**UNIVERSITY OF NORTH BENGAL**
**UG & PG Department of Botany**
**Darjeeling Government College**
**Choice Based Credit System (CBCS) Syllabus for M.Sc. (DGC Centre) Botany**

## COURSE STRUCTUREWITH NEW ALPHA-NUMERIC COURSE CODE FOR PG

## COURSE- BOTANY (DGC)

| New course paper code (alpha numeric) | Paper name | Full marks (External) | Full marks (Practical) | Full marks (Internal) | Total full marks | Credit |
|---|---|---|---|---|---|---|
| **SEMESTER- I** | | | | | | |
| DBOT-CT-101 | Phycology, Lichenology, Bryology, Pteridology, Gymnology and Paleobotany | 50 | | 25 | 75 | 3 |
| DBOT-CT-102 | Plant Anatomy and Development, Bioresource Utilisation | 50 | | 25 | 75 | 3 |
| DBOT-CT-103 | Taxonomy of Angiosperms | 50 | | 25 | 75 | 3 |
| DBOT-CP-104 | Phycology, Lichenology, Bryology, Pteridology, Gymnology and Paleobotany | | 50 | | 50 | 2 |
| DBOT-CP-105 | Taxonomy of Angiosperms and Plant Anatomy | | 50 | | 50 | 2 |
| DBOT-CP-106 | Project on Bio-resource Utilisation & Seminar on the Project | | 50 | | 50 | 2 |
| DBOT-CP-107 | Choice Based Seminar + Field Studies | | | 25 | 25 | 1 |
| Total Marks and Credits in Semester I | | | | | 400 | 16 |
| **SEMESTER- II** | | | | | | |
| DBOT-CT-201 | Microbiology | 50 | | 25 | 75 | 3 |
| DBOT-CT-202 | Mycology and Plant Pathology | 50 | | 25 | 75 | 3 |
| DBOT-CT-203 | Cytology and Genetics | 50 | | 25 | 75 | 3 |
| DBOT-CP-204 | Microbiology | | 50 | | 50 | 2 |
| DBOT-CP-205 | Mycology and Plant Pathology | | 50 | | 50 | 2 |
| DBOT-CP-206 | Cytology and Genetics | | 50 | | 50 | 2 |
| DBOT-CP-207 | Choice Based Seminar | | | 25 | 25 | 1 |
| Total Marks and Credits in Semester II | | | | | 400 | 16 |

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## COURSE STRUCTUREWITH NEW ALPHA-NUMERIC COURSE CODE FOR PG

## COURSE- BOTANY (DGC)

| New course code (alpha numeric) | Paper name | Full marks (External) | Full marks (Practical) | Full marks (Internal) | Total full marks | Credit |
|---|---|---|---|---|---|---|
| **SEMESTER- III** | | | | | | |
| DBOT-CT-301 | Plant Physiology | 50 | | 25 | 75 | 3 |
| DBOT-CT-302 | Plant Biochemistry | 50 | | 25 | 75 | 3 |
| DBOT-CT-303 | Ecology and Biostatistics | 50 | | 25 | 75 | 3 |
| DBOT-CP-304 | Plant Physiology | | 50 | | 50 | 2 |
| DBOT-CP-305 | Plant Biochemistry | | 50 | | 50 | 2 |
| DBOT-CP-306 | Ecology and Biostatistics | | 50 | | 50 | 2 |
| DBOT-CP-307 | Choice Based Review (Ability Enhancement Course) | | | 25 | 25 | 1 |
| Total Marks and Credits in Semester III | | | | | 400 | 16 |
| **SEMESTER- IV** | | | | | | |
| DBOT-CT-401 | Biophysics and Instrumentation in Biological Analysis | 50 | | 25 | 75 | 3 |
| DBOT-CT-402 | Environmental Biology | 50 | | 25 | 75 | 3 |
| DBOT-CT-403 | Elective special paper* (Theoretical paper- I) | 50 | | | 50 | 2 |
| DBOT-CT-404 | Elective special paper* (Theoretical paper- II) | 50 | | | 50 | 2 |
| DBOT-CP-405 | Elective special paper* (Practical) | | 75 | | 75 | 3 |
| DBOT-CP-406 | Dissertation | | 50 | | 50 | 2 |
| DBOT-CP-407 | Seminar on dissertation | | | 25 | 25 | 1 |
| Total Marks and Credits in Semester IV | | | | | 400 | 16 |

*Elective special papers (any one of the following): 1. Cytogenetics; 2. Microbiology; 3. Mycology and Plant Pathology; 4. Phycology; 5. Plant Biochemistry and Molecular Biology; 6. Plant Physiology and Biochemistry; 7. Taxonomy of angiosperms and Ecology

# SEMESTER I

**Theoretical Core Course**

**DBOT-CT-101: Phycology, Lichenology, Bryology, Pteridology, Gymnology and Paleobotany**
**L.H: 68; Credit: 02 + 01 (Class tests)**

**Phycology:**

i. Cell structure, pigments, reserve food and flagella
ii. Evolution of algal chloroplast and recent trend in algal classification and salient features of major groups
iii. Algal blooms, algal bio-fertilisers and uses in industry
iv. Economic and ecological importance of algae

**Lichenology:**

Thallus organisation in lichen and their physiological relationship

**Bryology:**

i. Recent classification of bryophytes and general account of major groups
ii. Bryophytic ecology, endemism, biogeographical distribution and hotspots of bryophytes
iii. Bryophytes through geological ages

**Pteridology:**

Origin and evolution of pteridophytes; General features of Psilopsida, Lycopsida, Sphenopsida and Pteropsida

**Gymnology:**

i. General account of Cycadeodales, Cordaitales and Pteridospermales
ii. Structure and reproduction in Cycadales, Ginkgoales, Coniferales and Gnetales

**Paleobotany:**

i. Geological time scale and stratigraphy\
ii. Continental drift and plate tectonics
iii. Radiometric dating

**DBOT-CT-102: Plant Anatomy and Development, Bioresource Utilisation**
**L.H: 68; Credit: 02 + 01 (Class tests)**

**Plant Anatomy and Development:**

i. Anatomy as a modern discipline; physiological-anatomical classification of plant tissue
ii. Development of root, shoot and leaf in higher plants
iii. Control of tissue differentiation
iv. Wood development in relation to environmental factors

**Bioresource Utilisation**

i. Plant and civilisation – centre of origin, botany, utilisation, cultivation an improvement of food plants, drugs, fibre
ii. Plant as a source of renewable energy
iii. Principles of plant breeding, conventional methods, non-conventional methods, polyploidy, genetic variability
*iv.* Chemistry and application of *Swertia, Gloriosa, Digitalis, Taxus, Stevia, Chlorophytum* and *Podophyllum*

**DBOT-CT-103: Taxonomy of Angiosperms** **L.H: 68; Credit: 02 + 01 (Class tests)**

i. Classification: Phases of Taxonomy (α, β, ω and others), needs and philosophy of some major systems of classification – Cronquist, Takhtajan, Dahlgren, Thorne and APG system of classification
ii. Taxonomic hierarchy, species, genus, family and other categories; principles used in assessing relationship, delimitation of taxa and attribution of rank
iii. Nomenclature – different methods, sources of names, salient features of the International Code of Botanical Nomenclature
iv. Biocode and Phylocode
v. Character concept and evolution of characters

vi. Taxonomic data sources; anatomy, palynology, embryology, cytology, phytochemistry and molecular biology
vii. Herbarium, botanical garden, taxonomic literature and keys
viii. Taxonomy and phylogeny of Magnoliales, Amentifereae, Asterales, Helobiae, Glumiflorae, Scitaminae and Orchidales
ix. Flora and vegetation of Eastern Himalayas
x. Traditional knowledge: Ethnological resources in India; documentation and utilisation of ethnic knowledge; Traditional methods of conservation; sacred grooves

**Practical Core Course**

**DBOT-CP-104: Phycology, Lichenology, Bryology, Pteridology, Gymnology and Palaeobotany**
**L.H: 102; Credit: 02**

i. Morphological study of the following algal genera: *Scytonema, Rivularia*, *Zygnema, Fucus*, *Batrachospermum*
ii. Morpho-anatomical studies of some locally available members of asco-, basidio- and cyano- lichen
iii. Morphological study of representative bryophyte members – *Lunularia*, *Porella*, *Dumortiera*, *Targionia*, *Plagiochasma*
iv. Morphological study of representative pteridophyte members – *Gleichenia*, *Cheilanthus*, *Polystrichum, Athyrium, Cyathea*
v. Comparative study of the anatomy of vegetative and reproductive parts of *Cryptomeria*, *Taxus*, *Cedrus*, *Cephalotaxus*, *Abies*
vi. Study of important fossil pteridophytes and gymnosperms from prepared slides and specimens

**DBOT-CP-105: Taxonomy of Angiosperms and Plant Anatomy** **L.H: 102; Credit: 02**

i. Work out of locally available plants, identification of up to species following some literature, preparation of artificial keys
ii. Training of using taxonomic literature – flora, herbaria, Journals etc; familiarity with Taxonomic Literature (e.g. Index Kewensis, Wall-Cat, Icones, Bibliographies, Dictionaries, Keys, Floras, etc
iii. Comparison of different species of a genus and different genus of a family to calculate similarity coefficient and preparations of dendrograms
iv. Palynological study of some taxa
v. Wood maceration from soft and hard tissues
vi. Study of nodal anatomy
vii. Anatomical study of different plant materials in relation to ecological adaptations
viii. Study of secretary tissues

**DBOT-CP-106: Project on Bio-resource & Seminar on the Project;** **L.H: 102; Credit: 02**

**DBOT-CP-107: Ability Enhancement Course** **L.H: 51; Credit: 01**
**Choice Based Seminar + Field Studies**

## SEMESTER II

**Theoretical core course**

**DBOT-CT-201: Microbiology** **L.H: 68; Credit: 02 + 01 (Class tests)**

i. New approaches to Bacterial Taxonomy
ii. Ultra-structure – cell wall, capsule and slime, flagella, pilli, ribosome, nuclear body, endospore, photosynthetic apparatus, reserve food material, gas vacuole, mesosome
iii. Metabolism: photosynthesis (anoxygenic and oxygenic); chemosyntghesis, fermentation (alcoholic, EDP Pathway; lactic acid – homo and hetero, propionic acid, mixed acid, butanediol and butanol: Stickland reaction); Respiration (anaerobic and aerobic)
iv. Bacterial growth; measurement of growth, generation time, continuous culture, synchronised growth, diauxy, environmental growth factor
v. Nutrition: Organic growth factors; inorganic requirements; physical and ionic requirements
vi. Organisation and replication of genetic material in bacteria; Extra chromosomal genetic elements; Genetic recombination
vii. Morphological classes of viruses; Principles of viral taxonomy; Structure of viruses; Assay of viruses; Lytic cycle and lysogeny
viii. Biological nitrogen fixation – Root nodulation; structure of nitrogenise and mode of action
ix. Food preservation and microbial control of food industry
x. Bacterial diseases of human – tuberculosis, leproscopy, syphilis: causal organisms, mode transmission and control

**DBOT-CT-202: Mycology and Plant Pathology** **L.H: 68; Credit: 02 + 01 (Class tests)**

i. Cell ultra-structure and cell wall composition of fungi
ii. Fungal growth and nutrition
iii. Fungi in industry, medicine – antibiotics-penicillin, organic acids – citric acids, plant growth regulators – gibberellins, alcohol and fungal enzymes
iv. Fungal toxins – host none selective toxins – mode of action of cerecosporin; host specific toxins – structure, mode of action and concept of Vb Gene, Mycotoxin – aflatoxin, biosynthetic pathway, genes and enzymes
v. Mycorrhizae; interaction; specific recognition in mychorrhizal association; application as biofertiliser and bioprotector in forestry and agriculture
vi. Molecular basis of disease development
vii. Control of plant diseases – chemical and biological measures
viii. Detailed studies of fungal disease: damping off, powdery mildew, down mildew, smut, burnt, rust, wilt, root rot, leaf spots, gall of economically important plants
ix. Virus diseases – symptoms, carrier, transmission, interaction of virus and the host, control strategies
x. Application of avirulence genes in control of plant pathogens

**DBOT-CT-203: Cytology and Genetics** **L.H: 68; Credit: 02 + 01 (Class tests)**

i. Chromosome structure and packaging of DNA molecule, organisation of centromere and telomere, nucleolus and ribosomal RNA genes; euchromatin and heterochromatin; karyotype analysis
ii. Mapping of genome; genetics of mitochondria and chloroplast
iii. Regulation of gene expression: prokaryotes and eukaryotes
iv. Genetic marker, construction of molecular maps, correlation of genetic and physical maps; somatic cell genetic and alternative approach to gene mapping

v. Transposable elements in prokaryotes and eukaryotes; mutation induced by transposons; site directed mutagenesis; DNA damage and repair mechanism, inherited human diseases and defects in DNA repair; initiation of cancer at cellular level, proto-oncogenes and oncogenes
vi. Breeding behaviour and genetics of structural heterozyogotes; complex translocation; heterozygotes translocation; tester sets; Robertsonian translocations; B – A translocations
vii. Flow cytometry, *in situ* hybridisation – concept and technique
viii. Transfer of whole genome, examples from wheat, *Arachis* and *Brassica*; transfer of individual chromosomes and chromosome segments; genetic basis of inbreeding and heterosis, exploitation of hybrid vigour

**Practical Core Course**

**DBOT-CP-204: Microbiology** **L.H.: 102; Credit: 02**

i. Staining – simple, negative, endospore, flagella, Gram staining of bacteria
ii. Sterilisation methods, preparation of media and stains
iii. Bacterial population count of soil, water, air
iv. Enumeration of bacterial population of liquid culture by Breed's method and Neubauer counting method Study of population of rhizosphericmicroflora
v. Study of population of phyllosphericmicroflora
vi. Determination of thermal death point of different bacteria
vii. Biochemical studies of the nitrogen fixing, nitrifying, sulphur oxidising and phosphate solubilising bacteria

**DBOT-CP-205: Mycology and Plant Pathology** **L.H.: 102; Credit: 02**

i. Morphological study of representative members of fungi – yeast, *Mucor*, *Penicillium*, *Aspergillus*, *Alternaria*, *Xylaria*, *Fusarium*, Members of *Agaricales* and *Polyporales* (available in Darjeeling)
ii. Sterilisation methods, preparation of media and stains, culture of fungus
iii. Histopathological studies of fungal diseases of economically important corps
iv. Identification of fungal culture: *Curvularia*, *Fusarium*, *Alternaria*, *Trichoderma*, *Pestalotiopsis*, *Exobasidium*, *Saccharomyces*
v. Antibiotic bioassay by agar disc method
vi. Detection of $ED_{50}$ of fungicides by spore germination method
vii. Thin layer chromatography and bioassay of antifungal compounds
viii. Comparison of phenol content between healthy and artificially inoculated plants
ix. Extraction and essay of phenylalanine ammonia lyase activity in plants following infection

**DBOT-CP-206: Cytology and Genetics** **L.H.: 102; Credit: 02**

i. Study of plant chromosome, chromosome staining schedules
ii. Isolation of nuclei and identification of histones by SDS-PAGE
iii. Isolation of plant DNA and its quantisation by spectrophotometric method
iv. Restriction digestion of plant DNA and separation by agarose gel electrophoresis and visualisation of ethidium bromide staining
v. Isolation of RNA and quantisation by spectrophotometric method
vi. Demonstration of SEM and TEM
vii. Staining of nucleolus

**DBOT-CP-207: Ability Enhancement Core Course** **L.H.: 17; Credit: 01**
**Choice-based Seminar**

# SEMESTER III

**Theoretical Core Course**

**DBOT-CT-301: Plant Physiology** **L.H: 68; Credit: 02 + 01 (Class tests)**

i. Photosynthesis: Photosynthetic light harvesting system and C1, C2, C3, C4 and CAM
ii. Plant growth substances: Chemistry and biosynthesis and mode of action
iii. Plant water relation and mineral nutrition: water potential and nutrient uptake
iv. Flowering: phytochrome, biochemical signalling and photoperiodism
v. Seed germination and dormancy: types, methods of breaking dormancy, hormonal role in seed germination
vi. Major biochemical pathways: Glycolysis, Kreb's cycle, Pentose phosphate pathway, gluconeogenesis, Shikimate pathsway; Senescence and programmed cell death: pattern, mechanism and PCD in plants
vii. Solute transport: passive and active transport, membrane transport process, membrane transport proteins
viii. Membrane transport mechanism – organisation of import molecules, ion channels

**DBOT-CT-302: Plant Biochemistry** **L.H: 68; Credit: 02 + 01 (Class tests)**

i. Bioenergetics: thermodynamic principles, energy rich compounds and phosphorylation
ii. Carbohydrates: classification, structure and biosynthesis, glycosides – structure and function
iii. Protein metabolism: chemistry, structure and synthesis
iv. Lipid metabolism: biosynthesis of fatty acids, lipid oxidation, triglycerol synthesis and membrane lipid biogenesis
v. Enzymes: classification, kinetics and inhibition
vi. Nucleosides: biosynthesis of purine and pyrimidine ribonucleotides and deoxy-ribonucleotides
vii. Nitrogen metabolism: nitrate and nitrite uptake and reduction, regulation of nitrogen metabolism
viii. Cell wall – molecular architecture, biosynthesis and assembly
ix. Secondary metabolites – types, biosynthetic pathways, role in plant defence mechanism

**DBOT-CT-303: Ecology and Biostatistics** **L.H: 68; Credit: 02 + 01 (Class tests)**

i. Pollution: parameters, regulation and genetics, community: concept, structure, dominance, fluctuations, succession
ii. Interaction between environment and biota, concept of habitat and niche, limiting factors, energy flow, food chain, food web and trophic level, ecological pyramids, biogeochemical cycles of nitrogen, phosphorous, sulphur, calcium, carbon, carbon-silicate, arsenic cycle in water
iii. Adaptation of wetland plants, plants on serpentine soil, phytoremediation, metallophyes, geobotany, cavernicolous life
iv. Air, water, soil and radioactive pollution sources, consequences and effect on biodiversity, different control measures
v. Global environmental issues – global warming, green house effect and Goldilock's phenomenon, degradation mechanism, Montreal and Kyoto protocol, modern technology and environment, dams and rivers, climatic changes, population explosion, sustainable development, the Great Flood in old literatures, environmental impact assessment and PAP
vi. Biodiversity – type, causes of decline and extinction, bio-invasion and Blitzkrieg hypothesis, Case study of Dodo and Martha; importance of biodiversity, conservation, MA/b, key stone species and umbrella species, biodiversity and ecosystem stability, hotspots, Brazilian rain forest and Chico Mendes, Earth summit
vii. Population, statistics, data, mean, median, mode, SD, co-efficient of correlation, regression, ANOVA, probability, $\chi^2$ test, T test, F test, construction of dendrograms

**Practical Core Course**

**DBOT-CP-304: Plant Physiology** **L.H.: 102; Credit: 02**

i. Determination of osmotic pressure of an integrated plant tissue
ii. Extraction and estimation of total chlorophyll from leaves of different chronological ages
iii. Effect of uncoupler and inhibitor on the rate of photosynthesis
iv. Determination of the effect of respiratory inhibitor on the rate of respiration
v. Study of leaf pigments by filter-paper chromatography
vi. Study and separation of leaf anthocyanin by thin layer chromatography
vii. Experiments on bioassay of IAA and kinetin
viii. Effect of plant hormone on water uptake
ix. Effect of heavy metal on seed germination
x. Photomorphogenetc effect of light on the development of seedling

**DBOT-CP-305: Plant Biochemistry** **L.H: 102; Credit: 02**

i. Preparation of standard curve of a known protein (BSA) and estimation of an unknown protein by Lowry's method
ii. Extraction and estimation of peroxidase from plant sample
iii. Extraction and estimation of free amino acid from plant sample
iv. Extraction and estimation of IAA-oxidase from plant sample
v. Extraction and estimation of nitrate reductase from plant sample
vi. Extraction and estimation of amylase from plant sample
vii. Extraction and estimation of Ascorbic acid from plant sample
viii. Extraction and estimation of Phenols from plant sample
ix. Extraction of phosphorous using $K_2HP_4$ standard curve
x. Extraction and estimation of titrable acids in plant sample

**DBOT-CP-306: Ecology and Biostatistics** **L.H: 102; Credit: 02**

i. Determination of frequency, density and abundance in field by quadrat method or from a given data set
ii. Determination of soil pH, soil texture, moisture content and soil humus of a supplied sample
iii. Quantitative estimation of dissolved oxygen and carbon dioxide of supplied water sample
iv. Determination of SD, co-efficient of correlation, regression, ANOVA, $\chi^2$ test, T test, F test
v. Construction of dendrograms with the help of software

**Continuing Evaluation**
**DBOT-CP-307: Ability Enhancement Core Course: Choice-based Review** **L.H: 51; Credit: 01**

# SEMESTER IV

## Theoretical Core Course

## Interdisciplinary Core Course

**DBOT-CT-401: Biophysics and Instrumentation in Biological Analysis**
**L.H: 68; Credit: 02 + 01 (Class tests)**

Physico-chemical properties of water; ionic product of water, pH, buffers, ampholytes, surface tension, viscosity, application of biomolecules
**Microscopy:** General principles and applications of compound microscopy, light microscope, bright field and dark field microscope, phase contrast microscope, fluorescent microscope, electron microscope, atomic force microscope.
**Spectrophotometry**: Principle of colorimetry, visible, UV, IR, atomic absorption spectrophotometry.
**Centrifugation:** Basic principles, fluorometry centrifugation.
**Radiobiology:** Law of radioactivity, radioactive carbon dating, application of radioactive isotopes in biological system.
**Chromatography:** Basic principles and application of thin layer chromatograpy, gas liquid chromatography, HPLC, mass spectrometry.
Protein immunoblotting, RIA, ELISA
Bio-electricity and bio-photons, rudimentary nervous mechanism in plants
Analysis of biomolecules by mass spectrometry and NMR

**DBOT-CT-402: Environmental Biology** **L.H: 68; Credit: 02 + 01 (Class tests)**

i. An introduction to environmental biology; ecosystem functions: energy flow and biogeochemical cycles
ii. Pollutants and contaminants, photochemical smog, PAN, heavy metal stress, serpentine soil and plants there on, phytoremediation, metallophytes and geobotany, microbial clean up of oil spill on ocean surface, BOD, COD, NOD, SOD, degradation of pesticides by microbes, solid waste management; electronic waste (e waste), sources and types, impacts, recycling and management
iii. Environmental toxicology, $LD_{50}$, case study of some pollution events: Bhopal disaster, Chernobyl, Three miles island, itaiitai or ouch ouch, Minamata, London smog, acid mine drainage, DDT disaster, thalidomide and teratogeny
iv. El Nino and La Nina
v. Environmental law and policies, environmental ethics, environmental economics
vi. Impact of man-plant relationship on environment; aforestation - deforestation – reforestation, agroforestry and social forestry
vii. Environmental Biotechnology: concept of waste management, biodegradation of xenobiotics and hydrocarbons, vermicomposting, farmyard manure, production and utilization of biofuels, biofertilizers and biopesticides
viii. Useful statistics in Environmental Biology: Mean, median, mode, SD, co-efficient of correlation, regression, ANOVA, probability, $\chi^2$ test, T test, F test, construction of dendrograms

**Elective Special Paper***

**Theoretical**

**DBOT-CT-403: Theoretical Paper- I** **L.H.: 68; Credit: 02**
**DBOT-CT-404: Theoretical Paper- II** **L.H.: 68; Credit: 02**

**DBOT-CT-403 and DBOT-CT-404: Elective Special paper (any one of the following):**

**(1) Cytogenetics, (2) Microbiology, (3) Mycology and Plant Pathology, (4) Phycology, (5) Plant Biochemistry and Molecular Biology, (6) Plant Physiology and Biochemistry, (7) Taxonomy of Angiosperms and Ecology**

**1. Cytogenetics**

**DBOT-CT-403**

i. Structural and functional genomics
ii. Cell cycles and cell signalling
iii. The techniques of Molecular Genetics: an overview of molecular genetic techniques, Southern-Northern-Western blot hybridisation, PCR, PAGE, FACS, TEM and SEM. Major plant genetic marker for crop improvement – AFLP, RFLP, RAPD, SSR, STS, EST, SNPs etc.
iv. Molecular concept of gene, regulation of gene expression in prokaryotes and eukaryotes
v. Gene silencing, DNA methylation and imprinting, gene amplification, Dosage compensation, Homeotic genes
vi. Tools of DNA technology-restriction enzymes, Vectors: plasmid, bacteriophage, other viral vectors, cosmid, phage M13, Ti plasmid, YAC, BAC, HAC, MAC etc. cDNA and gDNA library

**DBOT-CT-404**

i. Somatic embryogenesis, somaclonal variation – application in crop improvement, synthetic seeds, haploid production – its applications, Protoplast culture-fusion somatic hybridisation and application of protoplast technology
ii. Biotechnological approaches to the expression of foreign genes in plants Agrobacterium tumefaciens a natural tools for plant transformation. Updated molecular mechanism for T-DNA transfer to plant cell by Ti-plasmid
iii. Genetically Modified Organisms (GMOs)
iv. Biodiversity and Intellectual Property Rights (IPR)
v. An overview of the general approaches of structural and functional proteomics, Evolution of genetic code and evolution of protein synthesis
vi. Embryonic stem cell technology

**2. Microbiology**

**DBOT-CT-403**

i. General account: mycoplasma; gliding bacteria; actinomycetes
ii. Growth and growth control; counting viable but non-culturable prokaryotes; Quorum sensing; growth control by physical exclusion, heat, radiation and chemicals
iii. Microbial metabolism: Bacterial photosynthesis, respiration, fermentation
iv. Virus: Classification; principles of viral taxonomy; Purification and Assay of viruses; Lytic cycle and lysogeny
v. Extremophilic microorganisms: Characteristic of archaebacteria, thermophiles, halophiles, barophiles
vi. Water microbiology: Microbial load in water, examination of water quality, purification techniques
vii. Dairy microbiology: types and sources of microorganisms in milk, preservation techniques, role of microorganisms in production of different milk products
viii. Soil microbiology: Soil environment; soil microorganisms and interaction among them, role of microbes in biochemical transformations of nitrogen, phosphorous, carbon, sulphur compounds, PGPR, Plant-microbe interaction

ix. Human microbiome: Commensal microbiota of human body, interaction with the host; impact of gut microbiota in human body

**DBOT-CT-404**

i. Industrial microbiology: Fermentation technology, Bioreactors; Strain development, Production of antibiotics (penicillin & streptomycin), organic acid (citric & acetic acid), enzymes (amylase, protease & lipase), insulin, biotrasformation of steroids, commercial production of biofertiliser
ii. Antibiotics: Sources, chemistry, biosynthesis and mechanism of action; probiotics; prebiotics; symbiotics
iii. Genetics: Genetic code – its nature and deciphering; transcription, post-translational RNA processing, translation, operon (Lac operon & Trp operon)
iv. Genetic Enginerering: Splicing of DNA; insertion of DNA into vector; detection of recombinant molecules; PCR and its applications; expression of cloned genes
v. Role of plasmids and bacterophages as cloning vectors; resistance plasmids; cosmids
vi. Immunology: Antigens, immunoglbulins; antigen presentation; monoclonal antibodies; complement fixation, interleukin, immunodiagnosis; immunological techniques; development of vaccines; interferons – characteristics, production , chemical induction, regulation of production, mode of application
vii. Biodegradation of xenobiotics; degradativbe genes in the environment; genetically engineered microbes for biodegradation; biosurfactants; biopesticides
viii. Microbiology of bio-energy production: substrate digestor, production of biogas, biodesel, biohydrogen

**3. Mycology and Plant pathology**

**DBOT-CT-403**

i. Physiology and Biochemistry of fungi: Nutritive uptake, sensing and translocation; fungal growth; metabolism of fungi, secondary metabolites
ii. Cell Biology and Genetics of Fungi: Cell components of fungi; fungal cell division; chromosome theory, chromosome mapping; Parasexual cycle; gene as functional unit; the fine structure of genes; mechanism of genetics exchange, heterothallism; genetics of sporulation; extra cellular inheritance
iii. Molecular biology: yeast genome; the two micron circle; yeast cell cycle and its regulation; molecular biology of yeast killer system
iv. Applied mycoses: mycotoxins; mushroom cultivation, nutritional and medicinal importance, Industrial production of citric acid, alcohol, antibiotics, enzymes (amylase, cellulase and pectinase)
v. Plant disease epidemiology
vi. Genetics of plant disease

**DBOT-CT-404**

i. Modern concept of plant immunity and mechanisms of plant defence signalling
ii. Biotechnological approaches for the viral disese management
iii. Phytopathogenic bacterial plasmids and their genetic engineering
iv. Molecular biology of plant pathogen interaction
v. Avirulent gene for crop disease management
vi. Molecular biological techniques for disease management

**4. Phycology**

**DBOT-CT-403**

i. Prochlorophyta and Glaucophyta – General characteristics and phylogenetic importance

ii. Cyanobacteria in geothermal habitat: Geographic distribution, distribution determination by lip biomarker and 16s rRNA
iii. Heterokontophyta – Different classes and phyllogenetic significance of each groups
iv. Chlorophyta – Different classes and phyllogenetic significance of each groups
v. Distribution of algal genera in ocean with particular emphasis on Indian Continent

**DBOT-CT-404**

i. Palaeobotanical study and role of Algae in Petroleum industry
ii. Algal light harvesting complex: phycoboliproteins, constructing ore an rod elements of PBS, linker polypeptide, chromatic adaptation, structure and regulation of light harvesting genes
iii. Basic culturing techniques and mass cultivation: Biological principles, types of reactors for phototrophic algae, downstream processing of cell mass production, hetertrophic production of marine algae for aquaculture
iv. Role of algae in wetland ecology; Phytoplankton community – structure and function; water pollution, phytoremediation, Algal bloom, Red tide, Algae as ecological indicator and secondary metabolite production from algae
v. Environmental stress physiology:
a. Ecotoxicology of inorganic chemical stress on algae
b. Photoacclimation
c. Photo-inhibition and culture productivity
d. Salinity stress

**5. Plant Biochemistry and Molecular Biology**

**DBOT-CT-403**

i. Protein biochemistry: Transcription and post-translational modifications, translation, protein targeting and characterisation
ii. Amino acids metabolism: Biosynthesis of aspartic and aromatic amino acids families
iii. Brassinosteroids – structure, occurrence, biosynthesis, metabolism and effect on growth and development
iv. Sulphate metabolism – chemistry, uptake and transport, assimilation pathway
v. Alkaloids – chemistry, classification, biosynthesis, industrial application
vi. Protein sorting and vesicle traffic: machinery of protein sorting, targeting to mitochondria, plastids, peroxisomes, ER, vacuole, protein modification in Golgi apparatus
vii. RNAi and antisense RNA technology
viii. Enzymes: Purification of enzymes, enzyme immobilisation, alllosteric enzymes, multi-substrate reactions.

**DBOT-CT-404**

i. DNA replication, role of topoisomerase, DNA repair
ii. Plant Molecular biology: Restriction Endonucleases and cloning vectors, construction of cDNA and genomic libraries, identification of specific clones, DNA sequencing
iii. Molecular concept of gene, gene duplication and pseudogenes
iv. Regulation of gene expression in plants: plant gene structure and expression, regulatory mechanisms, control of transcription, post-trancriptional control of gene expression
v. DNA manipulation and alien gene transfer and application of recombinant DNA technology
vi. Polymerase chain reaction – PCR; types and application

**6. Plant physiology and Biochemistry**

**DBOT-CT-403**

i. Plant pigments: Types biosynthesis and degradation

ii. Nitrogen fixation: Nitrogen fixation and assimilation, components of nitrogenise, urea cycle, genetic engineering of nitrogenise gene cluster and nodulation genes
iii. Stress physiology: abiotic and biotic stress, role of amino acids and polyamines in stress tolerance
iv. Fruit ripening: Biochemistry and molecular basis
v. Signal transduction: signalling pathways, chemical signals and cellular receptors
vi. Translocation in phloem: pathways, pattern of pressure flow model for phloem transport, phloem loading
vii. Blue light response-stomatal movements and morphogenesis
viii. Crop physiology: new ideotypes, physiological basis of crops, economic index, and harvest index
ix. Molecular physiology of mineral nutrients – mechanism and regulation or $K^+$ transport, phosphorous nutrition and transport, plant responses of mineral toxicity
x. Protein biochemistry: transcriptional and post-transcriptional modifications, translation, protein targeting and characterisation

**DBOT-CT-404**

i. Amino acid metabolism: biosynthesis of aspartic acid and aromatic amino acid families
ii. Brassinosteroids – structure, occurrence, biosynthesis, metabolism and effect on growth and development
iii. Sulphate metabolism – chemistry, uptake and transport, assimilation pathway
iv. Alkaloids – chemistry, classification, biosynthesis, industrial application
v. Protein sorting and vesicle traffic: machinery of protein sorting, targeting to mitochondria, plastids, peroxisomes, ER, vacuole, protein modification in Golgi apparatus
vi. RNAi and antisense RNA technology
vii. Enzymes: Purification of enzymes, enzyme immobilisation, alllosteric enzymes, multi-substrate reactions
viii. DNA replication, role of topoisomerase, DNA repair
ix. Plant Molecular biology: Restriction endonuclease and cloning vectors, construction of cDNA and genomic libraries, identification of specific clones, DNA sequencing

## 7. TAXONOMY OF ANGIOSPERMS AND ECOLOGY

**DBOT-CT-403**

i. History of Indian Plant Taxonomy
ii. Pre-Darwinian and Post-Darwinian systems of classification: a historical background, A critical evaluation of the classification of Takhtajan, Cronquist, Dahlgren, Thorne and APG system of classification
iii. ICBN and other codes, application of code with problems; nomenclature of cultivated and hybrid plants
iv. Molecular systematic, molecular clock, cladistics and numerical taxonomy
v. Taxonomic Literature, keys, methods of identification, nomenclatural problems
vi. Species concept, evolution of terms: homology, analogy, plesiomorphy, apomorphy, symplesiomorphy, synapomorphy, anagensis, cladogenesis, stasigenesis
vii. Biosystermatics: importance, categories and major areas of biosystematics and its prospects, genecology, interaction between genes and environment, genetic barrier, phenotypic plasticity, speciation, heterobathmy
viii. Origin, evolution of diversity and phylogeny of angiosperms, cradle of angiosperms
ix. Application of palynology as tool
x. Bioelectromagnetosystematics: a new tool in taxonomy
xi. Analysis of data; commonly available software, construction of Dendrograms

**DBOT-CT-404**

i. Phytogeographic zones and floristic regions of India and World, megadiversity countries and conservation hotspot, major biomes of the world: forest, wetland, grassland, desert, tundra, ocean
ii. Biosphere II, planetary ecosystem and planetary engineering – biopoiesis and ecopoiesis, case study of a hypothetical planetary engineering project: terraformation on Mars, origin of life and evolution: Darwinism, Gaia and Red Queen hypothesis
iii. Natural selection, ring species, race, cline, industrial melanism and natural selection, mechanism of speciation and extinctions, Hardy-Weinberg Genetic Equilibrium, genetic polymorphism and selection, allele fixation, bottle neck, founder principle
iv. IUCN, Red List criteria, CITES, endemism and exotic flora of India, Ramsar sites
v. Case study of some ecological issues in India: Himalayan problems, desertification in India, salinity increase and decline of sundari tree in Sunderbans, Chipko movement, ecological and environmental problems leading to decline of Indus valley civilization, Narmada banchaoandolon, arsenic problem in drinking water, dams and rivers, instability of substratum in Raniganj coalfield
vi. Environmental Biotechnology: concept of waste management, biodegradation of xenobiotics and hydrocarbons, vermicomposting, farmyard manure, production and utilization of biofuels, biofertilizers and biopesticides
vii. Molecular and adaptive variation: hitch-hiking of gene, phylogeography and conservation genetics; role of NBPGR in conservation of Indian biodiversity
viii. Functional Genomics to study taxonomic and ecological variation -- approaches to analyze differential expression of genes - ESTs, SAGE, microarrays and their applications; principles in reverse genetics: gene tagging; gene trapping; gene silencing; knockout mutants; transcriptome; ribotype concept; concept, methodology and applications of proteomics
ix. Remote sensing for study of ecosystem

## Practical of Elective Special Paper

**DBOT-CP-405: Practical** **L.H:136; Credit: 03**

**Cytogenetics**

i. Study of plant chromosome, chromosome staining schedule, chromosome staining by fluorescence dye, differential staining of euchromatin and heterochromatin
ii. Differential *in-situ* staining of DNA and RNA of plant cells
iii. Isolation of plant genomic DNA and RNA from plant tissues and Quantification by spectrophotometric method
iv. Separation of DNA and RNA on agarose gel electrophoresis and visualisation by ethidium bromide staining
v. Digestion of genomic DNA with restriction enzymes
vi. PAGE and SDS-PAGE of plant proteins and chloroplast protein profile
vii. Anther-Pollen culture from tobacco and plant regeneration from embryo
viii. Isolation and culture of plant protoplast and its viability test
ix. Amplification of DNA by PCR
x. Study of plant genetic marker such as isozyme markers

**Microbiology**

i. Study of physiological and biochemical activities of bacteria(hydrolysis of starch, lipid, protein and urea: degradation of cellulose and pectin; catalase activity; nitrate reduction, IMVIC reaction, liquefaction of gelatin, oxidation and fermentation of carbohydrates
ii. Microbial growth kinetics
iii. Chemical estimation of sugar by DNS method
iv. Separation and identification of amino acids/sugars by paper/thin layer chromatographic method

v. Effect of substrate concentration and temperature on enzyme activity
vi. PAGE separation of microbial proteins
vii. Agarose gel separation of prokaryotic DNA
viii. Bacteriological examination of water using multiple tube fermentation/membrane filtration method
ix. Enumeration of bacteriophage from environmental samples
x. Enrichment and isolation of photosynthetic, endospore forming, phosphate solubilising, sulphur oxidising, ammonifying, nitrogen fixing bacteria
xi. Isolation of antibiotic resistant mutants
xii. Isolation of antibiotic producers from soil
xiii. Estimation of microbial biomass carbon by chloroform fumigation incubation method
xiv. Isolation of *Rhizobia* from root nodules and *Azotobacter*, determination of their PGPR ability
xv. Isolation and characterization of pesticide degrading microorganisms from soil

**Mycology and Plant Pathology**

i. Growth curve and sporulation of yeast
ii. Fermentation of citric acid and alcohol
iii. Antifungal antibiotic sensitivity test
iv. Quantitative estimation of protein, carbohydrate, amino acid, fat, DNA, RNA from fungi
v. TLC and paper chromatography of amino acids
vi. Isolation DNA, RNA and plasmid from yeast
vii. Agarose gel electrophoresis of DNA, RNA and Plasmid
viii. PAGE of proteins
ix. Koch's postulate
x. Enzyme assay of cellulose and pectinase
xi. *In vitro* antagonism study by bio-control agents

**Phycology**

i. Survey on algal group of different ecological niche of surrounding locality
ii. Chromosomal study of Algae
iii. Study of different biochemical parameters (dissolved $O_2$, dissolved $CO_2$, pH, temperature and salinity in relation to different algal genera
iv. Culture and maintenance of algae in laboratory condition
v. Study of algal flora in a permanent habitat
vi. Study of cyanobacteria flora in rice field
vii. Standardization of extraction procedure of algal DNA
viii. Chemical study of algal extracts in water ecosystem

**Plant Biochemistry and Molecular Biology**

i. Effect of time and enzyme concentration on rate of reaction of enzyme, substrate concentration and Km value
ii. Extraction and estimation of plant carbohydrate by anthrone method
iii. Extraction of plant protein and its estimation by Lowry's method and Bradford's method
iv. Separation of isozymes of peroxidise by native – PAGE
v. SDS-PAGE of soluble proteins extracted from plant material
vi. Fractionation of protein by gel-filtration chromatography
vii. Fraction of protein by ion exchange chromatography
viii. Extraction and estimation of nucleic acids from plant material
ix. Extraction and estimation of oil form fatty seeds
x. Determination of saponificaiton and iodine value of fat sample
xi. Estimation of DNA and RNA

xii. Extraction of genomic DNA and RNA from plants
xiii. Isolation of gene (nptgene from PUC7KAPA with *Bam* H1)
xiv. Transformation of E. coli – DH 5 with pUC19
xv. Isolation of plasmid from the selected transformants by miniprepmethod

**Plant physiology and Biochemistry**

i. Extraction of chloroplast pigments from leaves and preparation of the absorption spectrum of chlorophylls and cartenoids
ii. Seed viability of different seeds using TTC test
iii. Study of photolysis of water by Hill reaction with isolated chloroplast
iv. Determination of free amino acids from plant sample with paper chromatography and TLC
v. Breakdown of seed dormancy by cold treatment and scarification
vi. Effects of time and enzyme concentration on the rate of reaction of enzyme substrate concentration and Km value
vii. Extraction and estimation of plant carbohydrate by anthrone method
viii. Extraction of plant protein and its estimation by Lowry's method and Bradford method
ix. Separation of isozymes of peroxidise by native – PAGE
x. SDS-PAGE if soluble proteins extracted from plant material
xi. Fractionation of protein by gel-filtration chromatography
xii. Fractionation of protein by ion exchange chromatography
xiii. Extraction and estimation of nucleic acids from plant material
xiv. Extraction and estimation of oil from fatty seeds
xv. Determination of saponification and iodine value of fat sample

**Taxonomy of Angiosperms and Ecology**

i. Seasonal collection of local flora, processing, herbarium management
ii. Study of phenology of some common weeds
iii. Study of seed, endosperm, embryo and seedling morphology, study of leaf diversity including venation and vein islets in relation to identification of different angiosperm species
iv. Work out of different angiospermic plants (fresh and dry), their identification using literature and preparation of artificial keys, study of the trend of floral evolution of some locally available plants following some specific biota
v. Determination of correct name of a species
vi. Construction of dendograms or phenograms from a given data on character states with the help of software
vii. Preparation of pollen slides, description of common palynomorphs, preparation of identification keys
viii. Study of Raunkier's life forms and biological spectrum in field or from a given data set
ix. Determination different biodiversity indices from a field or given data set (Shannon, Simpson, Brillouin, Peat, McIntosh, Association index, Similarity index, etc.)
x. Physico-chemical analysis of soil in relation to organic carbon and N, P, K profile
xi. Determination of BOD and COD of a given sample
xii. Study of noise pollution in a congested area with a sound level meter
xiii. Measurement of slope, elevation and tree height with Abney Level

**DBOT-CP-406: Dissertation** **L.H: 238; Credit: 02**

**DBOT-CP-407: Seminar on Dissertation** **L.H: 34; Credit: 01**

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