VIDYASAGAR UNIVERSITY

MIDNAPORE

Botany Syllabus for M.Sc. Degree

Choice Based Credit System (CBCS)

[w.e.f. : 2018-19]

Prepared by

Department of Botany & Forestry

VIDYASAGAR UNIVERSITY

MIDNAPORE - 721102

PROGRAM OUTCOME

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 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: Teaching in 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 STRUCTURE

SEMESTER	COURSE NO.	COURSE TITLES		Full Marks	Credit
I	BOT 101	MICROBIOLOGY		50	4
	BOT 102	PHYCOLOGY & BRYOLOGY		50	4
	BOT 103	MYCOLOGY & PLANT PATHOLOGY		50	4
	BOT 104	PTERIDOPHYTES & GYMNOSPERMS		50	4
	BOT 195	BOT 195.1	MICROBIOLOGY	25	2
		BOT 195.2	PHYCOLOGY & BRYOLOGY	25	2
	BOT 196	BOT 196.1	MYCOLOGY & PLANT PATHOLOGY	25	2
		BOT 196.2	PTERIDOPHYTES & GYMNOSPERMS	25	2
		TOTAL		300	24
II	BOT 201	ANGIOSPERM TAXONOMY & BIOSYSTEMATICS		50	4
	BOT 202	PALAEOBOTANY, PALYNOLOGY & PLANT REPRODUCTIVE BIOLOGY		50	4
	BOT 203	PLANT ANATOMY AND PHARMACOGNOSY		50	4
	C-BOT 204	*PLANTS AND SOCIETY-I (CBCS)*		50	4
	BOT 295	BOT 295.1	ANGIOSPERM TAXONOMY & BIOSYSTEMATICS	25	2
		BOT 295.2	PALAEOBOTANY, PALYNOLOGY & PLANT REPRODUCTIVE BIOLOGY	25	2
	BOT 296	BOT 296.1	PLANT ANATOMY & PHARMACOGNOSY	25	2
		BOT 296.2	FIELD SURVEY REPORT	25	2
		TOTAL		300	24
III	BOT 301	CELL BIOLOGY, GENETICS & BIOTECHNOLOGY		50	4
	BOT 302	PLANT PHYSIOLOGY, BIOCHEMISTRY& MOLECULAR BIOLOGY		50	4
	BOT 303	ECOLOGY & ENVIRONMENTAL BIOLOGY		50	4
	C-BOT 304	*PLANTS AND SOCIETY-II (CBCS)*		50	4
	BOT 395	BOT 395.1	CELL BIOLOGY, GENETICS& BIOTECHNOLOGY	25	2
		BOT 395.2	PLANT PHYSIOLOGY, BIOCHEMISTRY& MOLECULAR BIOLOGY	25	2
	BOT 396	BOT 396.1	ECOLOGY & ENVIRONMENTAL BIOLOGY	25	2
		BOT 396.2	SEMINAR	25	2
		TOTAL		300	24
IV	BOT 401	SILVICULTURE, FOREST MENSURATION, SILVICULTURE SYSTEM & FOREST MANAGEMENT		50	4
	For BOT 402 & BOT 403 (SPECIAL PAPER) Any one of A/B/C/D/E/F/G will be opted				
	BOT 402	BOT 402A	ANGIOSPERM TAXONOMY	50	4
		BOT 402B	CYTOGENETICS		
		BOT 402C	ECOLOGY		
		BOT 402D	MICROBIOLOGY: BASIC		
		BOT 402E	APPLIED MYCOLOGY		
		BOT 402F	PALAEOBOTANY		
		BOT 402G	PLANT PHYSIOLOGY		
	BOT 403	BOT 403A	MOLECULAR SYSTEMATICS	50	4
		BOT 403B	MOLECULAR BIOLOGY & BIOTECHNOLOGY		
		BOT 403C	BIODIVERSITY		
		BOT 403D	MICROBIOLOGY: APPLIED		
		BOT 403E	PLANT PATHOLOGY		
		BOT 403F	PALYNOLOGY & PLANT REPRODUCTIVE BIOLOGY		
		BOT 403G	BIOCHEMISTRY AND MOLECULAR BIOLOGY		
	BOT 494	FOREST MENSURATION & SURVEY(practical)		25	2
	BOT 495	BOT 495A	ANGIOSPERM TAXONOMY & MOLECULAR SYSTEMATICS (practical)	50	4
		BOT 495B	CYTOGENETICS, MOLECULAR BIOLOGY & BIOTECHNOLOGY (practical)		
		BOT 495C	ECOLOGY & BIODIVERSITY (practical)		
		BOT 495D	MICROBIOLOGY (practical)		
		BOT 495E	MYCOLOGY & PLANT PATHOLOGY (practical)		
		BOT 495F	PALAEOBOTANY, PALYNOLOGY & PLANT REPRODUCTIVE BIOLOGY (practical)		
		BOT 495G	PLANT PHYSIOLOGY, BIOCHEMISTRY & MOLECULAR BIOLOGY (practical)		
	BOT 496	PROJECT WORK (SPECIAL PAPER BASED)		50	4
	BOT 497	GRAND VIVA		25	2
		TOTAL		300	24
		GRAND TOTAL		1200	96

*List of Special Papers (Choice based)

1. **Angiosperm Taxonomy & Molecular :**

   Systematics: 402A: Angiosperm Taxonomy

   403A: Molecular Systematics

2. **Cytogenetics & Biotechnology**

   402B: Cytogenetics

   403B: Molecular Biology & Biotechnology

3. **Ecology & Biodiversity**

   402C: Ecology

   403C: Biodiversity

4. **Microbiology: Basic & Applied**

   402D: Microbiology - Basic

   403D: Microbiology - Applied

5. **Mycology & Plant Pathology**

   402E: Applied Mycology

   403E: Plant Pathology

6. **Palaeobotany, Palynology & Plant Reproductive Biology**

   402F: Palaeobotany

   403F: Palynology & Plant Reproductive Biology

7. **Plant Physiology, Biochemistry & Molecular Biology**

   402G: Plant Physiology

   403G: Biochemistry and Molecular Biology

SEMESTER – I

THEORY

PAPER: BOT 101: MICROBIOLOGY Full Marks: 50

Course Outcome: Students will get information about the subject Microbiology. They 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.

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, *nif* genes, leghemoglobin and hydrogenase;

nod genes, Nod factors; 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, Penicillin, SUFU.

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

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PAPER: BOT 102: PHYCOLOGY & BRYOLOGY **Full Marks: 50**

Course Outcome: 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. The content in Bryology gives information on position and classification of the group, characteristics of different groups and economic uses of different members.

UNIT I: PHYCOLOGY **Marks: 25**

1. Parameters used in classifying algae: Classification and recent status of various algal groups: concept of Streptophyta and algal origin of land plants.

2. Algae in diversified habitats; Range in thallus organization; ultra-structure, Physiology and biochemistry of algal cell; Endosymbiotic theory of origin of chloroplasts;

3. Salient features of Cyanobacteria, Chlorophyta, Heterokontophyta (Xanthophyceae, Bacillariophyceae, Phaeophyceae) and Rhodophyta with special emphasis on evolutionary tendencies and phylogeny.

4. Economic importance : Phycocolloids - agar-agar, alginic acid, carageenan; Reclamation of soil by algae; Single cell protein; Algae in pisciculture; source of hydrocarbon from algae; Pheromone in algae, pathogenic algae.

UNIT II: BRYOLOGY **Marks: 25**

1. Outline of recent classification of bryophytes into three coordinate phyla: Marchantiophyta (liverworts), Anthocerophyta (hornworts) and Bryophyta (mosses).

2. Origin, evolution and fossil history of bryophytes. Characteristics, affinities and systematic position of Calobryales, Takakiales and Sphagnales. Comparative

study of the gametophyte and sporophyte of major groups with special reference to Indian forms.

3. Ecology, physiology, culture and economic importance of bryophytes; Role of bryophytes in plant succession and pollution monitoring. Bryophyte as site indicators; Bryomonitoring.

4. Cytogenetics of bryophytes, taxonomic implication of chromosome numbers and sex chromosome.

5. Bryophyte chemistry and taxonomic implications, biotechnology of Bryophytes.

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

Course Outcome: 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.

UNIT I: MYCOLOGY **Marks: 25**

1. Unique features of fungi: Modern concept regarding placement of fungi in separate kingdom. Any modern classification with characters upto phylum.
2. Homothallism, heterothallism, physiological and molecular basis of mating systems.
3. Ascomycota: Diversity of thallus structures and evolutionary trends in asexual and sexual reproductions, asci and their bearing on taxonomy; Development and types of ascocarps; Mechanism of ascospore discharge.
4. Basidiomycota: Somatic structures, reproduction; Mating system and classification; Origin and structures of basidiospores, basidia, and basidiocarps; Mechanism of basidiospore discharge.

5. Applied mycology: Use of fungi in antibiotics, organic acids and food production, role of fungi in biotechnology including vaccine production, in agriculture and forestry.
6. Mycotoxins: A general account with reference to aflatoxins & phytoalexins.

UNIT II: PLANT PATHOLOGY **Marks: 25**

1. History of plant pathology and its present status; Classification of plant diseases, diagnosis, modern methods; Knowledge on the agents of infectious and non-infectious diseases; Role of environment in disease development.
2. Production, liberation and dispersal of inoculums, inoculum potential.
3. Host pathogen interaction - mechanism of penetration, role of growth regulators.
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. Epidemiology & Disease forecasting.
6. Selected plant diseases: Downy mildew and powdery mildew of crop plants, Black stem rust of wheat, Loose smut of wheat, Brown spot and bacterial bight and blast of rice, Wilt of pigeon pea, Anthracnose of jute, Crown gall diseases, Scab of potato.
7. Control of plant diseases - exclusion, eradication.

PAPER: BOT 104: PTERIDOPHYTES & GYMNOSPERMS **Full Marks: 50**

Course Outcome: 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).

UNIT I: PTERIDOPHYTES **Marks: 25**

1. Introduction: Early land plants and their adaptation for successful colonisation on land habitats.
2. Rhyniopsida: characteristic features; important representatives and gametophytic structures.

3. Zosterophyllopsida: characteristic features, representative taxa exhibiting morphological diversity of the group; potentiality of the group as a progenitor of Lycopsida.
4. Lycopsida.
5. Trimerophytopsida: Characteristic features; diversity in vegetative structures; significance of the group in the evolution of higher clads of pteridophytes.
6. Filicopsida: Characteristic features, major clads of extinct and extant taxa of the group; classification of filicalian ferns as per Pichi-Sermolli (1977); phyletic slide and evolution of soral structures in the filicalian ferns.
7. Apospory and apogamy: Definition, factors for induction and significance.
8. Progymnosperms: concept, characteristics, classification, origin and evolution.

UNIT II: GYMNOSPERMS **Marks: 25**

1. General features and classification.
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 and Caytoniales.
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. Origin of seed-cone complex among extinct and extant conifers.
6. Gnetophytes: characteristics, comparative accounts of three genera, present status of gnetophytes based on molecular phylogeny.
7. Economic importance of gymnosperms with reference to wood, resin, essential oils, drugs and food.

PRACTICAL

PAPER: BOT 195 **Total Marks: 50**

Course Outcome: 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 on phycology and bryology will help students in characterizing and identifying various important members of the groups.

UNIT I: BOT 195.1: MICROBIOLOGY (Practical) 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 producers from bacteria, PDA for fungi.
8. Inoculation techniques.
9. Visit to a place of microbiological interest

UNIT II: BOT 195.2 PHYCOLOGY & BRYOLOGY (Practical) 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 and submission in the examination.

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.

PAPER: BOT 196 **Total Marks: 50**

Course Outcome: 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.

UNIT I: BOT 196.1 MYCOLOGY & PLANT PATHOLOGY (Practical) **Marks: 25**

1. Study of morphological characters and reproductive structures of 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.

UNIT II: BOT 196.2 PTERIDOPHYTES & GYMNOSPERMS (Practical) **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

** (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).

SEMESTER – II

THEORY

PAPER: BOT 201: ANGIOSPERM TAXONOMY & BIOSYSTEMATICS

Full Marks: 50

Course Outcome: 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 areaintegrating basic biology, chemistry, numerical approach for understanding the functional biology.

UNIT I: ANGIOSPERM 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 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.
3. Herbarium: Traditional and digital Herbarium, Methods of Herbarium preparation, local, regional, national and international Herbaria. Utilities of Herbarium.
4. ICN: Principles of ICBN, ICN, Biocodes or Phylocodes. Rejection of Names, Effective and valid publications, Typification, Author's citation.

UNIT II: 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.

PAPER: BOT 202: PALAEOBOTANY, PALYNOLOGY & PLANT REPRODUCTIVE BIOLOGY

Full Marks 50

Course Outcome: 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.

UNIT I: PALAEOBOTANY — Marks 25

1. Fossils: Definition, types, nomenclature, modes of preservation (Schopf 1975), Fossilization process – factors; Techniques of fossil study: Ground thin section, peel technique, peat analysis.
2. Principles of correlation and stratigraphy; outline of Standard Geologic time Scale.
3. Origin and evolution of early life forms recovered from Precambrian strata.
4. Major events of plant life through geologic history.
5. Indian Gondwana Sequence, Classification and distribution of the sequence; megafloristic assemblages in Gondwana Sequence.
6. Continental Drift Hypothesis and Plate Tectonics: Concept and validation.
7. Radiometric datings: Relative and Absolute datings; Basic principles of radiocarbon, uranium and potassium-argon dating.
8. Use of fossil plants in deciphering past vegetational and ecological history.

UNIT II: PALYNOLOGY & PLANT REPRODUCTIVE BIOLOGY — 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 plains.
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, evolutionary trends in pollination modes.
11. Breeding systems, self-incompatibility and compatibility control with reference to pollen-pistil interactions.

PAPER: BOT 203: PLANT ANATOMY & PHARMACOGNOSY Full Marks: 50

Course Outcome: Students will get knowledge about the way plants are constructed. Plant anatomy provides characters such as trichomes, stomata, cuticulor patterns, 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.

UNIT 1: PLANT ANATOMY Marks: 25

1. Differentiation**:** Alternate pathway of Development, Totipotency, Polarity, Pattern Formation, Genetic Control.
2. Cell wall: Chemistry, Ultrastructure, Biosynthesis and Phylogeny.
3. Secretory tissues in plants: Structure and distribution of secretary trichomes *(Drocera*, *Nepenthes*), Salt glands, Colleters, Nectaries, Resin ducts and Laticifers, Structure of bark and distribution pattern of laticifers in *Hevea brasiliensis*.
4. Laticifers: Types, Structure, Development and Economic importance of latex.
5. Xylem**:** Ontogeny, Ultrastructure, Lignification pattern and Phylogeny.
6. Phloem**:** Structure, p-protein, Transcellular strands, Ultrastucture and Phylogeny.
7. Nodal anatomy: Structure and evolutionary trends.
8. Bark**:** Types, Development and Ultrastructure.

9. Transfer cells: Distribution, Function and Phylogeny.
10. Stomata: Types (Metchalfe and Chalk), Ontogeny.
11. Wood: Physical, chemical and mechanical properties.
12. Plant fibres: Distribution, Structure and Commercial importance of Coir, Jute, and Cotton.

UNIT II: PHARMACOGNOSY **Marks: 25**

1. Pharmacognosy: Introduction & scope of pharmacognosy. Organoleptic, micromorphological and chemical characteristics of crude plant drugs – *Cinchona, Digitalis, Strychnos, Rauvolfia & Adhatoda.*
2. Secondary metabolites of plants and their significance. Production of secondary metabolites: – a brief account of acetate mevalonate pathway, acetate malonate pathway, shikimic acid pathway.
3. Alkaloids – properties; alkaloids obtained from stramonium, belladonna, ergot, rauwolfia, catharanthus, cinchona, tea, holarrhena and their uses.
4. Glycosides – classification, glycosides obtained from senna and their uses, sources and types of cardioactive glycosides and their uses.
5. Adulteration of drugs and detection.

PAPER: C-BOT 204: PLANTS AND SOCIETY (Part - I) (CBCS) **Full Marks: 50**

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

Unit I: 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 account of different groups of Microbes and plants – Bacteria, Virus, Algae, Fungi, Lichen, Bryophyta, Pteridophyta, Gymnosperm and Angiosperms.
3. An outline approach on plant cell and organelles, tissues and organs.

Unit II: Socio-economic aspects of Plants **Marks: 25**

1. Cereals and pulses (rice, wheat, maize, barley, lentil, mung, gram, pea, pigeon pea), edible and essential oil yielding (mustard, sunflower, saffola, rice bran, *Citronella*, *Eucalyptus*), species and condiments (coriander, foeniculum, nigella, carum, black pepper, chilli, turmeric, ginger), beverage (tea, coffee), fibre yielding (jute, cotton), dye yielding (*Bixa orellena*, *Butea monosperma*, *Crocus sativus*, *Eclipta prostrata*, *Indigofera tinctoria*, *Lawsonia inermis*).
2. Plants of special uses [cork, mat grass, *Saccarum officinarum*, Babui grass (*Eulaliosis bimata*), vetiver grass(*Chrysopogon zizanioides*)].
3. Ethnobotanical plants (*Adhatoda zeylanica*, *Ocimum* sp., *Aloe vera*, *Andrographis paniculata*, *Centella asiatica*, *Abrus precatorius*, *Strychnos nux-vomica*).
4. Commercial uses of fossil plant (Coal, Petroleum, Amber, Diatomites).

PRACTICAL

PAPER: BOT 295 **Total Marks: 50**

Course Outcome: 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.

UNIT I: 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.

UNIT II: 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.
3. ** (Submission of field and laboratory records including permanent slides)

Palynology & Plant Reproductive Biology

1. Pollen morphological studies of some pterodophytes, 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 morpho-types.
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)

PAPER: BOT 296 **Total Marks: 50**

Course Outcome: In anatomy and pharmacognosy study student will be able to observe internal structures 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.

UNIT I: BOT 296.1 PLANT ANATOMY & PHARMACOGNOSY **Marks: 25**

1. Comparative study of various types of stomata.
2. Study of various types of trichomes.
3. Study of different types of crystals.

4. Comparative study of stomatal indices of some selected plants.
5. Study of nodal anatomy – unilacunar, trilacunar & multilacunar types.
6. Wood anatomy of various groups of plant.
8. Macroscopic study of some important crude drugs of Indian Systems of Medicine.
9. Microscopic study of powder of some selected crude drugs.
10. Microchemical tests of some crude drugs and their extracts.
11. Study of basic principle of equipment demonstrated
12. Study of working principle of equipment and measurement of biological compounds.

UNIT II: **BOT 296.2:** Field survey, submission of report and viva-voce. **Marks: 25**

Visit at different phytogeographical regions of India including outside the state of West Bengal.

Evaluation of BOT 206 / Unit II: Only by External Experts.

SEMESTER – III

THEORY

PAPER: BOT 301: CELL BIOLOGY, GENETICS & BIOTECHNOLOGY

Full Marks: 50

Course Outcome: 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.

UNIT I: CELL BIOLOGY & GENETICS **Marks: 25**

1. 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, structural alteration of chromosome, mutation.
2. Ultra-structure of nucleus, nucleolus, plasma membrane, endoplasmic reticulum, Golgi apparatus.
3. Cell cycle: Biochemical and molecular events associated with the cell cycle, Molecular mechanism of cell cycle regulation.
4. Molecular organization of chromosome: DNA packaging in chromatin and chromosome, regulation of chromatin structure by histone n-terminal tails, ultra-structure of special chromosomes; Centromere & telomere: ultrastructure and function.
5. Chromosome banding: G banding, Fluorescent banding, R banding, C banding, NOR banding. FISH, GISH.
6. Genetic code: Properties of genetic code with evidences, deciphering of genetic code (code assignment).
7. 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*, CO_2 sensitivity and sex ratio of *Drosophila*.

8. Sex determination: basic types, Lyon hypothesis, dosage compensation - types, Barr body, Sex linked inheritance, sex influenced, sex linked and sex limited characters.
9. Transposable elements: definition, transposon and retroposon. Characteristic features of IS elements, Ac/Ds element and Copia element.
10. Population genetics: Hardy-Weinberg Hypothesis, factors affecting allelic frequency in population. Genetic drift, inbreeding depression.
11. DNA replication (outline procedure only), requisite factors and their roles.

UNIT II: BIOTECHNOLOGY **Full Marks: 25**

1. Recombinant DNA technology: Definition and properties of Plasmids, Cosmids, Phagemids, Bacterial artificial chromosomes (BACs), Yeast artificial chromosomes (YACs); Plasmid isolation, restriction enzymes, digestion, agarose gel electrophoresis and transformation.
2. Cloning strategies & 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.
3. Transcription: Molecular mechanisms of transcription; Regulation of gene expression with special reference to two component gene regulatory system; RNA processing.
4. Gene library: Construction of cDNA library and genomic library; Screening of libraries.
5. DNA hybridization & sequencing: Generation of radiolabeled probe and blotting techniques; Southern and Northern hybridization; DNA Sequencing methods.
6. Polymerase chain reaction: Principles, methods and application.
7. Blotting techniques, RFLP, RAPD, AFLP, ISSR, ITS, DNA finger printing, Chromosome walking, Chromosome jumping, Microarray, PCR, RT-PCR.
8. Plant breeding: Plant introduction, pure line selection, back cross, pedigree selection, mass selection and clonal selection (Procedures). Heterosis. Composite and Synthetic varieties.

9. 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.

PAPER: BOT 302: PLANT PHYSIOLOGY & BIOCHEMISTRY Full Marks: 50

Course Outcome: 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 speciallyimportant because the physiology of a plant is directly associated with plant yield / crop yield which has an economic impact.

UNIT I: PLANT PHYSIOLOGY Marks: 25

1. Plant Water Relation: Regulation of water supply, Aquaporins and facilitated water Transport, Soil Plant Atmosphere Continuum (SPAC), recent concept in stomatal physiology, Signal transduction in guard cell.
2. Solute Transport: Diffusion, Nernst equation, Uniport, Symport, Channels, ATP driven active transport (Phloem loading and unloading)
3. Photochemistry and Photosynthesis: Photosynthetic pigments, absorption and transformation of radiant energy, Light harvesting complexes, ETS, photo inhibition, O_2 and H_2O evolution, Regulation of Calvin cycle, RUBISCO activity, Photorespiration, CAM and C4 pathway.
4. Respiration: Overview of plant Respiration, EMP pathway, TCA cycle, PPP, Glyoxylate cycle, Mitochondrial ETS, Cyanide resistance pathway, Gluconeogenesis, High energy compounds: Synthesis and utilization, ATP synthesis.
5. Photoperiodism**:** Photoperiodic classes; Photoperiodic induction – importance of light and dark period; Mechanism of induction and role of phytochrome.
6. Plant growth regulators: Biosynthesis and action mechanism of: Auxins, Gibberellins, (GA), Cytokinins, Ethylene, Abscissic Acid, introduction of other hormones.
7. Seed Germination, Flowering and Fruit ripening: - Metabolic changes during seed germination, flowering initiation, maturity and fruiting, fruit ripening.

8. Senescence and ageing, senescence syndrome – physiological and biochemical changes; Regulation of senescence and SAGs; Abscission – cytological, physiological and biochemical changes in abscission zone; Hormonal and environmental control of senescence, programmed cell death in life cycle of plants.
9. Stress Physiology: Biotic and abiotic stresses, heat stress and salt stress.

UNIT II: BIOCHEMISTRY **Marks: 25**

1. Energy Dynamics: Structure of atoms, molecules and chemical bonds, principles of physical chemistry, principles of thermodynamics, free energy, Redox potentials, Dissociation and associations constants, Activation energy, Binding energy.
2. Enzymology: General classification, Isozymes, Factors affecting enzyme activity, Enzyme Kinetics, Michaelis - Menten equation, Competitive, uncompetitive and non competitive inhibition, Allosteric mechanism.
3. Carbohydrates: General classification, Synthesis and breakdown of carbohydrates (starch, glycogen, pectin, Glucose).
4. Amino acids & proteins: General classification of amino acids and proteins, Structure, synthesis and properties of amino acids, protein structure (Primary, secondary, tertiary and quaternary), Ramchandran plot.
6. Nitrogen metabolism: Nitrogen uptake, NOD factor, root nodulation and nitrogen fixation.
7. Secondary metabolites: General classification of Major pathways, Phenolics (Lignins, tannins) Flavonoids, terpenoids (steroids), Alkaloids, pigments (Carotenoids, Anthocynins).
8. Lipid metabolism: General classification of Phospho-, Spingo-, Glyco- lipids, biosynthesis and oxidation.

PAPER: BOT 303: ECOLOGY & ENVIRONMENTAL BIOLOGY Full Marks: 50

Course Outcome: 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.

UNIT I: 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 Realised 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.

UNIT II: ENVIRONMENTAL BIOLOGY 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.

PAPER: C-BOT 304: PLANTS AND SOCIETY- II (CBCS) Full Marks: 50

Course Outcome: 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.

Unit – I: 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.

PRACTICAL

PAPER: BOT 395

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

UNIT I: 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. Studies of abnormalities in cell division and chromosome morphology.
5. Karyotyping: the basic methods (with the well spread chromosomes of mitotic metaphase from worked out specimen or from earlier drawn picture or photograph).
6. Gel electrophoresis: acquaintance with the apparatus, mechanism of operation, basic principle and demonstration. (for demonstration only and not recommended for examination, except viva voce).
7. 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).
8. Measures of dispersion: Standard Deviation, Standard Error.
9. Chi square test for goodness of fit of (Fixed ratio hypothesis, Homogeneity Ratio and Contingency table).

UNIT II: 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.
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.

PAPER: BOT 396

Course Outcome: 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.

UNIT I: BOT 396.1: ECOLOGY & ENVIRONMENTAL BIOLOGY 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.

UNIT II: BOT 396.2 SEMINAR **Marks: 25**

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

SEMESTER-IV

THEORY

PAPER: BOT 401

Course Outcome 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.

SILVICULTURE, MENSURATION, SILVICULTURE SYSTEM AND FOREST MANAGEMENT **Full Marks: 50**

UNIT I: SILVICULTURE & 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).
4. Topographic (Affect of Altitude, Aspect & Exposure.
5. Edaphic: General, Parental rock influence on vegetation, Pan formation.
6. Biotic: Influence of plants, insects, wild animals, man and his animals.
7. Concept of regeneration of forest.
8. Mensuration: definition, object and scope.
9. Measurement of diameter and girth.
10. Breast height - Rules of diameter measurement, diameter and girth class.
11. Measurement of height of tree: Principles of height measurement (similar triangle, trigonometric).
12. Volume: Measurement of volume of standing and felled trees, volume table.

UNIT II: SILVICULTURE SYSTEM & FOREST MANAGEMENT Marks: 25

1. Classification and objective
2. Clear felling system: clear strip and alternate strip system. Regeneration by Taungya and /or departmental plantation.
3. Uniform system : Shelter wood system, kinds and pattern of felling, Periodic Block, Indian Irregular shelter wood system
4. Selection system
5. Coppice - System : Simple, Coppice with Standard
6. Principles and objective of Forest conservation and management
7. Forest Policy 1988
8. Reserve, Protected and unclassed forest.
9. Management classification: Working plan, working circle, Felling.
10. Sustained yield and progressive yield
11. Joint Forest Management: Concept, working and sustainability.

PAPER: BOT 402 (Special Paper)
ANGIOSPERM TAXONOMY & MOLECULAR SYSTEMATICS

BOT 402A: ANGIOSPERM TAXONOMY **Full Marks: 50**

Course Outcome: Candidates will get information on different advanced topics on angiosperm taxonomy and molecular systematic. They will get idea about Monophyly, Paraphyly & Polyphyly; Plesiomorphy & Apomorphy; Homology & Homoplasy; Convergent & Divergent, Flora, Vegetation, Revision, New Records. Contributions and taxonomic literature in relation to Angiosperms. They will get idea about the role of Botanical Survey of India (BSI) for taxonomic study. They will get idea about ICBN & ICN, APG system of flowering plant classification, biodiversity, IUCN, Megadiverse countries, Hot spots, Indian hotspots, conservation strategies, biome concept, endemism, invasions and introductions.

1. Definition: Taxonomy and Systematics, Molecular Systematics, Concept of Monophyly, Paraphyly & Polyphyly; Plesiomorphy & Apomorphy; Homology & Homoplasy; Convergent & Divergent, Flora, Vegetation, Revision, New Records.
2. 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.
3. Botanical Nomenclature: Nomenclature types, Basic differences between ICBN & ICN, ICN- its concept and description, Phylocode.
4. Concept of taxonomic characters: Role of macro- and micro- morphology, anatomy, palynology, embryology, cytology, serology, phytochemistry and molecular biology in deciphering taxonomic position.
5. The Angiosperms Phylogeny Group (APG) system of flowering plant classification: Phylogeneric relationships of Angiosperms. Concepts of palaeoherbs, eudicots.
6. Biodiversity: Definition, importance, levels, spatial distribution, value and loss; IUCN categories of threatened species, Megadiverse countries, Hot spots, Indian hotspots.
7. 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.
8. Phytogeography: Biome: concept and classification, characteristics of major terrestrial biomes; Phytogeographic zones of India, classification of vegetation of India. Endemism, disjunction: Invasions and Introductions.

PAPER: BOT 402 (Special Paper)

CYTOGENETICS, MOLECULAR BIOLOGY & BIOTECHNOLOGY

Course Outcome: This part of the syllabus deals with the basic information on the cytological and genetic aspects. Information on basic structure of cell and its organelles helps understand their significance, nature of work and relation between them. The aspects on genetics provides knowledge about the principles and modes of inheritance of different traits at the individual as well as population levels.

BOT 402B: CYTOGENETICS **Full Marks: 50**

1. Ultrastructures of cell membrane, mitochondria, chloroplast, peroxisome, glyoxysome and their functions.
2. Cell communication and signalling: general principle, signalling molecules and their receptors. Cell surface receptors (ion channel linked receptors, G protein coupled receptors, Tyrosine kinase linked receptors, Steroid hormone receptors).
3. Cell cycle check points. Cyclins and cyclin dependent kinases.
4. Cytoskeleton: brief knowledge, function of cytoskeleton, structure, actin filaments (microfilament), microtubule, intermediate filaments.
5. Quantitative genetics: Broad sense heritability and narrow sense heritability.
6. B chromosomes, Polytene and Lampbrush chromosomes and their significance.
7. Chromosomal characteristics and nuclear DNA content variation across plant kingdom.
8. Concept of speciation: types.
9. Population genetics: factors affecting allelic frequency, bottle neck effect, founder effect.

PAPER: BOT 402(Special Paper)

ECOLOGY & BIODIVERSITY

By studying ecology and biodiversity as a special paper, learners will get a detail knowledge different aspects of ecological phenomena and their intrecasies; the students will be made aware about the recent envioronmental and political issues like Montreal protocol, Reo earth summit, Kyoto protocol, Ramsar convention, COP 16, and environmental disesters like London smog, El Nino, Minamata tragedy, Chernobyl disaster, Bhopal tragedy and global environmental issues - Global warming, Acid rain, Smog, Ozone depletion, biological invasion. Students will get knowledge on population ecology which is a prerequisite for knowing any population structure of organisms.

BOT 402C: 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.

PAPER: BOT 402 (Special Paper)
MICROBIOLOGY

BOT 402D: MICROBIOLOGY- BASIC **Full Marks: 50**

Course Outcome: 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.

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; 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, 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.

PAPER: BOT 402 (Special Paper)
MYCOLOGY & PLANT PATHOLOGY

Course outcome: Mycology is the study of fungi, which is important to ecology and conservation and perhaps unsurpassed by any other branch of the biological sciences. Fungi are useful in our daily life- we simply enjoy the bread and beer, wine and cheese which are the labour of countless yeast cells and also savour the taste of freshly fried mushrooms.

BOT 402E: APPLIED MYCOLOGY **Full Marks: 50**

1. Nutrient sensing in fungi – the mechanism of entry of glucose and activation of gene in hyphae.
2. Spindle pole bodies (SPBs) – different types found in fungi and their function.
3. Fungal membrane transport – energetics of transport, nonmediated diffusion, facilitated diffusion, active transport.
4. Heterokaryosis – definition, occurrence, significance, modes of formation.
5. Spore dormancy – exogenous dormancy, endogenous dormancy.
6. Importance of fungi – nutrient recycling, biofertiliser, siderophore production, phosphate solubilisation, growth promoter, bioremediation, soil formation, biocontrol agent.
7. Edible fungi – SCP, marmite, vegemite, quorn, tempeh, ang kak, soy sauce, cheese, miso.
8. Production of citric, gluconic, itaconic, lactic, oxalic, fumaric, malic, succinic acids by fungi.
9. Scope and aims of fungal pharmacognosy.
10. Production of free radicals and their roles in some human ailments.
11. Production of penicillin, cephalosporin, griseofulvin, strobilurin, sordarin, gentamycin, plectasin, cyclosporin, cilofungin.

PAPER: BOT 402 (Special Paper)

PALAEOBOTANY, PALYNOLOGY & PLANT REPRODUCTIVE BIOLOGY

Course Outcome: 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 402F: PALAEOBOTANY **Full 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 Carboniferou 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 miofloristics 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; Palaeogene palaeofloristics and palaeoecology of Peninsular India; Neogene palaeofloristics and palaeoecology of Peninsular (Cuddalore Group and Bengal Basin) and Extrapeninsular (Siwalik Group) India.
9. Archaeobotany of Indian cultivated plants.

PAPER: BOT 402 (Special Paper)

PLANT PHYSIOLOGY, BIOCHEMISTRY & MOLECULAR BIOLOGY

Course Outcome 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 402G: PLANT PHYSIOLOGY **Full Marks: 50**

1. Organization of photosynthetic apparatus and light absorbing antenna system. Genes and polypeptide components of photosynthetic complexes. Rubisco and Rubisco genes.
2. ATP generation mechanisms in chloroplast and mitochondria.
3. Nitrate assimilation in plants. Structure function and regulation of nitrate assimilating enzymes. Nif gene, nod gene – structure, function and regulation.
4. Chloroplast structure, function and genetic engineering
5. Pumps, carriers and Channels – Structure and function, energetics of active transport, isophore and ionophore; vacuoles – structure and function.
6. PGRs - biosynthesis, transport, mechanism of action, bioassay.
7. Floral induction and development – hormonal control; molecular genetics of floral development and floral organ differentiation.
8. Senescence and programmed cell death (PCD) – Senescence and its regulations, hormonal and environmental control of senescence. Molecular Biology of PCD; fruit ripening.
9. Physiology and molecular biology of stress – abiotic stress, biotic stress, heavy metals, reactive oxygen species and their protection mechanism.

PAPER: BOT 403 (Special Paper)
ANGIOPERM TAXONOMY & MOLECULAR SYSTEMATICS

BOT 403A: MOLECULAR SYSTEMATICS **Full Marks: 50**

Course Outcome: in this course students will learn about the 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, Numerical Systematics, construction of taxonomic groups (OUT and Unit Characters), cluster analysis, Determination of phenetic structure, concept of cladogram, details analysis of systematic & phylogenic studies. Molecular Identification, DNA Barcoding: Adulteration of medicinal herbs. Recognize the importance of herbarium and Virtual herbarium; evaluate the important herbaria and botanical gardens.

1. Molecular **S**ystematics: 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 (Inter-Simple Sequence Repeat), SNPs (Single Nucleotide Polymorphism), ARMS (Amplification-Refractory Mutation System), Advancement in sequencing technology, NGS, Search engine and sequence repositories.
2. 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.
3. Systematic & Phylogenic studies: Distribution, Adaptive features and Phylogeny of special life form classes: Parasitic plants, Insectivorous, Mangrove Taxa.
4. Molecular Identification: Medicinal (Endangered & Threatened) Plants, Aromatic Medicinal Plants, Dye Yielding Plants
5. DNA Barcoding: A Sophisticated Method for Authentication and Identification of Medicinal Plants, Adulteration of medicinal herbs.
6. Digital Herbarium: Concept & application.

PAPER: BOT 403 (Special Paper)
CYTOGENETICS, MOLECULAR BIOLOGY & BIOTECHNOLOGY

Course Outcome: This part of syllabus covers different aspects of molecular genetics. It enables understanding the molecular basis of functioning in different genetic mechanisms. Under biotechnology both the basic principles of general biotechnology as well as plant biotechnology, like genetic engineering, plant tissue culture etc. would provide knowledge about the advanced techniques in vogue for the improvement of plants.

BOT 403B: MOLECULAR BIOLOGY & BIOTECHNOLOGY **Full Marks: 50**

1. Different conformations of DNA.
2. Structure and functions of different types of RNA (mRNA, tRNA, rRNA, Sn RNA, micro RNA), Ribozymes.
3. c-value, paradox, DNA renaturation kinetics, T_m, Cot curve. Unique and Repetitive DNA -mini- and microsatellites.
4. DNA repair mechanisms.
5. Eukaryotic gene expression control mechanisms (brief account only).
6. Organeller genomes.
7. Gene cloning: Biological method and physical method (with the use of PCR).
8. Gene transfer technology: using plasmids, Ti plasmid, electroporation, microinjection, gene gun.
9. Plant tissue culture: suspension culture, haploid culture, embryo culture, somatic hybridization, protoplast isolation, culture, hybridization
10. Transgenesis of plants for virus resistance, herbicide resistance, insect resistance.
11. In vitro production of secondary metabolites, biotransformation.
12. Brief idea about molecular farming / pharming.
13. Progeny testing, Pedigree selection, Single seed descent method, Diallele crossing.

PAPER: BOT 403 (Special Paper)

ECOLOGY & BIODIVERSITY

Course Outcome : From this course students will get knowledge about biodiversity, its economic and ecological aspects, threats and conservation stratigies.

BOT 403C: BIODIVERSITY **Full Marks: 50**

1. Biodiversity - definition, components, types, levels, spatial scales (alpha, beta & gamma diversity).
2. Measurement of biodiversity: Species richness, species evenness and overall diversity using various indices, Gause's Law.
3. Global concern and global status on biodiversity. Like Minded Megadiverse Countries (LMMC), Biological hotspots with special reference to four Indian hotspots.
4. Economic and ecological values of biodiversity with special reference to genetic diversity.
5. Threats to biodiversity - natural and manmade; invasive species and biodiversity loss.
6. Biodiversity conservation - The type of species to be conserved, Red data book and Blue data book; *ex situ* conservation- role of botanical gardens, museum, seed banks, pollen banks, gene banks, *in situ* conservation- national park, sanctuary, biosphere reserve, tiger project, Ramsar site, conservation through traditional methods. CBD and CITES - general idea.
7. Role of government and non-government initiatives in biodiversity study - Forest Conservation Act 1988, Environmental Protection Act 1986, Biodiversity Conservation Act 2006, role of BSI, ZSI, Biodiversity boards, IUCN, WWF in conservation.

PAPER: BOT 403 (Special Paper)

MICROBIOLOGY

BOT 403D: MICROBIOLOGY – Applied **Full Marks: 50**

Course Outcome: 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.

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, generalised 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.

PAPER: BOT 403 (Special Paper)
MYCOLOGY & PLANT PATHOLOGY

Course Outcome: Plant pathology is an important branch of agriculture. It is an interdisciplinary science which deals with various subjects like virology, mycology and bacteriology. It deals with the management of disease, their causal organism and their life cycle.

BOT 403E: 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.
9. Mycotoxins – a general account.
10. Poisonous fungi – types, active principles, general methods of identification.

PAPER: BOT 403 (Special Paper)
PALAEOBOTANY, PALYNOLOGY & PLANT REPRODUCTIVE BIOLOGY

Course Outcome: 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 403F: PALYNOLOGY & PLANT REPRODUCTIVE BIOLOGY **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 allele in 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 rDNA technology.

4 Pollen physiology and chemistry: Structure and chemical nature of pollen wall and ubisch body, pollen-expressed and pollen-specific genes.

5 Monitoring of airborne pollen/spore causing allergy and asthma: volumetric samplers (Burkard and Anderson samplers), Pollen calendar, Diagnosis of allergy by skin prick test (in vivo) and ELISA (in vitro) – principle & application.

6 Pollen analysis with reference to Quaternary vegetational history of India: Pleistocene vegetational history of Kashmir Valley, Holocene vegetational history of Bengal Basin.

7 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.

8. 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.

9 Flower adaptation to different pollinators (Biotic): Flowers pollinated by: i. Hymenoptera, ii. Diptera, iii. Coleoptera, iv. Lepidoptera, v. Birds, vi. Bats, vii. Nonflying mammals.

10 Floral advertisement & Floral rewards: i. Visual signals and Flower colors, ii. Pollen as rewards, iii. Nectar as reward, iv. Mimicry in flower ,

11 Breeding system & Pollination i. Sex Expression: Bisexual & Unisexual flowers; Monoecy and Dioaecy, ii. Dichogamy, iii. Herkogamy, iv. Heterostyly, v. Autogamy & allogamy: Inbreeding and out breeding.

PAPER: BOT 403 (Special Paper)

PLANT PHYSIOLOGY, BIOCHEMISTRY & MOLECULAR BIOLOGY

Course Outcome 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 403G: BIOCHEMISTRY & MOLECULAR BIOLOGY **Full Marks: 50**

9. Biosynthesis of carotenoids, amino acids, biological significance of carotenoids.
10. Proteins: Classification, structure and properties of amino acids, essential amino acids, biologically active peptides. Classification and properties of proteins, sequencing of proteins, conformation and structure of proteins-primary, secondary, tertiary and quaternary structure, coagulation and denaturation of proteins.
11. Protein purification, characterization, methods for the determination of amino acids sequences in protein.

12. Post translational modification of protein, protein targeting, protein transport, chaperon and protein folding.
13. Signal Molecules, signal perception and transduction in plants.
14. Proteomics applied to functional genomics.

SEMESTER-IV

PRACTICAL

PAPER: BOT 494 **Full Marks: 25**

Course outcome: In this practical course students will learn about studying a forest in the field. Measurement of forest produces, area survey etc. 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.

FOREST MENSURATION & SURVEYING

1. Measurement of diameter and Girth.
2. Girth class distribution.
3. Measurement of height of a tree.
4. Volume calculation.
5. Chain surveying.
6. Plane table survey.
7. Practical records.

PAPER: BOT 495A

SPECIAL PAPER

PRACTICAL **Full Marks: 50**

ANGIOPERM TAXONOMY & MOLECULAR SYSTEMATICS

Course Outcome: Students will learn different practical aspects of taxonomy and biosystematics.

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.

PAPER: BOT 495B

SPECIAL PAPER

PRACTICAL **Full Marks: 50**

CYTOGENETICS, MOLECULAR BIOLOGY & BIOTECHNOLOGY

Course Outcome: Students will learn different practical aspects of cytogenetics, molecular biology and biotechnology.

1. Study of Cytological Abnormalities.
2. Study of Karyotypes.
3. Study of Meiosis in Pollen Mother Cells.
4. Study of cytomixis.
5. Isolation of cell organelles.
6. Isolation and Colorimetric estimation of DNA and RNA.
7. Isolation of genomic DNA.
8. SDS PAGE of Seed Storage Protein/ PAGE of Isozyme.
9. Preparation of Plant Tissue Culture media.
10. Inoculation and Culture of Plant Tissues.
11. Regression Analysis.
12. Analysis of variance (One way ANOVA)

PAPER: BOT 495C

SPECIAL PAPER

PRACTICAL **Full Marks: 50**

ECOLOGY & BIODIVERSITY

Course Outcome: Students will learn different practical aspects of ecology and biodiversity, they will observe ecological adaptations of different plants.

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.

PAPER: BOT – 495D

SPECIAL PAPER

PRACTICAL **Full Marks: 50**

MICROBIOLOGY

Course Outcome: 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.

1. Study of fermentation of sugar by different bacteria.
2. Starch and protein hydrolysis.
3. Microbial assay of streptomycin (agar cup, disk and turbidity method).
4. Microbial examination of water for potability, IMVIC test.
5. Study of microbial growth curve.
6. Estimation of protein, sugar, DNA and RNA.
7. Determination of amino acid pool of an organism by TLC.
8. Determination of molecular weight of a protein by gel electrophoresis.
9. Isolation of plasmid from bacteria.
10. Agarose gel electrophoresis of plasmid.
11. Plate count of bacteria.
12. Preparation of survival curve of a bacterium after UV exposure and isolation of mutants.
13. Polymerase chain reaction (PCR) of selected genomic part of microorganism.
14. BLAST search and alignment of genomic sequence, preparation of phylogenetic tree.
15. Isolation of fungi and bacteria from soil.
16. Isolation of *Azotobacter* from soil and *Rhizobium* from root nodule.
17. MIC determination of different bacteria against different antibiotic (streptomycin, ofloxacin).
18. Phage counting by plaque method.
19. Study of immuno-diffusion technique.
20. Visit to a place of microbiological interest.

PAPER: BOT 495E

SPECIAL PAPER

PRACTICAL **Full Marks: 50**

MYCOLOGY & PLANT PATHOLOGY

Course Outcome: Students can analyse the benefit from antibiotics sequestered from moulds, study the loss of host plants through different diseases, experience the loss of much loved trees, value the horticultural therapy of nutrient-rich leaf mould, or with wider horizons, applaud the recycling of biomass worldwide and their intimate symbioses with higher plants.

1. Study of morphological characters and reproductive structures of some genera.
2. Preparation of fungal media.
3. Use of selective media.
4. Sterilization process.
5. Isolation of fungi from water / soil / air.
6. Use of some fungicides to study their effect on fungi.
7. Inoculation of fruit and subculturing.
8. Chemical tests for the detection of selected compounds.
9. Microscopic evaluation of some fungal specimens.
10. Study of Ectomycorrhiza.
11. Study of VAM in root.

PAPER: BOT 495F

SPECIAL PAPER

PRACTICAL **Full Marks: 50**

PALAEOBOTANY, PALYNOLOGY & PLANT REPRODUCTIVE BIOLOGY

Course Outcome: Students will be able to learn different field techniques of palaeobotany; how to explore plant mega fossils from natural fossiliferous beds;

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.

PAPER: BOT – 495G

SPECIAL PAPER

PRACTICAL **Full Marks: 50**

PLANT PHYSIOLOGY, BIOCHEMISTRY & MOLECULAR BIOLOGY

Course Outcome: Students will learn practical experimentation on plant physiology and biochemistry.

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

PAPER: BOT 496

PRACTICAL

SPECIAL PAPER BASED PROJECT WORK

in the form of

M. Sc. Thesis / Dissertation / Review Work **Full Marks: 50**

Course Outcome: 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.

PAPER: BOT 497

GRAND VIVA **Full Marks: 25**

Course Outcome: 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.

Evaluation of Grand viva will be conducted exclusively by external members covering the whole syllabus.

NB:

1. ***Medium of answering questions should be in English only***.
2. ***Special papers will be distributed equally among the offered special papers on Merit cum Choice basis*.**