PG Degree Programme Syllabus as per BSMA, ICAR

M.Sc. (Agri.) Plant Pathology

M.S. Swaminathan School of Agriculture
Centurion University of Technology and Management
Alluri Nagar, P.O. - R Sitapur, Via- Uppalada, Paralakhemundi
Dist: Gajapati – 761211
Odisha, India
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Preamble

Plant pathology as a discipline of agricultural science has played pivotal role over the years in understanding plant diseases and in mitigating losses through cultural and technological innovations. This is despite the disease scenarios that kept on evolving and changing due to biotic, abiotic and edaphic factors. The Plant Pathologists have eventually contributed significantly towards food security and in ameliorating the livelihood of farmers across the globe. The science of plant pathology has been an innovative and ever emerging discipline in its scope, importance and technologies. There have been many such innovations and advancements in each and every aspect of plant pathology starting from the identification of the pathogen, underlining the molecular mechanism of pathogenicity and resistance and also the management strategies. With the commencement of the concept of sustainable agriculture, plant disease management has become more important and has shifted from the traditional chemical based to more eco-friendly integrated disease management strategies with more focus on the biocontrol and other green technologies. The latest innovations in the field of detection and diagnosis, host resistance, disease forecasting and plant biotechnology have helped us in better management of the diseases but challenges are still many more.

Hence, it is very much essential to revise the course curriculum of Plant Pathology so that students' even teachers may be well acquainted with the present concept of development of the discipline. This will help bringing competency in students along with confidence so as to develop himself/herself or being tackling field problems and management of land. The existing M.Sc. (Ag) courses of Plant Pathology have been modified taking into account of present day need by incorporating the necessary and important topics in the respective courses.

The new look and restructured PG programme in Plant Pathology has been designed in considerations based on: demands of private sector harnessing commercial aspects, modern research tools and their applications, supplementary skills required, and to enhance the global competitiveness and employability of our students. Considerable efforts have, therefore, gone in for the preparation of this final document. While the restructured programme retains the classical contents of the subjects e.g., symptomatology, etiology, epidemiology and management of plant diseases, the current issues and modern approaches have been given new thrust. Some of the salient features of the revised curriculum are – application of biotechnological tools in systematics and breeding of disease resistant crop cultivars and biological control; and to alleviate post-harvest losses. Certification of planting material has gained utmost importance in the wake of global trade regimes, therefore, a full course on *Principles and Procedures of Certification* is proposed. A list of relevant and latest books has been provided for each course. Commonly used journals and web-sites pertaining to the three subjects have been added for the benefit of students. Some contemporary broad suggestive research topics are also listed for each subject to facilitate the students and their supervisors in the selection of appropriate topics for theses/dissertations

Content

Framework of the courses

The following nomenclature and credit hours need to be followed while providing thesyllabus for all disciplines

Course work	M.Sc. (Agri.) Credits
Major Courses	20
Minor Courses	08
Supporting Courses	06
Common compulsory courses	05
Seminar	01
Thesis/Research	30
Total	**70**

M.Sc. (Agri.) Plant Pathology

Course Code	Course title	Credit	Page No.
Major Courses			
PATH 0501*	Mycology	2+1	6
PATH 0502*	Plant Virology	2+1	7
PATH 0503*	Plant Pathogenic Prokaryotes	2+1	8
PATH 0504*	Plant Nematology	2+1	10
PATH 0505*	Principles of Plant Pathology	2+1	11
PATH 0506*	Techniques in Detection and Diagnosis of Plant Diseases	0+2	12
PATH 0507	Principles of Plant Disease Management	2+1	13
PATH 0508	Epidemiology and Forecasting of Plant Diseases	1+0	14
PATH 0509	Disease Resistance in Plants	2+0	15
PATH 0510	Ecology of Soil-Borne Plant Pathogens	1+1	15
PATH 0511	Chemicals and Botanicals in Plant Disease Management	2+1	16
PATH 0512	Detection and Management of Seed Borne Pathogens	2+1	18

PATH 0513	Biological Control of Plant Diseases	1+1	19
PATH 0514	Integrated Disease Management	2+1	20
PATH 0515*	Diseases Of Field and Medicinal Crops	2+1	20
PATH 0516	Diseases Of Fruits, Plantation and Ornamental Crops	2+1	21
PATH 0517	Diseases of Vegetable and Spices Crops	2+1	22
PATH 0518	Post-Harvest Diseases	2+1	23
PATH 0519	Plant Quarantine and Regulatory Measures	1+0	24
PATH 0591	Master's Seminar	0+1	--
PATH 0521	Master's Research	0+30	--
Minor Courses			
ENTO 0504	Insect Ecology	2+1	25
ENTO 0505	Biological Control of Insect Pests and Weeds	2+1	27
ENTO 0507	Host Plant Resistance	1 + 1	28
ENTO 0508	Concept of Integrated Pest Management	2+0	29
ENTO 0509	Pests of Field Crops	2+0	30
ENTO 0510	Pests of Horticultural and Plantation Crops	2+1	31
Supporting Courses			
STAT 0511	Experimental Designs	2+1	32
MMBB 0505	Techniques in Molecular Biology -II	0+3	33
STAT 0502	Statistical Methods for Applied Sciences	3+1	34
STAT 0531	Data Analysis Using Statistical Packages	2+1	36
MMCA 0512	Information Technology in Agriculture	1+1	37
BIOC0505	Techniques In Biochemistry	0+3	38
Common Courses			
PGSS 0501	Library and Information Services	0+1	39
PGSS 0502	Technical Writing and Communications Skills	0+1	40
PGSS 0503	Intellectual Property and its Management in Agriculture	1+0	40
PGSS 0504	Basic Concepts in Laboratory Techniques	0+1	41
PGSS 0505	Agricultural Research, Research Ethics and Rural Development Programmes	1+0	41

***Indicates course which is compulsory for M.Sc. (Agri.)**

M.Sc. (Agri.) Plant Pathology

MAJOR COURSES

Course Code: PATH 0501
Credit Hours: 2+1
Course Title: Mycology

Objective: To study the nomenclature, classification and characters of fungi

Theory
UNIT I
Introduction, definition of different terms, basic concepts. Importance of mycology in agriculture,relation of fungi to human affairs. History of mycology. Importance of culture collection and herbarium of fungi. Somatic characters and reproduction in fungi. Modern concept of nomenclature and classification, Classification of kingdom fungi: Stramenopila and Protists.

UNIT II
The general characteristics of protists and life cycle in the Phyla Plasmodiophoromycota, Dictyosteliomycota, Acrasiomycota and Myxomycota. Kingdom Stramenopila: characters and life cycles of respective genera under Hypochytriomycota, Oomycota and Labyrinthulomycota.

UNIT III
Kingdom fungi: General characters, ultrastructure and life cycle patterns in representative genera under Chytridiomycota, Zygomycota, Ascomycota; Archiascomycetes, Ascomycetous yeasts, Pyrenomycetes, Plectomycetes, Discomycetes, Loculoascomycetes, Erysiphales and anamorphs of ascomycetous fungi.

UNIT IV
Basidiomycota; general characters, mode of reproduction, types of basidiocarps and economic importance of Hymenomycetes. Uridinales and Ustilaginales; variability, hostspecificity and life cycle pattern in rusts and smuts. Mitosporic fungi; status of asexual fungi, their teliomorphic relationships,Molecular characterization of plant pathogenic fungi.

Practical
- Detailed comparative study of different groups of fungi;
- Collection of cultures and live specimens.Saccardoan classification and classification based on conidiogenesis.
- Vegetative structures and different types of fruiting bodies produced by slime molds, stramenopiles and true fungi.
- Myxomycotina: Fructification, plasmodiocarp, sporangia, plasmodium and aethalia. Oomycota; somatic and reproductory structures of *Pythium*, *Phytophthora*, downy mildews and Albugo,
- Zygomycetes: Sexual and asexual structures of *Mucor*, *Rhizopus*,General characters of VAM fungi.

- Ascomycetes; fruiting structures, Erysiphales, and Eurotiales; general identification characters of Pyrenomycetes, Discomycetes, Loculoascomycetes and Laboulbeniomycetes
- Basidiomycetes; characters, ultrastructures and life cycle patterns in Ustilaginomycetes and Teliomycetes,
- Deuteromycetes; characters of Hyphomycetes and Coelomycetes and their teliomorphic and anamorphic states, Collection,
- Preservation, culturing and identification of plant parasitic fungi. Application of molecular approaches and techniques foridentification of fungal pathogens.

Suggested Reading

Ainsworth GC, Sparrow FK &Susman HS. 1973. *The Fungi – An Advanced Treatise*. Vol.IV A & B). Academic Press, New York. Alexopoulos CJ, Mims CW & Blackwell M. 2000. *Introductory Mycology.* 5th Ed. John Wiley & Sons, New York.
Maheshwari R 2016. *Fungi: Experimental Methods in Biology* 2nd edn. CRC Press, US. Mehrotra RS & Arneja KR. 1990. *An Introductory Mycology*. Wiley Eastern, New Delhi. Sarbhoy AK. 2000. *Text book of Mycology*. ICAR, New Delhi. Singh RS. 1982. *Plant Pathogens – The Fungi*. Oxford & IBH, New Delhi
Webster J. 1980. *Introduction to Fungi*. 2nd Ed. Cambridge Univ. Press, Cambridge, New York

Course Code: PATH 0502
Credit Hours: 2+1
Course Title: Plant Virology

Objective: To acquaint with the structure, virus- vector relationship, biology and management of plantviruses.

Theory

UNIT I

History and economic significances of plant viruses. General and morphological characters, composition and structure of viruses. Myco-viruses, arbo and baculo viruses, satellite viruses, satellite RNAs, phages, viroids and prions**.** Origin and evolution of viruses and their nomenclature and classification.

UNIT II

Genome organization, replication in selected groups of plant viruses and their movement in host. Response of the host to virus infection: biochemical, physiological, and symptomatical changes.Transmission of viruses and virus-vector relationship. Isolation and purification of viruses.

UNIT III

Detection and identification of plant viruses by using protein and nucleic acid based diagnostic techniques. Natural (R-genes) and engineering resistance to plant viruses.

UNIT IV

Virus epidemiology and ecology (spread of plant viruses in fields, host range and survival).

Management of diseases caused by plant viruses.

Practical

- Study of symptoms caused by plant viruses (followed by field visit). Isolation and biological purification of plant virus cultures. Bioassay of virus cultures on indicator plants and host differentials.
- Transmission of plant viruses (Mechanical, graft and vector and study of disease development). Plant virus purification (clarification, concentration, centrifugation, high
- resolution separation and analysis of virions), Electron microscopy for studying viral particle morphology. Antisera production, Detection and diagnosis of plant viruses with serological (ELISA), nucleic acid (Non-PCR–LAMP, Later flow micro array & PCR based techniques. Exposure to basic bio-informatic tools for viral genome analysis and their utilization in developing detection protocols and population studies (BLASTn tool, Primer designing software, Bioedit tool, Claustal X/W, MEGA Software).

Suggested Reading

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.
Wilson C, 2014. *Applied Plant Virology.* CABI Publishing England

Course Code: PATH 0503
Credit Hours: 2+1
Course Title: Plant Pathogenic Prokaryotes

Objective: To acquaint with plant pathogenic prokaryote (procarya) and their structure, nutritional requirements, survival and dissemination.

Theory

UNIT I

Prokaryotic cell: History and development of Plant bacteriology, history of plant bacteriology in India. Evolution of prokaryotic life, Prokaryotic cytoskeletal proteins. Structure of bacterial cell. Structure and composition of gram negative and gram positive cell wall; synthesis of peptidoglycan; Surface proteins; Lipopolysaccaride structure; Membrane transport; fimbrae and pili (Type IV pili); Mechanism of flagellar rotatory motor and locomotion, and bacterial movement; Glycocalyx (S-layer; capsule); the bacterial chromosomes and plasmids; Operon and other structures in cytoplasm; Morphological feature of fastidious bacteria, spiroplasmas and Phytoplasmas.

UNIT II

Growth and nutritional requirements. Infection mechanism, role of virulence factors in expression of symptoms. Survival and dispersal of phytopathogenic prokaryotes.

UNIT III

Taxonomy of phytopathogenic prokarya: Taxonomic ranks hierarchy; Identification, Classification and nomenclature of bacteria, phytoplasma and spiroplasma. The codes of Nomenclature and characteristics. Biochemical and molecular characterization of phytopathogenic prokaryotes.

UNIT IV

Variability among phytopathogenic prokarya: general mechanism of variability (mutation); specialized mechanisms of variability (sexual like process in bacteria-conjugation; transformation; transduction); and horizontal gene transfer.

UNIT V

Bacteriophages, L form of bacteria, plasmids and bdellovibrios: Structure; Infection of host cells; phage multiplication cycle; Classification of phages, Use of phages in plant pathology/bacteriology, Lysogenic conversion; H Plasmids and their types, plasmid borne phenotypes.Introduction to bacteriocins. Strategies for management of diseases caused by phytopathogenic prokaryotes.

Practical

- Study of symptoms produced by phytopathogenic prokaryotes.
- Isolation, enumeration, purification, identification and host inoculation of phytopathogenic bacteria. Stains and staining methods.
- Biochemical and serological characterization.
- Isolation of genomic DNA plasmid. Use of antibacterial chemicals/antibiotics.
- Isolation of fluorescent *Pseudomonas*.
- Preservation of bacterial cultures.
- Identification of prokaryotic organisms by using 16SrDNA, and other gene sequences.
- Diagnosis andmanagement of important diseases caused by bacteria and mollicutes.

Suggested Reading

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. Salle AJ 1979. *Fundamental Principles of Bacteriology 7th edn.* Verma JP, Varma A & Kumar D. (Eds). 1995. *Detection of Plant Pathogens and their Management*. Angkor Publ., New Delhi.

Course Code: PATH 0504
Credit Hours: 2+1
Course Title: Plant Nematology

Objective: To project the importance of nematodes in agriculture and impart basic knowledge on allaspects of plant nematology.

Theory

UNIT I

Characteristics of Phylum Nematoda and its relationship with other related phyla, history and growth of Nematology; nematode habitats and diversity- plant, animal and human parasites; useful nematodes; economic importance of nematodes to agriculture, horticulture and forestry.

UNIT II

Gross morphology of plant parasitic nematodes; broad classification, nematode biology, physiology and ecology.

UNIT III

Types of parasitism; nature of damage and general symptomatology; interaction of plant-parasitic nematodes with other organisms.

UNIT IV

Plant nematode relationships, cellular responses to infection by important phytonematodes;physiological specialization among phytonematodes.

UNIT V

Principles and practices of nematode management; integrated nematode management.

UNIT VI

Emerging nematode problems, Importance of nematodes in international trade anduarantine.

Practical

- Studies on kinds of nematodes- free-living, animal, insect and plant parasites;
- Nematode extraction from soil; extraction of migratory endoparasites, staining for sedentary endoparasites;
- Examination of different life stages of important plant parasitic nematodes, their symptoms and histopathology.

Suggested Reading

Dropkin VH. 1980. *An Introduction to Plant Nematology*. John Wiley & Sons, New York.
Maggenti AR. 1981. *General Nematology*. Springer-Verlag, New York.
Perry RN & Moens M. 2013. *Plant Nematology*. 2nd Ed.CABI Publishing: Wallingford, UK.
Perry RN, Moens M, & Starr, JL. 2009. *Root-knot nematodes*, CABI Publishing: Wallingford, UK
Sikora RA, Coyne D, Hallman J and Timper P, 2018. *Plant Parasitic Nematodes in Subtropical*

*and Tropical Agriculture.*3rd edn. CABI Publishing, England.
Thorne G. 1961. *Principles of Nematology*. McGraw Hill, New Delhi.
Walia RK & Bajaj HK. 2003. *Text Book on Introductory Plant Nematology*. ICAR, New Delhi.
Walia RK. & Khan MR. 2018. *A Compendium of Nematode Diseases of Crop Plants*, ICARAICRP (Nematodes), IARI, New Delhi.

Course Code: PATH 0505
Credit Hours: 2+1
Course Title: Principles of Plant Pathology

Objective: To introduce the subject of Plant Pathology, its concepts and principles.

Theory
UNIT I
Importance, definitions and concepts of plant diseases, history and growth of plantpathology, biotic and abiotic causes of plant diseases.

UNIT II
Growth, reproduction, survival and dispersal of important plant pathogens, role of environment and host nutrition on disease development.

UNIT III
Host parasite interaction, recognition concept and infection, symptomatology, disease developmentrole of enzymes, toxins, growth regulators; defense strategies- oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors. Altered plant metabolism as affected by plant pathogens.

UNIT IV
Genetics of resistance; 'R' genes; mechanism of genetic variation in pathogens; molecular basis for resistance; marker-assisted selection; genetic engineering for disease resistance.

Practical
- Basic plant pathological techniques.
- Isolation, inoculation and purification of plant pathogens and proving Koch's postulates.
- Techniques to study variability in different plant pathogens.
- Purification of enzymes, toxins and their bioassay.
- Estimation of growth regulators, phenols, phytoalexins in resistant and susceptible plants.

Suggested Reading
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 2017. *Introduction to Principles of Plant Pathology*. 5th edn. MedTech, NewDelhi.

Singh RP 2012. *Plant Pathology* 2nd edn. Kalyani Publishers, New Delhi.
Singh DP & Singh A. 2007. *Disease and Insect Resistance in Plants.* Oxford & IBH, NewDelhi.
Upadhyay RK & Mukherjee KG. 1997. *Toxins in Plant Disease Development and Evolving Biotechnology*. Oxford & IBH, New Delhi.

Course Code: PATH 0506
Credit Hours: 0+2
Course Title: Techniques for Detection and Diagnosis of Plant Diseases

Objective: To impart training on various methods/techniques/instruments used in the study of plantdiseases/pathogens

Practical

- Detection of plant pathogens 1. based on visual symptoms, 2. Biochemical test 3. Using microscopic techniques, 4. Cultural studies; (use of selective media to isolate pathogens). 5. Biological assays (indicator hosts, differential hosts) 6. Serological assays 7. Nucleic acid based techniques (Non-PCR– LAMP, Later flow microarray & PCR based- multiplex, nested, qPCR, immune capture PCR, *etc.*).
- Phenotypic and genotypic tests for identification of plant pathogens.
- Molecular identification (16S rDNA and 16s-23S rDNA intergenic spacer region sequences-prokaryotic organisms; and eukaryotic organism by ITS region) and whole genome sequencing.
- Volatile compounds profiling by using GC MS and LC-MS. FAME analysis, Fluorescence in-situ Hybridization (FISH), Flow Cytometry, Phage display technique, biosensors for detection of plant pathogens.
- Genotypic tools such as genome/ specific gene sequence homology comparison by BLAST (NCBI and EMBL) and electron microscopy techniques of plant virus detection and diagnosis.

Suggested Reading

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, Totowa, New Jersey.
Matthews REF. 1993. *Diagnosis of Plant Virus Diseases*. CRC Press, Florida.
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.

Course Code: PATH 0507
Credit Hours: 2+1
Course Title: Principles of Plant Disease Management

Objective: 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
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. Label claimof fungicides.

UNIT III
Application of chemicals on foliage, seed and soil, role of stickers, spreaders and other adjuvants, health ***vis-a-vis*** environmental hazards, residual effects and safety measures

Practical

- Phytopathometry.
- Methods of in vitro evaluation of chemicals, antibiotics, bio agents against plant pathogens.
- Field evaluation of chemicals, antibiotics, bio agents against plant pathogens.
- Soil solarisation, methods of soil fumigation under protected cultivation.
- Methodsof application of chemicals and bio control agents.
- ED and MIC values, study of structural details of sprayers and dusters.
- Artificial epiphytotic and screening of resistance.

Suggested Reading
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

Course Code: PATH 0508
Credit Hours: 1+0
Course Title: Epidemiology and Forecasting of Plant Diseases

Objective: To acquaint with the principles of epidemiology and its application in disease forecasting.

Theory

UNIT I

Epidemic concepts, simple interest and compound interest disease, historical development. Elements of epidemics and their interaction. Structures and patterns of epidemics. Modelling, system approaches and expert systems in plant pathology.

UNIT II

Genetics of epidemics. Models for development of plant disease epidemics. Common and natural logarithms, function fitting, area under disease progress curve and correction factors, inoculum dynamics. Population biology of pathogens, temporal and spatial variability in plant pathogens.

UNIT III

Epidemiological basis of disease management. Survey, surveillance and vigilance. Remote sensing techniques and image analysis. Crop loss assessment.

UNIT IV

Principles and pre-requisites of forecasting, systems and factors affecting various components of forecasting, some early forecasting and procedures based on weather and inoculum potential, modeling disease growth and disease prediction. Salient features ofimportant forecasting models.

Suggested Reading

Campbell CL & Madden LV. 1990. *Introduction to Plant Disease Epidemiology*. John Wiley & Sons, New York

Cooke B, Jones DM and Gereth KB 2018 *The Epidemiology of Plant Diseases*. Springer Publications. 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 DiseaseEpidemics*. 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.

Course Code: PATH 0509

Credit Hours: 2+0

Course Title: Disease Resistance in Plant

Objective: To acquaint with the disease resistance mechanisms.

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 terminologies. Disease escape, non-host resistance and disease tolerance.

UNIT II

Genetic basis of disease resistance, types of resistance, identification of physiological races of pathogen, disease progression in relation to resistance, stabilizing selection pressure in plant pathogens.

UNIT III

Host defence system, morphological and anatomical resistance, pre-formed chemicals in host defence, post infectional chemicals in host defence, phytoalexins, hypersensitivity and its mechanisms. Genetic basis of relationships between pathogen and host, Gene-for-gene concept, protein-for-protein and immunization basis, management of resistance genes. Strategies for gene deployment.

Suggested Reading

Deverall BJ. 1977. *Defence Mechanisms in Plants*. Cambridge Univ. Press, Cambridge, NewYork.

Mills Dallice ***et al.***1996. *Molecular Aspects of Pathogenicity and Resistance: Requirementfor 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., LudhianaVan der Plank JE. 1975. *Principles of Plant Infection*. Academic Press, New York.

Van der Plank JE. 1978. *Genetic and Molecular Basis of Plant Pathogenes**is***. Springer Verlag. New York.

Van der Plank JE. 1982. *Host Pathogen Interactions in Plant Disease*. Academic Press, New York.

Course Code: PATH 0510

Credit Hours: 1+1

Course Title: Ecology of Soil Borne Plant Pathogens

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. Interaction of microorganisms.

UNIT II

Types of biocontrol agents. Inoculum potential and density in relation to host and soilvariables, competition, predation, antibiosis and fungistasis. Conducive and suppressive soils.

UNIT III

Biological control- concepts and potentialities for managing soil borne pathogens. Potentialof *Trichoderma* and fluorescent *Pseudomonas* in managing plant diseases.

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 soilborne pathogens by antagonistic microorganisms.
- Isolation and identification of different biocontrol agents.
- Study of various plant morphological structures associated with resistance, testing the effect of root exudates and extracts on spore germination and growth of plant pathogens.
- Estimating the phenolic substances, total reducing sugars in susceptible and resistant plants.
- Estimating the rhizosphere and root tissue population of microorganisms (pathogens) in plants.

Suggested Reading

Baker KF & Snyder WC. 1965. *Ecology of Soil-borne Plant Pathogens***.** John Wiley, NewYork.
Cook RJ & Baker KF. 1983. *The Nature and Practice of Biological Control of PlantPathogens*. APS, St Paul, Minnesota.
Garret SD. 1970. *Pathogenic Root-infecting Fungi*. Cambridge Univ. Press,Cambridge, NewYork.
Hillocks RJ & Waller JM. 1997. *Soil-borne Diseases of Tropical Crops*. CABI, Wallington. Mondia JL and Timper P 2016. Interactions of microfungi and plant parasitic nematodes. In:*Biology of Microfungi* (De-Wei-Lei Ed.). Springer Publications Parker CA, Rovira AD,Moore KJ & Wong PTN. (Eds). 1983. *Ecology and Management of Soil-borne PlantPathogens***.** APS, St. Paul, Minnesota

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Course Code: PATH 0511Credit

Hours: 2+1

Course Title: Chemicals and Botanicals in Plant Disease Management

Objective: To provide knowledge on the concepts, principles and judicious use of chemicals and botanicals in plant disease management.

Theory

UNIT I

History and development of chemicals; definition of pesticides and related terms; advantagesand disadvantages of chemicals and botanicals.

UNIT II

Classification of chemicals used in plant disease management and their characteristics.

UNIT III

Chemicals in plant disease control, *viz.*, fungicides, bactericides, nematicides, antiviral chemicals and botanicals. Issues related to label claim.

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. New generation fungicides and composite formulations of pesticides.

UNIT VI

Efficacy of different botanicals used and their mode of action. Important botanicals used against diseases. 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 against pathogens; persistence, compatibility with other agro-chemicals;
- Detection of naturally occurring fungicide resistant mutants of pathogen;
- Methods of application of chemicals.

Suggested Reading

Bindra OS & Singh H. 1977. *Pesticides - And Application Equipment*. Oxford & IBH, New Delhi.

Nene YL &Thapliyal PN. 1993. *Fungicides in Plant Disease Control.* 3rd edn. 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

Course Code: PATH 0512
Credit Hours: 2+1
Course Title: Detection and Management of Seed Borne Pathogens

Objective: To acquaint with seed-borne diseases, their nature, detection, transmission, epidemiology,impacts/losses 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 seedborne 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 pathogens/ 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 Reading

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***.** McMillan, London. Suryanarayana

D. 1978. *Seed Pathology***.** Vikash Publ., New Delhi.

Course Code: PATH 0513
Credit Hours: 1+1
Course Title: Biological Control of Plant Pathogens

Objective: To study principles and application of ecofriendly and sustainable management strategies ofplant diseases.

Theory
UNIT I
Concept of biological control, definitions, importance, principles of plant disease management with bioagents, history of biological control, merits and demerits of biological control.

UNIT II
Types of biological interactions, competition: mycoparasitism, exploitation for hypovirulence, rhizosphere colonization, competitive saprophytic ability, antibiosis, induced resistance, mycorrhizal associations, operational mechanisms and its relevance in biological control.

UNIT III
Factors governing biological control, role of physical environment, agroecosystem, operational mechanisms and cultural practices in biological control of pathogens, pathogens and antagonists and their relationship, biocontrol agents, comparative approaches to biological control of plant pathogens by resident and introduced antagonists, control of soil- borne and foliar diseases. Compatibility of bioagents with agrochemicals and other antagonistic microbes.

UNIT IV
Commercial production of antagonists, their delivery systems, application and monitoring, biological control in IDM, IPM and organic farming system, biopesticides available in market. Quality control system of biocontrol agents.

Practical
- Isolation, characterization and maintenance of antagonists,
- Methods of study of antagonism and antibiosis, application of antagonists against pathogen *in vitro and in vivo* conditions.
- Preparation of different formulations of selected bioagents and their mass production.Quality parameters of biocontrol agents.
- One week exposure visit to commercial biocontrol agents production unit.

Suggested Reading
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 ofPlant Diseases***.** Aditya Books, New Delhi.

Course Code: PATH 0514
Credit Hours: 2+1
Course Title: Integrated Disease Management

Objective: To emphasize the importance and the 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, rapeseed and mustard,pearl millet, pulses, vegetable crops, fruit, plantation and spice crops.

Practical

- Application of physical, biological and cultural methods,
- Use of chemical and biocontrol agents, their compatibility and integration in IDM.
- Demonstration of IDM and multiple disease management in crops of regional importance as project work.

Suggested Reading
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.

Course Code: PATH 0515
Credit Hours: 2+1
Course Title: Diseases of Field and Medicinal Crops

Objective: To acquaint with diseases of field and medicinal plants and their management.

Theory
UNIT I
Diseases of Cereal crops- Rice, wheat, barley, pearl millet, sorghum and maize.

UNIT II
Diseases of Pulse crops- gram, urdbean, mungbean, lentil, pigeonpea, soybean and cowpea.

UNIT III
Diseases of Oilseed crops- rapeseed and mustard, sesame, linseed, sunflower, groundnut, castor.

UNIT IV
Diseases of Cash crops- cotton, sugarcane.

UNIV V
Diseases of Fodder legume crops- berseem, oats, guar, lucerne,

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 Reading
Joshi L M, Singh D.V & Srivastava K. D. 1984. *Problems and Progress of Wheat Pathologyin South Asia*. Malhotra Publ. House, New Delhi.
Rangaswami G. 1999. *Diseases of Crop Plants in India*. 4th Ed.. Prentice Hall of India, NewDelhi.
Ricanel C, Egan BT, Gillaspie Jr AG & Hughes CG. 1989. *Diseases of Sugarcane, Major Diseases*. Academic Press, New York.
Singh RS. 2017. *Plant Diseases*. 10th Ed. Medtech, New Delhi.
Singh US, Mukhopadhyay AN, Kumar J & Chaube HS. 1992. *Plant Diseases of International Importance*. Vol. I. *Diseases of Cereals and Pulses*. Prentice Hall, Englewood Cliffs, New Jersey

Course Code: PATH 0516
Credit Hours: 2+1
Course Title: Diseases of Fruits, Plantation and Ornamental Crops

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, *ber,* banana, pineapple, papaya, fig, pomegranate, date palm custard apple and their management.

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, gerbera 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 Reading
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

Course Code: PATH 0517
Credit Hours: 2+1
Course Title: Diseases of Vegetable and Spices Crops

Objectiv: To impart knowledge about symptoms, epidemiology of different diseases of vegetables andspices and their management.

Theory
UNIT I
Nature, prevalence, factors affecting disease development of tuber, bulb, leafy vegetable, crucifers, cucurbits and solanaceaous vegetables. Diseases of crops under protected cultivation.

UNIT II

Symptoms and management of diseases of different root, tuber, 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, nutmeg, saffron, cumin, coriander, turmeric, fennel, fenugreek and ginger. Biotechnological approaches in developing disease resistant transgenics.

Practical

- Detailed study of symptoms and host pathogen interaction of important diseases of vegetable and spice crops.

Suggested Reading

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

Course Code: PATH 0518
Credit Hours: 1+1
Course Title: Post Harvest Diseases

Objective: To acquaint with the post-harvest diseases of agricultural produce and their eco-friendlymanagement.

Theory

UNIT I

Concept of post-harvest diseases, definitions, importance with reference to management and health, principles of plant disease management as pre-harvest and post-harvest, Types of post-harvest problems both by biotic and abiotic factors

UNIT II

Role of physical environment, agro-ecosystem leading to quiescent infection, operational mechanisms and cultural practices in perpetuation of pathogens, pathogens and antagonistand 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.

UNIT III

Integrated approaches in controlling diseases and improving the shelf life of produce using nutritional, bio-control agents and other agents, control of aflatoxigenic and mycotoxigenic fungi,

application and monitoring for health hazards

UNIT IV

Study of symptoms, toxicosis of various pathogens, knowledge of Codex Alimentarious for each product and commodity. Physical and biological agents/practices responsible for development/ prevention of post-harvest diseases- traditional and improved practices **Practical** Isolation, characterization and maintenance of post-harvest pathogens, application of antagonists against pathogens ***in vivo*** condition. Comparative efficacy of different fungicides and bioagents. Study of different post-harvest disease symptoms on cereals, pulses, oilseed, commercial crops, vegetables, fruits and flowers. Visit to cold storage.

Suggested Reading

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.

Course Code: PATH 0519
Credit Hours: 1+0
Course Title: Plant Quarantine and Regulations

Objective: To acquaint the learners about the principles and the role of plant quarantine in containmentof pests and diseases, plant quarantine regulations and set-up.

Theory

UNIT I

Historical development in plant quarantine, Definitions of pest, and transgenics as per Govt. notification; Organizational set up of plant quarantine in India. 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

Acts related to registration of pesticides and transgenics. History of quarantine legislations, alient features of 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. Visit to plant quarantine station and PEQ facilities.

Suggested Reading

Rajeev K & Mukherjee RC. 1996. *Role of Plant Quarantine in IPM***.** Aditya Books.

Rhower GG. 1991. Regulatory Plant Pest Management. In: *Handbook of Pest Managementin Agriculture***.** 2nd Ed. Vol. II. (Ed. David Pimental). CRC Press.

MINOR COURSES

Course Code: ENTO0504

Credit Hours: 2+1

Course Title: Insect Ecology

Objective: To teach the concepts of ecology, basic principles of distribution and abundance of organisms and their causes. Study life tables, constructing life tables, organization of communities, diversity indices. Train students in sampling methodology, calculation of diversity indices, 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. Population growth basic models – Exponential vs Logistic models. Discrete vs Continuous growth models. 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 seasonalityDiapause (Quiescence) - aestivation, hibernation.

UNIT III

Biotic factors- Food as a limiting factor for distribution and abundance, Nutritional Ecology. Food chain- web and ecological succession. Interspecific interactions- Basic factors governing the interspecific interactionsClassification of interspecific interactions - The argument of cost-benefit ratios. Competition- Lotka-Volterra model, Concept of niche ecological homologues, competitive exclusion. Evolution of mimicry, colouration, concept ofpredator satiation; evolution of life history strategies.

UNIT IV

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. Climate change and insect pest/ natural enemy population; ecological engineering

Practical

- Types of distributions of organisms.
- Methods of sampling insects, estimation of densities of insects and understanding the distribution parameters-
- Measures of central tendencies, Poisson Distribution, Negative Binomial Distribution. Determination of optimal sample size.
- Learning to fit basic population growth models and testing the goodness of fit.
- Fitting Holling's Disc equation, Assessment of prey-predator densities from natural systems and understanding the correlation between the two.
- Assessing and describing niche of some insects of a single guild.
- Calculation of niche breadth, activity breadth and diagrammatic representation of niches of organisms.
- Calculation of diversity indices- Shannon's, Simpson's and Avalanche Index and understanding their associations and parameters that affect their values. Problem solving in ecology.
- Field visits to understand different ecosystems and to study insect occurrence in these systems.

Suggested Reading

Begon, M., Townsend, C.R. and Harper, J. L. 2006. *Ecology: From Individuals to Ecosystems*. 4th Ed. Blackwell Publishing, USA/ UK/ Australia.

Chapman J. L. and Reiss MJ. 2006. *Ecology: Principles and Applications*. 2nd Ed. Cambridge Univ. Press,Cambridge.

Fowler, J., Cohen, L. and Jarvis, P. 1998. Practical Statistics for Field Biology. 2nd Ed. John Wiley & Sons, Chichester, West Sussex PO19 8SQ, England.

Gotelli N. J and Ellison AM. 2004. *A Primer of Ecological Statistics.* Sinauer Associates, Inc., Sunderland, MA. Gotelli N. J. 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. BenjaminCummings 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.

Schowalter, Timothy D. 2011. *Insect Ecology – An Ecosystem Approach*. 3rd Ed. Academic Press, London, UK/ CA, USA.

Southwood TRE and Henderson PA. 2000. *Ecological Methods.* 3rd Ed. Methuen and Co. Ltd.,

London.
Speight MR, Hunta MD and Watt AD. 2006. *Ecology of Insects: Concepts and Application*. Elsevier Science Publ., The Netherlands.
Townsend, Colin R., Begon, Michael and Harper, John L. 2008. *Essentials of Ecology*. 3rd Ed. Blackwell Publishing, USA/ UK/ Australia.
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*

Course Code: ENTO 0505

Credit Hours: 2+1

Course Title: Biological Control of Insect Pests and Weeds

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. History of insect pathology, infection of insects by bacteria, fungi, viruses, protozoa, rickettsiae, spiroplasma and nematodes.

UNIT II

Biology, adaptation, host seeking behaviour of predatory and parasitic groups of insects. Role of insect pathogenic nematodes, viruses, bacteria, fungi, protozoa etc., their mode of action. Biological control of weeds using insects. Epizootiology, symptomatology and etiology of diseases caused by the above and the factors controlling these. Defense mechanisms in insects against pathogens.

UNIT III

Mass production of quality bio-control agents- techniques, formulations, economics, field release/application and evaluation. Development of insectaries, 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

- Identification of common natural enemies of crop pests (parasitoids, predators, microbes) and weed killers.

- Visits 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.
- Field collection of parasitoids and predators.
- Hands-on training in culturing, identification of common insect pathogens.
- Qualitycontrol and registration standards for biocontrol agents.

Suggested Reading

Burges HD and 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 and Hall, New York.

Dhaliwal GS and Arora R. 2001. *Integrated Pest Management: Concepts and Approaches.* Kalyani Publ., New Delhi.

Gerson H and Smiley RL. 1990. *Acarine Biocontrol Agents – An Illustrated Key an Manual.*Chapmanand Hall NewYork

Huffaker CB and Messenger PS. 1976. *Theory and Practices of Biological Control.* Academic Press, London.

Ignacimuthu SS and Jayaraj S. 2003. *Biological Control of Insect Pests*. Phoenix Publ., NewDelhi.

Saxena AB. 2003. *Biological Control of Insect Pests*. Anmol Publ., New Delhi.

Van Driesche and Bellows TS. Jr. 1996. *Biological Control*. Chapman andHall, New York.

Course Code: ENTO 0507
Credit Hours: 1+1
Course Title: Host Plant Resistance

Objective: To acquaint the learners about the principles and the role of host resistance to pests

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 ofresistance. 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

- Screening techniques for measuring resistance;
- Measurement of plant characters and workingout their correlations with plant resistance;
- Testing of resistance in important crops; bioassay of plant extracts of susceptible/resistant varieties;
- Demonstration of antibiosis, tolerance and antixenosis.

Suggested Reading

Dhaliwal GS and Singh R. (Eds). 2004. *Host Plant Resistance to Insects -Concepts and Applications.* Panima Publ., New Delhi.

Maxwell FG and Jennings PR. (Eds). 1980. *Breeding Plants Resistant to Insects.* John Wileyand Sons, New York.

Painter RH. 1951. *Insect Resistance in Crop Plants*. MacMillan, London.

Panda N and Khush GS. 1995. *Plant Resistance to Insects.* CABI, London.

Smith CM. 2005. *Plant Resistance to Arthropods – Molecular and Conventional Approaches.* Springer, Berlin.

Course Code: ENTO0508
Credit Hours: 2+0
Course Title: Concepts of Integrated Pest Management

Objective: To familiarize the students with principles of insect pest management, including concept and philosophy of IPM**.** Train students in computation of ETL and implementing IPM programmes.

Theory

UNIT I

History, origin, definition and evolution of various terminologies. Importance of resistance, principles, classification, components, types and mechanisms of resistance. National and international level crop protection organizations; insecticide regulatory bodies; synthetic insecticide, bio-pesticide and pheromone registration procedures; label claim of pesticides – the pros and cons

.

UNIT II

Concept and philosophy, ecological principles, economic threshold concept and economic consideration. Insecthost plant relationships; theories and basis of host plant selection in phytophagous insects.

UNIT III

Tools of pest management and their integration- legislative, quarantine regulations, cultural, physical and mechanical methods; semiochemicals, biotechnological and bio-rational approaches in IPM. 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; case studies of successful IPM programmes. ITK-s in IPM, area-wide IPM and IPM for organic farming; components of ecological engineering with successful examples.

UNIT IV

Characterization of agro-ecosystems; sampling methods and factors affecting sampling; population estimation methods; crop loss assessment direct losses, indirect losses, potential losses, avoidable losses, unavoidable losses; global and Indian scenario of crop losses. Computation of EIL and ETL; crop modeling; designing and implementing IPM system. 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.

Suggested Reading

Dhaliwal GS and Arora R. 2003. *Integrated Pest Management – Concepts and Approaches.* Kalyani Publ., New Delhi.

Horowitz AR and Ishaaya I. 2004. *Insect Pest Management: Field and Protected Crops*. Sp Ignacimuthu SS and Jayaraj S. 2007. Biotechnology and Insect Pest Management. Elite Publ., New Delhi.

Pedigo RL. 2002. Entomology and Pest Management. 4th Ed. Prentice Hall, New Delhi. Norris RF, Caswell-Chen EP and Kogan M. 2002. Concepts in Integrated Pest Management. Prentice Hall, New Delhi.

Subramanyam B and Hagstrum DW. 1995. Integrated Management of Insects in Stored Products. Marcel Dekker, New York.ringer, New Delhi.

Course Code: ENTO0509
Credit Hours: **2+1**
Course Title: Pests of Field Crops

Objective: To familiarize the students about nature of damage and seasonal incidence of pestiferous insects 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. Insect pest scenario in relation to climate change.

UNIT I

Polyphagous pests: grasshoppers, locusts, termites, white grubs, hairy caterpillars, and non- insect pests (mites,birds, rodents, snails, slugs etc.). Insect pests of cereals and millets and their management.

UNIT II
Insect pests of pulses, tobacco, oilseeds and their management.

UNIT III
Insect pests of fibre crops, forage crops, sugarcane and their management.

Practical
- Field visits, collection and identification of important pests and their natural enemies
- Detection and estimation of infestation and losses in different crops; study of life history of important insect pests.

Suggested Reading
David, BV and Ramamurthy, VV. 2001. *Elements of Economic Entomology.* Popular Book Depot, Chennai.
Dhaliwal GS, Singh R and 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
and Mathur RP. 1987. *Management of Rodent Pests.* ICAR, New Delhi.
Saxena RC and Srivastava RC. 2007. *Entomology at a Glance*. Agrotech Publ. Academy,

Course Code: ENTO0510
Credit Hours: 2+1
Course Title: Pests of Horticultural and Plantation Crops

Objective: To impart knowledge on major pests of horticultural and plantation crops regarding theextent and nature of loss, seasonal history, their integrated management.

Theory
Systematic position, identification, distribution, host range, bionomics and seasonalabundance, 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, *aonla*, 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, 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

- Collection and identification of important pests and their natural enemies on different crops; study of life history of important insect pests and non-insect pests.

Suggested Reading

Atwal AS and Dhaliwal GS. 2002. *Agricultural Pests of South Asia and theirManagement.* Kalyani Publ., New Delhi.

Butani DK and Jotwani MG. 1984. *Insects and Vegetables.* Periodical Expert Book Agency,New Delhi.

Dhaliwal GS, Singh R and 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 and Goutham DC. 2004. *Pest Management in Horticulture Crops*:*Principles and Practices*. Asiatech Publ., New Delhi.

SUPPORTING COURSES

Course Code: STAT 0511
Credit Hours: 2+1
Course Title: Experimental Designs

Objective: This course is meant for students of agricultural and animal sciences other than Statistics.Designing an experiment is an integrated component of research in almost all sciences. students would be exposed to concepts of Design of Experiments so as to enable them to understand the concepts involved in planning, designing their experiments and analysis of experimental data.

Theory

UNIT I

Need for designing of experiments, characteristics of a good design. Basic principles of designs-randomization, replication and local control.

UNIT II

Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design.

UNIT III

Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments

with control treatment.

UNIT IV
Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designs and their applications ~ Lattice design, alpha design - concepts, randomisation procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures.

UNIT V Bioassays- direct and indirect, indirect assays based on quantal dose response, parallel line and slope ratio assays potency estimation.

Practical
- Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law;
- Analysisof data obtained from CRD, RBD, LSD;
- Analysis of factorial experiments without and with confounding;
- Analysis with missing data;
- Split plot and strip plot designs;
- Transformation of data;
- Analysis of resolvable designs;
- Fitting of response surfaces.

Suggested Reading
Cochran WG & Cox GM. 1957. *Experimental Designs*. 2nd Ed. John Wiley.
Dean AM & Voss D. 1999. *Design and Analysis of Experiments*. Springer. Federer WT. 1985. *Experimental Designs*. MacMillan. Fisher RA. 1953. *Design and Analysis of Experiments*. Oliver & Boyd. Nigam AK & Gupta VK. 1979. *Handbook on Analysis of Agricultural Experiments*. IASRI Publ.
Pearce SC. 1983. *The Agricultural Field Experiment: A Statistical Examination of Theoryand Practice*. John Wiley. Design Resources Server: www.iasri.res.in/design.

Course Code: MMBB 0505
Credit Hours: 0+3
Course Title: Techniques in Molecular Biology I

Objective
To provide hands on training on basic molecular biology techniques.

Practical
UNIT I
Good lab practices; Biochemical techniques: Preparation of buffers and reagents, Principle of centrifugation, Chromatographic techniques (TLC, Gel Filtration Chromatography, Ion exchange Chromatography, Affinity Chromatography).

UNIT II

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.

UNIT III

Gene cloning – Recombinant DNA construction, transformation and selection of transformants; PCR and optimization of factors affecting PCR.

UNIT IV

Dot blot analysis; Southern hybridization; Northern hybridization; Western blotting andELISA; Radiation safety and non-radio isotopic procedure.

Suggested Reading

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: aLaboratory Manual*. Cold Spring Harbour Laboratory Press

Course Code: STAT 0502
Credit Hours: 3+1
Course Title: Statistical Methods for Applied Sciences

Objective

This course is meant for students who do not have sufficient background of Statistical Methods. The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data, probability distributions, parameter estimation, tests of significance, regression and multivariate analytical techniques.

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 correlationcoefficient, 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'sncoefficient 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, testingof 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 andregression analysis, fitting of orthogonal polynomial regression; applications of dimensionality reduction and discriminant function analysis;
- Nonparametric tests.

Suggested Reading

Anderson TW. 1958. *An Introduction to Multivariate Statistical Analysis*. John Wiley.

Dillon WR & Goldstein M. 1984. *Multivariate Analysis - Methods and 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*. JohnWiley.

Learning Statistics: http://freestatistics.altervista.org/en/learning.php.

Electronic Statistics Text Book:http://www.statsoft.com/textbook/stathome.html.

Course Code: STAT0531
Credit Hours: 2+1
Course Title: Data Analysis Using Statistical Packages

Objective: This course is meant for exposing the students in the usage of various statistical packages for analysis of data. It would provide the students an hands on experience in the analysis of their research data. This course is useful to all disciplines.

Theory
UNIT I
Use of Software packages for: Summarization and tabulation of data; Descriptive statistics; Graphical representation of data, Exploratory data analysis.

UNIT II
Fitting and testing the goodness of fit of discrete and continuous probability distributions; Testing of hypothesis based on large sample test statistics; Testing of hypothesis using chi- square, *t* and *F* statistics

.
UNIT III
Concept of analysis of variance and covariance of data for single factor, multi-factor, one- way and multi-classified experiments, contrast analysis, multiple comparisons, Analyzing crossed and nested classified designs.

UNIT IV
Analysis of mixed models; Estimation of variance components; Testing the significance of contrasts; Correlation and regression including multiple regression.

UNIT V
Discriminant function; Factor analysis; Principal component analysis; Analysis of time series data, Fitting of non-linear models; Time series data; Spatial analysis; Neural networks.

Practical
- Use of software packages for summarization and tabulation of data, obtaining descriptive statistics, graphical representation of data.
- Robust Estimation, Testing linearity and normality assumption, Estimation of trimmed means etc.,
- Cross tabulation of data including its statistics, cell display and table format and means for different sub-classifications;
- Fitting andtesting the goodness of fit of probability distributions;
- esting the hypothesis for one sample *t*-test, two sample *t*-test, paired *t*-test, test for large samples - Chi-squares test, F test, One way analysis of variance , contrast and its testing, pairwise comparisons;

- Multiway classified analysis of variance - cross-classification, nested classification, factorial set up, fixed effect models, random effect models, mixed effect models, estimation of variance components;
- Generalized linear models - analysis of unbalanced data sets, testing and significance of contrasts, Estimation of variance components in unbalanced data sets - maximum likelihood, ANOVA, REML, MINQUE; Bivariate and partial correlation,
- Distances - to obtain a distance matrix, dissimilarity measures, similarity measures;
- Linear regression, Multiple regression, Regression plots, Variable selection, Regression statistics,
- Fitting of growth models - curve estimation models, examination of residuals;
- Discriminant analysis - fitting ofdiscriminant functions, identification of important variables, Factor analysis.
- Principal component analysis - obtaining principal component, spectral composition;
- Analysis of time series data - fitting of ARIMA models, working out moving averages. Spatial analysis; Neural networks

Suggested Reading

Anderson CW & Loynes RM. 1987. *The Teaching of Practical Statistics*. John Wiley.
Atkinson AC. 1985. *Plots Transformations and Regression*. Oxford University Press *Analysis*. Wadsworth, Belmount, California.
Chatfield C & Collins AJ. 1980. *Introduction to Multivariate Analysis*. Chapman & Hall. Chatfield C. 1983. *Statistics for Technology*. 3rd Ed. Chapman & Hall.Chatfield C. 1995.*Problem Solving: A Statistician's Guide*. Chapman & Hall.
Cleveland WS. 1985. *The Elements of Graphing Data*. Wadsworth, Belmont, California.
Ehrenberg ASC. 1982. *A Primer in Data Reduction*. John Wiley.Erickson BH & NosanchukTA. 1992. *Understanding Data*. 2nd Ed. Open University Press, Milton Keynes.
Snell EJ & Simpson HR. 1991. *Applied Statistics: A Handbook of GENSTAT Analyses*. Chapman & Hall.
Sprent P. 1993. *Applied Non-parametric Statistical Methods*. 2nd Ed. Chapman & Hall. Tufte ER. 1983. *The Visual Display of Quantitative Information*. Graphics Press, Cheshire,Conn.
Velleman PF & Hoaglin DC. 1981. *Application, Basics and Computing of Exploratory Data Analysis*. Duxbury Press.
Weisberg S. 1985. *Applied Linear Regression*. John Wiley.
Wetherill GB. 1982. *Elementary Statistical Methods*. Chapman & Hall. Wetherill GB.1986. *Regression Analysis with Applications*. Chapman &Hall.Learning
Statistics: http://freestatistics.altervista.org/en/learning.php.
Free Statistical Softwares: http://freestatistics.altervista.org/en/stat.php.
Statistics Glossary http://www.cas.lancs.ac.uk/glossary_v1.1/main.html.

Course Code: MMCA 0512

Credit Hours: 1+1
Course Title: Information Technology In Agriculture

Objective
This is a course on Introduction to Networking and Internet Applications that aims at exposing the students to understand analogy of computer, basic knowledge of MS Office. Also to understand Internet and WWW, use of IT application and different IT tools in Agriculture

Theory
UNIT I
Introduction to Computers, Anatomy of computer, Operating Systems, definition and types, Applications of MS Office for document creation & Editing, Data presentation, interpretationand graph creation, statistical analysis, mathematical expressions,

UNIT II
Database, concepts and types, uses of DBMS in Agriculture, World Wide Web Statistical Sciences: Computer Application(WWW): Concepts and components, Introduction to computer programming languages, concepts and standard input/output operations. e- Agriculture, concepts and applications,

UNIT III
Use of ICT in Agriculture, Computer Models for understanding plant processes. IT application for computation of water and nutrient requirement of crops, Computer controlled for farm advises, market price, postharvest management etc.

UNIT IV
Geospatial technology for generating valuable agri-information. Decision support systems, concepts, components and applications in Agriculture, Agriculture Expert System, Soil Information Systems etc. for supporting Farm decisions, Preparation of contingent crop- planning using IT tools.

Suggested Website
Vanitha G. 2011. *Agro-informatics*
http://www.*agrimoon*.com
http://www.agriinfo.in
http://www.eagri.org
http://www.agriglance.com
http://agritech.tnau.ac.in

Course Code: BIOC 0505
Credit Hours: 0+3
Course Title: Techniques In Biochemistry

Objective: To impart practical knowledge about various techniques used in purification and characterization and estimation of cellular constituents

Theory
UNIT I
Determination of absorption maxima; extraction and estimation of carbohydrates, amino acids, proteins and nucleic acids.

UNIT II
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. UNIT-III: Extraction, purification and characterization of enzymes; electrophoretic techniques to separate proteins and nucleic acids

UNIT-III
Centrifugation: Cell fractionation; application of GLC, HPLC, FPLC in separation of biomolecules; use of radioisotopes in metabolic studies
.
Suggested Reading
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.

COMMON COURSES

Course Code: PGSS0501
Credit Hours: 0+1
Course Title: Library and Information Services

Objective: To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical
- Introduction to library and its services,; Role of libraries in education, research and technology transfer;

- Classification systems and organization of library; sources of information-Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services(Science Citation Index,
- Biological Abstracts, Chemical abstracts, CABI Abstracts, etc.); tracing information from reference sources;
- Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; eresources access methods.

Course Code : PGSS0502
Credit Hours: 0+1
Course Title: Technical Writing and Communications Skills

Objective: To equip the students/scholars with skills to write dissertations, research papers, etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing)

Practical

- Technical Writing- Various forms of scientific writings- theses, technical papers, reviews, manuals, etc.
- Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion)
- Writing of communication; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations
- Writing of numbers and dates in scientific write –ups
- Editing and proof-reading;
- Writing of a review article. Communication Skills-Grammar(Tenses, parts of speech, clauses, punctuation marks); Error analysis(Common errors)
- Concord; Collocation; Phoneticsymbols and transcription;
- Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested Reading

Chicago Manual of Style. 14thEd. 1996 Prentice Hall of IndiaCollins' Cobuild English Dictionary.1995
Harper Collins.Gordon HM & Walter JA. 1970.
Technical Writing 3rdEd. Holt, Rinehart &Winston'abstracts, summaries, précis, citationsetc.; commonly used abbreviations in the theses and research.

Course Code: PGSS0503
Credit Hours: 1+0
Course Title: Intellectual Property and Its Management in Agriculture

Objective: The main objective of this course is to equip students and stakeholders with knowledge

of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License agreement.

Suggested Reading

Erbisch FH & Maredia K. 1998. Intellectual Property Rights in Agricultural Biotechnology.CABI.

Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.

Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.

Course Code: PGSS0504

Credit Hours: 0+1

Course Title: Basic Concepts in Laboratory Techniques

Objective: To acquaint the students about the basic of commonly used techniques in laboratory.

Practical

- Safety measures while in Lab;
- Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware;
- Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution;
- Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values.
- Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing.
- Preparation of media and methods of sterilization;
- Seed viability testing, testing of pollen viability; Tissue culture of crop plants;
- Description of flowering plants in botanical terms in relation to taxonom.

Suggested Reading

Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.
Gabb MH &Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

Course Code: PGSS0505
Credit Hours: 0+1
Course Title: Agricultural Research, Research Ethics and Rural Development Programmes

Objective: To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research, and rural development programmesand policies of Government

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Theory

UNIT I

History of agriculture in brief; Global agricultural research system: need, scope, opportunitites; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural research(CGIAR): International Agricultural Research centres(IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility

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UNIT II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics

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UNIT III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group- Area Specific Programme, Integrated Rural Development Programme(IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary agencies/Non-Governmental Organizations. Critical evaluation of rural development policies and programmes.Constraints in implementation of rural policies and programmes.

Suggested Reading

Bhalla GS & Singh G. 2001.Indian Agriculture- Four Decades of Development.Sage Publ. Punia MS. Manual on International Research and Research Ethics.CCS, HaryanaAgricultural University, Hisar.
Rao BSV. 2007. Rural Development Strategies and Role of Institutions- Issues, Innovationsand Initiatives. Mittal Publ