Vidyasagar University

Midnapore-721102, West Bengal

The SYLLABUS for

POST-GRADUATE Programme

in

BOTANY

Under Choice Based Credit System (CBCS)

(Semester Programme)



[w.e.f. 2022-23]

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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 programme in 2001, and UGC DRS SAP in 2012 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.

Program Outcomes (POs)

The famous Botanist Joseph Paxton once said that **"Botany, – the science of the vegetable kingdom, is one of the most attractive, most useful, and extensive departments of human knowledge. It is, above every other, the science of beauty".** Since time immemorial, human being has been using plants for different purposes in addition to food, clothes and shelter. With time, the possibility of botany studies has increased to a wide extent. Now we cannot think of any human activity without the involvement of plants.

Botany is the scientific study of plants. Most of the people believe that "Plants" - means a wide range of living organisms from the smallest bacteria to the largest living things - the giant banyan or sequoia trees. So, by definition plants include: algae, fungi, lichens, mosses, ferns, gymnosperms and flowering plants. Botany includes a wide range of scientific sub disciplines that deals with the structural and functional aspects of plants including microbes which comprises growth, reproduction, metabolism, development, diseases, ecology and evolution.

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.

As the field is so broad and diverse, so, there are many kinds of plant scientists and many different opportunities available. Botanists those are fascinated in ecology, can study interactions of plants with other organisms and the environment. Field botanists search to find new species or do experiments to discover how plants grow under different conditions and their mode of reproduction. Some botanists may study the structural aspects of plants. They

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may work in the field, concentrating on the pattern of the whole plant. Others use microscopes to study the most detailed fine structure of individual cells. Many botanists do experiments to determine how plants convert simple chemical compounds into more complex chemicals. They may even study how genetic information in DNA controls plant development. Botanists study processes that occur on a time scale ranging from fractions of a second in individual cells to those that unfold over eons of evolutionary time.

The results of botanical research increase and improve our supply of medicines, foods, fibers, building materials, and other plant products. Conservationists use botanical knowledge to help in managing national parks, sanctuaries, forests, medicinal plant gardens and other related areas. Public health and environmental protection professionals depend on their understanding of plant science to help solving pollution problems.

A career in Botany might just be one of the most preferred careers in India.

Employment Areas in Botany are: Schools, Colleges & Universities, Nursery Farms, Environmental Consultancies, Pharmaceutical Companies, Forest services and many more.

Job Profiles on which a botany person can work: Ecologist, Plant Taxonomist, Plant Biochemist, Researcher, Environmental consultant, Forest Ranger, Botanist, Nursery or Green House manager, Farming Consultant, Geneticist, Biotechnologist, Microbiologist etc. Botanical studies is surprisingly helpful in areas we wouldn't automatically consider it to have applications. Most of the important medicines come from the plant sources. Therefore, the need to study botany especially the M.Sc. curriculum is very important today as it ever was. So, learners may go for it.

COURSE OUTCOME:

BOT 101: Students will get information about the subject Microbiology. Students will get information on different applied aspects of the course and can use the same in everyday life. They can be self employed with the use of knowledge on fermentation technology, agricultural microbiology etc. Topics like virology, immunology will help them to understand about their health.

BOT 102: The content in Phycology provides information on the overview of algae, their recent taxonomic status. Students are also getting conversant about the economic significance of algae.

BOT 103: Learners will be able to define and explain the unique features of fungi; illustrate a modern classification with characters up to phylum; define and explain homothallism and heterothallism; define and explain phylum Ascomycota; define and explain phylum Basidiomycota.

Regarding Plant Pathology learners will be able to define and explain plant diseases; illustrate host-pathogen interactions; illustrate the role of growth regulators etc.

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BOT 104: Study of Pteridophytes helps in understanding origin and evolution of early vascular plants and other cryptogams especially ferns. Also helps to understand the different medicinal aspects and economic uses of the plant group.

Study of gymnosperms will help to understand the distribution of different taxa of the small but very important plant group especially at higher altitudes. Also helps in understanding the economic uses of the group (as a source of wood, medicine, resin).

BOT 195: Students will observe different microorganisms after staining and can understand about the nature of different microbes. They will know how to culture microbes, prepare media and sterilization process. Regarding sensitivity of test of antibiotics they will get hands on training. 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.

Practical course help students in identifying various important members of algae.

BOT 196: Practical courses help the learners in identifying different important members of fungi, Pteridophytes and gymnosperms through different morpho-anatomical characters. They will be able to identify the different plant diseases caused by fungi.

BOT 201: The knowledge in the new biology domain behind Molecular Taxonomy and systematics is changing fast to understand the biological system as a whole. Dynamic curriculum in this area integrating basic biology, chemistry, numerical approach for understanding the functional biology.

BOT 202: Palaeobotany helps in understanding the plant life patterns of prehistoric time; palaeoclimatology and how life has changed with the changing environment since its' origin.

Palynology has different applied aspects viz. in determining plant groups, bee forage pattern, pollen as allergens; criminology, oil exploration and plant reproductive biology.

BOT 203: Students will get knowledge about the way plants are constructed. Plant anatomy provides characters such as trichomes, stomata, cuticulorpatterns, leaf reaction, wood anatomy etc. to aid in species identification. It also provides better understanding of how to care for plants and fight plant diseases.

BOT 204: Students will get information on basics of the subject botany. They will know different groups of plants and their economic aspects.

BOT 295: Students will get an overview of the plant megafossils of the geologic past. They will learn the stratigraphic sequences of the fossiliferous beds, nature of preservation and area of occurrence. In palynology and plant reproductive biology students will get a detail knowledge regarding pollen morphological features, their viability and germination (in-vitro and in-vivo). Students will learn how pollen grains can be separated and identified from honey samples with respect to foraging behaviour of bee species.

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BOT 296: Field tour: An educational tour broadens the students' horizon and knowledge through the introduction of plant diversity in different ecological niche; students can apply their knowledge and skills acquired during classroom lectures and practical classes at laboratory. They will be able to explore the possibility of a chance to undertake research work in future.

BOT 301: Cell biology, Genetics and Biotechnology include topics enlightening students about basics of cell biology and genetics having much bearing on the applied subject of biotechnology. Topics under biotechnology provide fair knowledge on different advanced technology and techniques.

BOT 302: Students will get an overall knowledge about the structure, function and interaction of various biomolecules along with the study of different metabolic processes of plants which are associated with plant morphology, ecology and environmental effects on plants. This area of Botany is especially important because the physiology of a plant is directly associated with plant yield / crop yield which has an economic impact.

BOT 303: By studying ecology learners will get a thorough knowledge regarding ecosystem; different types of interaction between organisms and their environment; deep ecology and shallow ecology; habitat and niche concept; ecosystem organizations such as structure and functions, ecological pyramids, food chains and food webs, primary production; energy dynamics; ecological succession and climax concept; population concepts. Besides, study of Environmental Biology helps students in understanding interrelationships between the living world and the environment; concept on hydrosphere, lithosphere and atmosphere; biodiversity and conservation (in situ and ex situ); concept of Ramsar sites; greenhouse effect and global warming; ozone depletion; acid rain, smog, deforestation; Environmental pollution: Environmental Movements in India like Silent valley, Chipko movement, Beej bachao andolan, Narmada dam movement, debates on Eucalyptus; Earth summits.

BOT 304: Students will understand about the role of different plants and microbial groups. Environmental issues related to plants will be discussed. Students will get information about biotechnological applications of plants.

BOT 395: Practical subjects give good support in developing knowledge and skill on molecular biological technologies and biotechnological basics.

BOT 396: Students will know how to study life forms through Raunkier's method and biological spectrum; study of frequency, abundance and density of plants following standard methods; Ecological adaptation of plants.

During preparation for seminar students will gather knowledge on their topic of choice and will know how to collect information. Their writing and communication skill will also increase. Finally students will know how to interact with a large number of audiences.

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BOT 401: Students will get basic ideas on the subject forestry. Silviculture system of different forest plants their measurement process will help them to understand about the economic aspects of forest plants. How different factors influences nature of forest will also discussed in this course.

BOT 402 (Special paper Angiosperm Taxonomy): Assess the terms and concepts related to Molecular Systematics, Concept of Monophyly, Paraphyly & Polyphyly; Plesiomorphy & Apomorphy; Homology & Homoplasy; Convergent & Divergent, Flora, Vegetation, Revision, New Records. Evaluate the Important and History of Taxonomic study in India: Contributions and taxonomic literature in relation to Angiosperms. Brief out lines of the role of Botanical Survey of India (BSI) for taxonomic study. Interpret the rules of ICN in botanical nomenclature: Basic differences between ICBN & ICN, ICN- its concept and description, Phylocode. Classify Plant systematic. Assess terms and concepts related to Phylogenetic Systematics: The Angiosperms Phylogeny Group (APG) system of flowering plant classification: Phylogeneric relationships of Angiosperms. Concepts of palaeoherbs, eudicots. Putative relationship based on Cronquist System of Classification (Sub Classes) Generalize the characters, Phylogeneric relationships of Angiosperms. Assess terms and concepts related to Biodiversity, importance, levels, IUCN categories of threatened species, Megadiverse countries, Hot spots, Indian hotspots. Conservation: Strategies for conservation (in-situ and ex-situ), concept and types of protective areas; role of Botanic gardens; Cryopreservation: Seed banks, pollen banks, gene banks, germplasm conservation. Analysis the phytogeography or phytogeographical zones of India, Biome: concept and classification, characteristics of major terrestrial biomes;, classification of vegetation of India. Endemism, disjunction: Invasions and Introductions.

BOT 403 (Special paper Molecular Systematics): Assess the terms and concepts of Molecular characters (cp DNA, mt DNA and nuclear gene), Types of molecular data and analysis, use of molecular markers at different ranks in Angiosperm phylogeny, Internal transcribed spacer regions of nuclear ribosomal DNA (rDNA ITS), coding genes and non-coding spacers in the nuclear and plastid genomes, RAPD (Random Amplified Polymorphic DNA) RFLP (Restriction Fragment Length Polymorphism), Microsatellites ISSRs (InterSimple Sequence Repeat), SNPs (Single Nucleotide Polymorphism), ARMS (Amplification-Refractory Mutation System), Advancement in sequencing technology, NGS, Search engine and sequence repositories. Analysis the Molecular Systematics: Numerical Systematics: Objectives and principles, Phenetic and Cladistic, methods, construction of taxonomic groups (OUT and Unit Characters), cluster analysis, Determination of phenetic structure. Concept of cladogram with reference to Principle of Parsimony. Details analysis of Systematic & Phylogenic studies: Distribution, Adaptive features and Phylogeny of special life form classes: Parasitic plants, Insectivorous, Mangrove Taxa. Details analysis of Molecular Identification: Medicinal (Endangered & Threatened) Plants, Aromatic Medicinal Plants, Dye Yielding Plants, DNA Barcoding: A Sophisticated Method for Authentication and Identification of Medicinal Plants, Adulteration of medicinal herbs. Recognize the importance of herbarium and Virtual herbarium; evaluate the important herbaria and botanical gardens.

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BOT 402 (Special paper Microbiology- Basic): Students will know about microbial world, their metabolism, growth etc. Idea on mode of action of antibiotics, gene manipulation in microbial system will also be discussed in this course.

BOT 403 (Special paper Microbiology- Applied): This course will help the students to know different topics on applied microbiology. Food, industrial, agricultural, medical microbiology will be discussed in this course. Basic idea on bioinformatics will be given to the candidates.

BOT 402 (Special paper Palaeobotany): Students will be able to learn different aspects of plant fossils viz. types, preservation, age and area of occurrence, stratigraphic sequences, palaeoecology. A thorough knowledge regarding Indian Gondwana will be known to them. They will also learn the diversification of plant life forms through different ages.

BOT 403 (Special paper Palynology and Plant Reproductive Biology): Students will learn the role of palynology in oil exploration, sources of natural fuels, formation of coal and its varieties, coal palynology. In addition, students will know several aspects of pollination biology and pollen-pistil interactions. They will also learn 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.

BOT 402 & 403 (Special paper 'Plant Physiology & Biochemistry): Plant Physiology & Biochemistry deals with the cellular and molecular biology and interaction between biomolecules along with the study of photosynthesis, respiration, plant nutrition, plant hormone functions which are associated with plant morphology, ecology and environmental effects on plants. Plant physiology includes the study of all the internal activities of plants—those chemical and physical processes associated with life as they occur in plants. Students will get a detailed knowledge at many levels of scale of size and time. At the smallest scale are molecular interactions of photosynthesis and internal diffusion of water, minerals, and nutrients. At the largest scale are the processes of plant development, dormancy, and reproductive control. This part of the syllabus will also throw light on the response of plants to different environmental cues.'

BOT 494: Students will know how to survey of an area with plain table or prismatic compass. They will also know how to determine height of a standing tree and how to calculate volume of a tree.

BOT 495 (Special paper Microbiology): They will know how to culture, characterize and identify a microorganism. They will know process for characterization of different microbial metabolites. How to isolate genetic materials, enzyme etc. from a cell will also be demonstrated to the students. Students will prepare phylogenetic trees using different bioinformatics tools.

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BOT 495 (Special paper Palaeobotany, Palynology and Plant Reproductive Biology): Students will be able to learn different field techniques of palaeobotany; how to explore plant mega fossils from natural fossiliferous beds;

BOT 496: During their M.Sc. dissertation/project work students will be able to know the different aspects of a research work in nutshell. 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. Therefore, students those who want to undertake research work in future, get training through this course.

BOT 497: Students will learn how to face jury in an interview board; what would be the probable questions asked during the comprehensive viva; how to answer those questions etc. everything will be learnt by them.

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COURSE STRUCTURE (M.Sc. in BOTANY)

SEMESTER	COURSE NO.	COURSE TITLES		Full Marks	No of lectures (hours)	Credit
I	BOT 101	MICROBIOLOGY		50	40	4 (3-1-0)
	BOT 102	PHYCOLOGY & BRYOLOGY		50	40	4 (3-1-0)
	BOT 103	MYCOLOGY & PLANT PATHOLOGY		50	40	4 (3-1-0)
	BOT 104	PTERIDOPHYTES & GYMNOSPERMS		50	40	4 (3-1-0)
	BOT 195	BOT 195.1	MICROBIOLOGY	25	50	2 (0-0-4)
		BOT 195.2	PHYCOLOGY & BRYOLOGY	25	50	2 (0-0-4)
	BOT 196	BOT 196.1	MYCOLOGY & PLANT PATHOLOGY	25	50	2 (0-0-4)
		BOT 196.2	PTERIDOPHYTES & GYMNOSPERMS	25	50	2 (0-0-4)
			TOTAL	300	360	24
II	BOT 201	PLANT TAXONOMY & BIOSYSTEMATICS		50	40	4 (3-1-0)
	BOT 202	PALAEOBOTANY, PALYNOLOGY & POLLINATION ECOLOGY		50	40	4 (3-1-0)
	BOT 203	ECOLOGY, ENVIRONMENTAL BIOLOGY & PHYTOGEOGRAPHY		50	40	4 (3-1-0)
	C-BOT 204	PLANTS AND SOCIETY (CBCS - I) / SWAYAM		50	40	4 (3-1-0)
	BOT 295	BOT 295.1	PLANT TAXONOMY & BIOSYSTEMATICS	25	50	2 (0-0-4)
		BOT 295.2	PALAEOBOTANY, PALYNOLOGY & POLLINATION ECOLOGY	25	50	2 (0-0-4)
	BOT 296	BOT 296.1	ECOLOGY & ENVIRONMENTAL BIOLOGY	25	50	2 (0-0-4)
		BOT 296.2	FIELD SURVEY & SOCIAL OUTREACH	25	50	2 (0-0-4)
			TOTAL	300	360	24
III	BOT 301	CELL BIOLOGY, GENETICS & BIOTECHNOLOGY		50	40	4 (3-1-0)
	BOT 302	PLANT PHYSIOLOGY, BIOCHEMISTRY & MOLECULAR BIOLOGY		50	40	4 (3-1-0)
	BOT 303	SPECIAL PAPER I		50	40	4 (3-1-0)
	BOT 303 A	Angiosperm Taxonomy & Molecular Systematics: ANGIOSPERM TAXONOMY				
	BOT 303 B	Applied Mycology & Plant Pathology : APPLIED MYCOLOGY				
	BOT 303 C	Cytogenetics, Molecular Biology & Biotechnology : CYTOGENETICS				
	BOT 303 D	Ecology & Biodiversity : ECOLOGY				
	BOT 303 E	Microbiology: General & Applied : MICROBIOLOGY: GENERAL				
	BOT 303 F	Palaeobotany, Palynology & Plant Reproductive Ecology : PALAEOBOTANY				
	BOT 303 G	Plant Physiology, Biochemistry & Molecular Biology : PLANT PHYSIOLOGY & BIOCHEMISTRY				
	C-BOT 304	PLANTS AND SOCIETY (CBCS - II) / SWAYAM		50	40	4 (3-1-0)
	BOT 395	BOT 395.1	CELL BIOLOGY, GENETICS & BIOTECHNOLOGY	25	50	2 (0-0-4)
		BOT 395.2	PLANT PHYSIOLOGY, BIOCHEMISTRY & MOLECULAR BIOLOGY	25	50	2 (0-0-4)
	BOT 396 A	Angiosperm Taxonomy & Molecular Systematics: ANGIOSPERM TAXONOMY			50	
	BOT 396 B	Applied Mycology & Plant Pathology : APPLIED MYCOLOGY				
	BOT 396 C	Cytogenetics, Molecular Biology & Biotechnology : CYTOGENETICS				
	BOT 396 D	Ecology & Biodiversity : ECOLOGY				
	BOT 396 E	Microbiology: General & Applied : MICROBIOLOGY: GENERAL				
	BOT 396 F	Palaeobotany, Palynology & Plant Reproductive Ecology : PALAEOBOTANY				
	BOT 396 G	Plant Physiology, Biochemistry & Molecular Biology : PLANT PHYSIOLOGY & BIOCHEMISTRY		25		2 (0-0-4)
	BOT 397	SEMINAR		25	50	2 (0-0-4)
		TOTAL		300	360	24
IV	BOT 401	BOT 401.1	SILVICULTURE, FOREST MENSURATION, SILVICULTURE SYSTEM & FOREST MANAGEMENT	25	20	4 (3-1-0)

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		BOT 401.2	PLANT ANATOMY & PHARMACOGNOSY	25	20	
	BOT 402	BOT 402.1	INSTRUMENTATION AND BIOSTATISTICS	25	20	4 (3-1-0)
		BOT 402.2	BIOINFORMATICS	25	20	
	BOT 403	SPECIAL PAPER II				
		BOT 403 A	Angiosperm Taxonomy & Molecular Systematics : MOLECULAR SYSTEMATICS	50	40	4 (3-1-0)
		BOT 403 B	Applied Mycology & Plant Pathology : PLANT PATHOLOGY			
		BOT 403 C	Cytogenetics, Molecular Biology & Biotechnology : MOLECULAR BIOLOGY & BIOTECHNOLOGY			
		BOT 403 D	Ecology & Biodiversity: BIODIVERSITY			
		BOT 403 E	Microbiology: General & Applied : MICROBIOLOGY: APPLIED			
		BOT 403 F	Palaeobotany, Palynology & Plant Reproductive Ecology : PALYNOLOGY & PLANT REPRODUCTIVE ECOLOGY			
		BOT 403 G	Plant Physiology, Biochemistry & Molecular Biology : BIOCHEMISTRY AND MOLECULAR BIOLOGY			
	BOT 494	BOT 494.1	FOREST MENSURATION & SURVEY (PRACTICAL)	25	20	2 (0-0-4)
		BOT 494.2	PLANT ANATOMY AND PHARMACOGNOSY (PRACTICAL)	25	20	2 (0-0-4)
		Special Paper (Practical)				
	BOT 495	BOT 495 A	ANGIOSPERM TAXONOMY & MOLECULAR SYSTEMATICS: Molecular Systematics	25	50	2 (0-0-4)
		BOT 495 B	APPLIED MYCOLOGY & PLANT PATHOLOGY: Plant Pathology (practical)			
		BOT 495 C	CYTOGENETICS, MOLECULAR BIOLOGY & BIOTECHNOLOGY: Molecular Biology and Biotechnology			
		BOT 495 D	ECOLOGY & BIODIVERSITY: Biodiversity (practical)			
		BOT 495 E	MICROBIOLOGY: GENERAL & APPLIED : Microbiology: Applied (practical)			
		BOT 495 F	PALAEOBOTANY, PALYNOLOGY & PLANT REPRODUCTIVE ECOLOGY : Palynology & Plant reproductive ecology			
		BOT 495 G	PLANT PHYSIOLOGY, BIOCHEMISTRY & MOLECULAR BIOLOGY: Biochemistry & Molecular Biology			
	BOT 496		GRAND VIVA	25	50	2 (0-0-4)
	BOT 497		PROJECT WORK (SPECIAL PAPER BASED)	50	100	4
			TOTAL	300	360	24
*			GRAND TOTAL	1200	1440	96

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List of Special Papers

Angiosperm Taxonomy & Molecular Systematics:
303 A: Angiosperm Taxonomy
403 A: Molecular Systematics
Applied Mycology & Plant Pathology
303 B: Applied Mycology
403 B: Plant Pathology
Cytogenetics, Molecular Biology & Biotechnology
303 C: Cytogenetics
403 C: Molecular Biology & Biotechnology
Ecology & Biodiversity
303 D: Ecology
403 D: Biodiversity

Microbiology: Basic & Applied
303 E: Microbiology - Basic
403 E: Microbiology – Applied
Palaeobotany, Palynology & Plant Reproductive Ecology
303 F: Palaeobotany
403 F: Palynology & Plant Reproductive Ecology

Plant Physiology, Biochemistry & Molecular Biology
303 G: Plant Physiology
403 G: Biochemistry and Molecular Biology

Distinctive features of the courses:

- **Value-added course:** BOT-401 & BOT-402
- **Employability/entrepreneurship/ skill development:** BOT-101, BOT-103, BOT-201, BOT-202, BOT-301, BOT-302 & BOT-494.
- **Digital content:** BOT-201, BOT-303 A & BOT-403 A, BOT-101
- **Ethics, gender, human values, environment & sustainability:** BOT-203 (Environment)

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SEMESTER – I

THEORY

BOT 101: MICROBIOLOGY Full 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. Organization and replication of genetic material in bacteria, plasmids; genetic recombination-conjugation, transformation, and transduction & gene-mapping.
9. Viruses : structural organization and chemistry of viruses; Cultivation of viruses; 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; Virus related agents– viroids and prions; virus-induced cancer. oncogenesis; antiviral drugs; HIV and its importance.
10. 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 floraof 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.

BOT 102: PHYCOLOGY & BRYOLOGY Full Marks: 50

BOT 102.1: PHYCOLOGY Marks: 25

1. Parameters used in classifying algae. Classification and recent status of various algal groups: Polyphasic approach, concept of biome classification. Concept of Streptophyta and algal origin of land plants.
2. Significant ultra-structural features of algae, Physiology and biochemistry of algal cell. Heterocyst – structure and functions. Endosymbiotic theory of origin of chloroplasts;

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3. Salient features of Cyanoprokaryote, Glaucophyta, Rhodophyta, Chlorophyta, and Heterokontophyta (Xanthophyceae, Bacillariophyceae, Phaeophyceae) with evolutionary tendencies and phylogeny.
4. Economic importance: Phycocolloids - agar-agar, alginic acid, carrageenan. Reclamation of soil by algae. Single cell protein. Algae in pisciculture. Source of hydrocarbon from algae. Pheromone in algae. Pathogenic algae.
5. Algae in diversified habitats. Red tide. Algal bloom. Eutrophication. Algal toxins and their impact. Bloom control measures.

BOT 102.2 : 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, Takakiales, and Sphagnales.
3. Bryophyte Ecology: Role of bryophytes in plant successionand pollution monitoring. Bryophyte as site indicators; Bryomonitoring.
4. Cytogenetics of bryophytes: Taxonomic implication of chromosome numbers and sex chromosome.
5. Bryophyte chemistry: Biochemistry of bryophytes with their taxonomic implications
6. Bryophytes biotechnology: Applications.
7. Ethno-Bryology: Applications of Bryophytes in ethnomedicinal aspects.

BOT 103 : MYCOLOGY & PLANT PATHOLOGY **Full Marks: 50**

BOT 103.1 : MYCOLOGY **Marks: 25**

1. Unique features of fungi: modern concept regarding placement of fungi in separate kingdom. Any modem classification with characters upto phylum.

2. Sporulation - types, factors affecting sporulation, spore liberation and dispersal.

3. Homothallism, heterothallism, physiological and molecular basis of mating systems, para sexuality.

4. Development and types of ascocarps and basidiocarps; Mechanism of ascospore and basidiospore discharge.

5. Mycotoxins - a general account with reference to aflatoxins.

6. Applied mycology. Use of fungi in antibiotics, organic acids and food production, role of fungi in biotechnology, including vaccine production etc., role of fungi in agriculture and forestry.

103.2: PLANT PATHOLOGY **Marks: 25**

1. History of plant pathology and its present status, plant disease, diagnosis, modern methods.
2. Production, liberation and dispersal of inoculums, inoculum potential.
3. Host pathogen interaction - mechanism of penetration, role of growth regulators.

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4. Defense mechanism of host - pre and post infectional structural as well as biochemical defense with reference to role of PR-proteins: systemic acquired resistance.
5. Control of plant diseases - exclusion, eradication.
6. Epidemiology & Disease forecasting.
7. 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.

BOT 104: PTERIDOPHYTES & GYMNOSPERMS Full Marks: 50

BOT 104.1: PTERIDOPHYTES 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.

BOT 104.2: 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 in 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.

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Semester I PRACTICAL

BOT 195.1: 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

BOT 195.2: 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 inside State or Outside state)]
4. Students are required to submit field survey report and laboratory records, preserved and dried specimens and permanent slides.

BOT 196.1 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.

BOT 196.2 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 megafossils).
3. Field work

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** (Submission of field and laboratory records including permanent slides)

GYMNOSPERMS

1. A comparative study of the vegetative and reproductive parts of extant gymnosperms.
2. Study of some fossil gymnosperms.
3. Fieldwork.

** (Submission of field and laboratory records including permanent slides).

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SEMESTER – II

THEORY

BOT 201: PLANT TAXONOMY & BIOSYSTEMATICS Full Marks: 50

BOT 201.1: PLANT TAXONOMY Marks 25

1. Introduction: Definition of terms: Systematics, Taxonomy, Classification, Nomenclature, Identification; homology and homoplasy; plesiomorphy and apomorphy; monophyly, paraphyly and polyphyly; Flora, Vegetation, Monographs, Revision.
2. Classification: History and current systems of classification with Putative
3. Relationships: Takhtajan and Cronquist system of classification, Salient features, evolutionary trends and phylogeny in Magnoliidae, Hamamelidae, Caryophyllidae, Rosideae, Asteridae, Alismatidae and Liliidae (sensu lato Cronquist, 1981) and Outline concept of APG System of plant classification, concepts of palaeoherbs, eudicots.
4. Herbarium: Traditional and digital Herbarium, Methods of Herbarium preparation, local, regional, national and international Herbaria. Utilities of Herbarium.
5. ICN: Principles of ICBN, ICN, Biocodes or Phylocodes. Rejection of Names,
6. Effective and valid publications, Typification, Author's citation.

BOT 201.2: BIOSYSTEMATICS Marks 25

1. Biosystematics: Definition, principles, methods, categories and differences with classical taxonomy.
2. Taxonomic supportive evidences: Palynology, Ultrastructural morphology (Micro-morphology), Cytology, Phytochemistry.
3. Numerical Taxonomy: Phenetic and cladistic methods, Determination of phenetic/ cladistic structure.
4. Biodiversity: Level, spatial scale, loss, importance, value.
5. Ethnobotany: Definition, relevance and uses in human welfare.

BOT 202: PALAEOBOTANY, PALYNOLOGY & PLANT REPRODUCTIVE BIOLOGY Full Marks 50

BOT 202.1: PALAEOBOTANY 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.

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8. Radiometric datings: Basic principles of radiometric dating; radio-carbon dating.
9. Use of fossil plants in deciphering past vegetational and ecological history.

BOT 202.2: PALYNOLOGY & 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. Extraexinous wall material - perine, viscin-threads, pollen-kit.
5. Application of palynology in taxonornic 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, Immunoelctrophoresis, 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.

BOT 203: ECOLOGY, ENVIRONMENTAL BIOLOGY & PHYTOGEOGRAPHY Full Marks:50

BOT203.1: 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 hyper volume 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).

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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, randk selection, population interactions.

BOT203.2: 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 Ramsarsites– 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. EnvironmentalMovements 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. Earthsummits, Central pollution control board, State pollution control board: general idea.
9. Biodiversity in relation with Phytogeography- introduction, continuous and discontinuous distribution, phytogeography of India, vegentational regions of India. Plant indicators.

BOT 204: CBCS – I; PLANTS AND SOCIETY (Part - I) Full Marks: 50

BOT 204.1: General Concept on Plant Kingdom Marks: 25

1. Five Kingdom Concept (R. H. Whittaker, 1969) and Three domain concept (Woese et al. 1990) of Biological Classification.
2. General idea of different groups of Microbes and Plants – Bacteria, Virus, Algae, Fungi, Lichen, Bryophyta, Pteridophyta, Gymnosperm and Angiosperms.
3. Economic uses of bacteria, algae and fungi. Production of Cheese, Sausage, Pudding, Wine and Oriental fermented food
4. An outline approach on plant cell and organelles, tissues and organs. Types of plant tissues.
5. Types of inflorescence, flower and fruit

BOT 204.2: Socio-economic aspects of Plants Marks: 25

1. Uses of different plant parts Cereals and pulses (rice, wheat, maize, barley, lentil, mung, pigeon pea), edible and essential oil yielding plants (mustard, sunflower, rice bran, lemon grass, eucalyptus),: Spices and condiments (Foeniculum, Nigella, Carum, Coriander, Black

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Pepper, Chilli, Turmeric, Ginger), beverage (Tea, Coffee), fibre yielding (Jute, Cotton) dyeyieldingplants (neel, mehendi ,lipstick tree).
2. Plants of special uses (Cork, Mat Grass, Sugarcane, Babui Grass, Vetiver Grass)
3. Ethno-Medicinal plants (*Adhatoda zeylanica*, *Ocimum*sp., *Aloevera*,*Andrographis paniculata*, *Centella asiatica*, *Abrus precatorius*, *Strychnos nux-vomica*).
4. Commercial uses of fossil plant (Coal, Petroleum, Amber, Diatomites)

SEMESTER II PRACTICAL

BOT 295.1: 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. Fields 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.

BOT 295.2 PALAEOBOTANY, PALYNOLOGY & PLANT REPRODUCTIVE BIOLOGY

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 & Plant Reproductive Biology

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.

(Submission of laboratory records including permanent slides)

BOT 296.1 ECOLOGY, ENVIRONMENTAL BIOLOGY & PHYTOGEOGRAPHY Marks: 25

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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.

BOT 296.2 FIELD SURVEY AND SOCIAL OUTRICH **Marks: 25**

1. Field survey, submission of report and viva-voce.
2. Visit at different phytogeographical regions of India including outside the state of West Bengal.

Evaluation of BOT 296.2 will be made only by External Experts.

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SEMESTER III

THEORY

BOT 301: CELL BIOLOGY, GENETICS & BIOTECHNOLOGY Full Marks: 50

BOT 301.1: CELL BIOLOGY & GENETICS Marks: 25

1. Ultra-structure of Nucleus, Nucleolus, Chromatin – Euchromatin and Heterochromatin.
2. Cell cycle: Biochemical and molecular events associated with the 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 function.
4. Chromosome banding: G banding, Fluorescent banding, R banding, C banding, NOR banding. FISH, GISH.
5. Extension of Mendelian genetic analysis: Gene interactions and modified Mendelian ratios; Multiple factor and Polygenic inheritance, Linkage, Crossing over, Chromosome mapping, Molecular basis of recombination.
6. Extranuclear inheritance: definition, types (maternal inheritance, organeller inheritance and infectious heredity) explained with the examples of skin pigmentation of larvae of Ephestia kuehniella, shell coiling of Limnaea peregra, variegated leaves of Mirablis and maize, kappa particle of Paramoecium, CO2 sensitivity and sex ratio of Drosophila.
7. Sex determination: basic types, Lyon hypothesis, dosage compensation - types, Barr body, Sex linked inheritance, sex influenced, sex linked and sex limited characters.
8. Transposable elements: definition, transposon and retroposon. Characteristic features of IS elements, Ac/Ds element and Copia element.
9. Population genetics: Hardy-Weinberg Hypothesis, factors affecting allelic frequency in population. Genetic drift, inbreeding depression.

BOT 301.2: BIOTECHNOLOGY Full Marks: 25

1. Structural conformations of DNA (A, B and Z), major types of RNA. Biogenesis of ribosomes
2. DNA replication (outline procedure only), requisite factors and their roles.
3. Recombinant DNA technology - an overview. Structure and properties of Plasmids, Cosmids, Phagemids. Bacterial artificial chromosomes (BACs). Yeast artificial chromosomes (YACs). Plasmid isolation. Restriction enzymes, digestion, agarose gel electrophoresis. Transformation.
4. Cloning strategies and screening of recombinant clones. Lac operon: Blue/white selection. Purification and characterization of recombinant plasmid DNA; Expression vector - over expression and expression analysis; Applications of recombinant DNA in agriculture and medicine (some examples).
5. Transcription: Molecular mechanisms of transcription; Regulation of gene expression with special reference to two component gene regulatory system. RNA processing.
6. Gene library: Construction of cDNA library and genomic library. Screening of libraries.
7. DNA hybridization and sequencing: Generation of radiolabeled probe and blotting techniques; Southern and Northern hybridization; DNA Sequencing methods.

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8. Blotting techniques. RFLP, RAPD, AFLP, ISSR, ITS, DNA finger printing. Chromosome walking, Chromosome jumping. Microarray. PCR, RT-PCR (all procedures and applications).
9. Plant breeding: Plant introduction, pure line selection, back cross, pedigree selection, mass selection and clonal selection (Procedures). Heterosis. Transgenic inheritance. Composite and Synthetic varieties.
10. 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.

BOT 302: PLANT PHYSIOLOGY & BIOCHEMISTRY Full Marks: 50

BOT302.1: PLANT PHYSIOLOGY Marks: 25

1. *Photosynthesis and Respiration*

a. Genes and polypeptide components of photosynthetic complexes; Bioenergetics of light reaction, Generation of proton gradient and ATP synthesis; Water to Water Cycle; CO2concentratingmechanism in plants; Regulation of C2,C3, C4and CAM cycles.
b. Metabolic regulation of glycolysis, acetyl CoA synthesis and citric acid cycle; Mitochondrial electron transport complexes – structure, function; Mechanism of ATP synthesis; Gluconeogenesis; Glyoxylate cycle.

2. *Transport mechanism of water, ions and macromolecules*

Mechanisms of uptake and transport of water, ions, solutes and macromolecules fromsoiltoplants,Iontransporter-types,structureandfunction;Mechanismsofloadingand unloadingof photo assimilates.

3. *Developmental physiology*

a. Concept of hormones as chemical messengers, Biosynthesis and mechanisms of action of hormones, synthetic regulatory compounds and their uses.
b. 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.
c. Physiology of senescence and aging - Senescence promoters, whole plant senescenceand organ senescence, hormonal and environmental control of senescence, programmed cell death in lifecycle of plants.
d. Concept of dormancy and quiescence, types of dormancy, seed viability, dormancy enforcement and termination, biochemical and molecular basis of dormancy, hormonal regulation of dormancy and germination, circadian clock and germination control.

BOT302.2: BIOCHEMISTRY AND MOLECULAR BIOLOGY Marks: 25

1. *Biomolecules*

a. Protein: Hierarchy of protein structure, motifs and domains, torsion angle and Ramachandran plot, Forces stabilizing protein structure, fibrous proteins (keratins andcollagen), globular protein; Protein folding: Levinthal paradox, different models and concept of chaperones.

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b. Carbohydrates: Simple and conjugated sugars, nomenclature; structure; stereochemistry- Fischer projection, Haworth perspective, boat and chair conformation; mutarotation; glycoside formation; Derivative sugar; glycoproteins and proteoglycans.

c. Lipid: simple and conjugated lipid, different neutral & polar classes, nomenclature of different fatty acids, lipidomics concept.

2. *Enzymology and Metabolism*

Enzyme activity and specificity, Constitutive and Induced enzymes; Activesite, 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, irreversible with one example in each case.

3. *Nitrogen metabolism:* Structure and function of nitrogenase, Mechanism of nodule formation; Nitrate assimilation in plants.

4. *Lipid metabolism:* Biosynthesis andoxidation of fatty acids, regulation of FAS, Phospholipid synthesis and sterolsynthesis, LOX for biotic and abiotic stress.

5. *Reactive oxygen species*–formation, role and scavenging activity.

6. *Secondary metabolites* and metabolite trafficking; Biosynthetic pathways for secondary metabolism; Biological activities of phyto constituents (phenols and phenolic glycosides, sterols, steroidal alkaloids, stanols, miscellaneous isoprenoids, saponins, alkaloids, volatile oils, lipids and carbohydrates); turnover and degradation of secondary metabolites.

PAPER: BOT 303 (SPECIAL)

BOT 303 A. ANGIOSPERM TAXONOMY Full Marks: 50

1. Definition: Taxonomy and Systematics, Molecular Systematics, Concept of Monophyly, Paraphyly, Homoplasy & Polyphyly; Pleiomorphic & Apomorphy; Homology & Homoplasy; Convergent & Divergent, 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: Nomenclatural types, Basic differences between ICBN & ICN, ICN-Principles and rules (Articles 1-62).
4. The Angiosperms Phylogeny Group (APG) classification (APG-IV-2016 of flowering plant: Phylogenetic relationships of Angiosperms. Concepts of Basal Angiosperms, Palaeoherbs, Eudicots.
5. Biodiversity: Definition, importance, levels, Megadiverse countries, Hot spots, Indian hotspots. spatial distribution, value, and loss; IUCN categories of threatened species.

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6. Conservation: Strategies for conservation (in-situ and ex-situ), concept and types of protective areas; the role of Botanic gardens; Cryopreservation: Seed banks, pollen banks, gene banks, germplasm conservation.
7. Phytogeography: Phytogeographic regions of India (According to Prof. D. Chatterjee),C classification of the vegetation of India. Endemism, disjunction: Invasions and Introductions.
8. Digital Herbarium: Concept & application.

BOT 303 B: APPLIED MYCOLOGY **Full Marks: 50**

1. Spindle pole bodies (SPBs) – different types found in fungi and their function.
2. Heterokaryosis – definition, occurrence, significance, modes of formation.
3. Spore dormancy – exogenous dormancy, endogenous dormancy.
4. Importance of fungi – nutrient recycling, biofertiliser, siderophore production phosphate solubilisation, growth promoter, bioremediation, soil formation, biocontrol agent.
5. Edible fungi – SCP, marmite, vegemite, quorn, tempeh, ang kak, soy sauce, cheese, miso.
6. Production of citric, gluconic, itaconic, lactic, oxalic, fumaric, malic, succinic acids by fungi.
7. Production of free radicals and their roles in some human ailments.
8. Production of penicillin, cephalosporin, griseofulvin, strobilurin, sordarin, gentamycin, plectasin, cyclosporin, cilofungin.

CYTOGENETICS, MOLECULAR BIOLOGY & BIOTECHNOLOGY

BOT 303 C: CYTOGENETICS **Full 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 (microfilament), microtubule, 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: types.
11. Population genetics: factors affecting allelic frequency, bottle neck effect, founder effect.

ECOLOGY AND BIODIVERSITY

BOT 303D: ECOLOGY **Full Marks: 50**

1. Principles and current concepts in ecology.
2. Structureandfunctionofecosystemsincludingforest,mangroveandaquaticsystems.
3. Plantcommunity:Qualitativeandquantitativecharacteristics,phytosociologicalmethods

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4. Environmental diary- Stockholm conference, Montreal protocol, Reo earth summit, Kyoto protocol, Ramsar convention, COP 16.
5. Environmental disasters–Londonsmog, 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.

MICROBIOLOGY- BASIC and APPLIED

BOT 303 E: MICROBIOLOGY- BASIC Full 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. Esthetical issues of genetic engineering. Molecular biology of the bacteriophage lambda, M13 and P1.
11. Plant-microbe relationship, microbe 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.

PALAEO BOTANY, PALYNOLOGYAND PLANT REPRODUCTIVE ECOLOGY

BOT 303F: PALAEOBOTANY Full Marks:50

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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 theunits 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-Devonianlandfloras; Permo-Carboniferous floralprovinces; Devonian and Carboniferous floras of North-West India.
5. Early Mesozoic floras of Molteno and Chinle formations, later Mesozoic floras of York shire 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 palaeo floristics; Distribution of Tertiary strata in India; Palaeo genepalaeo floristics and palaeoecology of Peninsular India; Neogenepalaeo floristics and palaeoecology of Peninsular (Cuddalore Group and Bengal Basin) and Extrapeninsular (Siwalik Group) India.
9. Archaeobotany of Indian cultivated plants.

PLANT PHYSIOLOGY, BIOCHEMISTRY AND MOLECULAR BIOLOGY
BOT 303G: PLANT PHYSIOLOGY Full 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 stresses, 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 defence 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.

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BOT 304: CBCS - II; PLANTS AND SOCIETY (Part - II) Full Marks: 50

BOT 304.1: Plant and Environment Marks: 25

1. Ecosystem – terrestrial, aquatic (fresh water and marine), hill, mangrove.
2. Plant and ecological balance, Biomonitoring,
3. Phytoremediation,
4. Biodiversity, conservation and sustainable development,
5. Social ecology (Community movements and laws).

Unit – II: Biotechnology and Human Welfare Marks: 25

1. Microbial biotechnology: Cheese, Sausage, Pudding, Wine and oriental fermented food.
2. Plant biotechnology: Plant tissue culture, GM (transgenic) plants,
3. Petrocrops and biodiesel.

SEMESTER III PRACTICAL

BOT 395.1: CELL BIOLOGY, GENETICS AND BIOTECHNOLOGY
Marks: 25

1. Preparation of Pre-treating agents, fixatives and stains for cytological works.
2. Study of mitotic cell division (with the root tip and/or leaf tip meristematic tissue).
3. Study of meiotic cell division, stages of meiosis I & II divisions (with the Pollen Mother Cells of locally available plants).
4. Determination of mitotic index.
5. Karyotyping: the basic method (with the well spread chromosomes of mitotic metaphase from worked out specimen or from earlier drawn picture or photograph).
6. Plant Tissue Culture: Media preparation, Inoculation in front of laminar air-flow and maintenance of culture. (for demonstration only and not recommended for examination except viva voce).
7. Measures of dispersion: Standard Deviation, Standard Error.
8. Chi square test for goodness of fit of (Fixed ratio hypothesis, Homogeneity Ratio and Contingency table).

BOT 395.2 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.

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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.

BOT 396: Special Paper Practical **Full Marks: 25**

ANGIOPERM TAXONOMY AND MOLECULAR SYSTEMATICS

BOT396 A: ANGIOSPERMTAXONOMY **Full Marks25**

1. Taxonomic study of local flora, preparation of identification 'Keys' and identification of plants by use of key.
2. Acquaintance with taxonomic literature (Index Kewensis, Dictionaries, Manuals, Bibliographies and Flora) and their use.
3. Work out on inter/and intra specific morphological variations.
4. Bio systematics study: Comparative study of the starch grains on different storage organs, Ovules, Stomata, Seed and germination and Fruit morphology. Work out on pollen morphology of angiospermic taxa to study inter/ intraspecific and inter generic Palynological variations.
5. Field Study: One excursion to Acharya Jagadish Chandra Bose Indian Botanic Garden (Shibpur, Howrah) and Central National Herbarium (CNH).
6. Field visit to at least one phytogeographical region of India with rich biodiversity. Preparation of Field Note Book (authenticated) 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.

APPLIED MYCOLOGY and PLANT PATHOLOGY

396 B 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.

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7. Use of selective media.
8. Isolation of fungi from water / soil / air.

CYTOGENETICS, MOLECULAR BIOLOGY AND BIOTECHNOLOGY

BOT 396 C: CYTOGENETICS Full Marks25

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 ource 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.

ECOLOGY AND BIODIVERSITY

BOT396 D: ECOLOGY Full Marks: 25

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

MICROBIOLOGY: BASIC AND APPLIED

BOT 396 E: MICROBIOLOGY: GENERAL Full 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.

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PALAEOBOTANY, PALYNOLOGY AND PLANT REPRODUCTIVE ECOLOGY

BOT 396 F: PALAEOBOTANY Full Marks: 50

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.

PLANT PHYSIOLOGY, BIOCHEMISTRY AND MOLECULAR BIOLOGY:

BOT 396 G: PLANT PHYSIOLOGY Full 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

BOT 397 SEMINAR Marks: 25

Review on any topic selected by the candidates and its presentation through seminar.

The seminar paper will be evaluated only by the external experts.

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SEMESTER-IV

THEORY

BOT 401 **Full Marks: 50**

BOT 401.1 - SILVICULTURE, SILVICULTURE SYSTEM AND MENSURATION

Marks: 25

1. Silviculture: Definition, scope & objective.
2. Classification of Forest, Farm Forestry, Social Forestry & Agro-forestry.
3. Factors of locality: climatic (Light, Temperature & Frost). Topographic (Effect of Altitude, Aspect & Exposure. Edaphic: General, Parental rock influence 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: Shelterwood 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. Measurement of height of tree: principles of height measurement (similar, triangle and trigonometric). Volume: measurement of volume of standing and felled trees, volume table.
10. Joint Forest Management: concept.

BOT 401.2 PLANT ANATOMY AND PHARMACOGNOSY Full Marks 25

A. 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; structure of floral nectaries and seed coat.
6. Secretory tissues in plants: Structure and distribution of secretary trichomes (Drocera, Nepenthes), Salt glands, Colleters, Nectaries, Resin ducts and Laticifers.
7. Laticifers: Types, Structure, Development and Economic importance of latex.

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B. PHARMACOGNOSY

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

BOT 402.1 INSTRUMENTETION AND BIOSTATISTICS Full 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. Principle; 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

BOT 402.2 BIOINFORMATICS Full 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.

PAPER: BOT 403 (Special Paper)

ANGIOSPERM TAXONOMY & MOLECULAR SYSTEMATICS

BOT 403A: MOLECULAR SYSTEMATICS Full Marks 50

1. Definition: Molecular Systematics, Molecular Phylogenetics, Objectives of molecular taxonomy & Systematics, Clade, Cladistics, Co-evolution.

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2. Molecular Systematics: Molecular characters (cpDNA, mtDNA, nuclear gene & ITS), Types of molecular data and analysis.
3. Phylocode & Biocodes: Principle and applications.
4. Numerical Systematics or Neo-Adansonian Taxonomy: Objectives and principles, Phenetic and Cladistic methods, construction of taxonomic groups (OUTs 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 and Medicinal 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.

APPPLIED MYCOLOGY and PLANT PATHOLOGY

BOT 403B: PLANT PATHOLOGY **Full 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 of importance to plant pathology.
8. Development of disease resistant transgenic plants through Ti plasmid mediated gene transfer.

CYTOGENETICS, MOLECULAR BIOLOGY & BIOTECHNOLOGY

BOT 403C: MOLECULAR BIOLOGY & BIOTECHNOLOGY **Full 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.

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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.

ECOLOGY & BIODIVERSITY

BOT 403 D: ECOLOGY **Full 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.

MICROBIOLOGY: BASIC and APPLIED

BOT 403E: MICROBIOLOGY – Applied **Full 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.

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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.

PALYNOLOGY AND PLANT REPRODUCTIVE ECOLOGY

BOT 403 F: PLANTREPRODUCTIVE ECOLOGY Full Marks: 50

1. Trend of apertural and exine evolution in the pollen grains of angiosperms.
2. Pollination biology and pollen-pistil interaction: concept & significance; role of s allelein controlling gametophytic and sporophytic incompatibility, molecular basis of self-incompatibility.
3. Pollenbiotechnologyandcropimprovement:Overcomingpollinationconstraints,pollination control system for commercial production of hybrid seed through use of cytoplasmic male sterility (CMS),genicmale sterility(GMS) and rDNA technology.
4. Pollen physiology and chemistry: Structure and chemical nature of pollen wall and ubisch body, pollen-expressed and pollen-specificgenes.
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 ofcoal,coalpalynology;petroleum,itsorigin,migrationandconcentration,roleofpalynologyin 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 flowershapes, vii. Flower sizeand sizerange.
8. Pollinationsyndrome:Floweradaptationtodifferentpollinators(Biotic):Flowerspollinated by: I Hymenoptera, ii. Diptera, iii. Coleoptera, iv. Lepidoptera, v. Birds, vi. Bats, vii. Nonflying mammals.
9. Floral advertisement &Floral rewards: i. Visual signals and Flower colors, ii. Pollen asrewards,iii. Nectar as reward, iv. Mimicryin flower.
10. Breedingsystem&Pollinationi.SexExpression:Bisexual&Unisexualflowers;Monoecy and Dioaecy, ii. Dichogamy, iii. Herkogamy, iv. Heterostyly, v. Autogamy &allogamy:Inbreedingand out breeding.

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PLANT PHYSIOLOGY, BIOCHEMISTRY AND MOLECULAR BIOLOGY

BOT 403G: BIOCHEMISTRY AND MOLECULAR BIOLOGY Full Mark: 50

1. Fundamental concepts of Chemistry for explaining the properties of Biomolecules:Chemicalbonds,stabilizinginteractions(Vanderwalls,electrostatic,H-bonding,hydrophobicinteractions), biophysical chemistry (pH,buffer, reaction kinetics, colligative properties), Conformation of Protein (Secondary, tertiary, quaternary structures, domains, Motifs, Folds, Ramachandran Plot, Chaperonin and Protein folding), Nucleicacids (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. Omicsciences 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,capillary electrophoresis), Chromatography (HPLC, GLC ,Affinity chromatography, Ionexchange chromatography,), Spectroscopy (UV-VIS, fluorescence, NMR), X-raydiffraction, Massspectrometry, Radio labeling techniques, Blotting techniques.

SEMESTER-IV PRACTICAL

BOT 494.1: FOREST MENSURATION AND SURVEY Full 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.

BOT494.2 PLANTANATOMYAND PHARMACOGNOSY Full Marks: 25

A. PLANT ANATOMY

1. Cell types-trichomes, sclereids, tracheids, vessels and sieve tube elements.
2. Secretary structures and cell inclusions-nectaries, glandularhairs, oilglands, saltglands,resin canals, laticifers, phytoliths, cystolith andcrystals.
3. Nodal anatomy-unilacunar, trilacular, multilacunar

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4. Anatomy of bark
5. Wood anatomy fromTS, TLS, and RLS of woody plants.
6. Ecological leaf anatomy: sun and shade leaves, xeromorphic, succulent, halophytic and hydromorphic leaves.

B. PHARMACOGNOSY

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

BOT 495: SPECIAL PAPER **Full Marks: 25**

BOT 495 A: MOLECULAR SYSTEMATICS

1. Taxonomic study of unknown plants of local flora, preparation of identification 'Keys' and identification of plants by use of keys and matching
2. Acquaintance with taxonomic literature (Index Kewensis, Dictionaries, Manuals, Bibliographies and Flora) and their use
3. Workout of inter/ and intraspecific morphological variations
4. Biosystematics study: Comparative study of the starch grains on different storage organs, Ovules, Stomata, Seed and germination study, 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.

BOT 495 B: Applied Mycology and Plant Pathology

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.

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BOT495 C: CYTOGENETICS, MOLECULAR BIOLOGY & BIOTECHNOLOGY

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)

BOT 495 D: ECOLOGY & BIODIVERSITY

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.

BOT 495 E: MICROBIOLOGY: APPLIED

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 Rizobium from root nodule.
10. Study of immune-diffusion technique.
11. Visit to a place of microbiological interest.

BOT 495 F: PALAEOBOTANY, PALYNOLOGY & PLANT REPRODUCTIVE BIOLOGY

1. Field techniques in palaeobotany.

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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.

BOT 495 G: PLANT PHYSIOLOGY, BIOCHEMISTRY & MOLECULAR BIOLOGY

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

BOT 496: GRAND VIVA **Marks: 25**

Grand Viva based on all topics of Botany covering all disciplines under the subject.

BOT 497: PROJECT WORK **Marks: 50**

PROJECT WORK (based on Special Paper): M.Sc. Thesis/Dissertation/Review Work

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.

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