

**CURRICULUM**  
**OF**  
**PLANT PATHOLOGY**  
**BSc (Hons) MSc (Hons) & PhD**

**(Revised 2014)**



**HIGHER EDUCATION COMMISSION**  
**ISLAMABAD**

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## **CURRICULUM DIVISION, HEC**

Prof. Dr. Mukhtar Ahmed

Mr. Fida Hussain

Mr. Rizwan Shoukat

Mr. Abid Wahab

Mr. Riaz-ul-Haque

Chairman, HEC

Director General (Acad)

Deputy Director (Curr)

Assistant Director (Curr)

Assistant Director (Curr)

## PREFACE

The curriculum, with varying definitions, is said to be a plan of the teaching-learning process that students of an academic programme are required to undergo. It includes objectives & learning outcomes, course contents, scheme of studies, teaching methodologies and methods of assessment of learning. Since knowledge in all disciplines and fields is expanding at a fast pace and new disciplines are also emerging; it is imperative that curricula be developed and revised accordingly.

University Grants Commission (UGC) was designated as the competent authority to develop, review and revise curricula beyond Class-XII vide Section 3, Sub-Section 2 (ii), Act of Parliament No. X of 1976 titled “**Supervision of Curricula and Textbooks and Maintenance of Standard of Education**”. With the repeal of UGC Act, the same function was assigned to the Higher Education Commission (HEC) under its Ordinance of 2002, Section 10, Sub-Section 1 (v).

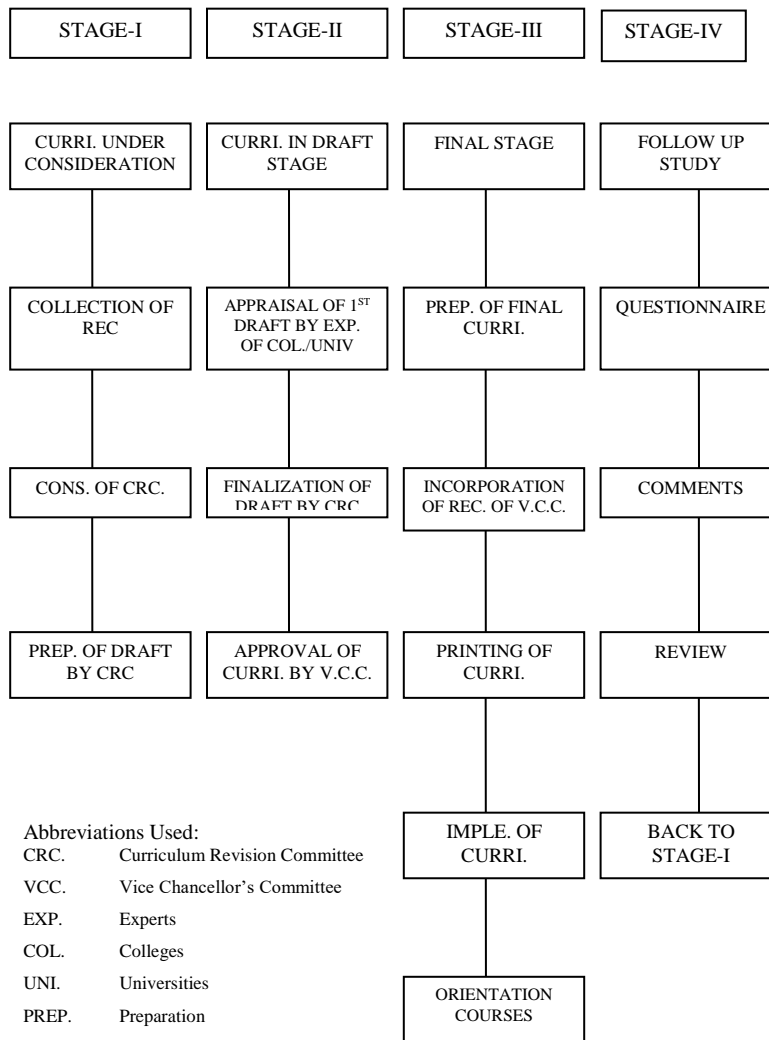
In compliance with the above provisions, the Curriculum Division of HEC undertakes the revision of curricula after every three years through respective National Curriculum Revision Committees (NCRCs) which consist of eminent professors and researchers of relevant fields from public and private sector universities, R&D organizations, councils, industry and civil society by seeking nominations from their organizations.

In order to impart quality education which is at par with international standards, HEC NCRCs have developed unified templates as guidelines for the development and revision of curricula in the disciplines of Basic Sciences, Applied Sciences, Social Sciences, Agriculture and Engineering in 2007 and 2009.

It is hoped that this curriculum document, prepared by the respective NCRC's, would serve the purpose of meeting our national, social and economic needs, and it would also provide the level of competency specified in Pakistan Qualification Framework to make it compatible with international educational standards. The curriculum is also placed on the website of HEC ([www.hec.gov.pk](http://www.hec.gov.pk)).

**(Fida Hussain)**  
**Director General (Academics)**

## CURRICULUM DEVELOPMENT PROCESS



## INTRODUCTION

Plant Pathology is the scientific study of plant diseases caused by pathogens and environmental conditions. Plant pathology also involves the study of pathogen identification, disease etiology, disease cycles, economic impact, crop losses and the economical disease management.

The HEC constituted National Curriculum Revision Committee (NCRC) for Plant Pathology consisting of professionals from universities/colleges and national research centers to review the existing curriculum of Plant Pathology and draft innovative Plant Pathology curricula for under graduate and post graduate degree programs. The NCRC on Plant Pathology developed frame work and revised the curriculum in two different meetings. The Preliminary meeting of NCRC in the discipline of Plant Pathology was held from December 16-18, 2014 at HEC Regional Centre, Lahore to review and prepare draft curriculum of Plant Pathology for BSc (Hons), MSc. (Hons) & PhD Programs. The Committee also approved recommendations for the implementation of new curriculum and further strengthening of the degree programs in Plant Pathology at both under-graduate and post-graduates levels in Pakistan.

### **Proceeding of the Preliminary NCRC meeting:**

The following members attended the meeting:-

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|----|--|----------|
| 1. | Dr. Muhammad Arif<br>Professor<br>Department of Plant Pathology<br>The University of Agriculture, Peshawar                             | Convener |
| 2. | Dr. Saleem Shehzad<br>Professor/Chairman<br>Department of Agriculture and Agribusiness<br>Management, University of Karachi<br>Karachi | Member   |
| 3. | Dr. Ch. Abdul Rauf<br>Professor/Chairman<br>Department of Plant Pathology<br>PMAS, Arid Agriculture University,<br>Rawalpindi          | Member   |
| 4. | Dr. Shahbaz Talib Sahi<br>Professor/Chairman<br>Department of Plant Pathology<br>University of Agriculture, Faisalabad                 | Member   |

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| 5.  | Dr. Shaukat Hussain<br>Professor<br>Department of Plant Pathology,<br>The University of Agriculture, Peshawar   | Member |
| 6.  | Dr. Syed Riaz Ali Gardezi<br>Professor<br>Department of Plant Pathology, University of<br>Poonch, Rawalakot   | Member |
| 7.  | Dr. Abdul Rauf Bhutta<br>Director<br>Federal Seed Certification and Registration<br>Department, Mauve area, Sector G-9,<br>Islamabad  | Member |
| 8.  | Dr. Muhammad Abid<br>Associate Professor<br>Department of Botany, Federal Urdu<br>University of Arts,<br>Science and Technology, Abdul Haq<br>Campus, Karachi   | Member |
| 9.  | Dr. Muhammad Mushtaq<br>Associate Professor<br>Department of Plant Sciences,<br>Faculty of Life Sciences,<br>Balochistan University of Information<br>Technology and Management Sciences,<br>Airport road, Baleli, Quetta | Member |
| 10. | Dr. Ahmad Ali Shahid<br>Assistant Professor<br>Institute of Agricultural Sciences,<br>University of the Punjab, Quaid-e-Azam<br>Campus, Lahore  | Member |
| 11. | Dr. Samiya Mahmood Khan<br>Assistant Professor<br>Department of Plant Pathology,<br>University College of Agriculture,<br>Bahauddin Zakaria University, Multan  | Member |
| 12. | Dr. Rehana Naz Syed<br>Assistant Professor<br>Plant Pathology Department,<br>Sindh Agriculture University, Tandojam   | Member |

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| 13. | Mr. Tamoor Khan<br>Assistant Professor<br>Plant Pathology Department, Lasbella<br>University of Agriculture, Water and Marine<br>Sciences, Uthal, Balochistan | Member    |
| 14. | Mr. Ahmad Khan<br>Assistant Professor<br>Department of Plant Pathology, Balochistan<br>Agriculture College, Quetta  | Member    |
| 15. | Riaz -ul-Haque<br>Assistant Director (Curriculum)<br>Higher Education Commission, H-9, Islamabad  | Member    |
| 16. | Dr. Zafar Iqbal<br>Principal/Chairman Department of Plant<br>Pathology<br>University College of Agriculture,<br>University of Sargodha                        | Secretary |

The meeting started with recitation from the Holy Quran by Mr. Riaz-ul-Haque, Assistant Director (Curriculum), HEC while Prof. Dr. Naeem Khalid, Adviser (Academics), presided over the inaugural session. He welcomed the participants on behalf of the Executive Director, HEC and thanked the participants for attending the meeting for this cause of national importance. He asserted the need of bringing curriculum at par with International standards. Prof. Khalid also presented Semester System implementation in Pakistan. Mr. Fida Hussain, Director General (Academics), also joined the session and asserted the need to address learning outcomes of course load of students. D.G (Acad) requested the participants to prepare their proposals for HEC to provide opportunities to the stake holders. He also encouraged the participants to feel free to submit their recommendations in the document to be drafted at the end of the meeting.

The committee members unanimously elected Prof. Dr. Muhammad Arif as Convener and Dr. Zafar Iqbal as Secretary of the NCRC in Plant Pathology 2014. The committee thoroughly reviewed the existing curricula for B.Sc. (Hons) Agri., M. Sc. (Hons) Agri. and Ph .D in Plant Pathology and made various sub-committees of the members to review existing curricula and incorporate recent trends in different areas of Plant Pathology in the light of template provided by HEC. The committees suggested improvements in almost all the courses,



replacement and addition of new courses at under graduate and graduate levels.

**Proceeding of the final NCRC meeting:**

The final meeting of National Curriculum Revision Committee (NCRC) in the discipline of Plant Pathology was held during May 26-28, 2014 at HEJ Research Institute of Chemistry, University of Karachi, Karachi, to review and finalize the curriculum of Plant Pathology for BSc (Hons), MSc (Hons) and PhD degree programmes. The committee also approved recommendations for the implementation of the new curriculum and further strengthening of the degree programmes in Plant Pathology at both under-graduate and post-graduates levels in Pakistan. The following members attended the meeting:

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|--|----------|
| 1. Dr. Muhammad Arif<br>Professor,<br>Department of Plant Pathology<br>The University of Agriculture, Peshawar                           | Convener |
| 2. Dr. Saleem Shehzad<br>Professor/Chairman,<br>Department of Agriculture and Agribusiness<br>Management, University of Karachi, Karachi | Member   |
| 3. Dr. Shahina Fayyaz<br>Director/ Professor,<br>National Nematological Research Centre,<br>University of Karachi,<br>Karachi            | Member   |
| 4. Dr. Zahir Shah<br>Professor/Chairman,<br>Department of Botany,<br>Islamia College University, Peshawar                                | Member   |
| 5. Dr. Shahbaz Talib Sahi<br>Professor/Chairman,<br>Department of Plant Pathology<br>University of Agriculture, Faisalabad               | Member   |
| 6. Dr. Shaukat Hussain<br>Professor,<br>Department of Plant Pathology,<br>The University of Agriculture, Peshawar                        | Member   |

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| 7.  | Dr. Ch. Abdul Rauf<br>Professor/Chairman,<br>Department of Plant Pathology,<br>PMAS University of Arid Agriculture,<br>Rawalpindi   | Member |
| 8.  | Dr. Syed Riaz Ali Gardezi<br>Professor/Chairman,<br>Department of Plant Pathology, University of<br>Poonch, Rawalakot   | Member |
| 9.  | Dr. Abdul Rauf Bhutta<br>Director,<br>Federal Seed Certification and Registration<br>Department Mauve area, Sector G-9, Islamabad   | Member |
| 10. | Dr. Nighat Sarwar,<br>Deputy Chief Scientist/Head Plant<br>Protection Division,<br>Nuclear Institute for Agriculture and<br>Biology, Faisalabad                                 | Member |
| 11. | Dr. Ahmad Ali Shahid<br>Associate Professor<br>Institute of Agricultural Sciences,<br>University of the Punjab, Lahore  | Member |
| 12. | Dr. Muhammad Abid<br>Associate Professor<br>Department of Botany, Federal Urdu<br>University of Arts, Science and Technology<br>Karachi   | Member |
| 13. | Dr. Muhammad Mushtaq<br>Associate Professor,<br>Department of Plant Sciences,<br>Balochistan University of Information<br>Technology and Management Sciences,<br>Baleli, Quetta | Member |
| 14. | Dr. Rashida Atiq<br>Associate Professor<br>Department of Plant Pathology,<br>Faculty of Agricultural Sciences & Technology,<br>B.Z.U., Multan                                   | Member |
| 15. | Dr. Rehana Naz Syed<br>Assistant Professor,<br>Department of Plant Pathology, Sindh   | Member |

Agriculture University,  
Tandojam.

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| 16. Mr. Tamoor Khan<br>Assistant Professor,<br>Plant Pathology Department, Lasbella<br>University of Agriculture,<br>Water and Marine Sciences, Uthal, Balochistan | Member    |
| 17. Mr. Ahmad Khan<br>Assistant Professor,<br>Department of Plant Pathology, Balochistan<br>Agriculture College,<br>Quetta   | Member    |
| 18. Mr. Rizwan Shoukat<br>Deputy Director (Curriculum),<br>Higher Education Commission, Islamabad  | Member    |
| 19. Dr. Zafar Iqbal<br>Principal/Chairman,<br>Department of Plant Pathology<br>University College of Agriculture,<br>University of Sargodha,<br>Sargodha           | Secretary |

The meeting started with recitation from the Holy Quran. Mr. Rizwan Shoukat, Deputy Director (Curriculum), Higher Education Commission (HEC), Islamabad, briefed the participants on importance of National Curriculum Revision Committee (NCRC) and obligation of HEC for the development of curricula as per international standard. Mr. Ghulam Hyder Khan and Mr. Mubashar Ahmad Memon, Director and Deputy Director, respectively, at HEC Regional Center, Karachi, welcomed the participants on behalf of Executive Director and HEC, Regional Centre, Karachi.

The Committee members unanimously approved the decision of Preliminary meeting and endorsed Prof. Dr. Muhammad Arif as Convener and Dr. Zafar Iqbal as Secretary of NCRC in Plant Pathology 2014. The Convener briefed the committee on the draft curriculum and appreciated the contribution of various sub-committees (27 sub-committees for the review of courses at undergraduate and 23 for post-graduate levels) for the development of the curriculum in Plant Pathology as per national and international requirements.

The Secretary of the committee presented the preliminary draft of the curriculum in Plant Pathology. The Committee thoroughly reviewed and discussed the draft curriculum for under-graduate and post-graduate

programmes in Plant Pathology. After detailed discussion during various technical sessions, a number of courses were further improved and additions /deletions were made in existing courses both at under-graduate and post-graduate levels. Advanced and recent literature was included in the curricula.

To apprise the students of recent trends in Plant Pathology, a list of new courses was included at under graduate and post graduate levels such as: Biotechnology and its Application in Plant Pathology, Plant Pathology and International Obligations and Bioinformatics in Plant Pathology etc.

Keeping in view the health hazards of pesticides and pollutants and significance of eco-friendly disease management, a new course entitled, "Plant Pathology and Environmental Concerns" was also included unanimously in the scheme of studies at post-graduate level.

After detailed discussion, the committee approved the suggestion to make compulsory at least two courses (Advances in Plant Pathology and Molecular Plant-Microbe Interactions) at PhD degree program in Universities and Degree awarding institutions. The committee finalized curriculum for BSc (Hons), MSc (Hons) and PhD programs in Plant Pathology and approved a total of 50 courses for under-graduate and post-graduate degree programmes (27 courses for under-graduate and 23 at post-graduate programs). The committee also finalized the recommendations for the implementation of the new curriculum and further strengthening of the degree programs in Plant Pathology at both under-graduate and post-graduates levels in Pakistan.

## FRAMEWORK / TEMPLATE FOR BSc (HONS) IN AGRICULTURAL DISCIPLINES

Duration	4 years
Number of semesters:	8
Weeks per semester:	16-18 (16 for teaching and 2 for exams)
Total credit hours:	130-140
Credit hours per semester:	15-18
Agriculture Courses:	77%
Non-Agriculture Courses:	23%

Non- Agriculture Domain							
Knowledge Area	Subject Area	Name of Course	CR	Total Courses	Total Credits	% Area	% over all
Humanities	English	English-I (Functional English)	3	2	6	19.35	4.44
		English-II (Communication Skills)	3				
	Culture	Pakistan Studies	2	2	4	12.9	2.96
		Islamic Stud./Ethics	2				
	Social Sciences	Rural Development	3	2	6	19.35	4.44
Marketing & Agri. Business		3					
Computing	IT	Intro to Comm. Technology	3	1	3	9.70	2.22
Natural Science	Mathematics/Biology	Maths-1 / Botany	3	2	6	19.35	4.44
		Maths-II / Zoology	3				
	Statistics	Statistics-I	3	2	6	19.35	4.44
		Statistics-II	3				
Sub-Total				11	31	100	23
Agriculture Domain							
Interdisciplinary	Agriculture Foundation	Basic Agriculture	3	9	27	26.0	20.0
		Agronomy	3				
		Plant Breeding & Genetics	3				
		Entomology	3				
		Introductory Plant Pathology	3				
		Food Technology	3				
		Horticulture	3				
		Soil Sciences	3				
		Agricultural Eco.	3				
		Supporting Courses (6-8 Courses)	Breadth Courses				
Forestry & Range Management	3						
Animal Sciences	3						
Human Nutrition	3						

Agriculture Domain							
Knowledge Area	Subject Area	Name of Course	CR	Total Courses	Total Credits	% Area	% over all
		Agriculture Chem.	3				
		Agriculture Engg.	3				
		Water Management	3				
		Any other recommended by University	3				
Major Courses (18-20 Courses)	Major Based Core (Depth)	Major	3	18-20	56-60	55.0	43.0
Project / Internship		Project / Internship	4	-	-	4	3
Total			-	31-35	99-109	100	77
Grand-Total			-	42-46	130-140	-	100

### Template for 4-Year BSc (Hons) in Agricultural Disciplines

#### 1. Compulsory Courses

	Credits Hours
Mathematics / Biology (2 courses)	6 (3-0) (2-1)
Statistics 1 & 2	6 (3-0) (3-0)
Computers / IT	3 (2-1)
Pakistan Studies	2 (2-0)
Islamic Studies	2 (2-0)
Communications Skills	3 (3-0)
English	3 (3-0)
Basic Agriculture	3 (2-1)
	<b>Sub-Total 28</b>

#### 2. Interdisciplinary Foundation Courses

Agronomy	3 (2-1)
Plant Breeding & Genetics	3 (2-1)
Entomology	3 (2-1)
Introductory Plant Pathology	3 (2-1)
Food Technology	3 (2-1)
Horticulture	3 (2-1)
Soil Sciences	3 (2-1)
Agriculture Economics	3 (2-1)
	<b>Sub-Total 24</b>

**3. Supporting Courses (6-8 courses (3 Cr. hr) amongst below}**

Agriculture Extension  
Forestry & Range Management  
Animal Science  
Marketing & Agri Business  
Rural Development  
Human Nutrition  
Agriculture Chemistry  
Agriculture Engineering  
Water Management  
Any other discipline recommended by the university

**Sub-Total 18-24**

<b>Sub-Total during the first four semesters</b>	<b>70-76</b>
<b>Semester 5, 6, 7 &amp; 8</b>	<b>56-60</b>
<b>Project / Internship</b>	<b>04</b>
<b>Grand Total</b>	<b>130-140</b>

1 credit of theory = one contact hour per week for 16-18 weeks  
and 1 practical / Lab hour = two contact hours per week for 16-18 weeks.

In case of non availability of department of supporting courses,  
courses from foundation courses can be opted.

**SCHEME OF STUDIES  
FOR UNDER-GRADUATE PROGRAMME IN  
PLANT PATHOLOGY  
LIST OF COURSES**

<b>S. No.</b>	<b>Title of Courses</b>	<b>Credit Hours</b>
1.	Introduction to Plant Pathogens	3(2-1)
2.	Introductory Plant Pathology	3(2-1)
3.	Introduction to Plant Viruses	3(2-1)
4.	Introduction to Plant Prokaryotes	3(2-1)
5.	Introductory Mycology	3(2-1)
6.	Introduction to Plant Parasitic Nematodes	3(2-1)
7.	Beneficial Microorganisms for sustainable agriculture	3(2-1)
8.	Diseases of Field Crops	3(2-1)
9.	Introductory Range and Forest Pathology	3(2-1)
10.	Diseases of Vegetable Crops	3(2-1)
11.	Plant Resistance to Diseases	3(2-1)
12.	Soil-borne Plant Pathogens	3(2-1)
13.	Methods and Techniques in Plant Pathology	3(1-2)
14.	Diseases of Fruits and Ornamentals	3(2-1)
15.	Seed and Postharvest Pathology	3(2-1)
16.	Plant Disease Management	3(2-1)
17.	Introductory Molecular Plant Pathology	3(2-1)
18.	Plant Disease Epidemiology	3(2-1)
19.	Histopathology of Diseased Plants	3(2-1)
20.	Pesticides, their Action and Application	3(2-1)
21.	Abiotic Diseases of Plants	3(2-1)
22.	Biotechnology and its Application in Plant Pathology	3(2-1)
23.	Biology and Cultivation of Edible Fungi	3(2-1)
24.	Plant Quarantine and SPS measures	3(2-1)
25.	Internship / Project Study.	4(0-4)

Total = 76\*

\*Minimum course requirement for the degree: 56-60 + Internship.



## **DETAIL OF COURSES FOR UNDER GRADUATE PROGRAMME IN PLANT PATHOLOGY**

**1. Title of the Course: INTRODUCTION TO PLANT PATHOGENS  
Credit Hours: 3(2-1)**

**Prerequisites:** Biology (Higher Secondary level)

**Learning Objectives:** To acquaint students with basic concepts and identification of plant pathogens

**Course Contents:**

Introduction; economic importance; general characteristics (morphology, reproduction and ecology); Identification of plant pathogens including fungi, prokaryotes, viruses, viroids, nematodes, fungus like organisms and phase rogamic parasites, taxonomic position of economically important plant pathogens.

**Practical**

Orientation of laboratory equipments; sterilization of glassware, preparation of media and isolation of different plant pathogens; study of characteristics of various plant pathogens through slides, live specimens and their comparative account/study

**Recommended Books:**

1. Agrios, G.N. 2005. Plant Pathology, 5<sup>th</sup> edition. Academic Press, New York, USA.
2. Ahmad, I., and A.R .Bhutta. 2005. Textbook of introductory Plant Pathology. Publisher NBF, 397 pp.
3. Alexopoulos, C.J., C.W. Mims and M. Blackwell. 1996. Introductory Mycology. 4<sup>th</sup> edition, John Wiley and Sons, Inc., New York, USA
4. Bos, L. 1999. Plant Viruses: Unique and Intriguing Pathogens: A textbook of Plant Virology. Backhuys Publishers.
5. Mehrotra, R.S. and A. Agarwal. 2003. Plant Pathology. 2<sup>nd</sup> Edition. TATA McGraw-Hill. Pub. Company Ltd. New Delhi.
6. Ravichandra, N.G. 2013. Fundamentals of Plant Pathology. Prentice Hall of India Pvt.,Ltd.
7. Trigiano, R.N., M.T. Windham and A.S. Windham. 2008. Plant Pathology: Concepts and Laboratory Exercises. 2<sup>nd</sup> edition. CRC Press.
8. Vidhyasekram, P. 2004. Concise Encyclopedia of Plant Pathology. Food product Press and Haworth Press Inc. Binghamton, New York, USA.

**2. Title of the Course: INTRODUCTORY PLANT PATHOLOGY**

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

**Prerequisites:** Biology (Higher Secondary level)

**Learning Objectives:** To acquaint students with basic concepts of Plant Pathology

**Course Contents:**

**Theory**

Introduction and history of plant pathology; basic characteristics of fungi, bacteria, viruses and nematodes; concept of disease in plants; economic importance of plant diseases; nature and cause of (biotic and abiotic) diseases; components of plant disease development; diagnosis of plant diseases; principles of plant disease management; Introduction to IDM and IPM; symptoms, etiology, mode of infection, disease cycle and management of representative diseases of agricultural and horticultural crops.

**Practical**

Demonstration of lab equipments and reagents; collection, preservation and identification of plant diseases based on symptoms; isolation and inoculation techniques; demonstration of Koch's postulates.

**Recommended Books:**

1. Agrios, G.N. 2005. Plant Pathology, 5<sup>th</sup> edition, Academic Press, New York, USA.
2. Ahmad, I. and A.R. Bhutta. 2005. A Text Book of Introductory Plant Pathology. Published by National Book Foundation, Islamabad, Pakistan.
3. Chaube, H.S. and R. Singh. 2002. Introductory Plant Pathology. International Book Distributing Co.
4. Hafiz, A. 1986. Plant Diseases. Pakistan Agricultural Research Council, Islamabad, Pakistan.
5. Mathew, J.D. 2003. Molecular Plant Pathology. Bios Scientific Publishers Ltd. UK.
6. Mehrotra, R.S. and A. Agarwal. 2003. Plant Pathology, 2<sup>nd</sup> Edition. TATA McGraw-Hill. Pub. Company Ltd. New Delhi.
7. Sambamurty, A.V.S.S. 2006. A Text Book of Plant Pathology. I.K. International Pvt. Ltd.
8. Schumann, G.L. and C.J. D'Arcy. 2010. Essential Plant Pathology. APS Press. 369.PP.
9. Strange, R.N. 2003. Introduction to Plant Pathology. John Willey & Sons, New York.

**3. Title of the Course: INTRODUCTION TO PLANT VIRUSES**

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

**Prerequisites:** Introductory Plant Pathology

**Learning Objectives:**

To introduce students to the basic and applied concepts of plant viruses

**Course Contents:**

**Theory**

Introduction, history and importance, morphology, composition and structure; classification of plant viruses, their replication, transmission and movement; symptomatology; serology and serological methods; ecology and epidemiology; management; study of specific virus diseases in Pakistan.

**Practical**

Field visits and study of virus infected plants; methods of virus transmission (mechanical inoculation, grafting, insect vectors); virus detection through biological (indicator hosts and host range) and serological methods (ELISA, Immunodiffusion) and molecular methods (polymerase chain reaction).

**Recommended Books:**

1. Ahlawat, Y.S. 2010. Diagnosis of Plant Viruses and Allied Pathogens. Stadium Press (India) Pvt. Ltd.
2. Bashir, M. and S. Hassan. 1998. Diagnostic Methods for Plant Viruses. Pakistan Agricultural Research Council, Islamabad, Pakistan.
3. Bos, L. 1999. Plant Viruses: Unique and Intriguing Pathogens: A text book of Plant Virology. Backhuys Publishers.
4. Compendia of different crops. American Phytopathological Society, St. Paul, Minnesota, USA.
5. Foster, G.D. and S.C. Taylor. 1998. Plant Virology Protocols- From Virus Isolation to Transgenic Resistance. Humana Press, New Jersey.
6. Hadidi, A., R. K. Khetarpal and H. Koganezawa (Eds.). 1998. Plant Virus Disease Control. APS, USA.
7. Hull, R. 2009. Comparative Plant Virology. 2<sup>nd</sup> edition. Academic Press.
8. Loebenstein, G. and G. Thottappilly (Eds.). 2004. Virus and Virus-like Diseases of Major Crops in Developing Countries. Springer Press.
9. Matthews. R.E.F. 1991. Plant Virology. 3<sup>rd</sup> revised edition. Academic Press.
10. Thresh, M. (Ed.). 2006. Plant Virus Epidemiology. Academic

press.

11. Walkey, D.G.A. 1985. Applied Plant Virology. John Wiley & Sons.

#### **4. Title of the Course: INTRODUCTION TO PLANT PROKARYOTES**

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

**Prerequisites:** Introductory Plant Pathology

##### **Learning Objectives:**

To introduce basic and applied concepts of Plant associated bacteria and mollicutes.

##### **Course Contents:**

###### **Theory**

Introduction, economic importance, general characteristics; morphology, reproduction and physiology; cultural characteristics; mode of infection and transmission of bacteria and mollicutes and their management; study of specific prokaryotic plant diseases in Pakistan.

###### **Practical**

Isolation, purification, identification and preservation of plant pathogenic prokaryotes; hypersensitive reactions and pathogenicity tests; Inoculum preparation and testing with known concentration.

##### **Recommended Books:**

1. Agrios, G.N. 2005. Plant Pathology. 5<sup>th</sup> edition. Academic Press, New York, USA.
2. Dworkin, M., S. Falkow, E. Rosenberg and K.H. Schleifer. 2006. The Prokaryotes: A Handbook on the Biology of Bacteria: Symbiotic Associations, Biotechnology, Applied Microbiology. 3<sup>rd</sup> edition. Springer.
3. Elliott, C. 2008. Manual of Bacterial Plant Pathogens. The Williams & Wilkins Company.
4. Jackson, R.W. 2009. Plant Pathogenic Bacteria: Genomics and Molecular Biology. Caister Academic Press.
5. Janse, J.D. 2008. Phytobacteriology: Principles and Practice. CABI Publishing.
6. Mishra, R.S. 2003. Bacterial Plant Diseases. Discovery Publication House, India.
7. Mukesh, S. 2006. Introductory Phytobacteriology. Eastern Book Corporation.

**5. Title of the Course: INTRODUCTORY MYCOLOGY**

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

**Prerequisites:** Introductory Plant Pathology

**Learning Objectives:**

To study the basic and applied aspects of fungi and fungi like organisms

**Course Contents:**

**Theory**

History and significance of fungi; methods of reproduction; anamorph, teleomorph and holomorph; evolution of classification of fungi and fungi-like organisms; ecology, genetics and dissemination of fungi; interaction of fungi with hosts/vectors; general characters; economic importance of various phyla; study of morphology and classification of economically important fungi and fungi-like organisms belonging to Plasmodiophoromycota, Oomycota, Chytridiomycota, Zygomycota, Glomeromycota, Ascomycota, Basidiomycota and Mitosporic fungi; study of life histories of fungi of agricultural, scientific and industrial importance.

**Practical**

Collection, isolation, mounting, identification and preservation of fungi from various sources; use of diagnostic keys for identification of important fungi; comparative study of representatives of various phyla.

**Recommended Books:**

1. Alexopoulos, C.J., C.W. Mims and M. Blackwell. 1996. Introductory Mycology. 4<sup>th</sup> edition, John Wiley & Sons, Inc. New York, USA.
2. Barnett, H.L. 1998. Illustrated Genera of Imperfect Fungi. 4<sup>th</sup> ed. ACS, Washington, DC, USA.
3. Carlile, M.J., S.C. Watkinson and G.W. Gooday. 2001. The Fungi. Academic Press.
4. Deacon, J. 2006. Fungal Biology, 4<sup>th</sup> edition. Blackwell.
5. Johri, R.M. 2005. A Textbook of Fungi. Dominant Publishers and Distributors, India.
6. Kendrick, B. 2000. The Fifth Kingdom. (3<sup>rd</sup> ed.). Focus Publishing/R. Pullins Company, Incorporated. 373 pp.
7. Liliane Elisabeth Petrini-Klieber, L.E. and O. Petrini. 2013. *Identifying Moulds: A Practical Guide*. Gebruder Borntraeger Verlagsbuchhandlung, Science Publishers.
8. Rai, M. 2010. Progress in Mycology. Springer.
9. Swanton, E.W. 2004. Hand Book of Fungi. Reprint Publication, India.

10. Ulloa, M. and R.T. Hanlin. 2000. Illustrated Dictionary of Mycology, American Phytopathological Society, St. Paul, Minnesota, USA.
11. Webster, J. and R. Weber. 2007. Introduction to Fungi. Cambridge University Press.

**6. Title of the Course: INTRODUCTION TO PLANT  
PARASITIC NEMATODES**

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

**Prerequisites:** Introductory Plant Pathology

**Learning Objectives:**

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

**Course Contents:**

**Theory**

Introduction to phylum nematoda and related phyla; abundance and importance of plant parasitic nematodes; nematode morphology and anatomy including study of their various systems viz. digestive, reproductive and nervous; taxonomy of plant parasitic nematodes according to feeding habits, fungivores, omnivores, predators and parasites including cellular changes brought during feeding; study of important nematode diseases, symptoms, etiology and their management.

**Practical**

Sampling, extraction, staining and identification of nematodes from soil and infested plant materials; preparation of temporary and permanent slides to study morphological features of nematodes; staining of nematodes and their egg masses in roots; demonstration of nematode inflicted foliage and root symptoms.

**Recommended Books:**

1. Agrios, G.N. 2005. Plant Pathology. 5<sup>th</sup> edition. Academic Press. 952 pp.
2. Bridge, J. and J.L. Starr. 2007. Plant Nematodes of Agriculture Importance: A color hand book. Manson Publishing.
3. Dropkin, H.V. 1980. Introduction to Plant Nematology. A Wiley-Interscience Publication, New York.
4. Hunt, D.J. 1993. Aphelenchida, Longidoridae and Trichodoridae: Their Systematics and Bionomics. CABI Publishing.
5. Luc, M., R. Sikora and J. Bridge. 2005. Plant Parasitic Nematodes in Tropical and Subtropical Agriculture. CABI Publishing.

6. Noe, P.J. 2003. Plant-Parasitic Nematodes. pp 61-67. In: Plant Pathology: Concepts and Laboratory Exercises. R. N. Trigiano, M. T. Windham, and A. S. Windham. (Eds.). CRC Laboratory Press, USA.
7. Noe, P.J. 2003. Pathogenicity and Isolation of Plant-parasitic Nematodes. pp 69-73. In: Plant Pathology: Concepts and Laboratory Exercises. R. N. Trigiano, M. T. Windham, and A. S. Windham. (Eds.). CRC Press, USA.
8. Perry, R.N. and M. Moens. 2006. Plant Nematology. CABI Publishing.
9. Saeed, M. 1990. Development of Phytonematology in Pakistan. pp 515-525. In: Progress in Plant Nematology. S. K. Saxena, A. Rashid, and R. M. Khan. (Eds.). CBS Publications Pvt. Ltd. Delhi.
10. Siddiqui, M.R. 2000. Tylenchida: Parasites of Plants and Insects. 2nd ed. Wallingford, CABI Publishing.

**7. Title of the Course: BENEFICIAL MICROORGANISMS FOR SUSTAINABLE AGRICULTURE**

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

**Prerequisites:** Introductory Plant Pathology

**Learning Objectives:** To acquaint the students with beneficial aspects of microbes

**Course Contents:**

**Theory**

Introduction to beneficial microorganisms; role of microorganisms in bioremediation and biodegradation of agricultural and industrial by-products/wastes; use of microorganisms (bacteria, cyanobacteria, nematodes and fungi inclusive of mycorrhizae) in bio-geochemical cycling and biocontrol of plant diseases; cultivation of edible fungi and yeasts; classification of soils based on their microbiological properties; principles and strategies for controlling the soil microflora for optimum crop production and protection; application of beneficial microorganisms; functions of microorganisms: putrefaction, fermentation, and synthesis; Introduction to use of cellulose decomposing fungi in paper and textile industry; use of fungi such as *Penicillium* and *Aspergillus* species in food processing including cheese ripening, pickle production etc; organisms as experimental tools and supplements of human food and animal feed (single cell protein, fodder yeast etc.); bacteriophages.

**Practical**

Isolation and identification of microorganisms from various substrates and screening and mass multiplication of industrially important

microbes; demonstration of antagonism, competition and antibiosis; Isolation and identification of nitrogen fixing bacteria.

**Recommended Books:**

1. Bahl, N. 1988. Handbook on Mushroom. 2<sup>nd</sup> edition. Oxford and IBH Publishing Company New Delhi, India.
2. Burges, H.D. 1998. Formulation of Microbial Biopesticides: Beneficial Microorganisms, Nematodes and Seed Treatments. Kluwer Academic Press.
3. Carandang, G.A. 2011. Grow Your Own Beneficial Indigenous Microorganisms and Bionutrients in Natural Farming [Kindle Edition]. Bronze Age Media. pp. 30.
4. Chang, S.T. and P.G. Miles. 2004. Mushroom Cultivation, Nutritional Value, Medicinal Effect and Environmental Impact. CRC Press, NYC, USA.
5. Dinesh K. and D.K. Maheshwari. 2012. Bacteria in Agrobiolgy: Plant Probiotics. Springer. 371 pp.
6. Elmerich, C. and W. Edward Newton. 2007. Associative and Endophytic Nitrogen-fixing Bacteria and Cyanobacterial. Springer. 322 pp.
7. Eugene, R. and G. Uri. 2011. Beneficial Microorganisms in Multicellular Life Forms. Springer. 348 pp.
8. Javaid, A. 2010. Beneficial Microorganisms for Mungbean Production. VDM Publishing Company. 212 pp.
9. Maheshwari, D.K. 2010. Plant Growth and Health Promoting Bacteria. Springer. pp. 445
10. Nasim, G. and R. Bajwa. 2010. Glomalean Spore Flora of Pakistan. HEC, Islamabad, Pakistan.
11. Podila, K. and D.D. Douds. 2000. Current Advances in Mycorrhizae Research. APS Press, USA.
12. Samuel, S. and S.S. Gnanamanickam. 2007. Plant-Associated Bacteria. Springer. 712 pp.
13. Sundh, I., A. Wilcks and M.S. Goettel. 2013. Beneficial Microorganisms in Agriculture, Food and the Environment: Safety Assessment and Regulation. CABI. 360 pp.

**8. Title of the Course: DISEASES OF FIELD CROPS**

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

**Prerequisites:** Introductory Plant Pathology

**Learning Objectives:** To study important diseases of field crops and their management.

**Course Contents:**

**Theory**

Importance of field crop diseases; detailed study of symptoms,



etiology, nature and extent of losses; disease cycle, methods of perpetuation, epidemiology and management of major diseases of cereals, pulses, fodder, oil seed, fiber, tobacco and sugar crops; integrated crop and disease management; field sanitation program and good agricultural practices (GAP).

**Practical**

Field surveys; collection, preservation of diseased specimens; identification of diseases based on symptoms and microscopic studies; isolation of major pathogens of above mentioned crops.

**Recommended Books:**

1. Bhutta. A.R. 2010. Text book of Introductory Seed Pathology. HEC Pakistan.
2. Compendia of wheat, barley, rice, maize, cotton, sorghum, pea, peanut diseases. American Phytopathological Society, St. Paul, Minnesota, USA.
3. Dickson, J.G. 2008. Diseases of Field Crops Biotech Books; Reprint of McGraw-Hill.
4. Gupta, G.P. 2004. Textbook of Plant Diseases. DPH, India.
5. Hafiz, A.1986. Plant Diseases. Pakistan Agricultural Research Council, Islamabad.
6. Mew, T.W. and P. Gonzales. 2002. A Handbook of Rice Seed Borne Diseases. IRRI, Science Publication, Philippine.
7. Nyal. R.F. 1989. Field Crops Disease Handbook. AVI Publishing Company Inc. Westport, Connecticut, USA.
8. Rangaswami, G. and A. Mahadevan. 2004. Diseases of Crop Plants in India. Prentice Hall, India.
9. Sharma, R.S. 2000. Plant Disease. Campus Book International, Delhi, India.
10. Vidhyasekram, P. 2004. Concise Encyclopedia of Plant Pathology. Kaganviva, India.
11. Zadoks, J.C. 2004. Modern Crop Protection. International Book Distribution Co, India.

**9. Title of the Course: INTRODUCTORY RANGE AND FOREST PATHOLOGY**

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

**Prerequisites:** Introductory Plant Pathology

**Learning Objectives:**

To introduce students to range and forest diseases and their management.

**Course Contents:**

**Theory**

Economic importance of forest and shade tree diseases;

development, epidemiology and management of important forest and shade tree diseases caused by biotic and abiotic agents; management of forest nursery diseases; mycorrhizae, their significance and application in forestry; management of important tree diseases in Pakistan.

### **Practical**

Visit to forest plantation; collection of diseased samples and identification based on symptoms; identification of causal agents of important diseases of tree; deterioration of timber and other forest trees; preservation of specimens of tree diseases; seed health testing of forest and shade tree seeds; seed treatments and their effect on nursery seedlings/plants.

### **Recommended Books:**

1. Bhutta. A.R. 2010. Text book of Introductory Seed Pathology. HEC Pakistan.
2. Khan, A.H. 1989. Pathology of Trees, Vol. II, Univ. of Agriculture, Faisalabad.
3. Manion, P.D. 1991. Tree Disease Concepts, 2<sup>nd</sup> Ed. Prentice Hall.
4. Sharma, R.C. and G.N. Sharma. 2006. Challenging Problems in Horticultural and Forest Pathology. Indus Publishing Company, India.
5. Sharma, V.K. 2004. Trees and Protection of Environment. Deep and Deep Publication (Pvt.) Ltd. India.
6. Strouts, R.G. and T.G. Winter. 1994. Diagnosis of Ill-health in Trees. HMS Office. London.
7. Tainter, F.H. and F.A. Baker. 1996. Principles of Forest Pathology. John Wiley & Sons. USA.
8. Zabel, R. and J.J. Morell, 1992. Wood Microbiology: Decay and its Preservation. Academic Press, San Diego. California, USA.

### **10. Title of the Course: DISEASES OF VEGETABLE CROPS**

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

**Prerequisites:** Introductory Plant Pathology

#### **Learning Objectives:**

To study basic and applied aspects of economically important diseases of vegetable crops of Pakistan.

#### **Course Contents:**

##### **Theory**

Importance and symptoms of various vegetable diseases; disease cycle; methods of perpetuation and control of major diseases of okra,

pea, solanaceous (chilies, potato, tomato, eggplant), crucifers (radish, turnip, cabbage, cauliflower), cucurbits (gourd, cucumber, squash, melon), bulbs (onion, garlic), lettuce, spinach, carrot and non traditional vegetables.

**Practical**

Identification of diseases on the basis of symptoms and isolation of pathogens; field visits, collection and preservation of diseased specimens; preparation of permanent mounts.

**Recommended Books:**

1. Bhutta. A.R. 2010. Text book of Introductory Seed Pathology. HEC Pakistan.
2. Compendia of cucurbits, onion and garlic, potato, tomato and pea diseases. American Phytopathological Society, St. Paul, Minnesota, USA.
3. Dixon, D.R. 1981. Vegetable Crop Diseases. McMillan Press, London, UK.
4. Gupta, V.K. and Y.S. Paal. 2001. Diseases of Vegetables Crops. Kalyani Publishers, New Delhi, India.
5. Hafiz, A. 1986. Plant Diseases. Pakistan Agricultural Research Council, Islamabad, Pakistan.
6. Koike, S., P. Gladders and A. Paulus. 2006. Vegetable Diseases: A Colour Handbook Manson Publishing Ltd.
7. Mukerji, K.G. 2004. Fruit and Vegetable Diseases. Springer.
8. Naqvi, S.A.M.H. 2004. Diseases of Fruits and Vegetables: Diagnosis and Management. Vol. 1 & 2. Kluwer Academic Publishers.
9. Sherf, A. F. and A. A. MacNab.1986. Vegetable Diseases and their Control. John Wiley & Sons Inc.

**11. Title of the Course: PLANT RESISTANCE TO DISEASES**

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

**Prerequisites:** Introductory Plant Pathology

**Learning Objectives:**

To introduce students to disease resistance mechanisms in plants.

**Course Contents:**

**Theory:**

Introduction, historical development and importance of plant resistance against various pathogens; types and mechanisms of resistance against pathogens such as fungi, bacteria, nematodes and viruses; mechanism and genetic basis of resistance towards plant pathogens; gene centers as a source of resistance; host defense system; strategies for gene deployment; transgenic approaches for crop protection; screening of germplasm and resistance mitigation by using

different rating scales/parameters and disease modeling; mechanism and genetic basis of plant resistance towards plant pathogens.

### **Practical**

Preparation of inoculum; inoculation techniques for various plant pathogens; demonstration of hypersensitive reaction, resistance and susceptibility; screening of germplasm in field and green house against major plant pathogens by using different rating scales/parameters and disease modeling; detection of resistance genes using molecular markers.

### **Recommended Books:**

1. Agrios, G.N. 2005. Plant Pathology, 5<sup>th</sup> edition, Academic Press, New York, USA.
2. Boland, G.J., L. David and Kuykendall. 1998. Plant Microbe Interactions and Biological Control. Marcel Dekker, Inc, USA.
3. Moore, D. and L.A.N. Frazer. 2002. Essential Fungal Genetics. Springer Verlag, New York, USA.
4. Punja, Z.K. and Z. Punja. 2004. Fungal Disease Resistance in Plants: Biochemistry, Molecular Biology, and Genetic Engineering. CRC Press.
5. Robert S.F. and E.L. Simms. 1992. Plant Resistance to Herbivores and Pathogens: Ecology, Evolution, and Genetics. The University of Chicago Press, Ltd. London.
6. Russel, G.C. 1981. Plant Breeding for Pest and Disease Resistance. Butterworths and Company, Ltd., London, UK.
7. Sadasivan, S. and B. Thayumanavan. 2003. Molecular Host Plant Resistance to Pest. Marcel Dekker, USA.
8. Singh, D.P. 2002. Breeding for Resistance to Biotic Stress, International Books Distribution Co. India.
9. Slusarenko, A.J., R.S.S. Fraser and L.C. Van Loon. 2000. Mechanisms of Resistance to Plant Diseases. Kluwer Academic Publishers.
10. Staples, C.R. and G.H. Toenniessen. 1981. Plant Disease Control Resistance and Susceptibility. John Wiley & Sons, Inc. New York, USA.
11. Stubbs, R.W., J.M. Prescott, E.E. Sarri and H.J. Dubin. 1986. Cereal Disease Methodology Manual. CIMMYT, Mexico.
12. Van der Plank, J.E. 1984. Disease Resistance in Plants 2<sup>nd</sup> Edition, Academic Press Inc., London 194 PP.
13. Vidhyasekaran, P. 2002. Bacterial Disease Resistance in Plants: Molecular Biology and Biotechnological Applications, Food Products Press, an imprint of the Haworth Press Inc. 455 PP.

**12. Title of the Course: SOIL-BORNE PLANT PATHOGENS**

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

**Prerequisites:** Introductory Plant Pathology

**Learning Objectives:**

To acquaint students with basic concepts of soil-borne plant pathogens and their management

**Course Contents:**

**Theory**

Importance of soil-borne diseases; introduction to soil-borne plant pathogenic fungi, bacteria, nematodes and viruses; survival mechanism of soil-borne plant pathogens; interaction between soil-borne plant pathogens; effect of soil edaphic factors on soil-borne pathogens; interaction of soil borne-pathogens with saprophytic soil microorganisms; management of soil-borne pathogens through chemicals, bio-control agents, plastic mulching and other cultural methods; molecular methods for detecting soil-borne pathogens; conventional, nested and real time PCR.

**Practical**

Techniques for isolation and identification of soil-borne pathogens; *in vitro* evaluation of chemical, physical and biological methods for the management of soil-borne pathogens; demonstration of different methods for management of soil-borne pathogens.

**Recommended Books:**

1. Ashok, P. and K.G. Mukerji. 2007. Biological Control of Plant Diseases. CRC Press.
2. Boland, G. and L. Bolis. 1998. Plant-microbe Interactions and Biological Control. CRC Press.
3. Bruehl, G.W. 1987. Soil-borne Plant Pathogens. Free Press.
4. Gnanamanickam, S.S. 2002. Biological Control of Crop Diseases. Marcel Dekker, Inc.
5. Hillocks, R.J. and J.M. Waller. 1997. Soil-borne Diseases of Tropical Crops. CABI, UK.
6. Jenkins, R. and C.K. Jain. 2010. Advances In Soil-borne Plant Diseases. Oxford Book Co., India.
7. Naik, M.K. and G.S. Devikarani. 2008. Advances in Soil-borne Plant Diseases. New India Publishing Agency Delhi, India.

**13. Title of the Course: METHODS AND TECHNIQUES IN PLANT PATHOLOGY**

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

**Prerequisites:** Introductory Plant Pathology

**Learning Objectives:**

To impart knowledge about methodologies and techniques used in Plant Pathology

**Course Contents:****Theory**

Plant disease clinic and its requirements; expert client interaction; diagnostic protocols; problem identification; hypothesizing; defining objectives; collection, handling, transport, processing and preservation of diseased specimens; protocols and procedures used for the isolation, identification, purification, multiplication and preservation of plant pathogens; Koch's postulates; microscopic, histo-pathological, serological and molecular techniques; experimental layout, data collection, statistical analysis interpretation and report writing; pre- and postharvest handling to reduce losses in vegetables and fruits.

**Practical**

Methods of collection and preservation of plant disease specimens; media preparation; equipments, glassware, chemicals and reagents for plant disease clinic; isolation and identification of different plant pathogens; maintenance and preservation of cultures; preparation of temporary and permanent slides; macro and micro-photography and micrometry of plant pathogens; use of haemocytometer; preparation of questionnaire; designing of survey performas; maintenance and preservation of cultures; histo-pathological, serological and molecular methods; experimental layout, data collection, statistical analysis interpretation; recommendation and report writing for clients.

**Recommended Books:**

1. Ahmad, I., M. Aslam and A. Munir. 1992. Phytopathological Diagnostic Techniques. Pakistan Agricultural Research Council, Islamabad, Pakistan.
2. Aneja, K.R. 2003. Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International (Pvt.) Ltd. New Delhi. India.
3. Bashir, M. and S. Hassan. 1998. Diagnostic Methods for Plant Viruses, PARC, Islamabad.
4. Bhutta, A.R. and I. Ahmad. 2001. Seed Pathological Techniques and their Application. National Book Foundation, Islamabad, Pakistan.
5. Burns. R. 2008. Plant Pathology; Techniques and Protocols (Methods in Molecular Biology). Humana Press
6. Foster, G.D., I.E., Johansen, Y. Hong and P.D. Nagy. (Eds). 2008. Plant Virology Protocols - From Viral Sequence to Protein Function (2nd edition). Humana Press.

7. Fox, R.T.V. 1994. Principles of Diagnostic Techniques in Plant Pathology. CAB International, UK.
8. Hampton, R., E. Ball and S. DeBoer. 1990. Serological Methods for Detection and identification of Viral and Bacterial Plant Pathogens - A Laboratory Manual. American Phytopathological Press, Saint Paul, Minnesota, USA
9. Malcolm C.S. and W.A. Charles. 2000. Diagnosing Plant Diseases Caused by Nematodes. American Phytopathological Society Press, St. Paul, Minnesota, USA.
10. Narayanasamy, P. 2001. Plant Pathogen Detection and Disease Diagnosis (2<sup>nd</sup> ed.). Marcel Dekker.
11. Schaad, N.W., J.B. Jones and W. Chun. 2001. Laboratory Guide for Identification of Plant Pathogenic Bacteria, Third Edition. American Phytopathological Society Press, St. Paul, Minnesota, USA.
12. Sinclair, J.B., and O.D. Dhingra. 1995. Basic Plant Pathology Methods. CRC Press USA.
13. Trigiano, R.N., M.T. Windham and A.S. Windham. 2007. Plant Pathology Concepts and Laboratory Exercises, Second Edition.

**14. Title of the Course: DISEASES OF FRUITS AND ORNAMENTALS**

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

**Prerequisites:** Introductory Plant Pathology

**Learning Objectives:**

To study basic and applied aspects of economically important diseases of fruits and ornamental plants and their management.

**Course Contents:**

**Theory**

Importance, symptoms, disease cycle, causal agent, methods of perpetuation; management of major diseases of tropical (banana, papaya, guava, mango and citrus), subtropical and temperate (pome, stone and nut fruits, grapes) fruits and common ornamental plants.

**Practical**

Field visits, collection and preservation of diseased specimens; identification of diseases on the basis of symptoms; isolation of pathogens and preparation of permanent mounts; orientation of management practices.

**Recommended Books:**

1. Chase, A.R. 1987. Compendium of foliage ornamental plant diseases. APS USA.
2. Compendia of apple and pear, citrus, grapes, stone fruits and

tropical fruits diseases. American Phytopathological Society, St. Paul, Minnesota, USA.

3. Compendium of ornamental plants, Foliage plant diseases, 1988. American Phytopathological Society, St. Paul, Minnesota, USA.
4. Gupta, V.K. and S.K. Sharma. 2000. Diseases of Fruit Crops. Kalyani Publishers New Delhi, India
5. Leslie, A.R. 1994. Handbook of Integrated Pest Management for Fruit and Ornamentals. CRC Press, London.
6. Machardv, W.E. 1996. Apple Scab. Biology, Epidemiology and Management. American Phytopathological Society, St. Paul, Minnesota, USA.
7. Pathak, V.N. 1981. Diseases of Fruit Crops. Oxford and IBH Publishing Company, New Delhi, India.
8. Ploetz, R.C. 2003. Diseases of Tropical Fruit Crops. CABI – UK.
9. Reddy, P.P. 2010. Bacterial and Viral Diseases and their Management in Horticultural Crops. Scientific Pub. 288 p.
10. Singh, R.S. 2001. Diseases of Fruit Crops. Science Publ. Inc.
11. Stefrud, A. 2005. Diseases of Fruits and Nuts. Biotech Book, Delhi.

**15. Title of the Course: SEED AND POST-HARVEST PATHOLOGY  
Credit Hours: 3(2-1)**

**Prerequisites:** Introductory Plant Pathology

**Learning Objectives:**

To study seed borne and post-harvest diseases and their management.

**Course Contents:**

**Theory**

Introduction, importance and significant losses due to seed and postharvest diseases;

Morphology and anatomy of healthy and infected seed; seed-borne diseases and their effect on seed germination and planting value; histopathology of infected seed and transmission of seed-borne pathogens; effect of biotic and abiotic diseases during storage/ transit and on shelf life of seeds and perishables; epidemiology of seed-borne diseases; seed health testing; mycotoxins and their hazards; economic importance of post harvest losses in seeds, fruits and vegetables during processing; factors affecting postharvest losses (physical, physiological, biochemical and pathological); management of seed and postharvest diseases; methods and structure of storage at farm and public level.

**Practical**

Seed health testing; different techniques for isolation and identification of microorganisms associated with seeds and their effect on



germination; postharvest losses estimation/ assessment; visits to grains, fruits and vegetables store houses; collection and identification of biotic and abiotic diseased specimens/samples of perishables; use of safe chemicals/fumigants for management of seed and post harvest diseases.

**Recommended Books:**

1. Agarwal, V.K. 2006. Seed Health. International Book Distributing Company. 554 pp.
2. Agarwal, V.K. and J.B. Sinclair. 1996. Principles of Seed Pathology, Second Edition. CRC Press. 560 pp.
3. Barkai-Golan, R. 2001. Post-harvest Diseases of Fruits and Vegetables: Development and Control. Elsevier. 418 pp.
4. Bartz, J.A. and J.K. Brecht. 2002. Post-harvest Physiology and Pathology of Vegetables. Marcel Dekker. India
5. Bhutta, A.R. and I. Ahmad. 2001. Seed Pathological Techniques and their Application. National Book Foundation, Islamabad, Pakistan
6. Bhutta, A.R., A. Hussain and M.R. Rahman. 2004. Hand book on Seed Processing and Storage. Federal Seed Certification and Registration Department, Islamabad, Pakistan.
7. Bhutta, A.R. 2010. Text Book of Introductory Seed Pathology. HEC, Pakistan.
8. Dasgupta, M.K. and N.C. Mandal. 1989. Postharvest Pathology of Perishables. Oxford & IBH Publishing Company Private, Limited. 638 pp.
9. Dennis, S.H. 2002. Pests of stored Foodstuffs and their Control. Kluwer Academic publishers. India
10. Gullino, M.L. and D. Prusky. 2009. Post-Harvest Pathology (Plant Pathology in the 21st Century). Springer.
11. Narayanasamy, P. 2006. Post-harvest Pathogens and Disease Management. John Wiley & Sons, Inc., Hoboken, New Jersey. 578 pp.
12. Neergaard, P. 1977 & 1988. Seed Pathology: Volume 1&2. John Wiley & Sons, Incorporated. pp.1187.
13. Prusky, D. and M. Lodovica Gullino. 2010. Post-harvest Pathology Springer. pp.211.
14. Schumann, G.L. and C.J. D'Arcy. 2010. Essential Plant Pathology. APS Press. 369 pp.
15. Snowdon, A.L. 2010. A color Atlas of Post-Harvest Diseases and Disorders of Fruits and Vegetables: Volume 1: General Introduction & Fruits. Wolfe Scientific Ltd. 302 pp.

**16. Title of the Course: PLANT DISEASE MANAGEMENT**

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

**Prerequisites:** Introductory Plant Pathology

**Learning Objectives:**

To introduce the students to plant disease management practices

**Course Contents:**

**Theory**

Principles and methods of plant disease management based on avoidance, exclusion, eradication of pathogens, protection (preventive and curative) and resistance (pathogen derived resistance, host resistance); management of plant diseases with emphasis on regulatory, cultural, biological, physical and chemical strategies; induced systemic resistance; integrated disease management (IDM), seed health certification system; philosophy of TOF (Training of Facilitators) and FFS (Farmer Field School); epidemiological basis of disease management strategies; concept of field biodiversity; conservation and crop appraisal.

**Practical**

Demonstration of different disease management practices; equipments and machinery used for disease management and their calibration; safety measures for disease managing chemicals; handling and application procedures; Crop Agro Ecosystem Analysis.

**Recommended Books:**

1. Agrios. G.N. 2005. Plant Pathology 5<sup>th</sup> ed. Academic Press New York.
2. Ahmad, I. and A.R. Bhutta. 2005. Textbook of Introductory Plant Pathology. National Book Foundation, Islamabad, Pakistan.
3. Atwal, A.S and G.S. Dhaliwal. 2008. Agricultural Pests of South East Asia and their Management. Kalyani Publishers, Ludhiana. India
4. Bhutta, A.R. 2010. Text book of Introductory Seed Pathology. HEC, Pakistan.
5. Gadewarr, A.V. 2006. Plant Protection in New Millennium. Vol.1. Hardcover Publisher.
6. Helyer, N., K. Brown and N.A. Cattlin. 2003. Biological Control in Plant Protection (A Colour Hand Book). Manson Publication Ltd, London, UK.
7. Narayanasamy, P. 2008. Molecular Biology in Plant Pathogenesis and Disease Management: Disease Management. Volume 3. Springer.
8. Singh, R.S. 2001. Plant Disease Management. Science Pub. Inc. India.

**17. Title of the Course: INTRODUCTORY MOLECULAR  
PLANT PATHOLOGY**

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

**Prerequisites:** Introductory Plant Pathology

**Learning Objectives:**

To acquaint the students with basic concepts and techniques of molecular plant pathology.

**Course Contents:**

**Theory**

Introduction to molecular techniques and their application; molecular mechanisms of pathogenesis with a focus on plant diseases; molecular biology of host parasite interaction and biochemical mechanisms of pathogenesis; molecular approaches to control pathogens; genes and diseases, gene variability in hosts and pathogens; genetics of virulence in pathogens and resistance in host plants; co-evolution of hosts and pathogens; signaling in plant disease development; functional analysis of MYB transcription factors in *Gibberella zeae*; molecular mechanisms of fungicide resistance in plant pathogenic fungi; Pre-existing structural and chemical defenses; defense through lack of essential factors; induced structural and biochemical defenses; resistance gene engineering; vectors for gene engineering; delivering genes to the plant, the use of cloned resistance genes; quorum sensing; programmed cell death; transgenic plants, RNA silencing.

**Practical**

Methods in molecular plant pathology including the use of molecular approaches to investigate plant diseases; primer design; BLAST search; alignment of sequences, sequence editing; open reading frames; familiarization to common molecular techniques used in plant pathology including DNA/ RNA isolation, hybridization, sequence analysis, various PCR reactions, library construction and screening, protein isolation and plant transformation, use of degenerated PCR for the detection of plant disease resistance in crop plants.

**Recommended Books:**

1. Ansari, T.M. 2008. Molecular Plant Pathology. Pearl Books, India.
2. De Roberties, E.D.P. and E.M.T. DeRoberties, Jr. 1992. Cell and Molecular Biology. 8th ed. John Willey & Sons, USA.
3. Desi, L. 2007. Molecular Plant Pathology. Paragon International.
4. Devi, P. 2005. Principles and Methods of Plant Molecular Biology, Biochemistry, Biotechnology and Genetics. Student Edition, India.

5. Dickinson, M. 2003. Molecular Plant Pathology. NIOS Scientific Publishers. 273 pp.
6. Gurr, S.J., M.J. Pherson and D.J. Bowles. 1991. Molecular Plant Pathology: A Practical Approach. Oxford University Press.
7. Gurr, S.J., M.J. McPherson and D.J. Bowles. 1992. Molecular plant Pathology: A Practical Approach. IRC Press at Oxford University Press. 328 pp..
8. Hafeez, F., Y. Zafar and A. M. Khalid. 2005. Modern Techniques in Biotechnology. A Theoretical Manual. NIBGE, Faisalabad.
9. Lakshman, D. 2007. Molecular Plant Pathology. Paragon, International Publishers.
10. Mathew, J.D. 2003. Molecular Plant Pathology. Bios Scientific Publishers, Ltd., UK.
11. Pena, L. 2005. Transgenic Plants. Methods and Protocol. Humana, USA.
12. Rastogi, S.C. 2006. Cell and Molecular Biology. New Age Publications (Academic).
13. Sigeer, D.C. 1993, 2005. Bacterial Plant Pathology: Cell and Molecular Aspects. Cambridge University Press. 329 pp.
14. Singh, U.S. and R.P. Singh. 1995. Molecular Methods in Plant Pathology. CRA Press Inc., pp. 527.
15. Vidhyasekaran, P. 2002. Bacterial Disease Resistance in Plants: Molecular Biology and Biotechnological Applications. Food Products Press, an imprint of the Haworth Press Inc., NY. 455 pp.

**18. Title of the Course: PLANT DISEASE EPIDEMIOLOGY**

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

**Prerequisites:** Introductory Plant Pathology

**Learning Objectives:** To study the development of plant disease epidemics

**Course Contents:**

**Theory**

Introduction, history, importance and types of plant disease epidemics; principles and components of epidemics; factors influencing dynamics of epidemics; global climate change and relationship between climate variation and plant disease epidemics; monitoring of plant disease epidemics; epidemic growth curve and growth rate; forecasting of epidemics and their modeling; disease warning systems.

**Practical**

Determination of meteorological parameters and their correlation with plant diseases; development of disease prediction models; use of

expert systems for monitoring epidemic development; crop loss assessment methods.

**Recommended Books:**

1. Agrios. G.N. 2005. Plant Pathology. 5<sup>th</sup> Ed. Academic Press N.Y. USA.
2. Campbell, C.L. and L.V. Madden. 1990. Introduction to Plant Disease Epidemiology. John Wiley & Sons, Inc. New York, USA.
3. Kranz, J. 2002. Comparative Epidemiology of Plant Diseases. Springer;
4. Kranz, J. 1990. Epidemics of Plant Diseases: Mathematical Analysis and Modeling. Springe Publ. London, UK.
5. Leonard, J.F. and D.A. Neher. 1997. Exercises in Plant Disease Epidemiology. American Phytopathological Society Press, St. Paul, Minnesota, USA.
6. Savary, S. and B.M. Cooke. 2006. Plant Disease Epidemiology: Facing Challenges of the 21<sup>st</sup> Century: Under the aegis of an International Plant Disease Epidemiology Workshop held at Landernau, France, 10-15th April, 2005. Springer.

**19. Title of the Course: HISTOPATHOLOGY OF DISEASED PLANTS**

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

**Prerequisites:** Introductory Plant Pathology

**Learning Objectives:** To study histo-pathological changes in diseased plants

**Course Contents:**

**Theory:**

Introduction to histopathology of diseased plants; water-soaking, pre-necrotic, necrotic, blighted tissues, abnormal coloration such as yellowing, chlorosis, of leaves; histopathology of affected stem showing wilting, die-back, rust, streak or stripe; histopathology of pitting, scald, scorch and shot hole of leaves and stem; Histopathology of tissues showing hypertrophic, hyperplastic, hypoblastic or abnormal growth including gall, knot, tumefaction, callus, canker; histopathology of russetting, scab, rotting, tissue softening and leaking; histopathology of special symptoms such as witches' broom, bunchy top, epinasty etc.

**Practical:**

Study and collection of different plant disease symptoms in field and their observation in laboratory by section cutting and slide mounting of infected tissues; preservation of infected parts of diseased plants

in formalin for future study and presentations; preparation of permanent mounts of infected tissues by section cutting and double staining method; small scale inoculation of pathogens on selected crop plants to study their specific symptoms.

**Recommended Books:**

1. Ayres, P.G. 1981. Effects of Disease on the Physiology of the Growing Plants. Cambridge University Press.
2. Baily, J.A. and B.J. Deverall. 1983. The Dynamics of Host Defense. Academic Press, New York, USA.
3. Fritig, B. and M. LeGrand. 1993. Mechanisms of Plant Defense Responses. Kluwer, Dordrecht, The Netherlands.
4. Goodman, R.N., Z. Kiraly, and K.R. Wood. 1986. The Biochemistry and Physiology of Plant Disease. Univ. of Missouri Press, Columbia, USA.
5. Kaul, T. and B.L. Dhar. 1986. The Biochemistry and Physiology of Plant Disease. Robert N. Goodman, Zoltán Király and K. R. Wood, 433 PP.
6. Lawlor, W.D. 2001. Photosynthesis. 3<sup>rd</sup> Ed. Viva Books (Pvt.) Ltd. India.
7. Misra, J.R. 2004. Photosynthesis in Plants. DPH, India.
8. Petrini, O. and G.B. Ouellette. 1994. Host Wall Alterations by Parasitic Fungi. American Phytopathology Society Press, St., Paul. Minnesota, USA.
9. Schumann, G. L. and C. J D'Arcy. 2010. Essential Plant Pathology. APS Press, 369 pp.
10. Strange, R.N. 2003. Introduction to Plant Pathology. John Wiley and Sons Ltd.
11. Dragoljub D. Šutić and J.B. Sinclair. 1991. Anatomy and Physiology of Diseased Plants. CRC Press, 232 pp.

**20. Title of the Course: PESTICIDES, THEIR ACTION AND APPLICATION**

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

**Prerequisites:** Introductory Plant Pathology

**Learning Objectives:**

To study pesticides, their application and mode of action in plants

**Course Contents:**

**Theory**

Introduction and history of pesticides; major groups of pesticides and their classification; formulation and mode of action; residues, resistance and phytotoxicity problems of pesticides (fungicides, bactericides, and nematocides etc.); equipments and different methods of application; FAO code of conduct for pesticide use and handling

(codex alimentarius; pesticide regulation, registration and distribution in Pakistan; major hazards of pesticides and their safety measures; pesticides compatibility and selectivity; pre-harvest safety intervals.

#### **Practical**

Demonstration of different groups of pesticides used to control plant diseases; preparation, formulation and doses; use of various equipments and calibration and measurement of droplet size; *In vitro* comparison of systemic and protectant pesticides; visits to pesticides testing labs and warehouses; protective measures and first aid.

#### **Recommended Books:**

1. Biddle, A. 2001. Seed Treatment, Challenges and Opportunities. The BCPC Publications, UK.
2. Harris, J. 2000. Chemical Pesticide Markets, Health Risks and Residues. CABI, UK.
3. Jorgen, S. 2004. Chemical Pesticide. Mode of Action and Toxicology. CRC Press, London.
4. Mathews, G.A. and M.A. Meladen. 2000. Pesticides Application Methods. 3<sup>rd</sup> ed. Blackwell Science Publication, New York.
5. Parmar, B.S. and S.S. Tomar. 2003. Pesticides Formulation. Theory and Practices. CBS Publ. Co. India.
6. Robert, T. 2000. Metabolism of Agro-chemicals in Plants. John Willey & Sons. USA.
7. Thompson, W.T. 1993. Agricultural Chemicals. Book IV. Fungicide. California, USA.
8. Tomlin, C. 2003. The Pesticide Manual. 13<sup>th</sup> Edition. BCPC – UK.

#### **21. Title of the Course: ABIOTIC DISEASES OF PLANTS**

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

**Prerequisites:** Introductory Plant Pathology

#### **Learning Objectives:**

To acquaint students with the basic concepts of abiotic plant diseases and their management

#### **Course Contents:**

##### **Theory**

Abiotic stresses and their types (temperature, soil moisture and light conditions, lack of oxygen, pollution, mineral deficiencies and toxicities; soil salinity problems; soil pH and improper cultural practices, etc.); symptomatology (differentiating features from biotic diseases); macro and micro nutrients and their effect on plants; management of major abiotic diseases.

**Practical**

Collection of samples of abiotic diseased plants, identification and preservation; studies on effect of abiotic factors on plants and their management.

**Recommended Books:**

1. Bergstrom, L. and H. Kirchmann. 1998. Carbon and Nutrient Dynamics in Natural and Agricultural Tropical Ecosystem. CAB Inc. UK.
2. Haard, N.F. and D.K. Salunkle. 1980. Symptoms on Post Harvest Biology and Handling of Fruits and Vegetables. The AUI Publishing Co. Inc. West Post Connecticut, USA.
3. Hill, M.K. 2004. Understanding Environmental Pollution, 2<sup>nd</sup> Ed., Cambridge Press, UK.
4. Shurtleff, M.C. and C.W. Averre. 1997. The Plant Disease Clinic and Field Diagnosis of Abiotic Diseases. American Phytopathological Society Press, St. Paul, Minnesota, USA.
5. Tandov, H.L.S and R.N. Roy. 2004. Integrated Nutrient Management. A Glossary of Terms. FAO, UN, Rome.

**22. Title of the Course: BIOTECHNOLOGY AND ITS APPLICATION IN PLANT PATHOLOGY**

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

**Prerequisites:** Introductory Plant Pathology

**Learning Objectives:** To apprise the students of various techniques of biotechnology and their application in Plant Pathology.

**Course Contents:****Theory**

Concept, history and development of biotechnology in relation to agriculture and plant pathology; plant cell and tissue culture techniques and production of disease free plants; plant transformation; genetic selection and screening of mutants; host pathogen interactions; recombinant DNA technique to produce disease free plants and to induce resistance in selected cultivars; construction and screening of DNA libraries; DNA sequencing; molecular biology techniques for diagnosis of plant pathogens; bioinformatics & its applications in plant diseases diagnosis and epidemiology; nucleic acid analysis; transgenic plant disease management against viral, bacterial and fungal resistance; plant transformation and genetic markers, selectable marker genes, screen able marker genes, analysis of GUS expression, production of GM plants for disease management.



### **Practical**

Introduction to standard techniques and instruments used in biotechnology laboratories (tissue culture and molecular biology labs); methods to produce disease free cultivars using tissue culture techniques; methods to induce resistance in crop plants against pathogens by gene manipulation (genetic engineering techniques); production of cDNA libraries of selected genes in appropriate expression systems; use of Blotting techniques (Southern, Northern and Western blots); visit to biotechnology labs.

### **Recommended Books:**

1. Agrios, G.N. 2005. Plant Pathology. Elsevier Academic Press.
2. Aneja, K. R. 2003. Experiments in Microbiology, Plant Pathology and Biotechnology, 4<sup>th</sup> Ed. New Age International Publishers, 609 pp..
3. Campbell, L.L. 1991. Biotechnology in Plant Pathology: Potential for Change. Physiopathology News, 25-30.
4. Chawla, H.S. 2004. Introduction to Plant Biotechnology, 2<sup>nd</sup> Edition. Science Publishers, Inc., USA. 541 pp.
5. [Ilan Chet](#), I. 1993. Biotechnology in Plant Disease Control. Wiley-Liss, 373 pp.
6. Kumar, A. and S.K. Sopory. 2008. Recent Advances in Plant Biotechnology and Its Applications. I.K. International Publishing House Pvt. Ltd., India. 694 pp.
7. Primrose, S.R. 2001. Molecular Biotechnology. 2<sup>nd</sup> edition. Panima Publ. Corp. India.
8. Punja, Z.K., S.H. De Boer and H. Sanfaçon. 2007. Biotechnology and Plant Disease Management. CAB International, North America.
9. Purohit, S.S. 2003. Plant Tissue Culture. (Student Edition), India, Rastogi Publications, India.
10. Rena, L. 2005. Transgenic plants, methods and protocols. Humana N.J. USA.
11. Srivastava, M. and R.R. Shoferma. 2004. Plant Propagation and Nursery Management. Int. Book Distribution, India.

### **23. Title of the Course: BIOLOGY AND CULTIVATION OF EDIBLE FUNGI**

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

**Prerequisites:** Introductory Plant Pathology

**Learning Objectives:** To acquaint students with biology and cultivation of edible fungi.

### **Course Contents:**

#### **Theory**

History of mushrooms; taxonomy, biology and cultivation of edible fungi in Pakistan; identification of edible and poisonous species; nutritional and medicinal importance of edible fungi; technical aspects of cultivation of button, oyster, straw, Chinese, shiitake, and medicinal edible fungi: growth rooms, pasteurization methods; national and international markets and commercial value of edible fungi; spawn types and processing techniques; pests and diseases of edible fungi and their management.

#### **Practical**

Taxonomic studies of wild and cultivated mushrooms; construction of model mushroom houses; Preparation of spawn; development of compost and beds from different agricultural and industrial wastes; control of pest and diseases of mushrooms.

#### **Recommended Books:**

1. Alexopoulos, C.J., C.W. Mims and M. Blackwell. 1996. Introductory Mycology. 4<sup>th</sup> ed. John Wiley & Sons, Inc. New York, USA.
2. Bahl, N. 1988. Hand book on Mushrooms. 2<sup>nd</sup> Ed. Oxford & IBH Publ. Co. New Delhi. India.
3. Chang, S.T. and P.G. Miles. 2004. Mushroom Cultivation, Nutritional Value, Medicinal Effect and Environmental Impact. CRC Press, NYC, USA.
4. Chang, S.T. and T.H. Quimio. 1982. Tropical Mushrooms: Biological Nature and Cultivation Methods. Chinese University Press.
5. Khan, S.M. and S.M. Khan. 2005. Mushroom cultivation. N SRS Publishers, Faisalabad.
6. Miles, P.G. and S.T. Chang. 1997. Mushroom Biology: Concise Basic and Current Developments. World Scientific Publishing Company.
7. Nasim, G. and R. Bajwa. 2010. Glomalean Spore Flora of Pakistan. HEC, Islamabad, Pakistan.

### **24. Title of the Course: PLANT QUARANTINE AND SPS MEASURES**

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

**Prerequisites:** Introductory Plant Pathology

**Learning Objectives:** To acquaint the students about plant quarantine rules and Sanitary and phytosanitary measures (SPS) measures

**Course Contents:****Theory**

Plant quarantine concepts and principles; plant and seed related issues of domestic and exotic quarantine object; domestic and International quarantine standards; plant quarantine Act 1976 (Rules, 1967) and Seed Act, 1976 (Seed Amendment Bill-2014) and their implementation in plant and seed import/export; outbreak of some important diseases introduced into Pakistan and elsewhere during import of plant, seed and food items; introduction to SPS measure under WTO regime and its relation to bio-security; inspection procedures and measures adopted under IPC and NAPHIS in Pakistan during import/export of agricultural commodities.

**Practical**

Visit to port of entry (dry, air and sea ports); practical demonstration of inspection of import/export consignments and collection of samples for analysis of various plants and seed/ planting material against various diseases; identification of diseases, inspection procedures and measures adopted under IPC and NAPHIS in Pakistan during import/export consignments; visit to seed testing station of Federal Seed Certification & Registration Department and Department of Plant Protection.

**Recommended Books:**

1. Devorshak, 2012. Plant Pest Risk Analysis, Concepts and Application CABI, International. 296 pp.
2. Bhutta, A.R. 2010. Introductory Seed Pathology, HEC Press Islamabad Pakistan. 557 pp.
3. Bhutta A.R. and I. Ahmed-2001. Seed Pathological Techniques and Their Applications Publ. by NBF, Islamabad
4. Ebbels, D.L, 2003. Principles of Plant Health and Quarantine- CABI, Publication.
5. FAO-2000. Multilateral Trade Negotiation on Agriculture. A Resource Manual-III SPS & TBT Agreement Publ. by FAO-UN, Rome, Italy.
6. Plant Quarantine Act-1976 and Rules 1967. Govt. of Pakistan, Karachi.
7. Ranjan.S, 2007. Sanitary and Phytosanitary Measures – An Introduction, Lefai Uni. Press India.
8. Seed Act, 1976, Seed Amendment Bill-2014 Govt. of Pakistan, Islamabad.

**25. Title of the Course: INTERNSHIP / PROJECT STUDY****Credit Hours: 4(0-4)****Prerequisites:** Introductory Plant Pathology

**Learning Objectives:**

It is intended to apprise students of the basics of how to design and conduct research, data analysis as well as technical report writing and presentation. Further, it covers a wide spectrum of experiments designed for students at undergraduate level. The experiments are selected to provide insight into the basic principles and techniques of Plant Pathology.

**Course Contents:**

Proposal development, on spot field training; report writing and project presentation. (Format as per thesis manual of the university concerned).

**Recommended Books:**

Relevant latest literature on target issues

**SCHEME OF STUDIES  
FOR POSTGRADUATE PROGRAMMES  
(MSc (Hons) & PhD) LIST OF COURSES**

<b>S.NO.</b>	<b>TITLE OF COURSE</b>	<b>Cr. Hr.</b>
1.	Mycology-I	3(2-1)
2.	Mycology-II	3(2-1)
3.	Fungal systematics	3(2-1)
4.	Fungal Plant Pathology*	3(2-1)
5.	Plant Virology*	3(2-1)
6.	Plant Bacteriology*	3(2-1)
7.	Plant Nematology*	3(2-1)
8.	Ecology and Epidemiology of Plant Diseases	3(2-1)
9.	Biochemistry and Physiology of Diseased Plants	3(2-1)
10.	Genetics of Plant Pathogens	3(3-0)
11.	Seed Pathology	3(2-1)
12.	Integrated Plant Disease Management	3(2-1)
13.	Post-harvest Pathology	3(2-1)
14.	Vector Transmission of Plant Diseases	3(2-1)
15.	Forest and Shade Tree Pathology	3(2-1)
16.	Advances in Plant Pathology **	3(3-0)
17.	Molecular Plant Virology	3(2-1)
18.	Molecular Plant Microbe Interactions **	3(2-1)
19.	Biological Control of Plant Pathogens	3(2-1)
20.	Plant Pathology and International Obligations	3(2-1)
21.	Bioinformatics in Plant Pathology	3(2-1)
22.	Plant Pathology and Environmental Concerns	3(3-0)
23.	Seminar-I (MSc (H) Thesis)	1(1-0)
24.	Special Problem	1(1-0)
25.	Research Thesis (MSc (H))	10 (0-10)
26.	Seminar-II (PhD Synopsis)	1(1-0)
27.	Seminar -III (PhD Thesis)	1(1-0)
28.	Research Thesis (PhD)	20(0-20)

\*Core courses for MSc (Hons) Specialization in Plant Pathology

\*\*Core courses for PhD.

**DETAIL OF COURSES  
FOR POST-GRADUATE PROGRAMMES MSc (HONS)/  
PHD IN PLANT PATHOLOGY**

**1.Title of the Course: 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

**Course Contents:**

**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:**

1. Alexopoulos, C.J., C.W. Mims. and M. Blackwell.1996. Introductory Mycology. 4<sup>th</sup> edition, John Wiley and Sons. Inc., New York, USA.
2. Kirk, P.M., J.A. Stalpers, D.W. Minter and P.F. Cannon. 2011. Dictionary of fungi. 10th ed. CABI, UK.
3. Lemke, P.A. and K. Esser. 2001. The Mycota. Volume VII.

- Systematics and Evolution. Part A. Springer.5. Kendrick, B. 2000. *The Fifth Kingdom*. (3<sup>rd</sup> ed.). Focus Publishing/R. Pullins Company, Incorporated.373 pp.
4. Liliane Elisabeth Petrini-Klieber, L.E. and O. Petrini. 2013. *Identifying Moulds: A Practical Guide*. Gebruder Borntraeger Verlagsbuchhandlung, Science Publishers.
  5. Mirza, J.H., S.M. Khan., S. Begum and S. Shagufta. 1979. *Mucorales of Pakistan*, University of Agriculture, Faisalabad, Pakistan.
  6. Webster, J. and R. Weber. 2007. *Introduction to Fungi*. Cambridge University Press.

**2. Title of the Course: MYCOLOGY-II (Zygomycota, Glomeromycota, Ascomycota, Basidiomycota and Mitospric fungi)**

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

Prerequisites: Introductory Mycology

**Learning Objectives:**

To study taxonomy and nomenclature of fungi of agricultural importance

**Course Contents:**

**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.

Ascomycota: Morphology, reproduction, life cycle patterns, sexual compatibility and parasexuality. Types of asci, conidia and ascocarps. Ascospore formation and conidiogenesis; principles and systems of classification of Ascomycota and mitosporic fungi; classification and life cycle of plant pathogenic species of agricultural importance in Pakistan. Ascolichens, general characters, anatomy and distribution in Pakistan. Basidiomycota: Introduction to Basidiomycetes; somatic structure, reproduction, basidiocarp developmental patterns, types of basidia and basidiospores; principles and systems of classification; life cycle and classification of taxa of agricultural importance. Basidiolichens and their taxonomy.

**Practical**

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

### Recommended Books:

1. Ahmad, S. 1978. Ascomycetes of Pakistan Vol.1 and II. Biological Society of Pakistan, Lahore, Pakistan.
2. Alexopoulos, C.J., C.W. Mims and M. Blackwell. 1996. Introductory Mycology. 4<sup>th</sup> edition, John Wiley and Sons. Inc., New York, USA.
3. Barnett, H. L. and B.B. Hunter. 1996. Illustrated Genera of Imperfect Fungi, 4<sup>th</sup> edition, American Phytopathological Society Press, St. Paul, Minnesota, USA.
4. Cole, G.T. and B. Kendrick. 1981. Biology of Conidial Fungi. Vol-II. Academic Press, New York, USA.
5. Cummins, E.A. 1971. The Rust Fungi of Cereals, Grasses and Bamboo. Springer-Verlag. Berlin, Germany.
6. Cummins, G.B. and Y. Hiratsuka. 2003. Illustrated Genera of Rust Fungi, 3rd Ed. APS Press, St. Paul Minnesota. 240 pp.
7. Hanlin, R.T. 1990. *Illustrated Genera of Ascomycetes*. Vol. 1. APS Press, St. Paul.
8. Minnesota. 263 pp.
9. Hanlin, R.T. 1998. *Illustrated Genera of Ascomycetes*. Vol. 2. APS Press, St. Paul
10. Minnesota. 258 pp.
11. Kálmán Vánky. 2012. Smut Fungi of the World. APS Press, St. Paul Minnesota. 1480 pp.
12. Kálmán Vánky. 2013. Illustrated Genera of Smut Fungi. 3rd Ed. APS Press, St. Paul
13. Minnesota. 280 pp.
14. Kendrick, B. 2000. *The Fifth Kingdom*. (3<sup>rd</sup> ed.). Focus Publishing/R. Pullins Company, Incorporated.373 pp.
15. Kirk, P.M., J.A. Stalpers, D.W. Minter and P.F. Cannon. 2011. Dictionary of Fungi. 10<sup>th</sup> ed. CABI, UK.
16. Lemke, P.A. and K. Esser. 2001. The Mycota. Volume VII. Systematics and Evolution. Part A. Springer.
17. Liliane Elisabeth Petrini-Klieber, L.E. and O. Petrini. 2013. *Identifying Moulds: A Practical Guide*. Gebruder Borntraeger Verlagsbuchhandlung, Science Publishers.
18. Webster, J. and R. Weber. 2007. Introduction to Fungi. Cambridge University Press.
19. White J.F. 2003.Claviciptalean fungi, Evolution, Biology, Chemistry, Bio and Cultural Control.



### **3. Title of the Course: FUNGAL SYSTEMATICS**

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

Prerequisites: Introductory Mycology

#### **Learning Objectives:**

To study taxonomy and nomenclature of fungi of agricultural importance

#### **Course Contents:**

##### **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:**

1. Alexopoulos, C.J., C.W. Mims and M. Blackwell. 1996. Introductory Mycology. 4th edition, John Wiley & Sons, Inc. New York, USA.
2. Cannon, P.F., P.M. Kirk, D.W. Minter and J.A. Stalpers. 2008. Dictionary of Fungi. 10<sup>th</sup> ed. CABI. England.
3. Dilip K., P.D. Arora, P.D. Bridge and D. Bhatnagar. 2004. Handbook of Fungal Biotechnology, Volume 20. Marcel Dekker.
4. Frisvad, J.C., D.K. Arora and P.D. Bridge. 1998. Chemical Fungal Taxonomy. Marcel Dekker
5. Lamour, K. and S. Kamoun. 2009. Oomycete Genetics and Genomics: Diversity, Interactions and Research Tools. John Wiley & Sons Inc.
6. Lebeda, A., T.N. Peter, Spencer-Phillips and B.M. Cooke. 2008. The Downy Mildews - Genetics, Molecular Biology and Control: Genetics. Springer.
7. Miyamoto, M.M. and J. Craft. 1991. Phylogenetic Analysis of DNA Sequences. Oxford University Press.
8. Moore, D. and L.N. Frazer. 2002. Essential Fungal Genetics.

Springer.

9. Rai, M. and P.D. Bridge. 2009. Applied Mycology. CABI, England.
10. Swanton, E.W. 2004. Hand Book of Fungi. Reprint Publication, India.
11. Webster, J. and R. Weber. 2007. Introduction to Fungi. Cambridge University Press.

**4. Title of the Course: 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

**Course Contents:**

**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:**

1. Agrios, G.N. 2005. Plant Pathology. 5<sup>th</sup> Ed.). Elsevier Academic Press Inc., New York.
2. Ahmad, I. and A.R. Bhutta. 2005. Textbook of Introductory Plant Pathology. NFB, Islamabad. 397 pp.
3. Burns, R. 2008. Plant Pathology; Techniques and Protocols (Methods in Molecular Biology). Humana Press.
4. Calderone, R.A. and R.L. Cihlar. 2001. Fungal Pathogenesis - Principles and Clinical Applications Marcel Dekker.

5. Hawksworth, D.L. 2000. Plant Pathologist's Pocket Book. 3rd Ed., CMI Kew, Surrey, England.
6. Narayanasamy, P. 2008. Molecular Biology in Plant Pathogenesis and Disease Management. Springer.
7. Prell, H.H. and P. Day. 2001. Plant-Fungal Pathogen Interaction - A Classical and Molecular View. Springer Verlag.
8. Schumann, G. and C. D'Arcy. 2010. Essential Plant Pathology. APS Press.
9. Triggiano, R.N., M.T. Windham and A.S. Windham. 2007. Plant Pathology Concepts and Laboratory Exercises, Second Edition. CRC Press. 369 pp.
10. Warren, J.K. 2000. Fungal Pathology. Kluwer Academic Publishers.

**5. 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

**Course Contents:**

**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.
2. Foster, G.D. and S.C. Taylor. 1998. Plant Virology Protocols- From Virus Isolation to Transgenic Resistance. Humana Press, New Jersey.
3. Foster, G.D., I.E. Johansen, Y. Hong and P.D. Nagy. (Eds.). 2008. Plant Virology Protocols – From Viral Sequence to Protein Function 2<sup>nd</sup> Ed. Humana Press
4. Hadidi, A., R.K. Khetarpal and H. Koganezawa (Eds). 1998. Plant

Virus Disease Control. American Phytopathological Society, St Paul, Minnesota, USA.

5. Hull, R. 2009. Comparative Plant Virology, 2<sup>nd</sup> Ed. Academic Press
6. Hull, R. 2002. Matthews' Plant Virology, Fourth Ed. Elsevier Ltd.
7. Loebenstein, G. and G. Thottappilly. (Eds.) 2004. Virus and Virus-like Diseases of Major Crops in Developing Countries. Springer
8. Matthews. R.E.F. 1991. Plant Virology. 3<sup>rd</sup> revised edition. Academic Press.

**6. Title of the Course: 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

**Course Contents:**

**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:**

1. De Boer, S.H. 2001. Plant Pathogenic Bacteria. Kluwer Academic Publishers.
2. Fahy, P.C. and G.J. Persley. (eds.). 1983. Plant Bacterial Diseases: A Diagnostic Guide. Academic Press, New York, USA.
3. Goto, M. 1992. Fundamentals of Bacterial Plant Pathology. Academic Press Inc., USA.

4. Hampton, R., E. Ball and S. DeBoer. 1990. Serological Methods for Detection and Identification of Viral and Bacterial Plant Pathogens. A Laboratory Manual. American Phytopathological Society Press, Saint Paul, Minnesota, USA.
5. Janse, J.D. 2008. Phytobacteriology: Principles and Practice. CABI Publishing.
6. Jayarman, J. and J.P. Verma. 2002. Fundamentals of Plant Bacteriology. Kalyani Publishers, Ludhiana, India.
7. Klement, Z., K. Rudolph and D.C. Sands. 1990. Methods in Phytobacteriology. Akademiai Kiado, Budapest, Hungary.
8. Misra, R.S. 2003. Bacterial Plant Diseases. Discovery Publishers and Distributors, India.
9. Srivastava, M. 2006. Introductory Phytobacteriology. Advance Publishing Concept, New Delhi India.

**7. Title of the Course: 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

**Course Contents:**

**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:**

1. Alam, M.M. and N. Sharma. 2002. Nematode Control in Crops.

- International Distributors, India.
2. Ferraz, L.C. and D.J.F. Brown. 2002. An Introduction to Nematodes: Plant Nematology. Pensoft Publishers. Sofia Bulgaria
  3. Gaugler, R. 2001. Entomopathogenic Nematodes. CABI Publishers, UK.
  4. Harish, K. Bajaj, R.S. Kanawar, D.C. Gupta. 2009. Handbook of Practical Nematology. Scientific Publishers, India.
  5. Luc, M., R.A. Sikora and J. Bridge. (Eds.) 2005. Plant Parasitic Nematodes in Subtropical and Tropical Agriculture. 2<sup>nd</sup> Ed., CABI, London, UK.
  6. Maqbool, M.A. and F. Shahina. 2001. Biodiversity of Nematode. Fauna in Pakistan. National Nematological Research Centre, University of Karachi, Pakistan.
  7. Perry, R.N. and M. Moens. 2006. Plant Nematology. CABI London, UK.
  8. Siddiqui, M.R. 2000. Tylenchida: Parasites of Plants and Insects. 2nd ed. Wallingford, CABI Publishing.

**8. Title of the Course: 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

**Course Contents:**

**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:**

1. Agrios, G.N. 2005. Plant Pathology. 5<sup>th</sup> Edition. Academic Press, New York.
2. Campbell, C.L. and L.V. Madden.1990. Introduction to Plant Disease Epidemiology. John Wiley & Sons, Inc. New York.
3. Cooke, B.M., D.G. Jones and B. Kaye. 2004. The Epidemiology of Plant Diseases. Springer Verlag, New York, USA.
4. Frantzen, J. 2007. Epidemiology and Plant Ecology: Principles and Applications. World Scientific Publishing Company.
5. Kranz, J. 1990. Epidemics of Plant Diseases: Mathematical Analysis and Modeling. Springer Verlag, New York, USA.
6. Leonard, J.F. and D.A. Neher. 1997. Exercises in Plant Disease Epidemiology. American Phytopathological Society Press, Saint Paul, Minnesota, USA.
7. Zadoks, J.C. and R.D. Schein. 1979. Epidemiology and Plant Disease Management. Oxford Univ. Press, London and New York, USA.

**9. Title of the Course: 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

**Course Contents:**

**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:**

1. Ayres, P.G. 1981. Effects of Disease on the Physiology of the Growing Plants. Cambridge University Press.
2. Baily, J.A. and B.J. Deverall. 1983. The Dynamics of Host Defense. Academic Press, New York, USA.
3. D. Šutić and J. B. Sinclair. 1991. Anatomy and Physiology of Diseased Plants. CRC Press. 232 pp.
4. Fritig, B. and M. LeGrand. 1993. Mechanisms of Plant Defense Responses. Kluwer, Dordrecht, the Netherlands.
5. Goodman, R.N., Z. Kiraly, and K.R. Wood. 1986. The Biochemistry and Physiology of Plant Disease. Univ. of Missouri Press, Columbia, USA.
6. Lawlor, W.D. 2001. Photosynthesis. 3<sup>rd</sup> Ed. Viva Books (Pvt.) Ltd. India.
7. Misra, J.R. 2004. Photosynthesis in Plants. DPH, India.
8. Petrini, O. and G.B. Ouellette. 1994. Host Wall Alterations by Parasitic Fungi. American Phytopathology Society Press, St., Paul. Minnesota, USA.
9. Schumann, G. and C. J. D'Arcy. 2010. Essential Plant Pathology. APS Press. 369 pp.
10. Strange, R.N. 2003. Introduction to Plant Pathology. John Wiley and Sons Ltd.

### **10. Title of the Course: 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

**Course Contents:**

#### **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:**

1. McDonald, B.A. 2004. Population Genetics of Plant Pathogens. American Phytopathology Society Press, St., Paul. Minnesota, USA.
2. Mills, D., H. Kunoh, N. Keen and S. Mayama. 1996. Molecular Aspects of Pathogenicity and Resistance: Requirements for Signal Transduction. American Phytopathology Society Press, St., Paul. Minnesota, USA
3. Moore, D. and L.A.N. Frazer. 2002. Essential Fungal Genetics. Springer-Verlag, N.Y. USA.
4. Nester, E.W. and D.P.S. Verma. 1993. Advances in Molecular Genetics of Plant-Microbe Interaction. Vol. 2. Kluwer Dordrecht, The Netherlands.
5. Nester, E.W. and S. Desh Pal Verma. 1993. Advances in Molecular Genetics of Plant-Microbe Interactions, Volume 2. 627 pp. Kluwer Academic Publishers, The Netherlands.
6. Sadasivan, S. and B. Thayumana. 2003. Molecular Host Plant Resistance to Pests. Marcel Dekker, USA.
7. Singh, D.P. 2002. Breeding for Resistance to Biotic Stress. International Books Distribution Co. India.
8. Singh, U.S., R.P. Singh and K. Kohmoto. 1995. Pathogenesis and Host Specificity in Plant Disease. Histopathological, Biochemical, Genetic and Molecular Bases. Vols. 1-3. Pergamon/Elsevier, Tarrytown, New York, USA.
9. Young, L. 1999. Genetics and Genetic Engineering. University Press. India.
10. Wolfe, MS. and C.E. Caten. 1987. Populations of Plant Pathogens: Their Dynamics and Genetics. Blackwell Scientific Publications. 280 pp.

**11. Title of the Course: 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

## **Course Contents:**

### **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:**

1. Agarwal, V.K. and J.B. Sinclair. 1996. Principles of Seed Pathology, Second Edition. CRC Press. 560 pp.
2. Agarwal, V.K. 2006. Seed Health. International Book Distributing Company. 554 pp.
3. Albrechtsen, S.E. 2006. Testing Methods for Seed-Transmitted Viruses: Principles and Protocols, CABI UK.
4. Bashir, M., Z. Ahmad and N. Murata. 2000. Seed-borne Viruses, Detection, Identification and Control. PARC, Islamabad.
5. Bhutta, A.R. and I. Ahmad. 2001. Seed Pathological Techniques and their Application. National Book Foundation, Islamabad, Pakistan.
6. Bhutta, A.R. 2010. Textbook of Introductory Seed Pathology. HEC, Islamabad, Pakistan.
7. Kruse, M. 2004. ISTA Handbook on Seed Sampling. 2<sup>nd</sup> Ed. ISTA, Switzerland.
8. Neergaard, P. 1977 & 1988. Seed Pathology: Volume 1&2. John Wiley & Sons, Incorporate. 1187 pp.
9. Singh, D. 2004. Histopathology of Seed-Borne Infections. CRC

- Press.
- Singh, T. and K. Agrawal. 2001. Seed Technology and Seed Pathology. Pointer Publisher, India. 498 pp.

**12. Title of the Course: INTEGRATED PLANT  
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.

**Course Contents:**

**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:**

- Arya, A.O. and A.E. Perello. 2010. Management of Fungal Plant Pathogens. CABI, England.
- Ciancio, A. and K.G. Mukerji. 2008. Integrated Management of Diseases Caused by Fungi, Phytoplasma and Bacteria. Springer.
- Inderjit and K.G. Mukerji. 2006. Allelochemicals: Biological Control of Plant Pathogens and Diseases. Springer.
- Kapoor, B.B.S. and N.K. Khatri. 2004. Management of Plant Diseases. Bikaner, Madhu Publications, India.
- Koul, O. and G.S. Dhaliwal. 2001. Microbial Biopesticides. CRC Press.
- Nehra, S. 2005. Plant Diseases: Biocontrol Management. Pointer Publishers, India.
- Razdan, V.K. and M. Sabitha. 2009. Integrated Disease Management: Concepts and Practices. Springer, Netherland.

**13. Title of the Course: 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

**Course Contents:**

**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:**

1. Barkai-Golan, R. 2001. Post-harvest Diseases of Fruits and Vegetables: Development and Control. Elsevier. 418 pp.
2. Bartz, J.A. and J.K. Brecht. 2005. Post-harvest Physiology and Pathology of Vegetables. Taylor & Francis e-Library. 815 pp.
3. Bhutani, R.C. 2003. Fruits and Vegetables Preservation. Biotech Books, India.
4. Bhutta, A.R., A. Hussain and M.R. Rehman. 2004. Handbook on Seed Processing and Storage, Federal Seed Certification and Registration Department, Islamabad. Pakistan.
5. Burg, S.P. 2004. Postharvest physiology and hypobaric storage of fresh produce. CABI Publishing.
6. Chakraverty, A., A.S. Mujundar, G.S. Raghavan and H.S. Ramaswamy. 2003. Handbook of Post harvest Technology. Marcel Dekker/NC. New York, USA.
7. Dennis, C. 1983. Postharvest Pathology of Fruits and Vegetables.

- Academic Press, New York, USA.
8. Kader, A. A. 2002. Postharvest Technology of Horticultural Crops. University of California.
  9. Narayanasamy, P. 2006. Postharvest Pathogens and Disease Management. John Wiley & Sons, Inc., Hoboken, New Jersey. 578 pp.
  10. Prusky, D. and M. Lodovica Gullino. 2010. Postharvest Pathology Springer. 211 pp.
  11. Snowdon, A.L. 2010. A colour Atlas of Post Harvest Diseases and Disorders of Fruits and Vegetables: Volume 1 General Introduction & Fruits. Manson Publishing Ltd. 301 pp.

**14. Title of the Course: 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

**Course Contents:**

**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:**

1. Basu, A.N. and B.K. Giri. 1993. The Essentials of Viruses, Vectors and Plant Diseases. Wiley Eastern Ltd., New Delhi, India
2. Leach, J.G. 2007. Insect Transmission of Plant Diseases. Daya Publishing House, India.
3. Vaishali, J.P. and T.V. Satte. 2003. Insect Predator and Pest Management. Daya Publishing House, Delhi.
4. Vanemden, H.F and M. Service. 2004. Pest and Vector Control. Cambridge University Press, UK.
5. Recent books, journals, reviews, proceedings, etc.

**15. 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

**Course Contents:**

**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:**

1. Agrios, G.N. 2005. Plant Pathology, Elsevier Academic Press, New York, USA
2. Bakhshi, E.K. 1976. Forest Pathology. Forest Institute, Dehradun, India.
3. Bhutta. A.R. 2010. Introductory Seed Pathology. Publisher HEC, Islamabad. 557 pp.
4. Khan, A.H. 1989. Pathology of Trees. 2<sup>nd</sup> Vol. Univ. Agric. Faisalabad.
5. Manson, P.D. 1991. Tree Disease, Concepts. 2<sup>nd</sup> Edition. Prentice Hall Eaglewood Cliffs, New Jersey, USA
6. Strouts, R.G. and T.G. Winter. 1994. Diagnosis of Ill-health in Trees. H.M.S.O. Publishers, London, UK
7. Zabel, R.A. and J.J. Morell. 1992. Wood Microbiology: Decay and its Prevention. Academic Press, San Diego, California, USA.

**16. Title of the Course: 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

**Course Contents:****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 Plant Pathology.

**17. Title of the Course: 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

**Course Contents:****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:**

1. Dijkstra, J. 1998. Practical Plant Virology: Protocols and Exercises. Springer Verlag.
2. Foster, G.D., I.E. Johansen, Y. Hong and P.D. Nagy. (Eds.). 2008. Plant Virology Protocols – From Viral Sequence to Protein Function. Humana Press.
3. Hadidi, A., R.K. Khetarpal and H. Koganezawa (Eds). 1998. Plant

Virus Disease Control. American Phytopathological Society, St Paul, Minnesota, USA.

4. Hull, R. 2002. Matthews' Plant Virology. 4<sup>th</sup> Ed. Elsevier Ltd.
5. Hull, R. 2009. Comparative Plant Virology, 2<sup>nd</sup> Edition. Academic Press.
6. Loebenstein, G. and G. Thottappilly. (Eds.). 2004. Virus and Virus-like Diseases of Major Crops in Developing Countries. Springer.
7. Tepfer, M. and E. Balazs. (Eds.). 1997. Virus-Resistant Transgenic Plants: Potential Ecological Impact. Springer Verlag.

**18. Title of the Course: 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

**Course Contents:**

**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:**

1. Boland, G., J.L. David and K. Dall. 1998. Plant Microbe Interaction and Biological Control. Marcel Dekker Inc. USA.
2. Bridge, P.D. 1998. Molecular Variability of Fungal Pathogens. CAB International, Ferry Lane, Kew, Surrey, England.
3. Davis, H. 1993. *Arabidopsis thaliana* as a model for Plant Pathogen Interaction. American Phytopathological Press, Saint Paul, Minnesota, USA.
4. Dickinson, M. 2003. Molecular Plant Pathology. Bios Science



- Publishers, London, UK.
5. Kosuge, T. and E.W. Nester. 1984. Plant-Microbe Interaction (Vol. 1 & 2). McMillan Publishing Co., New York, USA.
  6. Vander P. 1982. Host Pathogen Interactions in Plant Diseases. Academic Press, New York, USA.
  7. Recent books, journals, reviews, proceedings, reports in Plant Pathology.

**19. Title of the Course: 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

**Course Contents:**

**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:**

1. Bellows, T.S., T.W. Fisher, L.E. Caltagirone, D.L. Dahlsten, G. Gordh and C.B. Huffaker. 1999. Handbook of Biological Control, Principles and Applications of Biological Control. Academic Press, London.
2. Burge, M.N. 1988. Fungi in Biological Control System Manchester University Press UK.
3. Butt, T.M., C. Jackson and N. Magan. 2001. Fungi as Biocontrol Agents: Progress, Problems and Potential. CABI Publishing, UK.
4. Copping, L.G. 2004. The Manual of Biocontrol Agents. British Crop Protection Council, UK.
5. Copping, L.G. 2009. The Manual of Biocontrol Agents: A World

- Compendium. CABI Publishing; 4<sup>th</sup> revised edition. 896 pp.
6. Gnanamanickam, S.S. (Ed.). 2002. Biological Control of Crop Diseases. Marcel Dekker, New York.
  7. Trivedi, P.C. 1998. Plant Nematode Management: A Biocontrol Approach. CBS Publishers & Distributors, New Delhi.

**20. Title of the Course: 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

**Course Contents:**

**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:**

1. Devorshak, C. 2012. Plant Pest Risk Analysis: Concepts and Application. CABI International. 296 pp.
2. FAO, 2000. Multinational Trade Negotiation on Agriculture. A Resource Manual.-III. SPS & TBT agreement. Pub. By FAO-UN Rome, Italy.
3. Legal Affairs Division, World Trade Organization.2007. WTO Analytical Index 2 Volume Set: Guide to WTO Law and Practice 2<sup>nd</sup> Edition volume 1.Cambridge. 1566 pp.
4. Mosoti, V. and A. Gobena. 2007. International Trade Rules and

the Agriculture Sector: Selected implementation issues. FAO Legislative Study, For the Development Law service, FAO Legal Office FAO. 429 pp.

5. OECD, 2003. The Impact of Regulations on Agro-Food Trade, The Technical Barriers to Trade. OECD. 121 pp.
6. Osmanczyk, E.J. and A. Mango. 2003. Encyclopedia of the United Nations and International Agreements 3<sup>rd</sup> Ed. (4 vol. set), Rutledge UK.
7. Rangan, S. 2007. Sanitary and Phytosanitary Measures: An Introduction. University Press, India.
8. Wolfrum, R., P.T. Stoll and A. Seibert-Fohr. 2007. WTO: Technical Barriers and SPS Measures. Martinus Nijhoff Publishers, the Netherlands. 564 pp.

**21. Title of the Course: 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

**Course Contents:**

**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 micro array 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:**

1. Acton, Q.A. 2012. Advances in Biotechnology Research and Application: Scholarly Editions TM.

2. David Edwards, D., J. E. Stajich and D. Hansen. 2009. *Bioinformatics: Tools and Applications*. Springer. 451 pp.
3. Edwards, D. 2007. *Plant Bioinformatics: Methods and Protocols*. Humana Press Inc., 551 pp.
4. Mount, D.W. 2004. *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor, New York. 697 pp.
5. Pevsner, J. 2010. *Bioinformatics and Functional Genomics*. Wiley Backwell.
6. Rodriguezpeleta, N., M. Hackenberg and A. M. Aransay. 2012. *Bioinformatics for High Throughput Sequencing*. Springer. 255 pp.
7. Xiong, J. 2006. *Essential Bioinformatics*. Cambridge University Press. 340 pp.
8. Latest Bioinformatics Software.

**22. Title of the Course: 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

**Course Contents:**

**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:**

1. Agrios, G.N. 2005. *Plant Pathology*. 5th Ed. Elsevier Academic Press, USA.
2. Bhatt, S. 2004. *Environment Protection and Sustainable Development*. APH. Publishing Corp. India.
3. Geoffrey, S.A. and P. Azevedo. 2009. *Agricultural Wastes*. Nova Science Publishers, Inc. New York
4. Ralph, M. and Ji-Dong Gu. 2010. *Environmental Microbiology*. 2nd Ed. John Wiley & Sons, Inc., Hoboken, New Jersey.
5. Saleem, M.A and M. Ashfaq. 2004. *Environmental Pollution and*

Agriculture. B.Z. University Press, Multan, Pakistan.

**23. Title of the Course: SEMINAR-I (M. Sc (H) Thesis)**

**Credit Hours: 1(1-0)**

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

**Learning Objectives:**

To present research work carried out for M. Sc (H) Thesis

**24. Title of the Course: SPECIAL PROBLEM**

**Credit Hours: 1(1-0)**

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

**Learning Objectives:**

To conduct a pilot study determining feasibility of certain aspects of  
Ph. D research

**25. Title of the Course: Research Thesis (MSc (H))**

**Credit Hours: 10(0-10)**

**Prerequisites:** Completion of M. Sc research work in  
Plant Pathology and submission of thesis

**Learning Objectives:**

To present research work carried out for MSc (H) in thesis format

**26. Title of the Course: SEMINAR-II (PhD Synopsis)**

**Credit Hours: 1(1-0)**

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

**Learning Objectives:** To present proposed research work for Ph. D

**27. Title of the Course: SEMINAR-III (PhD Thesis)**

**Credit Hours: 1(1-0)**

**Prerequisites:** Completion of courses and research work  
for Ph. D

**Learning Objectives:** To present research work carried out for PhD

**28. Title of the Course: Research Thesis (PhD)**

**Credit Hours: 20(0-20)**

**Prerequisites:** Completion of courses, research work  
and submission of PhD thesis

**Learning Objectives:**

To present research work carried out for PhD in thesis format

**DETAIL OF COMPULSORY COURSES  
IN ENGLISH FOR  
UNDERGRADUATE LEVEL**

**English I (Functional English)**

**Credit Hrs. 3**

**Objective:** Enhance language skills and develop critical thinking.

**Course Contents**

Basics of Grammar

Parts of speech and use of articles

Sentence structure, active and passive voice

Practice in unified sentence

Analysis of phrase, clause and sentence structure

Transitive and intransitive verbs

Punctuation and spelling

**Comprehension**

Answers to questions on a given text

**Discussion**

General topics and every-day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students)

**Listening**

To be improved by showing documentaries/films carefully selected by subject teachers

**Translation skills**

**Urdu to English**

**Paragraph writing**

Topics to be chosen at the discretion of the teacher

**Presentation skills**

Introduction

*Note: Extensive reading is required for vocabulary building*

**Recommended Books**

1. **Functional English**

a) Grammar

1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492

2. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506
- b) Writing
    1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41.
  - c) Reading/Comprehension
    1. Reading. Upper Intermediate. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.
  - d) Speaking

## **English II (Communication Skills)**

**Credit Hrs. 3**

### **Objective**

Enable the students to meet their real life communication needs.

### **Course Contents**

#### **Paragraph writing**

Practice in writing a good, unified and coherent paragraph

#### **Essay writing**

Introduction

#### **CV and job application**

Translation skills

Urdu to English

#### **Study skills**

Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension

#### **Academic skills**

Letter/memo writing, minutes of meetings, use of library and internet

#### **Presentation skills**

Personality development (emphasis on content, style and pronunciation)

*Note: documentaries to be shown for discussion and review.*

### **Recommended Books:**

#### **Communication Skills**

- a) Grammar

1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press 1986. ISBN 0 19 431350 6.
- b) Writing
1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).
  2. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).
- c) Reading
1. Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 453403 0.
  2. Reading and Study Skills by John Langan
  3. Study Skills by Richard Yorke.

### **English III (Technical Writing and Presentation Skills) Crh. 3**

#### **Objective**

Enhance language skills and develop critical thinking

#### **Course Contents**

##### **Presentation skills**

##### **Essay writing**

Descriptive, narrative, discursive, argumentative

##### **Academic writing**

How to write a proposal for research paper/term paper

How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)

##### **Technical Report writing**

##### **Progress report writing**

*Note: Extensive reading is required for vocabulary building*

#### **Recommended Books**

Technical Writing and Presentation Skills

##### a) Essay Writing and Academic Writing

1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for



discursive, descriptive, argumentative and report writing).

2. College Writing Skills by John Langan. McGraw-Hill Higher Education. 2004.
3. Patterns of College Writing (4<sup>th</sup> edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.

b) Presentation Skills

c) Reading

The Mercury Reader. A Custom Publication. Compiled by northern Illinois University. General Editors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharon. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).

## ISLAMIC STUDIES (COMPULSORY)

### Objective:

This course is aimed at:

- 1 To provide Basic information about Islamic Studies
- 2 To enhance understanding of the students regarding Islamic Civilization
- 3 To improve Students skill to perform prayers and other worships
- 4 To enhance the skill of the students for understanding of issues related to faith and religious life.

### Detail of Courses

#### Introduction to Quranic Studies

- 1) Basic Concepts of Quran
- 2) History of Quran
- 3) Uloom-ul-Quran

#### Study of Selected Text of Holy Quran

- 1) Verses of Surah Al-Baqra Related to Faith (Verse No-284-286)
- 2) Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18)
- 3) Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11)
- 4) Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77)
- 5) Verses of Surah Al-Inam Related to Ihkam (Verse No-152-154)

#### Study of Selected Text of Holly Quran

- 1) Verses of Surah Al-Ihزاب Related to Adab al-Nabi (Verse No.6,21,40,56,57,58.)
- 2) Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment
- 3) Verses of Surah Al-Saf Related to Tafakar, Tadabar (Verse No-1,14)

#### Seerat of Holy Prophet (S.A.W) I

- 1) Life of Muhammad Bin Abdullah ( Before Prophet Hood)
- 2) Life of Holy Prophet (S.A.W) in Makkah

- 3) Important Lessons Derived from the life of Holy Prophet in Makkah

#### **Seerat of Holy Prophet (S.A.W) II**

- 1) Life of Holy Prophet (S.A.W) in Madina
- 2) Important Events of Life Holy Prophet in Madina
- 3) Important Lessons Derived from the life of Holy Prophet in Madina

#### **Introduction To Sunnah**

- 1) Basic Concepts of Hadith
- 2) History of Hadith
- 3) Kinds of Hadith
- 4) Uloom –ul-Hadith
- 5) Sunnah & Hadith
- 6) Legal Position of Sunnah

#### **Selected Study from Text of Hadith**

##### **Introduction To Islamic Law & Jurisprudence**

- 1) Basic Concepts of Islamic Law & Jurisprudence
- 2) History & Importance of Islamic Law & Jurisprudence
- 3) Sources of Islamic Law & Jurisprudence
- 4) Nature of Differences in Islamic Law
- 5) Islam and Sectarianism

##### **Islamic Culture & Civilization**

- 1) Basic Concepts of Islamic Culture & Civilization
- 2) Historical Development of Islamic Culture & Civilization
- 3) Characteristics of Islamic Culture & Civilization
- 4) Islamic Culture & Civilization and Contemporary Issues

##### **Islam & Science**

- 1) Basic Concepts of Islam & Science
- 2) Contributions of Muslims in the Development of Science
- 3) Quran & Science

##### **Islamic Economic System**

- 1) Basic Concepts of Islamic Economic System
- 2) Means of Distribution of wealth in Islamic Economics
- 3) Islamic Concept of Riba
- 4) Islamic Ways of Trade & Commerce

##### **Political System of Islam**

- 1) Basic Concepts of Islamic Political System
- 2) Islamic Concept of Sovereignty
- 3) Basic Institutions of Govt. in Islam

**Islamic History**

- 1) Period of Khlaft-E-Rashida
- 2) Period of Ummayyads
- 3) Period of Abbasids

**Social System of Islam**

- 1) Basic Concepts of Social System of Islam
- 2) Elements of Family
- 3) Ethical Values of Islam

**Reference Books:**

- 1) Hameed ullah Muhammad, "Emergence of Islam", IRI, Islamabad
- 2) Hameed ullah Muhammad, "Muslim Conduct of State"
- 3) Hameed ullah Muhammad, "Introduction to Islam"
- 4) Mulana Muhammad Yousaf Islahi,"
- 5) Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication Islamabad, Pakistan.
- 6) Ahmad Hasan, "Principles of Islamic Jurisprudence" Islamic Research Institute, International Islamic University, Islamabad (1993)
- 7) Mir Waliullah, "Muslim Jurisprudence and the Quranic Law of Crimes" Islamic Book Service (1982)
- 8) H.S. Bhatia, "Studies in Islamic Law, Religion and Society" Deep & Deep Publications New Delhi (1989)
- 9) Dr. Muhammad Zia-ul-Haq, "Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad (2001)

## PAKISTAN STUDIES (COMPULSORY)

### Introduction/Objective

- Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan.
- Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

### Course Outline

#### 1. Historical Perspective

- a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah.
- b. Factors leading to Muslim separatism
- c. People and Land
  - i. Indus Civilization
  - ii. Muslim advent
  - iii. Location and geo-physical features.

#### 2. Government and Politics in Pakistan

Political and constitutional phases:

- a. 1947-58
- b. 1958-71
- c. 1971-77
- d. 1977-88
- e. 1988-99
- f. 1999 onward

#### 3. Contemporary Pakistan

- a. Economic institutions and issues
- b. Society and social structure
- c. Ethnicity
- d. Foreign policy of Pakistan and challenges
- e. Futuristic outlook of Pakistan

### Recommended Books:

1. Burki, Shahid Javed. *State & Society in Pakistan*, the Macmillan Press Ltd 1980.

2. Akbar, S. Zaidi. *Issue in Pakistan's Economy*. Karachi: Oxford University Press, 2000.
3. S.M. Burke and Lawrence Ziring. *Pakistan's Foreign policy: An Historical analysis*. Karachi: Oxford University Press, 1993.
4. Mehmood, Safdar. *Pakistan Political Roots & Development*. Lahore, 1994.
5. Wilcox, Wayne. *The Emergence of Bangladesh.*, Washington: American Enterprise, Institute of Public Policy Research, 1972.
6. Mehmood, Safdar. *Pakistan Kayyun Toota*, Lahore: Idara-e-Saqafat-e-Islamia, Club Road, nd.
7. Amin, Tahir. *Ethno - National Movement in Pakistan*, Islamabad: Institute of Policy Studies, Islamabad.
8. Ziring, Lawrence. *Enigma of Political Development*. Kent England: WmDawson & sons Ltd, 1980.
9. Zahid, Ansar. *History & Culture of Sindh*. Karachi: Royal Book Company, 1980.
10. Afzal, M. Rafique. *Political Parties in Pakistan*, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
11. Sayeed, Khalid Bin. *The Political System of Pakistan*. Boston: Houghton Mifflin, 1967.
12. Aziz, K.K. *Party, Politics in Pakistan*, Islamabad: National Commission on Historical and Cultural Research, 1976.
13. Muhammad Waseem, *Pakistan Under Martial Law*, Lahore: Vanguard, 1987.
14. Haq, Noor ul. *Making of Pakistan: The Military Perspective*. Islamabad: National Commission on Historical and Cultural Research, 1993.

## COMPULSORY MATHEMATICS COURSES FOR BSC (HONS) AGRICULTURE

### 1. MATHEMATICS I (ALGEBRA)

**Prerequisite(s):** Mathematics at secondary level

**Credit Hours:** 3 + 0

**Specific Objective of the Course:** To prepare the students, not majoring in mathematics, with the essential tools of algebra to apply the concepts and the techniques in their respective disciplines.

**Course Outline:**

*Preliminaries:* Real-number system, complex numbers, introduction to sets, set operations, functions, types of functions.

*Matrices:* Introduction to matrices, types, matrix inverse, determinants, system of linear equations, Cramer's rule.

*Quadratic Equations:* Solution of quadratic equations, qualitative analysis of roots of a quadratic equations, equations reducible to quadratic equations, cube roots of unity, relation between roots and coefficients of quadratic equations.

*Sequences and Series:* Arithmetic progression, geometric progression, harmonic progression.

*Binomial Theorem:* Introduction to mathematical induction, binomial theorem with rational and irrational indices.

*Trigonometry:* Fundamentals of trigonometry, trigonometric identities.

**Recommended Books:**

Dolciani MP, Wooton W, Beckenback EF, Sharron S, *Algebra 2 and Trigonometry*, 1978, Houghton & Mifflin,

**Boston (suggested text)**

Kaufmann JE, *College Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston

Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6<sup>th</sup> edition), 1986, PWS-Kent Company, Boston.

## 2. MATHEMATICS II (CALCULUS)

**Prerequisite(s):** Mathematics I (Algebra)

**Credit Hours:** 3 + 0

**Specific Objective of the Course:** To prepare the students, not majoring in mathematics, with the essential tools of calculus to apply the concepts and the techniques in their respective disciplines.

**Course Outline:**

*Preliminaries:* Real-number line, functions and their graphs, solution of equations involving absolute values, inequalities.

*Limits and Continuity:* Limit of a function, left-hand and right-hand limits, continuity, continuous functions.

*Derivatives and their Applications:* Differentiable functions, differentiation of polynomial, rational and transcendental functions, derivatives.

*Integration and Definite Integrals:* Techniques of evaluating indefinite integrals, integration by substitution, integration by parts, change of variables in indefinite integrals.

**Recommended Books:**

Anton H, Bevens I, Davis S, *Calculus: A New Horizon* (8<sup>th</sup> edition), 2005, John Wiley, New York

Stewart J, *Calculus* (3<sup>rd</sup> edition), 1995, Brooks/Cole (suggested text)

Swokowski EW, *Calculus and Analytic Geometry*, 1983, PWS-Kent Company, Boston

Thomas GB, Finney AR, *Calculus* (11<sup>th</sup> edition), 2005, Addison-Wesley, Reading, Ma, USA

## 1. MATHEMATICS III (GEOMETRY)

**Prerequisite(s):** Mathematics II (Calculus)

**Credit Hours:** 3 + 0

**Specific Objective of the Course:** To prepare the students, not majoring in mathematics, with the essential tools of geometry to apply the concepts and the techniques in their respective disciplines.

**Course Outline:**

*Geometry in Two Dimensions:* Cartesian-coördinate mesh, slope of a line, equation of a line, parallel and perpendicular lines, various forms of



equation of a line, intersection of two lines, angle between two lines, distance between two points, distance between a point and a line.

*Circle*: Equation of a circle, circles determined by various conditions, intersection of lines and circles, locus of a point in various conditions.

*Conic Sections*: Parabola, ellipse, hyperbola, the general-second-degree equation

**Recommended Books:**

Abraham S, *Analytic Geometry*, Scott, Freshman and Company, 1969  
Kaufmann JE, *College Algebra and Trigonometry*, 1987, PWS-Kent Company, Boston  
Swokowski EW, *Fundamentals of Algebra and Trigonometry* (6<sup>th</sup> edition), 1986, PWS-Kent Company, Boston

*Note:*

1. *Two courses will be selected from the following three courses of Mathematics.*
2. *Universities may make necessary changes in the courses according to the requirement as decided by the Board of Studies.*

## **STATISTICS-I**

### **Credit 3 (2-1)**

Definition and importance of Statistics in Agriculture, Data Different types of data and variables

Classification and Tabulation of data, Frequency distribution, stem-and-Leaf diagram, Graphical representation of data Histogram, frequency polygon, frequency curve.

Measure of Central tendency, Definition and calculation of Arithmetic mean, Geometric mean, Harmonic mean, Median quantiles and Mode in grouped and un-grouped data.

Measure of Dispersion, Definition and Calculation of Range, quartile deviation, Mean deviation, Standard deviation and variance, coefficient of variation.

#### **Practicals**

- a. Frequency Distribution
- b. Stem-and-Leaf digram
- c. Various types of Graphs
- d. Mean, Geometric mean Harmonic Mean,
- e. Median, Quartiles Deviation, mean Deviation.
- f. Standard Deviation, Variance, Coefficient of variation,
- g. Skewness and kenosis

#### **Recommended Book:**

1. Introduction to Statistical Theory Part- I by Sher Muhammad and Dr. Shahid Kamal (Latest Edition)
2. Statistical Methods and Data Analysis by Dr. Faquir Muhammad
3. A. Concise Course in A. Level Statistic with world examples by J. Crawshaw and J. Chambers (1994)
4. Basic Statistics an Inferential Approach 2<sup>nd</sup> Ed. (1986) Fran II. Dietrich-II and Thomes J. Keans

#### **Statistics-II**

### **Credit 3 (2-1)**

Sampling Probability and non-Probability Sampling, Simple random sampling stratified random sampling Systematic sampling error, Sampling distribution of mean and difference between two means. Interference Theory: Estimation and testing of hypothesis, Type—I and

type-II error, Testing of hypothesis about mean and difference between two means using Z-test and t-test, Paired t-test, Test of association of attributes using  $\chi^2$  (chi-square) Testing hypothesis about variance.

**Practical**

- a. Sampling random sampling
- b. Stratified random sampling.
- c. Sampling distribution of mean
- d. Testing of hypotheses regarding population mean
- e. Testing of hypotheses about the difference between population means
- f. Chi-square test
- g. Testing of Correlation Coefficient
- h. Fitting of simple linear regression
- i. One-way ANOVA
- j. Two-way ANOVA

**Recommended Book:**

1. Introduction to Statistical Theory Part-II by Sher Muhammad and Dr. Shahid Kamal (Latest Edition)
2. Statistical Methods and Data Analysis by Dr. Faquir Muhammad
3. Principles and Procedures of Statistics A Bio-material approach, 2<sup>nd</sup> Edition, 1980 by R.G.D Steal and James H. Tarric
4. Statistical Procedures for Agricultural Research 2<sup>nd</sup> Edition (1980) by K.A. Gomez and A.A. Gomez

**Note:** *Universities may make necessary changes in the courses according to the requirement as decided by the Board of Studies.*

**Course Name:**

## **INTRODUCTION TO INFORMATION AND COMMUNICATION TECHNOLOGIES**

**Course Structure:** Lectures: 2 Labs: 1 **Credit Hours: 3**  
**Pre-requisite: None** **Semester: 1**

**Course Description:**

This is an introductory course on Information and Communication Technologies. Topics include ICT terminologies, hardware and software components, the internet and world wide web, and ICT based applications.

After completing this course, a student will be able to:

- Understand different terms associated with ICT
- Identify various components of a computer system
- Identify the various categories of software and their usage
- Define the basic terms associated with communications and networking
- Understand different terms associated with the Internet and World Wide Web.
- Use various web tools including Web Browsers, E-mail clients and search utilities.
- Use text processing, spreadsheets and presentation tools
- Understand the enabling/pervasive features of ICT.

**Course Contents**

- Basic Definitions & Concepts
- Hardware: Computer Systems & Components
- Storage Devices, Number Systems
- Software: Operating Systems, Programming and Application Software
- Introduction to Programming, Databases and Information Systems
- Networks
- Data Communication
- The Internet, Browsers and Search Engines
- The Internet: Email, Collaborative Computing and Social Networking
- The Internet: E-Commerce

- IT Security and other issues
- Project Week
- Review Week.

**Text Books/Reference Books:**

Introduction to Computers by Peter Norton,6th International Edition (McGraw HILL) Using Information Technology: A Practical Introduction to Computer & Communications by Williams Sawyer, 6th Edition (McGraw HILL) Computers, Communications & information: A user's introduction by Sarah E. Hutchinson, Stacey C. Swayer Fundamentals of Information Technology by Alexis Leon, Mathewsleon Leon Press.

**Functional Biology-I**

***Credit Hours 3+0***

**Biological Methods**

Principles of Cellular Life  
 Chemical Basis  
 Structure and Function  
 Principles of Metabolism  
 Energy Acquisition

**Principles of Inheritance**

Mitosis and Meiosis  
 Chromosomes  
 Observable Inheritance Patterns  
 DNA Structure and Function  
 RNA and Proteins  
 Genes  
 Genetic Engineering and Biotechnology

**Biodiversity**

Fundamental Concept of Biodiversity  
 One or two examples of each of the following from commonly found organism  
 Prions  
 Viruses  
 Bacteria  
 Protistans  
 Algae  
 Fungi  
 Plants  
 Crops  
 Animals

Invertebrates  
Vertebrates

**Reading**

1. Roberts, M.M., Reiss and G.Monger. 2000. Advanced Biology, Nelson.
2. Starr, C, and R, Taggart, 2001. Biology: The Unity and Diversity of Life Brooks and Cole.
3. Campbell, N.A., J.B, Reece, L.G. Mitchell, M.R, Taylor. 2001. Biology: Concepts and Connections. Prentice-Hall.

**Functional Biology-II**

***Credit Hours 3+0***

Myths and Realities of Evolution  
Microevolution  
Speciation  
Macroevolution  
Level of Organization

Plants

Tissues  
Nutrition and Transport  
Reproduction  
Growth and Development

Animals

Tissue, Organ System and Homeostasis  
Information Flow and Neuron  
Nervous System  
Circulation and Immunity  
Nutrition and Respiration  
Reproduction and Development

Ecology and Behavior

Ecosystems  
Biosphere  
Social Interactions  
Community Interactions  
Human Impact on Biosphere  
Environment Conservation

**Reading**

1. Roberts, M.M., Reiss and G. Monger. 2000. Advanced Biology, Nelson.

2. Starr, C, and R, Taggart, 2001. Biology: The Unity and Diversity of Life Brooks and Cole.
3. Campbell, N.A., J.B, Reece, L.G. Mitchell, M.R, Taylor. 2001. Biology: Concepts and Connections. Prentice-Hall.

**Note:** *Universities may make necessary changes in the courses according to the requirement as decided by the Board of Studies.*

## RECOMMENDATIONS

1. Plant Pathology books should be made available at affordable prices to the students of all kind. HEC should collaborate with National Book Foundation to publish the recent recommended books with the permission of original publishers and make them available to universities/colleges along with revised curricula.
2. HEC should facilitate the scientists to participate in conferences within the country through allocation of funds. It will help in exchange of information and ideas that invariably takes place at such fora.
3. Short trainings/workshops should be arranged for faculty members in national and international institutions to update their knowledge in Plant Pathology.
4. Refresher courses should be organized with the assistance of HEC on new courses.
5. Workshops should be organized with the assistance of HEC on emerging disease problems.
6. Expert and student exchange programmes within universities and research organizations in different disciplines of Plant Pathology should be further encouraged.
7. Panel of experts in Plant Pathology from professional societies (e.g. Pakistan Phytopathological society etc.) should be involved in the HEC/Government policy decisions regarding discipline of Plant Pathology.
8. Online access to the recommended research journals and latest books should be provided to all institutions by HEC.
9. HEC should increase research funds for MSc (H)/PhD. students.
10. HEC should provide funds for student internship programmes.
11. HEC needs to formulate a policy for credit hours sharing amongst the universities/institutions.
12. There should be a follow up meeting of conveners and secretaries of all NCRCs to review the actions taken by the HEC and other stakeholders in connection with the implementation of the new curricula.
13. HEC should encourage the local scientists to write reference books. Remuneration for authors and reviewers may be revised and enhanced reasonably.



14. HEC should coordinate to strengthen University-industry linkages seeking funding from industry for research projects.
15. Members of supervisory committees including co-supervisors of research students from R & D organizations should be honored with due remuneration.
16. NCRC recommends following journals to be made available to the Departments country-wide:

**International Scientific Research Journals**

1. Phytopathology, APS, USA
2. Plant Disease, APS, USA.
3. Molecular Plant Microbe Interactions, APS, USA
4. Plant Pathology, UK
5. Molecular Plant Pathology, UK
6. Mycologia, USA.
7. Australasian Plant Pathology, APPS, Australia
8. Physiological & Molecular Plant Pathology, UK
9. European Journal of Plant Pathology
10. Journal of Phytopathology

**National Scientific Research Journals**

1. Pakistan Journal of Botany, Karachi.
2. Pakistan Journal of Phytopathology, Faisalabad.
3. Pakistan Journal of Seed Technology, Islamabad.
4. Pakistan Journal of Nematology, Karachi
5. Mycopath, Lahore.
6. Sarhad Journal of Agriculture

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