CURRICULUM FOR THE DEGREE OF M.Sc. (Hons.) AGRICULTURE

in

PLANT PATHOLOGY

(Two Years Program)

INSTITUTE OF AGRICULTURAL SCIENCES

UNIVERSITY OF THE PUNJAB, LAHORE
SCHEME OF STUDIES FOR M.Sc. (Hons.) AGRICULTURE
in
PLANT PATHOLOGY
(Two Years Program)

Major Courses for M.Sc. (Hons) Agriculture (Plant Pathology)*

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*Core courses for M.Sc (Hons) Specialization in Plant Pathology

* Eight (8) Major courses comprised of at least 24 Credit Hours will be offered in 1\textsuperscript{st} and 2\textsuperscript{nd} semester of M.Sc (Hons.) Agriculture (Plant Pathology)

**Minor Courses for M.Sc. (Hons) Agriculture (Plant Pathology)**

Four (4) Minor courses comprised of 12 Credit Hours will be offered in 1\textsuperscript{st} and 2\textsuperscript{nd} semester of M.Sc (Hons.) Agriculture (Plant Pathology)

\textit{Any other course approved as Major Course in the curriculum of M.Sc (Hons.) Agriculture in Entomology, Horticulture, Agronomy, Plant Breeding and Genetics, Food Science and Technology and Soil Science can be taken as Minor Course in M.Sc (Hons.) Agriculture (Plant Pathology).}
PP - 701. MYCOLOGY-I (Straminopila, Protista & Chytridiomycota)

Credit Hours: 3(2-1)

Prerequisites: Introductory Mycology

Learning Objectives:

To study taxonomy and nomenclature of fungi and fungi-like organisms of agricultural importance

Theory

Evolution of classification of Fungi and Fungi-like organisms: the Six Kingdom System;

Kingdom Protista: Significance, general characteristics and systematic position of Myxomycota, Plasmodiophoromycota, Acrasiomycota and Dictyosteliomycota. Distinguishing characters of the genera of Plasmodiophoromycota; Life cycles of Plasmodiophora and Spongospora.

Kingdom Straminopila: Importance, morphology, biology, taxonomy and nomenclature of Hyphochytridiomycota, Labyrinthulomycota and Oomycota; important characters and classification of Oomycota up to orders and families level; Importance and life cycles of plant pathogens in Peronosporales, Sclerosporales and Pythiales.

Kingdom Fungi: General characters, importance and classification up to phyla. Chytridiomycota: General Characteristics and classification up to orders level; Biology of Synchytrium. Evolution of orders into new phyla.

Practical

Collection, preservation, culturing and identification of mycological specimens with special reference to taxa of agricultural importance; use of keys for identification.

Recommended Books:


PP - 702. MYCOLOGY-II (Zygomycota, Glomeromycota, Ascomycota, Basidiomycota and Mitosporic fungi)

Credit Hours: 3(2-1)

Prerequisites: Introductory Mycology

Learning Objectives:

To study taxonomy and nomenclature of fungi of agricultural importance

Theory

Zygomycota: General characters, various types of asexual reproductive structures; Zygosporogenesis; role of hormones in sexual reproduction; classification up to order level; Classification of Mucorales and Endogonales up to families and characteristics of important genera; evolution of Glomeromycota.


Practical

Collection, preservation, culturing and identification of mycological specimens with special reference to taxa of agricultural importance; use of keys for identification.
Recommended Books:


PP - 703. FUNGAL SYSTEMATICS

Credit Hours: 3(2-1)

Prerequisites: Introductory Mycology

Learning Objectives:

To study taxonomy and nomenclature of fungi of agricultural importance
Theory

Introduction to fungal systematics; diversity of fungi and Fungi-like organisms; concept of speciation in fungi; rules for fungal nomenclature; morphological, physiological and chemical characters as criteria for fungal classification; morphology-based systems for classification of fungi and fungi-like organisms; application of DNA sequence analysis to phylogenetic studies; different tree-making methods for molecular data; weighted parsimony; parsimony and phylogenetic inference using DNA sequences; statistical methods for testing molecular phylogenies; recent classification of fungi and fungi-like organisms on the basis of molecular phylogeny.

Practical

Use of diagnostic keys for the identification of various groups of fungi up to species level; speciation on the basis of molecular techniques; homology and phylogenetic weighting; use and comparison of different tree-making methods for molecular data.

Recommended Books:

PP - 704. FUNGAL PLANT PATHOLOGY

Credit Hours: 3(2-1)

Prerequisites: B. Sc. (Hons) Agriculture specialization in Plant Pathology

Learning Objectives: To study the fungal pathogens, pathogenesis and their management

Theory

History of fungal plant diseases; losses caused by plant pathogenic fungi; survival and dissemination of plant pathogenic fungi; stages in establishment of infection by fungal pathogens; mechanisms of host defense; effects of pathogens on plant physiological functions; symptoms caused by fungal pathogens; relationships between disease cycles and epidemics; mechanisms and stages of variation in fungal pathogens; genetics of virulence in fungal pathogens and resistance in host plants; chemical and non-chemical methods for disease management; study and management of important diseases caused by various groups of fungi and fungi-like organisms.

Practical

Symptomatology of fungal plant diseases; techniques for isolation, identification, sub-culturing and preservation of fungal plant pathogens; methods for confirmation of pathogenicity of various groups of plant pathogenic fungi; in vitro evaluation of fungicides and bio-control agents against fungal pathogens; demonstration of chemical and non-chemical methods of plant disease management.

Recommended Books:

PP - 705. Title of the Course: PLANT VIROLOGY

Credit Hours: 3(2-1)

Prerequisites: B. Sc. (Hons) Agriculture specialization in Plant Pathology

Learning Objectives: To study basic and advanced concepts of plant viruses and the diseases they cause

Theory

History and scope of plant virology; taxonomy and nomenclature; effects of viruses on plants; recent trends in virus transmission and movement in plants; structure of plant viruses; virus purification, replication, gene organization; physiology of virus infected plants; virus-vector-host interactions; natural and acquired resistance to virus infection; management of plant viruses; study of economically important viral diseases in Pakistan.

Practical

Field diagnosis of plant virus diseases; isolation and purification of plant viruses; basic virus characterization; serological techniques; electron microscopy; molecular techniques in virus detection.

Recommended Books:

1. Compendia of different crops, American Phytopathological Society, St Paul, Minnesota, USA.
PP - 706. PLANT BACTERIOLOGY

Credit Hours: 3(2-1)

Prerequisites: B. Sc. (Hons) Agriculture specialization in Plant Pathology

Learning Objectives: To study basic and applied concepts of plant pathogenic and allied bacteria

Theory

History of phytobacteriology; economic importance and characteristics of plant pathogenic bacteria; taxonomy and nomenclature, morphology, nutrition, growth and reproduction; survival mechanism in bacteria; bacterial pathogenesis and symptomology; hypersensitive reaction and host-specificity; ecology and spread of plant pathogenic bacteria; bacteriophages and bacteriocins; study of important bacterial diseases in Pakistan and their management; nitrogen fixing and nitrifying bacteria; plant growth promoting rhizobacteria (PGPR); effective microorganisms (EM).

Practical

Isolation, purification and identification of plant pathogenic bacteria on the basis of morphological, biochemical and molecular techniques; inoculation techniques and pathogenicity tests; demonstration of plant disease symptoms exhibited by bacteria/fastidious bacteria and mollicutes; sensitivity tests; characterization of bacteria using phages.

Recommended Books:

PP - 707. PLANT NEMATOLOGY

Credit Hours: 3(2-1)

Prerequisites: B. Sc. (Hons) Agriculture specialization in Plant Pathology

Learning Objectives:

To acquaint students with the basic and applied concepts of plant parasitic nematodes

Theory

Importance of plant parasitic nematodes; plant response to nematodes; environmental factors affecting survival and pathogenicity; morphology, anatomy, and reproduction; mode and mechanism of infection; concepts and principles of population dynamics; ecology of soil nematodes; estimation of crop losses; nematode-microbe interactions; molecular techniques for taxonomy; advances in phyto-nematological research with emphasis on nematode density/plant yield relationships; study of specific nematode diseases of Pakistan; management of plant parasitic nematodes; identification and propagation of entomopathogenic nematodes.

Practical

Isolation, identification and permanent mounting of important plant parasitic nematodes; pathogenicity tests; collection, handling and diagnosis of diseased plants by symptomatology; integrated management of plant parasitic nematodes.

Recommended Books:

PP – 708. ECOLOGY AND EPIDEMIOLOGY OF PLANT DISEASES

Credit Hours: 3(2-1)

Prerequisites: B. Sc. (Hons) Agriculture specialization in Plant Pathology

Learning Objectives:

To acquaint students with the concepts of ecology and plant disease epidemics

Theory

Definition, history and development of epidemiology, principles and concepts; effect of different environmental factors on growth, reproduction and spread of plant pathogens; ecological and population dynamic studies of different plant pathogens; influence of meteorological factors, host resistance and human interceptions on the development of epidemics; survival and propagation of plant pathogens; mapping of epidemic growth, analysis of epidemic growth curve and calculation of growth rate; disease progression and pattern of spread in nature (spatial and temporal); loss estimation using prediction models; pathometry; pre-requisites, visual assessment methods, descriptive and logarithmic scales, standard diagrams, incidence severity relationship, remote sensing, video image analysis.

Practical

Studies on the role of factors affecting disease development; use of different techniques to create artificial epidemics in greenhouse or growth chamber; calculation of severity of diseases by different procedures to monitor epidemics; plotting the growth curve by using different transformation procedures; monitoring disease; establishing prediction systems and executing control measures; use of agri-meteorological equipments and information

Recommended Books:


PP - 709. BIOCHEMISTRY AND PHYSIOLOGY OF DISEASED PLANTS

Credit Hours: 3(2-1)

Prerequisites: BSc. (Hons) Agriculture specialization in Plant Pathology

Learning Objectives: To study biochemical and physiological changes in diseased plants

Theory

Infection process of fungi, bacteria, viruses and nematodes; comparative analysis of biochemical and physiological changes in diseased and healthy plants; influence of plant pathogens on photosynthesis, respiration, translocation, transpiration, cell wall composition and metabolism, nucleic acid and protein metabolism; changes in secondary metabolites, membrane alterations; growth regulators phytoalexins and toxins; lectin degrading enzymes affecting host cell and cell wall; cutin and suberin degrading enzymes; effect of pathogens on trans-cellular and vascular transport; nature of morphological and biochemical resistance in host plants; energy use and metabolic regulation in plant-pathogen interactions; effects of root infecting fungi on structure and function of cereal roots; effects of disease on plant water relations; alterations in secondary metabolism; gene activation and interaction.

Practical

Experiments to illustrate infection processes by plant pathogens; histopathology of infected plant tissue; biochemical analysis to demonstrate changes induced by biotic and abiotic factors; bioassay of toxin and selection for host resistance.

Recommended Books:


PP - 710. GENETICS OF PLANT PATHOGENS

Credit Hours: 3(3-0)

Prerequisites: B. Sc. (Hons) Agriculture specialization in Plant Pathology

Learning Objectives: To study the genetics of plant pathogens

Theory

Mechanisms responsible for variation in plant pathogens including mutation, hybridization, heterokaryosis, parasexuality, adaptation, cytoplasmic inheritance and bacterial conjugation, transformation, and transduction; physiological specialization especially in fungi; Formation of new races and biotypes; The gene-for-gene-concept; genetics of host-pathogen interaction; speciation (species concepts), and population genetics of pathogen (Microevolution); study of pathogenicity of fungi, bacteria, viruses and nematodes; study of infection on differential hosts; recognition, colonization and virulence of plant pathogens; evolutionary biology of pathogens; phylogenetics (Macroevolution); genetic drift; gene flow; mating types/systems.

Recommended Books:

Co. India.

PP - 711. SEED PATHOLOGY

Credit Hours: 3(2-1)

Prerequisites: B. Sc. (Hons) Agriculture specialization in Plant Pathology

Learning Objectives:

To study the effects of plant pathogens on seed health and their management

Theory

Introduction to seed pathology; importance of seed-borne fungal, bacterial, viral and nematode diseases; histopathology of healthy and infected seeds/planting materials; mechanism of seed infection and disease transmission; factors affecting establishment of pathogens in seed; seed abnormalities and losses; seed quality control system for disease free seed production, processing and certification with special reference to Pakistan; seed crops and seed standards; seed treatment and equipments; seed processing and storage; seed health testing of consignment during export/import and testing of germplasm material; seed borne pathogens and their health hazards; description of important seed-borne diseases, forecasting of seed-borne diseases; accreditation of seed health testing/seed pathology labs; seed borne diseases and bioterrorism.

Practical

Seed-borne pathogens: identification, preservation, incidence and mode of seed transmission; effect of different chemicals and antagonistic microorganisms on seed-borne pathogens and seed germination; field crop inspection for disease assessment; seed sampling according to International Seed Testing Association (ISTA) methods; preparation of working sample for seed health testing; visits to seed testing laboratories and seed processing plants; maintenance of culture collection of identified seed-borne pathogens.

Recommended Books:


PP - 712. INTEGRATED PLAND DISEASE MANAGEMENT

Credit Hours: 3(2-1)

Prerequisites: B. Sc. (Hons) Agriculture specialization in Plant Pathology

Learning Objectives:

To acquaint the students with integrated plant disease management practices.

Theory

Introduction, history, concepts, prospects, principles, components and challenges in Integrated Plant Disease Management (IPDM); different plant disease management strategies, their integration and application; biological and environmental monitoring for sustainable disease management; role of biotechnology, remote sensing and information technology in IPDM; disinfection and pesticides application; resistance problems; production and evaluation of bio-control agents; biosafety regulations regarding release of biocontrol agents; role of community in IPDM; technology transfer in IPDM.

Practical

Integration of different methods for plant disease control; development of IPDM model.

Recommended Books:

3. Inderjit and K.G. Mukerji. 2006. Allelochemicals: Biological Control of Plant Pathogens and
Diseases. Springer.

PP - 713. POST-HARVEST PATHOLOGY

Credit Hours: 3(2-1)

Prerequisites: B. Sc. (Hons) Agriculture specialization in Plant Pathology

Learning Objectives: To study diseases affecting plants in transit and storage

Theory

Importance of post-harvest problems and economic losses; damage due to biotic and abiotic factors associated with grains and perishables during harvesting, transit and storage; physiological and biochemical changes in transit and storage due to diseases; mycotoxicoses of grains and perishables originating from field and storage fungi; effect of mycotoxins on human and animal health; management of post-harvest losses; use of radiation, waxing and other methods and their effect on product health and quality; grain storage management and fumigation technology; introduction and significance of commercial treatment including Vapor Heat Treatment (VHT) and Hot Water Treatment of perishable fruits for export to various countries; certification system of grains, fruits and vegetables; study of important postharvest diseases.

Practical

Visit to storages facilities and cargo centers for sampling; isolation and identification of microorganisms from diseased seeds and perishables; Estimation and management of losses; visits of VHT Treatment Plant and Hot Water Treatment Systems; visits of grains, fruits and vegetables storage houses.

Recommended Books:


**PP - 714 INSECTS IN RELATION TO PLANT DISEASES**

**Credit Hours:** 3(2-1)

**Objectives:**
To study role of insects in plant disease transmission

**Theory**
Insects as vector of plant diseases; Modes of transmission and dissemination of plant pathogens by insects; Ecology and insect-plant relationship; Factors affecting insect transmission; Symptomatology, etiology, epidemiology and management of fungal, bacterial and viral plant diseases transmitted by vectors.

**Practical**
Identification of insects as vectors of plant pathogens; methods of rearing and handling insect vectors for plant pathogenic studies; demonstration of modes of transmission of plant pathogens by insects, etc.

**Recommended Books:**
PP - 715. Title of the Course: FOREST AND SHADE TREE PATHOLOGY

Credit Hours: 3(2-1)

Prerequisites: B. Sc. (Hons) Agriculture specialization in Plant Pathology

Learning Objectives: To study forest and shade tree diseases and their management

Theory

Importance of forest and shade tree diseases; introduction to forest and shade tree diseases and their ecology, epidemiology and quantification of losses; forest operations in relation to development and spread of abiotic and biotic diseases; studies on specific diseases of representative groups; nursery plants and shade trees; management of important diseases.

Practical

Survey and collection of diseased specimens; study visits to national institutions working in forest and shade tree pathology; identification and preservation of causal agents; disease management based on cultural and chemical methods.

Recommended Books:


PP - 716. ADVANCES IN PLANT PATHOLOGY

Credit Hours: 3(3-0)

Prerequisites: B. Sc. (Hons) Agriculture specialization in Plant Pathology

Learning Objectives: To acquaint students with recent trends in Plant Pathology

Theory

Recent trends and developments in different disciplines of plant pathology; review of developments and future prospects of plant pathology; pathogenesis and host parasite specificity in bacteria, nematodes, fungi and viruses; molecular and biological techniques for identification and epidemiological studies of plant pathogens such as survival of pathogens and tracking of isolates; mechanism of genetic variability in pathogens; structure of genomes; allele specific and touch down PCR; molecular markers; molecular resistance; Review/Special Assignment/Presentation.

Recommended Books:

Recent books, journals, reviews, proceedings, reports in Planttt Pathology.

PP - 717. MOLECULAR PLANT VIROLOGY

Credit Hours: 3(2-1)

Prerequisites: B.Sc. (Hons) Agriculture specialization in Plant Pathology and Plant Virology course at M. Sc (H) level

Learning Objective: To study advances in virus research

Theory

Current concepts concerning biological, physical, serological and molecular properties of plant viruses and viroids; organization of virus genome; structure and in vitro assembly of plant viruses; events in plant virus infection; Molecular mechanisms of viral replication and pathogenesis; plant virus genome as source of novel function for gene manipulation; genetics of pathogen-derived resistance; genetic engineering with viroids, advances in virus host-cell interactions.
Practical

Plant virus diagnosis; study of viruses using molecular techniques; virus nucleic acid isolation and analysis; polymerase chain reaction for RNA and DNA virus genomes; production, analysis and field testing of transgenic plants.

Recommended Books:


PP - 718. MOLECULAR PLANT- MICROBE INTERACTIONS

Credit Hours: 3(2-1)

Prerequisites: BSc (Hons) Agriculture specialization in Plant Pathology

Learning Objectives:

To study various molecular interactions of plants and associated microbes

Theory

Theory of co-existence and co-evolution; plant-microbe associations; gradients of host- microbe interactions; molecular and genomic variability; pathogenesis: host recognition, signal transduction and compatibility; programmed cell death; hypersensitivity; production of antimicrobial compounds, enzymes, toxins and hormones; host and pathogen induced resistance, cross protection versus engineered resistance; gene silencing; hypo-virulence; disease management at molecular level i.e. gene manipulation for disease resistance (horizontal), systemic and local acquired resistances; clonal strategy and structural analysis of resistance genes.
Practical

DNA extraction, purification and quantification; DNA Hybridization; pathogenic variability based on molecular approaches.

Recommended Books:

7. Recent books, journals, reviews, proceedings, reports in Plant Pathology.

**PP - 719. PLANT PATHOLOGY AND INTERNATIONAL OBLIGATIONS**

**Credit Hours:** 3(3-0)

**Prerequisites:** B. Sc. (Hons) Agriculture specialization in Plant Pathology

**Learning Objectives:** To educate the students on international obligations and agreements with special reference to Plant Pathology

**Theory:**

International treaties, agreements and their relevance to Plant Pathology; an overview of Cartagena protocol on bio-safety; Codex Alimentarius commission (CAC); Intellectual property right (IPR); International plant protection convention (IPPC); Sanitary and phytosanitary measures (SPS) and their working; Food and agriculture organization (FAO) and its working related to World Trade Organization (WTO); issues and problems in import/export relating to phytosanitary aspects of agricultural commodities; impact of major agreements on economy of Pakistan; requirement of material transfer agreement (MTA) regarding movement of plant genetic materials and their testing for health status; worldwide major risks of plant diseases; Introduction to approved ISPMs by IPPC 1997; Framework for Pest Risk Analysis; ISO certification of Plant Pathology Technical Laboratories version 17025; introduction, importance and significance of alien species in international trade; biosecurity and measures to
encounter bioterrorism; Review/Special Assignment/Presentation.

**Recommended Books:**


**PP - 720. BIOLOGICAL CONTROL OF PLANT PATHOGENS**

**Credit Hours:** 3(2-1)

**Prerequisites:** B. Sc. (Hons) Agriculture specialization in Plant Pathology

**Learning Objectives:** To manage plant pathogens through biological approaches

**Theory**

History and importance of biological control; biological control and types of biological interaction; factors involved in biological control; different biocontrol approaches like antagonistic microorganisms, allelopathy, plant and pathogen-derived resistance; methods for stimulation of indigenous biocontrol agents; mass production and commercialization of biocontrol agents; study of different biological agents, mechanism of biocontrol at macro and molecular level.

**Practical**

Isolation, identification, purification and application of biocontrol agents under laboratory and field conditions; preparation of plant products and their evaluation against various plant pathogens; demonstration of mechanisms of biocontrol.
**Recommended Books:**


**PP - 721. BIOINFORMATICS IN PLANT PATHOLOGY**

**Credit Hours:** 3(2-1)

**Prerequisites:** B. Sc. (Hons) Agriculture specialization in Plant Pathology

**Learning Objectives:**

To study basic and applied aspects of Bioinformatics tools in Plant Pathology

**Theory**

Significance of bioinformatics in Plant Pathology; molecular evolution and goals of molecular phylogeny; properties and types of trees; stages of phylogenetic analysis; phylogenetic methods; access to biological sequence databases; basic local alignment search tool (BLAST); pair-wise and multiple sequence alignment; microarray data analysis: pre-processing, scatter plots and microarray plots, global and local normalization, ratios and other parameters; gene, promoter and regulatory element prediction in prokaryotes and eukaryotes; plant resistance genes database (PRGdb); ribosomal data bank project (RDBP); protein domains and motifs, protein sequence and structure, the protein data bank, protein structure, prediction and interaction.

**Practical**

Demonstration of bioinformatics tools; primer designing, sequence alignment, editing and
molecular phylogeny of plant pathogens; construction and analysis of phylogenetic trees.

**Recommended Books:**

8. Latest Bioinformatics Software.

**PP - 722. PLANT PATHOLOGY AND ENVIRONMENTAL CONCERNS**

**Credit Hours:** 3(3-0)

**Prerequisites:** B. Sc. (Hons) Agriculture specialization in Plant Pathology

**Learning Objectives:** To acquaint the students about the environmental issues relevant to Plant Pathology

**Theory**

Introduction to environmental complex; role of anthropogenic activities in degradation of natural resources; environmental pollution caused by use of pesticides and agricultural/industrial wastes; Environmental impact assessment (EIA) as instrument of environmental management; global climate change and its impact on distribution of plant diseases with special emphasis on disease outbreak; environmental and biosafety hazards of genetically modified organisms (GMOs) and risk assessment studies; biosensors as environmental Monitors; Microorganisms as bio-indicators of environmental pollution; bioremediation. Review/Special Assignment/Presentation.

**Recommended Books:**

PP - 723. VECTOR TRANSMISSION OF PLANT DISEASES

Credit Hours: 3(2-1)

Prerequisites: B. Sc. (Hons) Agriculture specialization in Plant Pathology

Learning Objectives: To study the role of insects in plant disease transmission

Theory

Insects, nematodes and fungus-like organisms as vectors of plant diseases; modes of transmission and dissemination of plant pathogens by vectors; ecology and vector-plant relationship; factors affecting vector transmission; symptomatology, etiology, epidemiology and management of major fungal, bacterial and viral plant diseases transmitted by vectors.

Practical

Identification of nematodes and fungus-like organisms as vectors of plant pathogens; methods of rearing and handling insect vectors for plant pathogenic studies; demonstration of modes of transmission of plant pathogens by vectors.

Recommended Books:

5. Recent books, journals, reviews, proceedings, etc.