ETERNAL UNIVERSITY

(ESTABLISHED UNDER HIMACHAL PRADESH GOVERNMENT ACT NO.3 OF 2009)

BARU SAHIB
HIMACHAL PRADESH

WORLD PEACE THROUGH VALUE BASED EDUCATION

DR. KHEM SINGH GILL AKAL COLLEGE OF AGRICULATURE

Ph.D. PLANT PTHLOLOGY AS PER BSMA COMMITTEE – ICAR NEP 2020 CURRICULUM

APPROVED VIDE ANNEXURE 4.1.3 OF 87TH ACADEMIC COUNCIL MEETING HELD ON 25TH JULY, 2025

TO BE IMPLEMENTED FROM THE ACADEMIC SESSION 2025-26

Dean
Academic Affairs
Eternal University
Baru Sahib (H.P.) 173101

Registrar (Officiating)
Eternal University
Baru Sahib (H.P.) 173101

ETERNAL UNIVERSITY

BARU SAHIB, RAJGARH, SIRMOUR
HIMACHAL PRADESH

Restructured and Revised Syllabi of Ph.D. Plant Pathology as per BSMA Committee – ICAR (NEP 2020)

Syllabi Applicable from Academic Session 2025-26 onwards

Dr. Khem Singh Gill Akal College of Agriculture

Common Academic Regulations for PG and Ph.D. Programmes as per BSMA Committee – ICAR (NEP 2020)

1. Academic Year and Registration

- An academic year shall be normally from August to July of the following calendar year otherwise required under special situations. It shall be divided into two academic terms known as semesters. Dates of registration, commencement of instructions, semester end examination, end of semester and academic year, etc. The Academic Calendar shall be developed by the concerned University from time totime and notified accordingly by the Registrar in advance.
- An orientation programme shall be organized by the Dean Academic Affairs / Dean PGS for the benefit of the newly admitted students immediately after commencement of the semester.
- On successful completion of a semester, the continuing students shall register for subsequent semester on the date specified in the Academic/ Semester Calendar or specifically notified separately. Every enrolled student shall be required to register at the beginning of each semester till the completion of his/ her degree programmes.

2. Credit requirements

2.1 Framework of the courses

The following nomenclature and Credit Hours need to be followed while providing the syllabus for all the disciplines:

	Doctoral Programme
(i) Course work	
Major courses	12
Minor courses	06
Supporting courses	05
Common courses	–
Seminar	02
(ii) Thesis Research	75

Total	100

Major courses: From the Discipline in which a student takes admission. Among the listed courses, the core courses compulsorily to be taken may be given *mark

Minor courses: From the subjects closely related to a student's major subject

Supporting courses: The subject not related to the major subject. It could be any subject considered relevant for student's research work (such as Statistical Methods, Design of Experiments, etc.) or necessary for building his/ her overall competence.

Common Courses: The following courses (one credit each) will be offered to all students undergoing Ph.D. programme if they have not studied any of these courses in Masters programme:

1. Library and Information Services
2. Technical Writing and Communications Skills
3. Intellectual Property and its management in Agriculture
4. Basic Concepts in Laboratory Techniques
5. Agricultural Research, Research Ethics and Rural Development Programmes

2.2 Supporting Courses

The following courses are being offered by various disciplines (The list is only indicative). Based on the requirement, any of the following courses may be opted under the supporting courses. The syllabi of these courses are available in the respective disciplines. If required, the contents may be modified to suit the individual discipline with approval of the concerned BoS:

Code	Course Title	Credit Hours
STAT 501	Mathematics for Applied Sciences	2+0
STAT 502	Statistical Methods for Applied Sciences	3+1
STAT 511	Experimental Designs	2+1
STAT 512	Basic Sampling Techniques	2+1
STAT 521	Applied Regression Analysis	2+1
STAT 522	Data Analysis Using Statistical Packages	2+1
MCA 501	Computers Fundamentals and Programming	2+1
MCA 502	Computer Organization and Architecture	2+0
MCA 511	Introduction to Communication Technologies, Computer Networking and Internet	1+1
MCA 512	Information Technology in Agriculture	1+1
BIOCHEM 501	Basic Biochemistry	3+1
BIOCHEM 505	Techniques in Biochemistry	2+2

2.3 Syllabus of Common Courses for PG programmes

LIBRARY AND INFORMATION SERVICES (0+1)

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; e-resources access methods.

TECHNICAL WRITING AND COMMUNICATIONS SKILLS (0+1)

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 abstracts, summaries, précis, citations, etc.;
- Commonly used abbreviations in the theses and research communications;
- 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, Phonetic symbols andtranscription;
- Accentual pattern: Weak forms in connected speech;
- Participation in group discussion;
- Facing an interview;
- Presentation of scientific papers.

Suggested Readings

1. Barnes and Noble. Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language*.
2. *Chicago Manual of Style*. 14th Ed. 1996. Prentice Hall of India.
3. *Collins' Cobuild English Dictionary*. 1995.
4. Harper Collins. Gordon HM and Walter JA. 1970. *Technical Writing*. 3rd Ed.
5. Holt, Rinehart and Winston. Hornby AS. 2000. *Comp. Oxford Advanced Learner'sDictionary of Current English*. 6th Ed. OXford University Press.
6. James HS. 1994. *Handbook for Technical Writing*. NTC Business Books.
7. Joseph G. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. AffiliatedEast-West Press.
8. Mohan K. 2005. *Speaking English Effectively*. MacMillan India.
9. Richard WS. 1969. *Technical Writing*.
10. Sethi J and Dhamija PV. 2004. *Course in Phonetics and Spoken English*. 2nd Ed.Prentice Hall of India.
11. Wren PC and Martin H. 2006. *High School English Grammar and Composition*. S. Chand & Co.

INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE(1+0)

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 Readings

1. Erbisch FH and Maredia K.1998. *Intellectual Property Rights in Agricultural Biotechnology*. CABI.
2. Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy*. McGraw-Hill.
3. *Intellectual Property Rights: Key to New Wealth Generation*. 2001. NRDC and Aesthetic Technologies.
4. Ministry of Agriculture, Government of India. 2004. *State of Indian Farmer*. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
5. Rothschild M and Scott N. (Ed.). 2003. *Intellectual Property Rights in Animal Breeding and Genetics*. CABI.
6. Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies*. Daya Publ. House.

The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; The Biological Diversity Act, 2002.

BASIC CONCEPTS IN LABORATORY TECHNIQUES (0+1)

Objective

To acquaint the students about the basics 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;
- Handling techniques of solutions;

- Preparation of different agro-chemical doses in field and pot applications;
- 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 taXonomy.

Suggested Readings

1. Furr AK. 2000. *CRC Hand Book of Laboratory Safety*. CRC Press.
2. Gabb MH and Latchem WE. 1968. *A Handbook of Laboratory Solutions*. ChemicalPubl. Co.

AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES (1+0)

Objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory

UNIT I History of agriculture in brief; Global agricultural research system: need, scope, opportunities; 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.

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

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 Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

1. Bhalla GS and Singh G. 2001. *Indian Agriculture - Four Decades of Development*.Sage Publ.
2. Punia MS. *Manual on International Research and Research Ethics.* CCS HaryanaAgricultural University, Hisar.
3. Rao BSV. 2007. *Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives*. Mittal Publ.
4. Singh K. 1998. *Rural Development - Principles, Policies and Management*. SagePubl.

2.4 Mandatory requirement of seminars

- There will be mandatory seminars two in Doctoral programmes (two Credits).
- The students should be encouraged to make presentations on the latest developments and literature in the area of research topic. This will provide training to the students on preparation for seminar, organizing the work, critical analysis of data and presentation skills.

3. Residential requirements

- The minimum and maximum duration of residential requirement for Ph.D. Programmes shall be as follows:

Programme	Duration of Residential Requirement	
	Minimum	Maximum
Ph.D.*	3 Academic Years	7 Academic Years
	(6 Semesters)	(14 Semesters)

*Student may be allowed to discontinue temporarily only after completion of course work

In case a student fails to complete the degree programme within the maximum duration of residential requirement, his/ her admission shall stand cancelled. The requirement shall be treated as satisfactory in the cases in which a student submits his/ her thesis any time during 6^{th} semester of his/ her residentship at the University for Ph.D. programme.

4. Evaluation of course work and comprehensive examination

- For Ph.D., the approach should be research oriented rather than exam oriented. In order to provide the student adequate time to concentrate on the research work and complete the degree in stipulated time, the examination may have to be only semester final. However, the course teacher may be given freedom to evaluate in terms of assignment/ seminar/ first test.
- For Ph.D., the comprehensive examination (Pre-qualifying examination) is required. As the students are already tested in course examinations, the comprehensive examination should be based on oral examination by an external expert and the evaluation should cover both the research problem and theoretical background to execute the project. This shall assess the aptitude of the student and suitability of the student for the given research topic. The successful completion of comprehensive examination is to obtain the "Satisfactory" remark by the external expert.

5. Registration and Award of Ph.D. Degree as per Students' Guide, Eternal University – 2021 & BSMA Committee Guidelines of ICAR

Restructured and Revised Syllabi of Ph.D. Plant Pathology as per BSMA Committee – ICAR (NEP 2020)

(i) Course work	Credits (Minimum requirement)
Major courses	12
Minor courses	06
Supporting courses	05
Common courses	-
Seminar	02
(ii) Thesis Research	75
Total	100

Note:

As per New Education Policy, the student has the option to exercise his choice for the courses. Hence semester wise syllabus scheme has to be prepared by the Major Advisor / Head of the Department by instructingand guiding the student to fill Programme of Study for Postgraduate Students (PSPS) popularly known as yellowform within one week after getting admission/registration

Course Title with Credit Load Ph. D. Plant Pathology

Course Code	Course Title	Credit Hours
Pl PATH 601*	Advances in Mycology	2+1
Pl PATH 602	Advances in Virology	2+1
PL PATH-603	Advances in Plant Pathogenic Prokaryotes	2+1
PL PATH-604*	Molecular Basis of Host-pathogen Interaction	2+1
PL PATH-605	Principles and Procedures of Certification	2+1
PL PATH-606	Plant Biosecurity and Biosafety	3+0
	Minor courses	06
	Supporting courses	05
PL PATH 691	Seminar I	1+0
PL PATH 692	Seminar II	1+0
PL PATH 699	Thesis Research	75

*Indicates Core course for Ph.D.

Major courses: *Mark course are compulsory to be registered by a student

Minor courses: From the subjects closely related to a student's major subject

Supporting courses: The subject not related to the major subject. It could be any subject considered relevant for student's research work (such as Statistical Methods, Design of Experiments, etc.) or necessary for building his/ her overall competence.

Common Courses: The following courses (one credit each) will be offered to all students undergoing Master's degree programme:

Common Courses: 05 credits

PGS 501	Library and Information Services	0+1
PGS 502	Technical Writing and Communications Skills	0+1
PGS 503	Intellectual Property and its management in Agriculture	1+0
PGS 504	Basic Concepts in Laboratory Techniques	0+1
PGS 505	Agricultural Research, Research Ethics and Rural Development Programmes	1+0

Note:

If a student has not cleared the Common Courses during Master's Degree Programme, then he/she has to study Common Courses during Doctoral Degree Programme

SCHEME OF EXAMINATION

(Continuous Assessment and End-Semester Examination)

MARKS DISTRIBUTION FOR DIFFERENT CREDIT HOUR COURSES

CREDITS	THEORY			PRACTICALS		
T+P	Total	Mid- Session	End Term	Total	Mid- Session	End Term
1+0	100	40	60	-	-	-
2+0	100	40	60	-	-	-
3+0	100	40	60	-	-	-
4+0	100	40	60	-	-	-
5+0	100	40	60	-	-	-
6+0	100	40	60	-	-	-
0+1	0	0	0	100	50	50
1+1	50	20 (15+5#)	30	50	-	50
2+1	65	25 (20+5#)	40	35	-	35
3+1	75	30 (25+5#)	45	25	-	25
4+1	80	35 (30+5#)	45	20		20
0+2	0	0	0	100	50	50
1+2	35	15 (10+5#)	20	65	-	65
2+2	50	20 (15+5#)	30	50		50
3+2	60	25 (20+5#)	35	40		40
0+3	0	0	0	100	50	50

#Assignments marks

Ph.D. Plant Pathology

Syllabus Scheme Semester Wise

Semester I				
S. No.	**Course Code**	**Course Title**	**Credit hours**	**Semester**
	Major courses (Compulsory Major Courses)			
1	Pl PATH- 601	Advances in Mycology	(2+1)= 3	I
	Major courses (Optional Courses)			
1	Pl PATH -602	Advances in Virology	(2+1)= 3	I
2	PL PATH-605	Principles and Procedures of Certification	(2+1) = 3	I
	Note-Student has to select minimum of three credits in optional courses from the above list in this semester.			
	Minor courses			
1	ENT-502	Insect Anatomy and Physiology	(2+1)= 3	I
2	GPB-502	Principles of Plant Breeding	(2+1)=3	I
3	VSC-504	Principles of Vegetable Breeding	(2+1)= 3	I
	Note-Student has to select minimum of three credits in minor courses from the above list in this semester.			
	Supporting courses			
1	SOIL-509	Remote Sensing and GIS Technique for Soil and Crop Studies	(2+1) = 3	I
2	MBB-504	Techniques in Molecular Biology I	(3+0) = 3	I
3.	ENT-505	Biological Control of Insect Pests and Weeds	(2+1) = 3	I
	Note-Student has to select minimum of three credits in supporting courses from the above list in this semester.			
	Compulsory Non-Credit Courses (Common Courses)			
1	PGS-501	Library and Information Services	(0+1) = 1	I
2	PGS-502	Technical Writing and Communications Skills	(0+1) = 1	I
	Doctoral Research			
1	PL PATH-699	Doctoral Research **(Research Proposal and Collection of review**	(0+2) = 2	I

		of literature)		
	Total	**6+3+3+2+2**	**16**	

Semester II

S. No.	Course Code	Course Title	Credit hours	Faculty
	Major courses (Compulsory Major Courses)			
1	PL PATH-604	Molecular Basis of Host-pathogen Interaction	(2+1) = 3	II
	Major courses (Optional Courses)			
1	PL PATH-603	Advances in Plant Pathogenic Prokaryotes	(2+1)= 3	II
2	PL PATH-606	Plant Biosecurity and Biosafety	(3+0)= 3	II
	Note-Student has to select minimum of three credits in optional courses from the above list in this semester.			
	Minor courses			
1	GPB-516	Breeding for Stress Resistance and Climate Change	(2+1) = 3	II
2	SOIL-508	Soil, Water and Air Pollution	(2+1) = 3	II
3	ENT-510	Pests of Horticultural and Plantation Crops	(2+1) = 3	II
	Note-Student has to select minimum of three credits in minor courses from the above list in this semester.			
	Supporting courses			
1	STAT-511	Experimental Designs	(2+1) = 3	II
2	AGRON-508	Agronomy of Medicinal, Aromatic & Underutilized Crops	(2+1) = 3	II
3	Soil-514	Introduction to Nanotechnology	(2+1) = 3	II
	Note-Student has to select minimum of three credits in supporting courses from the above list in this semester.			
	Compulsory Non-Credit Courses (Common Courses)			
1	PGS-503	Intellectual Property and Its Management in Agriculture	(1+0) = 1	II
2	PGS-504	Basic Concepts in Laboratory Techniques	(0+1) = 1	II
	Doctoral Seminar I			
1	PL PATH-691	Doctoral Seminar I	(1+0) = 1	II

	Doctoral Research			
1	PL PATH-699	Doctoral Research **(Synopsis Writing, Seminar and Collection of Material)**	(0+3) = 3	II
	Total	**6+3+3+2+1+3**	**18**	
Semester III				
S. No.	**Course Code**	**Course Title**	**Credit hours**	**Semester**
	Compulsory Non-Credit Courses (Common Courses)			
1	PGS-505	Agricultural Research, Research Ethics and Rural Development Programmes	(1+0) = 1	III
	Doctoral Seminar II			
1	PL PATH-692	Doctoral Seminar II	(1+0) = 1	III
	Doctoral Research			
1	Pl PATH-699	Doctoral Research	(0+10) = 10	III
	Total	**1+1+10**	**12**	
Semester IV				
	Doctoral Research			
1	PL PATH-699	Doctoral Research	(0+20) = 20	IV
	Total	**20**	**20**	
Semester V				
	Doctoral Research			
1	PL PATH-699	Doctoral Research	(0+20) = 20	V
	Total	**20**	**20**	
Semester VI				
	Doctoral Research			
1	PL PATH-699	Doctoral Research	(0+20) = 20	VI
	Total	**20**	**20**	
	Grand Total	**12+6+6+5+2+75**	**106**	

Course Contents
Ph.D. in Plant Pathology

PL PATH - 601
Advances in Mycology

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Aim of the course

To acquaint with the historical development and advances in mycology

Theory

Units	Content	Lectures
I	General introduction, historical development and advances in mycology. Recent taXonomic criteria, morphological criteria for classification. Serological, chemical (chemotaXonomy), molecular and numerical (computer based assessment) taXonomy. Interaction between groups: Phylogeny, Micro conidiation, conidiogenesis and sporulating structures of fungi imperfecti	7
II	Population biology, pathogenic variability/ vegetative compatibility. Heterokaryosis and paraseXual cycle. SeX hormones in fungi. Pleomorphism and speciation in fungi. Mechanism of nuclear inheritance. Mechanism of eXtra-nuclear inheritance. Biodegradation	7
III	Ultra structures and chemical constituents of fungal cells, functions of cell organelles. Mitosis, meiosis, gene action and regulation. Effects of fungal interaction with host plants and other microorganisms; parasitism, symbiosis and commensalism	7
IV	Genetic Improvement of Fungal strains.Fungal biotechnology. Fungi mediated synthesis of nano particles-characterization process and application. MycotoXins problems and its management	7

Practical

1	Isolation, purification and identification of cultures, spores and mating typedetermination	2
2	Study of conidiogenesis- Phialides, porospores, arthospores	4
3	Study of fruiting bodies in Ascomycotina	4
4	Identification of fungi up to species level	5
5	Study of hyphal anastomosis	5
6	Morphology of representative plant pathogenic genera form different groups of fungi	6
7	Molecular characterization of fungi	2

Teaching Methods/ Activities

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedure
- Group discussion

Learning outcome

After successful completion of this course, the students are expected to:

1. **Understand Fungal Diversity**: Gain insights into the classification and diversity of fungi, including the application of modern taxonomic techniques.
2. **Analyze Fungal Interactions**: Discuss the complex interactions between fungi and their hosts, along with implications for ecology and disease.
3. **Apply Biotechnological Techniques**: Evaluate the potential of fungi in biotechnological applications, including nanotechnology and bioremediation.
4. **Investigate Genetic Mechanisms**: Examine the mechanisms of inheritance in fungi, including implications for genetic improvement and strain development.
5. **Conduct Practical Skills**: Acquire hands-on experience in the isolation, identification, and characterization of fungal species, enhancing practical mycological skills.

Suggested Reading

- Alexopoulos CJ, Mims CW and Blackwell M. 1996. *Introductory Mycology*. John Wiley & Sons, New York.
- Dube HC. 2005. *An Introduction to Fungi.* 3rd Ed. Vikas Publ. House, New Delhi.
- Kirk PM, Cannon PF, David JC and Stalpers JA. (Eds.). 2001. *Ainsworth and Bisby's Dictionary of Fungi*. 9th Ed., CABI, Wallington.
- Maheshwari R. 2016. *Fungi: Experimental Methods in Biology* 2nd edn. CRC Press, US.
- Minnesota. Webster J and Weber R. 2007. *Introduction to Fungi.* Cambridge University Press, Cambridge.

PL PATH - 602
Advances in Plant Virology

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Aim of the course

To educate about the advanced techniques and new developments in plant virology.

Theory

Units	Content	Lectures
I	Origin, evolution and interrelationship with animal viruses. Virus morphology, structure, architecture, replication (overview of host and viral components required), assembly and virus specific cytological effects in infected plant cells. Mechanisms leading to the evolution of new viruses/ strains: mutation, recombination, pseudo- recombination, component re-assortment, etc.	7
II	Major vector groups of plant viruses and their taxonomy, virus-vector relationship, molecular mechanism of virus transmission by vectors. Terminologies used in immunology and serology. Classification, structure and functions of various domains of Immunoglobulins. Production of Polyclonal and monoclonal antibodies for detection of viruses. Immuno/ serological assays (Slide agglutination tests, Test tube precipitation test, Double agar diffusion test, ELISA (DAC, DAS, TAS), Dot Immuno Binding Assay, and nucleic acid based assays for detection of plant viruses.	7
III	Polymerase Chain Reaction based (PCR, reverse transcriptase PCR, multiplex PCR, Nested PCR, Real time/ q PCR) and non PCR based: LAMP, Fluorescent *in situ* hybridization (FISH), dot blot hybridization. Plant virus genome organization (General properties of plant viral genome- information content, coding and non- coding regions), replication, transcription and translational strategies of pararetroviruses, geminiviruses, tobamo-, poty-, bromo, cucumo, ilar, tospoviruses, satellite viruses and satellite RNA.	7
IV	Gene expression, regulation and viral promoters.Genetic engineering with plant viruses, viral suppressors, RNAi dynamics and resistant genes. Virus potential as vectors, genetically engineered resistance, transgenic plants. Techniques and application of tissue culture for production of virus free planting materials. Phylogenetic grouping system based on partial/ complete sequences of virus genomes and using of next generation sequencing technology in plant virus discovery.	7

Practical

1	Purification of viruses, SDS-PAGE for molecular weight determination, production of polyclonal antiserum, purification of IgG and conjugate preparation	7
2	Acquaintance with different serological techniques (i) DAC- ELISA (ii) DAS-ELISA (iii) DIBA (iv) Western blots (v) (ab) 2-ELISA. Nucleic acid isolation, DOT-blot, southern hybridization, probe preparation,and autoradiography;	7
3	PCR application and viral genome cloning of PCR products, plasmid purification, enzyme digestion, sequencing, annotation of genes, analysis of viral sequences (use of gene bank, blast of viral sequences and phylogeny);	7
4	Bioinformatics analysis tools for virology (ORF finder, Gene mark, Gene ontology, BLAST, Clustal X/W, Tm pred and Phylogeny programs).	7

Teaching Methods/ Activities

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedure
- Group discussion

Learning outcome

After successful completion of this course, the students are expected to:

1. **Understand Virus Biology**: Describe the origin, evolution, and structural characteristics of plant viruses, as well as their replication mechanisms.
2. **Analyze Vector Relationships**: Explain the taxonomy of virus vectors and the molecular mechanisms involved in virus transmission.
3. **Apply Molecular Techniques**: Utilize advanced molecular techniques such as PCR and LAMP for the detection and analysis of plant viruses.
4. **Implement Serological Methods**: Conduct various serological assays for the identification and quantification of plant viruses.
5. **Engage in Genetic Engineering**: Discuss the principles of genetic engineering in plants, including the use of viral vectors and RNA interference.
6. **Utilize Bioinformatics Tools**: Employ bioinformatics tools for sequence analysis and phylogenetic studies of plant viruses.

Suggested Reading

- Davies 1997. *Molecular Plant Virology: Replication and Gene Expression*. CRC Press, Florida. Fauquet *et al*. 2005. *Virus Taxonomy*. VIII Report of ICTV. Academic Press, New York.
- Gibbs A and Harrison B. 1976. *Plant Virology – The Principles*. Edward Arnold, London. Jones P, Jones PG and Sutton JM. 1997. *Plant Molecular Biology: Essential Techniques*. John Wiley & Sons, New York.
- Khan J A and Dijkstra. 2002. *Plant Viruses as Molecular Pathogens*. Howarth Press, New York.
- Maramorosch K, Murphy FA and Shatkin AJ. 1996. *Advances in Virus Research*. Vol. 46. Academic Press, New York.
- Pirone TP and Shaw JG. 1990. *Viral Genes and Plant Pathogenesis*. Springer Verlag, New York.

- Roger Hull. 2002. *Mathew's Plant Virology* (4th Ed.). Academic Press, New York.
- Thresh JM. 2006. *Advances in Virus Research.* Academic Press, New York.

PL PATH- 603
Advances in Plant Pathogenic Prokaryotes

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Aim of the course

To learn about the molecular basis of **o**rigin, evolution of prokaryotic life and latest developments in all the plant pathogenic prokaryotes asa whole.

Theory

Units	Content	Lectures
I	Prokaryotic cell: Molecular basis for **o**rigin and evolution of prokaryotic life, RNA world, prokaryotic cytoskeletal proteins. Flagella structure, assembly and regulation. Structure and composition **(bacteria)** cell wall/ envelop, Types of secretion systems (TI to TIV) and their molecular interaction, fimbriae and pili (Type IV pili), Bacterial chromosomes and plasmids, other cell organelles. Growth, nutrition and metabolism in prokaryotes(Embden-Meyerhof-Parmas (EMP) pathway, Phosphoketolase Pathway and Entner Doudoroff Pathway).	6
II	Current trends in taXonomy and identification of phytopathogenic prokarya**:** International code of nomenclature, Polyphasic approach, New/ special detection methods for identification of bacterial plant pathogens. TaXonomic ranks hierarchy;Identification,Advances in classification and nomenclature.	6
III	Bacterial genetics**:** General mechanism of variability (mutation), specialized mechanisms of variability. Transposable genetic elements in bacteria-integron and prophages, Mechanism of gene transfer. Pathogenicity islands, horizontal gene transfer, Bacterial Pan-Genome.	5
IV	Bacteriophages: Composition, structure and infection. Classification and use of phages in plant pathology/ bacteriology. Host pathogen interactions: Molecular mechanism of pathogenesis: Pathogenicity factors of soft rot, necrosis, wilt, canker, etc. Immunization, induced resistance/ Systemic Acquired Resistance, Quorum sensing. Bacterial pathogenicity and virulence**:** Molecular mechanism of virulence and pathogenesis, bacterial secretion systems, pathogenicity of bacterial enzymes that degrade the cell walls, Role of hrp/ hrc genes and TALE effectors. Synthesis and regulation of EPSs.	6
V	Beneficial Prokaryotes-Endophytes, PGPR, Phylloplane bacteria and their role in disease management. Endosymbionts for host defence. Advances in management of diseases caused by prokaryotes: genetic engineering, RNA silencing; CRISPR cas9.	5

Practical

1	Pathogenic studies and race identification, plasmid profiling of bacteria, fatty acid profiling of bacteria, RFLP profiling of bacteria and variability status, Endospore, Flagella staining, Test for secondary metabolite production, cyanides, EPS, siderophore, specific detection of phytopathogenic bacteria using species/ pathovar specific primers;	10
2	Basic techniques in diagnostic kit development, Molecular tools to identify phytoendosymbionts;	10

3	Important and emerging diseases and their management strategies.	8

Teaching Methods/ Activities

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedure
- Group discussion

Learning outcome

After successful completion of this course, the students are expected to:

1. **Understand Prokaryotic Biology**: Comprehend the molecular basis of prokaryotic life, including cell structure and metabolic pathways.
2. **Identify Phytopathogenic Prokaryotes**: Utilize current taxonomy and identification methods for bacterial plant pathogens.
3. **Analyze Genetic Variability**: Explain the mechanisms of genetic variability in bacteria and their implications for pathogenicity.
4. **Utilize Bacteriophages**: Assess the role of bacteriophages in plant pathology and their potential applications.
5. **Explore Beneficial Prokaryotes**: Investigate the role of beneficial prokaryotes in disease management and plant health.
6. **Implement Diagnostic Techniques**: Apply practical skills in diagnosing plant pathogens and developing management strategies for bacterial diseases.

Suggested Reading

- Dale JW and Simon P. 2004. *Molecular Genetics of Bacteria.* John Wiley & Sons, New York.
- Garrity GM, Krieg NR and Brenner DJ. 2006. *Bergey's Manual of Systematic Bacteriology: The Proteobacteria.* Vol. II. Springer Verlag, New York.
- Gnanamanickam SS. 2006. *Plant-Associated Bacteria*. Springer Verlag, New York.
- Mount MS and Lacy GH. 1982. *Plant Pathogenic Prokaryotes*. Vols. I, II. Academic Press, New York.
- Sigee DC. 1993. *Bacterial Plant Pathology: Cell and Molecular Aspects*. Cambridge Univ. Press, Cambridge.
- Starr MP. 1992. *The Prokaryotes*. Vols. I–IV. Springer Verlag, New York.

PL PATH- 604
Molecular Basis of Host-Pathogen Interaction

Credits: 2 + 1
Contact hours: 28+28

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Aim of the course

To understand the concepts of molecular biology and biotechnology in relation to host plant- pathogen interactions.

Theory

Units	Content	Lectures
I	History of host plant resistance and importance to Agriculture. Importance and role of biotechnological tools in plant pathology. Basic concepts and principles to study host pathogen relationship. Molecular genetics, imaging and analytical chemistry tools for studying plants, microbes, and their interactions.	7
II	Different forms of plant-microbe interactions and nature of signals/ effectors underpinning these interactions. Plant innate immunity: PAMP/ DAMP. Molecular basis of host-pathogen interaction-fungi, bacteria, viruses and nematodes; recognition system, signal transduction.	7
III	Induction of defence responses- HR, Programmed cell death, reactive oXygen species, systemic acquired resistance, induced systemic resistance, pathogenesis related proteins, phytoalexins and virus induced gene silencing. 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. Gene for gene systems: Background, genetics, phenotypes, molecular mechanisms, races, breakdown of resistance (boom-and-bust cycles), Coevolution-arms race and trench warfare models, Metapopulations, cost of resistance, cost of unnecessary virulence, GFG in agricultural crops vs. natural populations, Durability of resistance, erosion of quantitative resistance.	7
IV	Pathogen population genetics and durability, viruses vs cellular pathogens.Gene deployment, cultivar miXtures. Disease emergence, host specialization. Circadian clock genes in relation to innate immunity. Biotechnology and disease management; development of disease resistance plants using genetic engineering approaches, different methods of gene transfer, biosafety issues related to GM crops.	7

Practical

1	Protein, DNA and RNA isolation, plasmid extraction, PCR analysis, DNA and Protein electrophoresis, bacterial transformation	10
2	Gene mapping and marker assisted selection	9
3	Development and use of molecular markers in identification and characterizationof resistance to plant pathogens and their	9

	management.	

Teaching Methods/ Activities

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedure
- Group discussion

Learning outcome

After successful completion of this course, the students are expected to:

1. **Comprehend Historical Context**: Recognize the significance of historical developments in host resistance and their implications for modern agriculture.
2. **Analyze Host-Pathogen Interactions**: Evaluate various forms of interactions between plants and pathogens and the signals involved in these processes.
3. **Illustrate Defense Mechanisms**: Describe the molecular basis of plant defense strategies, including programmed cell death and systemic acquired resistance.
4. **Employ Molecular Techniques**: Utilize techniques for nucleic acid isolation, transformation, and electrophoresis in the study of plant-pathogen interactions.
5. **Implement Biotechnology Approaches**: Understand the principles of genetic engineering and their applications in developing disease-resistant plant cultivars.
6. **Discuss Resistance Durability**: Explore the concepts of resistance durability, costs associated with resistance, and the implications for agricultural practices.

Suggested Reading

- Chet I. 1993. *Biotechnology in Plant Disease Control.* John Wiley & Sons, New York.
- Gurr SJ, McPohersen MJ and Bowlos DJ. (Eds.). 1992. *Molecular Plant Pathology – A Practical Approach.* Vols. I & II, Oxford Univ. Press, Oxford.
- Mathew JD. 2003. *Molecular Plant Pathology*. Bios Scientific Publ., UK.
- Ronald PC. 2007. *Plant-Pathogen Interactions: Methods in Molecular Biology*. Humana Press, New Jersey.
- Stacey G and Keen TN. (Eds.). 1996. *Plant Microbe Interactions.* Vols. I-III. Chapman & Hall, New York; Vol. IV. APS Press, St. Paul, Minnesota.

PL PATH- 605

Principles and Procedures of Certification

Credits: 2 + 1
Contact hours: 2 8 + 2 8

Mid-Session Exam: 25 (20+5#)
Practical Exam: 35
End-Semester Exam: 40

Aim of the course: To acquaint with the certification procedures of seed and planting material.

Theory

Units	Content	Lectures
I	Introduction to certification. International scenario of certification and role of ISTA EPPO, OECD, etc. in certification and quality control. Case studies of certification systems of USA and Europe. National Regulatory mechanism and certification system including seed certification, minimum seed certification standards.	10
II	Methods used in certification of seeds, vegetative propagules and in-vitro cultures. Accreditation of seed testing laboratories. Role of seed/ planting material health certification in national and international trade.	10
III	National status of seed health in seed certification. Methods for testing genetic identity, physical purity, germination percentage, seed health, etc. Fixing tolerance limits for diseases and insect pests in certification and quality control programmes.	8

Practical

1	Seed health testing - blotter and agar plate methods.	5
2	Methods used in certification of seeds, ISTA, vegetative propagules and in-vitro cultures.	5
3	Methods for testing genetic identity, physical purity, germination percentage, seed health, etc.	5
4	Fixing tolerance limits for diseases and insect pests in certification and quality control programmes.	5
5	Indexing techniques for vegetatively propagated crops	4
6	Seed/ planting material health certification in national and international trade.	4

Teaching Methods/ Activities

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedure
- Group discussion

Learning outcome

National Regulatory mechanism and certification system including seed certification, minimum seed certification standards.

Suggested Reading

- Association of Official Seed Certifying Agencies. Hutchins D and Reeves JE. (Eds.). 1997.
- Seed Health Testing: Progress Towards the 21st Century. CABI, UK.
- ISHI-veg Manual of Seed Health Testing Methods.
- ISHI-F Manual of Seed Health Testing Methods. ISTA Seed Health Testing Methods.
- Tunwar NS and Singh SV. 1988. Indian Minimum Seed Certification Standards. Central Seed Certification Board, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi. US National Seed Health System.

e-Resources

http://www.aosca.org/index.htm.

http://www.worldseed.org/enus/international_seed/ishi_vegetable.html

http://www.worldseed.org/en-us/international _seed/ ishi_f.html

http://www.seedtest.org/en/content—1—1132—241.html

http://www.seedhealth.org

PL PATH- 606

Plant Biosecurity and Biosafety

Credits: 3 + 0
Contact hours: 4 2 + 0

Mid-Session Exam: 40 (30+10#)
End-Semester Exam: 60

Aim of the course: To facilitate deeper understanding on plant biosecurity and biosafety issues in agriculture.

Theory

Units	Content	Lectures
I	History of biosecurity, Concept of biosecurity, Components of biosecurity, Quarantine, Invasive Alien Species, Biowarfare, Emerging/ resurgence of pests and diseases. Introduction and History of biosecurity and its importance.	8
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.	10
III	Emerging Plant Pests, Pathogens, and Invasive Species. Identification and management of invasive alien species. Climate change and biosecurity risk enhancement. Case studies: Ug99 stem rust, Panama diseas.e Indian laws: Destructive Insects and Pests Act (1914), PQ Order (2003), Seeds Act (1966).	8
IV	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.	8
V	Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, Issues related to release of genetically modified crops. Emerging/ resurgence of pests and diseases in the changing scenario of climatic conditions. Issues related to release of genetically modified crops.	8

Teaching Methods/ Activities

- Classroom Lectures
- Assignment (written and speaking)
- Student presentation
- Hands on training of different procedure
- Group discussion

Learning outcome

Experience on the knowledge of National Regulatory Mechanism and International Agreements/ Conventions, viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures.

Suggested Reading

- Biosecurity: A Comprehensive Action Plan.
- Biosecurity Australia.

- Biosecurity for Agriculture and Food Production.
- FAO Biosecurity Toolkit 2008.
- Grotto Andrew J and Jonathan B Tucker. 2006. Biosecurity Guidance.
- Khetarpal RK and Kavita Gupta 2006. Plant Biosecurity in India – Status and Strategy. Asian Biotechnology and Development Review 9(2): 3963.
- Randhawa G J, Khetarpal R K, Tyagi R K and Dhillon BS (Eds.). 2001. Transgenic Crops and Biosafety Concerns. NBPGR, New Delhi.

e-Resources

http://www.inspection.gc.ca/english/anima/heasan/fad/biosecure.sht ml
www.fao.org/docrep/010/a1140e/a1140e00.htm Laboratory
http://www.who.int/csr/resources/publications/biosafety/WHO_CD S_EPR_2006.pdf
http://www.americanprogress.org/kf/biosecurity_ acomprehensive_ action_plan.pdf
www.biosecurity.govt.nz DEFRA. www.defra.gov.uk/animalh/diseases/control/biosecurity/ index.htm www.daff.gov.au/ba;www.affa.gov.au/biosecurityaustralia Biosecurity New Zealand. http://www.fao.org/biosecurity/ CFIA.

List of Journals

• Annals of Applied Biology – Cambridge University Press, London
• Annals of Plant Protection Sciences- Society of Plant Protection, IARI, New Delhi
• Annual Review of Phytopathology – Annual Reviews, Palo Alto, California
• Annual Review of Plant Pathology – Scientific Publishers, Jodhpur
• Canadian Journal of Plant Pathology – Canadian Phytopathological Society, Ottawa
• Indian Journal of Biotechnology – National Institute of Science Communication and Information Resources, CSIR, New Delhi
• Indian Journal of Mycopathological Research – Indian Society of Mycology, Kolkata.
• Indian Journal of Plant Protection – Plant Protection Association of India, NBPGR, Hyderabad.
• Indian Journal of Virology – Indian Virological Society, New Delhi
• Indian Phytopathology-Indian Phytopathological Society, IARI New Delhi.
• Journal of Mycology and Plant Pathology – Society of Mycology and Plant Pathology, Udaipur.
• Journal of Plant Disease Science- Association of Plant Pathologists (Central India) PDKV, Akola.
• Journal of Phytopathology – Blackwell Verlag, Berlin
• Mycologia – New York Botanical Garden, Pennsylvania
• Mycological Research – Cambridge University Press, London
• Physiological Molecular Plant Pathology – Academic Press, London – Phytopathology – American Phytopathological Society, USA
• Plant Disease – The American Phytopathological Society, USA
• Plant Disease Research – Indian Society of Plant Pathologists, Ludhiana
• Plant Pathology – British Society for Plant Pathology, Blackwell Publ.
• Review of Plant Pathology – CAB International, Wallingford
• Virology- New York Academic Press e-Resources
• www.shopapspress.org
• www.apsjournals.apsnet.org
• www.apsnet.org/journals
• www.cabi_publishing.org
• www.springer.com/life+Sci/agriculture
• www.backwellpublishing.com
• www.csiro.au
• www.annual-reviews.org