PLANT PATHOLOGY SECTION,
RCSM COLLEGE OF AGRICULTURE, KOLHAPUR
M. Sc. (Agri.) in Agricultural Microbiology
Started Year : 2009 -2010

Semester wise course layout of M.Sc. (Ag) in Microbiology

Semester No.	Course No.	Title	Credits
I	**Major Courses**		
	MICRO 502	Principles of Microbiology	3+1=4
	MICRO 503	Microbial Physiology and Metabolism	3+1=4
	MICRO 504	Microbial Genetics	2+1=3
	Minor Courses		
	BIOCHEM 501	Basic Biochemistry	3+1=4
	Supporting Courses – Nil		
	Total		**11+4=15**
	Non Compulsory Courses (NCCC)		
	PGS 501	Library and Information Services	0+1=1
	PGS 504	Basic Concepts in Laboratory Techniques	0+1=1
II	**Major Courses**		
	MICRO 505	Soil Microbiology	2+1=3
	MICRO 506	Microbial Biotechnology	2+1=3
	Minor Courses		
	BIOCHEM 505	Techniques in Biochemistry	2+2=4
	SOILS 506	Soil Biology and Biochemistry	2+1=3
	Supporting Courses		
	STAT 511	Experimental Design	2+1=3
		Total	**10+8=18**
	Non Credit Compulsory Courses (NCCC)		
	PGS 502	Technical Writing and Communication Skills	0+1=1
	PGS 503	Intellectual Property and its Management in Agriculture	1+0=1
III	**Major Courses**		
	MICRO 507	Food Microbiology	2+1=3
	Minor Courses Nil		
	Supporting Courses		
	BIOCHEM 510	Nitrogen and Sulphur Metabolism	2+1=3
		Total	**4+2=6**
	Non Credit Compulsory Courses (NCCC)		
	PGS 506	Disaster Management	1+0=1
	PGS 505	Agricultural Research Ethics and Rural Development Programmes	1+0=1
IV	**Major Courses**		
	Micro 591	Master's Seminar	1+0=1
	Micro 599	Master's Research	30
	Minor Courses Nil		
	Supporting Courses Nil		
	Total		**1+0=1**
	Grand Total		**26+12=38**

Major- 21 Minor- 11 Supporting – 06 Master's Seminar-01 Master's Research- 30

Proposed courses for M.Sc. degree programme

Major Courses	Title			Credits
MICRO-502*	Principles of Microbiology			3+1=4
MICRO-503*	Microbial physiology and metabolism			3+1=4
MICRO-504	Microbial Genetics			2+1=3
MICRO-505*	Soil Microbiology			2+1=3
MICRO-506	Microbial Biotechnology			2+1=3
MICRO-507*	Food Microbiology			2+1=3
Total Credits				**20**
Minor Courses				
BIOCHEM 501	Basic Biochemistry			3+1=4
BIOCHEM 505	Techniques in Biochemistry			2+2=4
SOILS 506	Soil Biology and Biochemistry			2+1=3
Total Credits				**11**
Supporting Courses				
BIOCHEM 510	Nitrogen And Sulphur Metabolism			2+1=3
STAT 511	Experimental Design			2+1=3
	Total Credits			**06**
Seminar				
MICRO 591	Master's Seminar			1+0=1
Total Credits				**01**
Grand Total				**38**
Master's Research				**30**
Major Credits	**Minor Credits**	**Supporting Credits**	**Seminar**	**Total Credits**
As per BSMA Credits				
20	**08**	**06**	**01**	**35**
Actually Offered Credits				
20	**11**	**06**	**01**	**38**

PG Courses

Course No.- MICRO 502 **Course Title :-** Principles of Microbiology

Credit – 3+1 **Semester -I**

Theory Syllabus

Block 1: Scope and History of Microbiology and Microscopy Unit1:
Scope of microbiology

Scope of microbiology, microbes and microbiologist. Emergence of Special Fields of Microbiology.

Unit2: History Routes

The Germ Theory of Disease, Early Studies: Pasteur's Further Contributions, Koch's Contributions, Work Toward Controlling Infections, spontaneous generation theory.

Unit3: Staining and microscopy

Microscopy; Bright field, Dark field, Phase contrast, Confocal, Fluorescence, TEM,SEM – Working Principles and applications; Properties of light; Simple staining, differential and special staining.

Block 2: Evolutionary Link of Prokaryotes Unit1:
Phylogenetic classification

Evolutionary relationship among prokaryotes. Prokaryotes and Eukaryotes, Phylogenetic and numerical taxonomy. Species concept.

Unit2: Methods of sequencing

Use of DNA and r-RNA sequencing in classifications.

Block 3: Microbial Growth, Characterization And Regulation
Unit1: Microbial growth and reproduction

Microbial growth and reproduction-communication, bacteria, yeast and virus growth, Replication, Cultivation methods, Normal micro flora of Human body; Immune response- specific and non-specific host resistance.

Unit2: Sterilization techniques

Physical and chemical methods of sterilization.

Unit3: Nutritional requirements for microbial growth

Classification of microbes: electron, energy and carbon sources.

Practicals

- Working principles and handling of different types of microscopes–Bright and Dark field microscopy
- Working principles and handling of different types of microscope-SEM and TEM
- Methods of isolation from different environments–soil, water, milk and food
- Use of selective media for isolation
- Purification techniques of bacteria and fungi
- Enumeration and Quantification techniques
- Maintenance and preservation of cultures

- Assessment of microbial quality of portable water.
- Morphological characterization of Bacteria
- Morphological characterization of fungi
- Biochemical characterization of bacteria
- Biochemical characterization of fungus

Suggested Reading

- Brock TD. 2008. *Biology of microorganisms* (Ed.) Madigan MT, Martinko JM, Dunlap PV, Clark DP, 12th ed. Pearson, New Jersey.
- Pelczar MJ.Jr., Chan, ECS and Kreig NR. 1997. *Microbiology, Concepts and Application*, 5th edition, Tata McGraw Hill, New York.
- Prescott, L.M., Harley and Klein. 2002. *Microbiology* 5th Edition, Tata McGraw Hill, New York.
- Bhatia, M.S. 2009. *Principles of Microbiology*. Swastik Publishers., Delhi.
- Madigan, M.T., J.M. Martinko, P.V. Dunlap and D.P. Clark. 2001. *Brock biology of Microorganism* 10th Ed. Pearson Education lnc, USA.
- Singh, U.S and K. Kapoor 2010. *Introductory microbiology* Oxford Book Company., Jaipur
- Tortora, G.J., B.J. Funke and C.L.Case. 2010. *Microbiology :anintroduction*. 10th Ed. Benjamin Cummings., New York
- Davis BD, Dulbecco R, Eisen HN and Ginsberg HS. 1990. *Microbiology* (4th edition).
- J.B. Lippincott company, New york.
- Alexopoulus CJ and CW. Mims. 1993. *Introductory Mycology* (3rd edition). Wiley Eastern Ltd, New Delhi.
- Elizabeth Moore-Landecker. 1996. *Fundamentals of the fungi*. (4th edition). Prentice Hall International, Inc, London.
- Heritage, J.Ev ans E.G.V. and Killington, R.A. 1996. *Introductory Microbiology*. Cambridge University Press.
- Webster J. 1993. Introduction to Fungi. (2nd edition). Cambridge University press, Cambridge.
- Prescott LM, Harley JP and Klein DA. 2006. Microbiology (7th edition) McGraw Hill, New york.
- Schaechter M and Leaderberg J. 2004. The Desken cyclopedia of Microbiology. Elseiver Academic press, California.
- Nester, E.W., Roberts, C.V. and Nester, M.T. 1995. *Microbiology: A human perspective*. IWOA, U.S.A.
- Pelczar Jr, M.J. Chan, E.C.S. and Kreig, N.R.1993. *Microbiology*, Mc.Graw Hill. Inc, New York.
- Holt J G and Bergey DH. 1994. *Bergey's Manual of Determinative Bacteriology* (9th Edition), Williams and Wilkins, Baltimore.
- Mara D. and Horan N. 2003. *The Handbook of Water and waste water Microbiology*. Academic Press-Anim print of Elsevier.
- Madigan MT, Bender KS, Buckley HD, Sattley WM, Stahl DA 2017. *Brock Biology of Microorganisms*- 15th edition. Pearson Education, USA.

Teaching schedule:

Theory

Lecture No.	Topic
1 - 5	**Scope and History of Microbiology and Microscopy** **Scope of microbiology** Scope of microbiology: microbes and microbiologist. Emergence of Special Fields of Microbiology.
6-11	**History Routes** The Germ Theory of Disease, Early Studies: Pasteur's Further Contributions, Koch's Contributions, Work Toward Controlling Infections, spontaneous generation theory.
12-18	Staining and microscopy **Microscopy; Bright field, Dark field, Phase contrast, Confocal, Fluorescence, TEM,SEM – Working** Principles and applications; Properties of light; Simple staining, differential and special staining.
19-23	**Evolutionary Link of Prokaryotes** **Phylogenetic classification** Evolutionary relationship among prokaryotes. Prokaryotes and Eukaryotes, Phylogenetic and numerical taxonomy. Species concept.
24-27	**Methods of sequencing** Use of DNA and r-RNA sequencing in classifications.
28-35	**Microbial Growth, Characterization And Regulation** **Microbial growth and reproduction** Microbial growth and reproduction-communication, bacteria, yeast and virus growth, Replication, Cultivation methods, Normal micro flora of Human body; Immune response-specific and non-specific host resistance.
36-40	**Sterilization techniques** Physical and chemical methods of sterilization.
41-46	**Nutritional requirements for microbial growth** Classification of microbes: electron, energy and carbon sources.

PRACTICAL

Practical No	Topic
1 - 2	Working principles and handling of different types of microscopes–Bright and Dark field microscopy
3 - 4	Working principles and handling of different types of microscope-SEM and TEM
5 - 6	Methods of isolation from different environments–soil, water, milk and food
7	Use of selective media for isolation
8	Purification techniques of bacteria and fungi
9	Enumeration and Quantification techniques
10	Maintenance and preservation of cultures
11	Assessment of microbial quality of portable water
12	Morphological characterization of Bacteria
13	Morphological characterization of fungi
14-15	Biochemical characterization of bacteria
15-16	Biochemical characterization of fungus

Course No.: MICRO 503

Course Title: Microbial Physiology and Metabolism

Credit: 3+1=4 **Semester:** I

Block1: Scope of Microbial Growth and Physiology

Unit1: Structure, function and biosynthesis of cellular components

Microbial nutrition– Chemical composition of microbial cell– Structure, function and assembly of cell membrane in prokaryotes, archaea and fungi– Macro and Micro-nutrients and their physiological functions – Transport of solutes across the membrane

Block 2: Pathways and their Significance; Growth Kinetics and Nutritional Classifications

Unit 1: Growth Kinetics, cell cycle, cell division, pathways and fermentation metabolism Microbial growth. Cell cycle and cell division. Bioenergetics-carbohydrate utilization via EMP, HMP, ED, TC Apathways, Aerobic and anaerobic respiration. Fermentative metabolism. Assimilation of nitrogen and sulphur - Oxygenic and anoxygenic photosynthesis-Mechanisms of carbon-dioxide fixation in prokaryotes. Ethanol, lactic acid, butanol, acetone and mixed acid fermentation. Fermentation of nitrogenous organic compounds Regulation of microbial metabolism.

Unit2: Growth and factors affecting growth and culture systems

Effects of physical, chemical and other environmental factors on growth Continuous culture, Diauxic growth and Synchronous culture. Method of growth measurement. Morphogenesis and cellular differentiation.

Unit3: Nutritional classification and spore formation and germination Metabolic diversity in photoautotrophs, photoheterotrophs, chemoautotrophs and chemoheterotrophs. Nutritional grouping/classification of microorganisms. Bacterial endospore-types, morphology, biochemistry and regulation of formation and germination

Block3: Enzymes and Microbial Metabolisms
Unit1: Kinetics and Mechanism of Enzymes

Enzyme kinetics: Michaelis Menten kinetics- mechanisms of inhibition of enzyme activity-coenzymes and prosthetic groups.

Unit2: Microbial metabolism

Methods to determine free energy of biochemical reactions - high energy compounds. Microbial metabolism: generation of ATP, reducing power, development of proton gradient and biosynthesis of ATP.

Block4: Synthesis of Macromolecules Unit1:
Biosynthesis of macromolecules

Biosynthesis of macromolecules –Synthesis and assembly of cell wall components –Methods of studying biosynthesis- regulation of microbial metabolism.

Suggested Reading

- Moat, A.G. and J.W. Foster. 2002. *Microbial Physiology*. John Wiley & Sons, New York, USA. 11th ed. Prentice- Hall, Inc. Englewood Cliffs, New Jersey.

- Madigan, M.T, J.M. Martinko and J.Parker. 2006. *Brock: Biology of Microorganisms*, 11th ed. Prentice-Hall, Inc. Englewood Cliffs, NewJersey.
- White, D.2007. *The Physiology and Biochemistry of Prokaryotes*, 3rd Edition. Oxford
- University Press.
- Downs, D.M.2006. *Understanding microbial metabolism*. Annual Review of Microbiology 60, 533–559.
- Hosler*etal*. 2006. *Energy Transduction: Proton Transfer Through the Respiratory Complexes*.
- Annual Review of Biochemistry 75, 165-187.
- Okuno *et al.* 2008. *Correlation between the conformational states of F1-ATPaseasde termined from its crystal structure and single- molecule rotation*. PNAS105 (52): 20722-20727.
- Itohetal (2004) Mechanically driven ATP synthesis by F1-ATPase. Nature427, 465-468.
- Doelle HW.1969. *Bacterial Metabolism*. Academic Press.
- Gottschalk G.1979. *Bacterial Metabolism.* Springer Verlag.
- NelsonDLandCoxMM.2017.*Lehninger,Principles of Biochemistry,* 4th Edition, W.H. Freeman & Company, 2004.(T1)
- Voet D and Voet JG. 2002. *Fundamentals of Biochemistry*, Upgrade Edition, Wiley.

Practicals

- Use of simple techniques in laboratory (Colorimetry, Centrifugation, electrophoresis and GLC, etc.).
- Determination of viable and total number of cells.
- Measurement of cellsize.
- Gross cellular composition of microbial cell. Growth– Factors affecting growth.
- Study of bacterial spores and factors affecting germination.
- Enzyme activity and kinetics– calculating Km and V_{max} of enzyme.
- Demonstration of thermos-, meso-, and psychrophilic micro-organisms.
- Production and testing of inducible enzymes in bacteria.
- Sporulation and spore germination in bacteria.
- Protoplasts formation and regeneration.
- Estimation of generation time and specific growth rate for bacteria and yeast.
- Diauxic growth curve.
- Production of synchronous cells.
- Effect of chemicals and environmental factors on bacterial growth.
- Isolation and Identification of reserve foodmaterial (Glycogen/polyphosphates, PHB) from bacteria (*Azotobacter*,*Bacillusmegaterium*).
- Growth of microorganisms on various carbon and nitrogen sources.

TEACHING SCHEDULE THEORY

Lecture No.	Topic
1-7	**Scope of Microbial Growth and Physiology** **Structure, function and biosynthesis of cellular components** Microbial nutrition– Chemical composition of microbial cell– Structure, function and assembly of cell membrane in prokaryotes, archaea and fungi– Macro and Micro- nutrients and their physiological functions – Transport of solutes across the membrane.
8-14.	**Pathways and their Significance; Growth Kinetics and Nutritional Classifications** **Growth Kinetics, cell cycle, cell division, pathways and fermentation metabolism** Microbial growth. Cell cycle and cell division. Bioenergetics- carbohydrate utilization via EMP, HMP, ED, TCA pathways
15-18	Aerobic and anaerobic respiration. Fermentative metabolism. Assimilation of nitrogen and sulphur - Oxygenic and anoxygenic photosynthesis-Mechanisms of carbon-dioxide fixation in prokaryotes.
19-22	Ethanol, lactic acid, butanol, acetone and mixed acid fermentation. Fermentation of nitrogenous organic compounds Regulation of microbial metabolism.
23-27	**Growth and factors affecting growth and culture systems** Effects of physical, chemical and other environmental factors on growth Continuous culture, Diauxic growth and Synchronous culture. Method of growth measurement. Morphogenesis and cellular differentiation.
28-34	**Nutritional classification spore formation and germination** Metabolic diversity in photoautotrophs, photoheterotrophs, chemoautotrophs and chemoheterotrophs. Nutritional grouping/classification of microorganisms. Bacterial endospore-types, morphology, biochemistry and regulation of formation and germination
35-39	**Enzymes and Microbial Metabolisms** **Kinetics and Mechanism of Enzymes** Enzyme kinetics: Michaelis Menten kinetics- mechanisms of inhibition of enzyme activity- coenzymes and prosthetic groups
40-42	**Microbial metabolism** Methods to determine free energy of biochemical reactions - high energy compounds. Microbial metabolism: generation of ATP, reducing power, development of proton gradient and biosynthesis of ATP.
43-48	**Synthesis of Macromolecules** **Biosynthesis of macromolecules** Biosynthesis of macromolecules –Synthesis and assembly of cell wall components –Methods of studying biosynthesis- regulation of microbial metabolism

Course No.- MICRO 504 **Course Title –** Microbial Genetics

Credit – 2+1=3 **Semester -** I

Theory Syllabus

Block1: Introduction to Microbial Genetics

Unit1: Historical perspectives of microbial genetics

Introduction to Microbial genetics; Historically important events and major contributions of scientists in the field of Microbial genetics; Terminologies employed in microbial genetics and definitions; Nucleic acid–overview DNA, RNA.

Unit2: Genome of prokaryote, eukaryote (fungi) and virus

Bacterial genome Eukaryotic genome; Viral genome; Difference between prokaryotic and eukaryotic genome; Mechanisms and role of prokaryotic genome-an overview.

Unit3: Genetic elements- chemical structure and property, enzymes associated and replication

Structure of DNA–A form, B form, Z form; RNA- tRNA, mRNA, rRNA; Role and Replication of DNA and RNA; Enzymes involved in Replication and its role.

Unit 4: Extra-chromosomal DNA in bacteria and eukaryotic cells

Plasmids, Mitochondrial DNA, Chloroplast DNA–structure and function.

Block 2: Gene Expression and Regulation

Unit1: Introduction to gene structure and expression

Gene structure and expression, principles of operon, gene expression in prokaryote and eukaryotes, intron and exons, post transcriptional modifications.

Unit2: Regulation of gene expression

Regulation of gene expression, negative expression (lac operon and trp operon), positive regulation (cAMP).

Block3: Mutation, Genetic Recombination and Sequencing

Unit1: Principles of mutation and types

Principles of mutation, spontaneous and Induced mutation, different types of mutations, selection principles of mutants.

Unit2: Mutagens and their mode of action

Mutagens and their mode of action, transposable elements and insertion sequences.

Unit3: DNA damage-DNA repair mechanisms

DNA damage, DNA repair mechanisms in bacteria.

Unit4: Genetic recombination in bacteria

Genetic recombination in bacteria, mechanisms of recombination, transformation, conjugation, transduction.

Unit 5: Gene sequencing

Gene cloning and gene sequencing. Impact of gene cloning, polymerase chain reaction, DNA sequencing, recombinant DNA technology.

Suggested Reading

Brown TA. 2001. Gene Cloning and DNA Analysis: An Introduction. Fourth Edition. Black well Science Inc., Oxford, UK.
Levin B. 2002. Gene VIII. Oxford Univ. Press, New York. p.990.

Maloy SR, Cronan JE, Freifelder D. 2008. Microbial Genetics-second edition. Narosa Publising house, New Delhi. p.525.
Omoto CK and Lurquin PF.2004. Genes and DNA: abeginner's guidetogeneticsandits applications. Colambia University Press, USA.
Sambrook J, Fritsch EF,ManiatisT.2000.Molecular Cloning:A laboratory Manuel. Third Edition.Cold Spring Harbor Press, NewYork.
Streips UN,Yasbin RE. 2006. Modern Microbial Genetics.Wiley–Liss. John Wiley & sons,Inc. Publication, NY.
Birge EA.1981.Bacterial and Bacteriophage Genetics. Springer Verlag.
Gardner JE, Simmons MJ and Snustad DP.1991.Principles of Genetics. John Wiley & Sons. Lewin B.1999.Gene.Vols.VI-IX.JohnWiley & Sons.
Maloy SR,Cronan JE and Friedfelder D.2008.Microbial Genetics.Narosa.
ScaifeJ, Leach Dand Galizzi A 1985. Genetics of Bacteria. Academic Press.William Hayes1981. Genetics of Bacteria. Academic Press.
Strips UN, Yasbin RE*2006.Modern Microbial Genetics.Wiley-Liss,NY.

Practical Syllabus

- Isolation of genomic DNA from pure cultures of bacteria and fungi.
- Visualization of mega plasmids of bacteria.
- Isolation of bacterial plasmids and Plasmid curring.
- Qualitative and quantitative assay of DNA by spectrometry and gel- electrophoresis.
- Inducing mutation by chemicals, physical and biological agents.
- Transformation and selection of transformants.
- Amplification of gene of interest by PCR– cloning and expression.
- Isolation of metagenomic DNA from environmental samples.

Teaching schedule Theory

Lecture No.	Topics
1-2	**Introduction to Microbial Genetics** **Historical perspectives of microbial genetics** Introduction to Microbial genetics; Historically important events and major contributions of scientists in the field of Microbial genetics;
3-4	Terminologies employed in microbial genetics and definitions; Nucleic acid– overview DNA, RNA.
5-6	**Genome of prokaryote, eukaryote (fungi) and virus** Bacterial genome Eukaryotic genome; Viral genome;
7-8	Difference between prokaryotic and eukaryotic genome; Mechanisms and role of prokaryotic genome-an overview.

9-11	**Genetic elements- chemical structure and property, enzymes associated and replication** Structure of DNA–A form, B form, Z form; RNA- tRNA, mRNA, rRNA; Role and Replication of DNA and RNA; Enzymes involved in Replication and its role.
12-13	**Extra-chromosomal DNA in bacteria and eukaryotic cells** Plasmids, Mitochondrial DNA, Chloroplast DNA–structure and function.
14-16	**Gene Expression and Regulation Introduction to gene structure and expression** Gene structure and expression, principles of operon, gene expression in and eukaryotes, intron and exons, post transcriptional modifications.
17-18	**Regulation of gene expression** Regulation of gene expression, negative expression (lac operon and trp operon), positive regulation (cAMP).
19-21	**Mutation, Genetic Recombination and Sequencing Principles of mutation and types** Principles of mutation, spontaneous and Induced mutation, different types of mutations, selection principles of mutants
22-23	**Mutagens and their mode of action** Mutagens and their mode of action, transposable elements and insertion sequences.
24-26	**DNA damage-DNA repair mechanisms** DNA damage, DNA repair mechanisms in bacteria
27-29	**Genetic recombination in bacteria** Genetic recombination in bacteria, mechanisms of recombination, transformation, conjugation, transduction.
30-32	**Gene sequencing** Gene cloning and gene sequencing. Impact of gene cloning, polymerase chain reaction, DNA sequencing, recombinant DNA technology.

Practical

Practical No.	Topics
1 - 2	Isolation of genomic DNA from pure cultures of bacteria and fungi.
3- 4	Visualization of mega plasmids of bacteria.
5 - 6	Isolation of bacterial plasmids and Plasmid curing.
7 - 8	Qualitative and quantitative assay of DNA by spectrometry and gel-electrophoresis.
9 - 10	Inducing mutation by chemicals, physical and biological agents
11 - 12	Transformation and selection of transformants
13 -14	Amplification of gene of interest by PCR– cloning and expression
15-16	Isolation of metagenomic DNA from environmental samples

Course No.: MICRO 505 **Course Title:** Soil Microbiology **Credit:** 2+1=3 **Semester –** II

Theory Syllabus

Block 1: Developments in Soil Microbiology and Soil Parameters

Unit 1: Historical prospective of soil microbiology. Factors affecting soil microflora.
Landmarks in the history of soil microbiology. Abiotic factors (physical and chemical) affecting soil microflora as pH, chemicals, moisture, air, temperature etc.

Unit 2: Ecology of soil microbiology

Soil biota, Soil microbial ecology, types of organisms in different soils; Soil microbial biomass; Microbial interactions: unculturable soil biota.

Block 2: Microbiology and Biochemistry of Plant Parts Unit 1: Plant parts and soil interface interaction

Microbiology and biochemistry of root-soil interface; phyllosphere, plant growth promoting rhizobacteria, soil enzyme activities and their importance.

Block 3: Role of Microorganisms in Nutrient Biocycle Unit 1: Microbial transformation of various nutrients

Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil. Siderophores and antimicrobials.

Unit 2: Microbial degradation of organic matter

Biochemical composition and biodegradation of soil organic matter and crop residues.

Unit 3: Microbial diversity

Endophytic microorganisms Mycorrhizae, types and role in phosphate mobilization. Potassium releasing bacterium. Microbes in biotic and abiotic stress management.

Unit 4: Role of microorganisms in biodegradation of xenobiotics and pesticides
Biodegradation of pesticides, Organic wastes and their use for production of biogas and manures: Biotic factors in soil development.

IV Practical Syllabus

- Determination of soil microbial population Basic Sciences: Microbiology
- Determination of Soil microbial biomass
- Decomposition studies in soil, Soil enzymes
- Measurement of important soil microbial processes such as ammonification, nitrification
- N2 fixation, S oxidation, P solubilization and mineralization of other micro nutrients
- Study of rhizosphere effect
- Microbial diversity Endophytic microorganisms
- Mycorrhizae, types and role in phosphate mobilization Potassium releasing bacterium
- Microbes in biotic and abiotic stress management

Suggested Reading

- Paul EA. 2015. *Soil Microbiology, Ecology and Biochemistry*. Elsevier
- Jan Dirk Van Elsas, Trevors JT and Elizabeth M.H. Wellington, 1997. *Modern Soil Microbiology*.

Marcel Dekker, Inc.
• Paul EA. 2007. *Soil Microbiology and Biochemistry* 3rd Edition. Academic Press.
• Cardon ZG and Whitbeck JL. 2007. *The Rhizosphere An Ecological Perspective*. Academic Press.
• Schulz BJE, Boyle CJC and Sieber TN (Edrs). 2006. *Microbial Root Endophytes*. Pub Springer.
• Magesin R and Schinner F. (Edrs). 2005. *Manual of soil analysis monitoring and assessing soil Bioremediation*. Pub: Springer.
• Pinton R, Varanini Z and Nannipiers P. The Rhizosphere Biochemistry & organic substances at the soil-plant interface. Pub: CRC Press.
• Prasad TV. 2011. *A Text Book of Soil Microbiology.* Dominant Publishers & Distributors, New Delhi.
• Mukerji KG, Manoharachary C and Singh J. 2006. *Microbial activity n the Rhizosphere.* Pub: Springer.

Teaching Schedule

Theory

Lecture No.	Topic
1-4	**Developments in Soil Microbiology and Soil Parameters** **Historical prospective of soil microbiology. Factors affecting soil microflora.** Landmarks in the history of soil microbiology. Abiotic factors (physical and chemical) affecting soil microflora as pH, chemicals, moisture, air, temperature etc.
5-9	**Ecology of soil microbiology** Soil biota, Soil microbial ecology, types of organisms in different soils; Soil microbial biomass; Microbial interactions: unculturable soil biota.
10-13	**Microbiology and Biochemistry of Plant Parts Plant parts and soil interface interaction** Microbiology and biochemistry of root-soil interface; phyllosphere, plant growth promoting rhizobacteria, soil enzyme activities and their importance.
14-18	**Role of Microorganisms in Nutrient Biocycle** **Microbial transformation of various nutrients** Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil. Siderophores and antimicrobials.
19-22	**Microbial degradation of organic matter** Biochemical composition and biodegradation of soil organic matter and crop residues.
23-28	**Microbial diversity** Endophytic microorganisms, Mycorrhizae, types and role in phosphate mobilization. Potassium releasing bacterium. Microbes in biotic and abiotic stress management.
29-32	**Role of microorganisms in biodegradation of xenobiotics and pesticides** Biodegradation of pesticides, Organic wastes and their use for production of biogas and manures: Biotic factors in soil development

Course No. - MICRO 506

Course Title – Microbial Biotechnology

Credit – 2+1=3

Theory Syllabus

Block 1: Scope of Microbial Technology and Fermentation Metabolism Unit1: Microbial Biotechnology:

Introduction, Scopes, historical development, application and challenges.

Unit 2: Fermentation Metabolism

Fermentative metabolism, isolation, preservation screening and genetic improvement of industrially important microbes; Microbial growth kinetics.

Unit 3: Fermenter/bioreactor design and operation

Fermenters – types of fermenter, stirred tank reactor, bubble column reactor, airlift reactor, packed bed reactor, fluidized bed reactor and trickle bed reactor, agitation and aeration in a reactor, mass transfer. Foam formation and control.

Unit 4: Fermentation system

Types, Batch, Fed batch and continuous fermentation- multistage system. Solid state fermentation, Overproduction of primary and secondary metabolites e.g. amino acids, organic acids, alcohols, enzymes, organic solvents, antibiotics, etc. Immobilization of enzymes; and cells; Scale-up principles; Down-stream processing, etc.

Block 2: Recombinant Products
Unit 1: Production of recombinant

Current advances in production of antibiotics, vaccines, and biocides; Steroid Basic Sciences: Microbiology transformation; Bioprocess engineering; Production of recombinant DNA products, Immobilization techniques.

Block 3: Microbial Conversion and their Product Formation
Unit 1: Industrial production of beverages, acid and solvent

Production of alcohol (ethanol, wine and beer) and improvement by genetic engineering. Microbial production of acids (citric, acetic and gluconic acid) solvents (glycerol acetone and butanol) aminoacids (lysine and glutamic acid).

Unit 2: New tools and recent advances in microbial biotechnology

Concept of probiotics and applications of new tools of biotechnology for quality feed/food production; Microorganisms and proteins used in probiotics; Lactic acid bacteria as live vaccines; Bioconversion of substrates, anti-nutritional factors present in feeds; Microbial detoxification of aflatoxins; Microbial polysaccharides: fermentative production of xanthan gums. Bacterial bioplastics, genetic engineering of microorganisms for the production of poly- 3 hydroxyalkanoates. Single cell protein, Bio-insecticides; Bio-fertilizers; Waste as source of energy/food Microbiologically produced food, colours, and flavours. Retting offlax. Recent advances in microbial biotechnology

Practical Syllabus

- Isolation and maintenance of industrially important microbes
- Production of alcohol
- Production of beer
- Production of citric acid
- Production of lactic acid
- Standardization of physical factors for the higher production of citric acid
- Production and assay of antibiotics
- Production of pullulan
- SCP production
- Study of bioreactors and their operation

Suggested Reading

- Cruger W and Cruger A. 2004. *Biotechnology - A Textbook of Industrial*
- *Microbiology*. 2nd Ed. Panima.
- Ward OP. 1989. *Fermentation Biotechnology*. Prentice Hall.
- Wiseman A. 1983. *Principles of Biotechnology.* Chapman & Hall
- Restructured and Revised Syllabi of Post-graduate Programmes Vol. 2
- Peppler HJ and Perlman D.1979. *Microbial Technology*. 2nd Ed. Academic Pre

Teaching Schedule Theory

Lecture No.	Topic
1-2	**Scope of Microbial Technology and Fermentation Metabolism Microbial Biotechnology:** Introduction, Scopes, historical development, application and challenges.
3-5	**Fermentation Metabolism** Fermentative metabolism, isolation, preservation screening and genetic improvement of industrially important microbes; Microbial growth kinetics.
6-10	**Fermenter/bioreactor design and operation** Fermenters – types of fermenter, stirred tank reactor, bubble column reactor, airlift reactor, packed bed reactor, fluidized bed reactor and trickle bed reactor, agitation and aeration in a reactor, mass transfer. Foam formation and control.
11-15	**Fermentation system** Types, Batch, Fed batch and continuous fermentation- multistage system. Solid state fermentation, Overproduction of primary and secondary metabolites e.g. amino acids, organic acids, alcohols, enzymes, organic solvents, antibiotics, etc. Immobilization of enzymes; and cells; Scale-up principles; Down-stream processing, etc.

16-18	**Recombinant Products** **Production of recombinant** Current advances in production of antibiotics, vaccines, and biocides; Steroid transformation; Bioprocess engineering; Production of recombinant DNA products, Immobilization techniques.
19-23	**Microbial Conversion and their Product Formation** **Industrial production of beverages, acid and solvent** Production of alcohol (ethanol, wine and beer) and improvement by genetic engineering. Microbial production of acids (citric, acetic and gluconic acid) solvents (glycerol acetone and butanol) amino acids (lysine and glutamic acid).
24-27	**New tools and recent advances in microbial biotechnology** Concept of probiotics and applications of new tools of biotechnology for quality feed/food production; Microorganisms and proteins used in probiotics; Lactic acid bacteria as live vaccines; Bioconversion of substrates, anti-nutritional factors present in feeds; Microbial detoxification of aflatoxins;
28-32	Microbial polysaccharides: fermentative production of xanthan gums. Bacterial bioplastics, genetic engineering of microorganisms for the production of poly-3 hydroxyalkanoates. Single cell protein, Bio-insecticides; Bio-fertilizers; Waste as source of energy/food Microbiologically produced food, colours, and flavours. Retting offlax. Recent advances in microbial biotechnology

Practical

Practical No.	Topic
1	Isolation and maintenance of industrially important microbes
2	Production of alcohol
3	Production of beer
4	Production of citric acid
5	Production of lactic acid
6	Standardization of physical factors for the higher production of citric acid
7	Production and assay of antibiotics
8	Production of pullulan
9	SCP production
10	Study of bioreactors and their operation

Course No.: MICRO 507 **Course Title:** Food Microbiology **Credit:** 2+1 **Semester –** III

Theory Syllabus

Block 1: Historical Perspective and Scope of Microbiology in Relation to Food Unit 1: Importance and significance of microorganisms in food

Introduction and scope; Food Microbiology Important microorganisms in food and their sources. Importance and significance of microorganisms in food.

Unit 2: Factors of special significance in Food Microbiology

Intrinsic and extrinsic factors influencing microbial growth in foods; Spores and their significance; Indicator organisms and Microbiological criteria.

Unit 3: Microbial spoilage of different types of foods

Microbial spoilage of meat, milk, fruits, vegetables and their products. Food-borne pathogens (bacteria, fungi and viruses) and intoxication.

Block 2: Fermentation and Food Preservation Methods Unit 1: Food fermentation

Fermented dairy, vegetable, meat products.

Unit 2: Preservatives and preservation methods

Physical methods, chemical preservatives and natural antimicrobial compounds. Biologically based preservation systems. Foods for Specified Health Probiotic bacteria; Bifidus factor. Bacteriocins and their applications; Pre-, probiotics and symbiotics. Microbes as food single cell protein.

Block 3: Food Safety and Quality Management Systems

Unit 1: Advanced techniques in detecting food-borne pathogens and toxins

Food safety and Quality Management Systems- General principles of food safety risk management, Recent concerns on food safety- Safe food alternatives (Organic foods), Good agricultural Practices (GAP), Food Indicators of water and food safety and quality Advanced techniques in detecting food-borne pathogens and toxins. HACCP (Hurdle technology and Hazard analysis. Critical control point) CODEX,

FSSAI (Food Safety and Standard Authority of India) systems in controlling microbiological hazards in foods. Food safety regulations

Practical Syllabus

- Statutory, recommended and supplementary tests for microbiological analysis of various foods
- Infant foods, canned foods, milk and dairy products, eggs, meat, vegetables, fruits, cereals, surfaces, containers, normal, spoiled, processed, fermented food and water
- Testing of antimicrobial agents
- Analysis of water
- HACCP Plan
- Visit to Food processing Industries

Suggested Reading

• Bibek Ray. 1996. *Fundamentals of Food Microbiology*. CRC Press.
• Frazier W.C. and Westhoff D.C. 1991. *Food Microbiology*. 3rd Ed. Tata McGraw Hill.
• George J Banwart. 1989. Basic Food Microbiology. AVI. James M Jay. 1987. Modern Food Microbiology. CBS.
Restructured and Revised Syllabi of Post-graduate Programmes Vol. 2
• Peppler H.J. and Perlman D. 1979. *Microbial Technology*. 2nd Ed. Academic Press.
• Adams, M.R., and M. O. Moss 1996. *Food Microbiology*, New Age International (Rt) Ltd., New Delhi.
• Frazier, W.C. and D.C. Westhoff, 1988. *Food Microbiology* (Reprint 1995), Tata McGraw Hill Publishing Ltd., New Delhi.
• James M. Jay., Loessner, M.J. and Golden D.A. 2005. *Modern Food Microbiology*, Seventh edition.
• Verma, L.K. and Joshi, V.K. 2000. *Post Harvest Technology of Fruits and Vegetables*, Tata McGraw Hill Publication.
• Bhunia AK. 2008. *Foodborne Microbial Pathogens- Mechanisms and Pathogenesis, Food Science text Series*, Springer International, New York, USA.
• Benwart, G.J. 1987. *Basic Food Microbiology*, CBS Publishers & Distributors, New Delhi.
• Deak, T. and Beuchat LR. 1996. *Hand Book of Food Spoilage Yeasts*, CRC Press, New York.
• Doyle, M.P. and Beuchat, L. R. 2007. *Food Microbiology- Fundamentals and Frontiers*, ASM Press.
• Garbutt, J., 1997. *Essentials of Food Microbiology*, Armold – International Students edition, London.
• Marriott, N.G. and Gravani R. B. 2006. *Principles of Food Sanitation, Food Science textSeries*, Springer International, New York, USA.

Teaching schedule Theory

Lecture No.	Topic
1-3	**Historical Perspective and Scope of Microbiology in Relation to Food Importance and significance of microorganisms in food** Introduction and scope; Food Microbiology Important microorganisms in food and their sources. Importance and significance of microorganisms in food.
4-6	**Factors of special significance in Food Microbiology** Intrinsic and extrinsic factors influencing microbial growth in foods; Spores and their significance; Indicator organisms and Microbiological criteria.
7-9	**Microbial spoilage of different types of foods** Microbial spoilage of meat, milk, fruits, vegetables and their products. Food-borne pathogens (bacteria, fungi and viruses) and intoxication.
10-11	**Fermentation and Food Preservation Methods Food fermentation** Fermented dairy, vegetable, meat products.
12-17	**Preservatives and preservation methods** Physical methods, chemical preservatives and natural antimicrobial compounds. Biologically based preservation systems. Foods for Specified Health Probiotic bacteria; Bifidus factor. Bacteriocins and their applications; Pre-, probiotics and symbiotics. Microbes as food single cell protein.

18-25	**Food Safety and Quality Management Systems** **Advanced techniques in detecting food-borne pathogens and toxins** Food safety and Quality Management Systems- General principles of food safety risk management, Recent concerns on food safety- Safe food alternatives (Organic foods), Good agricultural Practices (GAP), Food Indicators of water and food safety and quality Advanced techniques in detecting food-borne pathogens and toxins.
26-32	HACCP (Hurdle technology and Hazard analysis. Critical control point) CODEX, FSSAI (Food Safety and Standard Authority of India) systems in controlling microbiological hazards infoods. Food safety regulations

Practical

Practical No.	Topic
1	Statutory, recommended and supplementary tests for microbiological analysis of various foods
2	Infant foods, canned foods, milk and dairy products, eggs, meat, vegetables, fruits, cereals, surfaces, containers, normal, spoiled, processed, fermented food and water
3	Testing of antimicrobial agents
4	Analysis of water
5	HACCP Plan
6	Visit to Food processing Industries

B.Sc.(Hons.) Agriculture Courses of Plant Pathology

Sr. No.	Semester	Course No.	Credits	Course Title
1	I	MIBO -111	2(1+1)	Introductory Microbiology
2	II	PATH -121	3(2+1)	Fundamentals of Plant Pathology
3	III	PATH -232	2(1+1)	Principles of Integrated Disease Management
4	IV	ELE PATH -243	3(2+1)	Biofertilizers, biocontrol agents and biopesticides
5	V	PATH -354	3(2+1)	Diseases of Field and Horticultural Crops and their Management – I
6	VI	PATH -365	3(2+1)	Diseases of Field and Horticultural Crops and their Management-II
7	VIII	ELM PATH-486	10(0+10)	Mushroom Cultivation Technologies

Course : MIBO 111 **Credit:** 2(1+1) **Semester-I**
Course title: Introductory Microbiology

Syllabus

Theory

Introduction to Microbial world: History of Agril. Microbiology, Prokaryotic and eukaryotic microbes. Bacteria: cell structure, chemoautotrophy, photo autotrophy, growth. Bacterial nutrition: classification of nutrients Macroelements, Microelements, growth factors, culture media, nutritional classification of microorganisms Bacterial genetics: Genetic recombination- transformation, conjugation and transduction, plasmids, transposon.

Role of microbes in soil fertility and crop production: Carbon, Nitrogen, Phosphorus and Sulphur cycles. Biological nitrogen fixation- symbiotic, associative and asymbiotic. Azolla, blue green algae and mycorrhiza. Rhizosphere and phyllosphere. Microbes in human welfare: silage production, biofertilizers, biopesticides, biofuel production and biodegradation of agro-waste. **Mushrooms- edible and poisonous types, nutritive values, Culturing and production techniques.**

Practical

Introduction to microbiology laboratory and its equipments; Microscope- parts, principles of microscopy, resolving power and numerical aperture. Methods of sterilization. Nutritional media and their preparations. Enumeration of microbial population in soil- bacteria, fungi, actinomycetes. Methods of isolation and purification of microbial cultures. Isolation of *Rhizobium* from legume root nodule. Isolation of *Azotobacter* from soil. Isolation of *Azospirillum* from roots. Isolation of BGA. Staining and microscopic examination of microbes. Simple Staining, Negative staining and Gram Staining. Isolation of P and silicon Solubilizing Microbes, Mycorrhiza, Isolation of cellulose and Pectin degrading microbes for agro waste management

Teaching Schedule (Theory)

Lecture	Topic	Weightages (%)
1	Microbiology: Introduction, scope in agriculture and allied fields.	5
2	History of Agricultural Microbiology, development of Microbiology. Development of Microscope	5
3	Microbial World: Prokaryotic and eukaryotic microorganisms.	6
4	Bacteria: cell structure, morphology, cytology and other characters, functions of external and internal parts.	6
5	Bacteria: Nutrients required for growth of bacteria, chemoautotrophy, photo autotrophy, Microbial growth	6
6	Bacterial genetics: Genetic recombination- Gene transfer by transformation, conjugation and transduction, Plasmids,	8
7	Role of microbes in soil fertility and crop production. Microbial transformation of Nitrogen, Biological nitrogen fixation-symbiotic, asymbiotic and associative , Azolla, blue green algae.	8
8	Microbial transformation of phosphorus, sulphur and carbon, decomposition of organic matter	11
9	Mycorrhiza: structure, types, merits, demerits	5
10	Rhizosphere and Phylloshere: Rhizosphere concept, microbes of Rhizosphere, Phylloshere: Phylospheric microflora	6
11	Silage production, single cell protein, Bio-fuel production-concept	8
12	Biofertilizers: definition, types of biofertilizers,	6
13	Bio-pesticides-Microbial insecticides	4
14	Biodegradation of agro-waste	5
15	Mushrooms- edible and poisonous, culturing and production	6

16	Microbes in human welfare:	5
	Total	**100**

Teaching Schedule (Practical)

Experiment	Topic
1	Acquaintance with microscope and other lab equipments
2	Methods of sterilization
3	Nutritional media and their preparations.
4	Enumeration of microbial population in soil- bacteria, fungi, actinomycetes.
5	Methods of isolation and purification of microbial cultures.
6	Isolation of *Rhizobium* from legume root nodule.
7	Isolation of *Azotobacter* from soil.
8	Isolation of *Azospirillum* from roots.
9	Isolation of BGA
10	Simple staining of bacteria
11	Gram staining of bacteria
12	Isolation of P and silicon Solubilizing Microbes
13	Isolation of Potash solubilisingMicrobes
14	Isolation of Mycorrhiza
15	Isolation of cellulolytic microbes for agro waste management
16	Isolation of Pectin degrading microbes for agro waste management

Suggested Readings

1. M T Madigan, and J M Martinko, 2014. *Biology of Microorganisms* 14thEdn.
2. Pearson.M J Pelczer, 1998. *Microbiology* 5thEdn. Tata McGrow Hill Education Pvt. Ltd.
3. Strainer, R, 1987. *General Microbiology*. Palgrave Macmillan.EdwardAlchano, 2002. *Introduction to Microbiology*.Jones and Bartlett hearing.
4. R P Singh, 2007. *General Microbiology*. Kalyani Publishers.
5. J Heritage, E G V Evans, R A Killington, 2008. *Introductory Microbiology*. Cambridge University press P. date.
6. Pelczar, jr.M.J.E.C.S.Chan and Krieg, N.R. 1996. *Microbiology*. McGraw Hill Publishers, Newyork.
7. Prescott, L.M. Harley, J.P. and Klein, D.A (5ed) 2002. *Microbiology*. McGraw Hill Publishers, Newyork.
8. Jamaluddin, M. Malvidya, N. and Sharma, A. 2006. *General Microbiology*. Scientific Publishers, Washington.
9. Sullia, S.B, and Shantaram 1998. *General Microbiology*. Oxford and IBH.
10. Borkar,S,G, and Patil N.M. 2016.Mushroom,A nutritive food and its cultivation. Astral International Pvt.Ltd,New Delhi
11. Borkar,S.G. 2015.Beneficial Microbes as Biofertilizers and its Production Technology Woodhead Publisher,I ndia,New Delhi
12. Madigan, M. Martinkoj, M. and Parker (10 ed.) 2003. *Biology of Microorganisms*. Prentice Hall of India Pvt. Ltd., New Delhi.

Lesson Plan: MIBO 111

Course title : Introductory Microbiology

Theory

Lecture No.	Topics to be covered
1	Microbiology: Introduction, Scope in Agriculture and allied fields.
2	History of Agricultural Microbiology, development of Microbiology. Development of Microscope.
3	Microbial World: Prokaryotic and eukaryotic microorganisms.Group of Microorganism. Characters and importance of bacteria, fungi,actinomycetes, algae, viruses, mycoplasma.
4	Bacteria: cell structure, morphology, cytology and other characters, functions of external and internal parts. Morphology of bacteria size, shape, cell grouping.
5	Bacteria: Nutrients required for growth of bacteria, chemoautotrophy, photo autotrophy, Microbial growth, growth curve, growth phases, reproduction of bacteria.
6	Bacterial genetics: Genetic recombination- Gene transfer by transformation, conjugation and transduction, Plasmids.
7	Role of microbes in soil fertility and crop production. Microbial transformation of Nitrogen,Nitrogen cycle,steps in nitrogen cycles and microbes involved. Biological nitrogen fixation- symbiotic, asymbiotic and associative , Azolla, blue green algae.
8	Microbial transformation of phosphorus, sulphur and carbon,steps and microbe involved in each cycles. Decomposition of organic matter
9	Mycorrhiza: structure, types, merits, demerits
10	Rhizosphere and Phylloshere: Rhizosphere concept, microbes of Rhizosphere,.Effect of rhizospheric microflora on crop plants.Factors affecting rhizospheric microfloral population. Phylloshere: Phylospheric microflora and their effect on crop plants.
11	Silage production, single cell protein, Bio-fuel production-concept

12	Biofertilizers: definition, types of biofertilizers ,Types based on the basis of microbial group involved. Role of biofertilizers.
13	Bio-pesticides-Microbial insecticides.Microbial agents for plant disease control. *Trichoderma , Pseudomonas*.
14	Biodegradation of agro-waste .Criteria for biodegradation, Strategies for biodegradation. Microorganisms involved in biodegradation.
15	Mushrooms-morphology ,types of edible and poisonous mushrooms.
16	Microbes in human welfare. Microbes as biofertilizers, microbes in dairy industry and industrial applications, etc.

Course : PATH 121 **Credit:** 3(2+1) **Semester-II**
Course title: Fundamentals of Plant Pathology

Syllabus

Theory

Introduction: Importance of plant diseases, scope and objectives of Plant Pathology. History of Plant Pathology with special reference to Indian work. Terms and concepts in Plant Pathology. Pathogenesis, Cause and classification of plant diseases. Important plant pathogenic organisms, different groups: fungi, bacteria, fastidious vesicular bacteria, Phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa, phanerogamic parasites and nematodes with examples of diseases caused by them. Diseases and symptoms due to abiotic causes. Fungi: general characters, definition of fungus, somatic structures, types of fungal thalli, fungal tissues, modifications of thallus, reproduction (asexual and sexual). Nomenclature, Binomial system of nomenclature, rules of nomenclature, classification of fungi. Key to divisions, sub-divisions, orders and classes. Bacteria and mollicutes: general morphological characters. Basic methods of classification and reproduction.Viruses: nature, architecture, multiplication and transmission. Study of phanerogamic plant parasites. Nematodes: General morphology and reproduction, classification, symptoms and nature of damage caused by plant nematodes (Heterodera, Meloidogyne, *Anguina* etc.) Principles and methods of plant disease management. Nature, chemical combination, classification, mode of action and formulations of fungicides and antibiotics.

Practical

Acquaintance with various laboratory equipments and microscopy. Preparation of media,isolation and Koch's postulates. General study of different structures of fungi. Study of symptoms of various plant diseases. Study of representative fungal genera. Staining and identification of plant pathogenic bacteria. Transmission of plant viruses. Study of phanerogamic ant parasites. Study of morphological features and identification of plant parasitic nematodes. Extraction of nematodes from soil. Study of fungicides and their formulations. Methods of pesticide application and their safe use. Calculation of fungicide sprays concentrations.

Teaching Schedule (Theory)

Lecture	Topic	Weightage (%)
1	Importance of plant diseases, scope and objectives of Plant Pathology.....	3
2	History of Plant Pathology with special reference to Indian work	3
3, 4	Terms and concepts in Plant Pathology, Pathogenesis	6
5	classification of plant diseases	5
6,7, 8	Causes of Plant Disease Biotic (fungi, bacteria, fastidious vesicular bacteria, Phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa, and nematodes) and abiotic causes with examples of diseases caused by them	10
9	Study of phanerogamic plant parasites.	3
10, 11	Symptoms of plant diseases	6
12,13, 14	Fungi: general characters, definition of fungus, somatic structures, types of fungal thalli, fungal tissues, modifications of thallus,	7
15	Reproduction in fungi (asexual and sexual).	4
16, 17	Nomenclature, Binomial system of nomenclature, rules of nomenclature,	6
18, 19	Classification of fungi. Key to divisions, sub-divisions, orders and classes.	6
20, 21, 22	Bacteria and mollicutes: general morphological characters. Basic methods of classification and reproduction in bacteria	8
23,24, 25	Viruses: nature, architecture, multiplication and transmission	7
26, 27	Nematodes: General morphology and reproduction, classification of nematode Symptoms and nature of damage caused by plant nematodes (Heterodera, Meloidogyne, *Anguina*, etc.)	6
28, 29, 30	Principles and methods of plant disease management.	6
31, 32, 33	Nature, chemical combination, classification of fungicides and antibiotics.	7
34, 35, 36	Mode of action and formulations of fungicides and antibiotics.	7
	Total	**100**

Teaching Schedule (Practical)

Experiment	Topic
1.	Acquaintance with various laboratory equipments and microscopy
2.	General study of different structures of fungi.
3.	Study of symptoms of various plant diseases.
4.	Study of representative fungal genera
5.	Staining and identification of plant pathogenic bacteria

Experiment	Topic
6	Study of phanerogamic plant parasites
7	Transmission of plant viruses
8	Study of morphological features and identification of plant parasitic nematodes.
9	Preparation of media
10	Isolation and purification of fungi and bacteria
11	Extraction of nematodes from soil
12	Koch's postulates
13	Study of fungicides and their formulations
14	Methods of pesticide application and their safe use
15	Calculation of fungicide sprays concentrations**.**
16	Collection and preservation of disease specimen

Suggested Readings

1) Pathak, V. N. Essentials of Plant Pathology. Prakash Pub., Jaipur

2) Agrios, GN. 2010. *Plant Pathology*. Acad. Press.

3) Kamat, M. N. Introductory Plant Pathology. Prakash Pub, Jaipur

4) Singh RS. 2008. *Plant Diseases*.8th Ed. Oxford & IBH.Pub.Co.

5) Singh RS. 2013. *Introduction to Principles of Plant Pathology*.Oxford and IBH Pub.Co.

6) Alexopoulos, Mims and Blackwel. Introductory Mycology

7) Mehrotra RS &Aggarwal A. 2007.Plant Pathology.7th Ed. Tata McGraw Hill Publ. Co. Ltd.

8) Gibbs A & Harrison B. 1976. *Plant Virology - The Principles*. Edward Arnold, London.

9) Hull R. 2002. *Mathew.s Plant Virology*. 4th Ed. Academic Press, New York.

10) Verma JP. 1998. *The Bacteria*. Malhotra Publ. House, New Delhi.

11) Goto M. 1990. *Fundamentals of Plant Bacteriology*. Academic Press, New York.

12) Dhingra OD & Sinclair JB. 1986. *Basic Plant Pathology Methods*. CRC Press, London, Tokyo.

13) Nene YL &Thapliyal PN. 1993. *Fungicides in Plant Disease Control.* 3rd Ed. Oxford & IBH, New Delhi.

14) Vyas SC. 1993. *Handbook of Systemic Fungicides*. Vols. I-III. Tata McGraw Hill, New Delhi.

15) Rajeev K & Mukherjee RC. 1996. Role of Plant Quarantine in IPM. Aditya Books.

16) Rhower GG. 1991. Regulatory Plant Pest Management. In: Handbook of Pest Management in Agriculture. 2nd Ed. Vol. II. (Ed. David Pimental). CRC Press.

17) Singh RS &Sitaramaiah K. 1994. *Plant Pathogens – Nematodes*. Oxford & IBH, New Delhi.

18) Thorne G. 1961. *Principles of Nematology*. McGraw Hill, New Delhi.

19) Walia RK & Bajaj HK. 2003. *Text Book on Introductory Plant Nematology*. ICAR, New Delhi.

Lesson Plan: PATH 121

Course Title: Fundamental of Plant Pathology

Theory

Lecture No.	Topic to be covered
1	Defination of Plant Pathology, Importance of plant diseases:Potato late blight; Black rust of wheat; Leaf spot of rice; Coffee leaf rust,Sigatoka disease of banana; Downy mildew; scope and objectives of Plant Pathology.
2	History of Plant Pathology with special reference to Indian work. Contributior E.J.Butler;J.F.Dastur;G.S.Kulkarni;S.L.Ajrekar;B.B.Mundkur;M.K.Patel;K.C.Mehta; J.C.Luthra;S.N.Dasgupta&T.S.Sadashivan;V.P.Bhide;G.Rangaswamy;M.J.Thirumalac
3,4	Terms and concepts in Plant Pathology: Disease triangle; Koch's Postulates, Pathogenesis
5	Classification of plant diseases: Based on the mode of spread, severity of infection and geographic distribution of the disease. Based on the mode of primary infection & kind of perpetuation etc. , Simple interest disease & Compound interest disease
6,7,8	Causes of Plant Disease Biotic (fungi, bacteria, fastidious vesicular bacteria, Phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa, and nematodes) and abiotic causes with examples of diseases caused by them.
9	Study of phanerogamic plant parasites.Types : Root parasite & Stem parasite .
10,11	Symptoms of plant diseases. Defination,symptom and sign, Symptoms caused by plant pathogens
12,13,14	Fungi: general characters, definition of fungus, somatic structures, types of fungal thalli, fungal tissues, modifications of thallus.
15	Reproduction in fungi: defination, asexual reproduction and sexual reproduction.
16,17	Nomenclature, Binomial system of nomenclature, rules of nomenclature.
18,19	Classification of fungi. Key to divisions, sub-divisions, orders and classes.
20,21,22	Bacteria and mollicutes: general morphological characters. Bacteria: cell structure, morphology, cytology and other characters, functions of external and internal parts. Morphology of bacteria size, shape, cell grouping. Basic methods of classification and reproduction in bacteria.

23,24,25	Viruses: nature, architecture, multiplication and transmission of plant viruses.
26,27	Nematodes: General morphology and reproduction, classification of nematode Symptoms and nature of damage caused by plant nematodes (Heterodera, Meloidogyne, *Anguina* etc.)
28,29,30	Principles and methods of plant disease management.
31,32,33	Nature, chemical combination, classification of fungicides and antibiotics.
34,35,36	Mode of action and formulations of fungicides and antibiotics.

Course : PATH 232 **Credit:** 2(1+1) **Semester-III**

Course title: Principles of Integrated Disease Management

Syllabus

Theory

IPM: Introduction, history, importance, concepts, principles and tools of IPM. Economic importance of diseases and pest risk analysis. Methods of detection and diagnosis of diseases. Measurment of lossess causes due to diseases. Methods of control: Host plant resistance, cultural, mechanical, physical, legislative, biological and chemical control. Ecological management of crop environment. Introduction to conventional pesticides for the disease management. Survey, surveillance and forecasting of plant diseases. Development and validation of IPM module. Implementation and impact of IPM (IPM module for diseases. Safety issues in pesticide uses. Political, social and legal implication of IPM. Case histories of important IPM programmes.

Practical

Methods of diagnosis and detection of various plant diseases, Methods of plant disease measurement, Assessment of crop yield losses, calculations based on economics of IPM, Identification of biocontrol agents,Mass multiplication of *Trichoderma, Pseudomona*s, NPV etc. identification of diseases and their management. Crop (agro-ecosystem) dynamics of selected diseases. Plan & assess preventive strategies (IPM module) and decision making. crop monitoring attacked by diseases . Awareness campaign at farmers' fields.

Teaching Schedule (Theory)

Lecture	Topic	Weightage (%)
1	IPM: Introduction, history, importance, concepts.	8
2	Principles and tools of IPM	8
3	Economic importance of diseases	6
4	Pest risk analysis	6
5	Methods of detection and diagnosis of diseases	6
6	Measurement of losses causes due to diseases	6
7	Methods of control: Host plant resistance, cultural, mechanical, physical,	6
8	Legislative, biological and chemical control	6
9	Ecological management of crop environment	6
10	Introduction to conventional pesticides for the disease management	6
11	Survey surveillance and forecasting of plant diseases	6
12	Development and validation of IPM module	6
13	Implementation and impact of IPM (IPM module for diseases)	6
14	Safety issues in pesticide uses	6
15	Political, social and legal implication of IPM	6
16	Case histories of important IPM programmes	6
	Total	**100**

Teaching Schedule (Practical)

Experiment	Topic
1	Methods of diagnosis various plant diseases,
2,3	Methods of detection of various plant diseases
4,5	Methods of plant disease measurement
6	Assessment of crop yield losses
7	calculations based on economics of IPM
8	Identification of biocontrol agents
9	Mass multiplication of *Trichoderma*,
10	Mass multiplication of *Pseudomonas*,
11	Mass multiplication of NPV
12	Identification of diseases and their management
13	Crop (agro-ecosystem) dynamics of selected diseases

14	Plan & assess preventive strategies (IPM module) and decision making
15	Crop monitoring attacked by diseases
16	Awareness campaign at farmers fields.

Suggested Readings

1) Singh RS. 2013. *Introduction to Principles of Plant Pathology*. Oxford and IBH Co., New Delhi.

2) Pathak, V. N. Essentials of plant pathology. Prakash Pub., Jaipur

3) Agrios, G. N. Plant Pathology. 5th edition, Published by a division of Reed Elsvier India Pvt., Ltd., New Delhi (2005)

4) Kamat, M. N. Introductory Plant Pathology. Prakash Pub, Jaipur

5) Stakman EC &Harrar JG. 1957. *Principles of Plant Pathology*. Ronald Press, USA.

6) *Tarr SAJ*. 1964. *The Principles of Plant Pathology*. McMillan, London.

7) *Vander Plank, JE.* 1975. *Principles of Plant Infection.* Acad. Press

8) Verma JP, Varma A & Kumar D. (Eds). 1995. *Detection of Plant Pathogens and theirManagement*. Angkor Publ., New Delhi

9) Mehrotra RS &Aggarwal A. 2003. *Plant Pathology*. 2nd Ed. Oxford & IBH,

10) Dhingra OD & Sinclair JB. 1986. *Basic Plant Pathology Methods*. CRC Press

11) Fox RTV. 1993. *Principles of Diagnostic Techniques in Plant Pathology*. CABINene YL &Thapliyal PN. 1993. *Fungicides in Plant Disease Control*. Oxford & IBH, NewDelhi.

12) Palti J. 1981. *Cultural Practices and Infectious Crop Diseases*. Springer- Verlag, New York.

13) Vyas SC. 1993 *Handbook of Systemic Fungicides*. Vols. I-III. Tata McGraw

14) Rajeev K & Mukherjee RC. 1996. Role of Plant Quarantine in IPM. Aditya Books.

15) Rhower GG. 1991. Regulatory Plant Pest Management. In: Handbook of Pest Management in

16) Agriculture. 2nd Ed. Vol. II. (Ed. David Pimental). CRC Press.

Course : ELE PATH 243 **Credit:** 3(2+1) **Semester-IV**
Course title: Biofertilizers, biocontrol agents and biopesticides

Syllabus

Theory

Biofertilizers: Introduction and types and importance of biofertilizers, Biopesticides and bioagents in agriculture and organic farming system, History of biofertilizers production Classification of biofertilizers microorganisms used in biofertilizers production. A study of growth characteristics of various microbes used in biofertilizers production. Nitrogen cycle in Nature. Process of nodule formation, Role of Nif and Nod gene in Biological Nitrogen fixation, Enzyme nitrogenase and its component, Biochemistry of nitrogen fixation, Cross inoculation groups amongst *Rhizobium*, Methods used for the studying selection of efficient strain of *Rhizobium*. Quality standard for biofertilizers different methods of application of biofertilizers, role of microorganisms in decomposition of organic farm wastes, methods of quality control assessment in respect of biofertilizers, Strategies of Mass multiplication and packing Registration of biofertilizers. Strategies of marking and Registration with CIB of bioagents and biopesticides

Importance of *Trichoderma*spp., *Pseudomona*s spp. and *Bacillus* spp. as a biocontrolagents, Mechanism of disease control by these organisms bioagents. Types of diseases controlled bioagents formulations, Effectiveness of bioagents against seed borne and soil borne plant pathogens, Mass multiplication and packing , Strategies of marking, and Registration with CIB and organic farming institute

Importance of *Trichogramma, Cryptolaemus, Chrysoperla*, NPV and entomofungal pathogens. Establishing insectary for host insects and natural enemies, Mass production of *Verticillium/Beauveria/Metarhzium/Nomuraea/Paecilomyces*/*Hirsutella thompsoni/Trichoderma,/Pseudomonas/Bacillus/Potash Mobilizers/ Sulphur oxidizers /organic matter decomposers*

Practical

Equipment, machinery and tools used for biofertilizers, Biopesticides and bioagents production. Preparation of media used for isolation and culturing of biofertilizers : Jensen's

agar, NFb medium, Yeast extract manitol agar, BGA-medium, Pikovaskaya's medium; Isolation of *Rhizobium* from root nodules. Isolation of *Azotobacter* from rhizosphere of cereal crops, *Beijernickia, Acetobacter* from soil,

Azospirillium from roots of graminicious plants, BGA from soil, Mycorrhizae from the roots, PSM, sulphur oxidizing microorganisms, ion chealator, potash mobilizers, organic matter decomposers and their isolation in pure culture form. Estimating the efficiency of *Rhizobium* through pot culture experiments and through nodulation tests in test tubes and Leonard jar. Preservation of cultures of these organisms. Production of commercial biofertilizers*viz*. *Rhizobium, Azotobacter, Azospirillum* and *Acetobacter* : selection of efficient strains, carriers and their sterilization, mother culture preparation, mass multiplication using shake culture method, mixing of culture and carriers and preparation of packets. Production of carrier based and grain based phosphate solubilizing biofertilizers.

Methods of mass multiplication of BGA and *Azolla*. A large scale production of decomposting cultures. Va-mycorrhiza: growth on Guinea grass roots and observations for root colonization. Preparation of VA-mycorrhizal inoculum.

Methods of application of *Rhizobium, Azotobacter, Azospirillum* and phosphate solubilizing biofertilizers. Methods of application of *Azolla* and blue green algal biofertilizers in paddy farming. Production of compost cultures.

Quality control of biofertilizers: ISI standards specified and estimating the viable bacterial count in carrier based biofertilizers. Storage of biofertilizer packets. Visit to biofertilizer plants. Preparation of plan of biofertilizer production unit and proposal of loan.

Biopesticide and bioagents: Mass production of *Trichogramma, Cryptolaemus, Crysoperla,* Mass HaNPV, and EPN. Importance of *Verticillium/Beauveria/ Metarhzium/ Nomuraea/ Paecilomyces*/*Hirsutellathompsoni/Trichoderma,/Pseudomonas/Bacillus/ organic matter decomposers.* Testing of quality parameters and standardization of biopesticides.

Teaching Schedule (Theory)

Lecture	Topic	Weightage (%)
1	Introduction and types and importance of biofertilizers, Biopesticides and bioagents in agriculture and organic farming system	3
2	History of biofertilizers production	5
3,4	Classification of biofertilizers microorganisms used in biofertilizers production	4
5	A study of growth characteristics of various microbes used in biofertilizers production	4
6	Nitrogen cycle in Nature and its importance	5
7	Process of nodule formation ,Role of Nif and Nod gene in Biological Nitrogen fixation	3
8	Enzyme nitrogenase and its component	3
9	Biochemistry of nitrogen fixation,	4
10	Cross inoculation groups amongst *Rhizobium*,	3
11	Methods used for the studying selection of efficient strain of *Rhizobium*	5
12	Quality standard for biofertilizers,	3
13	Different methods of application of biofertilizers, biopesticides and bioagents	5
14	Methods of quality control assessment in respect of biofertilizers	3
15	Strategies of Mass multiplication and packing Registration of biofertilizers	4
16,17	Strategies of marking and Registration with CIB of bioagents and biopesticides	4
18	Role of microorganisms in decomposition of organic farm wastes	4
19,20	Importance of *Trichoderma*spp., *Pseudomona*s spp. and *Bacillus* spp. as a biocontrol agent.	4
21	Mechanism of disease control by these organisms bioagents	3
	Types of diseases by controlled bioagents formulations	3
22	Factors responsible for effectiveness of bioagents against seed borne and soil borne plant pathogens	4
23	Mass multiplication and packing	2
24,25	Strategies of marking, and Registration with CIB and organic farming institute	4
26,27	Importance of *Trichogramma*, *Cryptolaemus, Chrysoperla,* NPV and entomofungal pathogens.	4
28	Establishing insectary for host insects and natural enemies	3
29	Mass production of bioagents*Trichoderma,Bacillus,*Pseudomonas	4
30	Quality parameters as per CIB specifications, Registration of biopesticides and case	3
31,32	Importance of *Verticillium/Beauveria/ Metarhzium/Nomuraea/*	4

Lecture	Topic	Weightage (%)
	Paecilomyces/*Hirsutellathompsoni*as biopesticides and their mass production	
	Total	**100**

Teaching Schedule (Practical)

Experiment	Topic
1	Equipment, machinery and tools used for biofertilizers, Biopesticides and bioagents production.
2	Media used for biofertilizers, Biopesticides and bioagents production.
3	Isolation of *Rhizobium* from root nodules. Isolation of *Azotobacter ,Acetobactor, Beijernickia, Azospirillium*. I. By dilution pour plate technique and II. By enrichment culture technique
4	Isolation of *BGA,PSB,*sulphur oxidizing microorganisms, ion chealator, potash mobilizers ,organic matter decomposers I. By dilution pour plate technique and II. By enrichment culture technique
5	Estimating the efficiency of *Rhizobium* through pot culture experiments and through nodulation tests in test tubes and Leonard jar.
6	Production of *Rhizobium* commercial biofertilizers of *Azotobacter, Azospirillum, Acetobacter,* organic matter decomposers
7	Production of carrier biofertilizers of sulphur oxidizing microorganisms, ion chealator, potash mobilizers
6	Study of VA-mycorrhiza: growth on Guinea grass roots and observations for root colonization. Methods of preparation and application of VA-mycorrhizal inoculum
7	Mass production of Trichogramma,Cryptolaemus,Crysoperla
8	Mass production of HaNPV, SlNPV and EPN
9	Mass production of *Verticillium/Beauveria/ Metarhzium/Nomuraea/ Paecilomyces/Hirsutellathompsoni/Trichoderma*
10	Mass multiplication of BGA and *Azolla* and its application in paddy field
11	Methods of application of biofertilizers, Biopesticides and bioagents
12	Quality control of biofertilizers: ISI standards specified and estimating the viable bacterial count in carrier based biofertilizers, Biopesticides and bioagents
13	Quality control tests for the biofertilizers, Biopesticides and bioagents
14	Preparation of plan of biofertilizers, Biopesticides and bioagents production unit and proposal of loan.
15	CIB Registration for Biopesticides and bioagents
16	Visits to Commercial biocontrol units and Krishi Seva Kendra.

Suggested Readings

1. Alexander M. 1977. Soil Microbiology. John Wiley.
2. Bergerson FJ. 1980. Methods for Evaluating Biological Nitrogen Fixation. John Wiley and Sons.
3. Motsara, I.M.R., Bhattacharyya, P. and Srivastava, B. 1995. Biofertilizer Technology, Marketing and Usage- A Source Book-cum-glossary. FDCO, New Delhi.
4. SubbaRao, N.S. Biofertilizers in Agriculture and Forestry. 1993. Oxford and IBH. Publ. Co., New Delhi.
5. Burges, H.D. and Hussey, N.W. (1971). Microbial Control of Insects and mites. Academic Press, New York.
6. Burges, H.D. Formulation of microbial pesticides – Kluversep, ACB, Dordrecht-ISBN. 0412 625 202.
7. Coppel H.C. and J.W. Martin. (1977). Biological control of insect pest suppression. Springail.
8. De Bach P. 1964. Biological control of Insect Pest and Weeds Chapman and Hall, New York.
9. Gautam, R.D. (2006). Biological suppression of insect pests. Kalyani Publisher, New Delhi.
10. Huffaker, C.B. and Messenger, P.S. (1976). Theory and Practice of Biological control. Academic Press, New York.
11. Ignacimuthu, S.S. and Jayaraj, S. (2003). Biological Control of Insect Pests. Phoenix Publ. New Delhi.
12. Saxena, A.B. (2003). Biological Control of Insect Pests. Anmol Publ. New Delhi.
13. Huffaker, C.B. and Messenger, P.S. (1976). Theory and Practice of Biological control. Academic Press, New York.
14. Pepper HJ and Perlman D. 1979. Microbial Technology. 2nd Ed. Academic Press.
15. A century of Nitrogen Fixation Research Present status and Future propects. 1987. F.J. Bergersen and J.R. Postgate The Royal Soc., London.
16. Biology and Biochemistry of Nitrogen fixation. 1991. M.J. Dilworth,and A.R. Glenn, Elsevier, Amsterdam. .
17. Nitrogen Fixation in plants. 1986. R.O.D. Dixon,and C.T. Wheeler, Blackie USA, Chapman and Hall, New York.
18. A treatise on dinitrogen Fixation Section IV. Agronomy and Ecology 1977. R.W.F Hardy, and A.H. Gibson John Wiley & Sons, New York..
19. Bioresearches technology for sustainable agriculture. 1999. S. Kannaiyan, Assoc. Pub. Co., New Delhi.

20. Biofertilizer Technology, Marketing and usage- A source Book -cum-glossary 1995. Motsara, I. M.R., P. Bhattacharyya and BeenaSrivastava, FDCO, New Delhi.
21. Symbiotic nitrogen fixation in plants, 1976. P.S. Nutman, Cambridge Univ. Press, London.
22. Hand book for Rhizobia; Methods in legume Rhizobium Technology, 1994. P. Somasegaran and H.J. Hoben Springer-Verlag, New York.
23. Biofertilizers in Agriculture and Forestry 1993. N.S. SubbaRao Oxford and IBH Publ. Co., New Delhi.

Course : PATH 354 **Credit:** 3(2+1) **Semester-V**

Course title: Diseases of Field and Horticultural Crops and their Management – I

Syllabus

Theory:

Symptoms, etiology, disease cycle and management of major diseases of following crops:

Field Crops: Rice: blast, brown spot, bacterial blight, sheath blight, false smut, Khaira and tungro; Maize: stalk rots, downy mildew, leaf spots; Sorghum: smuts, grain mold and anthracnose, Bajra: downy mildew and ergot; Finger millet: Blast and leaf spot

Groundnut: early and late leaf spots, wilt. Soybean: Rhizoctonia blight, bacterial spot, seed and seedling rot and mosaic; Pigeonpea: Phytophthora blight, wilt and sterility mosaic; Black & green gram: Cercospora leaf spot and anthracnose, web blight and yellow mosaic; Castor: Phytophthora blight; Tobacco: black shank, black root rot and mosaic.

Horticultural Crops: Guava: wilt and anthracnose; Banana: Panama wilt, bacterial wilt, Sigatoka and bunchy top; Papaya: foot rot, leaf curl and mosaic, Pomegranate: bacterial blight;

Cruciferous vegetables: Alternaria leaf spot and black rot; Brinjal: Phomopsis blight and fruit rot and Sclerotinia blight; Tomato: damping off, wilt, early and late blight, buck eye rot and leaf curl and mosaic; Okra: Yellow Vein Mosaic; Beans: anthracnose and bacterial blight; Ginger: soft rot; Colocasia: Phytophthora blight;

Coconut: wilt and bud rot; Tea: blister blight; Coffee: rust

Practical

Identification and histopathological studies of selected diseases of field and horticultural crops covered in theory. Field visit for the diagnosis of field problems. Collection and preservation of plant diseased specimens for Herbarium;

Note: Students should submit 50 pressed and well-mounted specimens.

Teaching Schedule (Theory)

Lecture	Topic	Weightage (%)
	Symptoms, etiology, disease cycle and management of major diseases of following crops	
	Field crops	
1,2,3	Rice	6
4,5	Maize	5
6,7	Sorghum	5
8	Bajara	3
9	Finger millet	3
	Oilseed	
10	Groundnut	5
	Pulses	
11,12,13	Soybean , Black & green gram	8
14	Pigeonpea	5
	Cash Crop	
15	Caster	5
16	Tobacco	5
	Horticultural Crops	
17	Guava	5
18,19	Banana	5
20,21	Papaya	5
22,23	Pomegranate	5
	Cruciferous vegetables:	
24,25	Cruciferous vegetables	6
26,27	Brinjal, Tomato , Okra	9
28,29	Beans Ginger, Colocasia	6
	Plantation Crops	
30,31,32	Coconut, Tea, Coffee	9
	Total	**100**

Teaching Schedule (Practical)

Experiment	Topic
	Identification and histopathological studies of selected diseases of field and horticultural crops covered in theory. Collection and preservation of disease specimen (Note: Students should submit 50 pressed and well-mounted specimens)
1.	Rice: blast, brown spot, bacterial blight, sheath blight, false smut, Khaira and tungro
2.	Maize: stalk rots, downy mildew, leaf spots, Sorghum: smuts, grain mold and anthracnose, Bajra: downy mildew and ergot;
3.	Finger millet: Blast and leaf spot, Groundnut: early and late leaf spots , wilt.
4.	Soybean: Rhizoctonia blight, bacterial spot, seed and seedling rot and

	mosaic, Pigeonpea: Phytophthora blight, wilt and sterility mosaic
5.	Black & green gram: Cercospora leaf spot and anthracnose, web blight and yellow mosaic,.
6	Castor: Phytophthora blight; Tobacco: black shank, black root rot and mosaic
7	Guava: wilt and anthracnose; Papaya: foot rot, leaf curl and mosaic, Papaya ring spot,
8	Banana: Panama wilt, bacterial wilt, Sigatoka and bunchy top
9	Pomegranate: bacterial blight ,wilt
10	Cruciferous vegetables: Alternaria leaf spot and black rot,
11	Tomato: damping off, wilt, early and late blight, buck eye rot and leaf curl and mosaic
12	Brinjal: Phomopsis blight and fruit rot and Sclerotinia blight,
13	Okra: Yellow Vein Mosaic, Beans: anthracnose and bacterial blight
14	Ginger: soft rot; Colocasia: Phytophthora blight;
15	Coconut: wilt and bud rot; Tea: blister blight; Coffee: rust
16	Field visit for the diagnosis of field problems

Suggested Readings

1) Agrios, GN. 2010. *Plant Pathology*. Acad. Press
2) Diseases of Horticultural Crops fruits (1999) By Verma L.R and Sharma R.c,Indus Publishing company, New Delhi
3) Diseases of fruit crops (1986) By V.N.Pathak ,Oxford & IBH publication, New Delhi
4) Diseases of fruit crops (1986) By R.S.Singh ,Oxford & IBH publication, New Delhi
5) Diseases of Fruits and vegetables (2007) S.A.M.H. Naqvi,Springer Science & Business Media
6) Diseases of Plantation Crops (2014) By P.Chowdappa, Pratibha Sharma IPS 263pp
7) Diseases of Horticulture Crops and their management, ICAR e-book for B.Sc.(Agri) & B.Tech (Agri) By TNAU pp172
8) Advances in the diseases of Plantation crops & spices (2004) P.SanthaKumari,International Book Distributing Company , 247 pp
9) Mehrotra RS &Aggarwal A. 2007. *Plant Pathology.* 7th Ed. Tata McGraw Hill Publ. Co. Ltd
10) Vegetable Diseases : A Colour full Hand book (2006) by Steven T.Koike ,Peter Gladers and Albert Paulus ,Academic Press, pp448
11) Diseases of Vegetables crops by R.S.Singh (1987) Oxford & IBH publication, New Delhi
12) Plant Diseases.(2008) Singh RS. 20088th Ed. Oxford & IBH. Pub. Co.
13) Diseases of Crops Plants in India (2009) By PHI learning Pvt. Ltd, pp 548
14) Diseases of Vegetable crops (2005) by AlferdSteferud ,Biotech Books ,New Delhi
15) Mehrotra RS &Aggarwal A. 2007. *Plant Pathology.* 7th Ed. Tata McGraw Hill Publ.Co. Ltd

16) Diseases of Vegetable Crops ,Diagonosis and Management (2014) Dinesh Singh and P.Chodappa, Today and Tomorrow Printers ,pp734

17) Singh H. 1984. *House-hold and Kitchen Garden Pests - Principles and Practices.*Kalyani Publisher

Course : PATH 365 **Credit:** 3(2+1) **Semester-VI**

Course title: Diseases of Field and Horticultural Crops and their Management – II

Syllabus

Theory

Symptoms, etiology, disease cycle and management of following diseases:

Field Crops: Wheat: rusts, loose smut, karnal bunt, powdery mildew, alternaria blight, and ear cockle; Sugarcane: red rot, smut, wilt, grassy shoot, ratoon stunting and Pokkah Boeng; Sunflower: Sclerotinia stem rot and Alternaria blight; Rust, Downy mildew Mustard: Alternaria blight, white rust, downy mildew and Sclerotinia stem rot; Gram: wilt, grey mould and Ascochyta blight; Lentil: rust and wilt; Cotton: anthracnose, vascular wilt, and black arm; Pea: downy mildew, powdery mildew and rust

Horticultural Crops: Mango: anthracnose, malformation, bacterial blight and powdery mildew; Citrus: canker and gummosis, Grape vine: downy mildew, Powdery mildew and anthracnose; Apple: scab, powdery mildew, fire blight and crown gall; Peach: leaf curl, Strawberry: leaf spot Potato: early and late blight, black scurf, leaf roll, and mosaic;

Cucurbits: Downy mildew, powdery mildew, wilt; Onion and garlic: purple blotch, and Stemphylium blight; Chillies: anthracnose and fruit rot, wilt and leaf curl; Turmeric: leaf spot, Coriander: stem gall, Marigold: Botrytis blight; Rose: dieback, powdery mildew and black leaf spot.

Practical

Identification and histopathological studies of selected diseases of field and horticultural crops covered in theory. Field visit for the diagnosis of field problems. Collection and preservation of plant diseased specimens for herbarium.

Note: Students should submit 50 pressed and well-mounted specimens.

Teaching Schedule (Theory)

Lecture	Topic	Weightage (%)
	Symptoms, etiology, disease cycle and management of major diseases of following crops	
	Field crops	
1,2,3	Wheat: Rusts, loose smut, Karnal bunt, powdery mildew, Alternaria blight, and ear cockle	5
4,5	Sugarcane: Red rot, Smut, Wilt, Grassy shoot, Ratoon stunting and Pokka Boeng	5
	Oilseed	
6,7	Sunflower: Sclerotinia stem rot and Alternaria blight, Rust, Downy mildew	3
8,9	Mustard: Alternaria blight, White rust, Downy mildew and Sclerotinia stem rot	3
	Pulses	
10	Gram: wilt, grey mould and Ascochyta blight	5
	Lentil: rust and wilt	4
11	Linseed :Alternaria bud blight, Rust ,Powdery mildew	2
12	Pea: Downy mildew, Powdery mildew and Rust, wilt	5
	Cash Crop	
13,14	Cotton: Root rot, Wilt, Anthracnose, and black arm, Dahiya diseases, leaf curl of cotton, 2-4-D injury	7
	Horticultural Crops	
15,16,17,	Mango: Die back, Anthracnose, Mango-malformation, bacterial blight and powdery mildew, Spongy tissue, Red rust, Pink diseases, Loranthus, Stone graft Mortality, Lime induced chlorosis	6
18,19	Citrus : Citrus canker, Gummosis, Fruit rot, Citrus greening, Anthracnose, Tristeza, Citrus Exocortis, Scab of citrus, Mottle leaf of citrus	6
20,21	Grape vine: Downy mildew, Powdery mildew, Anthracnose, Bacterial Canker, Grape fan-leaf virus	6
22	Apple: Scab, Powdery mildew, Fire blight and Crown gall, Mosaic	3
23	Peach: leaf curl	2
23	Strawberry: Leaf spot	3
	Vegetables	
24	Potato: Early and late blight, black scurf, leaf roll, and Mosaic	5
25,26	Cucurbits: Downy mildew, powdery mildew, wilt, Angular leaf spot, Mosaic, TOSPO virus	5
27	Onion: Purple blotch, and Stemphylium blight, Downy mildew, Smut, Smudge, Erwinia rot	6
28	Garlic : Neck and bulb rot, and Stemphylium blight, Blemish, Black mould	3
29	Chilli : Anthracnose and fruit rot, Wilt and leaf curl	5
30	Coriander : Stem gall, Powdery mildew, Wilt	2
30	Turmeric: leaf spot	3
	Ornamental Crops	

Lecture	Topic	Weightage (%)
31	Marigold :Botrytis blight, Alternaria blight	3
32	Rose: Dieback, Powdery mildew and Black leaf spot	3
	Total	**100**

Teaching Schedule (Practical)

Experiment	Topic
	Identification and histopathological studies of selected diseases of field and horticultural crops covered in theory. Collection and preservation of disease specimen (Note: Students should submit 50 pressed and well-mounted specimens)
	Field crops
1	Wheat: Rusts, loose smut, Karnal bunt, powdery mildew, Alternaria blight, and ear cockle
2	Sugarcane: Red rot, Smut, Wilt, Grassy shoot, Ratoon stunting and Pokka Boeng
	Oilseed
3	Sunflower: Sclerotinia stem rot and Alternaria blight, Rust, Downy mildew
4	Mustard: Alternaria blight, White rust, Downy mildew and Sclerotinia stem rot
	Pulses
5	Gram: wilt, grey mould and Ascochyta blight, Pea: Downy mildew, Powdery mildew and Rust, wilt
6	Lentil: rust and wilt, Linseed :Alternaria bud blight, Rust ,Powdery mildew
	Cash Crop
6	Cotton: Root rot, Wilt, Anthracnose, and black arm, Dahiya diseases, leaf curl of cotton, 2-4-D injury
	Horticultural Crops
7	Mango: Die back, Anthracnose, Mango-malformation, bacterial blight and powdery mildew, Spongy tissue, Red rust, Pink diseases, Loranthus, Stone graft Mortality, Lime induced chlorosis
8	Citrus : Citrus canker, Gummosis, Fruit rot, Citrus greening, Anthracnose, Tristeza, Citrus Exocortis, Scab of citrus, Mottle leaf of citrus
9	Grape vine: Downy mildew, Powdery mildew, Anthracnose, Bacterial Canker, Grape fan-leaf virus
10	Peach: leaf curl, Apple: Scab, Powdery mildew, Fire blight and Crown gall, Mosaic. Strawberry: Leaf spot
	Vegetables
11	Potato: Early and late blight, black scurf, leaf roll, and Mosaic
12	Cucurbits: Downy mildew, powdery mildew, wilt, Angular leaf spot, Mosaic, TOSPO virus

Experiment	Topic
13	Onion: Purple blotch, and Stemphylium blight, Downy mildew, Smut, Smudge, Erwinia rot
14	Garlic : Neck and bulb rot, and Stemphylium blight, Blemish, Black mould
15	Chilli :Anthracnose and fruit rot, Wilt and leaf curl. Coriander : Stem gall, Powdery mildew, Wilt. Turmeric: leaf spot
	Ornamental Crops
16	Marigold :Botrytis blight, Alternaria blight, Rose: Dieback, Powdery mildew and Black leaf spot
17	Field visit for the diagnosis of field problems

Suggested Readings

1) Agrios, GN. 2010. *Plant Pathology*. Acad. Press
2) Diseases of Horticultural Crops fruits (1999) By Verma L.R and Sharma R.c,Indus Publishing company, New Delhi
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5) Diseases of Fruits and vegetables (2007) S.A.M.H. Naqvi,Springer Science & Business Media
6) Diseases of Plantation Crops (2014) By P.Chowdappa, Pratibha Sharma IPS 263pp
7) Diseases of Horticulture Crops and their management ,ICAR e-book for B.Sc.(Agri) &B.Tech (Agri) By TNAU pp172
8) Advances in the diseases of Plantation crops & spices (2004) P.SanthaKumari,International Book Distributing Company , 247 pp
9) Mehrotra RS &Aggarwal A. 2007. *Plant Pathology.* 7th Ed. Tata McGraw Hill Publ. Co. Ltd
10) Vegetable Diseases : A Colour full Hand book (2006) by Steven T.Koike ,Peter Gladers and Albert Paulus ,Academic Press, pp448
11) Diseases of Vegetables crops by R.S.Singh (1987) Oxford & IBH publication, New Delhi
12) Plant Diseases.(2008) Singh RS. 20088th Ed. Oxford & IBH. Pub. Co.
13) Diseases of Crops Plants in India (2009) By PHI learning Pvt. Ltd, pp 548
14) Diseases of Vegetable crops (2005) by AlferdSteferud ,Biotech Books ,New Delhi
15) Mehrotra RS &Aggarwal A. 2007. *Plant Pathology.* 7th Ed. Tata McGraw Hill Publ. Co. Ltd
16) Diseases of Vegetable Crops ,Diagonosis and Management (2014) Dinesh Singh and P.Chodappa, Today and Tomorrow Printers ,pp734
17) Singh H. 1984. *House-hold and Kitchen Garden Pests - Principles and Practices.* Kalyani Publishers.