture and production of triploids.

UNIT IV

Introduction to the processes of embryogenesis and organogenesis and their practical applications : Clonal Multiplication of elite species (micropropagation) – axillary bud, shoot – tip and meristem culture. Haploids and their applications. Somaclonal variations and applications (treasure your exceptions).

UNIT V

Introduction to protoplast isolation : Principles and applications . Testing of viability of isolated protoplast . Various steps in the regeneration of protoplast . Somatic hybridization – an introduction, Various methods for fusing protoplast, chemical and electrical . Use of makers for selection of hybrid cells. Practical applications of somatic hybridization (hybrids vs cybrids)

UNIT VI

Use of plant cells, protoplast and tissue culture for genetic manipulation of plant : Introdiuction to *A. tumefaciens*. Tumour formation on plants using *A. tumefaciens* (Monocots vs Dicots), Root – formation using *A.rhizogenes*

Practical

In vitro culture of different explants such as leaf, stem, shoot apex, cotyledonary nodes; Effect of explant age on propagation potential, Effect of growth regulators auxin, cytokinins and ethlyne on callus induction, organogenesis; Somatic embryogenesis, Effect of growth conditions such as temperature and photoperiod on organogenesis, Single – cell suspension cultures.

Suggested Readings

Bajaj YPS. (Ed.). 1991. *Biotechnology in Agriculture and Forestry*. Vol. XIV. Springer-Verlag.

Rajdan MK. 1993. *Plant Tissue Culture*. Oxford & IBH.

PP 509 PHYSIOLOGY OF CROP PLANTS – SPECIFIC CASE STUDIES 2+0

Objective

To impart knowledge of physiological aspects of different crop plants.

Theory

UNIT I

Crop physiological aspects of rice, wheat, maize, sorghum, millets, sugarcane, pulses, oil seeds, cotton and potato Crops. Six to Eight Species could be chosen based on local importance.

UNIT II

Crop specific topics.

UNIT III

Seed dormancy, photoperiodic and thermoperiodic responses.

UNIT IV

Source-sink relationship, Yield structure and factors influencing yield, Nutrients and other resource requirements and crop specific features.

Suggested Readings

Gardner FP, Pearce RB & Mitchell RL. 1988. *Physiology of Crop Plants.* Scientific Publ.

Pessarakli M. *Handbook of Plant and Crop Physiology.* CRC Press.

Selected reviews and articles from Periodicals and Journals.

PP 510 PHYSIOLOGICAL AND MOLECULAR ASPECTS OF PHOTOSYNTHESIS-CARBON AND NITROGEN ASSIMILATION 1+1

Objective

To impart knowledge about physiological and molecular aspects of carbon reduction cycle and nitrogen assimilation.

Theory

UNIT I

Photosynthesis- its significance in plant growth, development and bio productivity. Gaseous fluxes in atmosphere.

UNIT II

Physiological and biochemical aspects: chloroplast structure development and replication, ultra structure of thylakoids, photo systems, mechanism of light absorption, chloroplast electron transport chain, Coupling factors and mechanisms of ATP synthesis, and concept of quantum yield.

UNIT III

Photosynthetic carbon reduction cycle and its regulation. CO2Concentration Mechanism (CCM) as a complementary strategy for carbon fixation. CCM in photosynthetic bacteria, micro algae, Submerged Aquatic macrophages (SAM), C4, CAM and single celled C4 organisms, C3-C4 intermediates. Ecological significance of CCM.

UNIT IV

Rubisco structure, assembly and kinetics, photorespiration and its significance.

UNIT V

Carbon fluxes between chloroplast and cytoplasm and Carbon fixation as a diffusive process, the concept of ra, rs and rm. Pi recycling, starch and sucrose synthesis and export. Concept of canopy photosynthesis, influence of environmental factors such as water stress, high light stress VPD etc.

UNIT VI

Molecular aspects: chloroplast genome organization, expression and regulation of plastid genes Genes regulating potential traits of photosynthesis, biotechnological approaches for improving photosynthetic rate and productivity – transgenics. Conceptual approaches of expressing C4 photosynthesis genes in C3 species.

UNIT VII

Photosynthesis and crop productivity, energy utilization efficiency by crops. Photo inhibition, photo oxidation, excitation energy dissipation mechanisms, photochemical and no-photochemical quenching of chlorophyll fluorescence. Photosynthesis and transpiration interaction, significance of WUE, carbon isotope discrimination concept.

UNIT VIII

Prospects of improving photo synthetic rate and productivity – potential traits of photosynthesis- biotechnological approaches.

UNIT IX

Nitrogen assimilation in photosynthesizing cells – NO3-, NO2 - reduction, GS-GOGAT pathway. Photorespiration loss of Ammonia and its reassimilation and NUE.

Practical

Extraction and separation of plant pigments, Isolation of chloroplasts ETC reactions- O2 evolution, Determination of rubisco content (western and ELISA), activity and activation state, Enzymatic determination of starch and sucrose, Determination of photosynthetic rates –gas exchange. A, gs, Ci, A/gs, C/gs- intrinsic WUE by gas exchange rates. Light, CO2, VPD response curves, Determination of photorespiration by gas exchange- (TPSAPS). Genotypic/species differences in photosynthetic rates. Measurement of radiation, Eu% light interception, Determination of NH4 +, reduction of inorganic nitrogen species.

Suggested Readings

Edwin Oxlade & Graham Lawler (year). *Plant Physiology: The Structure of Plants Explained.* John Wiley & Sons.

Hopkins WG & Huner NPA.2004. *Introduction to Plant Physiology.* John Wiley & Sons.

Salisbury FB & Ross C.1992. *Plant Physiology.* 4th Ed. Wadsworth Publ.

Taiz L & Zeiger E. 2006. *Plant Physiology.* 4th Ed. Sinauer Associates.

PP 511 MINERAL NUTRITION 2+1

Objective

To impart knowledge about physiological and molecular aspects of carbon reduction cycle and nitrogen assimilation

Theory

UNIT I

Overview of essential mineral elements, kinetics of nutrient uptake by plants. Biological actions influencing nutrient availability near the root system.

UNIT II

Nutrient uptake by root cells, long distance transport in plants and movement into developing grains. Nutrient transport from vegetative to reproductive organs during reproductive stage of growth and maturity.

UNIT III

Molecular mechanism of ion uptake, ion transporters, specific examples of transporters for Nitrate, Phosphate, Potassium and other nutrients. Multiple transporters for a single ion and their functional regulation.

UNIT IV

Molecular physiology of micronutrient acquisition. Examples of genes encoding mineral ion transporters. Strategies plants adopt to acquire and transport minerals under deficient levels.

UNIT V

Physiological and molecular mechanisms underlying differential nutrient efficiency in crop genotypes, Examples of Phosphorous, Iron and Zinc efficient crop varieties.

UNIT VI

Breeding crop varieties for improved nutrient efficiency. Plant responses to mineral toxicity.

Practical

Physiological and biochemical changes in plants under nutrient sufficiency and deficiency levels. Quantification of pigment levels, enzyme activities.

Suggested Readings

Barker AB & Pilbeam DJ. 2007. *Handbook of Plant Nutrition.* CRC

Epstein E. 2007. *Mineral Nutrition of Plants.* John Wiley & Sons.

Marschner H. 1995. *Mineral Nutrition of Higher Plants.* Academic Press.

Press.

PP 601 FUNCTIONAL GENOMICS AND GENES ASSOCIATED WITH A FEW PHYSIOLOGICAL PROCESSES 2+0

Objective

To impart knowledge about physiological process of plant at molecular level.

Theory

UNIT I

Gene discovery: Finding Genes in Complex Plant System, Constructing Gene-Enriched Plant Genomic Libraries, In Silico Prediction of plant Gene Function, Quantitative Trait Locus Analysis as a Gene Discovery Tool.

UNIT II

Genetic tools for plant development- Understanding the importance of mutants in unraveling the physiological processes – T-DNA insertion mutants, Gain in function, Transposon mutagens, Transposition, Physical and Chemical mutagenesis, Gene and Enhancer Traps for Gene Discovery, High-Throughput TAIL-PCR as a Tool to identify DNA Flanking insertions, High-Throughput TILLING for functional Genomics.

UNIT III

Gene knock out approaches: Antisense technology, Virus induced gene silencing (VIGS), Custom Knock-outs with Haripin RNA-mediated Gene Silencing and other silencing tools, Complementation studies, DNA micro arrays.

UNIT IV

Gene Over expression approaches: Vector Construction for Gene Overexpression as a Tool to Elucidate Gene Function; Transient expression, Transgenics.

UNIT VI

Proteomics: Networking of Biotechnology for interpreting gene functions. Yeast two hybrid systems to study protein –protein interaction to study gene functions, Proteomics as a Functional Genomics Tool, Crystallographic and NMR approaches to determine protein structures.

UNIT VII

Functional characterization of genes associated with important cellular processes influencing crop growth and development.

UNIT VIII

Case studies of genes controlling photosynthesis, respiration, photorespiration, fatty acid biosynthesis, nutrient uptake, flowering, seed protein quality and quantity.

Suggested Readings

Selected articles from various journals

PP 602 SIGNAL PERCEPTIONS AND TRANSDUCTION AND REGULATION OF PHYSIOLOGICAL PROCESSES 2+0

Objective

To impart the knowledge about signal ling of hormones and regulation of physiological processes.

Theory

UNIT I

General aspects: Introduction to signaling-Long range (Diffusible) signaling and short range (contact) signaling. Components of signaling- Upstream components: receptor and ligands concept-types of ligands and its relevance-receptor kinases-Two component sensing system. Down stream components: G. proteins-second messengers-Cyclic AMP, adenylate cyclase cascade, cyclic GMP, calcium-calmodulin-Kinases-Effector molecules (transcription factor).

UNIT II

Hormone signaling: Hormone binding receptors-Transduction process. Effector molecules and gene expression.

UNIT III

Specific signaling pathways of Auxins, Cytokinisn, Gibberllins, Ethylene, ABA, Brassinosteroids which leads to formative effects. The cross talk in the signaling of different hormones-significance of studies with hormone action mutants.

UNIT IV

Light signaling: Perception of light-pigments involved-activation of phytochrome/ cryptochrome (study of mutants). Light signal transduction- Multiple signaling cascades-identification of signaling components through mutant analysis-changes in gene expression.

UNIT V

Abiotic stress signaling: Sensing of environmental factors (Temperature- Osmoticum-Ionic stress) Activation of specific molecules and secondary messengers-Activation of Down stream components-leading to stress gene expression. Case studies with different abiotic stresses.

UNIT VI

Cross talk between signaling pathways.

UNIT VII

Signal perception and transduction in plant defense responses: Role of salicylic acid and active oxygen species.

UNIT VIII

Signaling cascade during leaf senescence, abscission, flowering and tuberisation

UNIT IX

Transcription factor as signaling regulatory tools for improving growth processes-Case studies: Tbi- lateral branch development, Shi 4- grain shattering, GA1- Dwarfing.MADS, KNOX- flowering development, HAT 4- Shade development, AP2-EREBP- biotic/abiotic stresses.

Suggested Readings

Selected articles from various journals.

PP 603 MOLECULAR APPROACHES FOR IMPROVING PHYSIOLOGICAL TRAITS 2+1

Objective

To impart knowledge to improve the physiological traits using molecular approaches.

Theory

UNIT I

Importance of Molecular Breeding for complex multi-gene controlled physiological traits and its relevance in augmenting trait based breeding. Physiological traits with relevance to

growth, development, abiotic stress tolerance, nutrient acquisition, Approaches for accurate phenotyping of large germplasm accessions and/or mapping populations.

UNIT II

The advantages of "Trait based" breeding approaches. Concept of segregation, independent assortment and linkage. The concept of molecular markers, various types of Dominant and Co-dominant marker systems.

UNIT III

Relevance and development of mapping populations and genetic analysis using marker systems. Advantages of association mapping and the concept of linkage, LD decay and population structure.

UNIT IV

Statistical analysis to assess the variance in phenotypic traits and molecular data. Assessment of genetic parameters such as heritability, genetic advance etc.

UNIT V

Strategies for QTL introgression and Marker Assisted Selection (MAS). Map based cloning of novel genes and alleles. Allele mining

UNIT VI

Transgenic approach in improving physiological processes- Introduction to GMOs and application in crop improvement; gene mining, sequence structure & function analysis using bioinformatics tools, identification of candidate genes for various physiological process associated with specific traits (such as stress tolerance) and their potential benefits in transgenic crops.

UNIT VII

Cloning full-length candidate genes, stress inducible promoters, strategies to clone and characterize and make constructs for specific crops, gene stacking strategies, tissue specific expression and functional validation of genes.

UNIT VIII

Transformation of crop plants-*Agrobacterium* and use of other organisms for transformation-particle gun transformation and other methods.

UNIT IX

Selection of transformants- molecular analysis on the basis of qRT-PCR, Southern, Northern analysis and immunoassays; estimation of copy number. Concept of desirable number of independent events.

UNIT X

Evaluation of transgenics on basis of empirical/physiological/biochemical process under specific conditions on the basis of gene function. Generation of T1 populations, event characterization and generation of molecular data as per the regulatory requirements.

UNIT XI

Issues related to Biosafety and Registration of Transgenic Agricultural Organisms, methods to detect GMOs from agricultural products.

Practical

Phenotyping approaches for the different physiological traits. Genotyping options using gene-scan systems. Development of SSR, SNP and SCAR markers, resolution of polymorphism on agarose gels and PAGE, genotyping using a DNA sequencing machine, scoring of gels and assessment of polymorphism, Statistical approaches to assess genetic variability, heritability and other parameters, Phylogenic analysis, Principal component analysis and construction of dendrograms. Construction of Linkage map, QTL maps, population structure, LD decay etc leading to identification of QTLs, Bioinformatics – sequence analysis, structure analysis, Molecular biology - genomic/plasmid DNA isolation, RNA isolation. Full-length gene cloning, vector construction with specific promoter, gene stacking & transient assays. Transformation in model system,Crop transformation - *Agrobacterium* mediated transformation (inplanta & invitro), particle-gun transformation, Evaluation of transgenics – semiquantitative & quantitative RT-PCR, southern blot, northern blot, western blot and ELISA, biochemical/physiological assay based on the function of gene & testing LOD.

Suggested Readings

Selected articles from various journals.

PP 604 TECHNIQUES IN PLANT PHYSIOLOGY 0+2

Objective

To impart recent practical training to study various physiological processes in plants.

Practical

Photosynthetic gas exchange measurements, light and CO2 response curves-determination of relative limitations to photosynthesis; chlorophyll fluorescence measurements. Estimation of water use efficiency at whole plant and single leaf level. Use of stable and radioactive isotopes to understand physiological processes. DNA & RNA isolation, cDNA synthesis & library construction, semiquantitative & quantitative RT-PCR, northern blot, immunoassays; techniques for defined physiological processes, Quantification of mineral nutrients using advanced instruments like AAS.

Suggested Readings

Dhopte MA & Manuael Livera M. 1986. *Useful Techniques for Plant Scientists*. Forum for Plant Physiologists, R. D. G., Aloka.

PP 605 CLIMATE CHANGE AND CROP GROWTH 2+0

Objective

To impart knowledge about climate change and its implication to crop growth.

Theory

UNIT I

History and evidences of climate change and its implications. Effect of climate change on monsoons, hydrological cycle and water availability.

UNIT II

Natural and anthropogenic activities and agricultural practices on GHG production, Monitoring of greenhouse gases and their influence on global warming and climate change, Ozone depletion leading to increased ionizing radiations and its implications on crop growth.

UNIT III

Long-term and short-term projections of climate change effects on natural vegetations and ecosystems, crop-pest interaction, area shift, food production and supply.

UNIT IV

Approaches to mitigate climate change through studies on plant responses.

UNIT V

Direct and indirect effects of climate change on plant processes – phenology, net carbon assimilation, water relations, grain development and quality, nutrient acquisition and yield.

UNIT VI

Conventional and biotechnological approaches to improve the crop adaptation to climate change. Relevance of "Genome wide mutants" to identify genes/processes for improved adaptation to changing environments

UNIT VII

International conventions and global initiatives on Carbon sequestration, carbon trading.

Suggested Readings

Abrol YP & Gadgil S. (Eds.). 1999. *Rice in a Changing Climate.*

Reddy KR & Hodges HF. 2000. *Climate Change and Global Crop Productivity.* CABI.

Watson RT, Zinyowera MC & Moss RH. 1998. *The Regional Impacts of Climate Change - an Assessment of Vulnerability.* Cambridge Univ. Press.

PP 606 POST - HARVEST PHYSIOLOGY 2+0

Objective

To impart knowledge about physiological changes during senescence and ripening.

Theory

UNIT I

Environmental factors influencing senescence, ripening and post harvest life of flowers, vegetables and seeds.

UNIT II

Molecular mechanism of senescence and ageing. Physiological, biochemical and molecular aspects of senescence and fruit ripening.

UNIT III

Senescence associated genes and gene products.

UNIT IV

Functional and ultrastructural changes in chloroplast membranes, mitochondria and cell wall during senescence and ripening.

UNIT V

Regulatory role of ethylene in senescence and ripening, ethylene biosynthesis, perception and molecular mechanism of action.

UNIT VI

Post harvest changes in seed and tubers biochemical constituent's quality parameters. Effect of environmental factors on post harvest changes in seed and tubers.

UNIT VII

Biotechnological approaches to manipulate ethylene biosynthesis and action.

UNIT VIII

Alternate post harvest methodology and quality attributes. Scope for genetic modification of post harvest life of flowers and fruits.

UNIT IX

Uses of GM crops and ecological risk assessment.

Suggested Readings

Jeffrey K Brecht & Weichmann J. 2003. *Post Harvest Physiology and Pathology of Vegetables.* CRC Press.

PP 607 WEED PHYSIOLOGY AND HERBICIDE ACTION 1+1

Objective

To apprise students regarding weed and crop competition, and physiological and molecular aspects of herbicides.

Theory

UNIT I

Weed biology, ecology and physiology. Weed and crop competition, allelochemicals, their nature and impact. Weed-seed physiology.

UNIT II

Classification of herbicides and selectivity. Recent concepts on entry, uptake, translocation and metabolism of soil and foliar applied herbicides.Environmental and plant factors influencing entry, uptake and translocation of herbicides.

UNIT III

Classification and chemistry of common herbicides. Physiological, biochemical and molecular mechanism of action of different groups of herbicides; ACC synthase inhibitors, ALS inhibitors, Mitotic inhibitors, Cellulose biosynthesis inhibitors, Inhibitors of fatty acid biosynthesis, inhibitors of Photosynthesis, Auxinic Herbicides, New herbicides,

UNIT IV

Metabolic pathway of herbicide degradation in plants and soil. Herbicide adjuvants and their classification.

UNIT V

Molecular mechanism of action of herbicide synergists and antagonists.

UNIT VI

Physiological and molecular mechanism of herbicide selectivity.

UNIT VII

Herbicide resistant crops; transgenic & tissue culture approaches to develop herbicide tolerant varieties

Practical

Adjuvants and their effect on spray droplets, chemical entry and transport. Determination of physiological and biochemical processes like photosynthesis, respiration, cell division, Protein & fatty acid synthesis, membrane permeability as affected by herbicides. Quantification of pigment levels in leaves, specific enzyme activities affected by herbicides. Demonstration of translocating type of herbicides by radio labeling studies.

Suggested Readings

Devine MD, Duke SO & Fedtake C. 1993. *Physiology of Herbicide Action.* Prentice Hall.

Monaco TJ, Weller SC & Ashton FM. 2002. *Weed Science - Principles and Practices.* Wiley.com Publ.

PP 608 SEED PHYSIOLOGY 2+1

Objective

To apprise students regarding seed germination, dormancy and physiological processes involved in regulation of seed development

Theory

UNIT I

Seed and fruit development, seed and fruit abortion, proximate mechanism of seed and fruit abortion. Hereditary and environmental effect on seed development. Gene imprints and seed development.

UNIT II

Importance of seeds, seed structure and function, physiological and biochemical changes, environmental influences, physiology of seed and fruit development; seed and fruit abortion and means to overcome it; proximate mechanisms of seed and fruit abortion.

UNIT III

Structure of seeds and their storage resources, seed developmental patterns and source of assimilates for seed development.

UNIT IV

Pathway of movement of assimilates in developing grains of monocots and dicots, Chemical composition of seeds, Storage of carbohydrates, proteins and fats in seeds and their biosynthesis.

UNIT V

Seed respiration, mitochondrial activity, Seed ageing, Mobilization of stored resource in seeds, Chemistry of oxidation of starch, proteins and fats, Utilization of breakdown products by embryonic axis.

UNIT VI

Control processes in mobilization of stored resources, Role of embryonic axes, Gibberllin and a-amylase and other hydrolytic activity. Seed maturation phase and desiccation damage, Role of LEA proteins.

UNIT VII

Seed viability, Physiology of and means to prolong seed viability, Seed vigour: concept, importance, measurement; invigoration: methods and physiological basis of it, Seed dormancy, types and regulation, Means to overcome seed dormancy.

Practical

Determination of seed storage proteins, Sink drawing ability of ovules, empty ovule technique, Alpha-amylase activity in germinating seeds, Role of GA in inducing amylase activity, Role of embryo in GA induced aamylase activity, Protease and lipase activity in germinating seeds, Seed viability test and accelerated ageing test. Seed hardening/osmotic priming of seeds, Seed respiration rates, Seed viability losses through membrane leakage studies.

Suggested Readings

Bewley JD & Black M. 1985. *Seed Physiology of Development and Germination.* Plenum Publ.

Copeland LO & McDonald MB. *Principles of Seed Sciences and Technology.* Burgers Publ. Co.

Srivastav L M. Plant Growth and Development - Hormones and Environment, Academic Press.

List of Journals

American Journal of Botany

Annals of Arid Zone

Annual Review of Plant Physiology and Plant Molecular Biology

Australian Journal of Agricultural Research

Australian Journal of Biological Sciences

Australian Journal of Botany

Australian Journal of Plant Physiology

Biochemie und Physiologie der Pflanzen

Processing and after processing for seed law enforcement; Testing physical purity, Germination and moisture; Specifications for tags and labels to be used for certification purpose; Grow-out tests for pre and post-harvest quality control; Visits to regulatory seed testing laboratory, Including plant quarantine lab and seed certification agency.

Suggested Readings

Agarwal RL. 1997. *Seed Technology.* Oxford & IBH.

Anonymous 1992. *Legislation on Seeds.* NSC Ltd., Department of Agriculture and Cooperation, Ministry of Agriculture, New Delhi.

Nema NP. 1986. *Principles of Seed Certification and Testing.* Allied Publs.

Ramamoorthy K, Sivasubramaniam K and Th.A. Kannan 2006. *Seed Legislation in India.* Agrobios, Jodhpur.

Tunwar NS & Singh SN. 1988. *Indian Minimum Seed Certification Standards.* CSCB, Ministry of Agriculture, New Delhi.

SST 507 SEED PROCESSING AND STORAGE 2+1

Objective

To impart knowledge on the principles and techniques of seed processing for quality upgradation and of storage for maintenance of seed quality.

Theory

UNIT I

Introduction: Principles of seed processing; methods of seed drying including dehumidification and its impact on seed quality. Relative humidity and equilibrium moisture content of seed; Thumb rules of seed storage; loss of viability in important agricultural and horticultural crops, viability equations and application of nomograph.

UNIT II

Seed cleaning equipment and their functions: Preparing seed for processing; functions of scalper debearder, scarifier, huller, seed cleaner and grader. Screen cleaners, specific gravity separator, indented cylinder, velvet-spiral-disc separators, colour sorter, delinting machines; seed blending.

UNIT III

Assembly line of processing and storage, receiving, elevating and conveying equipments, plant design and layout, requirements and economic feasibility of seed processing plant.

UNIT IV

Seed treatments-methods of seed treatment, seed treating formulations and equipments, seed disinfestations, identification of treated seeds; Packaging: principles, practices and materials; bagging and labeling.

UNIT V

Seed storage: Seed drying and storage; drying methods-importance and factors affecting it, changes during storage, concepts and significance of moisture equilibrium, methods of

maintaining safe seed moisture content. Methods to minimize the loss of seed vigour and viability; factors influencing storage losses. Storage methods and godown sanitation. Storage structures- Designing of seed storage structures, Storage problems of recalcitrant seeds and their conservation.

Practical

Operation and handling of mechanical drying equipments; Effect of drying temperature and duration on seed germination and storability with particular reference to oil seeds; Seed extraction methods; Seed processing equipments; Seed treating equipments; Visit to seed processing plant and commercial controlled and uncontrolled Seed Stores;. Seed quality upgradation; Measurement of processing efficiency; Seed blending, Bag closures; Study of orthodox, Intermediary and recalcitrant seeds; Evaluating seed viability at different RH and temperature levels and packaging materials; Prediction of storability by accelerated ageing controlled deterioration tests.

Suggested Readings

Agrawal RL. 1996. *Seed Technology*. Oxford Publ.

Barton LV. 1985. *Seed Preservation and Longevity*. International Books and Periodicals Supply Service, New Delhi.

Hall CW. 1966. *Drying of Farms Crops*. Lyall Book Depot.

Justice OL & Bass LN. 1978. *Principles and Practices of Seed Storage*. Castle House Publ. Ltd.

Mathews RK, Welch GB, Delouche JC & Dougherty GM. 1969. *Drying, Processing and Storage of Corn seed in Tropical and Subtropical Regions*. Proc. Am. Agric. Eng. St. Joseph, Mich. Paper No. 69-67.

Sahay KM & Singh K.K. 1991. Unit Operations in Food Engineering. Vikas Publ.

Virdi SS & Gregg BG. 1970. *Principles of Seed Processing*. National Seed Corp., New Delhi.

SST 508 SEED QUALITY TESTING 2+1

Objective

To provide a comprehensive knowledge on all aspects of seed quality evaluation and their relevance to crop performance.

Theory

UNIT I

Introduction: Structure of monocot and dicot seeds; seed quality: objectives, concept and components and their role in seed quality control; instruments, devices and tools used in seed testing. National and international organizations in seed testing; ISTA and its role in seed testing.

UNIT II

Seed Sampling: definition, objectives, seed-lot and its size; types of samples; sampling devices; procedure of seed sampling; sampling intensity; methods of preparing composite and submitted samples; sub-sampling techniques, dispatch, receipt and registration of submitted sample in the laboratory, sampling in the seed testing laboratory.

UNIT III

Physical Purity: definition, objective and procedure, weight of working samples for physical purity analysis; components of purity analysis and their definitions and criteria; pure seed definitions applicable to specific genera and families; multiple seed units; general procedure of purity analysis; calculation and reporting of results, prescribed seed purity standards; determination of huskless seeds; determination of weed seed and other seed by number per kilogram; determination of other distinguishable varieties (ODV); determination of test weight and application of heterogeneity test.

UNIT IV

Seed moisture content: importance of moisture content; equilibrium moisture content; principles and methods of moisture estimation - types, instruments and devices used; pre-drying and grinding requirements, procedural steps in moisture estimation; calculation and reporting of results.

UNIT V

Germination: importance; definitions; requirements for germination, instrument and substrata required; principle and methods of seed germination testing; working sample and choice of method; general procedure for each type of method; duration of test; seedling evaluation; calculation and reporting of results; dormancy: definition, importance, causal mechanisms, types and methods for breaking dormancy.

UNIT VI

Viability and Vigour Testing: definition and importance of viability tests-different viability tests; quick viability test (TZ- test) - advantages, principle, preparation of seeds and solutions, procedure, evaluation and calculation of test results. Vigour testing: concept, historical development, definitions, principles and procedures of different methods used for testing vigour.

UNIT VII

Genetic purity testing : objective and criteria for genetic purity testing; types of test-laboratory, Growth Chamber and field testing based on seed , seedling and mature plant morphology; principles and procedures of chemical, biochemical and molecular tests.

UNIT VIII

Seed health Testing: field and seed standards; designated diseases, objectionable weeds - significance of seed borne disease vis-a-vis seed quality - seed health testing and detection methods for seed borne fungi, bacteria, viruses and nematodes. Important storage pests, their identification, monitoring and detection.

UNIT VIII

Testing of pelleted and coated seeds; Testing of GM seeds and trait purity, load of detection (LOD).

UNIT X

Preparation and dispatch of seed testing reports; storage of guard samples; application and use of seed standards and tolerances.

Practical

Structure of monocot and dicot seeds of important plant species; Identification and handling of instruments used in seed testing laboratory; Identification of seeds of weeds and crops; Physical purity analysis of samples of different crops; Estimation of seed moisture content (oven method);

Seed dormancy breaking methods requirements for conducting germination test, Specifications and proper use of different substrata for germination; Seed germination testing in different agri-horticultural crops; seedling evaluation; Viability testing by tetrazolium test in different crops; Seed and seedling vigour tests applicable in various crops; Species & cultivar identification; Genetic purity testing by chemical, Biochemical and molecular methods; Seed health testing for designated diseases, Blotter methods, Agar method and embryo count methods; Pest damage evaluation; Testing coated/pelleted seeds.

Suggested Readings

Agarwal RL. 1997. *Seed Technology*. Oxford & IBH.

Agrawal PK & Dadlani M.1992. *Techniques in Seed Science and Technology*. 2nd Ed. South Asian Publ.

Agrawal PK. (Ed.). 1993. *Handbook of Seed Testing*. Ministry of Agriculture, GOI, New Delhi.

Copland LO & McDonald MB. 1996. *Principles of Seed Science and Technology*.

Kluwer. ISTA 2006. *Seed Testing Manual*. ISTA, Switzerland.

Karuna V. 2007 *Seed Health Testing* Kalyani.

Martin C & Barkley D. 1961. *Seed Identification Manual*. Oxford & IBH.

Tunwar NS & Singh SV. 1988. *Indian Minimum Seed Certification Standards*. Central Seed Certification Board, Ministry of Agriculture, New Delhi.

SST 509 **SEED PHYSIOLOGY** **2+1**

Objective

To provide an insight into physiological processes governing seed quality and its survival.

Theory

UNIT I

Physiology of seed development and maturation; chemical composition, synthesis and accumulation of seed reserves, induction of desiccation tolerance, hormonal regulation of seed development.

UNIT II

Seed germination; factors affecting germination-role of embryonic axis; growth hormones and enzyme activities, effect of age, size and position of seed on germination. Physiological processes during seed germination; seed respiration, breakdown of stored reserves in seeds, mobilization and interconversion pathways. Seed dormancy- types, significance, mechanism, endogenous and exogenous factors regulating dormancy, role of phytochrome and PGR, genetic control of dormancy.

UNIT III

Seed viability and longevity, pre and post-harvest factors affecting seed viability; seed ageing; physiology of seed deterioration ; lipid peroxidation and other viability theories; means to prolong seed viability; mechanism of desiccation sensitivity and recalcitrance with respect to seed longevity.

UNIT IV

Seed vigour and its concept, vigour test methods, factors affecting seed vigour, physiological basis of seed vigour in relation to crop performance and yield. Seed invigoration and its physiological and molecular control.

Practical

Proximate analysis of chemical composition of seed; Methods of testing viability; kinetics of seed imbibition and solute leakage; seed germination and dormancy breaking methods; seed invigoration and priming treatments; accelerated ageing and controlled deterioration tests; enzymatic activities and respiration during germination and effect of accelerated ageing; vigour testing methods etc.

Suggested Readings

Agrawal PK & Dadlani M. (Eds.). 1992. *Techniques in Seed Science and Technology*. South Asian Publ.

Baskin CC & Baskin JM. 1998. *Seeds: Ecology, Biogeography and Evolution of Dormancy and Germination*. Academic Press.

Basra AS. 2006. *Handbook of Seed Science and Technology*. Food Product Press.

Bench ALR & Sanchez RA. 2004. *Handbook of Seed Physiology*. Food Product Press.

Bewley JD & Black M. 1982. *Physiology and Biochemistry of Seeds in Relation to germination*. Vols. I, II. Springer Verlag.

Bewley JD & Black M. 1985. *Seed: Physiology of Seed Development and Germination*. Plenum Press.

Copeland LO & Mc Donald MB. 1995. *Principles of Seed Science and Technology*. 3rd Ed. Chapman & Hall.

Khan AA. 1977. *Physiology and Biochemistry of Seed Dormancy and Germination*. North Holland Co.

Kigel J & Galili G. (Eds.). *Seed Development and Germination*.

Marcel Dekker. Murray DR. 1984. *Seed Physiology*. Vols. I, II. Academic Press.

Sadasivam S & Manickam A. 1996. *Biochemical Methods*. 2nd Ed. New Age.

SST 510 SEED PATHOLOGY 2+1

Objective

To acquaint the students with principles and practices of seed health testing and management of seed borne diseases.

Theory

UNIT I

History and economic importance of seed pathology in seed industry and plant quarantine; terminology, important seed transmitted pathogens; seed microbes and their mode of action, detection techniques and identification of common seed borne pathogens.