Level 6.0	Curriculum Matrix M.Sc. Botany						
Semester I					Marks Distribution		
Subject Type	Subject Code	Name of Subject	Hours/ week	Credit (L+T+P)	External	Internal	Total
Discipline Specific Core Course (DSCC)	MSC DSC - 101	Cell Biology and Biochemistry	3	3	70	30	100
	MSC DSC - 102	Algae, Bryophytes and Pteridophytes	3	3	70	30	100
	MSC DSC - 103	Diversity and Biology of Gymnosperms and Anatomy of Angiosperms	3	3	70	30	100
	MSC DSC - 104	Bio-Instrumentation	3	3	70	30	100
Laboratory	MSC DSC - 105	Lab Course I	2	1	35	15	50
	MSC DSC - 106	Lab Course II	2	1	35	15	50
Discipline Specific Elective Course (DSEC)	MSC DSE - 101	Plant Biotechnology **OR** Plant Pathology	4	4	70	30	100
	MSC DSE - 102						
Research Work	RM - 02	Research & Publication Ethics	4	4	70	30	100
		Total	**24**	**22**	**490**	**210**	**700**

Level 6.0	Curriculum Matrix M.Sc. Botany						
Semester II					Marks Distribution		
Subject Type	Subject Code	Name of Subject	Hours/ week	Credit (L+T+P)	External	Internal	Total
Discipline Specific Core Course (DSCC)	MSC DSC - 201	Computational Biology	3	3	70	30	100
	MSC DSC - 202	Ecology and Environment	3	3	70	30	100
	MSC DSC - 203	Plant Physiology and Metabolism	3	3	70	30	100
	MSC DSC - 204	Floral Morphology and Embryology of Angiosperms	3	3	70	30	100
Laboratory	MSC DSC - 205	Lab Course III	2	1	35	15	50
	MSC DSC - 206	Lab Course IV	2	1	35	15	50

Discipline Specific Elective Course (DSEC)	MSC DSE - 201 MSC DSE - 202	Economic Botany **OR** Paleobotany & Palynology	4	4	70	30	100
OJT/Internship/Project	INT - 01	Internship-I	4	4	70	30	100
		Total	**24**	**22**	**490**	**210**	**700**

Level 6.5	**Curriculum Matrix M.Sc. Botany**						
Semester III					**Marks Distribution**		
Subject Type	**Subject Code**	**Name of Subject**	**Hours/ week**	**Credit (L+T+P)**	**External**	**Internal**	**Total**
Discipline Specific Core Course (DSCC)	MSC DSC - 301	Angiosperms Taxonomy and Phytogeography	3	3	70	30	100
	MSC DSC - 302	Genetics and Breeding	3	3	70	30	100
Laboratory	MSC DSC - 303	Lab Course V	2	1	35	15	50
	MSC DSC - 304	Lab Course VI	2	1	35	15	50
Discipline Specific Elective Course (DSEC)-I	MSC DSE - 301 MSC DSE - 302	Microbial Diversity **OR** Ethnobotany	4	4	70	30	100
Discipline Specific Elective Course (DSEC)-II	MSC DSE - 303 MSC DSE - 304	Phytochemistry & Medicinal Botany **OR** Environmental Biotechnology	4	4	70	30	100
RP		Research Project and Proposal Writing	6	6	105	45	150
		Total	**24**	**22**	**455**	**195**	**650**

Level 6.5	**Curriculum Matrix M.Sc. Botany**						
Semester IV					**Marks Distribution**		
Subject Type	**Subject Code**	**Name of Subject**	**Hours/ week**	**Credit (L+T+P)**	**External**	**Internal**	**Total**

Discipline Specific Core Course (DSCC)	MSC DSC - 401	Plant Molecular Biology: Genetic Engineering	3	3	70	30	100
	MSC DSC - 402	Plant Resource Utilization and Conservation	3	3	70	30	100
Laboratory	MSC DSC - 403	Lab Course VII	2	1	35	15	50
	MSC DSC - 404	Lab Course VIII	2	1	35	15	50
Dissertation		Dissertation Work and Thesis Writing		12	175	75	250
		Dissertation		1	35	15	50
		Viva- Voce		1	35	15	50
		Total		**22**	**455**	**195**	**650**

SEMESTER I

CELL BIOLOGY AND BIOCHEMISTRY

Credit: 3

Course Objectives: **Total: 100 (70+30)**

1. **To understand the structural organization of plant cells** and study the function and biogenesis of key cellular components such as cell wall, plasma membrane, chloroplasts, mitochondria, and nucleus.
2. **To explore the molecular basis of genetic information flow** through the processes of DNA replication, transcription, and translation in both prokaryotic and eukaryotic systems.
3. **To examine mechanisms of cell communication and signalling**, including signal molecules, secondary messengers, and the regulation of the cell cycle and division.
4. **To study the structure, classification, and biochemical roles of biomolecules** such as carbohydrates, amino acids, proteins, and lipids.
5. **To gain knowledge of enzyme structure, kinetics, and regulation**, including enzyme specificity, inhibition, coenzymes, cofactors, and the principles of enzyme catalysis.

Course Outcome:

Skills that students obtain after completion of the course:

1. **Describe the detailed structure and function of plant cell organelles** and explain their roles in maintaining cellular integrity and metabolism.
2. **Explain the molecular mechanisms of genetic information transfer** and compare DNA replication, transcription, and translation processes in different organisms.
3. **Analyze cell signalling pathways and regulatory mechanisms** governing cell cycle progression, division, and intercellular communication.
4. **Identify and classify biomolecules** and correlate their chemical structures with their biological functions in cellular metabolism.
5. **Interpret enzyme kinetics and catalytic mechanisms**, calculate kinetic parameters (Km, Vmax), and evaluate factors influencing enzyme activity and regulation.

UNIT: I Structural organization of typical plant cell. Plant Cell wall biogenesis and structure, Plasma membrane, Structure and function of different cell organelles in cell, Structural organization of chloroplast and mitochondria. Nuclear envelope, nuclear pore complex, their ultra-structural model, Nucleolus: structure and function.

UNIT: II Central dogma: replication of DNA, semi-conservative mode of replication, DNA polymerases, transcription and translation in prokaryotic and eukaryotic cells.

UNIT: III Cell-Cell Interaction and signalling: Signalling molecules and mechanism of signalling, secondary messenger, Ca^{+2}, c-AMP, MAP kinase, Basic concepts of Cell division and cell cycle and Regulation.

UNIT: IV Structure and function of carbohydrates, Amino acid, Classification of amino acid, chemical and physical properties of amino acids, reactions of amino acids, peptides and peptide bond, Proteins types and functions, structural features of proteins including primary, secondary and tertiary structure; Lipids: synthesis of saturated and unsaturated fatty acids, oxidation of fatty acids.

UNIT:V Enzyme: definition and characteristics, Enzyme specificity, Enzyme inhibition, Nomenclature of enzymes, coenzyme and cofactors, factors affecting enzyme action, enzyme kinetics, Concepts of Km and Vmax, Michaelis-Menten equation of enzyme kinetics, Ribozyme.

SUGGESTED READINGS:

1. Alberts B. Johnson, A. Lewis, J. Raff, M. Roberts, K. Walter, P. 2008. Molecular Biology of the Cell. Garland Science Publisher. USA.
2. Berg, JM; Stryer L.2010. Biochemistry, W.H. Freeman; Seventh Edition.
3. DeRobertis and DeRobertis. 2010. Cell and Molecular Biology: Saunders College Publisher. UK.
4. Lewin Benzamin 2011.GeneX: Jones and Bartlett Learning Publisher. USA.
5. Lodish and Baltimore 2005.MolecularCellBiology:W H Freeman Publisher.UK.
6. Nelson and Cox. 2002. Lehninger Principle of Biochemistry: 3rd Edition: WH Freeman Publisher.UK.

ALGAE, BRYOPHYTES AND PTERIDOPHYTES

Credit: 3
Total Marks: 100 (70+30)

Course Objectives

1. To study the general characteristics, classification, and evolutionary trends of algae, bryophytes, and pteridophytes.
2. To understand the structural organization, reproduction, and life cycles of major algal, bryophytic, and pteridophytic groups.
3. To analyze the comparative morphology and anatomy of vegetative and reproductive structures.
4. To evaluate the ecological and economic importance of algae, bryophytes, and pteridophytes.
5. To develop skills in identification, classification, and comparative study of lower plant forms.

Course Outcome:

The skills that students obtain after completion of the course:

1. Students will be able to describe and classify major groups of algae, bryophytes, and pteridophytes.
2. Students will understand the diversity in cell structure, thallus organization, reproduction, and life cycles among lower plants.

3. Students will compare the gametophytic and sporophytic generations and explain their evolutionary significance.
4. Students will recognize the ecological roles and economic applications of algae, bryophytes, and pteridophytes.
5. Students will gain practical competence in identifying, analyzing, and documenting representative members of these plant groups.

UNIT: I General characters, classification and current trends in classification of algae, habitats, habit and thallus organization, reproduction and life cycle in algae, evolutionary trends in algae, economic importance algae.

UNIT: II Comparative account of cell structure, thallus organization, reproduction and life cycle of Cyanophyta, Chlorophyta, Phaeophyta, Rhodophyta, Bacillariophyta.

UNIT: III Generalcharacters, classification, origin of Bryophytes, Comparative account of gametophyte and sporophyte of Hepaticopsida, Bryopsida and Anthocerotopsida, Fossil bryophytes, economic importance of bryophytes.

UNIT: IV General characters and classification of Pteridophytes, Heterospory and seed habit, Evolution of sorus, Economic importance of Pteridophytes.

UNIT:V Comparative morphology and anatomy of vegetative and reproductive structure of sporophyte and gametophyte of Psilopsida, Lycopsida, Sphenopsida, Filicopsida.

SUGGESTED READINGS:

1. Bold and Wynne. 1985. Introduction to the Algae. Prentice Hall Publication. Mumbai.

2. Chapman, V.J. and Chapman D.J. 1973. The Algae. Macmill on and Company, New York.

3. Hoek, Christian et al. 1995. Alage: An Introduction to Phycology. Cambridge University Press. New Delhi.

4. Lee, R.E. 2009. Phycology. Cambridge University Press. New Delhi.

5. Parihar N.S. 1991. Bryophyta. Central Book Depot, Allahabad.

6. Parihar N. S. 1959. An Introduction to Pteridophyta. Central Book Depot, Allahabad.

7. Rashid A. 2011. An Introduction to Pteridophyta.Vikas Publishing House. New Delhi.

8. Rashid A. 2009. An Introduction to Bryophyta.Vikas Publishing house. New Delhi.

9. Round F.E. 1984. The Ecology of algae. Cambridge University Press. New Delhi.

10. Sharma, O.P. 2006. Textbook of Algae. Tata Mc GrawHill, New Delhi.

DIVERSITY AND BIOLOGY OF GYMNOSPERMS AND ANATOMY OF ANGIOSPERMS

Credit: 3
Total Marks: 100 (70+30)

Course Objectives:

1. **To develop an understanding of the classification, evolution, and fossil history of Gymnosperms** and to study fossilization processes and techniques for studying plant fossils.
2. **To familiarize students with the structural organization, reproduction, and affinities of important Gymnosperm orders** such as Ephedrales, Gnetales, and Welwitschiales, emphasizing their distribution and economic importance in India.
3. **To provide detailed knowledge of plant anatomy**, focusing on root and shoot apical meristems, permanent tissues, and internal structure of monocot and dicot organs, including vascular organization.
4. **To interpret and analyze secondary growth and anatomical anomalies** in stems and roots, along with understanding the formation and function of cambium, annual rings, and periderm.
5. **To understand seed anatomy and physiology**, including monocot and dicot seed structures, germination processes, seedling development, and hormonal regulation of growth.

Course Outcomes:

The skills that students obtain after completion of the course:

1. **Explain the classification, characteristics, and fossil records of Gymnosperms** and demonstrate knowledge of fossilization processes and plant fossil study techniques.
2. **Describe the morphology, anatomy, reproduction, and affinities of major Gymnosperm orders** and evaluate their ecological and economic significance in India.
3. **Identify and compare the internal structures of roots, stems, and leaves of monocot and dicot plants**, and understand the organization of vascular bundles and secretory tissues.
4. **Analyze various types of stomata, nodal anatomy, and secondary growth patterns**, and explain the occurrence of anatomical anomalies in selected plant species.
5. **Illustrate the anatomy and physiology of seeds**, explain the stages of germination and seedling development, and evaluate the role of hormones in regulating seedling growth.

UNIT: I Classification of Gymnosperms, Types of fossils and the Process of Fossilization, techniques for studying plant fossils, Brief account of the order Pteridospermales general account of Cordaitales and Pentoxylatles.

UNIT: II General characteristics of gymnosperms, general account of structure, reproduction and affinities of order Ephedrales, Gnetales and Welwitschiales and Genetales, Distribution of living Gymnosperms in India, Economic importance of Gymnosperms.

UNIT: III Root and shoot apical meristem, Theories of root and shoot apex organization, permanent tissues, anatomy of root, stem and leaf of monocot and dicot plants, types of vascular bundles.

Control of cell and tissue differentiation especially xylem and phloem, secretory ducts and laticifers.

UNIT: IV Types and phylogeny of stomata, types of nodal anatomy. Secondary growth in stem and root, cambium and its function, annual rings, sapwood and heartwood, periderm, anatomical anomalies in the primary structure of stem (Nyctanthus, Casuarina, Boerhaavia), anamolous secondary growth in Dracaena, Begnonia, Laptadani.

UNIT: V Seed anatomy of Monocotyledonous and Dicotyledonous, special features of seeds or seed appendages, seed germination seedling growth, hormonal control of seedling growth.

SUGGESTED READINGS:

1. Andrews, H.N. 1961. Studies in Palaeobotany. John Wiley. UK.
2. Arnold, C.A. 1974. An Introduction to paleobotany. MC GrawHill. UK.
3. Bhatnagar, S.P. and Moitra A.1996 The Gymnosperms. New Age International Pvt. Ltd. New Delhi.
4. Biswas C. and Johri B.M. 1997. The Gymnosperms. Narosa Publishing House, Delhi
5. Buvat, R. 1988. Ontogeny, Cell differentiation and structure of vascular plants. Springer-Verlag. USA.
6. Chamberlain, C.J. 1935. Gymnosperms-Structure and Evölution. Univ. of Chicago Press. USA.
7. Essau, K.1972. Plant Anatomy. John Willey. UK.
8. Raghavan. V. 1999. Developmental Biology of flowering plants. Springer. Verlag. New Delhi.

BIO-INSTRUMENTATION

Credit: 3
Total Marks: 100 (70+30)

Course Objectives:

1. To introduce students to the fundamental principles and instrumentation of centrifugation and microscopy, and their applications in biological research.
2. To provide an understanding of radioisotope techniques, radioactive decay, methods of detection, and safety measures along with applications of mass spectrometry in biological sciences.
3. To develop knowledge of spectrophotometric principles, UV–Visible, IR, atomic, and NMR spectroscopy techniques for structural and functional analysis of biomolecules.
4. To familiarize students with different chromatographic techniques, their principles, instrumentation, and applications for separation and purification of biomolecules.
5. To impart theoretical and practical insights into electrophoretic techniques for the separation, identification, and characterization of proteins, nucleic acids, and other macromolecules.

Course Outcome:
Skills that students obtain after completion of the course:

1. Demonstrate knowledge of centrifugation and microscopy principles and apply them in biological sample preparation and analysis.
2. Explain the principles of radioactivity, radioisotope safety, and evaluate the applications of radioisotopes and mass spectrometry in biological research.
3. Apply spectrophotometric laws and interpret data obtained from UV, IR, atomic, and NMR spectroscopy for molecular analysis.
4. Analyze biomolecules using various chromatographic methods and determine their suitability for specific biological applications.
5. Utilize electrophoretic methods for the separation, identification, and characterization of proteins, nucleic acids, and other macromolecules.

UNIT I

Centrifugation techniques: Basic Principles of Sedimentation.
Centrifuge and Rotor: Types, Instrumentation and Applications.
Microscopy: Principles of Microscopy; Types: Bright field, Dark field, Phase contrast, Confocal and Fluorescent, Electron Microscopes (SEM andTEM).

UNIT II

Radioisotopes Techniques: Radioactive decay. Detection and different methods of measurement of radioactivity.Use of radioactive isotopes in biology; Safety aspects.
Mass Spectrometry: Principles, Techniques and Applications;Mass spectrometer, MALDI-TOF.

UNIT III

Spectrophotometric Techniques: - Basic principles; Lambert Beer's Law, Absorbance, Transmittance and Extinction Coefficient.
UV, Visible and Infrared Spectroscopy: Theory, Instrumentation and Applications;

Atomic Spectroscopy and Nuclear Magnetic Resonance (NMR) Spectroscopy: Theory, Instrumentationand Application

UNIT IV

Chromatography Techniques: Basic Principles, Instrumentation and Applications;
Plane Chromatography: Paper and Thin Layer Chromatography (TLC).
Column chromatography: Adsorption, Partition, Gel filtration, Ion exchange, Affinity chromatography,High Performance Liquid chromatography (HPLC).

UNIT V

Electrophoretic Techniques: Theory, Instrumentation and Applications;
Types: Paper, Gel electrophoresis, Isoelectric Focusing, Pulse Field Gel Electrophoresis, Immuno-electrophoresis, Electroblotting techniques.

SUGGESTED READINGS:

1. Biophysical Chemistry Principles and Techniques: Upadhyay, Upadhyay and Nath.
2. Biotechniques Theory and Practice: S V S Rana; Rastogi Publications.
3. Principles and Techniques of Biochemistry and Molecular Biology: K Wilson and J Walkar.
4. Physical Biochemistry Principles and Application: D Sheehan; Wiley
5. Physical Biochemistry and Molecular Biology: Freifelder D.
6. Principles of instrumental analysis: Skoog and West.
7. Biochemical Techniques: Theory and Practice-Robyt and White.
8. Principles and Techniques of Practical Biochemistry: Williams and Wilson.

LAB COURSE I: CELL BIOLOGY AND BIOCHEMISTRY

Credit: 1
Total Marks: 50 (35+15)

Course Objectives:

1. To familiarize students with **microscopy techniques** for observing plant cell structures and organelles.
2. To enable identification and differentiation of **various plant cell types** and specialized structures such as stomata.
3. To provide hands-on experience in studying **cell division processes** including mitosis and meiosis.
4. To develop practical skills in **biochemical analysis** including extraction of DNA and qualitative tests for biomolecules.
5. To introduce quantitative methods for studying plant physiology, such as **chlorophyll estimation**.

Course Outcomes:
Skills that students obtain after completion of the course:

1. **Use light and compound microscopes** effectively to study plant cells and tissues.
2. **Identify plant cell types** (parenchyma, collenchyma, sclerenchyma) and understand their functional significance.
3. **Observe and analyze cell division** stages in mitosis and meiosis and relate them to plant growth and

reproduction.

4. **Perform extraction and qualitative tests** to detect DNA, carbohydrates, proteins, and lipids in plant materials.
5. **Estimate chlorophyll content** in leaves and interpret results to understand photosynthetic efficiency.

PRACTICALS

1. Study of plant cell structure using light and compound microscope.
2. Observation of epidermal cells (onion peel).
3. Study of stomata by using plant cell .
4. Identification of plant cell types (parenchyma, collenchyma, sclerenchyma).
5. Study of mitosis in root tip cells (Allium cepa).
6. Study of meiosis in onion bud.
7. Extraction of DNA from plant parts.
8. Qualitative detection of carbohydrates (starch, glucose, sucrose, cellulose).
9. Qualitative detection of proteins.
10. Qualitative detection of lipids (fats and oils).
11. Chlorophyll estimation from leaves.

LAB COURSE II: ALGAE BRYOPHYTES AND PTERIDOPHYTES

Credit: 1

Total Marks: 50 (35+15)

Course Objectives (COs)

1. To develop practical skills in preparing and observing temporary slides of algal specimens and identifying them.
2. To learn techniques for isolating and identifying local algal flora from natural habitats.
3. To understand the morphology and microstructure of bryophytes through detailed micro-preparations.
4. To observe bryophytes in their natural environments to understand their ecology and adaptive features.
5. To study the habit, anatomy, and reproductive structures of pteridophytes for better comprehension of their life cycle and diversity.

Course Outcomes (COs)

Skills that students obtain after completion of the course:

1. Prepare temporary slides of algae and accurately identify different algal species.
2. Isolate and classify local algal flora using standard laboratory techniques.
3. Perform micro-preparations of bryophytes and analyze their structural characteristics.
4. Conduct field observations of bryophytes and interpret their ecological and adaptive significance.
5. Examine and describe the habit, anatomy, and reproductive structures of pteridophytes, enhancing understanding of plant diversity and evolution.

PRACTICALS

1. Preparation of temporary slide of algal specimen and their identification
2. Isolation and identification of local algal flora.
3. Micro-preparation of different members of Bryophytes.
4. Study of Bryophytes in their natural habitats.
5. Study of habit, anatomy and reproductive structures of Pteridophytes.

PLANT BIOTECHNOLOGY

Credit: 4

Total Marks: 100 (70+30)

Course Objectives

1. Gain foundational knowledge of plant biotechnology, principles and applications of plant tissue culture.
2. Understand the molecular biology techniques used in micropropagation of plants.
3. Examine real-world applications of plant biotechnology in crop improvement, disease resistance, and stress tolerance.
4. Explore the role of plant biotechnology in agriculture, medicine, and industry.
5. Analyze the role of biotechnology in producing biopharmaceuticals, biofuels, and industrial enzymes.

Course Outcomes

The skills that students obtain after completion of the course:

1. Explain the basic concepts, tools, and techniques used in plant biotechnology.
2. Describe the process and applications of plant tissue culture and micropropagation.
3. Analyze the methods used for genetic transformation and expression of foreign genes in plants.
4. Evaluate the uses and implications of genetically modified crops in food security and environmental sustainability.
5. Demonstrate practical skills in plant biotechnology techniques, such as tissue culture and DNA analysis.

UNIT-I

Tools, techniques and procedures of Tissue culture: Media for in vitro culture - minerals, vitamins, and natural adjuvants like coconut milk and fruit juice. Requirements for auxin, cytokinin and other growth regulators. Solid and liquid media. Commercial prepacked media. Design of laboratory and commercial tissue culture facility.

Procedures in Tissue Culture: Fumigation, wet and dry sterilization, ultraviolet sterilization, ultrafiltration and surface sterilization. Laminar flow hood. Maintenance of axenic cultures.

Explants for Tissue Culture: Shoot tip, axillary buds, leaf discs, cotyledons, inflorescence and floral organs. Callus culture - initiation and maintenance of callus.

UNIT-II

Principles of Micropropagation: Direct and indirect morphogenesis, somatic embryogenesis, caulogenesis, rhizogenesis, acclamatization. Synthetic seed production.

Unit III

Tissue culture and Biotechnology: Mericloning for virus-free plants, selection of plantlets tolerant to biotic and abiotic stresses. Use of techniques of genetic engineering for obtaining transgenic plants resistant to diseases, insect pests, abiotic stress and herbicides.. Introduction of desired genes from microbes, plants and animals. Modifying the expression of resistent gene by antisense RNA technique. *In vitro* mutagenesis. Genetic engineering with protoplast and haploid cells.

Unit IV

Applications in Agriculture, Horticulture and Forestry: Achivements and current trends in improvement of cereals, vegetable crops, oil yielding plants, ornamental plants and forest trees.

Unit V

Tissue culture in Industrial and Medical Biotechnology: Suspension Culture systems, isolation of single and aggregate of cells. Immobilization of cells and use of bioreactors. Protoplast Culture: Isolation of protoplast and transformation. Bioprocessing for active principles. In vitro production of secondary metabolites, pharmaceuticals and aromatic chemicals. Edible vaccine**.**

Tissue Culture in Germplasm Conservation: Introduction to in vitro conservation. Storage techniques, equipment, cryopreservation and tissue culture components used for storage. Achievements and current trends.

SUGGESTED READINGS:

- Slater, A., Scott, N., & Fowler, M. (2008). *Plant biotechnology: The genetic manipulation of plants* (2nd ed.). Oxford University Press.
- Dhaliwal, O. P., & Dhawan, R. (2014). *Biotechnology of plants*. Scientific Publishers.
- Bhojwani, S. S., & Razdan, M. K. (1996). *Plant tissue culture: Theory and practice* (2nd ed.). Elsevier.

- Primrose, S. B., & Twyman, R. M. (2006). *Principles of gene manipulation and genomics* (7th ed.). Wiley-Blackwell.
- Chrispeels, M. J., &Gepts, P. (2009). *Plants, genes, and agriculture: Sustainability through biotechnology* (2nd ed.). Sinauer Associates.
- Singh, B. D. (2018). *Biotechnology: Expanding horizons* (5th ed.). Kalyani Publishers.

PLANT PATHOLOGY

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. Understand the types, causes, and classification of plant diseases.
2. Identify the symptoms and causal agents (fungi, bacteria, viruses, nematodes).
3. Explain disease cycles and host-pathogen interactions.
4. Apply molecular techniques for diagnosis and control of plant diseases.
5. Evaluate integrated disease management strategies in agriculture.

Course Outcomes:

Skills that students obtain after completion of the course:

1. Recognize major plant diseases caused by microbial pathogens.
2. Analyze disease progression using epidemiological models.
3. Design appropriate disease control strategies using IPM and biotechnology.
4. Critically assess the impact of plant diseases on crop productivity and food security.

UNIT **I:** Introduction to Plant Pathology

- Definition, history and scope.
- Classification of plant diseases.
- Koch's postulates.
- Symptoms and signs of diseases.

UNIT **II:** Disease Causative Agents

- Fungi, Bacteria, Viruses, Viroids, Phytoplasma, Nematodes.
- Pathogen identification and life cycles.

UNIT **III**: Mechanisms of Disease Development

- Infection, colonization and dissemination.
- Pathogen enzymes, toxins, and effectors.
- Host defenses: structural and biochemical.

UNIT **IV:** **Epidemiology and Disease Forecasting**

- Disease triangle and tetrahedron concepts.
- Factors influencing epidemics.
- Forecasting models and their applications.

UNIT **V**: **Disease Management**

- Cultural, chemical, biological control methods.
- Integrated Disease Management (IDM).
- Use of resistant varieties.
- Role of molecular biology and biotechnology in disease resistance.

SUGGESTED READINGS:

1. Aggrawal Ashok and Mehrotra R S. 2002. Plant Pathology. Tata Mcgraw Hill, 2nd edition. Mumbai.

2. Agrios George N. 2005. Plant Pathology, Academic Press, 5th Edition.UK.

3. Robert B. 2008. Plant Pathology: Techniques and Protocols (Methods in Molecular Biology), Humana Press.USA.

4. Gail L. Schumann and Cleora J.D' Arcy 2009.Essential Plant Pathology, 2nd Edition. American Phytopathological Society.USA.

5. Sharma P.2006. Plant Pathology, Alpha Science International Ltd. New Delhi.

RESEARCH & PUBLICATION ETHICS

Credit: 4

Total Marks: 100 (70+30)

Course Objectives:

1. Understand the philosophy and fundamentals of research ethics.
2. Apply ethical principles in scientific research and publication.
3. Identify unethical practices and avoid research misconduct.
4. Evaluate the credibility of journals and publishers.
5. Interpret research metrics and databases to assess publication quality.

Course Outcomes:

Skills that students obtain after completion of the course:

1. Explain the concept of ethics and philosophy in research.
2. Describe different forms of research and publication misconduct.
3. Recognize predatory journals and unethical publication practices.
4. Utilize tools for plagiarism detection and ethical publication.
5. Analyze impact metrics and databases to improve research dissemination.

UNIT I: Philosophy and Ethics

- Introduction to philosophy: definition, nature, and scope, concept, branches
- Ethics: definition, moral philosophy, nature of moral judgments and reactions

UNIT II: Scientific Conduct

- Ethics in conducting research
- Research misconduct: fabrication, falsification, plagiarism
- Conflict of interest
- Guidelines for ethical research

UNIT III: Publication Ethics

- Publication ethics: definition, importance
- Best practices/standards setting initiatives and guidelines (COPE, WAME, etc.)
- Publication misconduct: types, identification, and prevention
- Predatory publishers and journals

UNIT IV: Publication Misconduct

- Identification of publication misconduct
- Complaints and appeals
- Role of authorship and contribution
- Investigation tools (e.g., Turnitin, iThenticate)

UNIT V: Databases and Research Metrics

- Databases: Indexing databases (Scopus, Web of Science, etc.)
- Research metrics: Impact Factor, h-index, i10 index, altmetrics
- Citation databases and research visibility

SUGGESTED READINGS:

- ***Macrina, F. L.*** *(2014). Scientific Integrity: Text and Cases in Responsible Conduct of Research. ASM Press.*
- ***Resnik, D. B.*** *(2020). The Ethics of Science: An Introduction. Routledge.*
- ***Steneck, N. H.*** *(2007). ORI Introduction to the Responsible Conduct of Research. U.S. Department of Health and Human Services.*
- ***ICMR Guidelines*** *– Ethical Guidelines for Biomedical Research on Human Participants, ICMR, New Delhi.*
- ***COPE (Committee on Publication Ethics)*** *website: https://publicationethics.org/*
- ***Shamoo, A. E., & Resnik, D. B.*** *(2009). Responsible Conduct of Research. Oxford University Press.*
- *UGC E-Content on Research and Publication Ethics (Available on Swayam and UGC portals)*

SEMESTER II

COMPUTATIONAL BIOLOGY

Credit: 3

Total Marks: 100 (70+30)

Course Objectives (COs):

1. **Understand the fundamentals of biostatistics** including data types, collection, classification, tabulation, and graphical representation of biological data.
2. **Develop skills in statistical analysis** using measures of central tendency, dispersion, correlation, regression, and hypothesis testing (t-test, chi-square, F-test).
3. **Gain knowledge of biological databases** and sequence analysis tools, including EMBL, DDBJ, TAIR, KEGG, and Swiss-Prot, and understand optimal pairwise sequence alignment methods.
4. **Learn computational approaches for multiple sequence analysis** using sequence profiles, Hidden Markov Models, gene prediction, and phylogenetic analysis.
5. **Apply bioinformatics tools in evolutionary and genomic studies**, including in silico phylogenetic analysis, construction of phylogenetic trees, QTL mapping, and microarray data analysis.

Course Outcome:

Skills that students obtain after completion of the course:

1. **Ability to collect, organize, and represent biological data** effectively using statistical and graphical methods.
2. **Proficiency in applying statistical techniques** such as correlation, regression, and significance tests to interpret biological experiments.
3. **Competence in using major biological databases** and performing sequence alignments for genomics and proteomics studies.
4. **Capability to conduct multiple sequence analyses** and understand molecular evolution and gene prediction using computational models.
5. **Skill in applying computational tools** for phylogenetic studies, QTL mapping, and microarray data analysis to address biological research questions.

UNIT: I Scope of Biostatistics, variables in biology, collection, classification, tabulation of data. Frequency distribution, Diagrammatic and graphical presentation of statistical data, Sampling techniques. Measures of central location and dispersion.

UNIT: II Correlation and Regression, Least Square method of fitting, Standard error of estimate, Correlation and regression coefficient. Basic idea of significance testing, level of significance, student's 't' test, χ^2 (chi-square) test and F-test.

UNIT: III Biological databases, EMBL, DDBJ, TAIR, KEGG, Swis prot, Optimal Pair wise Alignment-Biological Sequences and the Exact String-Matching Problem-Fast Alignments: Genome Comparisons and Database Searches.

UNIT: IV Multiple Sequence Alignment- Sequence Profiles and Hidden Markov Models.-Gene Prediction-Phylogeny- Sequence Variation and Molecular Evolution

UNIT: V Testing Evolutionary Hypotheses, In silico analysis of phylogeny, construction of phylogenetic tree, dendrogram, Computational phylogenetics, Construction of QTL mapping, Microarray data analysis.

SUGGESTED READINGS:

1. Arthur, M. 2002. Introduction to Bioinformatics. Oxford University Press. New Delhi Bernard,

2. A. Rosner, 2006. Fundamentals of Biostatics. Thompson Publication Canada.

3. Khan and Khanam. 2003. Fundamental of Biostatistics. Ukaaz Publications. Hyderabad.

4. Krawetz. 2003. Introduction to Bioinformatics: A theoretical and Practical Approach. Humana Press.USA.
5. Miguel and Rade. 2003. Bioinformatics and Genome. Horizon Scientific Press. Utah. USA.

ECOLOGY AND ENVIRONMENT

Credit: 3
Total Marks: 100 (70+30)

Course Objectives:

1. **Understand ecological principles:** Introduce students to the fundamental concepts of ecology, including interactions between biotic and abiotic components, habitat, and niche dynamics.
2. **Analyze population and community dynamics:** Develop an understanding of population characteristics, growth patterns, regulatory mechanisms, and community structure, including succession processes.
3. **Explore ecosystem functions:** Examine ecosystem organization, energy flow, primary production, and ecological efficiencies to understand functional dynamics.
4. **Study biodiversity and conservation:** Assess biological diversity at genetic, species, and ecosystem levels, global biodiversity patterns, and conservation strategies including IUCN threat categories.
5. **Evaluate environmental challenges:** Investigate environmental pollution, climate change, ozone depletion, and the effects of xenobiotics on ecosystems and plant communities.

Course Outcome:

Skills that students obtain after completion of the course:

1. **Comprehend ecological interactions:** Students will be able to describe the relationships between organisms and their environment, and distinguish between fundamental and realized niches, resource partitioning, and character displacement.
2. **Assess population and community processes:** Students will analyze population growth models, life-history strategies, and community structure, and explain succession types, mechanisms, and climax concepts.
3. **Apply ecosystem concepts:** Students will measure primary production, understand energy flow pathways, and calculate ecological efficiencies within trophic levels.
4. **Evaluate biodiversity patterns:** Students will identify levels of biodiversity, recognize terrestrial biodiversity hotspots, and apply IUCN categories to assess conservation priorities.
5. **Analyze environmental impacts:** Students will evaluate the sources and effects of pollutants, understand the role of greenhouse gases and ozone depletion, and assess the ecological impact of xenobiotics and climate change.

UNIT: I Principles of Ecology, Physical environment; biotic environment; biotic and abiotic interactions, Concept of habitat and niche; fundamental and realized niche; resource partitioning; character displacement.

UNIT: II Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); Community: structure and attributes; edges and ecotones; Succession: Types; mechanisms; changes involved in succession; concept of climax.

UNIT: III Ecosystem Organization: Structure and Functions, Primary Production (methods of measurement, controlling factors), Energy Dynamics (trophic organization, energy flow pathways, ecological efficiencies).

UNIT: IV Biological diversity: Concept and levels; distribution and global patterns; terrestrial biodiversity, hot spots; IUCN categories of threat; inventory; conservation.

UNIT: V Environmental pollution: Kinds, sources, effects on plants and ecosystems, greenhouse gases, consequences of climate change; Ozone layer depletion: causes and consequences; Xenobiotics and its impact.

SUGGESTED READINGS:

1. Kormondy E.J., 2000. Concept of Ecology. 4th Edition. Benzamin Cummings. UK.
2. Odum E.P., 1996. Fundamentals of Ecology, Natraj Publishers, Dehradun.
3. Patrick L. 2000.Tropical Ecosystems and Ecological Concepts. Cambridge University Press.UK.
4. Sharma P.D.2007. Ecology and Environment. Rastogi Publication, Meerut.
5. Singh J.S., S.P. Singh and S.R. Gupta 2006.Ecology, Environment and Resource Conservation, Anamya Publication, New Delhi.

PLANT PHYSIOLOGY AND METABOLISM

Credit: 3

Course Objectives: **Total Marks: 100 (70+30)**

1. To understand the principles of **plant water relations**, including osmotic phenomena, water and mineral absorption, transpiration, and translocation of solutes.
2. To study the fundamental processes of **plant metabolism**, including photosynthesis, respiration, energy transfer, and carbon fixation in C3, C4, and CAM plants.
3. To explore **plant nutrition**, mineral acquisition, nutrient deficiency and toxicity, nitrogen metabolism, and mechanisms of nutrient assimilation in plants.
4. To examine **plant stress physiology**, including responses to drought, temperature extremes, salinity, oxygen deficiency, metal toxicity, and oxidative stress.
5. To investigate **plant sensory photobiology and growth regulation**, including photoreceptors, photoperiodism, and the physiological effects and mechanisms of plant growth hormones.

Course Outcome:

Skills that students obtain after completion of the course:

1. Students will be able to **explain the mechanisms of water absorption, translocation, and transpiration** and identify factors affecting these processes in plants.
2. Students will be able to **analyze photosynthetic and respiratory pathways**, including light and dark reactions, electron transport, and carbon fixation mechanisms in different plant types.
3. Students will be able to **identify essential nutrients, their uptake, and assimilation processes**, and diagnose nutrient deficiencies and toxicities in plants.
4. Students will be able to **evaluate plant responses to various abiotic stresses** and understand the biochemical and molecular mechanisms underlying stress tolerance.
5. Students will be able to **describe the role of photoreceptors, photoperiodism, and plant hormones** in regulating plant growth, development, and adaptive responses.

UNIT: I Plant Water relations: Osmotic phenomena, Water and osmotic, potential, Absorption of water, Mineral salt absorption, Ascent of Sap, Translocation of organic solutes, passive and active transports; Transpiration: Mechanism and Theories of Stomatal movement, Factors affecting transpiration.

UNIT: II Metabolism: Photosynthesis and Respiration: Light (Hill's) reaction, excitation energy transfer, mechanism of electron and proton transport in chloroplast, photo phosphorylation, photoprotective mechanisms, carbon fixation in C3 and C4 plants, CAM, Glycolysis and Kreb's Cycle.

UNIT: III Plant nutrition, Mineral nutrition and acquisition in plants, Mineral deficiency and toxicity in plants, Nitrogen metabolism, nitrate uptake and assimilation, biological nitrogen fixation, biology of nodule formation in legumes, Phosphate uptake and assimilation, Sulphur uptake and assimilation.

UNIT: IV Stress physiology: Water deficit and drought resistance, Chilling and Freezing, Heat stress and heat shock, Salinity and salt stress, Oxygen deficiency, Metal toxicity and tolerance in plants, Oxidative Stress and Anti-oxidative defense system, Stress induced gene expression.

UNIT: V Sensory photobiology: Phytochromes and cryptochromes, Photoperiodism and its significance, Plant growth regulators: Physiological effects and mechanism of action of plant growth hormones (Auxins, Gibberellins, Cytokinins, Ethylene and Abscisic acid).

SUGGESTED READINGS:

1. Devlin Robert M. 1983. Plant Physiology, Prindle Weber and Schmidt Publisher; 4th edition.UK

2. Devlin Robert M.1983. Plant Physiology, Prindle Weberand Schmidt Publisher; 4th edition.UK

3. Hans Lambers et al. 2008. Plant Physiological Ecology. Springer. Germany.

4. Hopkins and Hunner. 2010. Introduction to Plant Physiology. John Wiley. UK.

5. Salisbury Frankand Cleon Ross 1991. Plant Physiology. Brooks Cole Publishers; 4th edition. USA.

6. Taiz Lincoln and Zeiger Eduardo 2010. Plant Physiology. Sinauer Associates, Inc. Publishers, 5th edition. UK.

FLORAL MORPHOLOGY AND EMBRYOLOGY OF ANGIOSPERMS

Credit: 3
Total Marks: 100 (70+30)

Course Objectives:

1. To understand the morphological diversity of flowers, including types of gynoecium, stamen, and carpel, and evolutionary trends in placentation.
2. To study male gametophyte development, including anther structure, microsporogenesis, pollen wall formation, and factors affecting pollen fertility and viability.
3. To explore female gametophyte development, including ovule structure, megasporogenesis, embryo sac formation, and the functional role of synergids and antipodals.
4. To analyze the processes of pollination, pollen-pistil interactions, fertilization mechanisms, and post-fertilization changes in the embryo sac.
5. To examine endosperm and embryo development in angiosperms, including embryogenesis, suspensor function, and the application of embryology in plant breeding.

Course Outcome:
Skills that students obtain after completion of the course:

1. Students will be able to identify and describe flower morphology, stamen and carpel structures, and understand evolutionary trends in placentation.
2. Students will be able to explain anther structure, microsporogenesis, pollen development, and techniques for assessing pollen fertility and viability.
3. Students will be able to analyze ovule structure, megasporogenesis, types of embryo sacs, and understand the roles of various embryo sac cells.
4. Students will be able to describe the mechanisms of pollination, pollen-pistil interactions, incompatibility systems, and fertilization processes in angiosperms.
5. Students will be able to illustrate endosperm and embryo development, explain suspensor functions, and apply knowledge of plant embryology to plant breeding strategies.

UNIT: I Morphology of flowers, types of gynoecium, primitive and advanced structure of stamen and carpel, evolutionary trends in placentation.

UNIT: II Microsporangium (Anther), Structure and function of anther wall layers, micro sporogenesis, role of callose and tapetum in pollen development pollen wall morphogenesis ,microspore/pollen mitosis, division of generative cells, pollen fertility and male sterility, pollen storage and pollen viability.

UNIT: III Megasporangium (ovule) structure and types, megasporogenesis, megaspore tetrad, dyad and coenomegaspore (polarity of nuclei) Embryo sac types, ultrastucture of mature embryosac, synergid and

antipodal haustoria.

UNIT: IV Pollination, significance of pollen pistil interaction, incompatibility types and methods of overcoming incompatibilities, fertilization, syngamy and triple fusion, Post-fertilization metabolic and structural changes in embryosac.

UNIT: V Endosperm, types and their development, endosperm haustoria and their function, embryogenesis in monocot and dicot angiosperms, suspensor structure, cytology and functions, physiological and morphological relationship of endosperm and embryo, role of embryology in plant breeding.

SUGGESTED READINGS:

1. Bhojwani and Bhatnagar. 2000. The Embryology of Angiosperms. Vikas Publishing House. New Delhi.
2. Chaturvedi, S.K. and Chaturvedi,S. 2001. Biology of reproduction in angiospersm. Bioved research Society, Allahabad.
3. Johri, B.M. 1982. Experimental embryology of vascular plants. Narosa Publishing House, New Delhi
4. Maheshwari, P. 1950. An introduction to the embryology of angiosperms. Mcgraw Hill Book Company. Mumbai.
5. Proctor, M. and Yeo, P. 1973. The pollination of flowers. Collins, St. J. Place. London
6. Raghavan,V. 1999. Developmental biology of flowering plants. Springer verlag, New Delhi.

LAB COURSE III
COMPUTATIONAL BIOLOGY

Credit: 1
Total Marks: 50 (35+15)

Course Objectives:

1. **Understand basic statistical measures** such as mean, median, and mode, and their application in biological data analysis.
2. **Apply statistical tests**, including t-tests and analysis of variance (ANOVA), to determine the significance of experimental data.
3. **Analyze sequence data** to evaluate homology and functional relationships between biological sequences.
4. **Utilize bioinformatics tools**, such as BLAST, for sequence alignment and similarity searches.
5. **Perform phylogenetic analysis** to study evolutionary relationships using various computational methods.

Course Outcomes:

Skills that students obtain after completion of the course:

1. **Compute and interpret statistical measures** (mean, median, mode) from biological datasets.
2. **Perform t-tests and ANOVA** to assess statistical significance in experimental results.
3. **Evaluate sequence homology** to identify conserved regions and potential functional similarities.
4. **Effectively use BLAST** for sequence comparison and interpretation of similarity results.
5. **Construct and analyze phylogenetic trees** to infer evolutionary relationships among species or genes.

PRACTICALS

1. Determine the mean, median and mode from the given sample.
2. Calculate the t values of the given data and determine the its significance.
3. Calculation of analysis of variance from the given sample.
4. Study the sequence homology of the given sequences.
5. Testing the BLAST.
6. Phylogenetic analysis using various bioinformatics methods.

LAB COURSE IV

ECOLOGY AND ENVIRONMENT

Credit: 1
Total Marks: 50 (35+15)

Course Objectives:

1. **Understand plant population dynamics** – To determine the frequency, density, and dominance of plant species in various terrestrial ecosystems.
2. **Assess species importance** – To estimate the Importance Value Index (IVI) of species in woodland ecosystems for understanding community structure.
3. **Analyze vegetation structure** – To study life forms and functional types of plant species in different ecosystems.
4. **Evaluate ecosystem diversity and similarity** – To compare protected and unprotected grasslands using diversity indices and similarity coefficients.
5. **Measure ecosystem productivity and soil properties** – To estimate biomass using harvest methods and assess soil characteristics such as water holding capacity in different ecosystems.

Course Outcomes:
Skills that students obtain after completion of the course:

1. **Quantitative analysis of plant populations** – Students will be able to calculate and interpret frequency, density, and dominance of species in terrestrial ecosystems.
2. **Determine species ecological significance** – Learners will estimate IVI and understand the relative contribution of species to community structure.
3. **Classify vegetation types** – Students will identify and categorize life forms of plant species, understanding their ecological roles.
4. **Compare ecosystem diversity** – Learners will compute Shannon-Wiener, dominance, richness, equitability, and beta-diversity indices, and evaluate similarities between protected and unprotected ecosystems.
5. **Evaluate productivity and soil characteristics** – Students will perform biomass estimation, analyze water holding capacity of soils, and relate these to ecosystem health and functioning.

PRACTICALS:

1. To determine the frequency, density, dominance of plant species indifferent terrestrial ecosystems.
2. To estimate IVI of the species in a woodland ecosystem.
3. To study the life form of a woodland ecosystem.

4. To compare protected and unprotected grassland ecosystems using community coefficients (similarity indices).
5. To determine diversity indices (Shannon-Wiener, Concentration of Dominance, Species richness, Equitability and B-diversity) of protected and unprotected ecosystems.
6. Estimation of biomass estimation using harvest method.
7. To determine the water holding capacity of soils collected from different ecosystems.

ECONOMIC BOTANY

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. **Understand plant classification and taxonomy**: To introduce students to the principles, systems, and practices of plant taxonomy, nomenclature, and biosystematics.
2. **Identify economically important plants**: To familiarize students with the origin, cultivation, genetic resources, and uses of cereals, pulses, oilseeds, fibers, sugars, fodders, and plantation crops.
3. **Explore horticultural, medicinal, and industrial plants**: To study the origin, distribution, production, and utilization of fruits, vegetables, medicinal, aromatic, dye, tannin, gum, and resin-yielding plants.
4. **Conserve and manage plant genetic resources**: To impart knowledge on biodiversity, centers of origin, genetic diversity, evaluation, and conservation of plant genetic resources at national and international levels.
5. **Develop analytical and practical skills**: To equip students with the ability to use taxonomic and biosystematic tools, herbaria, monographs, and field manuals for identification and documentation of plants.

Course Outcome:
Skills that students obtain after completion of the course:

1. **Apply taxonomic knowledge**: Students will be able to classify and identify higher plants using modern taxonomic principles, tools, and nomenclature systems.
2. **Assess economic plants**: Students will gain the ability to describe and compare the origin, cultivation, and uses of major cereals, pulses, oilseeds, fibers, sugars, and plantation crops.
3. **Evaluate horticultural and medicinal resources**: Students will understand the significance, production, and utilization of fruits, vegetables, medicinal, aromatic, and industrial plants in agriculture and industry.
4. **Conserve plant biodiversity**: Students will be able to analyze plant genetic resources, understand biodiversity loss, and propose strategies for conservation and sustainable utilization.
5. **Demonstrate practical skills**: Students will develop competency in using herbaria, floras, manuals, and biosystematic tools for plant identification, documentation, and research applications.

Unit I: Plant Taxonomy and Biosystematics

Nomenclature, purpose, principles and systems of classification; Taxonomy of higher plants, floras, manuals, monographs, index, catalogues and dictionaries, herbaria; Concepts of biosystematics, evolution and differentiation of species; Biosystematic and taxonomic tools; Origin, evolution and biosystematics of selected crops (rice, wheat, rape seed & mustard, cotton).

Unit II: Economically important plants –I

Origin, history, domestication, Botany, genetic resource activities, cultivation, production and use of: Cereals: Wheat, rice, maize, sorghum, pearl millet and minor millets. Pulses: Pigeon pea, chickpea, black gram, green gram, cowpea, soyabean, pea, lentil, horsegram, lab-lab bean, ricebean, winged bean, French bean, lima bean, sword bean. Oilseeds: Groundnut, sesame, castor, rape seed, mustard, sunflower, safflower, niger, oil palm, coconut and linseed.

Unit III: Economically important plants –II

Origin, distribution, cultivation, production and utilization of economic plants of following groups such as Fibres: cotton, silk cotton, jute, sunnhemp, agave, flax and mesta (kenoff); Sugars: sugarcane, sugarbeet, sugarpalm and sweet sorghum; Fodders and green manure crops: Plantation crops: coconut, cocoa, tea; root and tuber crops-: potato, sweet potato, tapioca, aroids etc.

Unit IV: Economically important plants –III

Origin, distribution, classification, production and utilization of Fruits: mango, banana, citrus, guava, grapes and other indigenous fruits; apple, plum, pear, peach, cashewnut and walnut; Vegetables: tomato, brinjal, okra, cucumber, cole crops, gourds etc.; Fumigatories and masticatories: tobacco, betelvine, areacanut; medicinal and aromatic plants: sarpagandha, belladonna, cinchona, nux-vomica, vinca, mentha and glycirrhiza, plantago etc.; Narcotics: cannabis, datura, gloriosa, pyrethrum and opium; Dye-, tannin-, gum- and resin- yielding plants; Plant of agro-forestory importance: multipurpose trees/shrubs, subabool, Acacia nilotica, poplar, sesbania, neem etc.; non-traditional economic plants: jojoba, guayule, jatropha, carcus etc.

Unit V: Biodiversity and Plant Genetic Resources (PGR)

Biosphere and biodiversity; plant species richness and endemism; concept and importance of plant genetic

resources and its increasing erosion; Centres of origin and diversity of crop plants, domestication, evaluation, bioprospecting; National and International organizations associated with PGR; Convention on Biological Diversity (CBD), recent issues related to access and ownership of PGR, IPR,. PBRs, farmers rights, sui-generis system etc.

SUGGESTED READINGS:

1. Stace, C.A. (2019). *Plant Taxonomy and Biosystematics*. 4th Edition. Cambridge University Press.
2. Simpson, M.G. (2019). *Plant Systematics*. 3rd Edition. Academic Press.
3. Sen, S. (2012). *Economic Botany: Principles and Practices*. New Central Book Agency.
4. Judd, W.S., Campbell, C.S., Kellogg, E.A., & Stevens, P.F. (2015). *Plant Systematics: A Phylogenetic Approach*. 4th Edition. Sinauer Associates..
5. Gupta, S.K. (2010). *Medicinal and Aromatic Plants*. Agro Botanical Publishers.
6. Engels, J.M.M., & Ebert, A.W. (2010). *Plant Biodiversity and Genetic Resources*. Springer.
7. Verma, V. (2010). *Textbook of Economic Botany*. Ane Books.

PALEOBOTANY AND PALYNOLOGY

Credit: 4

Total Marks: 100 (70+30)

Course Objectives:

1. Understand the evolutionary history of plants and their preservation in the fossil record.
2. Describe early life forms during the Precambrian era, including cyanobacteria and microbial mats, and their significance in plant evolution.
3. Understand the evolution and diversity of ancient plant life through the fossil record.
4. Explore paleofloristics and reconstruct ancient palaeogeography and paleoclimatic conditions using paleobotanical and palynological data.
5. Study the morphology and taxonomy of pollen and spores, including their use in systematics and paleoecology.

Course Outcomes:

Skills that students obtain after completion of the course:

1. Explain the significance of paleobotany and palynology in understanding Earth's history, plant evolution, and climate change.
2. Identify major fossil plant groups and classify them based on their morphological and anatomical features.
3. Analyze pollen and spore samples using microscopic techniques for biostratigraphic and paleoenvironmental interpretation.
4. Correlate fossil records with geological time scales and interpret evolutionary trends and extinction events.
5. Assess the application of palynology in various fields, such as oil exploration, archaeology, and forensic science.

Unit I

Basic geological information – structure of Earth Types of rocks, stratigraphy, basic concepts of continental drift and plate tectonics; Dating the past, Geological time scale. Fossilization process, Types of fossils; techniques to study fossils, reconstruction and nomenclature of fossil--- concepts of Parataxa and Eutaxa, objectives of palaeobotany

Unit II

Prebiotic Environment, chemical evoluation and origin of life, Pre-Cambrian life; Indian Pre-cambrain stratigraphy and life forms; Diversification of algae, fungi and bryophytes through the ages; Origin and evolution of land plants, earliest records of pteridophytes and their evolutionary tendencies

Unit III

Emergence of first seeds plants, preovules, diversification of Gymnosperms in geological time scale. First Angiosperms, Angiosperm palaeofloristics; Concept of Indian Gondwana sequence, stratigraphy and correlation of Gondwana sequence in Peninsular Indian basins; Mega and microfloristics of Indian Gondwana formation; Indian Perigondwana floras

Unit IV

Fundamentals of Paleofloristics, Palaeogeography and Palaeoclimatology; Application of Palaeopalynology .Plant and animal interactions correlation, Archaeobotany with special reference to phytoliths and palynological studies

Unit V

Palynology- Introduction in scope of palynological science.

Morphology of pollen- Polarity, symmetry, size and shape, apertural pattern, exine stratification and ornamentation of pollen wall.

Aeropalynology- Principles, dissemination, distribution of aerospora and meteorological factors. Polen and spore allergy and clinical treatment. Importance of mellito palynology.Role of palynology in taxonomy**.**

SUGGESTED READINGS:

1. Steward W.N., Palaeobotany and evolution of plant. Cambridge University Press,New York.405 p.(1)
2. Stewart,W.N.,and G.W.Rothwell.1993 Palaeobotany and the evolution of plant. 2nd ed. Cambridge University Press, New York.521 p.(1)
3. Andrews ,H.N.,jr.1974 Palaeobotany 1947-1972 Annals of the Missouri Botanical Garden 61:179-202.(8)
4. Thomas N.Taylor.Edith L. Tailor.Michael Krings Palaeobotany:The biology and Evolution of Fossil Plants Amsterdam ; Boston, Mass.
5. P.K.K Nayar. Pollen Morphology of Angiosperms.
6. P.K.K Nayar. Essentials of Palynology.

ON JOB TRAINING (OJT)/INTERNSHIP/PROJECT

Credit: 4

Total Marks: 100 (70+30)

SEMESTER III

ANGIOSPERMS TAXONOMY AND PHYTOGEOGRAPHY

Credit: 3

Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of Taxonomy and Phytogeography of Angiosperms.
2. To be familiar with different Taxonomical and Phytogeographical concepts of Angiosperms.
3. To train the students to pursue further education.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Taxonomy and Phytogeography of Angiosperms and key principles of it.
2. Awareness of the major issues at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.
4. Ability to design experiments and understand the limitations of the experimental approach.

UNIT: I Taxonomic hierarchy, delimitation of taxa and attribution of rank. Typification, International Code of Botanical Nomenclature Salient Features Principles, important Rules and Recommendations, Provisions for the governance of the Code. Biosystematics.

UNIT: II Herbarium, flora, histological, cytological, serological, morphology, anatomy, palynology, embryology, phytochemistry, numerical taxonomy, DNA barcoding.

UNIT: III Phenitic versus phylogenetic systems, clasistics in taxonomy, relative merits and demerits of major systems of classification, relevance of taxonomy to conservation, Angiosperm phylogeny group (AGP), ancestors of Angiosperms, Interrelationship among the major groups of Angiosperms.

UNIT: IV Ranunculaceae, Capparidaceae, Malvaceae, Cucurbitaceae, Apiaceae, Rubiaceae, Asteraceae, Asclepiadaceae, Acanthaceae, Lamiaceae, Euphorbiaceae, Moraceae, Cyperaceae, Arecaceae, Poaceae, Nymphaeaceae.

UNIT: V A brief idea of Phytogeography, Phyto-geographical regions of the world with special reference to the Indian sub-continent, Endemism, Major vegetation, forest types of India and their distribution, Grassland types and their distribution in India.

SUGGESTED READINGS:

1. Davis, P.H. and V.H. Heywood. 1991. Principles of Angiosperm Taxonomy. Today and Tomorrow Publications, New Delhi

2. Eames, A.J. 1961. Morphology of Angiosperms. McGraw Hill, NY.

3. Naik,V.N.1984.Taxonomy of Angiosperms Tata McGraw-Hill Publication Com

4. Pandey, B.P. 2007. Taxonomy of Angiosperms. S. Chand and Company Limited.

New Delhi.

5. Sharma, O.P. 2009. Plant Taxonomy. Tata McGraw-Hill. Mumbai.

6. Singh Gurcharan. 2004. Plant Systematics: Theory and practice Oxford and YBH Publishing Co. Pvt. Ltd., New Delhi.

GENETICS AND BREEDING

Credit: 3
Total Marks: 100 (70+30)

Course Objectives:

1. To impart basic knowledge of Genetics and Breeding.
2. To be familiar with different concepts of Genetics and Breeding.
3. To train the students to pursue further education.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Genetics and Breeding and key principles of it.
2. Awareness of the major issues at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.
4. Ability to design experiments and understand the limitations of the experimental approach.

UNIT: I Classical genetics: Mendelian principles, Segregation, Independent Assortment; incomplete dominance,Co-dominance, Gene interactions, Epistasis, Chromosomal theory of inheritance, sex chromosomes and determination, dosage compensation, Extra nuclear inheritance.

UNIT: II Arrangement of genetic material: linkage and recombination, genetic and cytological crossing over, genetic and chromosome mapping, Change and structure of genetic material: Chromosome variation in number, Euploidy, Aneuploidy, polyploids. Changes in chromosome structure: deficiencies, duplications, translocations, Gene mutation.

UNIT: III Population Genetics: Population models, probability and distributions, Genotypic and phenotypic variation, Hardy-Weinberg, measures of genetic variation Gene frequencies and equilibrium, optimum phenotype and selection pressure, kinds of selection; Fisher's fundamental theorem of Natural selection.

UNIT: IV Genomics and Molecular Genetics: Maps of Chromosomes, Map position-based cloning of genes: Chromosome walks, chromosome jumps, Expressed sequences, Comparative genomics: Mitochondrial and Chloroplast genomes, genome evolution in plants.

UNIT: V Plant breeding: objectives and scope, hybridization in self-pollinated crops and cross-pollinated crops, inbreeding depression and heterosis, polyploidy breeding; breeding for disease resistance plants, molecular markers and plant breeding.

SUGGESTED READINGS:

1. Alberts B. Johnson, A. Lewis, J.Raff, M.Roberts, K.Walter, P. 2008. Molecular Biology of the Cell. Garland Science Publisher. USA.

2. Benzamin Lewin. 2011. GeneX. Jones and Batlett. Learning Publisher. USA.

3. Clugg and Cummings. 2011. Concepts of Genetics. Benzamin Cumming Publishing Company. UK.

4. Russel, P.J. 2010. Genetics. Benzamin Cumming Publishing Company. UK.

5. Singh, B.D. 2007. Plant Breeding. Kalyani Publications. New Delhi.

6. Tamarin. 2001. Genetics. McGraw Hill. New Delhi.

LAB COURSE V
ANGIOSPERMS TAXONOMY AND PHYTOGEOGRAPHY

Credit 1

Total Marks: 50 (35+15)

1. To prepare and preserve plant specimens,Collection, pressing, mounting, labeling, and documentation (minimum 10 specimens)

2. Detailed study of diagnostic features

- **Dicots:** Fabaceae, Solanaceae, Asteraceae, Malvaceae, Brassicaceae, Euphorbiaceae, Lamiaceae, Apocynaceae
- **Monocots:** Poaceae, Liliaceae, Orchidaceae, Cyperaceae

3. Mapping and marking major phytogeographic zones in india.

4. To write detailed morphological descriptions of specimens

LAB COURSE VI
GENETICS AND BREEDING

Credit 1

Total Marks: 50 (35+15)

1. Demonstration of special chromosomes of plants.
2. To study the spontaneous mutation by replica plating method.
3. To study the induced mutation in the selected organism.
4. Isolation of antibiotic resistant mutant by gradient plate technique.

5. Theoretical problems based on genetics.
6. Determination of χ^2. Demonstration various plant breeding techniques.
7. Study of molecular markers.
8. Construction of genetic maps.

MICROBIAL DIVERSITY

Credit 4
Total Marks: 100 (70+30)

Course Objectives:
1. To impart basic knowledge of Diversity of microoganisms.
2. To be familiar with different concepts of diversity.
3. To train the students to pursue further education.

Course Outcome:
Skills that students obtain after completion of the course:
1. Understanding of the fundamentals of Diversity and key principles of it.
2. Awareness of the major issues at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.
4. Ability to design experiments and understand the limitations of the experimental approach.

UNIT: I Bacteria : General characteristics, structure, mode of nutrition, classification and reproduction. Economic importance of bacteria. General account of Mycoplasma and Cyanobacteria

UNIT: II Virus: General account and classification, Bacteriophages: structure and life cycle (lytic and lysogenic cycle), regulation of lysis and lysogeny in lambdaphage, Cyanophages, Viroids and Prions, Plant viruses.

UNIT: III General characteristics of fungi: Distribution, Mode of nutrition, Reproduction: Vegetative, Asexual and Sexual reproduction and general principles of classification of fungi. Heterothallism and parasexuality; economic importance of fungi.

UNIT: IV General characteristics features of orders Plasmodiophorales, Chytridiales Peronosporales, Mucorales, Protomycetales, Erysiphales and Pezizales.

UNIT: V Uredinales, Ustilaginales, Agaricales and Melanconiales, Moniliales; Mycorrhiza.

SUGGESTED READINGS:

1. Alexopoulos, C.J. Mims, C.W. and Blackwell, M. 1996 - Introductory Mycology. John Wiley Publications.UK.

2. Madigan M. et al. 2001. Brocks biology of Microorganisms. Pearson. USA.

3. Mehrotra R.S. and Aneja K.R. An Introduction to Myocology. New Age International Publishers. New Delhi.

4. Prescott, Harley and Kleins. 2001. Microbiology, McGraw-Hill Education. USA.

5. Webster, J.2007.An Introduction to Fungi. Cambridge Univ. Press. New Delhi.

ETHNOBOTANY

Credit: 4

Total Marks: 100 (70+30)

Course Objectives:

1. Understand the foundational concepts of ethnobotany and its interdisciplinary nature.
2. Explore the relationships between indigenous communities and plant resources.
3. Examine traditional knowledge systems regarding the use of plants for food, medicine, rituals, and other purposes.
4. Analyze the cultural, ecological, and economic importance of plant biodiversity.
5. Promote awareness of conservation strategies influenced by ethnobotanical knowledge.

Course Outcomes:

Skills that students obtain after completion of the course:

1. Define key concepts, terminology, and historical development in ethnobotany.
2. Identify and describe plant species used traditionally by various ethnic or indigenous groups.
3. Analyze the role of plants in traditional healthcare systems and cultural practices.
4. Apply ethnobotanical methods for collecting, documenting, and interpreting indigenous plant knowledge.
5. Critically evaluate the implications of bioprospecting, intellectual property rights, and traditional knowledge protection**.**

Unit I

- Ethnobotany: History, general account and its sub disciplines.
- Interdisciplinary approaches & aim of ethno botany.
- Main world centers of Ethno botanical studies, workers & literature of Ethnobotany
- Ethnobotany with special reference to Chhattisgarh.
- Ethnobotanical Research done in India: Ethnobotany in relation to national priorities and health care programme.
- Practical application of ethno botany for tribal development programme.

Unit II

- Methods and techniques in ethno botany.

- General account of major and minor tribes of Chhattisgarh with special reference to Gond, Kamar, Baiga, Abujhmaria
- Ethnobotanical aspect of Art & literature.
- Abstract ethno botany with special reference to folklore, Taboos, Majico-religious beliefs.

Unit III

- Ethno botanical importance of Bacteria, Algae, Fungi, Bryophyte, Pteridophyta and Gymnosperm.
- Ethnovaterinary medicines from plants.
- Major & Minor Forest Products (NWFPs) of Chhattisgarh.
- Ethnobotany in relation to livelihood security reference to tribes.

Unit IV

- Ethnobotany and its role in domestication and conservation of native plant and genetic resources.
- The protection of plant varieties and Intellectual Properties Rights.
- General account of conservation of medicinal plants.

Unit V

- Ethnobotanical study of following plants with special reference to their medicinal importance 1. *Azadirachta indica* (Neem) 2. *Emblica officinalis* (Amla) 3. *Ricinus conmunis* (Andi) 4. *Madhuca indica* (Mahuaa) 5. *Cassia fistula* (Amaltash) 6. *Ficus religiosa* (Pipal) 7. *Oscimum sanctum* (Tulsi) 8. *Asparagus racemosus* (Satavar) 9. *Aloe vera* (Ghritkumari) 10. *Andographis paniculata* (Bhui neem).

SUGGESTED READINGS:

- Baker, H.G. 1978. Plants and Civilization (3 rd edition). C.A. Wadsworth, Belmont.
- Chandel, K.P.S., Shukla, G.& Sharma, N. 1996. Biodiversity in medicinal and Aromatic Plants in India: Conservation & Utilization. National Bureau of Plant Genetic Resources, New Delhi.

- Ambasta S.P. (ed.) (1986). The Useful Plants of India. Publications & Information Direxorate, CSIR, New Delhi India.
- Anon. (1978). The tribes of Madhya Pradesh. Dept. of Tribal Welfare, Govt. of M.P. Bhopal.
- Jain, S. K. (1991). Dictionary of India folk medicine and Ethnobotany. Deep publications. NEW DELHI, pp. 1-311.
- Jain, S.K. & Rao, R.R. (1977). A handbook off field and herbarium methods. New Delhi: Today & Tomorrow's Printers and Publishers.

PHYTOCHEMISTRY AND MEDICINAL BOTANY

Credit: 4

Total Marks: 100 (70+30)

Course Objectives:

1. Identify and list major active principles (e.g., alkaloids, glycosides, terpenoids) in the four target medicinal plants.
2. Perform and interpret standard phytochemical tests (e.g., alkaloid, flavonoid, glycoside detection).
3. Analyze one selected herb through a stepwise process from phytochemical screening to tangible application (e.g., evaluating cardiotonic or memory-enhancing activity
4. Understand classification of medicinal plants and recognize major systems of herbal medicine.
5. Identify threats and conservation methods—including in situ and ex situ approaches, IUCN classifications, CITES, biosphere reserves, and sacred groves.

Course Outcomes:

Skills that students obtain after completion of the course:

1. Identify and list major active principles (e.g., alkaloids, glycosides, terpenoids) in the four target medicinal plants.
2. Perform and interpret standard phytochemical tests (e.g., alkaloid, flavonoid, glycoside detection).
3. Analyze one selected herb through a stepwise process from phytochemical screening to tangible application (e.g., evaluating cardiotonic or memory-enhancing activity).
4. Classify plants according to their system of medicine (e.g., Ayurveda, Unani) and justify their uses.
5. Evaluate conservation strategies and analyze one threatened medicinal plant using IUCN/CITES criteria.

Unit I: Introduction to Phytochemistry

- Definition, scope, and significance of phytochemistry
- Primary vs. secondary metabolites
- Roles of phytochemicals in plants and human use
- Plant metabolic pathways: shikimic acid, acetate-malonate, mevalonate pathways

Unit II: Classification of Phytochemicals

- Alkaloids: classification, biosynthesis, examples (quinine, morphine, etc.)
- Terpenoids and Essential oils: classification, sources, uses

- Flavonoids, Tannins, and Phenolics: chemical nature, roles in plants, antioxidant properties
- Glycosides: cardiac, cyanogenic, and saponin glycoside.
- Steroids and Coumarins: structure, function, and bioactivity

Unit III: Extraction and Isolation Techniques

- Sample preparation and solvent selection
- Methods of extraction: maceration, percolation, Soxhlet, ultrasonic, microwave-assisted
- Chromatographic techniques: TLC, column chromatography, HPLC, GC-MS
- Spectroscopic methods for characterization: UV, IR, NMR, MS

Unit IV: Common Medicinal Plants and Their Uses

- Botanical name, family, morphology, active constituents, and uses of:
  - **Rauwolfia serpentina** (Reserpine)
  - **Withania somnifera** (Ashwagandha)
  - **Azadirachta indica** (Neem)
  - **Ocimum sanctum** (Tulsi)
  - **Phyllanthus niruri**, **Terminalia chebula**, **Curcuma longa**, **Tinospora cordifolia**
- Plants used in liver diseases, diabetes, skin disorders, and as immune boosters.

Unit V: Cultivation, Conservation & Ethnobotany

- Cultivation and harvesting techniques for medicinal plants
- In-situ and ex-situ conservation strategies
- Role of botanical gardens and herbal gardens
- Sacred groves and ethnomedicinal practices of tribal communities

SUGGESTED READINGS:

1. **G.E. Trease & W.C. Evans** *Pharmacognosy*.
2. **Harborne, J.B.** *Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis*.
3. **Tiwari, P.** *Textbook of Phytochemistry*

4. **R. Verpoorte** *Phytochemistry*
5. **S. S. Agarwal & Paridhavi, M.** *Herbal Drug Technology*
6. **P.C. Trivedi** *Medicinal Plants: Utilization and Conservation*
7. **S. K. Jain** *Medicinal Plants.*
8. **V. Singh & D.K. Jain** *Medicinal Plants of India*

ENVIRONMENTAL BIOTECHNOLOGY

Credit: 4
Total Marks: 100 (70+30)

Course Objectives:

1. To impart in-depth knowledge related to environmental biotechnology
2. Become familiar with the environment.
3. To train the students to pursue further education.
4. Gain experience with standard tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Environmental Biotechnology and key principles of its.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.
4. Ability to design experiments and understand the limitations of the experimental approach.

UNIT I

Environment: Basic concepts and issues. Environmental pollution: types of pollution, methods for measurement of pollution, methodology of environmental management- the problem solving approach, its limitations. Air pollution and its control through biotechnology.

UNIT II

Water Pollution and its control: water as a natural scarce resource, need for water management, measurement of water pollution, waste water collection, waste water treatment- physical, chemical and biological treatment processes. Microbiology of waste water treatment, Aerobic Processes – activated sludge, oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds. Anaerobic Processes – Anaerobic digestion, anaerobic filters, up-flow anaerobic sludge, blanket reactors.

UNIT III

Treatment schemes for waste waters of dairy, distillery, tannery, sugar and antibiotic industry. Microbiology of degradation of xenobiotics in environment; Ecological considerations, decay behavior and degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, and pesticides. Bioremediation of contaminated oils and waste lands.

UNIT IV
Bio-pesticides in integrated pest management. Solid waste: sources and management (composting, vermiculture and methane production). Global environmental problem: Ozone depletion, UV-B, green house effect and acid rain, their impact, and biotechnological approaches for management.

UNIT V Role of international and national organizations in Biotechnology; Cooperative efforts, government programs for biotechnology developments and applications, patenting biotechnical processes and production in different countries, regulation for biohazardous products.

SUGGESTED READINGS:

1. Comprehensive Biotechnology (Vol. 1-4): M.Y. Young (Eds.), Pergamon Press, Oxford.
2. Environmental Microbiology: W.D. Grant & P.E. Long, Blakie, Glassgow and London.
3. Microbial Gene Technology: H. Polasa (ED.) South Asian Publishers, New Delhi.
4. Bio-treatment Systems, Vol. 22, D. L. Wise (Ed.), CRC Press, INC.
5. Environmental Biotechnology: Alan and Scragg; Pearson Education Ltd. England.
6. Environmental Biotechnology: S.N. Jogdand; Himlaya Publishing House Bombay.
7. Waste Water Engineering – Treatment, Disposal and reuse: Metcalf and Eddy.
8. A.K. De, Environmental Chemistry Willey Eastern Ltd. New Delhi.
9. Introduction to Biodeterioration: D. Allsopp and K.J. Seal, ELBS/Edward Arnold.

RESEARCH PROJECT & PROPOSAL WRITING

Credit: 6

Total Marks: 150 (105+45)

Course objectives:

1. Understand principles of scientific research.
2. Equip life science students with skills to design and implement biological research.
3. Enhance scientific writing skills, especially for thesis and funding proposals**.**
4. Design experimental or observational studies suitable for life science research.
5. Write a structured research proposal aligned with life science standards.

Course outcomes:

Skills that students obtain after completion of the course:

1. Define and explain research concepts specific to life sciences.
2. Formulate testable hypotheses and objectives for biological research.
3. Conduct systematic literature reviews using biological databases.
4. Develop laboratory or field-based data collection methods and protocols.
5. Apply appropriate statistical and bioinformatics tools for biological data analysis

Unit I

Introduction to Life Science Research: Nature and purpose of biological research, Types of life science research: experimental, observational, field-based, molecular, etc., Scientific method in biological contexts, Research ethics: animal care, human samples, informed consent, biosafety, institutional review boards (IRBs)

Unit II

Research Problem and Hypothesis Formulation: Identifying gaps in life science research, Researchable questions in biology, biotechnology, ecology, etc., Writing SMART objectives, Formulating null and alternative hypotheses.

Literature Review and Information Management: Accessing life sciences databases: PubMed, Scopus, Web of Science, AGRIS, Reading and synthesizing scientific articles, Critical evaluation of scientific evidence, Writing an annotated bibliography, Referencing tools: Zotero, Mendeley, EndNote, Use of AI and digital tools responsibly in literature review.

Unit III

Experimental Design and Methodology: Experimental vs observational designs in biology, Designing in-vitro, in-vivo, or field experiments, Controls and replication in biological studies, Sampling methods in biodiversity, ecology, microbiology, Data collection tools: lab protocols, field logs, observation sheets, Pilot studies and protocol standardization, Risk assessment and biosafety level (BSL) protocols.

Unit IV

Writing a Research Proposal: Key sections of a biological research proposal- Background and rationale, Objectives and hypotheses, Experimental/field methodology, Materials, methods, and instrumentation, Ethical considerations and regulatory approvals, Budgeting: lab supplies, fieldwork, sequencing, travel, Work plan (Gantt chart). Review and critique of published proposals (e.g., DBT, DST, CSIR templates). Writing executive summaries and abstracts.

Unit V

Writing the Project Report: Structure of a biological research thesis/project- Abstract, Introduction, Materials & Methods, Results, Discussion, Conclusion. Presenting data with figures and tables. Writing effective figure legends and captions. Common writing errors in biological sciences. Plagiarism detection and referencing styles (e.g., Harvard, APA, Vancouver). Formatting and submission guidelines.

SUGGESTED READINGS:

1. Booth, W. C., Colomb, G. G., & Williams, J. M. (2016). *The craft of research* (4th ed.). University of Chicago Press.
2. Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.
3. Day, R. A., & Gastel, B. (2012). *How to write and publish a scientific paper* (7th ed.). Cambridge University Press.
4. Kothari, C. R. (2004). *Research methodology: Methods and techniques* (2nd ed.). New Age International.
5. Kumar, R. (2022). *Research methodology: A step-by-step guide for beginners* (6th ed.). SAGE Publications.
6. Punch, K. F. (2006). *Developing effective research proposals* (2nd ed.). SAGE Publications.
7. Turabian, K. L., Booth, W. C., Colomb, G. G., & Williams, J. M. (2018). *A manual for writers of research papers, theses, and dissertations: Chicago style for students and*

researchers (9th ed.). University of Chicago Press.
8. Singh, Y. K. (2006). *Fundamental of research methodology and statistics*. New Age International.
9. Singh, Y. K. (2006). *Fundamental of research methodology and statistics*. New Age International.

SEMESTER IV

PLANT MOLECULAR BIOLOGY: GENETIC ENGINEERING

Credit: 3

Total Marks: 100 (70+30)

Course Objectives:

1. To impart in-depth knowledge related to Plant Molecular Biology and Genetic Engineering.
2. Become familiar with the molecular biology techniques.
3. To train the students to pursue further education.
4. Gain experience with standard molecular tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Plant Molecular Biology and Genetic Engineering and key principles of its.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.
4. Ability to design experiments and understand the limitations of the experimental approach.

UNIT: I Basic concepts of DNA structure and properties, restriction enzymes, DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatise, Cohesive and blunt end ligation.

UNIT: II UNIT: II Plasmids, Bacteriophages, pBR322 and pUC series of vectors, M13 and P2 phase-based vectors, High capacity vectors: Cosmids, phagemid, phasemid, YAC, BAC, Insertion of foreign DNA into Host Cells, Transformation

UNIT: III Hybridization techniques, Northern, Southern and Colony Hybridization, Fluorescence insitu hybridization, Chromatin immunoprecipitation, footprinting, Isolation of Plasmid, DNA and Bacteriophage DNA.

UNIT: IV Polymerase chain reaction (PCR): Types of PCR-multiplex, nested, reverse

transcriptase, realtime PCR, touchdown PCR, hotstart PCR, colony PCR, insitu PCR, cloning of PCR products, Introduction of DNA into plant cells, transfection techniques.

UNIT: V Constructions of libraries, cDNA and genomic libraries, cDNA and genomic cloning, Expression cloning Protein-protein interactive cloning and Yeast two hybrid system.

SUGGESTED READINGS:

1. Brown T.A. 2007. Genomes 3.Garland Science Publication.USA.

2. Brown T.A.2011. Gene Cloning and DNA Analysis. Taylor and Francis.UK.

3. Primrose and Twyman, 2009. Principles of Gene manipulation and Genomics, Wiley-Blackwell Publishing. UK.

PLANT RESOURCE UTILIZATION AND CONSERVATION

Credit: 3

Total Marks: 100 (70+30)

Course Objectives:

1. To impart in-depth knowledge related to Utilization and Conservation of Plant Resources.
2. Become familiar with the concepts related to Utilization and Conservation of Plant Resources.
3. To train the students to pursue further education.
4. Gain experience with standard tools.

Course Outcome:

Skills that students obtain after completion of the course:

1. Understanding of the fundamentals of Utilization and Conservation of Plant Resources and key principles of its.
2. Awareness of the major issue at the forefront of the discipline.
3. Ability to dissect a problem in to its key features.
4. Ability to design experiments and understand the limitations of the experimental approach.

UNIT: I General aspects on resource types: Renewable resources, non-renewable resources, Resource degradation, Resource conservation; Natural resources, biological resources, plants as natural resources.

UNIT: II Utilization of plant resources, Bio-control-sources and advantages, Bio-control as

agribusiness, Untapped potential plant resources, seaweeds as potential resources– food, fodder and bio-fertilizer; Plant resources used in cosmetics, aromatics and pharmaceuticals, fibers; forest as potential resources: vegetable oil yielding plants, bio-energy.

UNIT: III Biodiversity, Levels and types of biodiversity, uses of biodiversity, Distribution of biodiversity, Regional pattern of biodiversity, Hot spots of biodiversity, Threats to biodiversity– Habitat loss and fragmentation, Alien invasive species, disturbance and pollution, harvesting and over-exploitation.

UNIT: IV An overview of Indian biodiversity; Biogeographic regions (zone) of India; Hot spots of Indian biodiversity; Status of biodiversity conservation in India; Protected area network of India;TheBiologicalDiversityAct2002;Bio-prospecting–Biochemical resources from plants.

UNIT: V Conservation of Biodiversity; IUCN red list categories, In situ conservation strategies – Protected areas, Biosphere reserves; Ex-situ conservation strategies – Restoration of endangered species, Sustainable use and public participation; International efforts for conserving biodiversity.

SUGGESTED READINGS:

1. Chandel K. P., S. Shukla G. and Sharma Neelam. 1996. Biodiversity in Medicinal and Aromatic Plants in India–Conservation and Utilization, Indian Bureau of Plant Genetic Resources, New Delhi

2. Kaufman Peter B. et al. 1999.Natural Products from Plants, CRC Press. UK.

3. Primack R. B. 2000. A Primer of Conservation Biology, Sinauer Asso. Publ., Massachusetts. USA.

4. Sahoo S. 2002. Plant Resource Utilization. Allied Publishers. Nagpur.

5. Singh J. S. Singh S. P. and Gupta S. R., 2006, Ecology, Environment and Resource Conservation, Anamya Publication, New Delhi.

6. Trivedi P.C. and Sharma N. 2010. Plant Resource Utilization and Conservation, Pointer Publishers. Jaipur.

LAB COURSE VII
PLANT MOLECULAR BIOLOGY: GENETIC ENGINEERING

Credit: 1
Total Marks: 50 (35+15)

1. Isolation of genomic DNA from plant cell.

2. Restriction digestion of plant DNA.

3. Isolation of total RNA from plant cell.

4. Preparation of competent cells using $CaCl_2$.

5. Synthesis of cDNA and analyses of mRNA expression using RT/Real Time PCR.

6. Isolation of plasmid DNA from bacteria.

7. Transformation study in *E. coli*.

8. PCR amplification of the selected plant gene

LAB COURSE VIII
PLANT RESOURCE UTILIZATION AND CONSERVATION

Credit: 1

Total Marks: 50 (35+15)

1. Study of fodder, food, fire, oil, fibre and oil of plants (five each)
2. Study of locally available medicinal and aromatic plants.
3. Study of Gums, resins, tannins, dyes yielding plants of Raipur, (CG).
4. Local Field study tour for plant wealth survey and report writing.

DISSERTATION

Credit: 14
Total Marks: 350 (250+50+50)

(A) : Project work/ Dissertation
Topic will be based on the major elective opted by students. Project will include laboratory/field-based work followed by submission of report and presentation.

(B) : Seminar
Students are required to deliver a seminar on a current topic related to the subject and to be evaluated by a panel of examiners.

(C) : Viva -Voce