Vidyasagar University

Post Graduate (M.Sc.) Syllabus in

Botany

[w.e.f.:2025-2026]

Brief history

Post-graduate (M. Sc.) teaching of Botany in Vidyasagar University was initiated in the year 1991 under the Faculty of Science. The Department also offered Ph.D. programme. The Department is now well established, with eight sanctioned faculty strengths. Extramural grants from DBT, DST, and UGC as well as intramural grants from the University, have strengthened the Department's research. Department got FIST programmein 2001, and UGC-DRS-SAP in 2012 and 2018 in two phases. The infrastructure facility of this department is quite good. We have three lecture gallery, three laboratory rooms, two instrument room, eight faculty rooms and a big computer laboratory in the department. The Choice-Based Credit System (CBCS) was initiated from 2018. The courses are assigned credits on the basis of teaching hours, which in turn is linked to course content and structure. The various courses of the programme are designed to include classroom teaching and lectures, laboratory work, project work, seminars, community and industrial survey.

PROGRAMME OUTLINES

	Type of Program	This is a regular mode M.Sc. programme, based on the guidelines of NEP 2020.
1	**Duration and Eligibility Criteria**	The department offers two types of M.Sc. programmes in Botany. Students who have completed a 3-year Honours degree in Botany are eligible for admission to the two-year M.Sc. programme**,** while those who have completed a 4-year Honours degree in Botany (with or without research) are eligible for admission to the one-year M.Sc. programme**.**
2	**Intake Capacity**	The current intake capacity of the programme is 77 students. Admission is carried out in accordance with the prevailing government norms, and the reservation rules for EWS, OBC, SC, ST, PWD, and other applicable categories are strictly followed.
3	**Admission procedure**	The university conducts a written admission test as part of the selection process. Admission is based primarily on the performance in the written test, along with consideration of marks obtained in the Undergraduate (UG) programme or in the Higher Secondary (HS) examination, as applicable. The Admission Committee supervises the entire admission process, ensuring that all rules and regulations are properly followed.
4	**Evaluation Process**	• The students will be assessed through a combination of continuous evaluation and end-semester examination. **Continuous Evaluation (CE)** carries **20% weightage**, while the **End-Semester Examination** accounts for **80%** of the total marks. • Two CEs will be conducted for each paper/course, and the average of these two will determine the final CE marks. The CEs may be conducted in diverse formats such as multiple-choice questions (MCQs), short answer type questions, open-book examinations, take-home exercises, case studies, assignments, or small projects. • The end-semester examination will comprise short-answer, medium answer, and long-answer type questions to evaluate the

		students' understanding and analytical skills comprehensively.
5	**Teaching Methods**	To achieve the intended learning outcomes, the following teaching–learning methods will be employed: • **Lecture-based Learning** – Structured delivery of core concepts through classroom lectures. • **Group Learning** – Collaborative discussions and group activities to promote teamwork and idea-sharing. • **Individual Learning** – Independent study and self-paced learning to strengthen conceptual clarity. • **Technology-based Learning** – Use of digital tools, software, and online resources to support interactive learning. • **Peer Teaching** – Students explaining concepts to peers, encouraging active participation and reinforcement of knowledge. • **Problem-solving Approach** – Learning through real-world problems, case studies, and exercises to develop analytical and critical thinking skills
6	**Special Instructions**	To align the syllabus with the National Education Policy (NEP) 2020, several general courses such as Indian Knowledge System (IKS), Intellectual Property Rights (IPR), Research Methodology and Ethics, Social Service/Community Engagement, Internship/Industry Visit or Industry-related Project, Field Visit, Research Project, and Life and Philosophy of Vidyasagar have been made compulsory. Alongside these, a set of core courses has been included to strengthen subject foundations. The syllabus also offers elective papers to provide flexibility and choice. In Semesters I and II, each elective paper provides two options, while in Semesters III and IV, each elective paper provides three options. Students are required to choose one elective paper from the available options. In MTM 401 & 402, each elective includes both a theory paper (2 credits) and a practical paper (2 credits), and students must opt for both components from the same elective to ensure coherence in learning.
7	**Research Projects**	The research project will be distributed by the mentor to the students in third semester and it will be evaluated in final semester.

Program Outcomes (POs) The Scope of Botany deals with the course content of the subject and the utility of such curriculum in relation to mankind. An attempt is made here to give a summary regarding the scope of botany studies.

PO1	**Inclusive Knowledge of Plant Sciences**: Acquire advanced understanding of extant plant diversity (algae, bryophytes, pteridophytes, gymnosperms, and flowering plants), diversity of prehistoric plants, fungal diversity, microbiology, biochemistry, plant physiology, genetics, biotechnology and ecology,
PO2	**Analytical and Critical Thinking Skills**: Develop the ability to analyze plant-related problems, interpret scientific data, and apply logical reasoning in biological research.
PO3	**Practical and Laboratory Competence**: Gain proficiency in laboratory techniques, microscopy, other high end instruments, plant and fungi identification, herbarium preparation, and field-based studies.
PO4	**Research Skills:** Formulate hypotheses, design experiments, and conduct

	independent research in numerous domains of plant sciences.
PO5	**Environmental Awareness:** Recognize varied environmental awareness programs and their importance, biodiversity conservation, impacts of climate change, and sustainable use of plant wealth.
PO6	**Use of Modern Tools and Techniques:** Develop skills in microbiology, molecular biology, bioinformatics, and other emerging technologies relevant to plant sciences.
PO7	**Communication Skills:** Efficiently communicate scientific thoughts through reports, seminar presentations, and academic writing.
PO8	**Ethics and Professional Responsibility:** Obey to ethical practices in research, environmental management, and professional conduct.
PO9	**Lifelong Learning** Engage in continuous learning, adapts to emerging trends in plant sciences, and pursues higher studies or professional development.
PO10	**Entrepreneurial and Employability Skills:** Develop skills relevant to careers in academia, research institutions, agriculture, forestry, pharmaceuticals, and environmental consultancy, including entrepreneurship in plant-based industries.
PO11	**Economic Development and Livelihood Support:** various industries and rural livelihoods such as Forestry, horticulture, floriculture, and agro-based industries; production of timber, fibers, oils, dyes, and other plant products; employment generation in agriculture, research, and environmental sectors

Program Specific Outcomes (PSOs)

After the successful completion of M.Sc. in Botany program, the students are expected to:

PSO1	Apply fundamental knowledge of plant science to real-world biological problems; can be absorbed in Schools, Colleges & Universities, Nurseries, Farms, Environmental Consultancy services, Pharmaceutical Companies, Forest services, Quality control, and Health Services.
PSO2	Conduct independent research and projects in areas of Plant Systematics, Microbiology, Plant Pathology, Plant Physiology, Biotechnology, Palynology & Pollination ecology.
PSO3	Apply botanical knowledge for societal benefit, including sustainable agriculture, climate change mitigation, and conservation of natural resources.
PSO4	Appreciate the historical and cultural development of Botany, including Indian Knowledge Systems, and apply botanical knowledge in socially relevant, ethical, and interdisciplinary contexts.

M.Sc. in BOTANY

(*For the students admitted during the academic year 2025-26 onwards*)

Sem	COURSE code	COURSE TITLES	Credits (L-T-P)	Maximum Marks		
				IA	ESE	Total
I	BOTC401X0 (DSC)	MICROBIOLOGY AND VIROLOGY	4(3-1-0)	10	40	50
	BOTC402X0(DSC)	ALGAL SCIENCE	2(1-1-0)	05	20	25
	BOTC403X0 (DSC)	ADVANCED BRYOLOGY	2(1-1-0)	05	20	25
	BOTC404X0 (DSC)	FUNGAL BIOLOGY	2(1-1-0)	05	20	25
	BOTO405VC (DSC)	INDIAN KNOWLEDGE SYSTEM	2(1-1-0)	05	20	25
	BOTC406X0 (DSC)	VASCULAR CRYPTOGAMS	2(1-1-0)	05	20	25
	BOTC407X0 (DSC)	GYMNOSPERMS	2(1-1-0)	05	20	25
	BOTC408X9 (DSCP)	MICROBIOLOGY	2(0-0-2)	--	25	25
	BOTC409X9 (DSCP)	PHYCOLOGY AND BRYOLOGY	1(0-0-1)	--	25	25
	BOTC410X9 (DSCP)	MYCOLOGY & PLANT PATHOLOGY	2(0-0-2)	--	25	25
	BOTC411X9 (DSCP)	PTERIDOPHYTES AND GYMNOSPERMS	1(0-0-1)	--	25	25
	BOTO412NC (NC)	VIDYASAGAR: LIFE AND PHILOSOPHY	Compulsory Non-credit	--	25	25
		TOTAL	22	40	285	325
II	BOTC451X0 (DSC)	PLANT TAXONOMY AND SYSTEMATICS	4(3-1-0)	10	40	50
	BOTC452X0 (DSC)	PALAEOBOTANY AND EARLY LIFE FORMS	2(1-1-0)	05	20	25
	BOTC453X0 (DSC)	POLLEN AND POLLINATION ECOLOGY	2(1-1-0)	05	20	25
	BOTC454X0 (DSC)	PLANT PATHOLOGY	2(1-1-0)	05	20	25
	BOTC455X0 (DSC)	ECOLOGY	2(1-1-0)	05	20	25
	BOTC456X0 (DSC)	ENVIRONMENTAL BIOLOGY AND PHYTOGEOGRAPHY	1(1-0-0)	05	20	25
	BOTC457X0 (DSC)	RESEARCH METHODOLOGY AND ETHICS	4(3-1-0)	10	40	50
	BOTC458X9 (DSCP)	PLANT TAXONOMY AND BIOSYSTEMATICS	2(0-0-2)	--	25	25
	BOTC459X9 (DSCP)	PALAEOBOTANY, PALYNOLOGY AND POLLINATION ECOLOGY	2(0-0-2)	--	25	25
	BOTC460X9 (DSCP)	ECOLOGY	1(0-0-1)	--	25	25
		TOTAL	22	45	255	300
III	BOTO501X0 (DSE)	MOOC COURSE FROM SWAAM	4(3-1-0)	30	70	100
	BOTC502X0 (DSC)	GENETICS AND CELL BIOLOGY	2(1-1-0)	05	20	25
	BOTC503X0 (SEC)	BIOTECHNOLOGY, PLANT PROPAGATION AND NURSERY TECHNIQUES	2(1-1-0)	05	20	25
	BOTC504X0 (DSC)	PLANT PHYSIOLOGY AND METABOLISM	2(1-1-0)	05	20	25
	BOTC505X0 (DSC)	BIOCHEMISTRY AND MOLECULAR BIOLOGY	2(1-1-0)	05	20	25
	BOTE506A0 (DSE)	One Elective to be chosen: ANGIOSPERM TAXONOMY AND MOLECULAR SYSTEMATICS: ANGIOSPERM TAXONOMY	4(3-1-0)			
	BOTE506B0 (DSE)	APPLIED MYCOLOGY AND PLANT PATHOLOGY : APPLIED MYCOLOGY				
	BOTE506C0 (DSE)	CYTOGENETICS, MOLECULAR BIOLOGY AND BIOTECHNOLOGY : CYTOGENETICS				
	BOTE506D0 (DSE)	ECOLOGY AND BIODIVERSITY : ECOLOGY				
	BOTE506E0 (DSE)	MICROBIOLOGY: GENERAL AND APPLIED : MICROBIOLOGY: GENERAL				
	BOTE506F0 (DSE)	PALAEOBOTANY, PALYNOLOGY AND PLANT REPRODUCTIVE ECOLOGY : PALAEOBOTANY				
	BOTE506G0 (DSE)	PLANT PHYSIOLOGY, BIOCHEMISTRY AND MOLECULAR BIOLOGY : PLANT PHYSIOLOGY AND BIOCHEMISTRY		10	40	50
	BOTC507X9 (SECP)	GENETICS AND BIOTECHNOLOGY AND PLANT PROPAGATION	1(0-0-1)	--	25	25
	BOTC508X9 (DSCP)	PLANT PHYSIOLOGY, BIOCHEMISTRY AND PLANT BIOTECHNOLOGY	2(0-0-2)	--	25	25
	BOTE509A9 (DSEP)	One Elective to be chosen: ANGIOSPERM TAXONOMY AND MOLECULAR SYSTEMATICS: ANGIOSPERM TAXONOMY	2(0-0-2)	--	25	25
	BOTE509B9 (DSEP)	APPLIED MYCOLOGY AND PLANT PATHOLOGY : APPLIED MYCOLOGY				
	BOTE509C9 (DSEP)	CYTOGENETICS, MOLECULAR BIOLOGY AND BIOTECHNOLOGY : CYTOGENETICS				
	BOTE509D9 (DSEP)	ECOLOGY AND BIODIVERSITY : ECOLOGY				
	BOTE509E9 (DSEP)	MICROBIOLOGY: GENERAL AND APPLIED : MICROBIOLOGY: GENERAL				

	BOTE509F9 (DSEP)		PALAEOBOTANY, PALYNOLOGY AND PLANT REPRODUCTIVE ECOLOGY : PALAEOBOTANY				
	BOTE509G9 (DSEP)		PLANT PHYSIOLOGY, BIOCHEMISTRY AND MOLECULAR BIOLOGY : PLANT PHYSIOLOGY AND BIOCHEMISTRY				
	BOTC510X9 (DSCP)		Internship/ Industry Project/ Innovative Project	1(0-0-1)	--	25	25
		TOTAL		22	60	290	350
IV	BOTC551X0 (DSC)	FOREST SCIENCE		2(1-1-0)	05	20	25
	BOTC552X0 (DSC)	INSTRUMENTATION AND BIOMATHEMATICS		2(1-1-0)	05	20	25
	BOTC553X0 (DSC)	PLANT ANATOMY AND ADVANCED PHARMACOGNOSY		2(1-1-0)	05	20	25
	BOTC554X0 (DSC)	OMICS SCIENCE		2(1-1-0)	05	20	25
	BOTE555A0 (DSE)	One Elective to be chosen	ANGIOSPERM TAXONOMY AND MOLECULAR SYSTEMATICS: MOLECULAR SYSTEMATICS	4(3-1-0)	10	40	50
	BOTE555B0 (DSE)		APPLIED MYCOLOGY AND PLANT PATHOLOGY: PLANT PATHOLOGY				
	BOTE555C0 (DSE)		CYTOGENETICS, MOLECULAR BIOLOGY AND BIOTECHNOLOGY: MOLECULAR BIOLOGY AND BIOTECHNOLOGY				
	BOTE555D0 (DSE)		ECOLOGY & BIODIVERSITY: BIODIVERSITY				
	BOTE555E0 (DSE)		MICROBIOLOGY: GENERAL AND APPLIED : MICROBIOLOGY: APPLIED				
	BOTE555F0 (DSE)		PALAEOBOTANY, PALYNOLOGY AND PLANT REPRODUCTIVE ECOLOGY : PALYNOLOGY AND PLANT REPRODUCTIVE ECOLOGY				
	BOTE555G0 (DSE)		PLANT PHYSIOLOGY, BIOCHEMISTRY AND MOLECULAR BIOLOGY: BIOCHEMISTRY AND MOLECULAR BIOLOGY				
	BOTC556X9 (DSCP)	FOREST MENSURATION AND SURVEY		1(0-0-1)	--	25	25
	BOTC557X9 (DSCP)	PLANT ANATOMY AND PHARMACOGNOSY		1(0-0-1)	--	25	25
	BOTE558A9 (DSEP)	One Elective to be chosen	ANGIOSPERM TAXONOMY AND MOLECULAR SYSTEMATICS: MOLECULAR SYSTEMATICS	2(0-0-2)	--	25	25
	BOTE558B9 (DSEP)		APPLIED MYCOLOGY AND PLANT PATHOLOGY: PLANT PATHOLOGY				
	BOTE558C9 (DSEP)		CYTOGENETICS, MOLECULAR BIOLOGY AND BIOTECHNOLOGY: MOLECULAR BIOLOGY AND BIOTECHNOLOGY				
	BOTE558D9 (DSEP)		ECOLOGY & BIODIVERSITY: BIODIVERSITY				
	BOTE558E9 (DSEP)		MICROBIOLOGY: GENERAL AND APPLIED : MICROBIOLOGY: APPLIED				
	BOTE558F9 (DSEP)		PALAEOBOTANY, PALYNOLOGY AND PLANT REPRODUCTIVE ECOLOGY : PALYNOLOGY AND PLANT REPRODUCTIVE ECOLOGY				
	BOTE558G9 (DSEP)		PLANT PHYSIOLOGY, BIOCHEMISTRY AND MOLECULAR BIOLOGY: BIOCHEMISTRY AND MOLECULAR BIOLOGY				
	BOTE559X9 (DSEP)	M.Sc. Thesis/ M.Sc. project		4(0-0-4)	--	50	50
	BOTC560X9 (DSCP)	FIELD SURVEY AND SOCIAL OUTREACH		2(0-0-2)	--	25	25
	TOTAL			22	30	260	
	GRAND TOTAL			88	175	1100	1275

Abbreviations: L- Lecture; T – Tutorial; P – Practical; DSC – Discipline Specific Core; DSCP - Discipline Specific Core Practical; NC – Non Credit Course; DSE - Discipline Specific Elective; SEC – Skill Enhancement Course; DSEP - Discipline Specific Elective Practical

COURSE OUTCOMEs (COs):

SEMESTER I

BOTC401X0 (DSC):

CO1: Students will get information about the subject Microbiology.

CO2: Students will get information on different applied aspects of the course and can use the same in everyday life.

CO3: They can be self-employed with the use of knowledge on fermentation technology, agricultural microbiology etc.

CO4: Topics like virology, immunology will help them to understand about their health.

BOTC402X0 (DSC):

CO1: The content in Algal Science provides information on the overview of algae, their recent taxonomic status.

CO2: Students are also getting conversant about the economic significance of algae.

BOTC403X0 (DSC):

CO1: Students will get knowledge on another cryptogamic group Bryology, their structure, and applications.

BOTC404X0 (DSC):

CO1: Learners will be able to define and explain the unique features of fungi;

CO2: Illustrate a modern classification with characters up to phylum;

CO3: They can define and explain homothallism and heterothallism;

CO4: Students will be able to define and explain phylum Ascomycota, Basidiomycota.

BOTC405X0 (DSC):

CO1: Students will understand philosophical and epistemological foundations of Indian Knowledge Systems (IKS) related to plants.

CO2: They will learn how to recognize and document plants using both vernacular/folk knowledge and modern botanical taxonomy.

CO3: Learners will be able to conduct ethnobotanical documentation and analysis across cultural/regional contexts.

CO4: They will be accomplished in analyzing the use of traditional plants using modern scientific methods (taxonomy, phytochemistry, ecology).

CO5: Students will be able to design ethical, scientifically rigorous research projects rooted in traditional knowledge — for conservation, herbal medicine research, sustainable agriculture, and biodiversity preservation.

CO6: After studying, this paper will train students to conserve plants in traditional Indian societies through religious, culture and social taboo.

BOTC406X0 (DSC):

CO1: Study of Vascular Cryptogams helps in understanding origin and evolution of early vascular plants and other cryptogams especially ferns.

CO2: Also helps to understand the different medicinal and economic uses of the plant group.

CO3: In addition, ferns are also used for food and decorative purposes and learners will gain knowledge by studying the paper.

BOTC407X0 (DSC):

CO1: Study of gymnosperms will help to understand the distribution of different taxa in India, abroad and especially grown at higher altitudes.

CO2: Also helps in understanding the economic uses of the group (as a source of wood, medicine, resin).

CO3: Many Gymnosperms are used as ornamental plants and avenue trees and learners will acquire knowledge about it.

BOTC408X9 (DSCP):

CO1: Students will observe different microorganisms after staining and can understand about the nature of different microbes.

CO2: They will know how to culture microbes, prepare media and sterilization process.

CO3: Regarding sensitivity of test of antibiotics they will get hands on training.

CO4: Students will visit different industries and institutes of microbiological interest and will observe applied aspects on the subject which are not possible to show them during their regular classes.

BOTC409X9 (DSCP):

CO1: Practical course help students in identifying various important members of algae and Bryophytes.

BOTC410X9 (DSCP):

CO1: Practical courses help the learners in identifying different important members of fungi and Plant Pathogens.

BOTC411X9 (DSCP):

CO1: Practical course will help to identify both the extinct and extant Pteridophytes and gymnosperms through study of different fossil slides and living specimens (morpho-anatomical characters) respectively.

CO2: Students will be able to recognize pteridophytes and gymnosperms in nature.

BOTO412NC (DSC): VIDYASAGAR: LIFE & PHILOSOPHY: After successful completion of the course, students will be able to:

CO1. Describe the life, historical background, and major contributions of Pandit Ishwar Chandra Vidyasagar in the context of 19th-century Bengal Renaissance.

CO2. Explain Vidyasagar's educational philosophy, including his views on women's education, rationalism, humanitarianism, and social justice.

CO3. Analyze Vidyasagar's role in social reform movements such as the Hindu Widow Remarriage Act (1856) and his opposition to social evils like child marriage and polygamy.

CO4. Evaluate Vidyasagar's contribution to Bengali language and literature, especially in prose development and textbook writing.

CO5. Interpret the ethical and moral values reflected in Vidyasagar's life, including compassion, simplicity, secularism, and dedication to public welfare.

CO6. Apply Vidyasagar's philosophical principles to contemporary issues in education, gender equality, and social reform.

CO7. Develop critical thinking skills by comparing Vidyasagar's ideas with other reformers of the Bengal Renaissance.

CO8. Appreciate the relevance of Vidyasagar's humanistic philosophy in modern Indian society.

SEMESTER II

BOTC451X0 (DSC):

CO1: The knowledge in the new biology domain behind Molecular Taxonomy and systematics is changing fast to understand the biological system as a whole.

CO2: Dynamic curriculum in this area integrating basic biology, chemistry, numerical approach for understanding the functional biology.

BOTC452X0 (DSC):

CO1: Palaeobotany helps in understanding the plant life patterns of prehistoric time;

CO2: Palaeoclimatology and how life has changed with the changing environment since its' origin.

CO3: Learners will also gain knowledge regarding different kinds of rocks, preservation of fossils, dating of rocks, cause of Tsunami and earthquakes etc.

BOTC453X0 (DSC): It will help learners in the following ways-

CO1: Understand the scope, history, and significance of Palynology in plant sciences.

CO2: Explain the structure, morphology, and development of pollen grains and spores.

CO3: Correlate palynological data with plant taxonomy and phylogeny.

CO4: Helps to apply palynological knowledge in Paleoecology and paleoclimatology (reconstruction of past vegetation and climate).

CO5: To understand foraging behavior of bees through Melissopalynology.

CO6: Forensic science (crime investigation using pollen evidence).

CO7: Allergy studies (identification of allergenic pollen).

CO8: Understand the fundamental concepts of pollination, including types such as self-pollination and cross-pollination, and their evolutionary significance.

CO9: Differentiate between various pollination mechanisms (abiotic and biotic), including wind, water, and animal-mediated pollination.

CO10: Explain the structural and functional adaptations of flowers related to different pollination syndromes (entomophily, ornithophily, chiropterophily, etc.).

CO11: Analyze plant–pollinator interactions and co-evolutionary relationships between flowering plants and pollinating agents.

BOTC454X0 (DSC): Studying Plant Pathology equips students with -

CO1: Scientific knowledge to understand, diagnose, and manage plant diseases affecting crops and ecosystems.

CO2: Students can explain the concepts of plant health and disease;

CO3: They can identify major groups of plant pathogens: fungi, bacteria, viruses, nematodes, and parasitic plants;

CO4: Students will be eligible to describe disease cycles and host–pathogen interactions;

CO5: They can be able to recognize symptoms and signs of plant diseases in field and laboratory conditions;

CO6: Students will understand the biology and management of important pathogens.

BOTC455X0 (DSC):

CO1: Students can understand and explain fundamental ecological concepts including ecosystem structure, energy flow, food chains, food webs, ecological pyramids, and biogeochemical cycles.

CO2: They will be able to describe the interactions between organisms and their environment, including population dynamics, community structure, and ecological succession.

CO3: Students can be able to analyze the structure and functions of different ecosystems such as forest, grassland, desert, and aquatic ecosystems.

CO4: To evaluate the causes and impacts of environmental problems such as pollution, climate change, deforestation, and biodiversity loss.

CO5: Students can be able to apply ecological principles to biodiversity conservation, natural resource management, and sustainable development practices.

BOTC456X0 (DSC):

By the end of the course, students will be able to:

CO1: Explain fundamental concepts of environmental biology, including ecosystems, biodiversity, and ecological principles.

CO2: Analyze the impact of human activities such as pollution, deforestation, urbanization, and climate change on the environment.

CO4: Evaluate major environmental issues such as global warming, loss of biodiversity, waste management, and resource depletion.

CO5: Apply environmental laws, policies, and sustainable development principles in solving environmental problems.

CO6: Demonstrate awareness of conservation strategies for protecting natural resources, wildlife, and ecosystems.

Regarding Phytogeography

By the end of the course, students will be able to:

CO1: Explain the meaning, scope, and importance of phytogeography in plant sciences;

CO2: Describe global patterns of plant distribution; identify major phytogeographical regions of the world;

CO3: explain migration routes and dispersal mechanisms; understand concepts of endemism; apply phytogeographical knowledge in biodiversity conservation; identify biodiversity hotspots and conservation priorities; Understand the relevance of phytogeography in climate change studies.

BOTC457X0 (DSC): Research Methodology and Ethics:

By the end of the course, students will be able to-

CO1: Understanding Research Fundamentals;

CO2: Formulating Research Problems;

CO3: Designing Research Studies;

Co4: Data Collection and Analysis;

CO5: Understanding Research Ethics;

CO6: Academic Writing and Reporting;

CO7: Application of Research Skills.

BOTC458X9 (DSCP):

By the end of the course, students will be able to:

CO1: Identify and classify plants using standard taxonomic keys and diagnostic morphological characters following systems such as those of George Bentham & Joseph Dalton Hooker.

CO2: Apply principles of plant nomenclature in accordance with the rules of the ICN for correct scientific naming and citation.

CO3: Construct and use dichotomous keys for identification of unknown plant specimens.

CO4: Prepare and maintain herbarium specimens following standard herbarium techniques and documentation procedures.

CO5: Interpret phylogenetic relationships using morphological and basic molecular data in modern classification systems such as the Angiosperm Phylogeny Group (APG system).

CO6: Conduct field surveys and collect plant specimens ethically, recording ecological and geographical data.

CO7: Utilize taxonomic literature, floras, and digital databases for plant identification and verification.

BOTC459X9 (DSCP): Course outcomes of the practical aspects of studying Palaeobotany, Palynology and Plant Reproductive Ecology are:

CO1: Students will be able to identify and classify Fossil Plants;

CO2: Recognize major fossil plant groups such as Pteridophytes, Gymnosperms, and Angiosperms based on morphological features;

CO3: Distinguish between different types of plant fossils (impressions, compressions, casts, permineralizations);

CO4: Students will get an overview of the plant megafossils of the geologic past.;

CO4: They will learn the stratigraphic sequences of the fossiliferous beds, nature of preservation and area of occurrence;

CO5: In palynology and plant reproductive biology section, students will get a detail knowledge regarding pollen morphological features, their viability and germination (in-vitro and in-vivo);

CO6: Students will learn how pollen grains can be separated and identified from honey samples with respect to foraging behaviour of bee species;

CO7: Apply knowledge of pollination biology in crop improvement, horticulture, and sustainable ecosystem management.

BOTC460X9 (DSCP):

By the end of this course, students will be able to:

CO1: Demonstrate skills in field sampling techniques for studying populations, communities, and ecosystems (e.g., quadrat, transect, capture–recapture methods);

CO2: Identify and classify local flora and fauna using standard ecological keys and field guides;

CO3: Measure and analyze abiotic factors such as soil composition, temperature, humidity, light intensity, pH, and water quality parameters;

CO4: Conduct biodiversity assessments and calculate ecological indices (Shannon–Wiener index, Simpson’s index, species richness, and evenness);

CO7: Assess environmental impacts and interpret ecological data for conservation and management planning.

CO8: Prepare scientific field reports following standard ecological documentation and data presentation methods.

Semester III

Paper: BOTC502XO (DSC):

After successful completion of the course, students will be able to:

CO1: Understand the fundamental concepts of cell structure and organization.

CO2: Describe the cell cycle, its regulation, and the mechanisms of cell division including mitosis and meiosis.

CO3: Comprehend the principles of classical genetics, including Mendelian laws, gene interactions, linkage, and crossing over.

CO4: Understand the molecular basis of heredity, including DNA structure, replication, transcription, and translation.

CO5: Explain gene regulation mechanisms in both prokaryotes and eukaryotes.

CO6: Apply knowledge of genetics to modern techniques such as genetic engineering, recombinant DNA technology, and genomics.

CO7: Interpret experimental data related to cytology and genetics, and develop critical

Paper: BOTC503XO (SEC):

After successful completion of the course, students will be able to:

CO1: Understand fundamental concepts of Biotechnology, including genetic engineering and molecular tools.

CO2: Explain techniques such as DNA isolation, PCR, gel electrophoresis, and gene cloning.

CO3: Apply principles of Genetic Engineering in crop improvement and medicine.

CO4: Analyze applications of plant, animal, and microbial biotechnology in agriculture and industry.

CO5: Evaluate ethical, legal, and biosafety issues related to biotechnology.

CO6: Develop basic laboratory skills relevant to molecular biology experiments.

CO7: Understand principles and methods of sexual and asexual propagation in plants.

CO8: Differentiate between natural and artificial propagation techniques (cutting, layering, grafting, budding).

CO9: Apply propagation methods for conservation and mass multiplication of economically important plants.

CO10: Analyze factors affecting seed germination and vegetative propagation.

CO11: Demonstrate practical skills in nursery-based plant propagation techniques.

CO12: Understand the role of propagation in horticulture and sustainable agriculture.

Paper: BOTC504XO (DSC):

After successful completion of the course, students will be able to:

CO1. Explain the fundamental principles of plant physiology, including cell structure, water relations, and transport mechanisms.

CO2. Analyze the mechanisms of mineral nutrition, ion uptake, and nutrient assimilation in plants.

CO3. Critically evaluate the biochemical and physiological processes of photosynthesis, including light reactions and carbon fixation pathways.

CO4. Interpret the processes of respiration and energy metabolism, including glycolysis,TCA cycle, and oxidative phosphorylation.

CO5. Evaluate the role and mechanism of plant growth regulators in controlling growth, development, and differentiation.

CO6. Assess plant physiological responses to abiotic and biotic stresses and their metabolic adaptations.

CO7. Integrate knowledge of physiological and metabolic pathways to explain plant productivity and efficiency.

Paper BOTC505X0 (DSC):

After successful completion of the course, students will be able to:

CO1. Explain the structure, properties, and functions of major biomolecules including carbohydrates, proteins, lipids, and nucleic acids.

CO2. Analyze enzyme structure, kinetics, mechanisms of action, and regulatory processes in biological systems.

CO3. Interpret the major metabolic pathways such as glycolysis, TCA cycle, oxidative phosphorylation, and lipid and amino acid metabolism.

CO4. Evaluate the integration and regulation of metabolic pathways under different physiological conditions.

CO5. Examine the biosynthesis and breakdown of primary metabolites such as carbohydrates, proteins, and lipids.

CO6. Analyze secondary metabolism pathways and their roles in plant defense and adaptation.

CO7. Evaluate modern molecular biology techniques (e.g., PCR, cloning, electrophoresis, sequencing) and their applications in research and biotechnology.

Paper BOTC508X9 (DSCP):

After successful completion of the course, students will be able to:

CO1. Demonstrate proficiency in basic laboratory techniques related to plant physiology, biochemistry, and molecular biology.

CO2. Perform experiments to analyze plant water relations, transpiration, photosynthesis, and respiration.

CO3. Quantitatively estimate biomolecules such as carbohydrates, proteins, lipids, pigments, and nucleic acids using standard biochemical assays.

CO4. Analyze enzyme activity, kinetics, and inhibition using appropriate experimental methods.

CO5. Isolate and purify biomolecules including DNA, RNA, and proteins from plant samples.

CO6. Apply molecular biology techniques such as PCR, gel electrophoresis, and blotting for analysis of nucleic acids and proteins.

CO7. Utilize laboratory instruments (e.g., spectrophotometer, centrifuge, electrophoresis units) effectively and safely.

CO8. Record, analyze, and interpret experimental data using statistical and graphical methods.

Paper BOTE555G0 (DSE):

After successful completion of the specialization, students will be able to:

CO1. Demonstrate advanced understanding of plant physiological processes and their biochemical and molecular bases.

CO2. Critically analyze complex metabolic pathways and their regulation under normal and stress conditions.

CO3. Integrate concepts of plant physiology, biochemistry, and molecular biology to explain growth, development, and adaptation mechanisms.

CO4. Apply advanced molecular biology and biochemical techniques for investigation of plant systems.

CO5. Design and execute independent research experiments in areas related to plant physiology and molecular biology.

CO6. Interpret and critically evaluate high-throughput data from genomics, transcriptomics, proteomics, and metabolomics studies.

CO7. Develop and test scientific hypotheses related to plant function, productivity, and stress tolerance.

BOTE506A0 (DSE):

After successful completion of this course, students will be able to:

CO1: Understand principles of plant taxonomy

CO2: Interpret and apply the guidelines of the International Code of Nomenclature (ICN) for naming angiosperms correctly.

CO3: Recognize classification systems

CO4: Identify angiosperm families

CO5: Use taxonomic tools and techniques

CO6: Understand phylogenetic relationships

CO8: Apply taxonomy in real-world contexts

CO9: Interpret modern taxonomic approaches

BOTE506B0 (DSE):

After successful completion of this course, students will be able to:

CO1: Analyze the structure and function of Spindle Pole Bodies (SPBs) to understand how these microtubule-organizing centers drive unique fungal cell division.

CO2: Evaluate the process of Heterokaryosis, including its formation and significance.

CO3: Distinguish between exogenous and endogenous spore dormancy to understand the physiological and environmental triggers that allow fungi to survive unfavorable conditions.

CO4: Assessment of the multifaceted roles of fungi in nutrient recycling, soil formation, as biocontrol agents or biofertilizers through processes like phosphate solubilization, siderophore production, etc.

CO5: Explain the application of fungi in the food industry.

CO6: Gain knowledge of how fungi are utilized as "cell factories" for the large-scale production of organic acids.

CO7: Identify and describe the fungal origins and mechanisms of life-saving antibiotics and immune suppressants.

BOTE506C0 (DSE):

After successful completion of this course, students will be able to:

CO1: Understand the fundamental concepts of cytogenetics.

CO2: Explain chromosomal variations such as numerical and structural aberrations.

CO4: Demonstrate knowledge of karyotyping, ideogram construction, and chromosome banding techniques.

CO5: Understand the principles and applications of molecular cytogenetic techniques

CO6: Evaluate recent advances in cytogenetics and their integration with genomics and biotechnology.

CO7: Enhance analytical and research-oriented thinking for solving cytogenetic problems.

BOTE506D0 (DSE):

After successful completion of the course, students will be able to:

CO1: Understand fundamental concepts of ecology and ecological principles, explain interactions between organisms and their environment.

CO2: Analyze population dynamics and demographic characteristics, evaluate community structure, species interactions and ecological succession.

CO3: Describe ecosystem structure and function, including energy flow, food chains, food webs, ecological pyramids, and productivity.

CO4: Understand biogeochemical cycles (carbon, nitrogen, phosphorus, water cycles) and their ecological significance.

CO5: Assess biodiversity, its importance, threats, and conservation strategies at local, regional, and global levels.

CO6: Evaluate environmental issues such as climate change, pollution, habitat loss, and their ecological impacts.

CO7: Apply ecological knowledge to sustainable resource management and environmental conservation practices.

BOTE506E0 (DSE):

After successful completion of this course, students will be able to:

CO1: Know about microbial world, their metabolism, growth etc.

CO2: Idea on mode of action of antibiotics, gene manipulation in microbial system will also be discussed in this course.

BOTE506F0 (DSE):

Students will be able to learn

CO1: Different aspects of plant fossils viz. types, preservation, age and area of occurrence, stratigraphic sequences, palaeoecology.

CO2: A thorough knowledge regarding Indian Gondwana will be known to them.

CO3: They will also learn the diversification of plant life forms through different ages.

Paper BOTE506G0 (DSE):

After successful completion of the course, students will be able to:

CO1. Critically explain fundamental concepts of plant physiology including water relations, mineral nutrition, and plant growth regulation.

CO2. Analyze physiological processes such as photosynthesis, respiration, translocation, and signal transduction pathways in plants.

CO3. Interpret biochemical pathways involved in primary and secondary metabolism, including enzyme kinetics and regulation.

CO4. Evaluate the structure and function of biomolecules such as carbohydrates, proteins, lipids, and nucleic acids in plant systems.

BOTC507X9 (DSEP):

CO1: Demonstrate proficiency in basic laboratory techniques in genetics, including microscopy, staining, and analysis of genetic materials.
CO2: Apply fundamental techniques of biotechnology such as DNA isolation, gel electrophoresis, and basic molecular analysis.
CO3: Develop skills in aseptic techniques and in vitro culture methods for plant tissue culture.
CO4: Execute different methods of plant propagation, including vegetative propagation and micropropagation.

CO5: Understand biosafety, laboratory ethics, and proper handling of biological materials.

Paper BOTC508X9 (DSCP):

After successful completion of the course, students will be able to:

CO1. Demonstrate proficiency in basic laboratory techniques related to plant physiology, biochemistry, and molecular biology.

CO2. Perform experiments to analyze plant water relations, transpiration, photosynthesis, and respiration.

CO3. Quantitatively estimate biomolecules such as carbohydrates, proteins, lipids, pigments, and nucleic acids using standard biochemical assays.

CO4. Analyze enzyme activity, kinetics, and inhibition using appropriate experimental methods.

CO5. Isolate and purify biomolecules including DNA, RNA, and proteins from plant samples.

CO6. Apply molecular biology techniques such as PCR, gel electrophoresis, and blotting for analysis of nucleic acids and proteins.

CO7. Utilize laboratory instruments (e.g., spectrophotometer, centrifuge, electrophoresis units) effectively and safely.

CO8. Record, analyze, and interpret experimental data using statistical and graphical methods.

BOTE509A9 (DSEP):

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

CO1: Identify and classify angiosperms.

CO2: Perform plant specimen collection and herbarium techniques.

CO3: Use field and laboratory tools effectively for taxonomic studies.

CO4: Develop skills in plant documentation, including field notes, digital records, and photographic evidence.

BOTE509B9 (DSEP):

After successful completion of this course, students will be able to:

CO1: Assessing Plant Growth Promoting (PGP) Traits
CO2: Taxonomic Identification
CO3: Media Preparation & Cultivation
CO4: Sterilization Techniques
CO5: Selective Isolation
CO6: Environmental Sampling

CO7: Microbial Analysis

BOTE509C9 (DSEP):

Upon completion of the practical course in Cytogenetics, students will be able to:

CO1: Prepare and analyze chromosome slides using standard cytological techniques.

CO2: Determine chromosome number and morphology, including karyotype analysis and construction of ideograms.

CO3: Assess numerical chromosomal variations including aneuploidy and polyploidy, using cytological evidence.

CO4: Apply cytogenetic techniques in plant breeding, taxonomy, and evolutionary studies.

CO5: Handle and maintain laboratory equipment such as microscopes, slides, and staining reagents with precision and safety.

BOTE509D9 (DSEP):

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

CO1. Apply ecological sampling techniques for the study of vegetation

CO2: Analyze population characteristics such as density, frequency, abundance, and distribution patterns.

CO3: Evaluate community structure using ecological indices (e.g., species diversity, richness, evenness).

CO4: Identify plant adaptations in relation to different ecological habitats (xerophytes, hydrophytes, mesophytes).

CO5: Conduct ecological data analysis using basic statistical tools and graphical representation.

CO6: Prepare field reports with proper scientific documentation, interpretation, and presentation of ecological data.

BOTE509E9 (DSEP):

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

CO1: Demonstrate aseptic techniques for handling microbial cultures to prevent contamination and ensure laboratory safety.

CO2: Prepare and sterilize culture media.

CO3: Isolate and culture microorganisms from diverse environmental samples

CO4: Identify microorganisms based on morphological, cultural, and basic biochemical characteristics.

CO5: Conduct microbial enumeration techniques, including serial dilution and colony counting methods.

BOTE509F9 (DSEP):

Upon completion of the practical course in Palaeobotany, students will be able to:

CO1: Understand fossilization processes and recognize different types of plant fossils such as impressions, compressions, petrifactions, and casts.

CO2: Prepare and examine fossil slides and specimens using standard laboratory techniques.

CO3: Interpret geological time scales and correlate fossil records with major plant evolutionary events.

CO4: Document and illustrate fossil specimens through scientific drawing and photography.

CO5: Develop skills in field collection and preservation of fossil plant materials.

BOTE509G9 (DSEP):

Upon completion of the practical course in Plant Physiology, students will be able to:

CO1: Demonstrate proficiency in handling laboratory instruments and executing standard physiological experiments with accuracy and safety.

CO2: Estimate and analyze key physiological parameters such as photosynthetic rate, transpiration rate, respiration, and enzyme activity using appropriate experimental techniques.

CO3: Perform quantitative estimation of biomolecules such as chlorophyll, carbohydrates, proteins, and enzymes using standard biochemical methods.

CO4: Interpret physiological responses of plants under varying environmental conditions such as light, temperature, and water stress.

BOTC510X9 (DSEP):

Upon completion of the internship, students will be:

CO1: Skilled on specific area which is helpful for entrepreneurship/start-up development

Semester IV

BOTC551X0 (DSC):

CO1: Students will get basic ideas on the subject forestry.

CO2: Silviculture system of different forest plants their measurement process will help them to understand about the economic aspects of forest plants.

CO3: How different factors influences nature of forest will also discussed in this course.

BOTC552X0 (DSC):

Upon completion of the course students will be able to:

CO1: Analyze Biological Data by applying statistical techniques.
CO2: Integrate Interdisciplinary Knowledge.
CO3: Enhance Problem-Solving Skills.
CO4: Interpret Scientific Results.
CO6: Develop the ability to apply biomathematical approaches in advanced studies and research in life sciences.
CO7: Explain the working principles, components, and applications of commonly used biological instruments.
CO8: Demonstrate proficiency in handling and operating instruments such as microscopes, spectrophotometers, centrifuges, pH meters, and electrophoresis units.
CO9: Utilize instrumentation techniques for qualitative and quantitative analysis of biological samples.
CO10: Follow standard laboratory safety protocols and ethical practices while using biological instruments.

BOTC553X0 (DSC):

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

CO1: Identify Plant Tissues and Systems and about the way plants are constructed

CO2: Understand about trichomes, stomata, cuticular patterns, wood anatomy etc. to aid in species identification.

CO3: Understand Principles of Pharmacognosy

CO4: Identify Crude Drugs

CO5: Correlate Anatomy with Drug Yield

CO6: Apply Knowledge in Applied Contexts

BOTC554X0 (DSC):

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

CO1: Explain the fundamental principles and scope of omics sciences, including genomics, transcriptomics, proteomics, metabolomics, and related integrative approaches.

CO2: Describe advanced technologies used in omics studies such as next-generation sequencing, microarrays, mass spectrometry, and bioinformatics platforms.

CO3: Integrate data from different omics levels to understand complex biological systems, gene regulation, metabolic pathways, and cellular networks.

CO4: Apply omics approaches in diverse fields such as agriculture, medicine, environmental science, and biotechnology for problem-solving and innovation.

CO5: Design omics-based experiments, including sample preparation, data acquisition, and validation strategies.

BOTE555A0 (DSE):

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

CO1: Understand fundamental concepts of molecular systematics, including molecular evolution, genetic variation, and phylogenetic relationships.

CO2: Explain the principles and applications of molecular markers such as DNA, RNA, and protein sequences in taxonomic classification.

CO3: Apply molecular techniques (e.g., PCR, DNA sequencing, gel electrophoresis) for the analysis of genetic diversity and systematics.

CO4: Interpret phylogenetic trees and evaluate evolutionary relationships using molecular data.

CO5: Assess the role of molecular systematics in biodiversity conservation, species identification, and evolutionary studies.

CO6: Critically evaluate scientific literature related to molecular taxonomy and systematics.

BOTE555B0 (DSE):

Upon completion of the course, students will be able to:

CO1: Understand fundamental concepts of plant pathology, including the nature, classification, and significance of plant diseases.

CO2: Identify causal agents such as fungi, bacteria, viruses, nematodes, and other pathogens affecting economically important crops.

CO3: Explain disease development mechanisms, including host–pathogen interactions, infection processes, and disease cycles.

CO4: Evaluate plant defense mechanisms, including structural and biochemical responses to pathogen attack.

BOTE555C0 (DSE):

Upon completion of the course, students will be able to:

CO1: Explain fundamental concepts of molecular biology, including DNA replication, transcription, translation, and gene regulation in prokaryotic and eukaryotic systems.
CO2: Understand the structure and function of biomolecules, particularly nucleic acids and proteins, and their role in cellular processes.
CO3: Apply molecular techniques such as PCR, gel electrophoresis, blotting methods, and DNA sequencing for analysis of genetic material.
CO4: Explain principles of biotechnology and their applications in agriculture, medicine, industry, and environmental management.
CO5: Analyze and solve problems related to molecular biology and biotechnology through critical thinking and scientific reasoning.

BOTE555D0 (DSE):

Upon completion of the course, students will be able to:

CO1: Explain the concept, levels (genetic, species, and ecosystem), and significance of biodiversity in maintaining ecological balance.
CO2: Assess Patterns of Biodiversity.
CO3: Evaluate Threats to Biodiversity such as habitat loss, climate change, pollution, invasive species, and overexploitation.
CO4: Understand Conservation Strategies.
CO5: Interpret Environmental Policies and Laws.
CO6: Recognize Socio-economic Importance.

BOTE555E0 (DSE):
This course will help the students to know:

CO1: Different topics on applied microbiology.
CO2: Food, industrial, agricultural, medical microbiology will be discussed in this course.
CO3: Basic idea on bioinformatics will be given to the candidates.

BOTE555F0 (DSE):

Upon completion of the course, Students will be able to learn

CO1: The role of palynology in oil exploration, sources of natural fuels, formation of coal and its varieties, coal palynology.
CO2: the structural and functional aspects of flower i.e. essential flower morphology, flowering phenology, flower types, different pollinator groups of flowers, floral advertisement and Floral rewards, breeding system of the flowers.
CO3: Several aspects of pollination biology and pollen-pistil interactions.

BOTE555G0 (DSE):

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

CO1: Understand biomolecular dtructure and function.

CO2: Comprehend enzyme mechanisms.

CO3: Analyze metabolic pathways such as glycolysis, TCA cycle, oxidative phosphorylation, and lipid and amino acid metabolism.

CO4: Explain molecular basis of genetic information; elucidate DNA replication, transcription, translation, and regulation of gene expression in prokaryotic and eukaryotic systems.

CO5: Interpret cellular signalling and regulation, understand cell signalling pathways, molecular interactions, and regulatory mechanisms governing cellular functions.

BOTC556X9 (DSCP):

CO1: Students will know how to survey of an area with plain table or prismatic compass.

CO2: They will also know how to determine height of a standing tree and how to calculate volume of a tree.

BOTC557X9 (DSCP):

Upon successful completion of the practical course, students will be able to:

CO1: Differentiate tissue systems and interpret their structural organization.

CO2: Identify diagnostic anatomical characters useful in the classification and authentication of plant materials.

CO3: Perform microscopic analysis of crude drugs and recognize cellular structures such as trichomes, stomata, fibers, vessels, and crystals.

CO4: Apply powder analysis techniques for the identification and detection of adulterants in herbal drugs.

CO5: Conduct organoleptic evaluation (colour, odour, taste, texture) of crude drugs for preliminary identification.

BOTE558A9 (DSEP):

Upon successful completion of this practical course, students will be able to:

CO1: Apply molecular marker techniques (e.g., RAPD, RFLP, SSR, AFLP) for genetic characterization and diversity analysis.

CO2: Carry out agarose gel electrophoresis and interpret banding patterns for molecular data analysis.

CO3: Understand and perform DNA sequencing procedures and evaluate sequence quality.

CO4: Construct and interpret phylogenetic trees using molecular data and appropriate software.

BOTE558B9 (DSEP):

Upon successful completion of the practical course, students will be able to Learn:

CO1: Fungicide Evaluation technique.
CO2: Inoculation & Subculturing.
CO3: Biochemical Testing.
CO4: Microscopic Evaluation.
CO5: Mycorrhizal Studies.

BOTE558C9 (DSEP):

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

CO1: Isolatate DNA and RNA through spectrophotometric estimation.

CO2: Extract and quantitatively analyse protein.

CO3: Prepare Plant Tissue Culture media.

CO4: Experiment on callus culture and shoot tip culture.

CO5: Do Regression Analysis and Analysis of variance (One way ANOVA).

BOTE558D9 (DSEP):

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

CO1: Field identification skills.

CO2: Biodiversity assessment methods.

CO3: Ecological interpretation.

CO4: Documentation and reporting.

BOTE558E9 (DSEP):

Upon successful completion of the practical course, students will be able to:

CO1: Know how to culture, characterize and identify a microorganism.

CO2: Know process for characterization of different microbial metabolites.

CO3: Know how to isolate genetic materials, enzyme etc. from a cell.

CO4: Know how to prepare phylogenetic trees using different bioinformatics tools.

BOTE558F9 (DSEP):

Upon successful completion of the practical course, students will be able to:

CO1: Analyze pollen morphology for taxonomic and systematic studies, aiding in the identification of plant taxa.
CO2: Apply quantitative methods in palynology, including pollen counting, frequency analysis, and construction of pollen diagrams.
CO3: Learn different palynological techniques especially identification and characterization of pollen morphological features from honey samples, soil samples and rock samples of geologic past.
CO4: Learn techniques related to pollination ecology of plants viz. pollen viability, stigma receptivity, *in-vivo* and *in-vitro* pollen germination etc.
CO5: Identify reproductive structures and strategies such as characterize floral morphology, breeding systems, and reproductive adaptations in diverse plant groups.
CO6: Conduct field-based pollination studies
CO7: Analyze breeding systems i.e., determine self-compatibility, cross-compatibility, and modes of reproduction through controlled pollination experiments.

BOTE558G9 (DSEP):

Upon successful completion of the practical course, students will be able to:

CO1: Estimate quantitatively ascorbic acid in plant tissue, proline in salt-stressed leaf-tissues

CO2: Evaluate seed viability.

CO3: Demonstrate Activity of ATPases in green plant material.

CO4: Separate amino acids by paper chromatographic technique.

CO5: Extract and estimate nucleic acids, enzyme catalase and amylase from plant samples.

CO6: Separate phenolic compounds by thin layer chromatography.

CO7: Purify protein by SDS-PAGE.

BOTE559X9 (DSEP):

CO1: During their M.Sc. dissertation/project work students will be able to know the different aspects of a research work in nutshell.

CO2: Besides experimental works, learners will learn how to write a M.Sc. thesis starting from introduction (including literature review), objectives of the work through material & methods, results, discussion, conclusion and lastly references.

CO3: Therefore, students those who want to undertake research work in future, get training through this course.

BOTC560X9 (DSCP):

After successful completion of this course, students will be able to:

CO1: Identify plant species in natural habitats using morphological and taxonomic characters.
CO2: Conduct systematic field surveys and prepare field notes, herbarium specimens, and photographic records.
CO3: Assess plant diversity across different ecosystems (forests, wetlands, grasslands, agroecosystems).
CO4: Analyze species distribution, abundance, and ecological interactions in the field. CO5: Document ethnobotanical knowledge through interaction with local communities, including uses of medicinal, aromatic, and economic plants.
CO5: Evaluate threats to plant biodiversity such as habitat loss, invasive species, and climate change.
CO6: Communicate scientific knowledge to local communities through awareness programmes, workshops, and campaigns.
CO7: Promote environmental education, conservation ethics, and sustainable practices among stakeholders.
CO8: Develop field-based skills including observation, sampling, mapping, and reporting.
CO9: Prepare detailed field reports, survey documentation, and outreach reports.

SEMESTER I

THEORY

BOTC401X0 (DSC): MICROBIOLOGY AND VIROLOGY **Marks: 50**

1. History, discoveries and contributions; Six Kingdoms hypothesis (Woese *et al*.1977) & Three Domains concept (Woese *et al*. 1990); scopes and areas of microbiology.
2. Principle characteristics used in the classification and identification of microbes, Bergey's manual of determinative bacteriology.
3. Morphology, ultrastructure & chemical nature of capsule; cell wall, flagella, pili, genome, and cytoskeletal elements of bacterial cell; principle of gram staining; reserve substances; endospore.
4. Nutrition of microbes; principles behind formulation of media; enrichment culture technique; anaerobic culture principles.
5. Methods of sterilization; dry and moist heat; UV and X-ray; Food sterilization.
6. Growth curve; mathematical nature and expression of growth; exponential and arithmetic growth; generation time; growth curve parameters-yield; synchronous cyclic batch culture & continues growth.
7. Microbial metabolism; respiration and fermentation, fermentation pathway (ED pathway etc.); nitrification; sulfur oxidation; nitrogen fixation.
8. Bacterial Genetics: Organization and replication of genetic material in bacteria; Conjugation: molecular mechanism of gene transfer and regulation, conjugation mapping; Plasmids: types, function and application; Transformation: natural transformation and competence, molecular mechanism of transformation; Transduction: generalized and specialized transduction, gene-mapping.
9. Gene regulation: positive and negative gene regulation and attenuation, *lac, gal, trp*, and *ara*-operons and their applications. Genetic switches. Quorum sensing. CRISPR-CAS evolutionary significance in bacterial innate immunity, mode of action and application.
10. Chemotherapy: physical and chemical methods; principles of chemotherapy, general mode of action of various chemotherapeutic agents, sulfa drugs; antibiotics: classification and mode of action, antibiotic resistance; vaccines and antivirals.
11. Applied microbiology: biological nitrogen fixation – symbiotic and nonsymbiotic; nitrogenase enzyme, leghemoglobin; microbial flora of air, Enumeration of aerial microbes: sampling methods; air-borne human diseases; microbial flora of water; Winogradsky column; Microbiological analysis of water: presumptive and confirmatory tests, water borne human diseases; production of alcohol, wine, beer.
11. Immunology: cells and organs of the immune system; lymphocytes, antigens, antibodies; immunoglobulin classes, structure of immunoglobulin G; polyclonal and monoclonal antibodies; interferon, vaccine; agglutination (Widal test, latex agglutination test, viral hemagglutination), Immunodiffusion

(SRID), ELISA, skin-prick test, immunoelectrophoresis, immunoprecipitation, RIA, Western Blotting, immunofluorescence.

12. Viruses: structural organization and chemistry of viruses; cultivation of viruses;
13. Virus purification and assays (hemagglutination and plaque assay); principles of viral taxonomy; replication of viral nucleic acids; One step growth curve; lytic and lysogenic cycle; early and late proteins.
14. Virus related agents – viroids and prions; virus-induced cancer. oncogenesis; antiviral drugs.
15. Human virus: HIV, SARS, HCV, Influenza genome organization, structure and replication.
16. Plant viruses: tobacco mosaic virus genome organization, structure and replication.

BOTC402X0 (DSC): ALGAL SCIENCE **Marks: 25**

1. Parameters used in classifying algae: classification and recent status of various algal groups; concept of Streptophyta.
2. Significance of ultra-structural features of algae.
3. Endosymbiotic theory of origin of chloroplasts.
4. Salient features of Cyanoprokaryote, Glaucophyta, Rhodophyta, Chlorophyta, and Heterokontophyta (Xanthophyceae, Bacillariophyceae, Phaeophyceae) with evolutionary tendencies and phylogeny.
5. Phycocolloids - agar-agar, alginic acid, carrageenan, economic importance of phycocolloids.
6. Reclamation of soil by algae; algae as single cell protein.
7. Algae in pisciculture.
8. Hydrocarbons from algae.
9. Pheromone in algae; pathogenic algae.
10. Eutrophication, Algal bloom, Red tide; Bloom control measures.
11. Algal toxins and their impact.

BOTC403X0 (DSC): ADVANCED BRYOLOGY **Marks: 25**

1. Outline of the recent classification of bryophytes by Mishler *et al*. (1994): Marchantiophyta (liverworts), Anthocerophyta (hornworts), and Bryophyta (mosses) compare with Proskauer (1957) Traditional Classification Class I. Hepaticopsida Class II. Anthocerotopsida Class III. Bryopsida.
2. Origin, evolution, and fossil history of bryophytes. Characteristics, affinities and systematic position and phylogeny of Calobryales, and Takakiales.
3. Bryophyte as site indicators; bryomonitoring.
4. Cytogenetics of bryophytes: Sex chromosome.
5. Bryophytes biotechnology: Applications.

BOTC404X0 (DSC): FUNGAL BIOLOGY **Marks: 25**

1. Unique features of fungi. Any modern classification with characters up to phylum focusing on diversity of fungal groups.
2. Homothallism, heterothallism, physiological and molecular basis of mating systems, parasexuality.
3. Development and types of ascocarps and basidiocarps; mechanism of ascospore and basidiospore discharge.
4. Applied mycology. Use of fungi in antibiotics, organic acids and food production; role of fungi in biotechnology including vaccine production; role of fungi in agriculture and forestry.

BOTC405X0 (DSC): INDIAN KNOWLEDGE SYSTEM **Marks: 25**

1. Introduction to IKS:

   a. Definition and characteristics of Indian Knowledge System.
   b. Historical evolution of IKS from ancient times till date.
   c. Impact of colonial education policies and the need for revisiting traditional knowledge.
   d. Traditional educational institutions: Takshashila, and Nalanda.
   e. Local heritage sites and their relevance (Kanakdurga temple in Chilkigarh, Pathra, Karnogarh Temple of Rani Siromani, Tamralipta and adjoining areas).

2. History and present day Botany in India:

   f. Conventional botany with its current multidisciplinary application.
   g. Important Botanist, their research and contrition for the society (Charak, Sushrut, J.C. Bose, Janaki Ammal, Birbal Sahni, Har Govind Khorana, Ashima Chatterjee and Arun Sharma).

3. Knowledge framework and history of Indian Medical System:

   h. Ayurveda, Unani, Siddha and Sowa Rigpa.
   i. Five element theory – Panchamahabuta siddhanta.

4. Introduction to Ayurveda:

   j. In-depth study of Ayurveda, its diagnostic methods, and therapeutic practices.
   k. Understanding the holistic approach to health encompassing physical, mental, and spiritual well-being in the light of ayurvedic philosophy.
   l. Ayurvedic principles in contemporary healthcare systems.

5. Usage and conservation of medicinal plants and sacred groves:

   m. Medicinal plant wealth of India.
   n. Plants used in wellness – Neem, Bel, Tulsi, Haldi and Kalmegh.
   o. Idea about ethnobotany.
   p. Threatened medicinal plants of India.
   q. Conservation of medicinal plants – *in-situ* and *ex-situ*.
   r. Sacred grove and their role in conservation.

BOTC406X0 (DSC): VASCULAR CRYPTOGAMS **Marks: 25**

1. Introduction: Early land plants and their adaptation for successful colonization on land habitats.
2. Similarities and dissimilarities with bryophytes and gymnosperms.
3. Classification of pteridophytes based on molecular data by Smith *et al*. 2006.
4. Distribution of pteridphytes with special reference to India.
5. Endangered pteridophytes and their conservation.
6. Rhyniopsida: Characteristic features; important representatives and gametophytic structures.
7. Zosterophyllopsida: Characteristic features, representative taxa exhibiting morphological diversity of the group; potentiality of the group as a progenitor of Lycopsida.
8. Lycopsida: General features, Orders of Lycopsida with examples, evolutionary significance.
9. Trimerophytopsida: Characteristic features; diversity in vegetative structures; significance of the group in the evolution of higher clads of pteridophytes.
10. Filicopsida: Characteristic features, major clads of extinct and extant taxa of the group; phyletic slide and evolution of soral structures in the filicalian ferns.
11. Apospory and apogamy: Definition, factors for induction and significance.
12. Progymnosperms: Concept, characteristics, classification, origin and evolution.
13. Importance: Ecological and economic importance of pteridophytes with special reference to food, medicine, bio-fertilizer, metal indicator plants and beautification.

BOTC407X0 (DSC): GYMNOSPERMS **Marks: 25**

1. General features and classification of gymnosperm (Stewart and Rothwell 1993).
2. Origin of seed habit, pre-pollen and pre-ovule concept, origin of true ovule.
3. General features, geologic range and phylogeny of Pteridospermales, Glossopteridales, Pentoxylales, Caytoniales and Bennettitales.
4. General features, evolutionary trends of leaves and megasporophylls among extinct and extant members of Cycadales; geographic distribution of extant cycads.
5. Coniferales: Characteristic features, distribution pattern of modern conifers in India. Classification of conifers up to different families.
6. Gnetophytes: Characteristics, comparative accounts of three genera viz. *Gentum*, *Welwitschia* and *Ephedra*; present status of gnetophytes based on molecular phylogeny.
7. Economic importance of gymnosperms with reference to wood, resin, essential oils, drugs and food.
8. Endangered gymnosperms, their conservation and present status.

SEMESTER - I

PRACTICAL

BOTC408X9 (DSCP): MICROBIOLOGY **Marks: 25**

1. Methods of sterilization, idea about microbiological instruments and laboratory.
2. Negative staining technique.
3. Gram staining.
4. Study of curd-organisms.
5. Endospore staining.
6. Sterilization of media and glass goods, demonstration of antibiotic sensitivity assay.
7. Isolation of spore producing bacteria.
8. Inoculation techniques.
9. Visit to a place of microbiological interest (Pharmaceutical/ Milk/ Distillery/ Food etc.)

BOTC409X9 (DSCP): PHYCOLOGY & BRYOLOGY **Marks: 25**

PHYCOLOGY:

1. Study of vegetative structures of gametophytic and sporophytic plant bodies of the members from different algal taxa.
2. Study of reproductive and other perennating structures of different members of algae.
3. Study of live algal species from nature and their habitat.
4. Collection of algal species from natural sources. Submission of the list of collected species with photographs taken under microscope.

BRYOLOGY:

1. Comparative morphology and anatomy of the gametophytes and sporophytes of the different groups of bryophytes (6 Members from Marchantiophyta, 1 Member from Anthocerophyta and 5 Members from Bryophyta)
2. Study of peristome structures of Nematodonteae and Arthrodonteae of the Bryopsida
3. Field work [spot dominated with lower Cryptogams from inside or outside state)]
4. Students are required to submit field survey report and laboratory records, preserved and dried specimens and permanent slides.

BOTC410X9 (DSCP): MYCOLOGY & PLANT PATHOLOGY **Marks: 25**

1. Study of morphological characters and reproductive structures of some common fungal taxa.
2. Isolation of yeasts from some fruits.
3. Submission of fungal specimens.
4. Study of diseased specimens.
5. Isolation and simple culture of pathogens.
6. Study of black stem rust of wheat, red rot of sugarcane, downy mildew and powdery mildew of crop plants.

BOTC411X9 (DSCP): PTERIDOPHYTES & GYMNOSPERMS **Marks: 25**

PTERIDOPHYTES

1. A comparative study of the vegetative and reproductive parts of some extant pteridophytes occurring in West Bengal.
2. Study of some fossils (slide and mega-fossils).
3. Field work
4. Submission of field and laboratory records including permanent slides.

GYMNOSPERMS

1. A comparative study of the vegetative and reproductive parts of some extant gymnosperms.
2. Study of some fossil gymnosperms.
3. Fieldwork.
4. Submission of field and laboratory records including permanent slides.

BOTO412NC: Vidyasagar: Life and Philosophy **Marks: 25**

.

SEMESTER – II

THEORY

BOTC451X0 (DSC): PLANT TAXONOMY & SYSTEMATICS **Marks: 50**

1. Introduction: definition of the terms: systematics, taxonomy, classification, nomenclature, Identification; homology and homoplasy; plesiomorphy and apomorphy; monophyly, paraphyly and polyphyly; Flora, Vegetation, Monographs, Revision.
2. Classification: Outline concept of APG system of plant classification, concepts of palaeoherbs, eudicots.
3. Relationships: Takhtajan and Cronquist system of classification, salient features, evolutionary trends and phylogeny in Magnoliidae, Caryophyllidae, Rosideae, Asteridae, Alismatidae and Liliidae (sensu lato Cronquist, 1981).
4. Herbarium: traditional and digital Herbarium.
5. ICN: Principles of ICBN & ICN
6. Systematics: definition, principles, methods, categories and differences with classical taxonomy.
7. Taxonomic supportive evidences: Palynology & Phytochemistry.
8. Numerical taxonomy: phenetic and cladistic
9. Biodiversity: level, spatial scale, loss, importance, value.
10. Ethnobotany: definition, relevance and uses in human welfare.

BOTC452X0 (DSC): PALAEOBOTANY AND EARLY LIFE FORMS **Marks: 25**

1. Fossils: definition, types, nomenclature, modes of preservation (Schopf 1975),
2. Fossilization process – factors; techniques of fossil study: ground thin section, peel technique, peat analysis.
3. Principles of correlation and stratigraphy; outline of Standard Geologic time Scale.
4. Origin and evolution of early life forms recovered from Precambrian strata.
5. Major events of plant life through geologic history.
6. Indian Gondwana Sequence, Classification and distribution of the sequence; megafloristic assemblages in Gondwana Sequence with special reference to Damodar Valley basin, Son valley basin and Rajmahal basin.
7. Continental Drift Hypothesis and Plate Tectonics: Concept and validation.
8. Radiometric datings: basic principles of radiometric dating; radio-carbon dating.
9. Use of fossil plants in deciphering past vegetational and ecological history.

BOTC453X0 (DSC): POLLEN & POLLINATION ECOLOGY **Marks: 25**

1. Microspore tetrads and polarity of spores and pollen grains.
2. Spore-pollen morphology: symmetry, shape, size, aperture patterns, NPC system of pollen-spore classification, exine stratification, surface structures and sculptures of sporoderm; LO-analysis.

3. Sporopollenin: physical and chemical nature, function; development of pollen wall, Ubisch body, pollen wall proteins, chemical markers of exine and intine.
4. Extra-exinous wall material - perine, viscin-threads, pollen-kit.
5. Application of palynology in taxonomic and phylogenetic deductions.
6. Aeropalynology with reference to allergy: aerobiological sampling method and formation of airborne pollen/spore calendar (general idea). Mechanism of Type I hypersensitivity caused by pollen/spores allergens, identification of pollen allergens by *in-vivo* (SPT) and *in-vitro* (ELISA, Immuno-elctrophoresis, Western blotting) tests, allergenic pollen/spores of West Bengal.
7. Melissopalynology, Indian species of honey bees, importance of pollen grains as constituent of bee-bread, pollen-collecting mechanism of honey bees, analysis of pollen loads and honey samples in understanding bee forage, objectives of melissopalynological studies, important bee plants of West Bengal.
8. Palaeopalynology: Introductory idea about palaeopalynological remains, significance of palaeopalynology.
9. Forensic palynology: definition and significance, a few well-known case studies.
10. Pollination Biology: pollen dispersal units; pollination types, contrivances for cross-and self-pollination; pollen vectors, pollination modes and floral organization.
11. Breeding systems, self-incompatibility and compatibility control with reference to pollen-pistil interactions.

BOTC454X0 (DSC): Plant Pathology **Marks: 25**

1. History of plant pathology and its present status, plant disease, diagnosis, modern methods.
2. Host pathogen interaction - mechanism of penetration, role of growth regulators.
3. Control of plant diseases - exclusion, eradication.
4. Epidemiology and disease forecasting.
5. Important pathogens causing selected plant diseases: brown spot, bacterial blight and blast of rice, wilt of pigeon pea, anthracnose of jute, crown gall diseases, scab of potato, downy mildew and powdery mildew of crop plants, black stem rust and loose smut of wheat.

BOTC455X0 (DSC): ECOLOGY **Marks: 25**

1. Significance and scope of ecology: concept in ecology; deep ecology and shallow ecology.
2. Habitat and niche concept and differences: fundamental and realized niche; aspects of ecological niche, habitat niche, trophic niche and hypervolume niche; niche construction and niche differentiation with examples.
3. Ecosystem organization: structure and functions, ecological pyramids, food chains and food webs, primary production (methods of measurement, controlling factors); energy dynamics (trophic organization, energy flow via grazing and detritus chains, ecological efficiencies).

4. Community ecology: concept of community and continuum; mechanism of ecological succession and climax concept (facilitation, tolerance and inhibition models); changes in ecosystem properties during succession.
5. Plant adaptations, Hydrophytes, Xerophytes and Halophytes: morphological, anatomical, physiological and biochemical.
6. Population concepts: population growth, population regulation, r and k selection, population interactions.

BOTC456X0 (DSC): ENVIRONMENTAL BIOLOGY AND PHYTOGEOGRAPHY Marks: 25

1. Interrelationship between the living world and the environment: Basic concept on hydrosphere, lithosphere and atmosphere.
2. Biodiversity(level, spatial scale, loss and importance) and conservation (*in-situ* and *ex-situ);* CBD and Ramsar sites– concept.
3. Impact of human activities: greenhouse effect and global warming; ozone depletion; acid rain, classical and photochemical smog, deforestation.
4. Environmental pollution: pollution of air, water and soil: sources, impact, prevention and control measure.
5. Biological control: biomonitoring of air and water pollution, bio-indicators, bio-remediation.
6. Environmental movements in India: Silent valley, Chipko movement, Beej bachao andolan, Narmada dam movement, debates on *Eucalyptus*.
7. Carrying capacity, sustainable development and environmental impact assessment.
8. Earth summits, central pollution control board, state pollution control board: general idea.
9. Biodiversity in relation with phytogeography: introduction, continuous and discontinuous distribution, phytogeography of India, vegetational regions of India, plant indicators.

BOTC457X0 (DSC): RESEARCH METHODOLOGY & ETHICS Marks: 25

1. Definition of research.
2. Types of research – descriptive vs. analytical, conceptual vs. empirical, applied vs. fundamental, quantitative vs. qualitative.
3. Need of conducting research and setting of objectives of research.
4. Benefits of conducting research.
5. Definition of research methodology and methods. Difference between research methodology and methods and their interdependence.
6. Research process (research methodology) – (a) Formulating research problem, (b) Literature review, (c) Setting of working hypothesis, (d) Preparing the research design, (e) Determination of sample design, (f) Collection of data, (g) Execution of research work, (h) Analysis of data, (i) Hypothesis testing, (j) Interpretation of the finding, (k) Drafting the research report.
7. Research methods – (a) Survey and (b) Experimental uses of primary data and secondary data, (c) Uses of instruments and other appliances.
8. Criteria of good research.
9. Motivations to conducting research.
10. Ethics followed to conducting research. Plagiarism – different kinds of it and check.

11. Measuring the standard of conducted research – impact factor of publication, H- index to determining the standard of the journal or any other literacy supplement.
12. Need of the use of statistics.
13. Elements of research paper and Ph.D. thesis; ethics followed during preparation of research papers and PhD thesis.
14. Reference citing in text and at the end of publication - different types.

SEMESTER – II

PRACTICAL

BOTC458X9 (DSCP): ANGIOSPERM TAXONOMY & BIOSYSTEMATICS **Marks: 25**

1. Drawing and description of a specimen from locally available representative families, identification up to species.
2. Comparative study of the pollen grains, fruit and seed morphology.
3. Field survey for familiarization with and study of vegetation types and floras of areas outside the state (long excursion) and inside the state (local excursion).
4. Training in collection and preservation, submission of field and laboratory records.

BOTC459X9 (DSCP): PALAEOBOTANY, PALYNOLOGY & POLLINATION ECOLOGY

Marks: 25

Palaeobotany

1. Palaeobotanical field work.
2. Study of representative megafloral assemblages and determination of age.

(Submission of field and laboratory records including permanent slides)

Palynology & Pollination Ecology

1. Pollen morphological studies of some pteridophytes, gymnosperms and angiosperms representing different morphological types using acetolysis / alkali maceration method.
2. Extraction of pollen grains from honey sample and study of the frequency of different morphotypes.
3. Study of *in-vivo* and *in-vitro* germination of pollen grains.
4. Morpho-anatomical study of stigma and style.
5. Study of the growth of pollen tube through stigma and style.
6. Studies of autogamous, geitonogamous and xenogamous pollination.

(Submission of laboratory records including permanent slides)

BOTC460X9 (DSCP): Ecology, Environmental Biology & Phytogeography Marks: 25

1. Study of Raunkier's life forms and biological spectrum.
2. Study of frequency, abundance and density, IVI of plants following standard method.
3. Measurement of various indices using statistical tools.
4. Ecological study on plant adaptation.
5. Ecological field study (excursion) of a given area and preparation of records.
6. Laboratory note book.

SEMESTER – III

THEORY

BOTO501X0 (DSE): MOOC Marks: 100 (70 + 30)

BOTC502X0 (DSC): GENETICS AND CELL BIOLOGY Marks: 25

1. Ultra-structure of nucleus, nucleolus, chromatin – euchromatin and heterochromatin.
2. Cell cycle**:** Molecular mechanism of cell cycle regulation.
3. Molecular organization of chromosome**:** DNA packaging in chromatin and chromosome. Ultrastructure of special chromosomes; centromere & telomere: ultrastructure and their functions.
4. Chromosome banding**:** G banding, Fluorescent banding, R banding, C banding, NOR banding. FISH, GISH.
5. Extranuclear inheritance**:** Definition, types.
6. Sex determination**:** Basic types, Lyon hypothesis, dosage compensation - types, Barr body, sex linked inheritance, sex influenced and sex limited characters.
7. Polygenes and Quantitative genetics.
8. Population genetics**:** Hardy-Weinberg Hypothesis, factors affecting allelic frequency in population. Genetic drift, inbreeding depression.
9. Transposable elements**:** Definition, transposon and retroposon; characteristic features of IS elements, Ac/Ds element and Copia element.
10. Structural conformations of DNA (A, B and Z), major types of RNA. biogenesis of ribosomes.
11. DNA replication (outline procedure only), requisite factors and their roles.

BOTC503XO (SEC): BIOTECHNOLOGY, PLANT PROPAGATION AND NURSERY TECHNIQUES **Marks: 25**

1. Recombinant DNA technology**:** An overview. structure and properties of plasmids, cosmids, phagemids; Bacterial Artificial Chromosomes (BACs); Yeast Artificial Chromosomes (YACs); plasmid isolation; restriction enzymes.
2. Cloning strategies and screening of recombinant clones; lac operon; blue/white selection; purification and characterization of recombinant plasmid DNA; expression vector; applications of recombinant DNA in agriculture and medicine (some examples).
3. Gene library**:** Construction of cDNA library and genomic library; screening of libraries.
4. Generation of radiolabeled probe and blotting techniques; Southern and Northern hybridization; RFLP, RAPD, AFLP, DNA finger printing, chromosome walking, chromosome jumping, microarray - PCR, RT-PCR; DNA sequencing methods.
5. Plant breeding: Plant introduction, pure line selection, back cross, pedigree selection, mass selection and clonal selection (Procedures); heterosis; transgenic inheritance; composite and synthetic varieties.
6. Plant tissue culture: Basic requisites, MS and White's media; Roles of nutritional inputs: principle, procedure and utility of callus culture; organogenesis, micropropagation and protoplast culture.
7. Plant Nursery: Definition, types and importance.
8. Basic facilities of a nursery; layout and components of a good nursery; nursery beds, growing media and nursery tools.
9. Outline of vegetative propagation techniques to produce planting material.
10. Nursery Management**:** Watering, weeding and nutrients; pests and diseases.

BOTC504X0 (DSC): PLANT PHYSIOLOGYAND METABOLISM **Marks: 25**

1. Photosynthesis and Respiration: Genes and polypeptide components of photosynthetic complexes; bioenergetics of light reaction, generation of proton gradient and ATP synthesis; water to water cycle; CO_2 concentrating mechanism in plants; regulation of C2, C3, C4 and CAM cycles.
2. Metabolic regulation of glycolysis, acetyl CoA synthesis and citric acid cycle; Mitochondrial electron transport complexes - structure, function; Mechanism of ATP synthesis; gluconeogenesis; glyoxylate cycle.
3. Transport mechanisms of water, ions and macromolecules: Mechanisms of uptake and transport of water, ions, solutes and macromolecules from soil to plants, ion transporter-types, structure and function; mechanisms of loading and unloading of photo assimilates.
4. Concept of hormones as chemical messengers, biosynthesis and mechanisms of action of hormones, synthetic regulatory compounds and their uses.
5. Concept on sensory photobiology and reproductive physiology: Structure, function

and action of phytochromes, cryptochromes and phototropins; stomatal movement; regulation of flowering by light temperature and hormones.

6. Physiology of senescence and aging: Senescence promoters, whole plant senescence and organ senescence, hormonal and environmental control of senescence, programmed cell death in lifecycle of plants.
7. Concept of dormancy and quiescence, types of dormancies, seed viability, dormancy enforcement and termination, biochemical and molecular basis of dormancy, hormonal regulation of dormancy and germination, circadian clock and germination control.

BOTC505X0 (DSC): BIOCHEMISTRY AND MOLECULAR BIOLOGY Marks: 25

1. Protein: Hierarchy of protein structure, motifs and domains, torsion angle and Ramachandran plot, forces stabilizing protein structure, fibrous proteins (keratins and collagen), globular protein; Protein folding: Levinthal paradox, different models and concept of chaperones.
2. Carbohydrates: Simple and conjugated sugars, nomenclature; structure; Stereochemistry - Fischer projection, Haworth perspective, boat and chair conformation, mutarotation, glycoside formation, derivative sugar; glycoproteins and proteoglycans.
3. Lipid: simple and conjugated lipid, different neutral & polar classes, nomenclature of different fatty acids, lipidomics concept.
4. Enzyme activity and specificity, constitutive and induced enzymes; active site, activation energy, reaction rate, mechanism of action; Kinetics: Rate order of reactions; derivation of Michaelis-Menten equation; single substrate, Michaelis-Menten plot and Lineweaver Burke plot; Enzyme inhibition - reversible and irreversible with one example in each case.
5. Nitrogen metabolism: Structure and function of nitrogenase, mechanism of nodule formation; nitrate assimilation in plants.
6. Lipid metabolism: Biosynthesis and oxidation of fatty acids, regulation of FAS, phospholipid synthesis and sterol synthesis, LOX for biotic and abiotic stress.
7. Reactive Oxygen Species: Formation, role and scavenging activity.
8. Secondary metabolites and metabolite trafficking: Biosynthetic pathways for secondary metabolism; biological activities of phytoconstituents (phenols and phenolic glycosides, sterols, steroidal alkaloids, stanols, miscellaneous isoprenoids, saponins, alkaloids, volatile oils, lipids and carbohydrates); turnover and degradation of secondary metabolites.

BOTE506A0 (DSE): ANGIOSPERM TAXONOMY **Marks: 50**

1. Definition: Taxonomy and Systematics, molecular systematics, concept of monophyly, paraphyly, polyphyly; pleiomorphy & apomorphy; analogy, homology & homoplasy; convergent, parallelism; flora, vegetation, revision, new records.
2. History of taxonomic study in India: Contributions and taxonomic literature in relation to angiosperms; different classical literature; brief outlines of the role of the Botanical Survey of India (BSI) for taxonomic study.
3. Plant Nomenclature: Basic differences between ICBN & ICN, ICN: Principles, nomenclatural types.
4. The Angiosperms Phylogeny Group (APG): APG-IV-2016 of flowering plant; phylogenetic relationships of angiosperms; concepts of basal angiosperms; concept of palaeoherbs and eudicots.
5. Biodiversity: Definition, importance, levels, megadiverse countries; hot spots, Indian hotspots; spatial distribution, value, and loss; IUCN categories of threatened species.
6. Conservation: Strategies for conservation (*in-situ* and *ex-situ*); concept and types of protected areas; the role of Botanic gardens; Cryopreservation: Seed banks, pollen banks, gene banks, germplasm conservation.
7. Digital Herbarium: Concept & application.

BOTE506B0 (DSE): APPLIED MYCOLOGY **Marks: 50**

1. Spindle pole bodies (SPBs): Different types found in fungi and their respective functions.
2. Heterokaryosis: Definition, occurrence, significance, modes of formation.
3. Spore dormancy: Exogenous and endogenous dormancy.
4. Importance of fungi: Nutrient recycling, biofertiliser, siderophore production, phosphate solubilization, growth promoter, bioremediation, soil formation, biocontrol agent.
5. Edible fungi: SCP, marmite, vegemite, quorn, tempeh, angkak, soy sauce, cheese, miso.
6. Production of acids by fungi: Citric, gluconic, itaconic, lactic, oxalic, fumaric, malic, succinic.
7. Production of free radicals and their roles in some human ailments.
8. Production of penicillin, cephalosporin, griseofulvin, strobilurin, sordarin, gentamycin, plectasin, cyclosporin, cilofungin.

BOTE506C0 (DSE): CYTOGENETICS **Marks: 50**

1. Ultrastructures of cell membrane, mitochondria, chloroplast, peroxisome, glyoxysome and their functions.
2. DNA methylation and histone methylation and acetylation and their impact.
3. Cell communication and signaling**:** General principle, signaling molecules and their receptors. Cell surface receptors (ion channel linked receptors, G protein coupled receptors, Tyrosine kinase linked receptors, Steroid hormone receptors).

4. Cell cycle check points. Role of different cyclins and cyclin dependent kinases in different stages of cell cycle; Apoptosis, Cancer.
5. Cytoskeleton**:** Brief knowledge, function of cytoskeleton, structure, actin filaments (microfilaments), microtubules, intermediate filaments.
6. Quantitative genetics**:** Broad sense heritability and narrow sense heritability.
7. B chromosomes and their significance.
8. Chromosomal characteristics and nuclear DNA content variation across plant kingdom.
9. Epigenetic regulation of trait.
10. Concept of speciation: Different types.
11. Population genetics: Factors affecting allelic frequency, bottle neck effect, founder effect.

BOTE506D0 (DSE): ECOLOGY **Marks: 50**

1. Principles and current concepts in ecology.
2. Structure and function of ecosystem: Including forest, mangrove and aquatic systems.
3. Plant community: Qualitative and quantitative characteristics, phytosociological methods
4. Environmental diary- Stockholm conference, Montreal protocol, Rio earth summit, Kyoto protocol, Ramsar convention, COP 16.
5. Environmental disasters: London smog, El Nino, Minamata tragedy, Chernobyl disaster, Bhopal tragedy.
6. Global environmental issues: Global warming, Acid rain, Smog, Ozone depletion, biological invasion.
7. Phytoremediation and plant response to environmental stresses: Drought, water logging, high and low temperatures, salinity.
8. Population ecology: Growth curve, carrying capacity, Sustainable development, population regulation, r-and K-strategy.

BOTE506E0 (DSE): MICROBIOLOGY- BASIC **Marks: 50**

1. Microscopy (Phase contrast; SEM, TEM, AFM).
2. Staining methods (Gram, Acid fast, Endospore).
3. General account of Actinomycetes, Spirochetes, Rickettsials and Mycoplasmas.
4. Bacterial culture medium, Enrichment culture; Isolation of pure cultures;
1. Batch culture and Continuous culture.
5. Measurements of bacterial growth - Generation time, mathematical expression of growth; Synchronized growth; Diauxic growth; Environmental factors influencing growth (pH and temperature); Biofilm formation and Quorum sensing.
6. Metabolic classes of microorganisms (autotroph, phototroph, chemotroph, heterotroph); Photosynthesis (anoxygenic and oxygenic), Photosynthetic microorganisms, photosynthetic pigments, and generation of reducing power by cyclic and non-cyclic photophosphorylation; Chemosynthesis (sulfur oxidation, iron oxidation, hydrogen oxidation and nitrification); Methanotrophy; Anaerobic Respiration - nitrate respiration (denitrification), sulfate reduction, and methanogenes

7. Detailed account of biological nitrogen fixation, nitrogenase and its alternative forms, nif gene, control and regulation.
8. Chemistry and mode of action of antibiotics (Penicillin, Streptomycin, Viricidin), microbial assay, mechanism of drug resistance.
9. General properties of plasmids, application of plasmid in cloning technology, cosmids.
10. Genetic engineering, restriction enzymes, topoisomerase, gyrase, methylase, genomic library, c-DNA library. Application of recombinant DNA technology. Esthetic issues of genetic engineering. Molecular biology of the bacteriophage lambda, M13 and P1.
11. Plant-microbe relationships, microbes as pathological agents in plants, animals and human system, toxins.
12. Enzyme kinetics, regulation of enzyme activity, mode of action of amylases and proteases.
13. Oncogenes and cancer (causes).
14. Virus; cultivation, isolation and purification, prions, viroids.

BOTE506F0 (DSE): PALAEOBOTANY **Marks: 50**

1. Outline classification of rocks according to their origin and composition; sedimentary processes; diastrophic changes in sedimentary strata (dip-strike, fold, fault); unconformity.
2. Principles of correlation and stratigraphy, geochronology; stratigraphic systems and the units of classification; Standard Geologic Time Scale.
3. Prebiotic environment; chemical evolution and origin of life; Precambrian life-forms. Indian Precambrian stratigraphy; palaeobiology of Vindhyans.
4. Siluro-Devonian land floras; Permo-Carboniferous floral provinces; Devonian and Carboniferous floras of North-West India.
5. Early Mesozoic floras of Molteno and Chinle formations, later Mesozoic floras of Yorkshire and Jura.
6. Concept of Indian Gondwana Sequence, stratigraphy and correlation of Gondwana Sequence in Peninsular Indian basins, mega- and mio-floristics of Peninsular Indian Gondwana formations; Indian Perigondwana floras.
7. Diversification of algae, fungi and bryophytes through ages.
8. Angiosperm palaeofloristics; Distribution of Tertiary strata in India; Palaeogenepalaeofloristics and palaeoecology of Peninsular India; Neogenepalaeofloristics and palaeoecology of Peninsular (Cuddalore Group and Bengal Basin) and Extrapeninsular (SiwalikGroup)India.
9. Archaeobotanyof Indian cultivated plants.

BOTE506G0 (DSE): PLANT PHYSIOLOGY **Marks: 50**

1. Plant nutritional physiology: Molecular regulation of intercellular and intracellular uptake and transport of nutrients. Structure and function of ATPase/pump. Signaling mechanism of nutrient transport with special reference to iron and phosphorus uptake. Regulation of nutrient homeostasis by target mimicry.

2. Signal transduction: Receptors and G-proteins, phospholipid signaling, calcium-calmodulin cascade, diversity in protein kinases and phosphatases. Role of cyclic nucleotides, miRNAs, circular RNAs and long-noncoding RNAs in plant growth, morphogenesis and flowering.
3. Stress Physiology: Freezing, heat, salinity, and heavy metals stresses in plants; plant responses to abiotic stress, mechanisms of abiotic stress tolerance in plants: water, drought, salinity and heavy metal tolerance.
4. Oxidative and nitrosative stress and antioxidative strategies: Nitrosative and oxidative stress - causes and effects, nitric oxide biosynthesis and metabolism, NO mediated signaling, markers of nitrosative stress, NO crosstalk with other hormones, cross talk between SA and JA in plants; antioxidant defense mechanism(s) in plants; regulation and functions of ascorbate-glutathione cycle in plants.
5. Programmed cell death (PCD): Concept of PCD and its types in plants during vegetative and reproductive stages. Developmental and stress-induced PCD. Plant senescence and its characteristics. Leaf and flower senescence. Altered metabolism during senescence and its regulation.
6. Floral induction and development: Hormonal control, molecular genetics of floral development and floral organ differentiation; Effect of low temperature on floral bud initiation (FBI) through silencing of FLC gene.

SEMESTER – III

PRACTICAL

BOTC507X9 (SECP): GENETICS, BIOTECHNOLOGY AND PLANT PROPAGATION

Marks: 25

1. Study of mitotic cell division
2. Study of meiotic cell division, stages of meiosis I & II divisions
3. Karyotyping: the basic method (with the well spread chromosomes of mitotic metaphase from worked out specimens or from earlier drawn pictures or photographs.
4. Plant Tissue Culture**:** Callus culture, organogenesis, micropropagation.
5. Chi square test for goodness of fit of Fixed ratio hypothesis
6. Plant propagules, vegetative propagation: cutting (with ramets), budding, air layering, grafting.
7. Nursery techniques**:** seed bed preparation, sapling growing, growth chamber, mist chamber.
8. Application of nutrients and pesticides.

BOTC508X9 (DSCP): PLANT PHYSIOLOGY, BIOCHEMISTRY & MOLECULAR BIOLOGY

Marks: 25

1. Determination of percentage seed viability of TTC test.
2. Effect of respiratory promoters/inhibitors on the rate of aerobic respiration.
3. Effect of photosynthetic promoters/ inhibitors on the rate of photosynthesis.
4. Determination of isotonic concentration and osmotic pressure of cell sap.
5. Isolation of chloroplasts and demonstration of Hill reaction.
6. Determination of isoelectric points of protein.
7. Extraction and comparative study of chlorophyll levels in leaves of different chronological ages.
8. Preparation of a standard curve for proteins and determination of protein levels in unknown samples using Folin-phenol reagent.
9. Preparation of a standard curve for amino acid and determination of amino acid levels in unknown samples using ninhydrin reagent.
10. Preparation of a standard curve for carbohydrates and determination of carbohydrate levels in unknown samples using anthrone reagent.
11. Preparation of a standard curve for IAA and determination of IAA levels in unknown samples using Salkowsky reagent.
12. Comparative study on the activities of catalase enzymes in different plant samples.
13. Comparative study on the activities of amylase enzymes in different plant samples.
14. Studies on paper chromatography of amino acids.

BOTE509A9 (DSEP): ANGIOSPERMTAXONOMY **Marks: 25**

1. Taxonomic study of local angiosperm flora, identification and preparation of dichotomous key.
2. Acquaintance with taxonomic literature (Index Kewensis, Dictionaries, Manuals, Bibliographies and Flora) and their respective uses.
3. Workout on inter/and intraspecific morphological variations.
4. Biosystematics study**:** Comparative study of the starch grains on different storage organs; ovules, stomata, seeds and fruit morphology. Workout on pollen morphology of angiospermic taxa to study inter/intraspecific and intergeneric Palynological variations.
5. Field study as one excursion to Acharya Jagadish Chandra Bose Indian Botanic Garden (Shibpur, Howrah) and Central National Herbarium (CNH).
6. Field visit as a long long collection and floristic study to at least one phytogeographical region of India with rich biodiversity. Preparation of Field Note Book (authenticated by teacher guide (s)) with field notes and photographs on the plants of the area of excursion and Herbarium specimens (identified with author citation, voucher number) to be submitted during examination.
7. Study of local flora and submission of a project treport highlighting phytogeographical characteristics of the region.

BOTE509B9 (DSEP): Applied Mycology **Marks: 25**

1. Siderophore production
2. Phosphate solubilization assay
3. HCN production assay
4. Study of morphological characters and reproductive structures of some genera.
5. Preparation of fungal media.
6. Sterilization process.
7. Use of selective media.
8. Isolation of fungi from water / soil / air.

BOTE509C9 (DSEP): CYTOGENETICS **Marks: 25**

1. Study of symmetric, asymmetric and bimodal karyotypes.
2. Induction of chromosomal and cell divisional abnormalities by the use of chemicals and plant tissue decoction/leaching and identification of different types of cytological abnormalities.
3. Induction of polyploidy.
4. Study of meiotic divisions from different source of plant
5. Study of cytomixis
6. Study of pollen sterility and viability.
7. Induction of pollen tube germination.
8. Chloroplast and nuclei isolation.
9. NOR staining
10. Centromere specific staining.

BOTE509D9 (DSEP): ECOLOGY **Marks: 25**

1. Study on ecological anatomy.
2. Physico-chemical studies of soil and water.
3. Field-based ecological studies (excursion) of different ecological areas.
4. Field records/ reports and Laboratory note book.

BOTE509E9 (DSEP): MICROBIOLOGY: GENERAL **Marks: 25**

1. Study of fermentation of sugar by different bacteria.
2. Starch and protein hydrolysis.
3. Plate count of bacteria.
4. Isolation of fungi and bacteria from soil.
5. Microbial examination of water for potability, IMVIC test.
6. Study of microbial growth curve.
7. Microbial assay of streptomycin (agar cup, disk and turbidity method).
8. MIC determination of different bacteria against antibiotic streptomycin.

BOTE509F9 (DSEP): PALAEOBOTANY Marks: 25

1. Field techniques in palaeobotany.
2. Study of megafossil assemblages from different geological horizons especially from India.
3. Laboratory extraction techniques of spores and pollen grains from coal, shale and other sedimentary rocks. Quantitative analysis of spore-dispersal in rock samples from different geologic horizons. Graphic representation of data for the determination of horizonand age.

BOTE509G9 (DSEP): PLANT PHYSIOLOGY Marks: 25

1. Investigation of the impact of high temperature stress on the level of soluble protein in germinating seeds.
2. Comparison of total dehydrogenase activity from seeds of different storage duration.
3. Extraction and estimation of carotenoid pigments.
4. Separation of plant pigments by TLC and their identification.
5. Assay of catalase, peroxidase and ascorbic acid oxidase activity;
6. Determination of Km value of Urease.
7. Complexometric assay of calcium and magnesium

BOTC510X9 (DSCP): INTERNSHIP/ INDUSTRY PROJECT/ INNOVATIVE PROJECT

Marks: 25

Students will visit to various industries/ Companies/ Corporate houses/ institutions/ Nurseries or any other similar organizations for the purpose.

SEMESTER – IV

THEORY

BOTO551X0 (DSC): FOREST SCIENCE **Marks: 25**

1. Silviculture**:** Definition, scope and objective.
2. Classification of forest, farm forestry, Social forestry and Agro-forestry.
3. Factors of locality: Climatic - light, temperature & frost; Topographic - effect of altitude, aspect & exposure; Edaphic - general, influence of parental rock on vegetation, Pan formation; Biotic - influence of plants, insects, wild animals, man and his animals.
4. Classification and objectives of silviculture system
5. Clear felling system**:** Clear stripe and Alternate stripe system; regeneration by Taungya and/or Departmental plantation.
6. Uniform system**:** Shelter wood system, kinds and patterns of felling, periodic block, Indian irregular shelter wood system.
7. Selection system**:** Coppice system - simple, coppice with standard.
8. Mensuration: definition, objective and scope.
9. Measurement of diameter and girth; Brest height – rules of diameter measurement, diameter and girth class.
10. Measurement of height of tree: Principles of height measurement (similar, triangle and trigonometric).
11. Volume: Measurement of volume of standing and felled trees, volume table.
12. Joint Forest Management**:** Concept and application.

BOTO552X0 (DSC): INSTRUMENTETION AND BIOMATHEMATICS **Marks: 25**

1. Microscopy: Light (Dark Field, Bright Field, Phase Contrast and Florescent); Electron (SEM, TEM); Other (AFM); Micrometry.
2. Sterilization (Autoclave, Hot air oven), Incubator, Centrifugation.
3. Bioreactor (types and applications); PCR (process and applications).
4. Colorimetry, Spectroscopy (UV-VIS, IR, NMR, Mass).
5. Chromatography/ Separation Science (Thin Layer Chromatography, Gel filtration, GC, HPLC, Rotary evaporator).
6. Lyophilizer, Gel Electrophoresis.
7. Determination of Central Tendencies in any given set of data.
8. Determination of Standard Deviation and Standard Error.
9. Chi square test of goodness of fit for Fixed Ratio Hypothesis.

BOTC553X0 (DSC): PLANT ANATOMY AND ADVANCED PHARMACOGNOSY

Marks 25

PLANT ANATOMY

1. Cell wall**:** Chemistry, ultrastructure, biosynthesis and phylogeny.
2. Differentiation: Alternate pathway of development, totipotency, polarity, pattern formation, genetic control.
3. Differentiation of primary and secondary plant bodies: Origin and development of sclereids, fibres and their control of differentiation; vascular cambium, factors influencing cambial activity; periderm structure and development; nature and development of cell wall of sieve elements; nature and function of p-protein.
4. Phylogeny of xylem and phloem elements; wood anatomy, nodal anatomy, leaf and wood anatomy in ecological perspective; anatomical response to pollutants.
5. Floral vasculature; development of pollen grains; structures of floral nectaries and seed coat.
6. Secretory tissues in plants: Structure and distribution of secretary trichomes (*Drosera* sp., *Nepenthes* sp.), salt glands, colleters, nectaries, resin ducts.
7. Laticifers: Types, structure, development and economic importance of latex.

ADVANCED PHARMACOGNOSY

1. Pharmacognosy: Introduction and scope of pharmacognosy. Organoleptic micromorphological and chemical characteristics of crude plant drugs – *Cinchona*, *Digitalis*, *Strychnos*, *Rauvolfia* and *Adhatoda*.
2. Alkaloids: Properties; alkaloids obtained from *Stramonium*, *Belladonna*, Ergot, Tea, *Rauvolfia*, *Catharanthus*, *Cinchona*, *Holarrhena* and their respective uses.
3. Glycosides: Classification, glycosides obtained from *Senna* and their uses; sources and types of cardioactive glycosides and their uses.

BOTC554X0 (DSC): OMICS SCIENCE **Marks: 25**

1. Introduction to bioinformatics; concept of hardware and software.
2. Different types of biological databases like sequence databases, structural, genomic and pathway interaction databases; information retrieval from biological databases; sequence analysis overview.
3. Introduction to genome browsers; online bioinformatics tools; different types of file formats used in bioinformatics analysis; genome annotation.
4. Nucleotide and protein sequence analysis, sequence alignment and applications.
5. Primer designing tools, Gene Prediction, Restriction Site Annotation, ORF finder
6. Phylogenetic analysis.
7. Introduction to protein structure, prediction and analysis; drug designing.

BOTE555A0 (DSE): MOLECULAR SYSTEMATICS **Marks: 50**

1. Definition**:** Molecular systematics, molecular phylogenetics, objectives of molecular taxonomy & systematics, clade, cladistics, co-evolution.
2. Molecular Systematics**:** Molecular characters (cp-DNA, mt-DNA, nuclear gene & ITS), Types of molecular data and analysis.
3. Phylocode & Biocodes**:** Principle and basic concept.
4. Numerical Taxonomy or Neo-Adansonian Taxonomy*:* Objectives and principles, phenetic and cladistic methods, construction of taxonomic groups (OTUs and Unit Characters), merits and demerits.
5. Concept of taxonomic characters**:** Phytochemistry (secondary metabolites); Serology (antigen & antibody) in deciphering taxonomic position.
6. Systematic & Phylogenic studies**:** Distribution; Adaptive features and phylogeny of special life form classes - parasitic plants, insectivorous, mangrove taxa, saprophytic taxa.
7. Molecular identification**:** Medicinal (endangered & threatened) plants, aromatic plants, dye yielding plants & DNA Barcoding with authentication and identification of medicinal plants, adulteration of herbaceous medicinal plants.
8. Molecular phylogenetic analysis: Sequence acquisition, Multiple sequence alignment, Substitution model, Tree building and Tree evaluation.

BOTE555B0 (DSE): PLANT PATHOLOGY **Marks: 50**

1. Diagnosis of infectious and noninfectious diseases.
2. Plant disease development – mechanism of prepenetration, active invaders, passive invaders.
3. Plant disease control – general principles.
4. Timber decay – major types, factors responsible for decay, naturally decay resistant species, decay during storage, control by preservatives.
5. Mycorrhiza - definition, origin and evolution, mycorrhiza and disease control.
6. Selected tree diseases: Root rot of sal, Bacterial wilt of teak, Root rot of teak, Wilt of sissoo, Root rot of sissoo, stem wilt of *Casuarina*, Spike disease of sandal wood, Root rot of khair, Pink disease of *Eucalyptus*.
7. Important tissue culture techniques as importance to plant pathology.
8. Development of disease resistant transgenic plants through Ti plasmid mediated gene transfer.

BOTE555C0 (DSE): MOLECULAR BIOLOGY & BIOTECHNOLOGY **Marks: 50**

1. Physical properties of different conformations of DNA.
2. Brief introduction on small nuclear RNA, small nucleolar RNA, RNAi, gRNA, micro RNA. Ribozymes.

3. C-value, paradox, DNA renaturation kinetics, Tm, Cot curve. Unique and Repetitive DNA -mini- and microsatellites.
4. DNA repair mechanisms.
5. Eukaryotic gene expression control mechanisms (brief account only).
6. Genome imprinting.
7. Gene silencing and its applications; CRISPR; genome editing.
8. Organeller genomes.
9. Different types of PCR – Real Time PCR, Quantitative Real Time PCR, Reverse Transcriptase PCR, Multiplex PCR, Nested PCR, Single-cell PCR, Long ranging PCR, Fast Cycling PCR (Principle and Uses of each type).
10. Micrarray Technique, Flow cytometry.
11. Gene transfer technology**:** Using plasmids, Ti plasmid, electroporation, microinjection, gene gun.
12. Plant tissue culture: Suspension culture, Haploid culture, Embryo culture, Protoplast isolation culture, somatic hybridization, synthetic seed,
13. Transgenesis of plants for virus resistance, herbicide resistance, insect resistance.
14. In vitro production of secondary metabolites, biotransformation.
15. Brief idea about molecular farming / pharming.
16. Progeny testing, Pedigree selection, Single seed descent method, Diallele crossing.

BOTE555D0 (DSE): ECOLOGY **Marks: 50**

1. Principles and current concepts in ecology.
2. Structure and function of ecosystems including forest, mangrove and aquatic systems.
3. Plant community**:** Qualitative and quantitative characteristics, phytosociological methods.
4. Environmental diary**:** Stockholm conference, Montreal protocol, Reo earth summit, Kyoto protocol, Ramsar convention, COP 16.
5. Environmental disasters: London smog, El Nino, Minamata tragedy, Chernobyl disaster, Bhopal tragedy.
6. Global environmental issues: Global warming, acid rain, smog, ozone depletion, biological invasion.
7. Phytoremediation and plant response to environmental stresses: Drought, water logging, high and low temperatures, salinity.
8. Population ecology: Growth curve, carrying capacity, Sustainable development, population regulation, r-and k-strategy.

BOTE555E0 (DSE): MICROBIOLOGY – Applied **Marks: 50**

1. Bacterial fermentation process; Role of microorganisms in the production of fermented dairy products, meat and fishery products, plant products, breads; Applications of microbial enzymes in dairy industry.

2. Probiotics: Concept and application.
3. Primary and secondary microbial metabolites, properties of industrial microorganisms.
4. Fermentation technology: Fermentor and its application; fermentation scale up; industrial production of alcohol, organic acids, amino acids, antibiotics, enzymes.
5. Biopesticides (*Bacillus thuringiensis*), biopolymers (bacterial plastics) - brief account and application.
6. Air, water and soil microbiology. Control of pollution by microbes; bioremediation.
7. Wastewater treatments: Sewage and sludge, generalized plan of a sewage treatment plant - trickling and activated sludge treatment; biodegradation of petroleum and xenobiotics; biofertilizers; biogas production.
8. Microbial leaching of metals (with special emphasis on copper).
9. Medical microbiology: Principles of epidemiology, air borne transmission of food and water borne diseases; immunological and serological methods in common medical practices.
10. Immunoglobulin classes, humoral and cell mediated immunity, immunological memory, mechanism of antibody diversity, monoclonal antibody, vaccine.
11. Bioinformatics: Basic idea.

BOTE555F0 (DSE): PALYNOLOGY & PLANT REPRODUCTIVE ECOLOGY Marks: 50

1. Trends of apertural and exine evolution in the pollen grains of angiosperms.
2. Pollination biology and pollen-pistil interaction: concept and significance; role of s-allelein controlling gametophytic and sporophytic incompatibility; molecular basis of self-incompatibility.
3. Pollen biotechnology and crop improvement: Overcoming pollination constraints, pollination control system for commercial production of hybrid seed through use of cytoplasmic male sterility (CMS), genic male sterility (GMS) and r-DNA technology.
4. Pollen physiology and chemistry: Structure and chemical nature of pollen wall and ubisch body, pollen-expressed and pollen-specific genes.
5. Pollen analysis with reference to Quaternary vegetational history of India: Pleistocene vegetational history of Kashmir Valley, Holocene vegetational history of Bengal basin.
6. Life as a fuel maker; sources of natural fuels; peat; coal and its varieties, constitution of coal,coal palynology; petroleum – its origin, migration and concentration, role of palynology in oil exploration.
7. Floral design and function: Essential flower morphology, i. Perianth – development, diversity, function and evolutionary aspects, ii. Androecium – development, diversity, function and evolutionary aspects, iii. Gynoecium – development, diversity, function and evolutionary aspects, iv. Flower and inflorescence features, v. Particular flower shapes, vii. Flower size and size range.
8. Pollination syndrome: Flower adaptation to different pollinators (Biotic): Flowers pollinated by: I Hymenoptera, ii. Diptera, iii. Coleoptera, iv. Lepidoptera, v. Birds, vi. Bats, vii. Nonflying mammals.
9. Floral advertisement and floral rewards: i. Visual signals and flower colors, ii. Pollen as rewards,iii. Nectar as reward, iv. Mimicry in flower.

10. Breeding system and Pollination: i. Sex Expression - bisexual & unisexual flowers; monoecy and dioaecy ii. Dichogamy iii. Herkogamy iv. Heterostyly v. Autogamy and allogamy (Inbreeding and outbreeding).

BOTE555G0 (DSE): BIOCHEMISTRY AND MOLECULAR BIOLOGY Mark: 50

1. Fundamental concepts of chemistry for explaining the properties of biomolecules: chemical bonds, stabilizing interactions (Vanderwalls, electrostatic, H-bonding and hydrophobic interactions), biophysical chemistry (pH, buffer, reaction kinetics and colligative properties), conformation of protein (secondary, tertiary, quaternary structures, domains, Motifs, Folds, Ramachandran plot, chaperonin and protein folding), nucleic acids (A, B, Z-DNA, tRNA, Micro RNA).
2. Bioenergitics: Laws of thermodynamics, concepts of entropy, enthalpy and free energy, Oxidative reactions, group transfer, biolgical energy transducers
3. Membrane chemistry and function: Structure of model membrane, lipid bilayer and membrane prote in diffusion; Membrane transport - pumps, carriers, channels, mechanism of sorting, intracellular transport; electrical properties of membrane, membrane raft.
4. Protein chemistry: Protein purification, characterization, methods for the determination of amino acids sequences in proteins, protein folding pathways and Levinthal Paradox.
5. Omic sciences in plant biology: Basic concepts of proteomics, transcriptomics, genomics and their application in plant biology and agriculture.
6. Applied Biochemistry: Fundamentals of proteomics, metabolomics and genomics and their application in agriculture; principle and application of biochemical and biophysical methods - electrophoresis (ID, 2D and capillary electrophoresis), chromatography (HPLC, GLC, affinity chromatography and ion exchange chromatography), spectroscopy (UV-VIS, fluorescence and NMR), x-ray diffraction, mass spectrometry, radio labeling techniques, blotting techniques.

SEMESTER – IV
PRACTICAL

BOTC556X9 (DSCP): FOREST MENSURATION AND SURVEY **Marks: 25**

1. Measurement of Diameter and Girth
2. Girth class distribution.
3. Measurement of Height of a tree.
4. Volume calculation.
5. Chain surveying.
6. Plain Table Survey.
7. Practical Records.

BOTC557X9 (DSCP): PLANT ANATOMYAND PHARMACOGNOSY **Marks: 25**

PLANT ANATOMY

1. Cell types: Trichomes, sclereids, tracheids, vessels and sieve tube elements.
2. Secretary structures and cell inclusions: Nectaries, glandular hairs, oil glands, salt glands, resin canals, laticifers, phytoliths, cystolith and crystals.
3. Nodal anatomy: unilacunar, trilacular, multilacunar
4. Anatomy of bark.
5. Wood anatomy: Structure in TS, TLS, and RLS of woody plants.
6. Ecological leaf anatomy: Sun and shade leaves, xeromorphic, succulent, halophytic and hydromorphic leaves.

PHARMACOGNOSY

1. Microchemical examination of some crude drugs and their extracts.
2. Organoleptic and microscopic evaluation of selected powder or whole plant drugs.
3. Microscopical study of some crude drugs: *Strychnos* (seed)*, Rauvolfia* (roots/rhizomes) and *Adhatoda* (leaves).

BOTE558A9 (DSEP): MOLECULAR SYSTEMATICS **Marks: 25**

1. Taxonomic study of unknown plants of local flora, identification of plants by use of flora/ books and establish the nomenclature of the plant.
2. Acquaintance with taxonomic literature (Index Kewensis, Dictionaries, Manuals, Bibliographies and Flora) and their uses.
3. Workout of inter/ and intraspecific morphological variations

4. Biosystematics study: Comparative study of the starch grains on different storage organs, ovules, stomata, seeds and fruit morphology. Work out of pollen morphology of angiospermic taxa; work out of inter/intraspecific, intergeneric palynological variations.
5. Workout on techniques in chemotaxonomy and molecular systematics [Chromatography (Paper and Thin Layer Chromatography), Polyacrylamide gel electrophoresis for proteins, Starch gel electrophoresis for Isozymes and Agarose gel electrophoresis for DNA].
6. Exercise on numerical analysis of phytochemical data (methods of Sokal and Sneath, Romero Lopes *et al*) to study interspecific variation and construction of dendrograms.
7. Field study (Phytogeographically biodiversity reached different areas in India): Collection, photography, processing of plant specimens for herbarium, preservation and submission of field report.

BOTE558B9 (DSEP): Applied Mycology and Plant Pathology **Marks: 25**

1. Use of some fungicides to study their effect on fungi.
2. Inoculation of fruit and subculturing.
3. Chemical tests for the detection of selected compounds.
4. Microscopic evaluation of some fungal specimens.
5. Study of ectomycorrhiza.
6. Study of VAM in root.

BOTE558C9 (DSEP): CYTOGENETICS, MOLECULAR BIOLOGY & BIOTECHNOLOGY

Marks: 25

1. Isolation and spectrophotometric estimation of DNA and RNA.
2. Extraction and quantitative analyses of protein.
3. SDS PAGE of Seed Storage Protein.
4. Preparation of Plant Tissue Culture media.
5. Experiment on callus culture and shoot tip culture.
6. Acquaintance with instrument from the visit of laboratories.
7. Regression Analysis.
8. Analysis of variance (One way ANOVA)

BOTE558D9 (DSEP): ECOLOGY & BIODIVERSITY **Marks: 25**

1. Studies of diverse plant communities by different methods (quadrats and transects)
2. Determination of IVI
3. Study on ecological anatomy.
4. Physico-chemical studies of soil and water.
5. Field-based ecological studies (excursion) of different ecological areas.
6. Field records/ reports and laboratory note book.

BOTE558E9 (DSEP): MICROBIOLOGY: APPLIED **Marks: 25**

1. Determination of amino acid pool of an organism by TLC.
2. Determination of molecular Weight of a protein by Gel electrophoresis.
3. Isolation of plasmid from bacteria.
4. Agarose gel electrophoresis of plasmid.
5. Estimation of protein, sugar, DNA and RNA.
6. Preparation of survival curve of a bacterium after UV exposure and isolation of mutants.
7. Polymerase Chain Reaction (PCR) of selected genomic part of microorganism.
8. Blust search and alignment of genomic sequence, preparation of phylogenetic tree.
9. Isolation of *Azotobactor*from soil and *Rhizobium* from root nodule.
10. Study of immune-diffusion technique.
11. Visit to a place of microbiological interest.

BOTE558F9 (DSEP): PALAEOBOTANY, PALYNOLOGY & PLANT REPRODUCTIVE ECOLOGY **Marks: 25**

1. Field techniques in palaeobotany.
2. Study of megafossil assemblages from different geological horizons especially from India.
3. Study of spore / pollen morphology of some extant representatives of pteridophytes, gymnosperms and angiosperms.
4. Laboratory extraction techniques of spores and pollen grains from coal, shale and other sedimentary rocks; quantitative analysis of spore-dispersal in rock samples from different geologic horizons: graphic representation of data for the determination of horizon and age.
5. Extraction, identification and quantitative analysis of spore / pollen assemblages from air, honey and soil.
6. Study of pollen germination and pollen tube growth in vitro.
7. Tests for pollen viability.
8. Tests for pollen-pistil Interaction.
9. Tests for self-incompatibility.

BOTE558G9 (DSEP): PLANT PHYSIOLOGY, BIOCHEMISTRY & MOLECULAR BIOLOGY

Marks: 25

1. Quantitative estimation of ascorbic acid in plant tissue.
2. Evaluation of seed viability by reliable physiological and biochemical methods.
3. Effect of water stress on root metabolic activity.
4. Quantitative estimation of proline in salt-stressed leaf-tissues.
5. Activity of ATPases in green plant material.
6. Colorimetric estimation of Iron.

7. Extraction and estimation of fat.
8. Extraction and estimation of pectin and sugars from fruits.
9. Separation of amino acids by paper chromatographic technique.
10. Extraction and estimation of nucleic acids from plant samples.
11. Extraction and estimation of the enzyme catalase and amylase form plant samples.
12. Separation of phenolic compounds by thin layer chromatography.
13. Purification of protein by SDS-PAGE.

BOTE559X9 (DSEP): PROJECT WORK/ M.Sc. Thesis/ Dissertation Marks: 50

Project Work/ M.Sc. Thesis/ Dissertation/ Review Work (based on Elective/Special Paper):

BOTC560X9 (DSCP): FIELD SURVEY AND SOCIAL OUTREACH Marks: 25

NB: Medium of answering questions should be in English only.

Special papers will be distributed equally among the offered special papers on Merit cum Choice basis.

List of Special Papers:

- **ANGIOSPERM TAXONOMY AND MOLECULAR SYSTEMATICS**
- **APPLIED MYCOLOGY AND PLANT PATHOLOGY**
- **CYTOGENETICS, MOLECULAR BIOLOGY AND BIOTECHNOLOGY**
- **ECOLOGY & BIODIVERSITY**
- **MICROBIOLOGY: GENERAL AND APPLIED**
- **PALAEOBOTANY, PALYNOLOGY AND PLANT REPRODUCTIVE ECOLOGY**
- **PLANT PHYSIOLOGY, BIOCHEMISTRY AND MOLECULAR BIOLOGY**