STRUCTURE OF THE SYLLABUS FOR 2 YEAR PG PROGRAMME

SCHOOL NAME - ROYAL SCHOOL OF LIFE SCIENCES (RSLSC)

DEPARTMENT NAME - BOTANY

PROGRAMME NAME - M.Sc. Botany

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
BOT144S121	Mushroom Cultivation: Principles and Commercial Applications	400	2	1-0-2
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
BOT144D201	Herbal Medicinal Practices in India	500	2	2-0-0
BOT144S221	Nursery Cultivation & Floriculture	500	2	1-0-2
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	0-0-16
TOTAL CREDIT FOR 3rd SEMESTER			20	
OR 3rd SEMESTER (For students with 3rd and 4th Semester Research)				
BOT144R321	Dissertation I	500	20	0-0-40
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	0-0-24
OR 4th SEMESTER (For students with 3rd and 4th Semester Research)				
BOT144R421	Dissertation II	500	20	0-0-40
TOTAL CREDIT FOR 2nd YEAR =			**40**	

DETAILED SYLLABUS FOR 1st SEMESTER

PAPER I: MICROBES AND MICROBIAL TECHNOLOGY
SUBJECT CODE: BOT144C101
COURSE LEVEL: 400
CREDIT: 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	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.	12
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.	12
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).	12
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	12
Total		48

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

---

PAPER II: PLANT SYSTEMATICS
SUBJECT CODE: BOT144C102
COURSE LEVEL: 400
CREDIT: 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

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.	12
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.	12
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.	12

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.	12

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:

4. Radford, A. E. (1986). *Fundamentals of Plant Systematics.* Harper & Row, New York
5. Gifford, E. M., & Foster, A. S. (1989). *Morphology and Evolution of Vascular Plants.* W. H. Freeman
6. 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
7. Turland, N. J., et al. (2018). *International Code of Nomenclature for Algae, Fungi, and Plants (ICN) – Shenzhen Code.* IAPT (International Association for Plant Taxonomy).
8. Heywood, V. H. (1993). *Flowering Plants of the World.* Oxford University Press.

PAPER III: DEVELOPMENTAL BIOLOGY OF PLANTS
SUBJECT CODE: BOT144C103
COURSE LEVEL: 400
CREDIT: 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**

Detailed Syllabus:

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	12

	networks in stem cell regulation. Hormonal and environmental signals regulating root development and root architecture.	
II	Cell Division and its regulation. Flower development and its regulation in plants; Pollen development, fertilization mechanisms, and molecular basis of self-incompatibility. Genetic and hormonal control of senescence, abscission, and programmed cell death, with ROS-mediated regulation of developmental transitions.	12
III	**Organogenesis and Differentiation** Phyllotactic patterning and auxin-mediated organ positioning. Regulation of leaf polarity. Hormonal regulation of Axillary meristem activation and shoot branching. Root gravitropism, amyloplast sedimentation, and lateral root initiation. Vascular differentiation. Hormonal control of xylem and phloem specification. Secondary growth regulation through cambium activity, lignification pathways, and wood formation.	12
IV	**Environmental and Evolutionary Regulation of Development** 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.	12
Total		48

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.

PAPER IV: GENETICS, CYTOGENETICS & PLANT BREEDING
SUBJECT CODE: BOT144C104, L-T-P-C= 3-0-0-3,
COURSE LEVEL: 400
CREDIT UNITS: 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: Apply advanced genetic principles and molecular breeding techniques for trait improvement, hybridization, and genomic selection in crop breeding programs.

CO2: Utilize genome editing and biotechnological tools such as CRISPR, marker-assisted selection (MAS), and mutation breeding for developing stress-resilient and high-yield crops.

CO3: Analyse population genetics and evolutionary mechanisms to enhance biodiversity conservation, genetic variation, and adaptive breeding strategies.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Principles of Genetics** Genetic Principles, Mendelian inheritance and its extension. Extranuclear Inheritance and Maternal Effects: Mitochondrial and chloroplast DNA inheritance.	**12**
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.	**14**
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.	**10**
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.	**12**
Total		**48**

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

PAPER V: MICROBIOLOGY AND PLANT SYSTEMATICS PRACTICAL
SUBJECT CODE: BOT144C115,
COURSE LEVEL: 400
CREDIT UNITS: 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**

Detailed syllabus:

Modules	Topics / Course content	Periods
I	1. Method of obtaining pure culture by streak plate method, subculturing and preservation 2. Determination of bacterial growth curve by spectrophotometric method. 3. Isolation of Plasmid DNA.	18
II	4. Determination of biochemical activities (Amylase, cellulase and caseinase) by the bacteria 5. Isolation of Rhizobia and testing nodulation activity by rhizobia	24
III	6. Collection and preparation and submission of herbarium specimens. 7. Identification of plants using dichotomous keys, floras, and manuals. 8. Preparation of diagnostic taxonomic keys for plant species. 9. Study of vegetative and reproductive structures in major plant families.	24
IV	10. Local Field Visit and Report Submission	6
Total		72

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.

PAPER VI: CYTOGENETICS, GENETICS, PLANT BREEDING AND DEVELOPMENTAL BIOLOGY PRACTICAL
SUBJECT CODE: BOT144C116
COURSE LEVEL: 400
CREDIT UNITS: 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**

Modules	Topics / Course content	Periods
I	1. Monohybrid, Dihybrid, and Trihybrid Crosses: Analysis of segregation ratios using chi-square test. 2. Linkage and Recombination: Mapping genes using three-point test cross data	20
II	3. Preparation of root tip squashes for mitotic chromosome studies. 4. Meiotic chromosome analysis. 5. Preparation of permanent slides 6. Cytological Study of Chromosomal Aberrations and Polyploidy Induction 7. Tetrazolium test for seed viability	20
III	8. Microscopic Examination of Shoot and Root Apical Meristems 9. Study of anomalous secondary growth using available specimens. 10. Pollen Viability and Germination Test	20

	11. Dissection and Morphological Study of Floral Organs	
IV	12. Hybridization Techniques and Heterosis Study 13. Emasculation and self-pollination study	12
Total hours		72

Suggested Readings

Textbooks:

1. Klug, W. S., Cummings, M. R., Spencer, C. A., & Palladino, M. A. (2018). *Concepts of Genetics (12th Edition).* Pearson.

Snustad, D. P. & Simmons, M. J. (2019). *Principles of Genetics (7th Edition).* Wiley.

SEC : MUSHROOM CULTIVATION: PRINCIPLES AND COMMERCIAL APPLICATIONS (PROJECT BASED)

SUBJECT CODE: BOT144S121, COURSE LEVEL: 400 **CREDIT UNITS: L-T-P-C 0-0-0-2** **EVALUATION SCHEME: PRACTICAL ONLY (P)**

Course Objective: Develop 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 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. Entrepreneurial Module: Basics of startup planning, funding sources (NABARD, MSME, Agri-tech incubators), subsidy programs.	**5**
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). Eco-Solutions: composting waste, circular economy models. Entrepreneurial Module: Feasibility analysis, business cost estimation, profit modeling, investment planning, and risk mitigation.	**5**
III.	**Hands-on Practical, Industry Exposure and project**	**14**

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

Suggested Readings :

Textbook:

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

Additional References:

2. Pathak, V. N., Gaur, R. D., & Agarwal, K. C. (1998). *Mushroom Production and Processing Technology.* Agrobios.
3. Kaul, T. N. (2001). *Biology and Conservation of Edible Fungi.* Oxford & IBH Publishing.
4. Singh, M. & Vijay, B. (2005). *Mushroom Cultivation, Marketing, and Consumption.* ICAR.
5. Chang, S. T. (2017). *Functional Properties of Edible Mushrooms.* Elsevier.
6. 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: 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]

Detailed Syllabus:

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	
II	**Fungal Associations:** Application of mycorrhizal inoculants in agriculture, environmental monitoring using lichens, AMF as bio-stimulants and bio-protectants of crops	
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	
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	

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.

PAPER II: PLANT PHYSIOLOGY
SUBJECT CODE: BOT144C201,
COURSE LEVEL: 500
CREDIT UNITS: 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: **Understand and interpret** the different physiological processes affecting plant development and growth **[BT4]**

CO2: **List** the different plant hormones and **interpret** its application for crop improvement programs. [**BT2 and BT4]**

CO3: **Identify** the key signalling pathways of different processes that can be targeted for enhancing the plant trait and yield. **[BT4]**

Detailed Syllabus:

Module	Course content	Lecture hours
I	**Nutrient uptake:** Water potential (ψ): 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.	**12**
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.	**12**
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). Hormones as chemical messengers (auxin, cytokinin, gibberellin- structure, function), newer classes of hormones (phytosulfokine, karrikins).	**12**
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**	**12**

	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.	
Total		**48**

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.

CORE SUBJECT: ECOLOGY AND ECOSYSTEM ANALYSIS
SUBJECT CODE: BOT144C203; COURSE LEVEL: 500
CREDIT: 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 the impact of human activities on ecological processes **[BT4]**

CO3: **Evaluate and synthesize** ecological theories, ecosystem services, and conservation strategies for sustainable management. **[BT5]**

Detailed syllabus:

Modules	Topics / Course content	Periods
I	**Fundamentals of Ecology** **Ecological Principles:** Concept of limiting factors and ecological thresholds; Physical environmental factors (soil, water, light, temperature, fire) and their interactions with biotic components. **Ecological Hierarchies and Species Interactions:** Ecological levels: Individual, population, community, ecosystem, biosphere; Niche concept: Species interactions: Competition, predation, mutualism, allelopathy. **Adaptations to Environmental Conditions:** Plant adaptations to arid, aquatic, and extreme environments; Microclimate influence on plant growth and survival.	12

II	**Population, Community, and Successional Dynamics** **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. **Community Structure and Biodiversity:** Nature of communities, species diversity, and dominance; Measurement of Biodiversity indices; Community stability and resilience. **Ecological Succession and Niche Dynamics:** Primary and secondary succession: Mechanisms and changes; Climax community concepts; Habitat fragmentation and edge effects.	12
III	**Ecosystem Functioning:** Food webs, trophic levels, and energy flow and pyramids; Productivity: NPP and GPP and community respiration. **Biogeochemical Cycles:** Importance of Carbon, Nitrogen, Phosphorus, and hydrological cycles.	12
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.	12
Total		48

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: MYCOLOGY, PHYSIOLOGY, BIOCHEMISTRY, AND ECOLOGY PRACTICAL
SUBJECT CODE: BOT144C214,
COURSE LEVEL: 500
CREDIT UNITS: 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:

1. **Demonstrate and identify** techniques used to analyse plant physiological and biochemical processes **[BT2 & BT3].**

Modules	Topics / Course content	Periods
I	1. Symptomatology and histopathology of locally available diseased plants and identification of pathogens. 2. Isolation and identification of AMF (Arbuscular Mycorrhizal Fungi) from soil sample 3. Role of yeast in bread making 4. Collection and submission of diseased plant samples with fungal, bacterial, and viral symptoms.	**18**
II	5. To study the effect of different concentrations of IAA on coleoptile elongation (IAA Bioassay). 6. Experimental demonstration of Hill's reaction.	**18**
III	7. Estimation of soluble protein content from plant tissues. 8. Chromatographic separation of amino acids. 9. Estimation of amino acids from plant tissues by ninhydrin reaction.	**18**
IV	10. Estimation of primary productivity using Winkler's method 11. Community characterization and species diversity indices 12. Calculation of Importance Value Index (IVI) for dominant species. 13. Preparation of population life tables and analysis of survivorship curves	**18**
Total		**72**

Textbooks:

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

PAPER V: HERBAL MEDICINAL PRACTICES IN INDIA
SUBJECT CODE: BOT144D201,
CREDIT UNITS: L-T-P-C: 0-1-2-3,

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: Analyze 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**

Detailed syllabus

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** Phytochemistry and bioactive compounds in few common medicinal plants (*Ashwagandha, Neem, Tulsi, Amla, Giloy, Turmeric*). Role of medicinal plants in One Health: Antimicrobial resistance, zoonotic diseases, and environmental health. Conservation and sustainability: Role of IUCN, National Medicinal Plants Board (NMPB), and WHO guidelines in medicinal plant conservation.	**8**
III	**Practical/Fieldwork Component** • Visit to herbal gardens, Ayurvedic research centres, or community-led ethnobotanical initiatives. • Case study analysis of One Health applications using traditional medicinal plants.	**15**

Suggested Readings

Core Textbook:

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

Additional References:

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

3. 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.

PAPER III: NURSERY CULTIVATION & FLORICULTURE
SUBJECT CODE: BOT144S221,
CREDIT UNITS: L-T-P-C = 2-0-0-2
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]**

Detailed Syllabus:

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	**4**
II.	**Floriculture Business, Post-Harvest Handling, and Market Trends** Post-harvest physiology & handling: Packaging, cold chain storage, shelf-life enhancement. Floriculture crops: Genetic improvement, hybrid varieties, nutrient management, growth regulators. Floriculture business models: Cut flowers, ornamental landscaping, essential oils, indoor plants, bonsai, urban gardening. E-commerce and Export Strategies: International floriculture markets, logistics, startup incubation.	**4**
III.	**Project-Based Entrepreneurship Development (e.g.,)** • Value-added product development: Essential oils, herbal extracts, organic flower-based accessories. • Controlled environment floriculture: designing of high-tech nurseries, urban greenhouses. • Market research & branding: Study of floriculture businesses, digital	**20**

	marketing, online sales platforms. • Post-harvest handling techniques: Flower preservation, storage, arrangement, aesthetic value addition.	

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:

3. Bose, T. K., Yadav, L. P., & Pal, P. (2003). *Commercial Floriculture (Vol. I & II).* Naya Udyog, Kolkata.
4. Rangaswami, G. & Mahadevan, A. (2002). *Diseases of Crop Plants in India (4th Edition).* Prentice Hall.
5. 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