Department of Plant Pathology and Agricultural Microbiology
Mahatma Phule Krishi Vidyapeeth
Rahuri-413 722, Dist. Ahmednagar (MS)

Doctoral Programme in Plant Pathology

Course Layout

Minimum Credit Requirements

Sr. No.	Subject	Minimum credit (s)
1.	Major	18
2.	Minor	10
3.	Supporting	05
4.	Seminar	02
5.	Research	45
6.	Total Credits	35+45=80
7.	Compulsory Non Credit Courses	06

Sr. No.	Course Number	Course Title	Credits
Plant Pathology			
A) Major subjects (Min. 18 credits)			
I Semester			
1.	PL. PATH.601	Advanced Mycology	2+1=3
2.	PL. PATH.602	Advanced Virology	2+1=3
3.	PL. PATH.603	Advanced Bacteriology	2+1=3
II Semester			
4.	PL.PATH.518	Epidemiology and Forecasting of Plant Diseases	2+1=3
5.	PL. PATH.604	Molecular Basis of Host Pathogen Interaction	2+1=3
III Semester			
6.	PL. PATH.605	Principles and Procedures of Certification	1+0=1
7.	PL. PATH.606	Plant Biosecurity and Biosafety	2+0=2
		Total	13+5=18

B) Minor Subjects (Min. 10 credits)			
I Semester			
1.	**GP 604**	**Molecular and Chromosomal Manipulations for crop Breeding**	**2+0=2**
2.	**BIOCHEM 607**	**Advanced Techniques in Biochemistry**	**0+2=2**
II Semester			
3.	**NEMA 603**	**Advances in Nematode Management**	**2+1=3**
4.	**GP 608**	**Advances in Breeding of major field crop**	**3+0=3**
		Total	**7+3=10**
C) Supporting Subjects (Min. 06 credits)			
II Semester			
1.	**BIOCHEM 603**	**Biochemistry of Biotic and Abiotic Stresses**	**3+0=3**
III Semester			
2.	**ENT 608**	**Advanced Host Plant Resistance**	**3+0=3**
		Total	**6+3=06**
D) Seminar (Min. 02 credits)			
III Semester			
1.	**PL. PATH.691**	**Doctoral Seminar-I**	**0+1=1**
IV Semester			
2.	**PL. PATH.692**	**Doctoral Seminar-II**	**1+0=1**
		Total	**1+1=02**
E) Doctoral Research (Min. 06 credits)			
1.		**Doctoral Research**	**45**
F) Non Credit Compulsory Courses			
I Semester			
1.	**PGS 501**	**Library and Information Services**	**0+1=1**
2.	**PGS 504**	**Basic concepts in Laboratory techniques**	**1+0=1**
II Semester			
3.	**PGS 502**	**Technical Writing and Communication Skill**	**0+1=1**
4.	**PGS 503**	**Intellectual Property and its Management in Agriculture**	**1+0=1**
III Semester			
5.	**PGS 505**	**Agricultural Research Ethics and Rural Development Programme**	**1+0=1**
6.	**PGS 506**	**Disaster Management**	**0+1=1**
		Total	**3+3=06**

Course Contents

A) Major Subject:-

I Semester:-
i) Advanced Mycology
Theory Syllabus:
UNIT I
General introduction, historical development and advances in mycology.
UNIT II
Recent taxonomic criteria, morphological criteria for classification. Serological, Chemical (chemotaxonomy), Molecular and Numerical
(Computer based assessment) taxonomy.
UNIT III
Interaction between groups: Phylogeny. Micro conidiation, conidiogenesis and sporulating structures of fungi imperfecti. Morphology and reproduction of representative plant pathogenic genera from different groups of fungi. Sexual reproduction in different groups of fungi.
UNIT IV
Population biology, pathogenic variability/vegetative compatibility.
UNIT V
Heterokaryosis and parasexualcycle.Sex hormones in fungi.
Pleomorphism and speciation in fungi.Mechanism of nuclear inheritance.
Biodegradation.

Practical Syllabus:

Study of conidiogenesis- phialides, porospores, arthospores. Study of fruit bodies in Ascomycotina. Identification of fungi up to species level.Study of hyphal anastomosis.Morphology of representative plant pathogenic genera from different groups of fungi.Mechanism of extra-nuclear inheritance.

Text book and Reference books:

Alexopoulos C.J., Mimms C.W & Blackwell M. 1996. *Introductory Mycology*. John Wiley & Sons, New York.

Dube H.C. 2005. *An Introduction to Fungi*. 3rd Ed. Vikas Publ. House, New Delhi.

Kirk P.M., Cannon PF, David J.C &Stalpers J.A. (Eds.). 2001. *Ainswsorth and Bisby's Dictionary of Fungi*. 9th Ed., CABI, Wallington.

Ulloa M &Hanlin R.T. 2000. *Illustrated Dictionary of Mycology*. APS, St. Paul, Mennisota.

Webster J & Weber R. 2007. *Introduction to Fungi*.Cambridge Univ. Press, Cambridge.

ii) Advanced Virology
Theory Syllabus
UNIT I
Mechanism of virus transmission by vectors, virus vector relationship, bimodal transmission and taxonomy of vectors and viruses, vector specificity for classes of viruses, virus replication, assembly and architure, ultra structural changes due to virus infection, variation mutation and virus strains
UNIT II
Immunoglobulin structure and functions of various domains, methods of immunodiagnosis, hybridoma technology and use of monoclonal antibodies in identification of viruses and their strains, polymerase chain reaction.
UNIT III
Genome organization, replication, transcription and translational strategies of pararectro viruses and Gemini viruses, satellite viruses and satellite RNA genome organization in tobamo – poty, bromo, cucumo, ilur and tospoviruses
UNIT IV
Gene expression and regulation, viral promoters, molecular mechanism of host virus interactions, virus induced gene, molecular mechanism of vector transmission, symptom expression, viroid and prions
UNIT V
Genetic engineering with plant viruses viral suppressors, a RNAi dynamics, resistant genes, viruses potential as vectors, genetically engineered resistance, transgenic plants
UNIT VI
Techniques and application of tissue culture, origin, evolution and inter relationship and animal viruses

Practical Syllabus:

Purification of virus(es). SDS-PAGE for molecular weight determination. Production of polyclonal antiserum, purification of IgG and conjugate preparation, serological techniques (i) DAC-ELISA (ii) DAS-ELISA (iii) DIBA (iv) Western blots (v) (ab) 2-ELISA, vector transmission (one each with aphid, leaf hopper and whitefly), methods for collecting vectors and their maintenance, nucleic acid isolation, DOT-blot, southern hybridization, probe preparation and autoradiography, PCR application and viral genome cloning, sequencing annotation of genes.

Text book and Reference books:

Davies 1997. Molecular Plant Virology, Replication and Gene Expression. CRC Press, Florida.

Thresh J. M. 2006. Plant Virus Epidemiology.Advances in Virus Research 67.Academic Press.New York.

iii) <u>Advanced Bacteriology</u>
Theory Syllabus:
UNIT I
Current approaches for the characterization and identification of phytopathogenic bacteria. Ultrastructures and Biology of bacteria.
UNIT II
Current trends in taxonomy of phytopathogenicprokarya.
UNIT III
Role of enzyme, toxin, expolysaccharide, polypeptide signals in disease development. Mechanism of wilt *(Ralstoniasolanacearum*) development, mechanism of soft rot (Erwinia spp.) development, mechanism of Crown gall formation (*Agrobacterium tumifaciens*)
UNIT IV
Host-bacterial pathogen interaction, quorum-sensing phenomenon, Type III secretion system, HR/SR reactions, R- genes, Avr-genes, hrp genes, Effector protein.
UNIT V
Molecular variability among phytopathogenicprokarya and possible host defense mechanism (s).Genetic engineering for management of bacterial plant pathogens-gene silencing, RNAi technology.
UNIT VI
Epidemiology in relation to bacterial plant pathogens.Development of diagnostic kit.
UNIT VII
Beneficial prokaryotes-Endophytes, PGPR, phylloplane bacteria and their role in disease management.Endosymbionts for host defense.

Practical Syllabus:

Pathogenic studies and race identification, plasmid profiling of bacteria, fatty acid profiling of bacteria, RAPD profiling of bacteria and variability status, endospore, flagella straining, test for secondary metabolite production-cyanide, extra-cellular polysaccharides and siderophore, specific detection of plant pathogenic bacteria using species/pathovar specific primers. Basic techniques in diagnostic kit development, molecular tools to identify phytoendosymbionts.

Text book and Reference books:

Dale J.W & Simon P. 2004. *Melecular Genetics of bactaeria.* John Wiley & Sons, New York.

Garrity G.M, Krieg N.R & Brenner D.J. 2006. *Bergey's Manual of Systematic Bacteriology; the Proteobacteria.* Vol. II Springer Verlag, New York.

Gnanamanicham S.S. 2006. Plant-Associated Bacteria.SpringerVerlag. New York.

Mount M.S.& Lucy. GH. 1982. Plant Pathogenic Prokaryotes. Voles. I, II, Academic Press, New York.

SigeeD.C. 1993, Bacterial Plant Pathology; Cell and Molecular Aspects
CambridgeUniv. Press, Cambridge.
Starr M.P. 1992. The Prokaryotes. Vols. I-IV.SpringerVerlag, New York.

Books and manuals recommended (Practical):

Cuppucino, J.G.and Sherman, N. 1987. Microbiology A Laboratory Manual, 2nd Edition, The Benjamin Cummings Publishing Company Inc.
Klement, Z., rudolph, K. and Sands, D.C. 1990. Methods in phytobacteriology. Akademiai Kiado, Budapest.

II Semester:-
iv. Epidemiology and Forecastingof Plant Diseases
Theory Syllabus:
UNIT I
Epidemic concept and historical development, pathometry and crop growth stages, epidemic growth and analysis.
UNIT II
Common and natural logarithms, function fitting area under disease progress curve and correction factors, inoculum dynamics, population biology of pathogens, temporal spatial variability in plant pathogens.
UNIT III
Survey, surveillance and vigilance, crop loss assessment and models.
UNIT IV
Principles and pre-requisites of forecasting, systems and factors affecting various components of forecasting, some early forecasting, procedures based on weather and inoculum potential, modeling disease growth and disease prediction.

Practical Syllabus:

Measuring diseases, spore dispersal and trapping, weather recording survey, multiplication of inoculum, computerized data analysis, function fitting, model preparation and validation.

Text book and Reference books:

Campbell C.L & Madden L.V. 1990. Introduction to Plant Disease Epidemiology.John Wiley & Sons. New York
Chiarappa L. 1971. Crop loss assessment methods, FAO manual. Close R.C. Harvey I.C. and Sanderson F.R. 1978. Epidemiology and croploss assessment, Proceedings of a workshop held at Lincoln College, Canterbury, New Zealand.
Cowling E.B &Horsefall J.G. 1987. Plant Disease. Vol. II Academic Press,New York.
Laurence V.M, Gareth H & Frame Van den Bosch (Eds). The Study of Plant Disease Epidemics.APS, St. Paul, Minnesota.
Nagarajan S. 1983. Plant disease epidemiology, Oxford and IBH publishing Co, New Delhi.

Nagrajan S. and Muralidharan 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.
Vanderplank, J.E. 1963. Plant Diseases; Epidemics and control. Acad, Press, London
Zodaks J.C. and Schein, R.D. 1979. Epidemiology and Plant Disease Management. OxfordUniv., Press, London.

Suggested Reading(Practical):

Close R.C. Harvey I.C. and Sanderson F.R. 1978. Epidemiology and crop loss assessment, Proceedings of a workshop held at Lincoln College, Canterbury, New Zealand.
Chiarappa L. 1971. Crop loss assessment methods, FAO manual.

v) <u>Molecular basis of Host Pathogen Interaction</u>
Theory Syllabus:
UNIT I
Importance and role of biotechnological tools in Plant Pathology-Basic concepts and principles to study host pathogen relationship.
UNIT II
Molecular basis of host – pathogenesis interaction-fungi, bacteria and viruses: recognition system, signal transduction.
UNIT III
Induction of defense responses-pathogenesis related proteins, HR, reactive oxygen species, phytoatexins and systemic acquired resistance. Programmed Cell Death, Viral induced gene silencing.
UNIT IV
Molecular basis of gene-for-gene hypothesis; R-gene expression and transcription profiling, mapping and cloning of resistance genes and marker-aided selection, pyramiding of R genes.
UNIT V
Biotechnology and disease management; development of diseases resistance plants using genetic engineering approaches, different methods of gene transfer, biosafety issues related to GM crops.

Practical Syllabus:

Protein, DNA and RNA isolation, Plasmids extraction, PCR analysis, DNA and Protein electrophoresis, bacterial transformation.

Text book and Reference books:

ChetI. 1993, *Biotechnology in Plant Disease Control*. John Wiley & Sons, New York.
Gurr SJ, Mc Pohersen MJ & Bowlos DJ. (Eds.) 1992, *Molecular Plant Pathology-A Practical Approach*.Vols. I& II, Oxford, Univ. Press, Oxford, London
Mathew J.D. 2003, *Molecular Plant Pathology, Bios Scientific Publ*., U.K.
Ronald P.C, 2007 *Plant Pathogen Interactions*: *Methods in Molecular Biology* Humana Press, New Jersey.

Stacey G & Keen T.N. ((Eds.). 1996. Plant Microbe Interactions. Vols, I-III Chapman & Hall, New York; Vol. IV.APS Press, St. Paul, Minnesota.

Books and manuals recommended:

David T.Plummer 1988. An Introduction to Practical Biochemistry, 3rd Edition, Tata McGraw Hill Publishing Company Limited, New Delhi.
Mahadevan, A. and Ulaganthan, K. 1992. Techiques in Molecular Plant Pathology.Sivakami Publications, Madras.

III Semester:-
vi) Principles and Procedure of Certification
Theory Syllabus:
UNIT I
Introduction to certification.International scenario o0f certification and role of ISTA, EPPO, OECD etc. in certification and quality control.
UNIT II
Case studies of certification systems of USA and Europe, National Regulatory mechanism and certification system including seed certification, minimum seed certification standards. National status of seed health in seed certification Methods for testing genetic identity, physical purity, germination percentage, seed health etc.
UNIT III
Fixing tolerance limits for disease and insect pests in certification and quality control programmes. Methods used in certification of seeds, vegetative prop gules and *in vitro* cultures. Accreditation of seed testing laboratories.Role of seed/ planting material health certification in national and international trade.

Text book and Reference books:

Association of Official Seed Certifying Agencies.http://www.aosca.org/index.htm.
Hutchins D & Reeves J.E. (Eds.). 1197. Seed Health Testing: Progress *Towards the 21st Century* . CABI, UK.
ISHI-*veg Manual of Seed HealthTestingMethods.*http://www.worlseed.org/en-us/international_seed/ishi_vegetable.html ISHI-F*Manual of Seed Health Testing Methods.* http://www.worldseed.org/en-us/international_seed/ishi_f.html
ISTA *Seed Health Testing Methods.* http:/www.seedtest.org/en/content---1—1132—241.html
Tunwar N.S & Singh Seed sv. 1988. *Indian Minimum seed Certification Standards.*Central Seed Certification Board, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi.
US National Seed Health System. http://www/seedhealth.org/

vii) Plant Biosecurity and Biosafety
Theory Syllabus:
UNIT I
History of biosecurity, Concept of biosecurity, Components of biosecurity,
Quarantine, Invasive Alien Species, Biowarfare, Emerging/resurgence of pests and diseases.

UNIT II
National Regulatory Mechanism and International Agreements/Conventions viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures/World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity.
UNIT III
Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, Issues related to release of genetically modified crops.

Text book and Reference books:

FAO Biosecurity Toolkit 2008.www.fao.org/docrep/010/a1140e/a1140e00.htm
Laboratory Biosecurity Guidance.
http://www.who.int/csr/resources/publications/biosafety/WHO_CDS_EPR_2006.pdf
Grotto Andrew J & Jonathan B Tucker. 2006. *Biosecurity: AComprehensive Action Plan.*
http://www.americanprogress.org/kf/biosecurity_a_comprehensive_action_plan.pdf*Biosecurity Australia*
www.daff.gov.au/ba;www.affa.gov.au/biosecurityaustralia*Biosecurity New Zealand.* www.biosecurity.govt.nz DEFRA.
www.defra.gov.uk/animalh/diseases/control/biosecurity/index.htm
Randhawa G.J, Khetarpal R.K, Tyagi R.K &Dhillon. B.S (Eds.). 2001.
*Transgenic Crops and Biosafety Concerns.*NBPGR, New Delhi.
Khetarpal R.K &Kavita Gupta 2006.*Plant Biosecurity in India - Status and Strategy.* Asian Biotechnology and Development Review 9(2): 39-63.
Biosecurity for Agriculture and Food Production.http://www.fao.org/biosecurity/
FIA.http://www.inspection.gc.ca/english/anima/heasan/fad/biosecure.shtMl