

**Minutes of the
17th Meeting of the Board of Studies
of
Department of Botany
Central University of Jammu**



Venue: Office of Head, Department of Botany, CUJ, Bagla

Date: 3 June, 2024

Time: 11:00 AM

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17th meeting of the Board of Studies, Department of Botany, Central University of Jammu was held on 3 June, 2024 in the office of Head of the Department at 11.00AM. Following members attended the meeting:

S. No.	Name of the member	Affiliation
1.	Prof. B.S. Bhau (Chairperson and HoD)	Head, Dept. of Botany, CUJ
2.	Prof. Namrata Sharma (External Expert)	Professor, Dept. of Botany, University of Jammu
3.	Dr. Shweta Yadav (External Member)	Assistant Professor, Dept. of Environmental Studies, CUJ
4.	Prof. Suram Singh (Special Invitee)	Dean Academics, CUJ
5.	Dr. Uday Pratap Singh (Special Invitee)	Associate Dean Academics, CUJ
6.	Dr. Yogesh Kumar (Member)	Associate Professor, Dept. of Botany, CUJ
7.	Dr. Ashok Kumar (Member)	Assistant Professor, Dept. of Botany, CUJ
8.	Dr. Deepak Bhardwaj (Special Invitee)	Associate Professor, Dept. of Botany, CUJ
9.	Dr. Samantha Vaishnavi (Special Invitee)	Assistant Professor, Dept. of Botany, CUJ
10.	Dr. Vikas Srivastava (Special Invitee)	Assistant Professor, Dept. of Botany, CUJ

1. Opening remarks by the Chair.

Prof. B.S. Bhau welcomed all the members and thanked them for making it convenient to attend the meeting.

2. To consider and approve course contents for core courses under New Education Policy for the 5th semester of Integrated B.Sc. (Hons.) - M.Sc. Botany programme.

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The Board considered and approved the course structure and the two core courses 'Plant Physiology' and 'Molecular Biology and Plant Biotechnology', to be offered to the students of the 5th semester of Integrated B.Sc. (Hons.) - M.Sc. Botany programme under New Education Policy. The course structure is as follows, and the contents of the two courses are placed at Annexure-I:

Course Structure Semester-V

Course Code	Course Title	Course Type	Credits	CIA	MSE	ESE	Max. marks
Core courses							
	Plant Physiology	Theory + Lab (3+1)	4				100
	Molecular Biology and Plant Biotechnology	Theory + Lab (3+1)	4				100
Open Elective Courses (SEC/VAC/AEC/OEC) or on Swayam Platform-MOOC courses							
#	Open Elective Courses		12	-	-	-	300
Total			20	-	-	-	500

The student has to earn minimum of 20 credits during the semester- V. Apart from two core courses of 4 credits (3 of Theory and 1 of Lab) each, the student has to earn 12 more credits from the open elective basket offered by the Department or other Departments or on Swayam platform- MOOC courses.

3. To consider and approve course contents for core courses under New Education Policy for the 6th semester of Integrated B.Sc. (Hons.) - M.Sc. Botany programme.

The Board considered and approved the course structure and the two core courses 'Fundamentals of Genetics and Cytogenetics' and 'Ecology and Environment' to be offered to the students of the 6th semester of Integrated B.Sc. (Hons.) - M.Sc. Botany programme under New Education Policy. The course structure is as follows, and the contents of the two courses are placed at Annexure-II:

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Course Structure of Semester VI

Course Code	Course Title	Course Type	Credits	CIA	MSE	ESE	Max. marks
Core courses							
	Fundamentals of Genetics and Cytogenetics	Theory + Lab (3+1)	4				100
	Ecology and Environment	Theory + Lab (3+1)	4				100
Open Elective Courses (SEC/VAC/AEC/OEC) or on Swayam Platform-MOOC courses							
#	Open Elective Courses		12	-	-	-	300
Total			20	-	-	-	500

The student has to earn minimum of 20 credits during the semester- VI. Apart from two core courses of 4 credits (3 of Theory and 1 of Lab) each, the student has to earn 12 more credits from the open elective basket offered by the Department or other Departments or on Swayam platform- MOOC courses.

4. To consider and approve course contents for the Open Elective Courses 'Introduction to Virology', 'Molecular Diagnostics', 'Biodiversity and its Conservation', 'Insights into Immunology', 'Enzymology', and 'Microbial World' to be offered by the Department of Botany under NEP2020.

The board considered and approved the course contents of six more Open Elective Courses 'Introduction to Virology', 'Molecular Diagnostics', 'Biodiversity and its Conservation', 'Insights into Immunology', 'Enzymology', and 'Microbial World' proposed to be offered under NEP-2020 by the Department of Botany.

The contents of these courses are placed at Annexure-III.

5. To consider and approve course contents for the Elective Courses 'Advanced Plant Virology' and 'Perspectives in Plant Diversity' to be offered by the Department of Botany in the Ph.D. course work.

The board considered and approved course contents of the two courses 'Advanced Plant Virology' and 'Perspectives in Plant Diversity' to be added to the list of electives offered in the Ph.D. Botany course work. The contents of these courses are placed at Annexure-IV.

6. To consider and approve the names of external examiners for question paper setting and conducting the End-semester Practical examination.

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The board considered and approved the proposed list of external examiners for question paper setting, and smooth conduct of the End-semester Practical examination. The list is placed at Annexure-V.

7. To report the minutes of the Ph.D. RAC meeting held on 30 May, 2024.

The board was apprised with the minutes of the RAC meeting held on 30 May, 2024 to monitor the six-month progress of the Ph.D. scholars of the Department of Botany. The minutes of this meeting are placed at Annexure-VI


8. Any other item with permission of the chair.


The board considered and approved a minor revision in contents of the Core Course 'Fundamentals of Cell Biology' offered in the 3rd Semester of Integrated B.Sc. (Hons.) - M.Sc. Botany programme under NEP-2020. The revised syllabus is place at Annexure-VII.


9. The meeting ended with a vote of thanks.


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Prof. B.S. Bhau (Chairperson and HoD)



03/06/24
Prof. Namrata Sharma (External Expert)



3/6/24
Dr. Shweta Yadav (External Member)


03/06/24
Prof. Suram Singh (Dean Academics)


03/06/2024
Dr. Uday Pratap Singh (Associate Dean Academics)


03/06/24
Dr. Yogesh Kumar (Member)


Dr. Ashok Kumar (Member)


Dr. Deepak Bhardwaj (Special Invitee)


3/6/2024
Dr. Samantha Vaishnavi (Special Invitee)


03.06.24
Dr. Vikas Srivastava (Special Invitee)

Plant Physiology

LTP: 3-0-2

Credits: 4

Course Objectives:

- 1) Understand the fundamental principles of plant physiology and their relevance to plant growth, development, and responses to the environment.
- 2) Explore the mechanisms of water uptake, transport, and mineral nutrition in plants.
- 3) Examine the process of photosynthesis, including light reactions, carbon fixation, and factors influencing photosynthetic efficiency.
- 4) Investigate the hormonal regulation of plant growth and development, focusing on the role of phytohormones and their interactions.
- 5) Analyze various plant responses to environmental stimuli such as light, gravity, temperature, and biotic/abiotic stressors, and develop an understanding of the signal transduction pathways underlying these responses.

Course Outcomes:

- 1) Describe the concepts of water potential, osmosis, water uptake, transpiration, and nutrient transport in plants, including their mechanisms and significance in plant cells.
- 2) Outline the process of photosynthesis, including light capture, carbon fixation, and its role in the global carbon cycle. Evaluate factors influencing photosynthetic efficiency and differentiate between C3 and C4 pathways.
- 3) Discuss the role of phytohormones in regulating plant growth and development, covering processes such as cell division, growth, photomorphogenesis, senescence, and abscission.
- 4) Analyse plant responses to various environmental stimuli, including light, gravity, temperature, and stressors. Explain the mechanisms and significance of phototropism, photoperiodism, gravitropism, and thigmotropism.
- 5) Discuss the defense mechanisms employed by plants against biotic and abiotic stressors and understand the signal transduction pathways involved in plant responses to environmental cues.


Theory

Unit 1: Plant Water Relations and Mineral Nutrition

Introduction to Plant Physiology, Water and Plant Cells: Mechanisms of water uptake and transport, osmosis and its role in plant cells, movement, ascent of sap (include root pressure and guttation), transpiration and its significance, and cohesion-tension theory, Water potential and its components, stomatal movements –ion theory. Soil-Plant Relationships: Soil composition, nutrient availability, and root adaptations. Mineral Nutrition: Essential elements, nutrient uptake, and transport in plants, classification of mineral elements: Essential elements (macro- and micronutrients) and beneficial elements, General role of essential elements, transport of ions across membrane, active and passive transport (brief account of carriers, channels and pumps). Composition of phloem sap, girdling experiments, Pressure Flow Model, phloem loading and unloading.

Unit 2: Photosynthesis and Respiration










Overview of Photosynthesis: Light reactions and Calvin cycle, Light Capture and Energy Conversion: Photosynthetic pigments, light absorption, and electron transport, Carbon Fixation and Calvin Cycle: Carbon dioxide fixation, RuBisCO enzyme, carbohydrate synthesis, Photosynthetic Efficiency: Factors influencing photosynthetic rate, environmental regulation, and C3/C4/CAM pathways, Photosynthesis and Global Carbon Cycle: Impacts of photosynthesis on atmospheric carbon dioxide levels, Photorespiration, Metabolite pool and exchange of metabolites, synthesis and degradation of sucrose and starch, Respiration in plants and Cyanide resistant respiration.

Unit 3: Plant Growth and Development and response to light and temperature

Hormonal Regulation of Plant Growth: Phytohormones and their roles in plant growth and development, Auxins, cytokinins, gibberellins, abscisic acid, and ethylene, Photomorphogenesis: Light-mediated regulation of plant development, Senescence and Abscission: Aging processes in plants and leaf/fruit shedding.

Photoperiodism - discovery (SDP, LDP, day neutral plants), concept of florigen; phytochrome (discovery and physiological role), vernalization: Genes involved in environmental responses.

Unit 4: Nitrogen metabolism and Plant Responses to Environmental Stimuli

Nitrate assimilation (NR and NiR), biological nitrogen fixation in legumes (nodulation and role of dinitrogenase) Ammonia assimilation: GS-GOGAT, reductive amination and transamination, ROS, RNS and anti-oxidative defence strategies.

Plant Responses to Light, Gravity and Touch (Phototropism): Gravitropism and thigmotropism, Plant Responses to Temperature: Effects of temperature on plant growth and metabolism, Plant Responses to Biotic and Abiotic Stress: Defense mechanisms against pathogens, drought, salinity, and other stressors, Signal Transduction Pathways: Mechanisms underlying plant responses to environmental cues.

Practical

- 1) To demonstrate imbibition.
- 2) To demonstrate osmosis in the living cells of potato.
- 3) To measure the rate of transpiration by using Ganong's potometer under two environmental conditions such as direct sunlight and diffused sunlight.
- 4) To find out the stomatal frequency and transpiration index of a leaf.
- 5) To Study Hill's reaction
- 6) To show the effect of carbon dioxide concentration on the rate of photosynthesis by using test tube funnel experiment.
- 7) To separate the leaf pigments by paper chromatographic technique.
- 8) To separate the leaf pigments by thin layer chromatographic technique.
- 9) To determine respiration in the absence of O_2 .
- 10) To demonstrate Respiratory Quotient (RQ)
- 11) To demonstrate alcoholic fermentation of sugar by microorganisms and anaerobic respiration.

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- 12) To estimate the sugar content of the given sample of orange fruit by colorimetric method.
- 13) To study the effect of different concentrations of ABA on stomatal closure.
- 14) To study the effect of light and dark on seed germination.
- 15) To study induction of amylase activity in germinating barley grains.
- 16) To study the effect of ethylene on fruit ripening.
- 17) To study the effect of auxin on rooting.

Suggested readings:

1. Govindjee, & Whitmarsh, J. (Eds.). (2011). Photosynthesis: Plastid Biology, Energy Conversion and Carbon Assimilation (Advances in Photosynthesis and Respiration) (Vol. 34). Dordrecht, Netherlands: Springer.
2. Taiz, L., & Zeiger, E. (2010). Plant Physiology. Sunderland, MA: Sinauer Associates.
3. Campbell, N. A., & Reece, J. B. (2008). Biology (8th ed.). San Francisco, CA: Pearson Benjamin Cummings.
4. Davies, P. J. (Ed.). (2010). Plant Hormones: Biosynthesis, Signal Transduction, Action! Dordrecht, Netherlands: Springer.
5. Quail, P. H. (2002). Photosensory Perception and Signalling in Plant Cells: New Paradigms? *Current Opinion in Plant Biology*, 5(5), 469-475.

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Molecular Biology and Plant Biotechnology

LTP: 3-0-2

Credits: 4

Course Objectives:

- 1) Introduce students to the foundational concepts of molecular biology, including the central dogma, nucleic acid structure and function, and chromatin organization.
- 2) Familiarize students with the processes of transcription and translation, and the mechanisms of gene regulation at transcriptional, post-transcriptional, and translational
- 3) Provide an overview of plant cell biology, tissue culture techniques, and genetic engineering principles in plant biotechnology.
- 4) Explore advanced topics in plant biotechnology, such as genome editing, metabolic engineering, and stress tolerance mechanisms.
- 5) Discuss the ethical and regulatory considerations surrounding genetic engineering and biotechnological advancements.

Course Outcomes:

Upon completion of this course, students should be able to:

- 1) Explain the central dogma of molecular biology and its implications in DNA replication, transcription, and translation. Analyse the structure and function of nucleic acids, including DNA, RNA, and chromatin, and their role in gene expression.
- 2) Differentiate between prokaryotic and eukaryotic transcription and translation processes, including post-transcriptional modifications and translational control mechanisms. Discuss various mechanisms of gene regulation, including transcriptional, epigenetic, and post-transcriptional regulation, along with their significance in cellular function.
- 3) Apply basic plant biotechnology techniques such as tissue culture, genetic engineering, and genomics/transcriptomics analysis in research and practical applications.
- 4) Evaluate the principles and applications of genome editing technologies in plants, including CRISPR/Cas9, TALENs, and ZFNs.
- 5) Analyse metabolic pathways in plants and explain strategies for engineering plant metabolism to produce desired compounds. Examine genetic engineering approaches aimed at enhancing stress tolerance in plants and their potential applications in agriculture and environmental sustainability.

Theory**Unit 1: Introduction to Molecular Biology**

Discovery of nucleic acids, Experiments that established nucleic acids (DNA & RNA) as the carrier of genetic information: Griffith's, Hershey & Chase, Avery, McLeod and McCarty. Central Dogma: Nucleic Acids: Structure and Function of DNA and RNA, DNA Replication: General principles – bidirectional, semiconservative and semi-discontinuous replication. Brief account of initiation, elongation, and termination. Chargaff's rule; Watson and Crick model; salient features of DNA double helix. Types of DNA: A, B & Z conformations, denaturation and renaturation, types of RNA (brief account of mRNA, rRNA, tRNA, small RNAs). Organellar DNA: Chloroplast and Mitochondria.

Unit 2: Gene Expression and Regulation

Transcription: RNA synthesis: Initiation, elongation, and termination. Differences between prokaryotic and eukaryotic transcription. Post-transcriptional modifications: capping, splicing, polyadenylation. Translation: Ribosome structure and function. Genetic code: Codons, amino acids, start, and stop codons. Mechanism of translation: Initiation, elongation, and termination. Regulation of translation: Translational control elements, riboswitches. Gene Regulation: Transcriptional regulation: Operons, transcription factors (brief account), enhancers, silencers.

Unit 3: Fundamentals of Plant Biotechnology

Overview of the field, its importance, and applications. Plant Tissue Culture: Techniques involved in growing plant cells, tissues, and organs in an artificial environment. Genetic Engineering Basics: Restriction endonucleases- biological role and application. Cloning vectors- Plasmids, phagemid, cosmid, shuttle vector, eukaryotic vectors. Principles and techniques of genetic engineering, including gene cloning and transformation: Recombinant DNA, bacterial transformation and selection of recombinant clones. Genomic and cDNA libraries, PCR.

Unit 4: Advanced Plant Biotechnology

Methods of gene transfer to plants: Agrobacterium-mediated transformation (Ti and Ri plasmids, development of binary vectors). Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; selection of transgenic plants: selectable marker genes (Positive selection markers – antibiotic- and herbicide-resistance conferring genes) and reporter genes (Luciferase, GUS, GFP); Introduction to genome editing. Pest resistant (Bt-cotton) and herbicide resistant plants; Transgenic crops with improved quality traits (Flavr Savr™ tomato, Golden™ rice); Biosafety of transgenic plants.

Practical

Molecular Biology

1. Preparation of LB medium and raising *E. coli*.
2. Preparation of stock solutions of different molarity and molality.
3. To study the restriction digestion and gel electrophoresis of plasmid DNA through pictures.
4. To quantify the unknown DNA by diphenylamine reagent (colorimetry).
5. To study of DNA replication mechanisms through photographs and appropriate study materials (Rolling circle, Theta replication and semi-discontinuous replication).
6. To study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through electron and fluorescence micrographs.
7. To observe the photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's and Hershey).
8. To study the following through photographs: Assembly of Spliceosome machinery, Splicing mechanism in group I & group II introns and Ribozyme.

Plant Biotechnology

9. To prepare the MS medium.

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10. To demonstrate the *in vitro* sterilization and inoculation methods using leaf and nodal explants.
11. To study the anther, embryo and endosperm culture, micropropagation, somatic embryogenesis and artificial seeds through videos and pictures.
12. Isolation of cauliflower genomic DNA.
13. To study the isolation of protoplasts through pictures.
14. To study the methods of gene transfer through photographs: *Agrobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment etc.
15. To study of steps of genetic engineering for production of *Bt* cotton, Golden rice, Flavr Savr tomato.

Suggested Readings:

1. William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino, & Darrell Killian (2019). Concepts of Genetics. Pearson; 12th edition.
2. Snustad, D.P. and Simmons, M.J. (2019). Principles of Genetics. John Wiley, 7th edition.
4. Russell, P. J. (2010). iGenetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
3. Griffiths, A.J.F., John Doebley J., Peichel, C., Wassarman D.A. (2020). Introduction to Genetic Analysis. W H Freeman & Co; 12th edition.
4. Brown, T. A. (2020) Gene Cloning & DNA Analysis: An Introduction. 8th edn. UK: Wiley Blackwell.
5. Glick, B.R., & Patten C. (2022). Molecular Biotechnology: Principles and Applications. 6th edn. Washington, U.S.: ASM Press.

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Fundamentals of Genetics and Cytogenetics**LTP: 4-0-0****Credits: 4****Course Objective:**

The objective of this course is to provide knowledge of classical Mendelian and non-Mendelian genetics and basic cytogenetics. The students who successfully complete this course to are expected to have sufficient basic knowledge to study advanced topics in genetics and cytogenetics.

Course Outcomes:

Upon the successful completion of this course, students should be able to:

1. Describe Mendelian and non-Mendelian inheritance.
2. Perform monohybrid and dihybrid crosses in eukaryotes, solving problems of incomplete dominance, multiple alleles, sex-linkage and epistasis using Punnett Squares.
3. Map genes in eubacteria and eukaryotes by 2 - or 3 - point test crosses.
4. Recognize, describe and discuss the different aspects of chromosomal structure and function.
5. Identify and describe different types of chromosomal aberrations, and their role in evolution.
6. Understand that inheritance can also be extra-nuclear, and be able to elucidate the different modes.

Theory**Unit 1 : Mendelian genetics and its extension**

Pre- Mendelian genetic concepts, Concepts of phenotype and genotype, haploid and diploid, alleles, heredity and variation; Mendelian experiments on pea plants – concept of dominant and recessive traits, monohybrid cross in pea plant, Law of segregation, back cross and test cross, dihybrid cross in pea plant, Law of independent assortment, penetrance and expressivity (genetic problems related to above topics); Extensions of Mendelian principles - codominance, incomplete dominance, gene interactions - complementary gene interaction/ duplicate recessive epistasis (flower colour in *Lathyrus odoratus*), supplementary gene interaction/ recessive epistasis (grain colour in maize), dominant epistasis (fruit colour in *Cucurbita pepo*), duplicate dominant epistasis (shepherd's purse fruit shape), dominant recessive epistasis; multiple alleles - ABO blood groups and Rh factor in humans, pleiotropy.

Unit 2: Chromosome structure, types and function

Chromosome - gross morphology, fine structure and molecular organization of chromatin; Structure and significance of centromere and telomeres; Structure and functions of specialized chromosomes – polytene, lampbrush and B-chromosome; Review of meiosis; Synapsis, synaptonemal complex, Chromosomal theory of inheritance; Linkage - complete linkage and incomplete linkage, significance of linkage; Crossing-over – definition, recombination and recombination frequency; mechanism of crossing over and chiasma formation, cytological

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basis of crossing-over – Creighton and McClintock's experiments on maize. Stern's experiment in *Drosophila*; Understanding linkage and crossing over, and their implications in inheritance patterns; Chromosome mapping - two factor and three factor crosses, interference and coincidence.

Unit 3: Structural and numerical changes in chromosomes

Basic and haploid chromosome number; Structural chromosomal aberrations – Origin, genetical and cytogenetical identification of deletion, duplication, inversion (paracentric, pericentric), translocation (reciprocal and Robertsonian translocations). Role of aberrations in evolution; Numerical variations of chromosomes – Origin, cytological and breeding behaviour of aneuploids (monosomics, trisomics) and euploids (autopolyploids, allopolyploids). Induction of polyploidy, Role of polyploids in evolution – wheat, cotton and *Brassica*.

Unit 4: Extrachromosomal inheritance

Chloroplast mutation - Variegation in Four o'clock plant; Mitochondrial mutations in yeast; Maternal effects - Shell coiling in snail; Infective heredity- Kappa particles in *Paramecium*; Cytoplasmic male sterility in plants.

Practical

1. To study mitosis in *Allium cepa* through temporary squash preparation of root tips.
2. To study meiosis in *Allium cepa* / *Tradescantia* / *Phlox* through smear preparation of anthers.
3. Genetic problems on monohybrid cross.
4. Genetic problems on dihybrid cross.
5. To study deviations of Mendelian dihybrid ratio and incomplete dominance and (12:3:1, 9:3:4, 9:7, 15:1, 13:3) through seed samples.
6. Chromosome mapping using test cross data.
7. Study of autosomal and sex-linked dominant and recessive inheritance through pedigree analyses.
8. Photographs/Permanent slides showing translocation ring, quadrivalents, laggards, dicentric / inversion bridge through permanent slides.
9. Study of human genetic traits: Sickle cell anemia, Xeroderma Pigmentosum, Albinism, red-green Colour blindness, Widow's peak, Rolling of tongue, Hitchhiker's thumb and Attached ear lobes.
10. To study the syndromes (Downs, Klinefelters, and Turners) through karyotypes.

Suggested readings

- 1) Klug, W. S., Cummings, M., Spencer, C. A., Palladino, M. A., & Darrell, K. (2019). Concepts of Genetics (12th ed.). San Francisco, NY: Pearson. ISBN-13: 9780134604718.

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- 2) Griffith, A. J. F., Wessler, S. R., Carroll, S. B., & Doebley, J. (2010). Introduction to Genetic Analysis (10th ed.). W. H Freeman & Co. ISBN-13: 978-0716768876
- 3) Gardner, E. J., Simmons, M. J., & Snustad, D. P. (2006). Principles of Genetics (8th ed.). USA: Wiley. ISBN-13: 978-8126510436.
- 4) Elrod, S., & Stansfield, W. (2010). Schaum's Outline of Genetics (5th ed.). McGraw Hill. ISBN-13: 978-0071625036.

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Ecology and Environment

LTP: 3-0-2

Credits: 4

Course Objectives:

- 1) Understand the fundamental concepts of ecology, including its definition, branches, historical development, and significance in addressing environmental challenges.
- 2) Explore the dynamics of populations, including growth models, limiting factors, and regulation mechanisms, and analyse trends and challenges related to the human population.
- 3) Examine the structure and interactions within ecological communities, including species interactions, the role of keystone species, succession processes, and community stability.
- 4) Analyse the components and functioning of ecosystems, including energy flow, nutrient cycling, and primary productivity, and evaluate human impacts on ecosystems and conservation strategies.
- 5) Explore factors influencing species distribution and biogeographic realms. Integrate and apply ecological concepts to analyse real-world ecological issues, employ research methodologies, and explore future directions in the field.

Course Outcomes:

- 1) Demonstrate a thorough understanding of ecological concepts, including levels of organization, population dynamics, community structure, and ecosystem functioning.
- 2) Critically evaluate ecological theories, research findings, and environmental issues, and apply quantitative and qualitative methods to analyze ecological data, population trends, species interactions, and ecosystem dynamics.
- 3) Effectively communicate ecological concepts, research findings, and conservation strategies through written reports, presentations, and discussions.
- 4) Recognize the interdisciplinary nature of ecology and its connections with other scientific disciplines, social sciences, and environmental management.
- 5) Consider the ethical implications of ecological research and conservation practices, demonstrating awareness of environmental ethics and sustainability principles.

Theory**Unit 1: Introduction to Ecology**

Overview of Ecology: Definition, branches, and its significance in understanding ecosystems and environmental issues. Historical Development: Contributions of key figures such as Darwin and Odum to ecological theory. Levels of Organization: Understanding individual, population, community, ecosystem, and biosphere levels. Application in Environmental Issues: Linking ecological principles to real-world challenges like climate change and habitat loss. Habitat and Niche: Understanding habitat and niche, their characteristics, and their importance in species survival and coexistence.

Unit 2: Population Ecology

Population Dynamics: Characteristics of populations, growth models (exponential and logistic), and carrying capacity. Limiting Factors: Understanding factors that limit population

growth and the concept of carrying capacity. Population Regulation: Exploring density-dependent and density-independent regulation mechanisms. Human Population: Trends, implications, and strategies for addressing related challenges.

Unit 3: Community Ecology

Community Structure: Factors influencing structure and understanding ecological communities. Species Interactions: Types of interactions like competition, predation, mutualism, and their examples. Keystone Species: Importance and examples, trophic cascades, and food webs. Succession and Stability: Types of succession, factors affecting it, and its relationship with stability.

Unit 4: Ecosystem Functioning and Biogeography

Ecosystem Introduction: Components, types, energy flow, and nutrient cycling. Primary Productivity: Understanding factors influencing productivity and ecosystem energetics. Human Impact: Threats to ecosystems and biodiversity, consequences, and conservation strategies. Biogeography: Factors influencing species distribution, biogeographic realms, and their characteristics. Synthesis and Application: Integrating concepts, real-world applications, research methodologies, and future directions in ecology.

Practical

- 1) To investigate the population growth of a model organism under controlled conditions and understand the concepts of exponential and logistic growth models.
- 2) To examine the effects of different species interactions (competition, predation, mutualism) on community structure and dynamics.
- 3) To quantify nutrient cycling rates in a terrestrial or aquatic ecosystem and understand the importance of nutrient availability for ecosystem functioning.
- 4) To determine the habitat preferences of selected species and explore the concept of niche specialization for species survival and coexistence.
- 5) To observe the effects of trophic cascades on community dynamics and understand the role of keystone species in ecosystem stability.
- 6) To estimate the carrying capacity of an ecosystem for a particular species and investigate the factors influencing population regulation.
- 7) To study the process of ecological succession in a disturbed area and analyze the changes in species composition and ecosystem structure over time.
- 8) To measure primary productivity in a selected ecosystem and assess the factors influencing energy flow and ecosystem energetics.
- 9) To analyze species distribution patterns in different biogeographic regions and identify the factors shaping species diversity and distribution.
- 10) To assess the ecological consequences of human activities on local ecosystems and propose conservation strategies to mitigate negative impacts.
- 11) Field visit

Suggested readings:

- 1) Molles Jr., M. C. (2014). Ecology: Concepts and Applications. McGraw-Hill Education.

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Introduction to Virology

LTP: 4-0-0

Credits: 4

Course objective:

The course aims to provide an overview of viruses, covering their origins, evolution, taxonomy, structure, transmission, replication, diagnostics, and control strategies. Viruses evolve rapidly and can lead to severe diseases in economically significant plants, animals, and humans, posing a substantial threat to agriculture, food security, and animal and human health. Understanding viruses will equip the students to tackle these challenges effectively.

Course outcomes:

On successful completion of this course, the students should be able to:

- 1) understand the origin and evolution of viruses, the history of virology, taxonomy of viruses, and differentiate between viruses and virus-like infectious agents.
- 2) describe structures and genome organisations of viruses and various events involved in virus replication.
- 3) comprehend various methods to study and diagnose viruses.
- 4) strategize control measures, and devise applications of viruses.
- 5) gain knowledge about the biosafety protocols necessary for conducting virological studies, as well as the ethical considerations inherent in virology experiments.

Syllabus

Unit 1: Introduction to viruses and virus-like infectious agents

Introduction to viruses, history of virology, origin and evolution of viruses, virus taxonomy. Defective particles, satellite nucleic acids and satellite viruses, viroids, prions, bacteriophages and virophages.

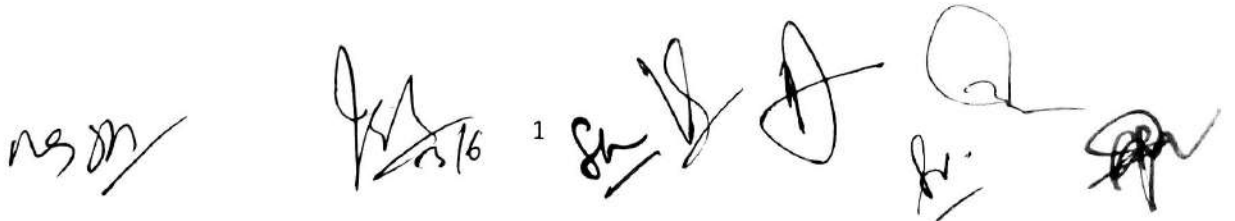
Unit 2: Virus structure and replication

Structure of viruses, genome organization and expression of viral genomes. Replication of RNA and DNA Viruses: entry, genome replication, transcription, translation, assembly and exit with emphasis on influenza, HIV, hepatitis, *Coronavirus*, *Tobacco mosaic virus*, *Caulimovirus*, *Tomato leaf curl virus*.

Unit 3: Virological Techniques

Host range, transmission, movement and symptomatology of viruses with emphasis on common plant, animal and human viruses. Propagation, purification and characterization of viruses. Physical, biochemical, serological and molecular methods of virus detection, diagnosis and assay.

Unit 4: Virus control and applications



Conventional and transgenic approach to control plant viruses, quarantine, antiviral compounds and vaccines. Applications of viruses in biotechnology, nanotechnology, medicine and human health. Viruses as biological warfare, bio-crime and bioterrorism agents.

Units 5: Biosafety and ethics in virology

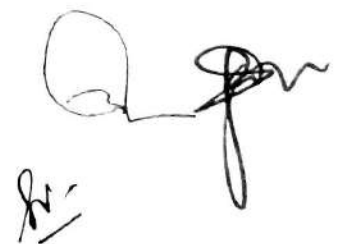
Laboratory bio-safety, classification of bio-safety levels and risk groups, containment, Good Laboratory Practices, disinfection, decontamination and sterilization procedures. Ethics in virus-related research, ethical and regulatory issues in animal experiments, issues related to Good Manufacturing Practices (GMP), Intellectual Property Rights (IPR): concepts and importance.

Suggested Readings:

- 1) Roger Hull. Comparative Plant Virology. Academic Press. 2009. ISBN: 978-0123741547
- 2) Alan J. Cann. Principles of Molecular Virology. 6th Edition. Academic Press. 2015. ISBN: 978-0128019467
- 3) J. Carter and V. Saunders. Virology: Principles and Applications. John Wiley & Sons Ltd. 2013. ISBN: 978-1119991427
- 4) S.J. Flint, L.W. Enquist, V.R. Racaniello, A.M. Skalka. 2009. Principles of Virology. American Society for Microbiology. ISBN: 978-1555814434
- 5) D.M. Knipe and P.M. Howley. Fields Virology. 2013. Lippincott Williams and Wilkins. ISBN: 978-1451105636



2



Molecular Diagnostics

LTP: 4-0-0

Credits: 4

Course Objectives:

The objectives of this course are to provide students with a comprehensive understanding of the principles, techniques, and applications of molecular diagnostics, as well as its role in clinical practice and research.

Course Outcomes:

On successful completing this course, students should be able to:

- 1) describe various molecular diagnostic techniques and their applications
- 2) comprehend the principles behind various immunological tests used in molecular diagnostics.
- 3) understand principles and applications of nucleic acid-based molecular diagnostic techniques.
- 4) evaluate advances and emerging technologies in molecular diagnostics.
- 5) consider ethical and regulatory issues in molecular diagnostics.

Pre-requisites:

- Successful completion of courses in, Molecular Biology, Genetics, Biochemistry and Biostatistics.
- Basic knowledge of molecular biology and genetics concepts, including DNA structure, gene expression, and genetic inheritance

Syllabus

Unit 1: Introduction to molecular diagnostics

Introduction to the basics of molecular biology and genetics, including DNA structure, gene expression, and genetic inheritance. Introduction to molecular diagnostics, applications of molecular diagnostics, types of molecular diagnostic techniques and their clinical applications. History and evolution of molecular diagnostics, its current status, and future directions.

Unit 2: Immuno-diagnostic techniques

Immunoassays: Direct, indirect, sandwich, competitive and dot ELISA, enzymes and types of antisera available in immunoassays. Direct, indirect, sandwich, competitive and solid-phase radioimmunoassay (RIA), western blotting, immune-tissue printing, Immunoelectron microscopy (IEM), and immune-capture PCR.

Unit 3: Nucleic acid-based diagnostic techniques

Principles, advantages, and limitations of Polymerase chain reaction (PCR), reverse transcription PCR, gel electrophoresis techniques, nucleic acid hybridization, microarrays, real-time PCR, and their applications in clinical practice and research. Methods of radiolabelled

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and non-radiolabelled probe preparation, PCR primer and probe designing. Use of molecular diagnostics for infectious diseases, cancer, and genetic disorders.

Unit 4: Advanced and emerging technologies in molecular diagnostics

DNA sequencing and its variations, Next-generation sequencing, liquid biopsy, and circulating tumour DNA. Bioinformatics tools for sequence analysis, 2D gel electrophoresis, MALDI-TOF, and their importance in understanding disease mechanisms and identifying diagnostic biomarkers. Emerging trends and technologies in molecular diagnostics, such as nanotechnology and biosensors.

Unit 5: Ethical and regulatory considerations in molecular diagnostics

Introduction to bioethics and ethical principles relevant to healthcare and diagnostics. Overview of regulatory agencies governing molecular diagnostics (e.g., CDSCO, FDA, EMA, CDC). Principles of quality control and assurance in molecular diagnostics. Ethical challenges posed by emerging technologies in molecular diagnostics. Ethical issues related to genetic testing and personalized medicine.

Suggested readings:

1. Patrinos, G. P., Ansoorge, W. J., & Danielson, P. B. (2017). *Molecular Diagnostics* (3rd ed.). Academic Press Elsevier. ISBN: 978-0-12-802971-8.
2. Buckingham, L. (2019) *Molecular diagnostics: fundamentals, methods and clinical applications*. FA Davis. ISBN: 978-0803668294
3. Grody, W. W., Nakamura, R. M., Kiechle, F. L., & Strom, C. (Eds.). (2009). *Molecular diagnostics: techniques and applications for the clinical laboratory*. Academic Press. 978-0123694287
4. Wilson, K., & Walker, J. (2010). *Principles and Techniques of Biochemistry and Molecular Biology* (7th ed.). Cambridge University Press. ISBN-13: 978-0521731676.
5. Punt, J., Stranford, S., Jones, P., & Owen, J. A. (2018). *Kuby Immunology* (8th ed.). WH Freeman Publisher. ISBN-13: 978-1319114701.
6. Brown, T. A. (2016). *Gene Cloning and DNA Analysis: An Introduction* (7th ed.). Wiley-Blackwell. ISBN-13: 978-1119072560.

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and non-radiolabelled probe preparation, PCR primer and probe designing. Use of molecular diagnostics for infectious diseases, cancer, and genetic disorders.

Unit 4: Advanced and emerging technologies in molecular diagnostics

DNA sequencing and its variations, Next-generation sequencing, liquid biopsy, and circulating tumour DNA. Bioinformatics tools for sequence analysis. 2D gel electrophoresis, MALDI-TOF, and their importance in understanding disease mechanisms and identifying diagnostic biomarkers. Emerging trends and technologies in molecular diagnostics, such as nanotechnology and biosensors.

Unit 5: Ethical and regulatory considerations in molecular diagnostics

Introduction to bioethics and ethical principles relevant to healthcare and diagnostics. Overview of regulatory agencies governing molecular diagnostics (e.g., CDSCO, FDA, EMA, CDC). Principles of quality control and assurance in molecular diagnostics. Ethical challenges posed by emerging technologies in molecular diagnostics. Ethical issues related to genetic testing and personalized medicine.

Suggested readings:

1. Patrinos, G. P., Ansorge, W. J., & Danielson, P. B. (2017). *Molecular Diagnostics* (3rd ed.). Academic Press Elsevier. ISBN: 978-0-12-802971-8.
2. Buckingham, L. (2019) *Molecular diagnostics: fundamentals, methods and clinical applications*. FA Davis. ISBN: 978-0803668294
3. Grody, W. W., Nakamura, R. M., Kiechle, F. L., & Strom, C. (Eds.). (2009). *Molecular diagnostics: techniques and applications for the clinical laboratory*. Academic Press. 978-0123694287
4. Wilson, K., & Walker, J. (2010). *Principles and Techniques of Biochemistry and Molecular Biology* (7th ed.). Cambridge University Press. ISBN-13: 978-0521731676.
5. Punt, J., Stranford, S., Jones, P., & Owen, J. A. (2018). *Kuby Immunology* (8th ed.). WH Freeman Publisher. ISBN-13: 978-1319114701.
6. Brown, T. A. (2016). *Gene Cloning and DNA Analysis: An Introduction* (7th ed.). Wiley-Blackwell. ISBN-13: 978-1119072560.

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Biodiversity and its Conservation

LTP-4-0-0

Credits: 4**Course Objective:**

Purpose of the course is to have sound understanding of biodiversity, species, ecosystems and the interconnection of the living world. Students will be able to use the indices for the analysis of diversity. They will be able to understand the dire need of conservation of biodiversity.

Course Outcomes:

With completion of this course, students will be able to:

1. Understand the concept of biodiversity, importance of biodiversity
2. Use the indices for quantitative analysis of biodiversity in term of species richness and evenness.
3. Get familiar with method of conservation of biodiversity.
4. They will further be able to know about the international bodies involved in biodiversity conservation.

Syllabus**Unit: I Concept and key areas of biodiversity**

Concept of biodiversity; diversity forms: ecological, morphological, functional; Biodiversity as source of food, fodder and fuel and medicine; ethical values; cultural values; RET species.

Unit: II Biodiversity pattern and theories of distribution

Latitudinal gradients in species diversity; Concept of hot spot of biodiversity and hot spot of biodiversity region in India and world. The phylogeographic regions of the world.

Unit: III Assessment of biodiversity

Plant collections, Species Inventories, Species Richness and Evenness, Diversity indices, Genetic Diversity Analysis: polymerase chain reaction (PCR), DNA sequencing.

Unit: IV Loss of biodiversity:

Extinction of Species; natural, mass, anthropogenic; Causes of extinction, consequences of extinction of species, biodiversity erosion, Impact of climate change on biodiversity and food security, climate change

Unit: V Conservation strategies:

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Insights into Immunology

LTP: 4-0-0

Credits: 4

Course Objectives:

- 1) Understand the fundamental concepts, components, and organization of the immune system, including the mechanisms of innate and adaptive immunity.
- 2) Explain the roles and functions of innate immune cells, pattern recognition receptors, phagocytosis, inflammation, the complement system, and natural killer cells in protecting the body from pathogens and maintaining homeostasis.
- 3) Describe the development, activation, and differentiation of T cells in cellular immunity, their role in immune responses against intracellular pathogens, and their involvement in immunological disorders.
- 4) Explain B cell development, antigen recognition, antibody production, and the structure and function of antibodies. Recognize the importance of humoral immunity in combating extracellular pathogens and vaccination strategies.
- 5) Explore the dynamic interplay between the immune system and various pathological conditions, including hypersensitivity reactions, autoimmunity, immunodeficiency disorders, and investigate cutting-edge approaches in cancer immunotherapy and the principles of immunosurveillance.

Course Outcomes:

- 1) Differentiate between innate and adaptive immunity, detailing key immune cells and their functions.
- 2) Identify primary immune organs and tissues responsible for immune system functions.
- 3) Recognize the significance of pattern recognition receptors in pathogen detection.
- 4) Explain the roles of the complement system and natural killer cells in immune responses.
- 5) Discuss the central involvement of T cells in immune responses, including their role in immune-mediated diseases, activation, differentiation in cellular immunity, as well as the importance of B cells, antibody production, hypersensitivity reactions, autoimmunity, and cancer immunotherapy.

Syllabus

Unit 1: Introduction to Immunology

Overview of the immune system, Components and organization of the immune system, Functions of the immune system, Distinction between innate and adaptive immunity, Immune cells and their roles, Primary organs and tissues involved in immune function

Unit 2: Innate Immunity

Mechanisms of innate immune response, Pattern recognition receptors, Phagocytosis and its significance, Inflammatory responses, The complement system, Natural killer cells and their cytotoxic functions

Unit 3: Adaptive Immunity: Cellular

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Overview of adaptive immunity, T cell development, activation, and differentiation. Role of T cells in immune responses against intracellular pathogens, T cell-mediated immunological disorders

Unit 4: Adaptive Immunity: Humoral

B cell development and activation, Antigen recognition and antibody production, Structure and function of antibodies, Effector mechanisms of antibodies, Immunological memory Role of humoral immunity in vaccination strategies

Unit 5: Immune Responses and Disorders

Hypersensitivity reactions, Autoimmunity, Immunodeficiency disorders, Cancer immunotherapy Principles of immunosurveillance, Discussion on immune system dysfunction and its implications

Suggested readings:

- 1) Janeway's Immunobiology by Kenneth Murphy et al. (Textbook)
- 2) Immunology: A Short Course by Richard Coico et al. (Textbook)
- 3) Immunology for Medical Students by Nima Rezaei et al. (Textbook)
- 4) Clinical Immunology: Principles and Practice by Robert R. Rich et al. (Textbook)
- 5) Abbas AK, Lichtman AH, Pillai S. Cellular and Molecular Immunology. Elsevier Health Sciences.

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Course Objective:

This course aims to provide students with a comprehensive understanding of enzymology, covering the historical background, classification, structure, function, inhibition, regulation, factors affecting activity, and advanced topics in the field. By the end of the course, students should be equipped with the knowledge and skills necessary to comprehend the fundamental principles of enzymology and apply them to various industrial, clinical, and environmental contexts.

Course Outcomes:

- 1) Understand enzyme classification and historical background, including protein nature, coenzymes, and metal-activated enzymes.
- 2) Identify and explain enzyme terminology, nomenclature, and activity, incorporating coenzymes, cofactors, and isozymes.
- 3) Describe enzyme structure at various levels and analyze active sites and substrate binding.
- 4) Apply enzyme kinetics principles (Michaelis-Menten equation, K_m , V_{max}) for understanding enzyme catalysis mechanisms.
- 5) Analyze enzyme inhibition mechanisms, such as reversible and irreversible inhibition, and explore regulatory processes like feedback regulation and allosteric regulation.

Syllabus**Unit 1: Introduction to Enzymes**

Historical background and discovery of enzymes

General terminology and nomenclature

Classification of enzymes: protein nature, non-protein enzymes (ribozymes, DNAzymes), metalloenzymes, and metal-activated enzymes

Enzyme activity: chemical nature, specific activity, enzyme units (Katal and IU)

Coenzymes and cofactors: prosthetic groups, classification, and involvement in metabolic pathways

Isozymes, abzymes, synzymes

Unit 2: Enzyme Structure and Function

Enzyme structure: primary, secondary, tertiary, and quaternary structure.

Enzyme active sites and substrate binding.

Enzyme kinetics: Michaelis-Menten equation, K_m , V_{max} , Lineweaver-Burk plot, turnover number, K_{cat} .

Enzyme mechanisms: acid-base, covalent, metal ion, proximity, and orientation effects.

Mechanisms of enzyme catalysis: lock and key, induced fit, transition state hypotheses.

Specific examples: mechanism of serine proteases (chymotrypsin, lysozyme, carboxypeptidase A, ribonuclease), proenzymes (zymogens).

Unit 3: Enzyme Inhibition and Regulation

Enzyme inhibition: reversible (competitive, non-competitive, uncompetitive, mixed, substrate, allosteric, product), irreversible (suicide inhibition), examples (penicillin, iodoacetamide, DIPF).

Feedback regulation, allosteric regulation, reversible covalent modification, proteolytic activation.

Organization of enzymes in the cell: localization, compartmentation of metabolic pathways, enzymes in membranes etc.

Mechanisms of enzyme degradation: lysosomal and non-lysosomal pathways, with examples.

Unit 4: Factors Affecting Enzyme Activity

Factors affecting enzyme activity: concentration, pH and temperature.

Kinetics of allosteric enzymes.

Industrial and clinical uses of enzymes (applied enzymology): thermophilic enzymes, amylases, lipases, proteolytic enzymes in industries (meat, leather), enzymes in fermentation processes, cellulose and metal degrading enzymes.

Unit 5: Advanced Topics in Enzymology

Enzyme kinetics of multi-substrate reactions.

Cooperative enzyme kinetics.

Enzyme engineering and directed evolution.

Enzymes in drug discovery and development.

Enzymes in bioremediation and environmental applications.

Suggested readings:

1. Nelson, D.L., Cox, M.M. (2017). "Lehninger Principles of Biochemistry." Publisher: W. H. Freeman.
2. Copeland, R.A. (2020). "Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis." Publisher: Wiley.
3. Palmer, T. (2018). "Enzymes: Biochemistry, Biotechnology, Clinical Chemistry." Publisher: CRC Press.
4. Ruzene, J.S., Campos, V.F. (2016). "Industrial Enzymes: Structure, Function and Applications." Publisher: Springer.
5. Ellis, G.M., Ladisch, M.R. (Eds.). (2017). "Enzymes in Synthetic Biology: Technologies and Applications." Publisher: Academic Press.

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Microbial World

LTP: 4-0-0

Credits: 4

Course Objectives:

- 1) Cover foundational microbiology concepts, emphasizing microorganism diversity and characteristics.
- 2) Study virus, bacteria, viroids, and prions structures, replication cycles, and classification.
- 3) Analyze how microorganisms contribute to infectious diseases and impact human health.
- 4) Explore the economic importance of microorganisms in medicine, agriculture, industry, and environmental management.
- 5) Introduce microbial biotechnology applications, including industrial processes, enzyme production, and bioremediation, while considering environmental and ethical implications.

Course Outcomes:

- 1) **Understanding Microbiology Fundamentals:** Students will be able to describe the characteristics, classification, and replication cycles of various microorganisms, including viruses, bacteria, viroids, and prions.
- 2) **Analyzing Microorganism Roles:** Students will demonstrate a comprehensive understanding of the impact of microorganisms on human health through disease and pathogenesis, as well as their economic importance in medicine, agriculture, and industry.
- 3) **Applying Microbial Biotechnology:** Students will analyze and assess the applications of microbial biotechnology in industrial processes, enzyme production, bioremediation, and environmental management, including nutrient cycling and decomposition.
- 4) **Developing Practical and Analytical Skills:** Students will gain proficiency in laboratory techniques for handling microorganisms and critically evaluate research and real-world applications of microbiology. Communication skills will be honed through presentations, discussions, and written reports.
- 5) **Promoting Ethical Practices and Teamwork:** Students will exhibit ethical awareness and responsible practices in microbial applications and collaborate effectively in group projects, demonstrating leadership and teamwork skills.

Syllabus**Unit 1. Foundations of Microbiology**

Introduction to the Microbial World

Discovery and Characteristics of Viruses

Classification of Viruses (Baltimore Classification)

General Structure of Viruses, Viroids, and Prions

Replication: DNA Virus (T-Phage) - Lytic and Lysogenic Cycle

Replication: RNA Virus (TMV)

Viral Diseases: Pox, Polio, HIV, Covid, TMV and CMV.

Unit 2: Bacterial Diversity and Physiology

Discovery and General Characteristics of Bacteria

Types of Bacteria: Archaeobacteria, Eubacteria, Wallless Forms

Bacterial Cell Structure and Nutritional Types

Bacterial Reproduction: Vegetative, Asexual, and Recombination

Bacterial Diseases: Typhoid, Salmonella, Botulinum, Syphilis, Gonorrhoea and citrus canker.

Unit 3: Applied Microbiology and Economic Importance

Economic Importance of Viruses: Vaccine Production, Research, Medicine, Diagnostics, and Plant Diseases

Economic Importance of Bacteria: Role in Agriculture and Industry (Fermentation and Medicine)

Microbes and Quality of Environment: Distribution and Isolation from Soil, Air, and Water

Microbial Flora of Water: Pollution Sources, Control Measures, and Water Quality Indicators.

Unit 4: Microbial Biotechnology

Bioreactors/Fermenters and Fermentation Processes

Types of Bioreactors: Laboratory, Pilot Scale, and Production Fermenters

Fermentation Techniques: Solid-State and Liquid-State, Batch and Continuous

Microbial Production of Industrial Products: Enzymes, Organic Acids, Alcohol, Antibiotics

Microbial Enzymes of Industrial Importance: Applications and Immobilization Method

Unit 5: Microbial Ecology and Environmental Applications

Microbial Diversity in Natural Environments

Microbial Interactions and Ecosystem Dynamics

Role of Microbes in Environmental Processes: Nutrient Cycling, Decomposition, and Bioremediation

Microbial Applications in Wastewater Treatment and Pollution Control

Microbes in Agriculture: Plant-Microbe Interactions and Biostimulation.

Suggested readings:

- 1) Pelczar, M.J. (2001). *Microbiology*, 5th edition. New Delhi, Delhi: Tata McGraw-Hill Co. (Chapter 1 for Unit 1;)
- 2) Talaro, KP, Talaro A. 2006. *Foundations in Microbiology*. New Delhi, Delhi: McGraw-Hill
- 3) Campbell, N.A., Reece, J.B., Urry, L.A., Cain, M.L., Wasserman, S.A., Minorsky, P.V., Jackson, R.B. (2008). *Biology*, 8th edition. San Francisco, California: Pearson Benjamin Cummings.
- 4) Prescott, L.M., Harley J.P., Klein D. A. (2005). *Microbiology*, 6th edition. New Delhi, Delhi: McGraw Hill. (Chapter 3,5 for Unit 3; Chapter 6 for Unit 1)

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- 5) Tortora, G.J., Funke, B.R., Case, C.L. (2007). *Microbiology*. San Francisco, U.S.A: Pearson Benjamin Cummings.

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Advanced Plant Virology

LTP: 4-0-0

Credits: 4

Course Objective:

The course aims to provide advanced knowledge and understanding of plant virology, including the latest research and developments in the field, and to equip students with the skills to apply this knowledge to address complex problems in plant virus diagnosis, management, and research.

Course Outcomes:

On successful completion of this course, the students should be able to:

- 1) critically evaluate the latest advances and emerging topics in plant virology research, including viroid biology, satellite viruses, and prions.
- 2) design and propose innovative applications of plant viruses in biotechnology, such as gene therapy, vaccine development, and gene editing.
- 3) analyse and discuss the ethical considerations and biosafety regulations surrounding plant virology research and applications, including gene editing and GMO regulations.
- 4) develop research proposals addressing frontier areas in plant virology.
- 5) communicate research papers on the significance and implications of plant virology and its applications.

Syllabus

Unit 1: Plant viruses and virus-like infectious agents

History of virology, origin of viruses, mechanisms of virus emergence and re-emergence, role of genetic drift, mutation, and recombination in virus evolution, virus taxonomy, Baltimore and ICTV classification of viruses, case studies of emerging plant viruses (e.g. begomoviruses and potyviruses). Viroids, prions, defective particles, bacteriophages, virophages, satellite nucleic acids and satellite viruses.

Unit 2: Plant virus structure, replication and interaction with host

Genome organization and capsid structures of plant viruses, replication of RNA and DNA viruses: entry, genome replication, transcription, translation, assembly and exit. Plant-virus interactions: recognition, signalling, and response. Plant defence mechanisms: RNA silencing, hormone regulation, and programmed cell death. Viral counter-defence strategies: suppressors of RNA silencing and hormone manipulation. Case studies of plant-virus interactions (e.g., *Tobacco mosaic virus*, *Tomato leaf curl virus*)

Unit 3: Plant virus transmission, epidemiology and diagnostic methods

Plant virus host-range, vector (insects, nematodes, fungi), seed, pollen and contact transmission. Epidemiology of plant virus diseases: factors affecting spread and disease development. Symptoms of plant viruses, case studies of plant virus epidemics (e.g., *Potato*

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virus Y, Cotton leaf curl virus). Physical, biochemical, serological (e.g. ELISA and its variations, Western blotting, radioimmunoassay, immune tissue printing) and molecular methods (e.g. PCR, RT-PCR, real-time PCR, Rolling Circle Amplification, Northern and Southern hybridization, microarray) of virus detection, diagnosis and assay.

Unit 4: Disease management strategies

Management strategies: cultural (e.g., crop rotation, pruning), chemical (e.g., pesticides, fungicides), biological (e.g., biopesticides, beneficial insects), and integrated pest management approaches. Conventional and transgenic approaches of disease management, quarantine, antiviral compounds and their applications. Case studies of successful virus management programs (e.g., *Citrus tristeza virus*, *Papaya ringspot virus*).

Unit 5: Frontiers in plant virology research and applications

Emerging topics in plant virology: Advances in genome sequencing methods, applications of plant viruses in biotechnology (gene therapy, vaccine development, and gene editing), nanotechnology, medicine and human health. Bioinformatic tools used in plant virology: multiple sequence alignment, phylogenetic and recombination analysis, PCR primer and real-time PCR probe designing tools. Cutting-edge technologies: CRISPR-Cas gene editing for virus resistance, RNA interference (RNAi) for virus control, and synthetic biology approaches. Ethical considerations and biosafety regulations. Future directions in plant virology research.

Suggested Readings:

- 1) Roger Hull. *Plant Virology*. 5th ed. Amsterdam: Academic Press, 2013. ISBN: 9780123848710
- 2) Sastry, K. Subramanya, and Thomas A. Zitter, eds. *Plant Virus and Viroid Diseases in the Tropics: Volume 1: Fundamentals and Laboratory Diagnostic Techniques*. Dordrecht: Springer, 2014. ISBN :9789400778206.
- 3) Gaur, R. K., Thomas Hohn, and Pradeep Sharma, eds. *Plant Virus-Host Interaction: Molecular Approaches and Viral Evolution*. Amsterdam: Academic Press, 2014. ISBN: 9780124115842.
- 4) Alan J. Cann. *Principles of Molecular Virology*. 6th Edition. Academic Press. 2015. ISBN: 978-0128019467
- 5) S.J. Flint, L.W. Enquist, V.R. Racaniello, A.M. Skalka. 2009. *Principles of Virology*.
- 6) D.M. Knipe and P.M. Howley. *Fields Virology*. 2013. Lippincott Williams and Wilkins. ISBN: 978-1451105636

Perspectives in Plant diversity

LTP-4-0-0

Credits: 4

Course Objective:

Objective of the course is to have sound understanding of plant diversity, patterns of diversity, ecosystems and the interconnection of the plant world. Students will be able to get in depth knowledge of the plants used for different ailments. They will be able to use the indices for qualitative and quantitative analysis of plant diversity. They will be able to understand the dire need of conservation of biodiversity.

Course Outcomes:

With completion of this course, students will be able to:

- 1) Understand the concept of biodiversity, importance of biodiversity
- 2) Collect the information of the traditional medicinal plants
- 3) Use the indices for quantitative analysis of biodiversity in term of species richness and evenness.
- 4) Discuss the causes of loss of biodiversity in past and present threats.
- 5) Get familiar with method of conservation of biodiversity. They will further be able to know about the international bodies involved in biodiversity conservation.

Syllabus

Unit-I Introduction to plant diversity and evolution

Importance of plant diversity, Levels of diversity: genetic, species, and ecosystem diversity. Patterns of plant diversity across different habitats and biome. Major events in plant evolution (e.g., vascular tissue, seeds). Modern Phylogenetic classification system for angiosperm: APG IV

Unit-II Plant diversity and Human Well-being

Cultural and aesthetic values of biodiversity, biodiversity as heritage and inspiration. Sustainable use of biodiversity, traditional medicinal plants for human health, sustainable agriculture and bioprospection. Economic valuation of plant diversity, ecosystem services and natural capital.

Unit-III Assessment of diversity

Plant collections, Species Inventories, Species Richness and Evenness, Diversity. Species richness indices Margalef's diversity index, Richness-Evenness indices, Shannon-Wiener diversity index, Brillouin index, Simpson's index, Pielou index. ecological niche modeling (ENM), Tools for Niche Modeling: Generalized Linear Models (GLM), Generalized Additive

Models (GAM), BIOMOD, MaxEnt. Genetic Diversity Analysis: polymerase chain reaction (PCR), RFLP (Restriction Fragment Length Polymorphism): AFLP (Amplified Fragment Length Polymorphism): RAPD (Random Amplified Polymorphic DNA): SSR (Simple Sequence Repeats) or Microsatellites: ISSR (Inter-Simple Sequence Repeats), DNA Barcoding: Chloroplast and Mitochondrial DNA Analysis, NGS (Next-Generation Sequencing). Phylogenetic Analysis Software: MEGA (Molecular Evolutionary Genetics Analysis) BEAST (Bayesian Evolutionary Analysis by Sampling Trees). Geographic Information System (GIS) Software: ArcGIS, QGIS. Statistical Analysis Software: Vegan, BiodiversityR, and phyloseq.

Unit-IV Diversity conservation strategies:

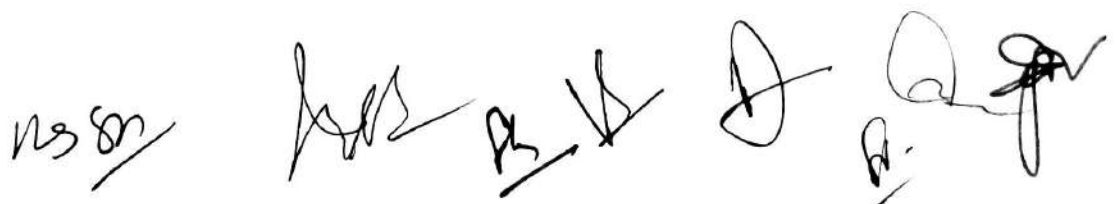
Programmes for diversity conservation, convention on biological diversity (CBD), SDGs, CITES, UNFCCC, Kyoto Protocol, TRIPS, Ramsar Convention on Wet Lands, Cartagena Protocol on Bio-Safety 2000 (CPB); The Nagoya Protocol, IUCN, Red List. Conservation strategies; In-situ: Wildlife sanctuaries, National parks, Biosphere reserves, mangrooves. Ex-situ: Botanical Gardens, Seed banks, Field gene banks.

Unit-V Emerging trends in Plants diversity

Climate-Resilient Species Selection, Digital Plant Identification and Monitoring through AI. Bioprospecting and Medicinal Plant Exploration, Community Seed Banks and Ex Situ Conservation, Agroecology and Sustainable Agriculture, Plant Microbiome Research.

Suggested readings:

1. Gaston, K.J. and Spicer J.I. (2004). Biodiversity: An Introduction. 2nd Edition. Blackwell Science Limited, U.S.A.
2. Hubbel, S.P. (2001). The unified neutral theory of biodiversity and biogeography. Princeton University Press, Princeton NJ.
3. Gaston, K.J & Blackburn, M.J. (2000). Pattern and Process in Macroecology. Blackwell Sciences Limited, Oxford, UK.
4. Huston, M.A. (1994). Biological Diversity. Cambridge University Press, Cambridge, U.K.
5. Dombois, D.M & Ellenberg, H. (1974). Aims and methods of vegetation ecology. John Wiley and Sons Inc, New York.

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Panel of External examiners for setting the End semester examination question paper and conducting the practical examination.
9th semester

Applied Plant in vitro Technology				
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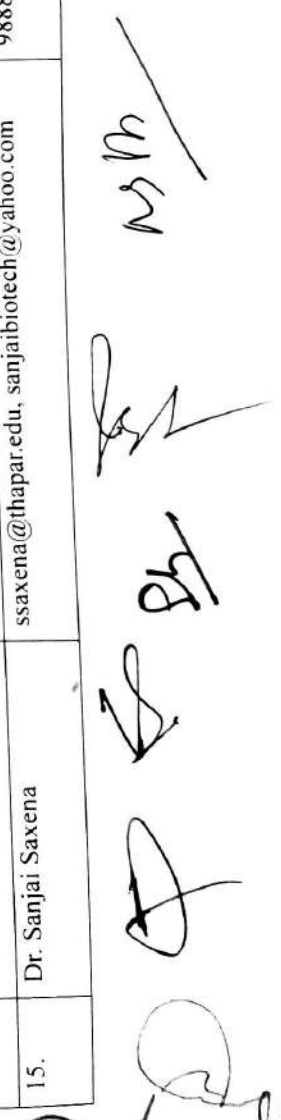
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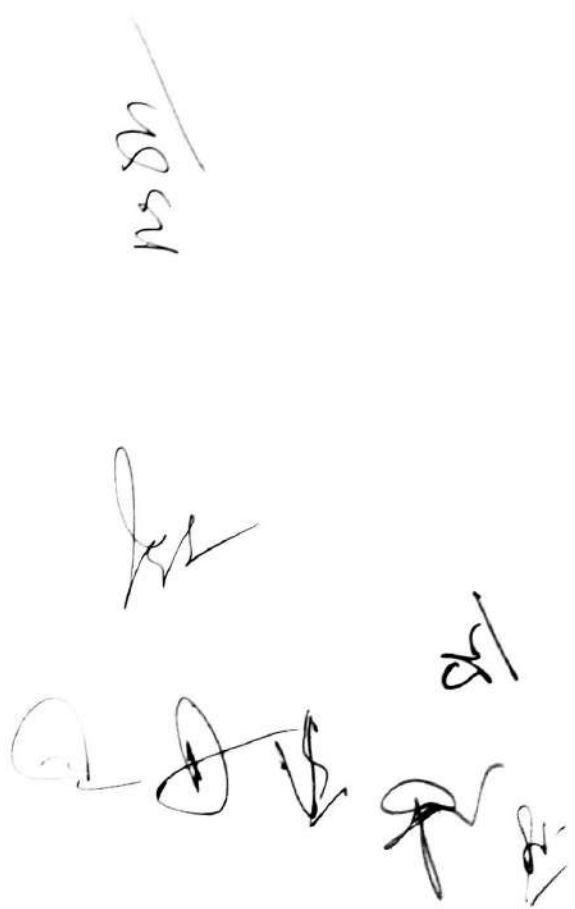
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