ROYAL GLOBAL UNIVERSITY
GUWAHATI

# ROYAL SCHOOL OF LIFE SCIENCES (RSLSC)
# DEPARTMENT OF BOTANY
# COURSE STRUCTURE & SYLLABUS
# (BASED ON NATIONAL EDUCATION POLICY 2020)
# FOR

## M.Sc. IN BOTANY

**W.E.F**
**AY - 2025 – 26**

**TABLE OF CONTENTS**

| 1st SEMESTER | | | | |
|---|---|---|---|---|
| **COURSE CODE** | **COURSE TITLE** | **LEVEL** | **CREDIT** | **L-T-P** |
| BOT144C101 | Microbes and Microbial Technology | 400 | 3 | 3-0-0 |
| BOT144C102 | Plant Systematics | 400 | 3 | 3-0-0 |
| BOT144C103 | Plant Developmental Biology | 400 | 3 | 3-0-0 |
| BOT144C104 | Genetics, Cytogenetics & Plant Breeding | 400 | 3 | 3-0-0 |
| BOT144C115 | Microbiology & Plant Systematics Practical | 400 | 3 | 0-0-6 |
| BOT144C116 | Developmental Biology, Genetics & Plant Breeding Practical | 400 | 3 | 0-0-6 |
| BOT144C121 | Mushroom Cultivation: Principles and Commercial Applications | 400 | 2 | 0-0-4 |
| MOOCS | *MOOCs/online course will be identified by the dept from the list of courses available on MOOC online platform/SWAYAM Platform | 400 | 4 | |
| **TOTAL CREDIT FOR 1st SEMESTER** | | | **24** | |
| **2nd SEMESTER** | | | | |
| **COURSE CODE** | **COURSE TITLE** | **LEVEL** | **CREDIT** | **L-T-P** |
| BOT144C201 | Applied Mycology & Crop Protection | 500 | 4 | 4-0-0 |
| BOT144C202 | Plant Physiology | 500 | 4 | 4-0-0 |
| BOT144C203 | Plant Ecology & Ecosystem Analysis | 500 | 4 | 4-0-0 |
| BOT144C214 | Applied Mycology, Plant Physiology, Ecology Practical | 500 | 4 | 0-0-8 |
| BOT144C241 | Herbal Medicinal Practices in India | 500 | 2 | 1-0-2 |
| BOT144C221 | Nursery Cultivation & Floriculture | 500 | 2 | 0-0-4 |
| MOOCS | *MOOCs/online course will be identified by the dept from the list of courses available on MOOC online platform/SWAYAM Platform | 400 | 4 | |
| **TOTAL CREDIT FOR 2nd SEMESTER** | | | **24** | |
| **TOTAL CREDIT FOR 1st YEAR = 40** | | | | |
| **3rd SEMESTER** | | | | |
| **COURSE CODE** | **COURSE TITLE** | **LEVEL** | **CREDIT** | **L-T-P** |
| BOT144C301 | Plant Biochemistry & Molecular Biology | 500 | 4 | 4-0-0 |
| BOT144C302 | Plant Biotechnology | 500 | 4 | 4-0-0 |
| BOT144C313 | Biochemistry, Molecular Biology & Biotechnology Practical | 500 | 4 | 0-0-8 |
| BOT144C321 | Project Dissertation I | 500 | 8 | |
| **TOTAL CREDIT FOR 3rd SEMESTER** | | | 20 | |
| **OR 3rd SEMESTER (For students with 3rd and 4th Semester Research)** | | | | |
| BOT144R321 | Dissertation I | 500 | 20 | |
| **4th SEMESTER** | | | | |
| **COURSE CODE** | **COURSE TITLE** | **LEVEL** | **CREDIT** | **L-T-P** |
| ***(for 'Coursework only' in lieu of Research)*** | | | | |
| BOT144C401 | Biostatistics & Bioinformatics | 500 | 4 | 4-0-0 |
| BOT144C402 | Environment Pollution and Climate Change Mitigation | 500 | 4 | 4-0-0 |
| BOT144C421 | Project Dissertation II | 500 | 12 | |
| **OR 4th SEMESTER (For students with 3rd and 4th Semester Research)** | | | | |
| BOT144R421 | Dissertation II | 500 | 20 | |
| **TOTAL CREDIT FOR 2nd YEAR =** | | | **40** | |

## DETAILED SYLLABUS FOR 1st SEMESTER

**PAPER I: MICROBES AND MICROBIAL TECHNOLOGY**
**SUBJECT CODE: BOT144C101 COURSE LEVEL: 400**
**CREDIT: 03 L-T-P-C 3-0-0-3**
**SCHEME OF EVALUATION: THEORY (T)**

**Course Objective:** This course aims to explore microbial growth, genetics, and their applications in industry, environment, and health.

**Course outcomes:** By the end of the course the students will be able to:

| | | |
|---|---|---|
| **CO1** | Discover bacterial growth and describe various methods of control of microbial growth. | **BT3** |
| **CO2** | Interpret the various aspects of Virology | **BT3** |
| **CO3** | Analyse the role of microbes in industries and environment. | **BT4** |

**Module Structure & Course Content**

| Module | Topic and Course content | Lecture hours |
|---|---|---|
| I | **Microbial Growth and regulation:** Bacterial growth kinetics; Control of microorganisms; Mechanism of genetic exchange in bacteria; concepts of gene mapping; Regulation of bacterial cellular processes, chemotaxis, Quorum sensing. | 15 |
| II | **Viruses, Viroids and Prions**: Characteristics, structure and genome; Virus isolation and cultivation; Genetic switch of Bacteriophage Lambda; Types of oncogenic viruses; antiviral compounds and their mode of action. Use of viral vectors in cloning and expression. | 15 |
| III | **Microbial biotechnology**: Microbial products and their industrial importance; Fermentation technology, types of bioreactors and measurement of fermentation parameters; strain improvement and product optimization; Production of microbial polyesters, biosurfactants, and recombinant products (insulin and vaccine). | 15 |
| IV | **Environmental Microbiology:** Microbial interactions; Microbes in extreme environments. Understanding microbial diversity in the environment by culture-dependent, and independent molecular approaches; Microbial degradation of toxic chemicals and agricultural residues; Bioremediation; Microbes as hyper accumulators | 15 |
| **Total** | | 60 |

| CREDIT DISTRIBUTION | | |
|---|---|---|
| **LECTURE/TUTORIAL** | **PRACTICALS** | **EXPERIENTIAL LEARNING** |
| 60 | 00 | 30<br>•HOME ASSIGNMENTS<br>•SEMINARS<br>•VIVAVOCE<br>•FIELD VISITS |

**Suggested readings:**

**Textbooks**


1. Pelczar, M.J. 2005. Microbiology. Tata McGraw-Hill Co, New Delhi
2. Stainer, Roger Y, Ingrahan JL, Wheelis ML, Painter PR. Microbial World 5th edition. Prentice-Hall India, Pvt. Ltd. New Delhi (1990).

3. Dubey RC, Maheshwari D K. A Text book of Microbiology, S.C.Chand and Company, Ltd. Ramnagar, New Delhi (2002).

**Reference Books**

1. Madigan M.T., Martinko J.M., Bender K.S., Buckley D.H., Stahl D.A., Brock T. Brock. 2014. Biology of Microorganisms (14th Edition). Pearson Publisher.
2. Prescott H, Klein S. Microbiology., 12th Edition McGraw-Hill International Edition, 2022
3. Tortora G.J., Funke B.R., Case C.L., Weber D and Bair W. 2018. Microbiology: An Introduction. Pearson Publisher
4. Prescott and Dunns Industrial Microbiology 4th edition (Pb 2004). CBS Publisher.
5. LEJR Casida. Industrial Microbiology Paperback 2nd edition (2019) New Age International Publisher
6. JC Bertrard, P Caumette, P Lebaron, Environmental Microbiology: Fundamentals and Applications 2015. Springer

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**PAPER II: PLANT SYSTEMATICS**
**SUBJECT CODE: BOT144C102 COURSE LEVEL: 400**
**CREDIT: 03 L-T-P-C 3-0-0-3**
**SCHEME OF EVALUATION: THEORY ONLY (T)**

**Course Objectives:** This course aims to apply the fundamental principles of plant systematics, including species concepts, classification systems, and botanical nomenclature in conservation and research.

**Course outcomes:**

| CO | Outcome | BT level |
|---|---|---|
| **CO1** | Apply the key concepts of plant systematics, including species, genera, and families. | BT3 |
| **CO2** | Differentiate between taxon based on various classification systems | BT4 |
| **CO3** | Design various conservation measures for extinct and important plant groups. | BT5 |

**Module Structure & Course Content**

| Modules | Topics / Course content | Lecture hours |
|---|---|---|
| I | **Principles, Approaches, and Tools in Plant Systematics** Fundamentals of Plant Systematics; Phylogenetics and Evolutionary Relationships; Monophyly, Paraphyly, and Polyphyly; Cladistics, Phenetics, and Evolutionary Systematics. | 15 |
| II | **Botanical Nomenclature and Principles of Classification:** International Code of Botanical Nomenclature (ICN**);** Principles and ranks of taxa; Rules of priority and limitations; Effective and valid publications. **Nomenclature and Typification:** Definitions: Synonym, Basionym, Tautonym, Superfluous name, Nomen nudum, homonym; Legitimate and illegitimate names; Type method and typification concepts. | 15 |
| III | **Angiosperm Phylogeny and Classification:** APG (Angiosperm Phylogeny Group) system of classification; Cladistic relationships among major families. Concept of PhyloCode. **Molecular Systematics**: DNA based markers, RAPD, AFLP, RFLP, SNP in molecular systematics. Construction of Dendrograms and cladogram. | 15 |

| | | |
|---|---|---|
| IV | **Biogeography and Speciation in Plants:** Typological, Biological, Evolutionary, and Phylogenetic species concepts.; Vicariance vs. Dispersal, Endemism, Adaptive Radiation.; Evolutionary Trends in Plant Diversity: Coevolution with Pollinators, Seed Dispersers; Genome Duplication and Hybridization.; Floristics and plant identification: Use of keys, floras, and monographs. | 15 |

| **CREDIT DISTRIBUTION** | | |
|---|---|---|
| **LECTURE/TUTORIAL** | **PRACTICALS** | **EXPERIENTIAL LEARNING** |
| 60 | 00 | 30<br>•HOME ASSIGNMENTS<br>•SEMINARS<br>•VIVAVOCE<br>•FIELD VISITS |

**Suggested readings:**

**Textbooks:**


1. Singh G. Plant Systematics (Theory & Practice). 4th edition, CBS publishing, 2022
2. Judd, W. S., Campbell, C. S., Kellogg, E. A., Stevens, P. F., & Donoghue, M. J. (2016). *Plant Systematics: A Phylogenetic Approach.* Sinauer Associates.
3. Singh OP. Plant Taxonomy 2nd Edition, McGraw Hill Education 2017


**Reference Books:**


1. Radford, A. E. (1986). *Fundamentals of Plant Systematics.* Harper & Row, New York
2. Gifford, E. M., & Foster, A. S. (1989). *Morphology and Evolution of Vascular Plants.* W. H. Freeman
3. Govaerts, R., Nic Lughadha, E., Black, N., Turner, R., & Paton, A. (2021). *The World Checklist of Vascular Plants: A New Research Infrastructure for Taxonomy.* Plants, People, Planet, 3(3), 229-240
4. Turland, N. J., et al. (2018). *International Code of Nomenclature for Algae, Fungi, and Plants (ICN) – Shenzhen Code.* IAPT (International Association for Plant Taxonomy).
5. Heywood, V. H. (1993). *Flowering Plants of the World.* Oxford University Press.


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**PAPER III: PLANT DEVELOPMENTAL BIOLOGY**
**SUBJECT CODE: BOT144C103 COURSE LEVEL: 400**
**CREDIT: 03 L-T-P-C 3-0-0-3**
**SCHEME OF EVALUATION: THEORY ONLY (T)**

**Course Objective:** Understand the fundamental principles and molecular mechanisms regulating plant development, including growth patterns, organogenesis, hormonal regulation, reproductive biology, and environmental influences.

**Course outcomes:**

| | | |
|---|---|---|
| **CO1** | Describe key developmental stages in plants, including embryogenesis, seedling growth, vegetative phases, and reproductive transition | **BT1** |
| **CO2** | Explain the roles of plant hormones, genetic regulators, and environmental cues in growth, differentiation, and adaptation. | **BT2** |
| **CO3** | Analyse how environmental factors such as light, temperature, and stress impact plant developmental processes. | **BT4** |

**Module Structure & Course Content**

| MODULE | COURSE CONTENT | Lecture Hours |
|---|---|---|
| **I** | Apical-basal and radial polarity and their regulatory mechanism organization and maintenance of the shoot and root apical meristems (SAM & RAM), interplay of CLAVATA-WUSCHEL and KNOX gene networks in stem cell regulation. Hormonal and environmental signals regulating root development and root architecture. | 15 |
| **II** | Cell Division and its regulation. Flower development and its regulation in plants; Pollen development, fertilization mechanisms, and molecular basis of self-incompatibility.<br>Genetic and hormonal control of senescence, abscission, and programmed cell death, with ROS-mediated regulation of developmental transitions. | 15 |
| III | **Organogenesis and Differentiation**<br>Phyllotactic patterning and auxin-mediated organ positioning. Regulation of leaf polarity. Hormonal regulation of Axillary meristem activation and shoot branching.<br>Root gravitropism, amyloplast sedimentation, and lateral root initiation. Vascular differentiation.<br>Hormonal control of xylem and phloem specification. Secondary growth regulation through cambium activity, lignification pathways, and wood formation. | 15 |
| IV | **Environmental and Evolutionary Regulation of Development**<br>Light-mediated development through phytochromes, cryptochromes, and phototropins. Seedling photomorphogenesis, shade avoidance, and circadian clock regulation. Biotic interactions influencing morphogenesis, including pathogen-induced development and systemic acquired resistance. Genetic and epigenetic modifications driving developmental evolution and adaptation. Applications of developmental biology in crop improvement, biotechnology, and synthetic biology. | 15 |
| **Total** | | 60 |

| CREDIT DISTRIBUTION | | |
|---|---|---|
| **LECTURE/TUTORIAL** | **PRACTICALS** | **EXPERIENTIAL LEARNING** |
| 60 | 00 | 30<br>•HOME ASSIGNMENTS<br>•SEMINARS<br>•VIVAVOCE<br>•FIELD VISITS |

**Suggested Readings:**

**Text Book:**


1. Bhojwani, S.S. and Bhatnagar, S.P. (2014). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition
2. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2023). Plant Physiology and Development (7th Edition). Sinauer Associates.
3. Evert, R. F. (2013). Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body (3rd Edition). Wiley.


**Reference Book:**


1. Haig D and Westoby M. Seed size, pollination costs and angiosperm success.1991. Springer-Verlag, Netherlands. (Research Paper).
2. Johri, B.M. Embryology of Angiosperms. 2015. Springer-Verlag, Netherlands.

3. Johri, B.M. Reproductive biology of Angiosperms. 2012. Springer-Verlag, Netherlands
4. Raghavan, V. Molecular embryology of flowering plants. 1997. Cambridge, University Press.
5. Went van J.L. Fertilization in Angiosperm plants. 1992. Springer-Verlag, Netherlands. (Research paper)
6. Pandey B.P. Embryology of Angiosperm. 2017. Rastogi publication, Meerut.
7. Raghavan, V. Developmental Biology of Flowering plants. 2000. Springer, Netherlands.

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**PAPER IV: GENETICS, CYTOGENETICS & PLANT BREEDING**
**SUBJECT CODE: BOT144C104 COURSE LEVEL: 400**
**CREDIT UNITS: 03 L-T-P-C 3-0-0-3**
**SCHEME OF EVALUATION: THEORY ONLY (T)**

**Course objective:** To equip students with advanced knowledge and practical skills in genetics and plant breeding, integrating classical and modern biotechnological approaches for crop improvement, evolutionary analysis, and genomic innovations.

**Course outcomes:**

| | | |
|---|---|---|
| CO1 | **Recall and explain** core principles of classical and extranuclear inheritance in plants, including Mendelian and maternal inheritance patterns. | BT1 |
| CO2 | **Describe** chromosomal and molecular mechanisms involved in mutagenesis and their role in modern crop improvement techniques. | BT2 |
| CO3 | **Apply** knowledge of population genetics and quantitative trait analysis using molecular tools such as GWAS, MAS, and genomic selection. | BT3 |

**Module Structure & Course Content**

| Modules | Topics / Course content | Lecture Hours |
|---|---|---|
| **I** | Principles of Genetics Genetic Principles, Mendelian inheritance and its extension. Extranuclear Inheritance and Maternal Effects: Mitochondrial and chloroplast DNA inheritance. | **15** |
| **II** | Genomic Alterations, Mutagenesis, and Crop Improvement Chromosomal Aberrations and Genome Engineering: Structural and numerical chromosomal variations. Application of chromosomal aberration in plant improvement. Spontaneous vs induced mutations, mechanisms, targeted mutagenesis in precision breeding. TILLING, Gene editing and its applications. | **15** |
| **III** | Population and Evolutionary Genetics:Population Genetics and Quantitative Trait Analysis: Hardy-Weinberg equilibrium, genetic drift, gene flow, natural selection, molecular markers in QTL mapping. Genomic Selection and Breeding for Climate Resilience: GWAS (Genome-Wide Association Studies), marker-assisted selection (MAS), gene pyramiding. | **15** |
| **IV** | Plant Breeding and its Translational Applications Selection methods in plant breeding: Mass selection, pure-line selection, recurrent selection, participatory plant breeding. Hybridization techniques, heterosis and hybrid vigor, cytoplasmic and nuclear male sterility (CMS, GMS), doubled haploidy breeding. Autopolyploidy and allopolyploidy, chromosome substitution lines, wide hybridization, alien gene introgression. Speed breeding, precision phenotyping, metabolomics in trait improvement, synthetic biology-based crop design. | **15** |
| Total | | **60** |

| **CREDIT DISTRIBUTION** | | |
|---|---|---|
| **LECTURE/TUTORIAL** | **PRACTICALS** | **EXPERIENTIAL LEARNING** |
| 60 | 00 | 30<br>•HOME ASSIGNMENTS<br>•SEMINARS<br>•VIVAVOCE<br>•FIELD VISITS |

**Suggested Readings:**

**Textbooks:**

1. George M. M., 2005. Freifelder's Essentials of Molecular Biology. 4th edition. Narosa Publishing House, New Delhi.
2. Singh, B.D., 2005. Plant Breeding, principles and methods (7th Revised and enlarged edition). Kalyani publishers, New Delhi.
3. Gupta, P.K., 2007. Genetics - Classical to modern. Rastogi Publications, Meerut, India.

**Reference Books:**

1. George W. Burns, 1969. The Science of Genetics. An introduction to heredity. The Macmillan company. New York.
2. Gardener,J, Simmons, H.J and Snustad, D.P. 1991. Principles of Genetics (8th edition), John Wiley & Sons, New York.
3. Darbeshwar Roy, 2012. Plant breeding - A biometrical Approach. Narosa Publishing House, New Delhi

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**PAPER V: MICROBIOLOGY AND PLANT SYSTEMATICS PRACTICAL**
**SUBJECT CODE: BOT144C115 COURSE LEVEL: 400**
**CREDIT UNITS:03 L-T-P-C: 0-0-6-3,**
**SCHEME OF EVALUATION: PRACTICAL ONLY (P)**

**Course Objectives:** To enable students with advance hands-on training on microbial techniques and plant systematics

**Course Outcomes:**

| | | |
|---|---|---|
| **CO1** | Master the isolation of pure bacterial cultures and preservation techniques; analyse biochemical activities of bacteria | **BT2, BT3** |
| **CO2** | Obtain hands on experience in developing herbariums and preserving plant materials | **BT3** |
| **CO3** | Apply theoretical knowledge in field | **BT4** |

**Module Structure & Course Content**

| Modules | Topics / Course content | Lecture Hours |
|---|---|---|
| I | 1. Method of obtaining pure culture by streak plate method, subculturing and preservation<br>2. Determination of bacterial growth curve by spectrophotometric method.<br>3. Isolation of Plasmid DNA. | 20 |
| II | 4. Determination of biochemical activities (Amylase, cellulase and caseinase) by the bacteria<br>5. Isolation of Rhizobia and testing nodulation activity by rhizobia | 20 |
| III | 6. Collection and preparation and submission of herbarium specimens.<br>7. Identification of plants using dichotomous keys, floras, and manuals.<br>8. Preparation of diagnostic taxonomic keys for plant species.<br>9. Study of vegetative and reproductive structures in major plant families. | 20 |
| IV | 10. Local Field Visit and Report Submission | 30 |
| **Total** | | 90 |

| CREDIT DISTRIBUTION | | |
|---|---|---|
| **LECTURE/TUTORIAL** | **PRACTICALS** | **EXPERIENTIAL LEARNING** |
| 00 | 60 | 30<br>•HOME ASSIGNMENTS<br>•SEMINARS<br>•VIVAVOCE<br>•FIELD VISITS |

**Suggested Readings:**

**Textbooks:**


1. KR Aneja. Experiments in Microbiology, Plant Pathology and Biotechnology, 2007. New Age International.
2. James G. Cappuccino. Microbiology- A Laboratory Manual, 2014. Pearson.
3. Judd, W. S., Campbell, C. S., Kellogg, E. A., Stevens, P. F., & Donoghue, M. J. (2016). *Plant Systematics: A Phylogenetic Approach (4th Edition).* Sinauer Associates.


**Additional Resources**


1. Bridson, D. & Forman, L. (1998). *The Herbarium Handbook (3rd Edition).* Royal Botanic Gardens, Kew.
2. Lawrence, G. H. M. (1951). *Taxonomy of Vascular Plants.* Macmillan.
3. Radford, A. E., Dickison, W. C., Massey, J. R., & Bell, C. R. (1974). *Vascular Plant Systematics.* Harper & Row.


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**PAPER VI:** DEVELOPMENTAL BIOLOGY, GENETICS & PLANT BREEDING PRACTICAL
**SUBJECT CODE: BOT144C116 COURSE LEVEL: 400**
**CREDIT UNITS: 03 L-T-P-C: 0-0-6-3**
**SCHEME OF EVALUATION: PRACTICAL ONLY (P)**

**Course Objective:**

Develop practical expertise in classical genetics, cytogenetics, and plant morphology, integrating experimental techniques, statistical analysis, and comparative morphological studies to understand inheritance, chromosome dynamics, and plant adaptation strategies.

**Course Outcomes (COs)**

| | | |
|---|---|---|
| **CO1** | Apply Mendelian principles, gene mapping techniques, and population genetics calculations for trait inheritance studies. | **BT3** |
| **CO2** | Analyse chromosomal structures, meiotic behaviour, and cytogenetic variations using experimental plant models. | **BT4** |
| **CO3** | Compare adaptive morphological features in plant species and evaluate floral organ variation and reproductive adaptations. | **BT4** |

**Module Structure & Course Content**

| **Modules** | **Topics / Course content** | **Lecture Hours** |
|---|---|---|
| I | 1. Monohybrid, Dihybrid, and Trihybrid Crosses: Analysis of segregation ratios using chi-square test.<br>2. Linkage and Recombination: Mapping genes using three-point test cross data | 20 |
| II | 3. Preparation of root tip squashes for mitotic chromosome studies.<br>4. Meiotic chromosome analysis.<br>5. Preparation of permanent slides<br>6. Cytological Study of Chromosomal Aberrations and Polyploidy Induction<br>7. Tetrazolium test for seed viability | 30 |
| III | 8. Microscopic Examination of Shoot and Root Apical Meristems<br>9. Study of anomalous secondary growth using available specimens.<br>10. Pollen Viability and Germination Test<br>11. Dissection and Morphological Study of Floral Organs | 20 |
| IV | 12. Hybridization Techniques and Heterosis Study<br>13. Emasculation and self-pollination study | 20 |
| Total hours | | 90 |

| CREDIT DISTRIBUTION | | |
|---|---|---|
| **LECTURE/TUTORIAL** | **PRACTICALS** | **EXPERIENTIAL LEARNING** |
| 0 | 60 | 30<br>•HOME ASSIGNMENTS<br>•SEMINARS<br>•VIVAVOCE<br>•FIELD VISITS |

**Suggested Readings**

**Textbooks:**


1. Klug, W. S., Cummings, M. R., Spencer, C. A., & Palladino, M. A. (2018). Concepts of Genetics (12th Edition). Pearson.
2. Snustad, D. P. & Simmons, M. J. (2019). Principles of Genetics (7th Edition). Wiley.
3. Sharma, A. K. & Sharma, A, Chromosome Techniques: Theory and Practice, Butterworths.


**Reference books**


1. Sinnott, E. W., Dunn, L. C., & Dobzhansky, T. Principles of Genetics, Tata McGraw-Hill.
2. Stebbins, G. L. Variation and Evolution in Plants, Columbia University Press.


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**PAPER VII: MUSHROOM CULTIVATION: PRINCIPLES AND COMMERCIAL APPLICATIONS (PROJECT BASED)**
**SUBJECT CODE: BOT144C121, COURSE LEVEL: 400**
**CREDIT UNITS: 02 L-T-P-C 0-0-4-2**
**EVALUATION SCHEME: PRACTICAL ONLY (P)**

**Course Objective: D**evelop a scientific understanding of mushroom biology, cultivation techniques, and commercial production, integrating strain selection, substrate preparation, pest management, and value-added processing for sustainable entrepreneurship.

**Course Outcomes (COs):**

| | | |
|---|---|---|
| **CO1** | Apply scientific techniques for mushroom spawn production, substrate preparation, and cultivation under controlled conditions. | **BT3** |
| **CO2** | Analyze environmental and biological factors affecting mushroom yield, disease outbreaks, and pest infestations in commercial production. | **BT4** |
| **CO3** | Evaluate post-harvest handling techniques, including drying, packaging, and value-added processing, for market-ready mushroom products. | **BT4** |

**Module Structure & Course Content**

| Module | Course Content | Lecture Hours |
|---|---|---|
| **I.** | Fundamentals of Mushroom Cultivation<br>Mushroom Cultivation Techniques: Techniques for indoor & outdoor farming, sustainable cultivation using local materials. Substrate Optimization: Use of agricultural waste, industrial byproducts, and organic substrates. Spawn Production & Scaling Up: Low-cost production methods, lab-to-commercial scale spawn production.<br>Entrepreneurial Module: Basics of startup planning, funding sources (NABARD, MSME, Agri-tech incubators), subsidy programs. | **7** |
| **II.** | **Pest Management, Value Addition & Commercialization**: Disease & Pest Management. Post-Harvest & Value Addition; Market Linkages & Business Strategy: Export potential, branding, pricing, marketing strategies (online, B2B, B2C platforms).<br>Eco-Solutions: composting waste, circular economy models.<br>Entrepreneurial Module: Feasibility analysis, business cost estimation, profit | **8** |

| | | |
|---|---|---|
| | modeling, investment planning, and risk mitigation. | |
| **III.** | **Hands-on Practical, Industry Exposure and project**<br>1. Mushroom Identification & Classification: Recognizing edible vs. toxic species.<br>2. Lab-Based Spawn Production: Creating mother culture, sterilization techniques, inoculation methods.<br>3. Commercial Mushroom Bag Preparation & Incubation: Testing different substrates, optimizing conditions for high yield.<br>4. Post-Harvest & Product Development: Hands-on drying, powder extraction, processing into functional food products.<br>5. Business & Market Field Visits: Exposure to commercial mushroom farms, processing industries, export hubs. | **15** |

| **CREDIT DISTRIBUTION** | | |
|---|---|---|
| **LECTURE/TUTORIAL** | **PRACTICALS** | **EXPERIENTIAL LEARNING** |
| 0 | 30 | 30<br>•HOME ASSIGNMENTS<br>•SEMINARS<br>•VIVAVOCE<br>•FIELD VISITS |

**Suggested Readings :**

**Textbook:**


1. Chang, S. T. & Miles, P. G. (2004). *Mushrooms: Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact.* CRC Press.


**Reference Books:**


1. Pathak, V. N., Gaur, R. D., & Agarwal, K. C. (1998). *Mushroom Production and Processing Technology.* Agrobios.
2. Kaul, T. N. (2001). *Biology and Conservation of Edible Fungi.* Oxford & IBH Publishing.
3. Singh, M. & Vijay, B. (2005). *Mushroom Cultivation, Marketing, and Consumption.* ICAR.
4. Chang, S. T. (2017). *Functional Properties of Edible Mushrooms.* Elsevier.
5. Das, S. & Kamal, S. (2020). *Post-Harvest Technologies of Mushrooms.* Springer.


**Online Resources & Industry Guidelines**

1. Food and Agriculture Organization (FAO) – Mushroom Cultivation Guide: www.fao.org
2. ICAR-Directorate of Mushroom Research (India): www.nrcmushroom.org
3. National Horticulture Board (NHB) Guidelines on Mushroom Farming: www.nhb.gov.in

## DETAILED SYLLABUS FOR 2nd SEMESTER

**PAPER I: APPLIED MYCOLOGY & CROP PROTECTION**
**SUBJECT CODE: BOT144C201 COURSE LEVEL: 500**
**CREDIT UNITS: 04 L-T-P-C = 4-0-0-4**
**SCHEME OF EVALUATION: Theory (T)**

**Course Objective:**
The course is designed with the objectives to introduce pathological significance of various plant pathogens and to build up the knowledge among the students about host parasite interaction and the methods to develop disease free plants.

**Course Outcomes:** By the end of the course the students will be able to:

| | | |
|---|---|---|
| **CO1** | Review and relate to different types of fungal association and the recent trends in its application. | BT3 |
| **CO2** | Categorize the different types of plant pathogens and the host parasite mechanism of action. | BT4 |
| **CO3** | Explain the different biotechnological techniques that can be used for disease and pest management. | BT4 |

**Module Structure & Course Content**

| MODULE | COURSE CONTENT | Lecture Hours |
|---|---|---|
| **I** | **Applied Mycology:** Bioactive compounds from fungi and their applications; Fungi in food & brewing industry: Production of food additives, flavour & texture development, fermentation agents, enzyme production, cheese production, organic acids, mycoproteins; Single Cell Proteins; uses and innovations in brewing industry, Bioremediation | **15** |
| **II** | **Fungal Associations:** Application of mycorrhizal inoculants in agriculture, environmental monitoring using lichens, AMF as bio-stimulants and bio-protectants of crops | **15** |
| **III** | **Plant Diseases:** Molecular basis of host-pathogen interaction, disease development-role of enzymes, toxins, defense strategies- oxidative burst; Phenolics, Phytoalexins, PR proteins, Elicitors. Rust disease, Blight disease, Smut disease, Canker disease, signalling mechanism of localized and systemic acquired resistance | **15** |
| **IV** | **Crop Protection:** Integrated Disease and Pest Management, Disease Forecasting, Plant Quarantine, Epidemics; Serological, molecular techniques and immunodiagnostics for detection of plant pathogens; Nanotechnology in crop protection, fungicide resistance management. Cryopreservation; IPR in crop protection | **15** |

| CREDIT DISTRIBUTION | | |
|---|---|---|
| **LECTURE/TUTORIAL** | **PRACTICALS** | **EXPERIENTIAL LEARNING** |
| 60 | 00 | 30<br>•HOME ASSIGNMENTS<br>•SEMINARS<br>•VIVAVOCE<br>•FIELD VISITS |

**Suggested Readings**
**Textbooks**


1. Alexopoulos, C. J., Mims, C. W., & Blackwell, M. (2007). *Introductory Mycology.* Wiley.
2. Agrios, G. N. (2005). *Plant Pathology (5th Ed.).* Elsevier.
3. Lucas, J. A. (2020). *Plant Pathology and Plant Pathogens.* Wiley.

**Reference Books**


**1.** Kendrick, B. (2017). *The Fifth Kingdom.* Focus Publishing.
**2.** Mehrotra, R. S., & Aggarwal, A. (2016). *Plant Pathology.* Tata McGraw Hill.
**3.** Dickinson, M. (2003). *Molecular Plant Pathology.* Taylor & Francis.
**4.** Schumann, G. L., & D'Arcy, C. J. (2006). *Essential Plant Pathology.* APS Press.
**5.** Smith, S. E., & Read, D. J. (2008). *Mycorrhizal Symbiosis.* Academic Press.
**6.** Strange, R. N., & Scott, P. R. (2005). *Plant Disease: A Threat to Global Food Security.* Annual Review of Phytopathology.


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**PAPER II: PLANT PHYSIOLOGY**
**SUBJECT CODE: BOT144C202, COURSE LEVEL: 500**
**CREDIT UNITS: 04 L-T-P-C = 4-0-0-4**
**SCHEME OF EVALUATION: Theory (T)**

**Course objectives:** To provide an in-depth understanding of the complex biochemical pathways in plants, the intricate interactions between these pathways, and the regulatory mechanisms and factors that modulate their biosynthesis and overall function.

**Course outcomes:**

| | | |
|---|---|---|
| CO1 | **Explain** the key physiological processes influencing plant development and growth under varying environmental and genetic contexts. | BT2 |
| CO2 | **Apply** knowledge of plant hormones to optimize crop traits and interpret hormone-based responses in crop improvement strategies. | BT3 |
| CO3 | **Analyze** major signaling pathways involved in growth, stress, and adaptation, and **evaluate** their potential for trait enhancement. | BT4, BT5 |

**Module Structure & Course Content**

| Module | Course content | Lecture hours |
|---|---|---|
| **I** | **Nutrient uptake:** Water potential ($\psi$): concept and significance, Transpiration and guttation. Soil-plant-atmosphere continuum, Role of root architecture in water uptake. Apoplastic and symplastic transport mechanisms, role of aquaporins and transporters. Mineral nutrition: kinetics of uptake, deficiency symptoms and their early detection. | **15** |
| **II** | **Bioenergetic pathways:** Carbon and nitrogen redox pathways, bioenergetic transformation involving carbon redox pathways, ATP homeostasis, and C/N ratio regulation for plant metabolic efficiency. | **15** |
| **III** | **Plant Growth:** Structure, function and mechanisms of action of photoreceptors; skotomorphogenesis and photomorphogenesis. Flowering as a multi-organ function – floral models. Regulation of flowering by light and temperature. Role of circadian rhythm. Growth kinetics, concepts of LAR, NAR, LAR, harvest index. Concept of Root system architecture (RSA).<br>Hormones as chemical messengers (auxin, cytokinin, gibberellin- structure, function), newer classes of hormones (phytosulfokine, karrikins). | **15** |
| **IV** | **Stress physiology:** Hormones in plant defense against abiotic and biotic stresses (jasmonates, brassinosteroids, ABA). Adaptive responses of plants to stress, oxidative stress. Signalling cascades in response to stress (Second messengers, receptors, G-proteins, calcium-calmodulin) **Senescence and ageing:** Molecular mechanism of senescence and ageing, role of salicylic acid and ethylene in senescence and ripening and strategies for extending post-harvest shelf life. | **15** |
| **Total** | | **60** |

| CREDIT DISTRIBUTION | | |
|---|---|---|
| **LECTURE/TUTORIAL** | **PRACTICALS** | **EXPERIENTIAL LEARNING** |
| 60 | 00 | 30<br>•HOME ASSIGNMENTS<br>•SEMINARS<br>•VIVAVOCE<br>•FIELD VISITS |

**Suggested Readings**

**Text Books:**


1. Dennis D. T., Turpin, D. H. Lefebvre D. D. and Layzell D. B.(eds) (1997). Plant Metabolism (Second Edition) Longman, Essex, England.
2. Willium G Hopkins, Norman P Hunar (2009) Introduction To Plant Physiology, Wiley.
3. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.


**Reference Books:**


1. Buchanan B.B, Gruissem W. and Jones R. L (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland,USA.
2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.
3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.


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**CORE SUBJECT: PLANT ECOLOGY AND ECOSYSTEM ANALYSIS**
**SUBJECT CODE: BOT144C203; COURSE LEVEL: 500**
**CREDIT:04 L-T-P-C 4-0-0-4**
**SCHEME OF EVALUATION: THEORY (T)**

**Course objectives:** To provide an in-depth understanding of the fundamental ecological concepts, including species and community interactions, ecosystem dynamics, and environmental factors

**Course outcomes:**

| | | |
|---|---|---|
| CO1 | Apply ecological methods and techniques for biodiversity assessment, ecosystem monitoring, and environmental data analysis. | BT3 |
| CO2 | Analyse population ecology, community structure, ecological succession, ecosystem stability, biogeochemical cycles, and impacts of human activities. | BT4 |
| CO3 | Evaluate and synthesize ecological theories, ecosystem services, and conservation strategies for sustainable ecosystem management. | BT5 |

**Module Structure & Course Content**

| Mod | Topics / Course content | Periods |
|---|---|---|
| **I** | **Fundamentals of Ecology**<br>**Ecological Principles:** Concept of limiting factors and ecological thresholds; Physical environmental factors (soil, water, light, temperature, fire) and their interactions with biotic components.<br>**Ecological Hierarchies and Species Interactions:** Ecological levels: Individual, population, community, ecosystem, biosphere; Niche concept: Species interactions: Competition, predation, mutualism, allelopathy.<br>**Adaptations to Environmental Conditions:** Plant adaptations to arid, aquatic, and extreme environments; Microclimate influence on plant growth and survival. | 15 |
| **II** | **Population, Community, and Successional Dynamics**<br>**Population Ecology and Demographics:** Population characteristics and growth models (exponential and logistic); Life history strategies (r- and K-selection); survivorship curves; Metapopulation dynamics, dispersal, and extinctions.<br>**Community Structure and Biodiversity:** Nature of communities, species | 15 |

| | | |
|---|---|---|
| | diversity, and dominance; Measurement of Biodiversity indices; Community stability and resilience.<br>**Ecological Succession and Niche Dynamics:** Primary and secondary succession: Mechanisms and changes; Climax community concepts; Habitat fragmentation and edge effects. | |
| **III** | **Ecosystem Functioning:**<br>Food webs, trophic levels, and energy flow and pyramids; Productivity: NPP and GPP and community respiration.<br>**Biogeochemical Cycles:** Importance of Carbon, Nitrogen, Phosphorus, and hydrological cycles. | 15 |
| **IV** | **Ecosystem Services:** Provisioning services: Food, water, timber, and genetic resources; Regulating services: Climate regulation, disease control; Cultural services**:** Spiritual, aesthetic, recreational, and educational benefits; Supporting services. | 15 |
| **Total** | | 60 |

| CREDIT DISTRIBUTION | | |
|---|---|---|
| **LECTURE/TUTORIAL** | **PRACTICALS** | **EXPERIENTIAL LEARNING** |
| 60 | 00 | 30<br>•HOME ASSIGNMENTS<br>•SEMINARS<br>•VIVAVOCE<br>•FIELD VISITS |

**Suggested Readings:**

**Textbooks**


1. Odum, E. P. (2005). Fundamentals of Ecology. Cengage Learning.
2. Begon, M., Townsend, C. R., & Harper, J. L. (2021). Ecology: From Individuals to Ecosystems. Wiley-Blackwell.
3. Molles, M. C., & Sher, A. A. (2018). Ecology: Concepts and Applications. McGraw-Hill.


**References:**


1. Tilman, D. (1982). Resource Competition and Community Structure. Princeton University Press.
2. Chapin, F. S., Matson, P. A., & Vitousek, P. M. (2011). Principles of Terrestrial Ecosystem Ecology. Springer.
3. Schlesinger, W. H., & Bernhardt, E. S. (2020). Biogeochemistry: An Analysis of Global Change. Academic Press.
4. Costanza, R., et al. (1997). The Value of the World's Ecosystem Services and Natural Capital. Nature, 387(6630), 253-260.
5. Daily, G. C. (1997). Nature's Services: Societal Dependence on Natural Ecosystems. Island Press.
6. MEA (2005). Millennium Ecosystem Assessment: Ecosystems and Human Well-being. World Resources Institute.


**Additional Online Resources**

1. Global Biodiversity Information Facility (GBIF) – www.gbif.org
2. IUCN Red List of Threatened Species – www.iucnredlist.org
3. Millennium Ecosystem Assessment – www.millenniumassessment.org
4. NASA Earth Observatory (Climate Data) – www.earthobservatory.nasa.gov

**PAPER IV: APPLIED MYCOLOGY, PLANT PHYSIOLOGY, AND ECOLOGY PRACTICAL**
**SUBJECT CODE: BOT144C214 COURSE LEVEL: 500**
**CREDIT UNITS: 04 L-T-P-C: 0-0-8-4**
**SCHEME OF EVALUATION: PRACTICAL (P)**

**Course Objectives:**

The course will impart basic knowledge about different techniques used in plant physiology, biochemistry, applied mycology and crop protection, and plant molecular biology.

**Course Outcomes:**

By the end of the course the students shall be able to:

| | | |
|---|---|---|
| CO1 | **Demonstrate** basic techniques in fungal identification, histopathology, and microbial applications in agriculture and biotechnology. | BT2, BT3 |
| CO2 | **Apply** experimental methods in plant physiology and biochemistry to analyze growth responses and metabolic constituents. | BT3 |
| CO3 | **Interpret** results from protein and amino acid estimations and chromatographic techniques used in biochemical analysis. | BT3 |
| CO4 | **Analyze** ecological data using species diversity indices, life tables, and productivity estimation to evaluate ecosystem characteristics. | BT4 |

**Module Structure & Course Content**

| Module | Topics / Course content | Lecture Hours |
|---|---|---|
| **I** | 1. Symptomatology and histopathology of locally available diseased plants and identification of pathogens.<br>2. Isolation and identification of AMF (Arbuscular Mycorrhizal Fungi) from soil sample<br>3. Role of yeast in bread making<br>4. Collection and submission of diseased plant samples with fungal, bacterial, and viral symptoms. | **20** |
| **II** | 5. To study the effect of different concentrations of IAA on coleoptile elongation (IAA Bioassay).<br>6. Experimental demonstration of Hill's reaction. | **20** |
| **III** | 7. Estimation of soluble protein content from plant tissues.<br>8. Chromatographic separation of amino acids.<br>9. Estimation of amino acids from plant tissues by ninhydrin reaction. | **20** |
| **IV** | 10. Estimation of primary productivity using Winkler's method<br>11. Community characterization and species diversity indices<br>12. Calculation of Importance Value Index (IVI) for dominant species.<br>13. Preparation of population life tables and analysis of survivorship curves | **30** |
| Total | | **90** |

| CREDIT DISTRIBUTION | | |
|---|---|---|
| **LECTURE/TUTORIAL** | **PRACTICALS** | **EXPERIENTIAL LEARNING** |
| 00 | 60 | 30<br>•HOME ASSIGNMENTS<br>•SEMINARS<br>•VIVAVOCE<br>•FIELD VISITS |

**Suggested Readings**

**Textbooks:**


1. Santra S. Practical Botany Vol.1 and 2. 2015. NCBA Publisher.
2. Bendre and Kumar. Practical Botany Vol.1 and 2. 2018. Rastogi Publications.
3. Alexopoulos, C. J., Mims, C. W., & Blackwell, M. (2007). *Introductory Mycology.* Wiley.

**Reference books:**


1. Aneja, K. R. (2003). *Experiments in Microbiology, Plant Pathology and Biotechnology* (4th ed.). New Delhi: New Age International Publishers.
2. Plummer, D. T. (1987). *An Introduction to Practical Biochemistry* (3rd ed.). New Delhi: Tata McGraw-Hill Publishing Company.
3. Jayaraman, J. (1981). *Laboratory Manual in Biochemistry*. New Delhi: New Age International.
4. Moore, T. C. (1979). *Research Experiences in Plant Physiology: A Laboratory Manual*. New York: Springer-Verlag.
5. Trivedi, P. C. (2008). *Plant Pathology and Biotechnology*. Jaipur: Pointer Publishers.
6. Krebs, C. J. (1999). *Ecological Methodology* (2nd ed.). Menlo Park, CA: Benjamin Cummings.
7. Odum, E. P., & Barrett, G. W. (2005). *Fundamentals of Ecology* (5th ed.). Belmont, CA: Thomson Brooks/Cole.


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**PAPER V: HERBAL MEDICINAL PRACTICES IN INDIA**
**SUBJECT CODE: BOT144C241,**
**CREDIT UNITS: 02 L-T-P-C: 1-0-2-2,**
**EVALUATION SCHEME: THEORY & PRACTICAL (TP)**

**Course Objective:** Integrate Traditional Knowledge Systems (TKS) with modern botany, Indian Knowledge Systems (IKS), and the One Health approach, focusing on medicinal plant biodiversity, phytochemistry, and their role in human, animal, and environmental health.

**Course Outcomes (COs)**

| | | |
|---|---|---|
| **CO1** | Apply ethnobotanical techniques to document and analyze traditional plant-based healthcare practices. | **BT3** |
| **CO2** | Analyse the role of phytochemicals in medicinal plants and their relevance to human, animal, and environmental health (One Health approach). | **BT4** |
| **CO3** | Evaluate the conservation and sustainable utilization of medicinal plants in the context of biodiversity protection and public health. | **BT4** |

**Module Structure & Course Content**

| Module | Course Content | Lecture Hours |
|---|---|---|
| **I** | **Indian Knowledge Systems:** Ayurveda, Siddha, Unani, and herbal medicine used by tribes of NE india; Plant-based healing traditions in India. Documentation of sacred groves, folk medicine, and traditional agroforestry practices. | **7** |
| **II** | **Medicinal Plants and Their Role in One Health**<br>Phytochemistry and bioactive compounds in few common medicinal plants (*Ashwagandha, Neem, Tulsi, Amla, Giloy, Turmeric*).<br>Role of medicinal plants in One Health: Antimicrobial resistance, zoonotic diseases, and environmental health.<br>Conservation and sustainability: Role of IUCN, National Medicinal Plants Board (NMPB), and WHO guidelines in medicinal plant conservation. | **8** |
| **III** | **Practical/Fieldwork Component**<br>• Visit to herbal gardens, Ayurvedic research centres, or community-led ethnobotanical initiatives.<br>• Case study analysis of One Health applications using traditional medicinal plants. | **15** |

| CREDIT DISTRIBUTION | | |
|---|---|---|
| **LECTURE/TUTORIAL** | **PRACTICALS** | **EXPERIENTIAL LEARNING** |
| 00 | 15 | 15<br>•HOME ASSIGNMENTS<br>•SEMINARS<br>•VIVAVOCE<br>•FIELD VISITS |

**Suggested Readings**

**Textbooks:**


1. Chatterjee, A. & Pakrashi, S. C. (1994). *The Treatise on Indian Medicinal Plants (Vols. 1-6).* CSIR, New Delhi.


**Reference Books:**


2. Jain, S. K. (1991). *Dictionary of Indian Folk Medicine and Ethnobotany.* Deep Publications.
3. Pushpangadan, P. & Nair, K. N. (2005). *Ethnobotany: The Role of Indigenous Knowledge in Conservation and Use of Biodiversity.* Deep Publications.
4. Sharma, P. V. (1999). *Charaka Samhita (Revised English Translation).* Chaukhambha Orientalia.
5. WHO (2013). *WHO Traditional Medicine Strategy 2014-2023.* World Health Organization.
6. Rastogi, S. & Mehrotra, B. N. (1993). *Compendium of Indian Medicinal Plants (Vols. 1-5).* CDRI, Lucknow.
7. Tewari, D., Sah, A. N., Meena, H., & Mishra, A. (2020). *Modern Approaches in the Validation of Herbal Medicine.* Springer.


**Online Resources & Policy Documents**

1. National Medicinal Plants Board (NMPB): www.nmpb.nic.in – Conservation policies and medicinal plant guidelines.
2. IUCN Red List for Medicinal Plants: www.iucnredlist.org – Conservation status of medicinal plants.
3. AYUSH Ministry (India): www.ayush.gov.in – Ayurvedic and Siddha plant-based healthcare.

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**PAPER III: NURSERY CULTIVATION & FLORICULTURE**
**SUBJECT CODE: BOT144C221,**
**CREDIT UNITS: 2 L-T-P-C = 0-0-4-2**
**SCHEME OF EVALUATION: Practical Only (P)**

**Course Objectives:**

The course is devised to help students understand the concepts and develop advanced skills in commercial nursery cultivation and floriculture.

**Course Outcomes:** On completion of the course the student will be able to:

| | | |
|---|---|---|
| **CO1** | Apply advanced nursery management techniques, including plant propagation, controlled environment cultivation, and automation in plant production | **BT3** |
| **CO2** | Analyse the impact of climate, soil conditions, and pest/disease management on nursery and floriculture crop productivity | **BT4** |

**Module Structure & Course Content**

| Module | Course Content | Lecture Hours |
|---|---|---|
| **I.** | **Advanced Nursery Cultivation and Business Strategies** Commercial nursery structures: Polyhouses, net houses, hydroponic setups, vertical gardening. Propagation techniques: Micropropagation, grafting, somatic embryogenesis, cloning, use of biofertilizers. Pest & Disease Management in Nursery: Integrated Disease & Pest Management (IPM), use of biopesticides, eco-friendly pest control. Business strategy: Nursery startup costs, government schemes (NHB, MSME), loan and subsidy applications. IPR in Government schemes | **7** |
| **II.** | **Floriculture Business, Post-Harvest Handling, and Market Trends** Post- | **8** |

| | | |
|---|---|---|
| | harvest physiology & handling: Packaging, cold chain storage, shelf-life enhancement. Floriculture crops: Genetic improvement, hybrid varieties, nutrient management, growth regulators.<br>Floriculture business models: Cut flowers, ornamental landscaping, essential oils, indoor plants, bonsai, urban gardening.<br>E-commerce and Export Strategies: International floriculture markets, logistics, startup incubation. | |
| **III.** | **Project-Based Entrepreneurship Development (e.g.,)**<br>• Value-added product development: Essential oils, herbal extracts, organic flower-based accessories.<br>• Controlled environment floriculture: designing of high-tech nurseries, urban greenhouses.<br>• Market research & branding: Study of floriculture businesses, digital marketing, online sales platforms.<br>• Post-harvest handling techniques: Flower preservation, storage, arrangement, aesthetic value addition. | **15** |

| CREDIT DISTRIBUTION | | |
|---|---|---|
| **LECTURE/TUTORIAL** | **PRACTICALS** | **EXPERIENTIAL LEARNING** |
| 0 | 15 | 15<br>•HOME ASSIGNMENTS<br>•SEMINARS<br>•VIVAVOCE<br>•FIELD VISITS |

**Textbooks:**


1. Randhawa, G. S. & Mukhopadhyay, A. (1998). *Floriculture in India.* Allied Publishers.
2. Hartmann, H. T. & Kester, D. E. (2010). *Plant Propagation: Principles and Practices (8th Edition).* Prentice Hall.


**Reference Books:**


1. Bose, T. K., Yadav, L. P., & Pal, P. (2003). *Commercial Floriculture (Vol. I & II).* Naya Udyog, Kolkata.
2. Rangaswami, G. & Mahadevan, A. (2002). *Diseases of Crop Plants in India (4th Edition).* Prentice Hall.
3. Bhattacharjee, S. K. (2011). *Post-Harvest Technology of Flowers and Ornamental Plants.* Pointer Publishers.


**Online Resources & Industry Standards**

- FAO Floriculture & Nursery Management Guide: www.fao.org
- ICAR Horticulture Database: www.icar.org.in
- National Horticulture Board (NHB) - Floriculture Trends & Policies: www.nhb.gov.in
- International Society for Horticultural Science (ISHS): www.ishs.org
- National Horticulture Board (NHB): www.nhb.gov.in
- MSME Startup India – Floriculture & Nursery Business Schemes: www.startupindia.gov.in
- Floriculture Export Association of India: www.apeda.gov.in

## DETAILED SYLLABUS OF 3rd SEMESTER

**PAPER I: PLANT BIOCHEMISTRY & MOLECULAR BIOLOGY**
**SUBJECT CODE: BOT144C301**
**CREDIT UNITS: 04 L-T-P-C = 4-0-0-4**
**SCHEME OF EVALUATION: Theory (T)**

**Course Objectives:** Integrate biochemical principles with the structure, function, and regulation of biomolecules (carbohydrates, lipids, amino acids, proteins, enzymes, and nucleic acids), emphasizing their roles in cellular processes, gene expression, and epigenetics, with applications in industrial and biological contexts.

**Course Outcomes:** On completion of the course the student will be able to:

| | | |
|---|---|---|
| CO1 | Describe the structure and functional roles of carbohydrates, lipids, amino acids, and proteins, including biosynthetic pathways and post-translational events | BT2 |
| CO2 | Explain enzyme structure, mechanisms, kinetics, and industrial applications including immobilization technology | BT2 |
| CO3 | Analyze the structure and functional organization of nucleic acids and the molecular mechanisms of replication, transcription, and translation | BT4 |
| CO4 | Compare and interpret gene regulation processes in prokaryotes and eukaryotes | BT4 |
| CO5 | Examine the genetic code, its exceptions, and epigenetic mechanisms influencing gene expression and plant development | BT4 |

**Module Structure & Course Content**

| Module | Course content | Lecture hours |
|---|---|---|
| **I** | Carbohydrates and their derivatives: synthesis and inter-conversions. Lipids: biosynthesis of fatty acids and their regulation; phospholipids and their role in signal transduction in cells.<br>Amino acids: structure and function, properties of amino acids.<br>Proteins: structure and function, folding and sub-unit assembly, posttranslational processing. | **15** |
| **II** | Enzymes: structure of active site, mechanisms of action, kinetics of enzymes catalysed reactions, regulation of enzyme activity; industrial enzymology: principles of immobilized enzyme technology; applications of immobilized enzymes. | **15** |
| **III** | Structure of nucleic acids: DNA and its A, B and Z conformations, tRNA, rRNAs; DNA replication: machinery and mechanism in prokaryotes and eukaryotes; RNA transcription: machinery and mechanism in prokaryotes and eukaryotes; RNA processing. Translation: machinery and mechanism (tRNA charging, initiation in prokaryotes and eukaryotes, elongation and termination); regulation of gene expression in prokaryotes and eukaryotes. | **15** |
| **IV** | Genetic code and exceptions to its universality. Introduction to epigenetics: definition, mechanism, inheritance, influence of environment and role in disease. Importance in plant development – nature vs. nurture. | **15** |
| **Total** | | **60** |

| CREDIT DISTRIBUTION | | |
|---|---|---|
| **LECTURE/TUTORIAL** | **PRACTICALS** | **EXPERIENTIAL LEARNING** |
| 60 | 00 | 30<br>•HOME ASSIGNMENTS<br>•SEMINARS<br>•VIVAVOCE<br>•FIELD VISITS |

**Suggested Readings**

**Textbooks:**


1. Alberts, B., Bray, D. and Hopkin, K. 2018. Essential Cell Biology. Garland Science, U.S.A
2. Cox, M., and Nelson, D. L. 2017. Principles of Biochemistry. Freeman and company, New York.
3. Dale, W.J. and Schontz, V.M. 2011. From Genes to Genomes. John Wiley & sons ltd., England.


**Reference Books:**


1. Buchanan, B.B., Gruissem, W. and Jones R.L. (2015). Biochemistry and Molecular Biology of Plants, Wiley Blackwell, Sussex, UK
2. Conn, E.E. and Stumpf, P.K. (1994). Outlines of Biochemistry. Wiley Eastern.
3. Dennis, D.T. (1998). Plant metabolism. Longman.
4. Heldt, H. (1997). Plant Biochemistry and Molecular Biology. Oxford Univ. Press.
5. Miglani G.S. 2002. Advanced Genetics, Alpha Science International Ltd.
6. Grafi, G. and Ohad, N. (2013). Epigenetic and memory in Plants: 18 (Signaling and Communication in Plants). Springer-Verlag Berlin and Heidelberg GmbH & Co. K


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**PAPER II: PLANT BIOTECHNOLOGY**
**SUBJECT CODE: BOT144C302,**
**CREDIT UNITS:04 L-T-P-C = 4-0-0-4**
**SCHEME OF EVALUATION: Theory (T)**

**Course Objectives:** The course is devised to acquaint students with various fields of plant biotechnology and its applications.

**Course Outcomes:** On completion of the course the student will be able to:

| | | |
|---|---|---|
| CO1 | Understand fundamental concepts of plant tissue culture, including totipotency, organogenesis, and somatic embryogenesis | BT2 |
| CO2 | Apply knowledge of protoplast culture, micropropagation, and germplasm conservation in practical biotechnological contexts | BT3 |
| CO3 | Explain the principles and Analyse gene cloning methods, recombinant transformation techniques, and selection of transgenic plants DNA technology, including the use of vectors and restriction enzymes | BT4 |

**Module Structure & Course Content**

| Module | Course content | Lecture hours |
|---|---|---|
| **I** | Plant Tissue Culture: Plant Tissue Culture: Historical perspective. Composition of media; Nutrient and hormone requirements (role of vitamins and hormones). Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation). | **15** |
| **II** | Recombinant DNA technology: Restriction Endonucleases (History, Types I-IV, biological role and application). Restriction Mapping (Linear and Circular). Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC). | **15** |
| **III** | Gene Cloning and Recombinant DNA: Gene Construct; PCR mediated gene cloning; Bacterial Transformation and selection of recombinant clones. Construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; Methods of gene transfer: *Agrobacterium*-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP). | **15** |

| | | |
|---|---|---|
| **IV** | Applications of Biotechnology: Case studies on - Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean). Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice). Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); Edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase). Genetically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns. | **15** |
| **Total** | | **60** |

| **CREDIT DISTRIBUTION** | | |
|---|---|---|
| **LECTURE/TUTORIAL** | **PRACTICALS** | **EXPERIENTIAL LEARNING** |
| 60 | 00 | 30<br>•HOME ASSIGNMENTS<br>•SEMINARS<br>•VIVAVOCE<br>•FIELD VISITS |

**Suggested Readings**

**Textbooks:**


1. Bhojwani, S.S. and Razdan, M.K. Plant Tissue Culture: Theory and Practice. 2004. Elsevier Science Amsterdam. The Netherlands.
2. Malik Z.A. Plant Biotechnology: Principles and applications. 2017. Springer
3. Glick, B.R., Pasternak, J.J. Molecular Biotechnology- Principles and Applications of recombinant DNA. 2003. ASM Press, Washington.


**Reference Books:**


1. Chawla, H. S. (2009). *Introduction to plant biotechnology* (3rd ed.). Science Publishers.
2. Slater, A., Scott, N. W., & Fowler, M. R. (2008). *Plant biotechnology: The genetic manipulation of plants* (2nd ed.). Oxford University Press..
3. Old, R. W., & Primrose, S. B. (2001). *Principles of gene manipulation and genomics* (6th ed.). Blackwell Publishing.
4. Purohit, S. S. (2012). *Biotechnology: Fundamentals and applications* (3rd ed.). Agrobios.
5. Singh, B. D. (2015). *Biotechnology: Expanding horizons* (4th ed.). Kalyani Publishers.
6. Brown, T. A. (2016). *Gene cloning and DNA analysis: An introduction* (7th ed.). Wiley-Blackwell.


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**PAPER III: BIOCHEMISTRY, MOLECULAR BIOLOGY & BIOTECHNOLOGY PRACTICAL**
**SUBJECT CODE: BOT144C313,**
**CREDIT UNITS:04 L-T-P-C = 0-0-8-4**
**SCHEME OF EVALUATION: Practical (P)**

**Course Objectives:** The student will have a hand on knowledge of laboratory techniques required for biotechnology-based processes.

**Course Outcomes:** On completion of the course the student will be able to:

| | | |
|---|---|---|
| CO1 | Master the technique of bacterial isolation, transformation, plasmid isolation, and related molecular techniques | BT3 |
| CO2 | Apply standard protocols for plant DNA/RNA isolation, restriction digestion, and gel electrophoresis | BT3 |
| CO3 | Outline and apply tissue culture techniques including media preparation, explant inoculation, and callus culture | BT4 |

**Module Structure & Course Content**

| Module | Course content | Lecture hours |
|---|---|---|
| **I** | 1. Transformation of bacteria and plasmid isolation.<br>2. Isolation of plant genomic DNA and estimation.<br>3. Isolation of RNA from plant tissues and its estimation.<br>4. Restriction digestion and gel electrophoresis of plasmid DNA. | **15** |
| **II** | 5. Lab safety and sterilization techniques in plant tissue culture.<br>6. Preparation of MS medium and its components (stock solutions, hormones)<br>7. Surface sterilization and inoculation of explants, callus induction from seed, leaf or stem explants.<br>8. Micropropagation: Nodal and shoot tip culture | **15** |
| **III** | 9. Two dimensional (paper/TL) chromatographic separation of Amino Acids<br>10. Estimation of starch from plant tissues by iodine reaction.<br>11. Estimation of amino acids from plant tissues by ninhydrin reaction.<br>12. Estimation of soluble protein content from plant tissues by Lowry's method.<br>13. Separation of soluble proteins by gel electrophoresis. | **15** |
| **IV** | 14. Assay of phosphatase activity in plant cells.<br>15. Assay of nitrate reductase activity in cells.<br>16. Isolation of chloroplasts and assay of Hill's reaction | **15** |
| **Total** | | **60** |

| CREDIT DISTRIBUTION | | |
|---|---|---|
| **LECTURE/TUTORIAL** | **PRACTICALS** | **EXPERIENTIAL LEARNING** |
| 00 | 60 | 30<br>•HOME ASSIGNMENTS<br>•SEMINARS<br>•VIVAVOCE<br>•FIELD VISITS |

**Textbooks:**


1. Santra S. Practical Botany Vol.1 and 2. 2015. NCBA Publisher.
2. Bendre and Kumar. Practical Botany Vol.1 and 2. 2018. Rastogi Publications.


**Reference Books:**


1. Plummer, D. T. (1990). *An introduction to practical biochemistry* (3rd ed.). Tata McGraw-Hill.
2. Sambrook, J., & Russell, D. W. (2001). *Molecular cloning: A laboratory manual* (3rd ed.). Cold Spring Harbor Laboratory Press.
3. Brown, T. A. (2016). *Gene cloning and DNA analysis: An introduction* (7th ed.). Wiley-Blackwell.
4. Slater, A., Scott, N. W., & Fowler, M. R. (2008). *Plant biotechnology: The genetic manipulation of plants* (2nd ed.). Oxford University Press.
5. Sadasivam, S., & Manickam, A. (2008). *Biochemical methods* (3rd ed.). New Age International.
6. Gupta, P. K. (2022). *A textbook of biotechnology* (5th ed.). Rastogi Publications.

## DETAILED SYLLABUS OF 4TH SEMESTER

| | |
|---|---|
| **PAPER I: BIOSTATISTICS & BIOINFORMATICS** | |
| **SUBJECT CODE: BOT144C401** | **COURSE LEVEL: 500** |
| **CREDIT UNITS: 04** | **SCHEME OF EVALUATION: L-T-P-C 4-0-0-4** |
| **EVALUATION SCHEME: THEORY ONLY (T)** | |

**Course Objective: D**evelop a scientific understanding of statistical tests and their utility oin decoding interpretation of scientific studies.

**Course Outcomes (COs):**

| | | |
|---|---|---|
| **CO1** | Retrieve and interpret biological sequence and structural data from primary and secondary databases. | BT2 |
| **CO2** | Perform sequence alignment and construct phylogenetic trees using standard bioinformatics tools. | BT3 |
| **CO3** | Explain protein structure hierarchy and demonstrate the use of visualization tools for molecular modeling. | BT2 |
| **CO4** | Apply statistical methods and hypothesis testing (parametric and non-parametric) to analyze biological data. | BT3<br>BT4 |

**Module Structure & Course Content**

| Module | Course Content | Lecture Hours |
|---|---|---|
| **I.** | Concept, Scope and Evolutionary Milestones<br>Relevance of Bioinformatics in Contemporary Biology and Plant Sciences.<br>Biological Information Systems: Classification of Databases –Primary, Secondary, and Composite<br>Genomic Databases: GenBank, EMBL for Nucleotide Sequences<br>Proteomic Repositories: UniProt and Protein Data Bank (PDB). Phylogenetic Reconstruction: Tree-Building Approaches and InterpretationComputational Tools in Phylogenetics: MEGA, PhyML for Evolutionary Analysis | **15** |
| **II.** | **Structural Bioinformatics in Plant Systems:**<br>Exploration of structural organization in key plant proteins; annotation using plant-specific PDB entries; visualization of catalytic and binding domains with PyMOL and RasMol; prediction of unknown protein structures through homology modeling for functional insights.<br>**Plant-Based Drug Discovery and Design:**<br>Use of bioinformatics to identify molecular targets of phytochemicals; in silico docking of alkaloids, flavonoids, and terpenoids; application of virtual screening techniques to discover plant-based leads for nutraceutical and therapeutic development. | **15** |
| **III.** | **Statistics and Biostatistics**: Applied in designing experiments, analyzing biological datasets, and interpreting omics data<br>Frequency Distribution: Used to assess variation in plant traits, disease prevalence, and gene expression levels<br>**Measures of Central Tendency**: Mean, median, and mode applied to summarize morphological, physiological, and biochemical traits<br>**Measures of Dispersion**: Range, standard deviation, and coefficient of variation used to evaluate variability in field and lab data<br>Correlation Analysis: Pearson's and multiple correlation used to study relationships among environmental variables, plant responses, and gene interactions | **15** |
| | **Satistical Analysis:** Regression: Curve fitting by the method of least squares, fitting the lines y = a + bx and x = a + by, Multiple regression, standard error of regression Probability: Definition of probability, Binomial distribution, Normal | **15** |

| | | |
|---|---|---|
| | distribution, Poisson's distribution, properties - problems Sample, Population, large sample, small sample, Null hypothesis, alternative hypothesis, sampling, essence of sampling, types of sampling, Error-I type, Error-II type, Standard error of mean (SEM)<br>Parametric test: t-test (Sample, Pooled or Unpaired and Paired), ANOVA, (One way and Two way), Least Significance difference<br>Non-Parametric tests: Wilcoxon Rank Sum Test, Mann-Whitney U test, Kruskal- Wallis test, Friedman Test | |
| **TOTAL** | | |

| **CREDIT DISTRIBUTION** | | |
|---|---|---|
| **LECTURE/TUTORIAL** | **PRACTICALS** | **EXPERIENTIAL LEARNING** |
| 60 | 00 | 30<br>•HOME ASSIGNMENTS<br>•SEMINARS<br>•VIVAVOCE<br>•FIELD VISITS |

**Suggested Readings**

**Textbooks:**


**1.** "Bioinformatics: Sequence and Genome Analysis" by David W. Mount

**2.** "Introduction to Bioinformatics" by Arthur M. Lesk

**3.** "Bioinformatics and Functional Genomics" by Jonathan Pevsner


**Reference Books:**


**1.** "Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids" by Richard Durbin, Sean R. Eddy, Anders Krogh, and Graeme Mitchison

**2.** "Structural Bioinformatics" by Jenny Gu and Philip E. Bourne

**3.** "Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases, and Analytical Tools" by Supratim Choudhuri

**4.** "Systems Biology: A Textbook" by Edda Klipp, Wolfram Liebermeister, Christoph Wierling, and Axel Kowald

**5.** "Bioinformatics Data Skills: Reproducible and Robust Research with Open Source Tools" by Vince Buffalo.

**6.** Developing Bioinformatics Computer Skills" by Cynthia Gibas and Per Jambeck

**7.** "Bioinformatics Algorithms: An Active Learning Approach" by Phillip Compeau and Pavel Pevzner


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**PAPER II: ENVIRONMENT POLLUTION AND CLIMATE CHANGE MITIGATION**
**SUBJECT CODE: BOT144C402 COURSE LEVEL: 500**
**CREDIT UNITS: 04 SCHEME OF EVALUATION: L-T-P-C 4-0-0-4**
**EVALUATION SCHEME: THEORY ONLY (T)**

**Course Objective:**

This course aims to develop a comprehensive understanding of the causes, effects, control, and policy frameworks related to environmental pollution and climate change. Emphasis is placed on analyzing pollutant impacts on ecosystems and human health, and evaluating scientific and policy-based mitigation strategies.

**Course Outcomes:**

| | | |
|---|---|---|
| CO1 | Describe different types of environmental pollution, their sources and effects. | BT2 |
| CO2 | Demonstrate analytical skills to assess environmental pollution using monitoring techniques and datasets. | BT3 |
| CO3 | Evaluate scientific models and technologies for climate change mitigation. | BT4 |
| CO4 | Design context-specific mitigation strategies based on pollution and climate vulnerability data. | BT5 |

**Module-wise Course Content:**

| Module | Topic and Course Content | Lecture Hours |
|---|---|---|
| I | Advanced Pollution Monitoring & Impact Analysis:<br>Instrumentation and field techniques for air, water, and soil monitoring; SMOG, Ozone, PM2.5, BOD, COD, and heavy metals; Radioactive and Biohazard waste, Acid rain, photochemical smog, ozone depletion<br>- Case studies: Bhopal Gas Tragedy, Minamata, Chernobyl Assessments using environmental indicators; | 12 |
| II | Climate Change and global responses<br>Greenhouse gases and global warming; IPCC climate models: SSP scenarios, Paris Agreement, and NAPCC; Regional climate vulnerabilities: Himalayan glaciers, Northeast India; Climate change and biodiversity loss | 12 |
| III | Pollution and Climate Mitigation Technologies<br>Waste treatment (solid, liquid, hazardous, biomedical); Biodegradation, bioremediation, phytoremediation; Renewable energy technologies (solar, wind, bioenergy); case studies | 12 |
| IV | Application: Designing nature based solutions or Bio-remediation or Urban greening recommendations for pollution hotspots (any relevant area of applications of plant sciences in Environmental health and climate change mitigation) | 12 |
| Total | | 48 |

| CREDIT DISTRIBUTION | | |
|---|---|---|
| **LECTURE/TUTORIAL** | **PRACTICALS** | **EXPERIENTIAL LEARNING** |
| 60 | 00 | 30<br>•HOME ASSIGNMENTS<br>•SEMINARS<br>•VIVAVOCE<br>•FIELD VISITS |

**Suggested Readings:**

***Textbooks***


1. Hill, Marquita (2010). Understanding Environmental Pollution, 3rd Ed., Cambridge University Press
2. Joseph, Benny (2005). Environmental Studies, McGraw Hill
3. Sharma, P. D. (2015). Ecology and Environment, Rastogi Publications
4. De, Anil Kumar and De, Arnab Kumar (2016). Environmental Studies, New Age International


***Reference Books***


1. Wright, R. T. & Boorse, D. F. (2011). Environmental Science: Toward a Sustainable Future, 11th Ed., Pearson
2. McConnell, R. & Abel, D. (2008). Environmental Issues: An Introduction to Sustainability, Pearson
3. Ghosh, G. K. (1992). Environmental Pollution, Ashish Publishing House
4. Jaiswal, P. S. (2007). Environmental Law, Pioneer Publication