

**UNIVERSITY OF THE PUNJAB**

**NOTIFICATION**

It is hereby notified that the Syndicate at its meeting held on 17-12-2022 has approved the recommendations of the Academic Council made at its meeting dated 24-11-2022 regarding permission to start of Ph.D. Plant Pathology Program at the Department of Plant Pathology and its Curriculum with effect from the Academic Session, Fall 2023.

The Curriculum of Ph.D. Program in Plant Pathology is attached, vide Annexure 'A'.

**Admin. Block,  
Quaid-i-Azam Campus,  
Lahore.**

*Sd/-*  
**Shahid Javed  
Registrar**

**No. D/ 646 /Acad.**

**Dated: 25-01-2023**

Copy of the above is forwarded to the following for information and further necessary action: -

1. The Dean, Faculty of Agricultural Sciences
2. The Chairman, Department of Plant Breeding & Genetics
3. Chairperson, DPCC
4. Director (IT) for placement at website.
5. Admin Officer (Statutes)
6. Secretary to the Vice-Chancellor
7. Secretary to the Registrar
8. Assistant Syllabus (with file)

*Mazhar*  
Assistant Registrar (Academic)  
for Registrar

**CURRICULUM**  
**OF**  
**PLANT PATHOLOGY**  
**M.Sc. (Hons.) & PhD**



**DEPARTMENT OF PLANT PATHOLOGY**  
**UNIVERSITY OF THE PUNJAB**  
**LAHORE**

**SCHEME OF STUDIES  
FOR POSTGRADUATE PROGRAMMES  
(M.Sc. (Hons) & PhD) LIST OF COURSES**

<b>Course Code</b>	<b>Title of Course</b>	<b>Cr. Hr.</b>
PP-701.	Mycology-I	3(2-1)
PP-702.	Mycology-II	3(2-1)
PP-703.	Fungal Systematics	3(2-1)
PP-704.	Fungal Plant Pathology*	3(2-1)
PP-705.	Plant Virology*	3(2-1)
PP-706.	Plant Bacteriology *	3(2-1)
PP-707.	Plant Nematology *	3(2-1)
PP-708.	Ecology and Epidemiology of Plant Diseases	3(2-1)
PP-709.	Biochemistry and Physiology of Diseased Plants	3(2-1)
PP-710.	Genetics of Plant Pathogens	3(3-0)
PP-711.	Seed Pathology	3(2-1)
PP-712.	Integrated Plant Disease Management	3(2-1)
PP-713.	Post-harvest Pathology	3(2-1)
PP-714.	Vector Transmission of Plant Diseases	3(2-1)
PP-715.	Forest and Shade Tree Pathology	3(2-1)
PP-716.	Advances in Plant Pathology **	3(3-0)
PP-717.	Molecular Plant Virology	3(2-1)
PP-718.	Molecular Plant Microbe Interactions **	3(2-1)
PP-719.	Biological Control of Plant Pathogens	3(2-1)
PP-720.	Plant Pathology and International Obligations	3(2-1)
PP-721.	Bioinformatics in Plant Pathology	3(2-1)
PP-722.	Plant Pathology and Environmental Concerns	3(3-0)
PP-723.	Seminar-I (M.Sc. (Hons.) Thesis)	1(1-0)
PP-724.	Special Problem	1(1-0)
PP-725.	Research Thesis (M.Sc. (Hons.))	10(0-10)
PP-726.	Seminar-II (PhD Synopsis)	1(1-0)
PP-727.	Seminar-III (PhD Thesis)	1(1-0)
PP-728.	Research Thesis (PhD)	20(0-20)

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

\*Core courses for PhD.

## **Basic Information:**

PP - 701: MYCOLOGY-I (Straminopila, Protista & Chytridiomycota)

Credit Hours: 3(2-1)

- **Pre-requisites course requirements/ skills:**

M. Sc. (Hons) Agriculture specialization in Plant Pathology

- **Learning Outcomes:**

1. To study taxonomy and nomenclature of fungi and fungi-like organisms of agricultural importance
2. To gain the knowledge about the evolution of fungi
3. To acquire the ability to isolate, purify and preserve the Fungi.
4. To attain the skill to identify the Fungi.

- **Contents**

### **Theory**

1. Evolution of classification of Fungi and Fungi-like organisms:
2. the Six Kingdom System
3. Kingdom Protista:
  - 3.1 significance,
  - 3.2 general characteristics
  - 3.3 systematic position of Myxomycota, Plasmodiophoromycota, Acrasiomycota and Dictyosteliomycota.
4. Distinguishing characters of the genera of Plasmodiophoromycota
5. Life cycles of Plasmodiophora and Spongospora.
6. Kingdom Straminopila
  - 6.1 Importance, morphology, biology, taxonomy and nomenclature of Hyphochytridiomycota
  - 6.2 Importance, morphology, biology, taxonomy and nomenclature of Labyrinthulomycota
  - 6.3 Importance, morphology, biology, taxonomy and nomenclature of Oomycota;
7. Important characters and classification of Oomycota up to orders and families level
8. Importance and life cycles of plant pathogens in Peronosporales, Sclerosporales and Pythiales.
9. Kingdom Fungi: General characters, importance and classification up to phyla.
10. Chytridiomycota: General characteristics and classification up to orders level

## 11. Biology of Synchronytrium. Evolution of orders into new phyla.

### Practical

1. Collection and isolation of mycological specimens with special reference to taxa of agricultural importance
2. Culturing and Purification of mycological specimens
3. Preservation of isolated mycological specimens
4. Identification of mycological specimens with use of keys for identification

- **Teaching-learning Strategies**

Lectures will be delivered using classroom teaching aids including white board, overhead projector and multimedia. Handouts and related literature will be provided to the class after covering each topic. Practical s will be performed in the general labs of the department. Visits to the well-equipped related national research institutes/laboratories will be arranged. Seminars of the expert of the filed will be arranged for the students.

- **Assignments- Types and Number with calendar**

Students will be given one assignment for the theory and one for the practical of weightage 25% in each course.

- **Assessment and Examinations:**

Regular Evaluation of students will be done in classroom through quizzes, tests and group discussions.

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	It takes place at the mid of the semester.
2.	Formative Assessment	25%	It is regular assessment. It includes: class participation, attendance, assignments and presentations, homework, attitude and behavior, hands-on-Trainings, class tests, quizzes etc.
3.	Final	40%	It takes place at the end of the semester. It is mostly in the form of a

	Assessment		test, but according to the nature of the course. The teacher may evaluate their students through papers, research proposal, Presentations, field work and report writing etc.
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- **Suggested Readings**

**Books**

1. Alexopoulos, C.J., C.W. Mims. and M. Blackwell. 1996. Introductory Mycology. 4th edition, John Wiley and Sons. Inc., New York, USA. Burge, M.N. 1988. Fungi in Biological Control System Manchester University Press UK.
2. Elvira Aguirre-Acosta. 2020. Illustrated Generic Names of Fungi. ISBN: 978-0-89054-619-2
3. Frank, M.D. 2017. The Identification of Fungi: An Illustrated Introduction with Keys, Glossary, and Guide to Literature. ISBN: 978-0-89054-504-1
4. Kirk, P.M., J.A. Stalpers, D.W. Minter and P.F. Cannon. 2011. Dictionary of fungi. 10th ed. CABI, UK.
5. Lemke, P.A. and K. Esser. 2001. The Mycota. Volume VII.
6. Systematics and Evolution. Part A. Springer.5. Kendrick, B. 2000. The Fifth Kingdom. (3rd 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. Mirza, J.H., S.M. Khan., S. Begum and S. Shagufta. 1979. Mucorales of Pakistan, University of Agriculture, Faisalabad, Pakistan.
9. Sarah, W., L. Boddy, N. Money. 2015. The Fungi, 3rd Edition. Paperback ISBN: 9780123820341
10. Webster, J. and R. Weber. 2007. Introduction to Fungi. Cambridge University Press.

**Basic Information:**

PP - 702: MYCOLOGY-II (Zygomycota, Glomeromycota, Ascomycota, Basidiomycota and Mitosporic fungi) Credit Hours: 3(2-1)

**• Pre-requisites course requirements/ skills:**

M. Sc. (Hons) Agriculture specialization in Plant Pathology

**• Learning Outcomes:**

1. To study taxonomy and nomenclature of fungi of agricultural importance.
2. To acquire the ability to isolate, purify and preserve the Fungi.
3. To gain the ability to identify the Fungi.

**• Contents****Theory**

1. Zygomycota: General characters, various types of asexual reproductive structures
2. Zygosporogenesis; role of hormones in sexual reproduction
3. Classification up to order level
4. Classification of Mucorales and Endogonales up to families and characteristics of important genera
5. Evolution of Glomeromycota
6. Ascomycota: Morphology, reproduction, life cycle patterns, sexual compatibility and parasexuality
7. Types of asci, centra and ascocarps
8. Ascosporeogenesis and conidiogenesis
9. Principles and systems of classification of Ascomycota and Mitosporic fungi
10. Classification and life cycle of plant pathogenic species of agricultural importance in Pakistan
11. Ascolichens, general characters, anatomy and distribution in Pakistan.
12. Basidiomycota: Introduction to Basidiomycetes
  - 12.1 Somatic structure, reproduction, basidiocarp developmental patterns, types of basidia and basidiospores
  - 12.2 Principles and systems of classification
13. Life cycle and classification of taxa of agricultural importance
14. Basidiolichens and their taxonomy

## Practical

1. Collection and isolation of mycological specimens with special reference to taxa of agricultural importance
2. Culturing and Purification of mycological specimens
3. Preservation of isolated mycological specimens
4. Identification of mycological specimens with use of keys for identification

- **Teaching-learning Strategies**

Lectures will be delivered using classroom teaching aids including white board, overhead projector and multimedia. Handouts and related literature will be provided to the class after covering each topic. Hands on practice will be done in the general labs of the department. Visits to the subject related well-equipped national research institutes/laboratories will be arranged. Sessions /Lectures of the expert of the field will be arranged for the students.

- **Assignments- Types and Number with calendar**

Students will be given one assignment for the theory and one for the practical of weightage 25% in each course.

- **Assessment and Examinations:**

Regular Evaluation of students will be done in classroom through quizzes, tests and group discussions.

Sr. No.	Elements	Weightage	Details
1	Midterm Assessment	35%	It takes place at the mid of the semester.
2	Formative Assessment	25%	It is regular assessment. It includes: class participation, attendance, assignments and presentations, homework, attitude and behavior, hands-on-Trainings, class tests, quizzes etc.
3	Final	40%	It takes place at the end of the semester. It is mostly in the form of a



	Assessment		test, but according to the nature of the course. The teacher may assess their students based on papers, research proposal, Presentations, field work and report writing etc.
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- **Suggested Readings**

### **Books**

1. Ahmad, S. 1978. Ascomycetes of Pakistan Vol.1 and II. Biological Society of Pakistan, Lahore, Pakistan.
2. Yadav, A.N. 2021. Recent Trends in Mycological Research. Series Title. Fungal Biology. Springer
3. Alexopoulos, C.J., C.W. Mims. and M. Blackwell.1996. Introductory Mycology. 4th edition, John Wiley and Sons. Inc., New York, USA. Burge, M.N. 1988. Fungi in Biological Control System Manchester University Press UK.
4. Barnett, H. L. and B.B. Hunter. 1996. Illustrated Genera of Imperfect Fungi, 4th edition, American Phytopathological Society Press, St. Paul, Minnesota, USA.
5. Cole, G.T. and B. Kendrick. 1981. Biology of Conidial Fungi. Vol-II. Academic Press, New York, USA.
6. Cummins, E.A. 1971. The Rust Fungi of Cereals, Grasses and Bamboo. Springer-Verlag. Berlin, Germany.
7. Cummins, G.B. and Y. Hiratsuka. 2003. Illustrated Genera of Rust Fungi, 3rd Ed. APS Press, St. Paul Minnesota. 240 pp.
8. Hanlin, R.T. 1990. Illustrated Genera of Ascomycetes. Vol. 1. APS Press, St. Paul Minnesota. 263 pp.
9. Hanlin, R.T. 1998. Illustrated Genera of Ascomycetes. Vol. 2. APS Press, St. Paul Minnesota. 258 pp.
10. Kálmán Vánky. 2012. Smut Fungi of the World. APS Press, St. Paul Minnesota. 1480 pp
11. Kálmán Vánky. 2013. Illustrated Genera of Smut Fungi. 3rd Ed. APS Press, St. Paul Minnesota. 280 pp.
12. Kendrick, B. 2000. The Fifth Kingdom. (3rd ed.). Focus Publishing/R. Pullins Company, Incorporated.373 pp

13. Kirk, P.M., J.A. Stalpers, D.W. Minter and P.F. Cannon. 2011. Dictionary of Fungi. 10th ed. CABI, UK.
14. Kirk, P.M., J.A. Stalpers, D.W. Minter and P.F. Cannon. 2011. Dictionary of Fungi. 10th ed. CABI, UK.
15. Lemke, P.A. and K. Esser. 2001. The Mycota. Volume VII. Systematics and Evolution. Part A. Springer.
16. Liliane Elisabeth Petrini-Klieber, L.E. and O. Petrini. 2013. Identifying Moulds: A Practical Guide. Gebruder Borntraeger Verlagsbuchhandlung, Science Publishers
17. Gupta, V.K., M. Tuohy. 2022. Laboratory Protocols in Fungal Biology, Current Methods in Fungal Biology. Springer Cham
18. Webster, J. and R. Weber. 2007. Introduction to Fungi. Cambridge University Press.
19. White J.F. 2003. Clavicipitalean fungi, Evolution, Biology, Chemistry, Bio and Cultural Control.

## **Basic Information:**

PP -703. FUNGAL SYSTEMATICS

Credit Hours: 3(2-1)

- **Pre-requisites course requirements/ skills:**

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

- **Learning Outcomes:**

1. Discuss the importance of fungi in various ecological roles
2. Demonstrate an understanding of how fungi impact human affairs
3. Outline the higher taxonomy of the fungi and how the fungi relate to other organisms
4. Discuss the characteristics of the major classes and orders within the fungal kingdom
5. Identify the major families and certain species of mushrooms and other macrofungi
6. Demonstrate a working knowledge of how fungi grow and reproduce, and where and how they can be isolated

- **Contents**

### **Theory**

1. Introduction to fungal systematics
2. Diversity of Fungi and Fungi-like organisms
3. Concept of speciation in fungi
4. Rules for fungal nomenclature
5. Morphological, physiological and chemical characters as criteria for fungal classification
6. Morphology-based systems for classification of fungi and fungi like organisms
7. Application of DNA Sequence Analysis to Phylogenetic Studies
8. Different Tree-Making Methods for Molecular Data
9. Weighted Parsimony
10. Parsimony and Phylogenetic Inference using DNA sequences
11. Statistical methods for testing molecular phylogenies
12. Recent classification of fungi and fungi-like organisms on the basis of molecular phylogeny.

### **Practical**

1. Use of diagnostic keys for the identification of various groups of fungi up to species level
2. Speciation on the basis of molecular techniques
3. Homology and Phylogenetic Weighting
4. Use and comparison of different Tree-Making methods for molecular data

- **Teaching-learning Strategies**

Lectures will be delivered using classroom teaching aids including white board, overhead projector and multimedia. Handouts and related literature will be provided to the class after covering each topic. Practical s will be performed in the general labs of the department. Visits to the well-equipped related national research institutes/laboratories will be arranged. Seminars of the expert of the filed will be arranged for the students.

- **Assignments- Types and Number with calendar**

Students will be given one assignment for the theory and one for the practical of weightage 25% in each course.

- **Assessment and Examinations:**

Continuous assessment will be done in classroom through quizzes, tests and group discussions.

Sr. No.	Elements	Weightage	Details
1	Midterm Assessment	35%	It takes place at the mid-point of the semester.
2	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentations, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

- **Suggested Readings**

**Books**

1. Alexopoulos, C.J., C.W. Mims and M. Blackwell. 1996. Introductory Mycology. 4th edition, John Wiley & Sons, Inc. New York, USA.
2. Bridge, P., Smith, D. and Stackebrandt, E., 2021. Trends in the Systematics of Bacteria and Fungi. Cabi international Publishers.

3. Cannon, P.F., P.M. Kirk, D.W. Minter and J.A. Stalpers. 2008. Dictionary of Fungi. 10th ed. CABI. England.
5. Dilip K., P.D. Arora, P.D. Bridge and D. Bhatnagar. 2004. Handbook of Fungal Biotechnology, Volume 20. Marcel Dekker.
6. Frisvad, J.C., D.K. Arora and P.D. Bridge. 1998. Chemical Fungal Taxonomy. Marcel Dekker.
7. Heitman, J., Howlett B.J., Crous, P.W., Stukenbrock, E.H., James, T.Y., Neil A. R. 2020. The Fungal Kingdom. Wiley Publisher. ISBN: 1555819583, 9781555819583.
8. Lamour, K. and S. Kamoun. 2009. Oomycete Genetics and Genomics: Diversity, Interactions and Research Tools. John Wiley & Sons Inc.
9. Lebeda, A., T.N. Peter, Spencer-Phillips and B.M. Cooke. 2008. The Downy Mildews - Genetics, Molecular Biology and Control: Genetics. Springer.
10. Miyamoto, M.M. and J. Craft. 1991. Phylogenetic Analysis of DNA Sequences. Oxford University Press.
11. Moore, D. and L.N. Frazer. 2002. Essential Fungal Genetics. Springer.
12. Rai, M. and P.D. Bridge. 2009. Applied Mycology. CABI, England.
13. Swanton, E.W. 2004. Hand Book of Fungi. Reprint Publication, India.
14. Webster, J. and R. Weber. 2007. Introduction to Fungi. Cambridge University Press.

**Basic Information:**

PP - 704. FUNGAL PLANT PATHOLOGY                      Credit Hours: 3(2-1)

- **Pre-requisites course requirements/ skills:**

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

- **Learning Outcomes:**

1. To acquire the basic knowledge about Principle of plant pathology.
2. To acquire the learning of fundamentals of Mycology and its taxonomy.
3. To provide basis for fungal disease diagnostics
4. Learning of plant pathogenic fungi for economically important agricultural crops and control of these pathogens.

- **Contents**

**Theory**

1. History of fungal Plant Diseases
2. Losses caused by plant pathogenic fungi
3. Survival and dissemination of plant pathogenic fungi
4. Stages in establishment of infection by fungal pathogens
5. Mechanisms of host defense
6. Effects of pathogens on plant physiological functions
7. Symptoms caused by fungal pathogens
8. Relationships between Disease Cycles and Epidemics
9. Mechanisms and stages of variation in fungal pathogens
10. Genetics of virulence in fungal pathogens and resistance in host plants
11. Chemical and non-chemical methods for disease management
12. Study and management of important diseases caused by various groups of fungi and fungi-like organisms.

**Practical**

1. Symptomatology of fungal plant diseases
2. Techniques for Isolation, identification, purification and preservation of fungal plant pathogens
3. Methods for confirmation of pathogenicity of various groups of plant pathogenic fungi
4. In vitro evaluation of fungicides and bio-control agents against fungal pathogens
5. Demonstration of chemical and non-chemical methods of plant disease management

- **Teaching-learning Strategies**

Lectures will be delivered using classroom teaching aids including white board, overhead projector and multimedia. Handouts and related literature will be provided to the class after covering each topic. Practical s will be performed in the relevant fungal labs of the department. Visits to the well-equipped related national research institutes/laboratories will be arranged. Seminars of the expert of the filed will be arranged for the students.

- **Assignments- Types and Number with calendar**

Students will be given one assignment for the theory and one for the practical of weightage 25% in each course.

- **Assessment and Examinations:**

Continuous assessment will be done in classroom through quizzes, tests and group discussions.

Sr. No.	Elements	Weightage	Details
1	Midterm Assessment	35%	It takes place at the mid-point of the semester.
2	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentations, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

- **Suggested Readings**

**Books**

1. Alexopoulos, C.J., C.W. Mims and M. Blackwell. 1996. Introductory Mycology. 4th edition, John Wiley & Sons, Inc. New York, USA.
2. Bridge, P., Smith, D. and Stackebrandt, E., 2021. Trends in the Systematics of Bacteria and Fungi. Cabi international Publishers.

3. Cannon, P.F., P.M. Kirk, D.W. Minter and J.A. Stalpers. 2008. Dictionary of Fungi. 10th ed. CABI. England.
4. Dilip K., P.D. Arora, P.D. Bridge and D. Bhatnagar. 2004. Handbook of Fungal Biotechnology, Volume 20. Marcel Dekker.
5. Frisvad, J.C., D.K. Arora and P.D. Bridge. 1998. Chemical Fungal Taxonomy. Marcel Dekker.
6. Lamour, K. and S. Kamoun. 2009. Oomycete Genetics and Genomics: Diversity, Interactions and Research Tools. John Wiley & Sons Inc.
7. Lebeda, A., T.N. Peter, Spencer-Phillips and B.M. Cooke. 2008. The Downy Mildews - Genetics, Molecular Biology and Control: Genetics. Springer.
8. Miyamoto, M.M. and J. Craft. 1991. Phylogenetic Analysis of DNA Sequences. Oxford University Press.
9. Moore, D. and L.N. Frazer. 2002. Essential Fungal Genetics. Springer.
10. Rai, M. and P.D. Bridge. 2009. Applied Mycology. CABI, England.
11. Rojas, C. and Stephenson S.L. 2021. Myxomycetes: Biology, Systematics, Biogeography and Ecology.
12. Swanton, E.W. 2004. Hand Book of Fungi. Reprint Publication, India.
13. Webster, J. and R. Weber. 2007. Introduction to Fungi. Cambridge University Press.



**Basic Information:**

PP-705: PLANT VIROLOGY Credit Hours: 3(2-1)

- **Pre-requisites course requirements/ skills:**

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

- **Learning Outcomes:**

1. Know and understand the taxonomy, nomenclature and ability to recognize virus and viroid-induced plant diseases based on disease symptoms.
2. Ability to establish a reliable relationship between etiological agent and disease
3. Know and understand the main aspects of pathogenesis and induction of symptoms through virus or viroid and plant interactions.
4. Knowledge and understanding of the basic methodologies used for detection and identification of viruses and viroids and ability to critically interpret the results of laboratory diagnostic tests.
5. Ability to adopt the most appropriate control methods for limiting endemic, emerging and quarantine viruses and viroids as well as making informed judgements and choices to formulate a strategy for the sustainable control of viruses and viroids.

- **Contents**

**Theory**

1. History and scope of plant virology; taxonomy and nomenclature
2. Effects of viruses on plants; recent trends in virus transmission and movement in plants
3. Structure of plant viruses; virus purification, replication and gene organization
4. Physiology of virus infected plants
5. Virus-vector-host interactions
6. Natural and acquired resistance to virus infection
7. Management of plant viruses
8. Study of economically important viral diseases in Pakistan

**Practical**

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

- **Teaching-learning Strategies**

Classroom teaching aids including, white board, overhead projector and multimedia will be used for delivering lecture. Handouts and related literature will be provided to the class after covering each topic. Practicals will be performed in general labs of the department. Visits to well-equipped related national research institutes/laboratories will be arranged. Experts of plant virology will be invited for delivering seminars for the students.

- **Assignments- Types and Number with calendar**

Students will be given one assignment for the theory and one for the practical of weightage 25% in each course.

- **Assessment and Examinations:**

Continuous formal and informal assessment will be done in classroom through quizzes, tests and group discussions.

Sr. No.	Elements	Weightage	Details
1	Midterm Assessment	35%	It takes place at the mid-point of the semester.
2	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentations, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

- **Suggested Readings**

## **Books**

1. Aiming W. and Yi L. 2021. Plant Virology: Methods and Protocols (Methods in Molecular Biology, 2400) Springer protocols.
2. Awasthi, L. P. 2020. Applied Plant Virology: Advances, Detection, and Antiviral Strategies. Elsevier Science & Technology.
3. Compendia of different crops, American Phytopathological Society, St Paul, Minnesota, USA.
4. Foster, G.D. and S.C. Taylor. 1998. Plant Virology Protocols From Virus Isolation to Transgenic Resistance. Humana Press, New Jersey.
5. Foster, G.D., I.E. Johansen, Y. Hong and P.D. Nagy. (Eds.). 2008. Plant Virology Protocols – From Viral Sequence to Protein Function 2nd Ed. Humana Press
6. Hadidi, A., R.K. Khetarpal and H. Koganezawa (Eds). 1998. Plant Virus Disease Control. American Phytopathological Society, St Paul, Minnesota, USA.
7. Hull, R. 2009. Comparative Plant Virology, 2nd Ed. Academic Press
8. Hull, R. 2002. Matthews' Plant Virology, Fourth Ed. Elsevier Ltd.
9. Loebenstein, G. and G. Thottappilly. (Eds.) 2004. Virus and Virus like Diseases of Major Crops in Developing Countries. Springer
10. Matthews. R.E.F. 1991. Plant Virology. 3rd revised edition. Academic Press.

**Basic Information:**

PP - 706. PLANT BACTERIOLOGY Credit Hours: 3(2-1)

- **Pre-requisites course requirements/ skills:**

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

- **Learning Outcomes:**

1. To become familiar with current taxonomy of plant pathogenic prokaryotes and important bacterial diseases.
2. To equip with techniques for manipulating bacteria such as isolation, identification and inoculation of pathogens.
3. To gain the knowledge of different pathogenic mechanisms used by different groups of major bacterial pathogens.
4. To understand the ecology of various plant pathogenic bacteria and current disease management strategies for bacterial diseases.
5. To develop the academic ability to critically review research articles about biological/agricultural sciences.

- **Contents**

**Theory**

1. History of Phytobacteriology
2. Economic importance and characteristics of plant pathogenic bacteria
3. Taxonomy and nomenclature
  - 3.1 morphology
  - 3.2 nutrition
  - 3.3 growth
  - 3.4 reproduction
4. Survival mechanism in bacteria
5. Bacterial pathogenesis and symptomology
6. Hypersensitive reaction and host-specificity
7. Ecology and spread of plant pathogenic bacteria
8. Bacteriophages and bacteriocins
9. Study of important bacterial diseases in Pakistan and their management
10. Nitrogen fixing and nitrifying bacteria
11. Plant growth promoting rhizobacteria (PGPR)
12. Effective microorganisms (EM)

## Practical

1. Isolation, purification and identification of plant pathogenic bacteria on the basis of morphological, biochemical and molecular techniques
2. Inoculation techniques and pathogenicity tests
3. Demonstration of plant disease symptoms exhibited by bacteria/fastidious bacteria and mollicutes
4. Sensitivity tests; Characterization of bacteria using phages.

- **Teaching-learning Strategies**

Classroom lectures will be delivered using teaching aids including white board, overhead projector and multimedia which ever needed according to topic. Relevant literature and lecture handouts will be provided to the class after completion of each topic. Practical will be performed in the general labs of the department. Visits to the well-equipped related national research institutes/laboratories will be arranged. Seminars of the expert of the field will be arranged for the students.

- **Assignments- Types and Number with calendar**

Each independent assignment for theory and practical will be given to students by the weightage of 25% in each course.

- **Assessment and Examinations:**

Regular class assessments will be done through quizzes, tests and group discussions.

Sr. No.	Elements	Weightage	Details
1	Midterm Assessment	35%	It takes place at the mid-point of the semester.
2	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentations, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.

3	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.
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- **Suggested Readings**

- Books**

4. De Boer, S.H. 2001. Plant Pathogenic Bacteria. Kluwer Academic Publishers.
5. Fahy, P.C. and G.J. Persley. (eds.). 1983. Plant Bacterial Diseases: A Diagnostic Guide. Academic Press, New York, USA.
6. Goto, M. 1992. Fundamentals of Bacterial Plant Pathology. Academic Press Inc., USA.
7. 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.
8. Jayarman, J. and J.P. Verma. 2022. Fundamentals of Plant Bacteriology. Kalyani Publishers, Ludhiana, India.
9. Janse, J.D. 2008. Phytobacteriology: Principles and Practice. CABI Publishing.
10. Klement, Z., K. Rudolph and D.C. Sands. 1990. Methods in Phytobacteriology. Akademiai Kiado, Budapest, Hungary.
11. Misra, R.S. 2021. Bacterial Plant Diseases. Discovery Publishers and Distributors, India.
12. Srivastava, M. 2006. Introductory Phytobacteriology. Advance Publishing Concept, New Delhi India.

**Basic Information:**

PP - 707. PLANT NEMATOLOGY    Credit Hours: 3(2-1)

**• Pre-requisites course requirements/ skills:**

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

**• Learning Outcomes:**

1. To acquaint students with the basic and applied concepts of plant parasitic nematodes
2. To acquire the ability to identify and isolate plant parasitic nematodes.
3. To equip the students with latest research tools, techniques and bioinformatics soft wares to study plant parasitic nematodes.
4. To develop the skills among students involved in management of plant parasitic nematodes.

**Contents****Theory**

1. Importance of plant parasitic nematodes
2. Plant response to nematodes
3. Environmental factors affecting survival and pathogenicity of plant parasitic nematodes
4. Morphology, anatomy, and reproduction of plant parasitic nematodes
5. Mode and mechanism of infection caused by plant parasitic nematodes
6. Concepts and principles of population dynamics of plant parasitic nematodes
7. Ecology of soil nematodes
8. Estimation of crop losses caused due to plant parasitic nematodes
9. Nematode-microbe interactions
10. Molecular techniques for taxonomy of plant parasitic nematodes
11. Advances in phyto-nematological research with emphasis on nematode density/ plant yield relationships
12. Study of specific nematode diseases of Pakistan
13. Management of plant parasitic nematodes
14. Identification and propagation of entomopathogenic nematodes

**Practical**

1. Isolation, identification and permanent mounting of important plant parasitic nematodes
2. Pathogenicity tests
3. Collection, handling and diagnosis of diseased plants by symptomatology
4. Integrated management of plant parasitic nematodes

- **Teaching-learning Strategies**

Whiteboards, overhead projectors, and other classroom teaching tools will be used to deliver lectures. Following each topic, the students will receive handouts and relevant readings. Practicals will be completed in the department's general labs. Visits to the modern national research institutes and laboratories in the field will be planned. Students will have access to seminars delivered by subject-matter experts.

- **Assignments- Types and Number with calendar**

Quizzes, examinations, and group discussions will be used in the classroom to assess students continuously.

- **Assessment and Examinations:**

Quizzes, examinations, and group discussions will be used in the classroom to assess students continuously.

Sr. No.	Elements	Weightage	Details
1	Midterm Evaluation	35%	It happens in the middle of the semester.
2	Formative Evaluation	25%	It is ongoing evaluation. Participation in class, showing up, assignments and presentations, homework, attitude and behaviour, hands-on activities, quick tests, quizzes, and other similar things are all part of it.
3	Final Evaluation	40%	It happens at the conclusion of the semester. The majority of it takes the form of a test, but due to the nature of the course, the teacher may also evaluate their pupils on the basis of a term paper, the creation of a research proposal, fieldwork, report writing, etc.

- **Suggested Readings**

**Books**



1. Alam, M.M. and N. Sharma. 2002. Nematode Control in Crops. 54 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. 2nd 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. Ramzan M. 2017. Plant Nematology: How Conduct Survey For Community Analysis of Nematodes. LAP Lambert Academic Publishing.
9. Siddiqui, M.R. 2000. Tylenchida: Parasites of Plants and Insects. 2nd ed. Wallingford, CABI Publishing.
10. Subbotin, S. A., Rius, J. E. P., & Castillo, P. 2021. Systematics of root-knot nematodes (Nematoda: Meloidogynidae). Brill, Leiden; Netherland.

## **Basic Information:**

PP-708: ECOLOGY AND EPIDEMIOLOGY OF PLANT DISEASES

Credit Hours: 3(2-1)

- **Pre-requisites course requirements/ skills:**

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

- **Learning Outcomes:**

1. To study the development of plant disease epidemics
2. To understand the principles and concepts of plant disease epidemiology.
3. To be familiar with analysis methods to study plant disease epidemiology.
4. To apply the knowledge to study plant disease epidemiology supporting future food production and ecological sustainability.

## **Contents**

### **Theory**

1. Introduction
  - 1.1 Definition
  - 1.2 History
  - 1.3 Development of epidemiology
  - 1.4 Principles and concepts of epidemics
2. Effect of different environmental factors
  - 2.1 Growth, reproduction and spread of plant pathogens
  - 2.2 Ecological and population dynamic studies of different plant pathogens
  - 2.3 Survival and propagation of plant pathogens
3. Influence of meteorological factors, host resistance and human interceptions on the development of epidemics
4. Mapping of epidemic growth
  - 4.1 Analysis of epidemic growth curve
  - 4.2 Calculation of growth rate
  - 4.3 Disease progression and pattern of spread in nature (spatial and temporal)
  - 4.4 Loss estimation using prediction models
  - 4.5 Pathometry
  - 4.6 Visual assessment methods
  - 4.7 Descriptive and logarithmic scales
  - 4.8 Standard diagrams
  - 4.9 Incidence severity relationship

## 5. Remote sensing

### 5.1 Video image analysis.

#### **Practical**

1. Studies on the role of factors affecting disease development
2. Use of different techniques to create artificial epidemics in greenhouse or growth chamber
3. Calculation of severity of diseases by different procedures to monitor epidemics; plotting the growth curve by using different transformation procedures
4. Monitoring disease
5. Establishing prediction systems and executing control measures
6. Use of agri-meteorological equipments and information

#### • **Teaching-learning Strategies**

Lectures will be delivered using classroom teaching aids including white board, overhead projector and multimedia. Handouts and related literature will be provided to the class after covering each topic. Practical s will be performed in the general labs of the department. Visits to the well-equipped related national research institutes/laboratories will be arranged. Seminars of expert of the field will be arranged for the students.

#### • **Assignments- Types and Number with the calendar**

Students will be given one assignment for the theory and one for the practice of weightage 25% in each course.

#### • **Assessment and Examinations:**

Continuous assessment will be done in the classroom through quizzes, tests and group discussions.

Sr. No.	Elements	Weightage	Details
1	Midterm Assessment	35%	It takes place at the mid-point of the semester.
2	Formative Assessment	25%	It is a continuous assessment. It includes classroom participation,

			attendance, assignments and presentations, homework, attitude and behavior, hands-on activities, short tests, quizzes etc.
3	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, fieldwork and report writing etc.

- **Suggested Readings**

**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. Leonard, J.F. and D.A. Neher. 1997. Exercises in Plant Disease Epidemiology. American Phytopathological Society Press, St. Paul, Minnesota, USA
4. Kranz, J. 2002. Comparative Epidemiology of Plant Diseases. Springer.
5. Kranz, J. 1990. Epidemics of Plant Diseases: Mathematical Analysis and Modeling. Springe Publ. London, UK.
6. Paul, P.A. and L.V. Madden. 2015. Meta-analysis in plant disease epidemiology. Exercises in Plant Disease Epidemiology. KL Stevenson and MJ Jeger, eds. American Phytopathological Society, St. Paul, MN, pp.137-145.

## **Basic Information:**

PP - 709. BIOCHEMISTRY AND PHYSIOLOGY OF DISEASED PLANTS

Credit Hours: 3(2-1)

- **Pre-requisites course requirements/ skills:**

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

- **Learning Outcomes:**

1. To study biochemical and physiological changes in diseased plants.
2. To equip the students with the understanding of biochemical basis of resistance.
3. To acquaint the students with toxins and enzymes produced by the pathogens to damage the host plants.
4. To give knowledge about biochemical markers for disease diagnostics.

- **Contents**

### **Theory**

1. Infection process
  - 1.1 of fungi
  - 1.2 Bacteria
  - 1.3 Viruses and
  - 1.4 Nematodes
2. Comparative analysis of biochemical and physiological changes in diseased and healthy plants
3. Influence of plant pathogens on:
  - 3.1 Photosynthesis
  - 3.2 Respiration
  - 3.3 Translocation
  - 3.4 Transpiration
  - 3.5 Cell wall composition and metabolism
  - 3.6 Nucleic acid and protein metabolism
4. Changes in secondary metabolites
5. Membrane alterations
6. Growth regulators phytoalexins and toxins
7. Lectin degrading enzymes affecting host cell and cell wall
8. Cutin and suberin degrading enzymes
9. Effect of pathogens on trans-cellular and vascular transport

10. Nature of morphological and biochemical resistance in host plants
11. Energy use and metabolic regulation in plant-pathogen interactions
12. Effects of root infecting fungi on structure and function of cereal roots
13. Effects of disease on plant water relations
14. Alterations in secondary metabolism
15. Gene activation and interaction

### **Practical**

1. Experiments to illustrate infection processes by plant pathogens
2. Histopathology of infected plant tissue
3. Biochemical analysis to demonstrate changes
  - 3.1 Induced by biotic factors
  - 3.2 abiotic factors
4. Bioassay of toxin
5. Selection for host resistance

- **Teaching-learning Strategies**

Classroom teaching aids including white board, overhead projector and multimedia. Handouts and related literature will be provided to the class after covering each topic. Practical s will be performed in the general labs of the department. Visits to the well-equipped related national research institutes/laboratories will be arranged. Seminars of the expert of the filed will be arranged for the students.

- **Assignments- Types and Number with calendar**

Students will be given one assignment for the theory and one for the practical of weightage 25% in each course.

- **Assessment and Examinations:**

Continuous assessment will be done in classroom through quizzes, tests and group discussions.

Sr. No.	Elements	Weightage	Details

4.	Midterm Assessment	35%	It takes place at the mid-point of the semester.
5.	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentations, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
6.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

- **Suggested Readings**

**Books**

1. Abdelrehman, M. and S. Jogaiah. 2020. Bioactive Molecules in Plant Defense: Saponins. Springer, Cham. ISBN: 978-3-030-61149-1
2. Ayres, P.G. 1981. Effects of Disease on the Physiology of the Growing Plants. Cambridge University Press.
3. Baily, J.A. and B.J. Deverall. 1983. The Dynamics of Host Defense. Academic Press, New York, USA.
4. D. Šutić and J. B. Sinclair. 1991. Anatomy and Physiology of Diseased Plants. CRC Press. 232 pp.
5. Fritig, B. and M. LeGrand. 1993. Mechanisms of Plant Defense Responses. Kluwer, Dordrecht, the Netherlands.
6. Goodman, R.N., Z. Kiraly, and K.R. Wood. 1986. The Biochemistry and Physiology of Plant Disease. Univ. of Missouri Press, Columbia, USA.
7. Lawlor, W.D. 2001. Photosynthesis. 3rd Ed. Viva Books (Pvt.) Ltd. India.
8. Misra, J.R. 2004. Photosynthesis in Plants. DPH, India.
9. Petrini, O. and G.B. Ouellette. 1994. Host Wall Alterations by Parasitic Fungi. American Phytopathology Society Press, St., Paul. Minnesota, USA.

10. Schumann, G. and C. J. D'Arcy. 2010. Essential Plant Pathology. APS Press. 369 pp.
11. Strange, R.N. 2003. Introduction to Plant Pathology. John Wiley and Sons Ltd.



**Basic Information:**

PP - 710. GENETICS OF PLANT PATHOGENS

Credit Hours: 3(3-0)

**• Pre-requisites course requirements/ skills:**

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

**• Learning Outcomes:**

1. To study the genetics of plant pathogens
2. To understand mechanisms responsible for variation in plant pathogens
3. To understand host-pathogen interaction at molecular basis
4. To give basis of molecular plant pathology

**Contents****Theory**

1. Mechanisms responsible for variation in plant pathogens including mutation, hybridization, heterokaryosis, parasexuality, adaptation, cytoplasmic inheritance and bacterial conjugation, transformation, and transduction.
  2. Physiological specialization especially in fungi
  3. Formation of new races and biotypes
  4. The gene-for-gene-concept
  5. Genetics of host-pathogen interaction
  6. Speciation (species concepts), and population genetics of pathogen (Microevolution)
  7. Study of pathogenicity of fungi, bacteria, viruses and nematodes; study of infection on differential hosts
  8. Recognition, colonization and virulence of plant pathogens
  9. Evolutionary biology of pathogens
  10. Phylogenetics (Macroevolution); genetic drift; gene flow; mating types/systems
- Teaching-learning Strategies**
- Lectures will be delivered using classroom teaching aids including white board, and multimedia. Handouts and related literature will be provided to the class after covering each topic. Visits to the well-equipped related national research institutes/laboratories will be arranged. Seminars of the expert of the field will be arranged for the students.
- Assignments- Types and Number with calendar**
- Students will be given one assignment for the theory weightage 25%.

- **Assessment and Examinations:**

Continuous assessment will be done in classroom through quizzes, tests and group discussions.

Sr. No.	Elements	Weightage	Details
1	Midterm Assessment	35%	It takes place at the mid-point of the semester.
2	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentations, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

- **Suggested Readings**

**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. Sinclair, J.B., O.D. Dhingra. 2019. Basic Plant Pathology Methods. 2nd Edition. CRC Press.
7. Lawlor, W.D. 2001. Photosynthesis. 3rd Ed. Viva Books (Pvt.) Ltd. India.

8. Dickinson, M., J. Beynon. 2020. Molecular Plant Pathology. First Edition. 1st Edition. CRC Press.
9. Misra, J.R. 2004. Photosynthesis in Plants. DPH, India.
10. Petrini, O. and G.B. Ouellette. 1994. Host Wall Alterations by Parasitic Fungi. American Phytopathology Society Press, St., Paul. Minnesota, USA.
11. Schumann, G. and C. J. D'Arcy. 2010. Essential Plant Pathology. APS Press. 369 pp.
12. Strange, R.N. 2003. Introduction to Plant Pathology. John Wiley and Sons Ltd.

## **Basic Information:**

PP-711: SEED PATHOLOGY

Credit Hours: 3(2-1)

- **Pre-requisites course requirements/ skills:**

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

- **Learning Outcomes:**

5. To learn about the seed pathological diseases and their management.
6. To study post-harvest diseases and their management.
7. To acquire the latest developments in the management of seed and post-harvest diseases.

- **Contents**

### **Theory**

1. Introduction to seed pathology
  - 1.1 Importance of seed-borne fungal, bacterial, viral and nematode diseases
2. Histopathology of healthy and infected seeds/planting materials
  - 2.1 Mechanism of seed infection and disease transmission
3. Factors affecting the establishment of pathogens in seed
4. Seed abnormalities and losses
5. Seed quality control system for disease-free seed production,
  - 5.1 Processing and certification with special reference to Pakistan
  - 5.2 Seed crops and seed standards
  - 5.3 Seed treatment and equipments
  - 5.4 Seed processing and storage
  - 5.5 Seed health testing of consignment during export/import and testing of germplasm material
  - 5.6 Accreditation of seed health testing/seed pathology labs; seed borne diseases and bioterrorism
6. Seed-borne pathogens and their health hazards
7. Description of important seed-borne diseases
8. Forecasting of seed-borne diseases

### **Practical**

1. Seed-borne pathogens
  - 1.1. Identification
  - 1.2. Preservation
  - 1.3. Incidence and mode of seed transmission

2. Effects of different chemicals and antagonistic microorganisms on seed-borne pathogens and seed germination
3. Field crop inspection for disease assessment;
  - 3.1 Seed sampling according to International Seed Testing Association (ISTA) methods
  - 3.2 Preparation of working sample for seed health testing
  - 3.3 Visits to seed testing laboratories and seed processing plants
4. Maintenance of culture collection of identified seed-borne pathogens.

- **Teaching-learning Strategies**

Lectures will be delivered using classroom teaching aids including a whiteboard, overhead projector, and multimedia. Handouts and related literature will be provided to the class after covering each topic. Practicals will be performed in the general labs of the department. Visits to the well-equipped related national research institutes/laboratories will be arranged. Seminars of experts in the field will be arranged for the students.

- **Assignments- Types and Numbers with the calendar**

Students will be given one assignment for the theory and one for the practice of weightage 25% in each course.

- **Assessment and Examinations:**

Continuous assessment will be done in the classroom through quizzes, tests and group discussions.

Sr. No.	Elements	Weightage	Details
1	Midterm Assessment	35%	It takes place at the mid-point of the semester.
2	Formative Assessment	25%	It is a continuous assessment. It includes classroom participation, attendance, assignments and presentations, homework, attitude and behavior, hands-on activities, short tests, quizzes etc.
3	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their

			students based on term paper, research proposal development, fieldwork and report writing etc.
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● **Suggested Readings**

**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. 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. Gaur, A. 2020. An introduction to seed pathology. Galgotia Publications Pvt Ltd. ISBN: 9788175156302, 9788175156302
8. Kruse, M. 2004. ISTA Handbook on Seed Sampling. 2nd Ed. ISTA, Switzerland.
9. Neergaard, P.1977 & 1988. Seed Pathology: Volume 1&2. John Wiley & Sons, Incorporate. 1187 pp.
10. Singh, D. 2004. Histopathology of Seed-Borne Infections. CRC 59 Press.
11. Singh, T. and K. Agrawal. 2001. Seed Technology and Seed Pathology. Pointer Publisher, India. 498 pp.

**Basic Information:**

PP - 712. INTEGRATED PLANT DISEASE MANAGEMENT      Credit Hours: 3(2-1)

- **Pre-requisites course requirements/ skills:**

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

- **Learning Outcomes:**

- 1 To introduce the students with concepts, prospects, and principles of integrated plant disease management.
- 2 To integrate different plant disease management practices.
- 3 To make the students learn about the use of remote sensing and information technology in IPDM

- **Contents**

**Theory**

1. Introduction, history, concepts, prospects, principles, components and challenges in Integrated Plant Disease Management (IPDM)
2. Different plant disease management strategies, their integration and application
3. Biological and environmental monitoring for sustainable disease management
4. Role of biotechnology, remote sensing and information technology in IPDM
5. Disinfection and pesticides application
6. Resistance problems
7. Production and evaluation of biocontrol agents
8. Biosafety regulations regarding release of biocontrol agents
9. Role of community in IPDM
10. Technology transfer in IPDM

**Practical**

1. Integration of different methods for plant disease control
2. Development of IPDM model.
3. Comparison among various IPDM strategies in greenhouse/field.

- **Teaching-learning Strategies**

- 1- Use of white board and/or multimedia presentation during lectures.
- 2- Recommendation of a book or a book chapter for detailed study by the students, in which the most relevant text to the given course contents is available.

3- Preparation of self-prepared notes for the students on a specific topic if suitable text is not available in an available book.

- **Assignments- Types and Number with calendar**

1- Assignment is given to the students in a semester, one each for theory and practicals.

2- Each assignment is of 25 marks.

3- Marks distribution is as follows:

Written assignment	10
Presentation	10
Attendance etc	5

- **Assessment and Examinations:**

For each of theory and practical, there are two exams in a semester, Midterm and Final Term.

Sr. No.	Elements	Weightage	Details
1	Midterm Assessment	35%	<p>1- It takes place at the mid-point of the semester after 8 week's teaching.</p> <p>2- Midterm papers are of 35 Marks and 1½ h duration.</p> <p>3- Theory paper consists of Objective and subjective portions. Objective portion in both the terms consists of 4 questions of 5 marks each. The 1<sup>st</sup> question is of MCQs type with 10 parts, each part is of ½ mark. Likewise, 2<sup>nd</sup> and 3<sup>rd</sup> questions are True/False and Fill in the Blanks, respectively, each has 10 parts of 5 marks. The 4<sup>th</sup> question consists of 5 short descriptive statements/definitions/differentiate between etc.</p> <p>4- Subjective portion of a Theory paper consists of 3 descriptive questions (each of 5 marks).</p> <p>5- Practical paper is of 35 marks consisting of short and long questions.</p>
2	Formative	25%	It is continuous assessment. It includes:



	Assessment		classroom participation, attendance, assignments and presentations, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3	Final Assessment	40%	<p>1- It takes place at the end of the semester in 18<sup>th</sup> week. Its duration is 2 h.</p> <p>2- Theory paper is of 40 marks. Its format is same as that of mid-term exam but has an extra descriptive question of 5 marks.</p> <p>3- Practical paper is of 40 marks and consists of short questions and designing of experiments (descriptive).</p>

- **Suggested Readings**

**Books**

- 1- Arya, A.O. and A.E. Perello. 2010. Management of Fungal Plant Pathogens. CABI, England.
- 2- Ciancio, A. and K.G. Mukerji. 2008. Integrated Management of Diseases Caused by Fungi, Phytoplasma and Bacteria. Springer.
- 3- Gullino, M.L., R. Albajes and P.C. Nicot. 2020. Integrated Pest and Disease Management in Greenhouse Crops (Plant Pathology in the 21st Century, 9) 2<sup>nd</sup> ed. Springer.
- 4- Inderjit and K.G. Mukerji. 2006. Allelochemicals: Biological Control of Plant Pathogens and Diseases. Springer.
- 5- Kapoor, B.B.S. and N.K. Khatri. 2004. Management of Plant Diseases. Bikaner, Madhu Publications, India.
- 6- Koul, O. and G.S. Dhaliwal. 2001. Microbial Biopesticides. CRC Press.
- 7- Nehra, S. 2005. Plant Diseases: Biocontrol Management. Pointer Publishers, India.
- 8- Razdan, V.K. and M. Sabitha. 2009. Integrated Disease Management: Concepts and Practices. Springer, Netherland.
- 9- Sharma, R.C. and J.N. Sharma. 2016. Integrated plant disease management. Scientific Publishers.

**Basic Information:**

PP - 713 POST HARVEST PATHOLOGY

Credit Hours: 3(2-1)

- **Pre-requisites course requirements/ skills:**

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

- **Learning Outcomes:**

1. Students will learn about the seed pathological diseases and their management
2. Students will be able to learn about post-harvest diseases and their management
3. Students will learn about the latest developments in the management of seed and post-harvest diseases.

- **Contents**

**Theory**

1. Importance of post-harvest problems and economic losses
2. Damage due to biotic and abiotic factors associated with grains and perishables during harvesting, transit and storage
3. Physiological and biochemical changes in transit and storage due to diseases
4. Mycotoxicoses of grains and perishables originating from field and storage fungi
5. Effect of mycotoxins on human and animal health
6. Management of post-harvest losses
7. Use of radiation, waxing and other methods and their effect on product health and quality
8. Grain storage management and fumigation technology
9. Introduction and significance of commercial treatment including Vapor Heat Treatment (VHT) and Hot Water Treatment of perishable fruits for export to various countries
10. Certification system of grains, fruits and vegetables; study of important postharvest diseases

**Practical**

1. Visit to storages facilities and cargo centres for sampling
2. Isolation and identification of microorganisms from diseased seeds and perishables
3. Estimation and management of losses
4. Visits of VHT treatment plant and hot water treatment systems
5. Visits of grains, fruits and vegetable storage houses

- **Teaching-learning Strategies**

Classroom teaching will be done in the form of lectures with aids including white board, overhead projector and multimedia. Relevant literature and lecture notes will be provided to the students after completion of each topic. Practical will be performed in the general labs of the department. Visits to the well-equipped related national research institutes/laboratories or seed storing industries will be arranged regularly. Seminars by the field experts will be arranged for the students fortnightly.

- **Assignments- Types and Number with calendar**

One assignment for the theory and one for practical by the weightage of 25% will be given in each course.

- **Assessment and Examinations:**

Weekly assessments will be done in classroom through quizzes, tests and group discussions.

Sr. No.	Elements	Weightage	Details
1	Midterm Assessment	35%	It takes place at the mid-point of the semester.
2	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentations, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

- **Suggested Readings**

**Books**

1. Bhutani, R.C. 2003. Fruits and Vegetables Preservation. Biotech Books, India.

2. Bhutta, A.R., A. Hussain and M.R. Rehman. 2004. Handbook on Seed Processing and Storage, Federal Seed Certification and Registration Department, Islamabad. Pakistan.
3. Burg, S.P. 2004. Postharvest physiology and hypobaric storage of fresh produce. CABI Publishing.
4. Chakraverty, A., A.S. Mujundar, G.S. Raghavan and H.S. Ramaswamy. 2003. Handbook of Post harvest Technology. Marcel Dekker/NC. New York, USA.
5. Dasgupta, M.K. and N.C. Mandal. 1986. Post Harvest Pathology of Perishables. Oxford and IBH Publ. Co., New Delhi, India
6. Dennis, C. 1983. Postharvest pathology of fruits and vegetables. Academic Press, New York, USA.
7. Kader, A. A. 2002. Postharvest technology of horticultural crops. University of California.
8. Naard, N.F. and D.K. Salunkhe. 1980. Postharvest Biology and Handling of Fruits and Vegetables. The AVI Publ. Co., Inc., Connecticut, USA.
9. Palou, L., and J.L. Smilanick (Eds.). (2019). Postharvest pathology of fresh horticultural produce. CRC Press.

## **Basic Information:**

PP - 714. VECTOR TRANSMISSION OF PLANT DISEASES      Credit Hours: 3(2-1)

- **Pre-requisites course requirements/skills:**

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

- **Learning Outcomes:**

1. To study the role of biological vectors in plant disease transmission
2. To study mechanism of action of disease spread through various insects & other vectors.
3. To manage insects & vectors transmitted diseases using in direct & direct control strategies.

- **Contents**

### **Theory**

1. Insects, nematodes and fungus-like organisms as vectors of plant diseases
2. Modes of transmission of plant pathogens by vectors
3. Modes of dissemination of plant pathogens by vectors
4. Ecology and vector-plant relationship
5. Factors affecting vector transmission of plant pathogens
6. Symptomatology, etiology, epidemiology and management of major fungal, bacterial and viral plant diseases transmitted by vectors

### **Practical**

1. Identification of nematodes and fungus-like organisms as vectors of plant pathogens
2. Survey of fields and pest scouting of vectors transmitting plant diseases
3. Methods of rearing and handling insect vectors for plant pathogenic studies
4. Demonstration of modes of transmission of plant pathogens by vectors

- **Teaching-learning Strategies**

Whiteboards, overhead projectors, and other classroom teaching tools will be used to deliver lectures. Following each topic, the students will receive handouts and relevant readings. Practicals will be completed in the department's general labs. Visits to the modern national research institutes and laboratories in the field will be planned. Students will have access to seminars delivered by subject-matter experts.

- **Assignments- Types and Number with calendar**

Each course will include two assignments, one for theoretical and one for practical, each worth 25% of the course grade.

- **Assessment and Examinations:**

Quizzes, examinations, and group discussions will be used in the classroom to assess students continuously.

Sr. No.	Elements	Weightage	Details
1	Midterm Evaluation	35%	It happens in the middle of the semester.
2	Formative Evaluation	25%	It is ongoing evaluation. Participation in class, showing up, assignments and presentations, homework, attitude and behaviour, hands-on activities, quick tests, quizzes, and other similar things are all part of it.
3	Final Evaluation	40%	It happens at the conclusion of the semester. The majority of it takes the form of a test, but due to the nature of the course, the teacher may also evaluate their pupils on the basis of a term paper, the creation of a research proposal, fieldwork, report writing, etc.

- **Suggested Readings**

**Books**

1. Awasthi, L. P. (Ed.). (2020). Applied Plant Virology: Advances, Detection, and Antiviral Strategies. Elsevier Science & Technology.
2. Basu, A.N. and B.K. Giri. 1993. The Essentials of Viruses, Vectors and Plant Diseases. Wiley Eastern Ltd., New Delhi, India.
3. Butter, N. S. (2018). Insect Vectors and Plant Pathogens. Taylor & Francis Group.
4. Leach, J.G. 2007. Insect Transmission of Plant Diseases. Daya Publishing House, India.
5. Vaishali, J.P. and T.V. Satte. 2003. Insect Predator and Pest Management. Daya Publishing House, Delhi.
6. Vanemden, H.F and M. Service. 2004. Pest and Vector Control. Cambridge University Press, UK. 5. Recent books, journals, reviews, proceedings, etc.

## **Basic Information:**

PP - 715. FOREST AND SHADE TREE PATHOLOGY      Credit Hours: 3(2-1)

- **Pre-requisites course requirements/ skills:**

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

- **Learning Outcomes:**

- 1 To study forest and shade tree diseases
- 2 To acquire the ability to identify and isolate potential causal agents of economically important forest diseases.
- 3 To acquaint the students with different approaches used in plant pathogen management
- 4 To manage plant pathogens through biological approaches.

- **Contents**

### **Theory**

1. Introduction to forest and shade tree diseases
2. Importance of forest and shade tree diseases
3. Ecology of forest and shade tree diseases
4. Epidemiology of forest and shade tree diseases
5. Quantification of losses of forest and shade tree diseases
6. Forest operations in relation to the development and spread of:
  - 6.1 abiotic diseases
  - 6.2 biotic diseases
7. Studies on specific diseases of representative groups
  - 7.1 nursery plants
  - 7.2 shade trees
8. Management of important diseases

### **Practical**

1. Survey and collection of diseased specimens
2. Isolation of causal agents
3. Identification and preservation of causal agents
4. Disease management based on different methods
  - 4.1 disease management using cultural methods
  - 4.2 disease management using chemical methods
  - 4.3 disease management using biological methods

5. Study visits to national institutions working in forest and shade tree pathology

- **Teaching-learning Strategies**

Lectures will be delivered using classroom teaching aids including a whiteboard, overhead projector, and multimedia. Handouts of the related topics will be provided to the class. All the concerned practicals will be performed in the assigned labs of the department. Visits to the different national forests will be arranged. Seminars of experts in the field or the authorities in forestry will be arranged for the students.

- **Assignments- Types and Numbers with the calendar**

The students will be given one project in each course of the theory and practical of weightage 25%.

Constant assessment will be done in classroom through quizzes, tests and group discussions.

Sr. No.	Elements	Weightage	Details
1	Midterm Assessment	35%	It takes place at the mid-point of the semester.
2	Formative Assessment	25%	It is a continuous assessment. It includes classroom participation, attendance, assignments, and presentations, homework, attitude and behavior, hands-on activities, short tests, quizzes etc.
3	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on a term paper, research proposal development, fieldwork, and report writing etc.

- **Suggested Readings**



## Books

1. Bakhshi, E.K. 1976. Forest Pathology. Forest Institute, Dehradun, India.
2. Khan, A.H. 1989. Pathology of Trees. 2nd Vol. Univ. Agric. Faisalabad.
3. Manson, P.D. 1991. Tree Disease, Concepts. 2nd Edition. Prentice Hall Eaglewood Cliffs, New Jersey, USA
4. Zabel, R.A. and J.J. Morell. 1992. Wood Microbiology: Decay and its Prevention. Academic Press, San Diego, California, USA.
5. Strouts, R.G. and T.G. Winter. 1994. Diagnosis of Ill-health in Trees. H.M.S.O. Publishers, London, UK
6. Agrios, G.N. 2005. Plant Pathology, Elsevier Academic Press, New York, USA
7. Bhutta. A.R. 2010. Introductory Seed Pathology. Publisher HEC, Islamabad. 557 pp.
8. Parthasarathy, S., Thiribhuvanamala, G., Muthulakshmi, P., & Angappan, K. 2021. Diseases of Forest Trees and their Management. 1<sup>st</sup> Edition, 10.1201/9781003173861. Narendra Publishing house; CRC Press, New Dehli, India.

**Basic Information:**

PP - 716. ADVANCES IN PLANT PATHOLOGY

Credit Hours: 3(3-0)

**• Pre-requisites course requirements/ skills:**

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

**• Learning Outcomes:**

1. To familiarize with development in molecular techniques emerging in plant pathology.
2. To acquaint students with recent trends in Plant Pathology.
3. To study various molecular techniques to understand the interactions of plants and associated microbes.
4. To give understanding about changes during disease development at molecular basis.

**• Contents****Theory**

1. Recent trends and developments in different disciplines of plant pathology
2. Review of developments and future prospects of plant pathology
3. Pathogenesis and host-parasite specificity
  - 3.1. host-parasite specificity in bacteria
  - 3.2. host-parasite specificity in nematodes
  - 3.3. host-parasite specificity in fungi
  - 3.4. host-parasite specificity in viruses
4. Molecular and biological techniques for identification and epidemiological studies of plant pathogens such as survival of pathogens and tracking of isolates
5. Mechanisms of genetic variability in pathogens
6. Structure of genomes
7. Allele-specific and touch-down PCR
8. Molecular markers
9. Molecular resistance
10. Review/Special Assignment/Presentation

**• Teaching-learning Strategies**

The classroom facilities like a whiteboard, overhead projector, and multimedia will be used for delivering the lectures. Handouts and related literature will be provided to the class after covering each topic. Visits to the well-equipped related

national research institutes/laboratories will be arranged. A workshop in the field will be arranged for the students.

- **Assignments- Types and Numbers with the calendar**

Students will be assigned one assignment to cover in this course that would weigh 25%.

- **Assessment and Examinations:**

Continuous assessment will be done in the classroom through quizzes, tests, and group discussions.

Sr. No.	Elements	Weightage	Details
7.	Midterm Assessment	35%	It takes place at the mid-point of the semester.
8.	Formative Assessment	25%	It is a continuous assessment. It includes classroom participation, attendance, assignments, and presentations, homework, attitude and behavior, hands-on activities, short tests, quizzes etc.
9.	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on a term paper, research proposal development, fieldwork and report writing etc.

- **Suggested Readings**

**Books**

1. Josphert N. Kimatu. 2018. Advances in Plant Pathology. 1<sup>st</sup> edition, Publisher – IntechOpen. ISBN 978-1-78923-608-8. DOI # 10.5772/intechopen.71796.
2. J.H. Andrews, I.C. Tommerup, 1995. Advances in Plant Pathology. vol. 11. Academic Press, New York, USA.

3. L. P. Awasthi, 2015. Recent Advances in the Diagnosis and Management of Plant Diseases. 1<sup>st</sup> edition. Springer New Delhi, India. DOI <https://doi.org/10.1007/978-81-322-2571-3>.
4. Peter Scott, Richard Strange, Lise Korsten, Maria Lodovica Gullino, 2021. Plant Diseases and Food Security in the 21st Century. 1<sup>st</sup> edition, Springer Nature Switzerland AG 2021. DOI # <https://doi.org/10.1007/978-3-030-57899-2>
5. Journals, reviews, proceedings, reports in Plant Pathology.

**Basic Information:**

PP-717: MOLECULAR PLANT VIROLOGY Credit Hours: 3(2-1)

- **Pre-requisites course requirements/ skills:**

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

- **Learning Outcomes:**

1. To know and understand the fundamental principles of molecular biology of plant viruses
2. Learning of practical plant virus detection methods with different methods including immunological methods.
3. To have knowledge of basic methodologies and molecular techniques used for detection and identification of viruses and viroids in plants.
4. Knowledge and understanding to critically interpret the results of laboratory diagnostic tests.
5. Learning of diagnostic methods, symptom recognition, immunological and molecular detection methods

- **Contents**

**Theory**

1. Current concepts concerning biological, physical, serological and molecular properties of plant viruses and viroids
2. Organization of virus genome; structure and in vitro assembly of plant viruses
3. Events in plant virus infection
4. Molecular mechanisms of viral replication and pathogenesis
5. Plant virus genome as source of novel function for gene manipulation
6. Genetics of pathogen-derived resistance
7. Genetic engineering with viroids
8. Advances in virus host-cell interactions

**Practical**

1. Plant virus diagnosis
2. Study of viruses using molecular techniques
3. Virus nucleic acid isolation and analysis
4. Polymerase chain reaction for RNA and DNA virus genome
5. Production analysis and field testing of transgenic plants

- **Teaching-learning Strategies**

Classroom teaching aids including, white board, overhead projector and multimedia will be used for delivering lecture. Handouts and related literature will be provided to the class after covering each topic. Practicals will be performed in general labs of the department. Visits to well-equipped related national research institutes/laboratories will be arranged. Experts of molecular plant virology will be invited for delivering seminars for the students.

- **Assignments- Types and Number with calendar**

Students will be given one assignment for the theory and one for the practical of weightage 25% in each course.

- **Assessment and Examinations:**

Continuous formal and informal assessment will be done in classroom through quizzes, tests and group discussions.

Sr. No.	Elements	Weightage	Details
1	Midterm Assessment	35%	It takes place at the mid-point of the semester.
2	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentations, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

- **Suggested Readings**

**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. Gaur R.K., Paul Khurana S.M. and Pradeep S. 2021. Plant Virus-Host Interaction: Molecular Approaches and Viral Evolution. Thomas Hohn Academic Press.
4. Hadidi, A., R.K. Khetarpal and H. Koganezawa (Eds). 1998. PlantVirus Disease Control. American Phytopathological Society, St Paul, Minnesota, USA.
5. Hull, R. 2002. Matthews' Plant Virology. 4th Ed. Elsevier Ltd.
6. Hull, R. 2009. Comparative Plant Virology, 2nd Edition. Academic Press.
7. Loebenstein, G. and G. Thottappilly. (Eds.). 2004. Virus and Viruslike Diseases of Major Crops in Developing Countries. Springer.
8. Tepfer, M. and E. Balazs. (Eds.). 1997. Virus-Resistant Transgenic Plants: Potential Ecological Impact. Springer Verlag.

**Basic Information:**

PP - 718. Molecular Plant- Microbe Interactions

Credit Hours: 3(2-1)

- **Pre-requisites course requirements/ skills:**

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

- **Learning Outcomes:**

To study various molecular interactions of plants and associated microbes

- **Contents**

**Theory**

1. Theory of co-existence and co-evolution
2. Plant-microbe associations
3. Gradients of host- microbe interactions
4. Molecular and genomic variability
5. Pathogenesis: host recognition, signal transduction and compatibility
6. Programmed cell death
7. Hypersensitivity
8. Production of antimicrobial compounds, enzymes, toxins and hormones
9. Host and pathogen induced resistance, cross protection versus engineered resistance
10. Gene silencing
11. Hypo-virulence
12. Disease management at molecular level i.e. gene manipulation for disease resistance (horizontal), systemic and local acquired resistances
13. Clonal strategy and structural analysis of resistance genes

**Practical**

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

- **Teaching-learning Strategies**

Lectures will be delivered using classroom teaching aids including white board, and multimedia. Handouts and related literature will be provided to the class after covering each topic. Practical will be performed in the general labs of the department. Visits to the well-equipped related national research institutes/laboratories will be arranged. Seminars of the expert of the field will be arranged for the students.



- **Assignments- Types and Number with calendar**

Students will be given one assignment for the theory and one for the practical of weightage 25% in each course.

- **Assessment and Examinations:**

Continuous assessment will be done in classroom through quizzes, tests and group discussions.

Sr. No.	Elements	Weightage	Details
1	Midterm Assessment	35%	It takes place at the mid-point of the semester.
2	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentations, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

- **Suggested Readings**

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

5. Kosuge, T. and E.W. Nester. 1984. Plant-Microbe Interaction (Vol. 1 & 2).  
McMillan Publishing Co., New York, USA.
6. Mathew, J.D. 2003. Molecular Plant Pathology. Bios Scientific Publishers, Ltd.,  
UK.
7. Vander P. 1982. Host Pathogen Interactions in Plant Diseases. Academic Press,  
New York, USA.

### **Basic Information:**

PP - 719. BIOLOGICAL CONTROL OF PLANT PATHOGENS      Credit Hours: 3(2-1)

- **Pre-requisites course requirements/ skills:**

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

- **Learning Outcomes:**

1. To manage plant pathogens through biological approaches.
2. To acquire the ability to identify and isolate potential bio-control agents.
3. To equip the students with modern biological control products and their application in the field.
4. To acquaint the students with allelopathic compounds used in plant pathogen management.

- **Contents**

#### **Theory**

1. History and importance of biological control
2. Biological control and types of biological interaction
3. Factors involved in biological control
4. Different biocontrol approaches
  - 4.1 like antagonistic microorganisms
  - 4.2 allelopathy
  - 4.3 plant and pathogen-derived resistance
5. Methods for stimulation of indigenous biocontrol agents
6. Mass production
  - 6.1 Commercialization of biocontrol agents
7. Study of different biological agents
8. Mechanism of biocontrol
  - 8.1 At macro level
  - 8.2 Molecular level

#### **Practical**

1. Isolation of biocontrol agents
2. Identification of biocontrol agents
3. Purification of biocontrol agents

4. Application under laboratory and field conditions
5. Preparation of plant products and their evaluation against
  - 5.1 Fungal pathogens
  - 5.2 Bacterial pathogens and etc.
6. Demonstration of mechanisms of biocontrol

- **Teaching-learning Strategies**

Lectures will be delivered using classroom teaching aids including white board, overhead projector and multimedia. Handouts and related literature will be provided to the class after covering each topic. Practical s will be performed in the general labs of the department. Visits to the well-equipped related national research institutes/laboratories will be arranged. Seminars of the expert of the filed will be arranged for the students.

- **Assignments- Types and Number with calendar**

Students will be given one assignment for the theory and one for the practical of weightage 25% in each course.

- **Assessment and Examinations:**

Continuous assessment will be done in classroom through quizzes, tests and group discussions.

Sr. No.	Elements	Weightage	Details
1	Midterm Assessment	35%	It takes place at the mid-point of the semester.
2	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentations, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the

			course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.
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- **Suggested Readings**

**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
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; 4th revised edition. 896 pp.
6. Gnanamanickam, S.S. (Ed.). 2002. Biological Control of Crop Diseases. Marcel Dekker, New York.
7. Jogaiah, S. 2021. Biological Control Agents and Secondary Metabolites: Applications and Immunization for Plant Growth and Protection. Woodhead Publishing. Elsevier Inc.
8. Merillon, J.M. and K.G. Ramawat. 2020. Plant Defence: Biological Control. 2<sup>nd</sup> Ed. Springer.
9. Trivedi, P.C. 1998. Plant Nematode Management: A Biocontrol Approach. CBS Publishers & Distributors, New Delhi.

**Basic Information:**

PP - 720: PLANT PATHOLOGY AND INTERNATIONAL OBLIGATIONS

Credit Hours: 3(3-0)

**• Pre-requisites course requirements/ skills:**

M. Sc. (Hons) Agriculture specialization in Plant Pathology

**• Learning Outcomes:**

1. To educate the students on international obligations and agreements with special reference to Plant Pathology
2. To acquaint the students about International Trade, treaties and their relevance to Plant Pathology
3. To study the Issues and problems in import/export relating to phytosanitary aspects of agricultural commodities;

**Contents****Theory**

1. International treaties, agreements and their relevance to Plant Pathology
2. An overview of Cartagena protocol on bio-safety
3. Codex Alimentarius commission (CAC)
4. Intellectual property right (IPR)
5. International plant protection convention (IPPC)
6. Sanitary and phytosanitary measures (SPS) and their working
7. Food and agriculture organization (FAO) and its working related to World Trade Organization (WTO)
8. Issues and problems in import/export relating to phytosanitary aspects of agricultural commodities
9. Impact of major agreements on economy of Pakistan
10. Requirement of material transfer agreement (MTA) regarding movement of plant genetic materials and their testing for health status
11. Worldwide major risks of plant diseases
12. Introduction to approved ISPMs by IPPC 1997
13. Framework for Pest Risk Analysis
14. ISO certification of Plant Pathology Technical Laboratories version 17025
15. Introduction, importance and significance of alien species in international trade

16. Biosecurity and measures to encounter bioterrorism

17. Review/special assignment/presentation

- **Teaching-learning Strategies**

Lectures will be delivered using classroom teaching aids including white board, overhead projector and multimedia. Handouts and related literature will be provided to the class after covering each topic. Practicals will be performed in the general labs of the department. Visits to the well-equipped related national research institutes/laboratories will be arranged. Lectures of the expert of the field will be arranged for the students.

- **Assignments- Types and Number with calendar**

Students will be given one assignment Review/Special Assignment/Presentation for the theory of weightage 25% in each course.

- **Assessment and Examinations:**

Regular evaluation of students will be done in classroom through quizzes, tests and group discussions.

Sr. No.	Elements	Weightage	Details
1	Midterm Assessment	35%	It takes place at the mid of the semester.
2	Formative Assessment	25%	It is regular and mandatory practice to evaluate the students. It includes: class participation, attendance, assignments and presentations, homework, attitude and behavior, hands-on-Trainings, class tests, quizzes etc.
3	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but according to the nature of the course. The teacher may assess their students based on papers, research proposal, Presentations, field work and

			report writing etc.
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- **Suggested Readings**

- **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 2nd 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 3rd Ed. (4 vol. set), Rutledge UK.
7. Pierre A. David. 2021.International Logistics: the Management of International Trade Operations.6th edition. Cicero Books, LLC
8. Rangan, S. 2007. Sanitary and Phytosanitary Measures: An Introduction. University Press, India
9. United States Trade Representative .2022 National Trade Estimate Report on Foreign Trade Barriers. Office of the United States Trade Representative Ambassador Katherine C. Tai
10. Wolfrum, R., P.T. Stoll and A. Seibert-Fohr. 2007. WTO: Technical Barriers and SPS Measures. Martinus Nijhoff Publishers, the Netherlands. 564 pp.
11. WTO PUBLICATIONS CATALOGUE 2021/2022. [www.wto.org/publications](http://www.wto.org/publications). WTO Online Bookshop <https://onlinebookshop.wto.org>



**Basic Information:**

PP - 721. BIOINFORMATICS IN PLANT PATHOLOGY

Credit Hours: 3(2-1)

- **Pre-requisites course requirements/ skills:**

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

- **Learning Outcomes:**

1. To study basics of Bioinformatics
2. To study applied aspects of Bioinformatics tools in Plant Pathology

- **Contents**

**Theory**

1. Significance of bioinformatics in Plant Pathology
2. Molecular evolution and goals of molecular phylogeny
3. Properties and types of trees
4. Stages of phylogenetic analysis
5. Phylogenetic methods
6. Access to biological sequence databases
7. Basic local alignment search tool (BLAST)
8. Pair-wise and multiple sequence alignment
9. Microarray data analysis
10. Pre-processing, scatter plots and micro array plots, global and local normalization, ratios and other parameters
11. Gene, promoter and regulatory element prediction in prokaryotes and eukaryotes
12. Plant resistance genes database (PRGdb)
13. Ribosomal data bank project (RDBP)
14. Protein domains and motifs, protein sequence and structure, the protein data bank, protein structure, prediction and interaction

**Practical**

1. Demonstration of bioinformatics tools
2. Primer designing, sequence alignment, editing and molecular phylogeny of plant pathogens
3. Construction and analysis of phylogenetic trees

- **Teaching-learning Strategies**

Lectures will be delivered using classroom teaching aids including white board, and multimedia. Handouts and related literature will be provided to the class after covering each topic. Practical will be performed in the general labs of the department. Seminars of the expert of the field will be arranged for the students.

- **Assignments- Types and Number with calendar**

Students will be given one assignment for the theory and one for the practical of weightage 25% in each course.

- **Assessment and Examinations:**

Continuous assessment will be done in classroom through quizzes, tests and group discussions.

Sr. No.	Elements	Weightage	Details
1	Midterm Assessment	35%	It takes place at the mid-point of the semester.
2	Formative Assessment	25%	It is continuous assessment. It includes: classroom participation, attendance, assignments and presentations, homework, attitude and behavior, hands-on-activities, short tests, quizzes etc.
3	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.

- **Suggested Readings**

**Books**

1. Acton, Q.A. 2012. Advances in Biotechnology Research and Application: Scholarly Editions TM.
2. Balamurugan, S., Krishnan, A. T., Goyal, D., Chandrasekaran, B. 2021. Computation in BioInformatics: Multidisciplinary Applications. Wiley Backwell.

3. Datta, S., Scholtens, D., Lin, S. 2022. *Bioinformatics Methods: From Omics to Next Generation Sequencing*. Chapman and Hall/CRC.
4. David Edwards, D., J. E. Stajich and D. Hansen. 2009. *Bioinformatics: Tools and Applications*. Springer. 451 pp.
5. Edwards, D. 2007. *Plant Bioinformatics: Methods and Protocols*. Humana Press Inc., 551 pp.
6. Latest Bioinformatics Software.
7. Mount, D.W. 2004. *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor, New York. 697 pp.
8. Pevsner, J. 2010. *Bioinformatics and Functional Genomics*. Wiley Backwell.
9. Rodriguezepeleta, N., M. Hackenberg and A. M. Aransay. 2012. *Bioinformatics for High Throughput Sequencing*. Springer. 255 pp.
10. Xiong, J. 2006. *Essential Bioinformatics*. Cambridge University Press. 340 pp.

## **Basic Information:**

PP-722: PLANT PATHOLOGY AND ENVIRONMENTAL CONCERNS Credit Hours: 3(3-0)

- **Pre-requisites course requirements/ skills:**

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

- **Learning Outcomes:**

1. To learn the sustainable use of our world's natural resources through the study of plant diseases or learning about our role in conservation.
2. To acquire the knowledge of impact of pathogens on the environment.
3. To ascertain the impact of agriculture pollution on health and economy.

## **Theory**

1. Introduction to environmental complex
2. Role of anthropogenic activities in the degradation of natural resources
3. Environmental pollution caused by the use of pesticides and agricultural/industrial wastes
4. Environmental impact assessment (EIA) as instrument of environmental management
5. Global climate change and its impact on distribution of plant diseases with special emphasis on disease outbreak
6. Environmental and biosafety hazards of genetically modified organisms (GMOs) and risk assessment studies
7. Biosensors as Environmental Monitors
  - 7.1 Microorganisms as bioindicators of environmental pollution
  - 7.2 Bioremediation.
8. Review/special assignment/presentation

- **Teaching-learning Strategies**

Lectures will be delivered using classroom teaching aids including a whiteboard, overhead projector, and multimedia. Handouts and related literature will be provided to the class after covering each topic.

- **Assignments- Types and Numbers with the calendar**

Students will be given one assignment for the theory and one for the practice of weightage 25% in each course.

- **Assessment and Examinations:**

Continuous assessment will be done in the classroom through quizzes, tests and group discussions.

Sr. No.	Elements	Weightage	Details
1	Midterm Assessment	35%	It takes place at the mid-point of the semester.
2	Formative Assessment	25%	It is a continuous assessment. It includes classroom participation, attendance, assignments and presentations, homework, attitude and behavior, hands-on activities, short tests, quizzes etc.
3	Final Assessment	40%	It takes place at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, fieldwork and report writing etc.

- **Suggested Readings**

- 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. Kumar, A. and Droby, S. 2020. Food Security and Plant Disease Management. Woodhead Publishing.
5. Ralph, M. and Ji-Dong Gu. 2010. Environmental Microbiology. 2nd Ed. John Wiley & Sons, Inc., Hoboken, New Jersey.
6. Saleem, M.A and M. Ashfaq. 2004. Environmental Pollution and Agriculture. B.Z. University Press, Multan, Pakistan.

**Basic Information: PP-723: SEMINAR-I (M. Sc. (H) Thesis) Credit Hours: 1(1-0)**

- **Prerequisites:** B. Sc. (Hons) Agriculture specialization in Plant Pathology
- **Learning Outcomes:**
  1. To present research work carried out for M. Sc. (H) Thesis.
  2. To train the students to deliver their research work to audience coming from different backgrounds.
  3. To justify the outcome and application of the findings in the actual field.
- **Assessment and Examinations:**

The assessment will be done by the teacher on the basis of presentation and response to the questions from the listeners.

**Basic Information: PP-724: SPECIAL PROBLEM Credit Hours: 1(1-0)**

- **Prerequisites:** B. Sc. (Hons) Agriculture specialization in Plant Pathology
- **Learning Objectives:**
  1. To conduct a pilot study determining feasibility of certain aspects of Ph. D research.
  2. To ascertain the ability of scholar to extract information available in the literature.
  3. To get an insight of designing and conducting experimental work with specific objectives.
- **Assessment and Examinations:**

The assessment will be done by the teacher on the basis of experimentation and literature survey compiled.

**Basic Information: PP-725: 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:**
  1. To present research work carried out for MSc (H) in thesis format.
  2. To ascertain the ability of the students to deliver their research work to audience coming from different backgrounds.
  3. To justify the outcome and application of the findings in the actual field.
- **Assessment and Examinations:**

The assessment will be done by the teacher and external examiner on the basis of presentation and response to the questions from the listeners.

**Basic Information: PP-726: SEMINAR-II (Ph.D. Synopsis)** Credit Hours: 1(1-0)

- **Prerequisites:** M. Sc. (Hons) Agriculture specialization in Plant Pathology
- **Learning Objectives:**
  1. To present proposed research work for Ph.D.
  2. To justify the merits of the study.
  3. To explain the scheme of study.
- **Assessment and Examinations:**

The assessment will be done by the teacher on the basis of presentation and response to the questions from the listeners.

**Basic Information: PP-727: SEMINAR-III (Ph.D. Thesis) Credit Hours: 1(1-0)**

- **Prerequisites:** Completion of courses and research work for Ph.D.
- **Learning Objectives:**
  1. To present research work carried out for Ph.D.
  2. To justify the results obtained during the study.
- **Assessment and Examinations:**

The assessment will be done by the teacher on the basis of presentation and response to the questions from the listeners.

**Basic Information: PP-728: Research Thesis (Ph.D.) Credit Hours: 20(0-20)**

- **Prerequisites:** Completion of courses, research work and submission of PhD thesis.
- **Learning Objectives:**
  - 14.1.1.1 To present research work carried out for PhD in thesis format.
  - 14.1.1.2 To justify the outcome and application of the findings in the actual field.
  - 14.1.1.3 To determine the ability of the students to deliver their research work to audience coming from different backgrounds.
- **Assessment and Examinations:**

The assessment will be done by the teachers/external examiners on the basis of presentation and response to the questions from the listeners.