





SHAILABALA WOMEN'S AUTONOMOUS COLLEGE, CUTTACK
STATE MODEL SYLLABUS FOR UNDER
GRADUATE COURSE IN BOTANY
(Bachelor of Science Examination)

UNDER
CHOICE BASED CREDITS SYSTEM

**CROSS CUTTING ISSUES RELEVANT TO PROFESSIONAL
ETHICS, GENDER, HUMAN VALUES AND ENVIRONMENT &
SUSTAINABILITY**

Mapping Colour Index:

-  - Gender
-  - Human values
-  - Professional Ethics
-  - Environment & Sustainability

| Course Structure of U.G. Botany Honours | | | | |
|--|------------------|--|---------------|--------------------|
| Semester | Course | Course Name | Credit | Total marks |
| Semester-I | AECC-I | | 4 | 100 |
| | C-1(Theory) | Microbiology and Phycology | 4 | 75 |
| | C-1(Practical) | Microbiology and Phycology | 2 | 25 |
| | C-2(Theory) | Biomolecules and Cell Biology | 4 | 75 |
| | C-2(Practical) | Biomolecules and Cell Biology | 2 | 25 |
| | GE-1A(Theory) | Biodiversity (Microbes, Algae, Fungi & Archegoniate) | 4 | 75 |
| | GE-1A(Practical) | Biodiversity (Microbes, Algae, Fungi & Archegoniate) | 2 | 25 |
| Semester-II | AECC-II | | 4 | 100 |
| | C-3(Theory) | Mycology and Phytopathology | 4 | 75 |
| | C-3(Practical) | Mycology and Phytopathology | 2 | 25 |
| | C-4(Theory) | Archegoniate | 4 | 75 |
| | C-4(Practical) | Archegoniate | 2 | 25 |
| Semester-III | C-5(Theory) | Anatomy of Angiosperms | 4 | 75 |
| | C-5(Practical) | Anatomy of Angiosperms | 2 | 25 |
| | C-6(Theory) | Economic Botany | 4 | 75 |
| | C-6(Practical) | Economic Botany | 2 | 25 |
| | C-7(Theory) | Genetics | 4 | 75 |
| | C-7(Practical) | Genetics | 2 | 25 |
| | SEC-1 | | 4 | 100 |
| | GE-1B(Theory) | Plant Ecology & Taxonomy | 4 | 75 |
| | GE-1B(Practical) | Plant Ecology & Taxonomy | 2 | 25 |
| Semester-IV | C-8(Theory) | Molecular Biology | 4 | 75 |
| | C-8(Practical) | Molecular Biology | 2 | 25 |
| | C-9(Theory) | Plant Ecology & Phytogeography | 4 | 75 |

| | | | | |
|-------------|---------------------|---|------------|-------------|
| | C-9(Practical) | PlantEcology&Phytogeography | 2 | 25 |
| | C-10(Theory) | PlantSystematics | 4 | 75 |
| | C-10(Practical) | PlantSystematics | 2 | 25 |
| | SECII | | 4 | 100 |
| Semester-V | C-11(Theory) | ReproductiveBiologyofAngiosperms | 4 | 75 |
| | C-11(Practical) | ReproductiveBiologyofAngiosperms | 2 | 25 |
| | C-12(Theory) | PlantPhysiology | 4 | 75 |
| | C-12(Practical) | PlantPhysiology | 2 | 25 |
| | DSE-1(Theory) | AnalyticalTechniquesinPlantsSciences | 4 | 75 |
| | DSE-1(Practical) | AnalyticalTechniquesinPlantsSciences | 2 | 25 |
| | DSE-2(Theory) | NaturalResourceManagement | 4 | 75 |
| | DSE-2(Practical) | NaturalResourceManagement | 2 | 25 |
| Semester-VI | C-13(Theory) | PlantMetabolism | 4 | 75 |
| | C-13(Practical) | PlantMetabolism | 2 | 25 |
| | C-14(Theory) | PlantBiotechnology | 4 | 75 |
| | C-14(Practical) | PlantBiotechnology | 2 | 25 |
| | DSE-3(Theory) | HorticulturePractices&PostHarvestTechnology | 4 | 75 |
| | DSE-3(Practical) | HorticulturePractices&PostHarvestTechnology | 2 | 25 |
| | DSE- 4 Project work | Project Work/ Industrial Management | 6 | 100 |
| Total | | | 130 | 2000 |

BOTANY

HONOURSPAPERS:

Core course – 14 papers

Discipline Specific Elective – 4 papers

Generic Elective for Non Botany students –

4 papers. In case University offers 2 subjects as GE, then papers 1 and 2 will be the GE paper.

Marks per paper – Midterm: 15 marks, End term: 60 marks (Theory) + 25 marks (Practical), Total – 100 marks

Credit per paper – 6

Teaching hours per paper – 40 hours (theory) + 10 hours (practical)

Core Paper I

MICROBIOLOGY AND PHYCOLOGY

Unit-I

Introduction to microbial world, microbial nutrition, growth and metabolism. **Viruses:-** Discovery, physicochemical and biological characteristics; classification (Baltimore), general structure with special reference to viroid and prions; replication (general account), DNA virus (T-phage), lytic and lysogenic cycle; RNA virus (TMV). Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases.

Unit-II

(i) Bacteria:- Discovery, general characteristics, types - archaeobacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts), cell structure, nutritional types, reproduction - vegetative, asexual and recombination (conjugation, transformation and transduction). Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine).

(ii) Cyanobacteria:-

Ecology and occurrence, cell structure, heterocyst, reproduction, economic importance; role in biotechnology. Morphology and life-cycle of Nostoc. General characteristics of prochlorophyceae, Evolutionary significance of Prochloron.

Unit-III

(i) Algae:-

General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigments system, reserve food (of only groups represented in the syllabus), flagella; and methods of reproduction, classification; criteria, system of Fritsch, Role of algae in the environment, agriculture, biotechnology and industry.

(ii) Chlorophyta:-

General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycles of Volvox, Oedogonium and Coleochaete.

Unit-IV

(i) **Charophyta**: -General characteristics; occurrence, morphology, cell structure and life-cycle of Chara; evolutionary significance.

(ii) **Xanthophyta**: -General characteristics; Occurrence, morphology and life-cycle of Vaucheria.

(iii) **Phaeophyta**: -Characteristics, occurrence, cell structure and reproduction. Morphology and life-cycles of Ectocarpus.

(iv) **Rhodophyta**: -General characteristics, occurrence, cell structure and (v) reproduction. Morphology and life-cycle of Polysiphonia.

PRACTICAL

Microbiology

(i) Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/Photographs of Lytic and Lysogenic Cycle.

(ii) Types of Bacteria to be observed from temporary/permanent slides/photographs. (iii) Examination of bacteria from natural habitat (curd) by simple staining

(iv) Electron micrographs of bacteria, binary fission, endospore, conjugation, root Nodule (live materials and photographs).

(v) Gram staining.

Phycology

Study of vegetative and reproductive structures of Nostoc, Volvox, Oedogonium, Coleochaete, Chara, Vaucheria, Ectocarpus, and Polysiphonia, Prochloron, Diatoms through electron micrographs, temporary preparations and permanent slides (based on availability of materials).

Text Books:

1. Singh, Pandey and Jain (2017). Microbiology and Phycology, Rastogi Publication, Meerut.

Reference Books:

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
2. Prescott, L.M., Harley J.P., Klein D.A. (2010). Microbiology, McGraw-Hill, India. 8th edition.
3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
4. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.
5. Pelczar et al. (2011) Microbiology, 8th edition, Tata McGraw-Hill Co, New Delhi.
6. Willey, Sherwood and Christopher. Laboratory exercises in Microbiology. McGraw-Hill, India. 9th edition.
7. P.R. Vasista (2017) Botany for Degree student, Algae, S. Chand Publication, New Delhi.
8. B.K. Mishra (2018) Microbiology and Phycology, Kalynai Publishers, New Delhi.

Core Paper II

BIOMOLECULES AND CELL BIOLOGY

Unit-I

(i) Biomolecules and Bioenergetics: Types and significance of chemical bonds; Structure and properties of water; pH and buffers. Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions.

(ii) Enzymes: Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced-fit theory), Michaelis-Menten equation, enzyme inhibition and factors affecting enzyme activity.

(iii) Carbohydrates: Nomenclature, classification and function of
Disaccharides, Oligosaccharides and Polysaccharides
Monosaccharides;

Unit-II

(i) Proteins: Structure of amino acids; Peptide bonds; Level of protein structure - primary, secondary, tertiary and quaternary; Isoelectric point; Protein denaturation and biological roles of proteins.

(ii) Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of tRNA

(iii) Lipids: Definition and major classes of storage and structural lipids. Fatty acids structure and functions. Essential fatty acids. Triacylglycerols structure, functions and properties.

Unit-III

(i) The cell: Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).

(ii) Cell division: Eukaryotic cell cycle, stages of mitosis and meiosis. Regulation of cell cycle.

(iii) Cell wall and plasma membrane: Chemistry, structure and function of Plant Cell Wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport - Passive, active and facilitated transport, endocytosis and exocytosis.

Unit-IV

(i) Cell organelles: Nucleus; Structure - nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.

(ii) Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament

(iii) Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast. Structure and function: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes,

PRACTICAL

- (i) Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
- (ii) Study of plant cell structure with the help of epidermal peel mount of Onion/*Rhoeo* (iii) Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.
- (iv) Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains).
- (v) Study the phenomenon of plasmolysis and deplasmolysis.
- (vi) Study different stages of mitosis and meiosis using acetocarmine and acetoorcin method.

Text Books:

1. V.B. Rastogi (2016). Introductory Cytology, Kedar Nath & Ram Nath, Meerut
2. P.K. Gupta (2017). Biomolecules and Cell Biology, Rastogi Publication, Meerut.

Reference Books:

1. K. Sahoo (2017) Biomolecules and Cell Biology, Kalynai Publishers, New Delhi.
2. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H. Freeman
3. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
4. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
5. Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G.P. 2009 The World of the Cell. 7th edition . Pearson Benjamin Cummings Publishing, San Francisco

Core Paper III

MYCOLOGY AND PHYTOPATHOLOGY

nit-I

- (i) Introduction to true fungi: Definition, General characteristics; Affinities with plants and animals; Thallus organization; Cell wall composition; Nutrition; Classification.
- (ii) Zygomycota: General characteristics; Ecology; Thallus organisation; Life cycle with reference to *Rhizopus*.
- (iii) Ascomycota: General characteristics (asexual and sexual fruiting bodies); Ecology; Heterokaryosis and parasexuality; life cycle and classification with reference to *Saccharomyces*, *Penicillium*.
- (iv) Basidiomycota: General characteristics; Ecology and Classification; Life cycle of *Puccinia* and *Agaricus*.

Unit-II

(i) Allied Fungi: General characteristics; Status of Slimemolds, Classification; Occurrence; Type of plasmodia; Types of fruiting bodies.

(ii) Oomycota: General characteristic; Ecology; Lifecycle and classification with reference to *Phytophthora*.

(iii) Symbiotic associations: Lichen – Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction. Mycorrhiza – Ectomycorrhiza, Endomycorrhiza and their significance.

Unit-III

Applied Mycology: Role of fungi in biotechnology, Application of fungi in food industry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Mycoproteins); Secondary metabolites (Pharmaceutical preparations) Agriculture (Biofertilizers; Mycotoxins; Biological control (Mycofungicides, Mycoherbicides, Mycoinsecticides, Myconematicides); Medical mycology. Mushroom cultivation,

Unit-IV

Phytopathology: Terms and concepts; General symptoms; etiology; symptomology; Host-Pathogen relationships; disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine. Bacterial diseases – Citrus canker and angular leaf spot disease of Cotton. Viral diseases – Tobacco Mosaic viruses, vein clearing. Fungal diseases – Early blight of potato, Loose and covered smut.

PRACTICAL

(i) Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, ascocarps & basidiocarps).

(ii) *Rhizopus*: study of asexual stage from temporary mounts and sexual structures through permanent slides.

(iii) *Penicillium*: study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs.

(iv) *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*, and fairy rings are to be shown.

(v) *Albugo*: Study of symptoms of plants infected with *Albugo*; asexual phase study through section/temporary mounts and sexual structures through permanent slides.

(vi) Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Viral diseases: Mosaic disease of ladies' finger, papaya, cucurbits, moong, black gram, Fungal diseases: Blast of rice, Tikka disease of groundnut, powdery mildew of locally available plants and White rust of crucifers.

Text Books:

1. B. K. Mishra (2017), Mycology and Phytopathology, Kalynai Publishers, New Delhi.

Reference Books:

1. Sharma, P.D. (2017). Mycology and Phytopathology Rastogi Publication, Meerut.
2. Agrios, G.N. 1997 Plant Pathology, 4th edition, Academic Press, U.K.
3. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
4. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
5. Sethi, I.K. and Walia, S.K. (2011). Textbook of Fungi and Their Allies, Macmillan Publishers India Ltd.
6. Mehrotra, R.S. (2011). Plant Pathology. Tata McGraw-Hill Publishing Company Limited, New Delhi

Core Paper IV

ARCHEGONIATE

Unit-I

(i) Introduction: Unifying features of archegoniates; Transition to land habit; Alternation of generations. General characteristics; Origin of land plants and Adaptation to land habit;

(ii) Bryophytes: Origin and Classification; Range of thallus organization. Classification (upto family). Reproduction and evolutionary trends in *Riccia*, *Marchantia*, *Funaria* (developmental stages not included). Ecological and economic importance of bryophytes.

Unit-II

Pteridophytes: General characteristics, classification. Classification (upto family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Marselia*. Apogamy, and apospory, heterospory and seed habit, telome theory, stelar evolution and economic importance.

Unit-III

Gymnosperms: General characteristics, classification (upto family), morphology, anatomy and reproduction of *Cycas*, *Pinus* and *Gnetum*. (Developmental details not to be included). Ecological and economic importance.

Unit-IV

Palaeobotany: Geological timescale, fossils and fossilization process. Morphology, anatomy and affinities of *Rhynia*, *Lepidodendron*, *Cycadeoidea* and *Williamsonia*.

PRACTICAL

- (i) Morphology of thallus and anatomy of *Riccia*, *Marchantia*, *Funaria*
- (ii) *Selaginella* - Morphology, whole mount of leaf with ligule, transverse section of stem, whole mount of strobilus, whole mount of microsporophyll and megasporophyll

(temporary slides), longitudinal section of strobilus (permanent slide).

(iii) *Equisetum*-
Morphology, transverse section of internode, longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wet and dry) (temporary slide), transverse section of rhizome (permanent slide).

(iv) Study of temporary preparations and permanent slides of *Marselia*

(v) Study from permanent slides of *Marselia* (L.S. of sporocarp) and *Lycopodium* (L.S. of strobilus).

(vi) *Cycas*-
Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll and megaspore, T. S. Root, leaflet

(vii) *Pinus*-
Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and female cones), T.S. Needle, stem, L.S. male cone, whole mount of microsporophyll, whole mount of Microspores (temporary slides), L.S. of female cone

(viii) *Gnetum*-
Morphology (stem, male & female cones), transverse section of stem, vertical section of ovule (permanent slide)

(ix) Study of some fossil slides/photographs as per theory. (x) Botanical excursion/study tour.

Text Books:

1. P.R. Vasista (2017) Botany for Degree student, Bryophyta, S. Chand Publication, New Delhi.
2. Singh, Pandey and Jain (2017). Archegoniate, Rastogi Publication, Meerut.

Reference Books:

1. B.S. Acharya (2017), Archegoniate, Kalynai Publishers, New Delhi.
2. Vashistha, P.C., Sinha, A. K., Kumar, A. (2010). Pteridophyta. S. Chand. New Delhi, India.
3. Bhatnagar, S. P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
4. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.

Core Paper V

ANATOMY OF ANGIOSPERMS

nit-I

(i) Introduction and scope of Plant Anatomy: Applications in systematics, forensics and pharmacognosy.

(ii) Tissues: Classification; Simple and complex tissues (no phylogeny); cyto-differentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Cell wall in growth and transfer cells, encrustation and incrustation, Ergastic substances.

Unit-II

(i) Stem: Organization of shoot apex (Apical cell theory, Histogen theory, Tunica-Corpus theory, continuing meristematic residue, cyto-histological zonation); Types of vascular bundles; Anatomy of dicot and monocot stem. Vascular Cambium: Structure, function and seasonal activity of cambium; secondary growth in stem (normal and anomalous).

(ii) Leaf: Anatomy of dicot and monocot leaf, Kranz anatomy.

Unit-III

(i) Root: Organization of root apex (Apical cell theory, Histogen theory, Korper-Kapp theory); Quiescent centre; Root cap; Anatomy of dicot and monocot root; Endodermis, exodermis and origin of lateral root. Secondary growth in roots.

(ii) Wood: Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclical pectins and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology.

(iii) Periderm: Development and composition of periderm, rhytidome and lenticels.

Unit-IV

(i) Adaptive and Protective Systems Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni- and multicellular, glandular and nonglandular: two examples of each), stomata (classification); Anatomical adaptations of xerophytes and hydrophytes.

(ii) Secretory System: Hydathodes, cavities, lenticels and laticifers.

PRACTICAL

1. Study of distribution and types of parenchyma, collenchyma and sclerenchyma, Xylem: Tracheary elements - tracheids, vessel elements; thickenings; perforation plates; xylem fibres, Phloem: Sieve tubes - sieve plates; companion cells; phloem fibres.
2. Wood: ring porous; diffuse porous; tyloses; heart- and sapwood.
3. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
4. Root: monocot, dicot, secondary growth.
5. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.
6. Leaf: isobilateral, dorsiventral, C_4 leaves (Kranz anatomy).

Text Books:

1. Singh, Pandey and Jain (2017). Anatomy of Angiosperms, Rastogi Publication, Meerut.

Reference Books:

1. Eames and McDaniel's (). An introduction to plant anatomy, Tata McGraw Hills, New Delhi
2. Esau, K. (1977). Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi.
3. M.S. Talal (2012) Rajpal and Sons, New Delhi
4. B.K. Mishra (2017). Anatomy of Angiosperms, Kalynai Publishers, New Delhi.
5. B.P. Pandey (2017) Plant Anatomy, S. Chand Publication, New Delhi.

Core Paper VI

ECONOMIC BOTANY

Unit-I

- (i) Origin of Cultivated Plants: Concept of Centres of Origin, their importance with reference to Vavilov's work. Plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.
- (ii) Cereals: General account and Cultivation of Wheat, Rice, Millets
- (iii) Legumes: General account, importance to man and ecosystem.
- (iv) Sugars & Starches: Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses.

Unit-II

- (i) Spices: Listing of important spices, their family and part used, economic importance with special reference to fennel, saffron, clove and black pepper. Beverages: Tea, Coffee (morphology, processing & uses)
- (ii) Drug-yielding plants: Therapeutic and habit-forming drugs with special reference to Cinchona, Digitalis, Papaver and Cannabis.
- (iii) Tobacco: Tobacco (Morphology, processing, uses and health hazards)

Unit-III

- (i) Oils & Fats: General description, classification, extraction, their uses and health implications groundnut, coconut, linseed and *Brassica* (Botanical name, family & uses)
- (ii) Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.

Unit-IV

- (i) Natural Rubber: Para-rubber: tapping, processing and uses.
- (v) Timber plants: General account with special reference to teak and pine. Fibers: Classification based on the origin of fibers, Cotton and Jute (morphology, extraction and uses).

PRACTICAL

- (i) Cereals: Rice (habit sketch, study of paddy and grain, starch grains).
- (ii) Legumes: Soybean/ moongbean/ black gram, Groundnut, (habit, fruit, seed structure, micro-chemical tests).
- (iii) Sugars & Starches: Sugarcane (habit sketch; cane juice - micro-chemical tests), Potato (habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, starch grains, micro-chemical tests).
- (iv) Spice and Beverages: clove, black pepper, Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).
- (v) Oils & Fats: Groundnut, Mustard – plant specimen, seeds; tests for fats in crushed seeds.
- (vi) Drug-yielding plants: Specimens of *Digitalis*, *Papaver* and *Cannabis*.
- (vii) Woods: *Tectona*, *Pinus*/Sal: Specimen, Section of young stem

(viii)Fiber-yielding plants: Cotton (specimen, whole mount of seed to show lint and fuzz; whole mount of fiber and test for cellulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fiber).

Text Books:

1. B. P. Pandey (2017) Economic Botany. S. Chand Publication, New Delhi.

Reference Books:

1. Kochhar, S. L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2. Samba Murty and Subrahmanyam (2011). Text Book of Modern Economic Botany, CBS Publishers and Distributors, New Delhi.
3. Hill, Albert F. Economic Botany, Tata McGraw Hill Publishing Company, Ltd. New Delhi.
4. Wickens, G. E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.
5. Singh, Pandey and Jain (2017). Economic Botany, Rastogi Publication, Meerut. 6. B. Baruah (2017). Economic Botany, Kalyani Publishers, New Delhi.

Core Paper VII

GENETICS

Unit-I

(i) Mendelian genetics:

Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Incomplete dominance and codominance; Multiple alleles, Letal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Polygenic inheritance.

(ii) Extrachromosomal Inheritance: Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast; Maternal effects - shell coiling in snail; Infective heredity - Kappa particles in Paramecium.

Unit-II

Linkage, crossing over and chromosome mapping; Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on gene mapping; Sex Linkage.

Unit-III

(i) Variation in chromosome number and structure: Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy

(ii) Gene mutations: Types of mutations; Molecular basis of Mutations; Mutagens - physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: CIB method. Role of Transposons in mutation. DNA repair mechanisms.

Unit-IV

(i) Fine structure of gene: Classical vs. molecular concepts of gene; Cis-Trans complementation test for functional allelism; Structure of Phage T4, rII Locus.

(ii) Population and Evolutionary Genetics: Gene pool, Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.

PRACTICAL

1. Meiosis through temporary squash preparation.
2. Mendel's law through seed ratios. Laboratory exercises in probability and chi-square analysis.
3. Chromosome mapping using test cross data.
4. Pedigree analysis for dominant and recessive autosomal and sex linked traits.
5. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
6. Blood Typing: ABO groups & Rh factor.
7. Chromosome anomaly: Translocation Ring, Laggards and Inversion Bridge, break etc.

Text Books:

1. B.D. Singh (2017). Fundamental of Genetics, Kalyani Publishers, New Delhi.
2. P.K. Gupta (2017). Genetics, Rastogi Publication, Meerut.

Reference Books:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & Sons, India. 8th edition.
2. Sinnot, Dunn and Dobzhansky (1985) Principles of Genetics, Tata McGraw Hill, New Delhi
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. Benjamin Cummings, U.S.A. 10th edition.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W.H. Freeman and Co., U.S.A. 10th edition.
5. Strickberger, Monroe, W. Genetics, Pearson Publishers, 3rd Edition
6. V.B. Rastogi (2017). Genetics, Kedar Nath & Ram Nath, Meerut

Core Paper VIII

MOLECULAR BIOLOGY

Unit-I

Nucleic acids: Carriers of genetic information: Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty), Types of genetic material, denaturation and renaturation. Organization of DNA - Nucleosome concept and Fraenkel-Conrat's experiment. Organelle DNA - mitochondria and chloroplast DNA. Chromatin structure - Euchromatin, Heterochromatin - Constitutive and Facultative heterochromatin.

Unit-II

(i) ThereplicationofDNA:ChemistryofDNAsynthesis(Kornberg’sdiscovery);Generalprinciples–bidirectional,semi-conservativeandsemidiscontinuousreplication,RNApriming;VariousmodelsofDNAreplication,replicationoflineard-DNA,replicationofthe5’endoflinearchromosome;EnzymesinvolvedinDNAreplication

(ii) Centraldogmaandgeneticcode:Keyexperimentsestablishing-TheCentralDogma(Wobble Hypothesis),Geneticcode(deciphering&salientfeatures)

(iii) ProcessingandmodificationofRNA:Splitgenes-conceptofintronsandexons,splicingpathways of groupI&groupIIintron, Spliceosome mediated and alternative splicing;Ribozymes,exonshuffling;RNAeditingandmRNAttransport.

Unit-III

MechanismofTranscription:Transcriptioninprokaryotesandeukaryotes; Regulationoftranscriptioninprokaryotesandeukaryotes:Prokaryotes:Operonconcept-Regulationoflactosemetabolismandtryptophansynthesisin*E. coli*. Eukaryotes:transcriptionfactors,heatshockproteins,steroidsandpeptidehormones; Genesilencing

Unit-IV

Translation(Prokaryotesandeukaryotes):Ribosomestructureandassembly;ChargingofRNA,aminoacylRNA synthetases; Variousstepsinproteinsynthesis,proteinsinvolvedininitiation,elongationandterminationofpolypeptides;Fidelityoftranslation;Inhibitorsofprotein synthesis;Post-translationalmodificationsofproteins.

PRACTICAL

- 1.PreparationofLBmediumandraising*E. coli*.
- 2.IsolationofgenomicDNAfrom*E. coli*./onionroots3.RNA estimationbyorcinolmethod.
- 4.DNAestimationbydiphenylaminereagent/UV Spectrophotometry.
- 5.Photographsestablishingnucleicacidasgeneticmaterial(MesselsonandStahl’s,Averyetal, Griffith’s,Hershey&Chase’sandFraenkel&Conrat’sexperiments)
- 6.StudyofBarrbodyfrombuccalsmearpreparation.

TextBooks:

- 1.P.K.Gupta(2017).MolecularBiology,RastogiPublication,Meerut.

ReferenceBooks:

1. WatsonJ. D.,Baker,T. A.,Bell,S. P.,Gann,A.,Levine,M.,Losick,R.(2007). MolecularBiologyoftheGene,PearsonBenjaminCummings,CSHLPRESS,NewYork, U.S.A.6thedition.
2. Snustad,D. P.andSimmons,M. J.(2010).PrinciplesofGenetics.JohnWileyandSonsInc.,U.S.A.5thedition.
3. Klug,W. S.,Cummings,M. R.,Spencer,C. A.(2009).ConceptsofGenetics.BenjaminCummings.U.S.A.9thedition.

4. SheelarandBianchi(2009)MolecularBiologyoftheCell,WilleyPublisher,NewDelhi
5. Griffiths,A.J.F.,Wessler,S.R.,Carroll,S.B.,Doebley,J.(2010).IntroductiontoGeneticAnalysis.W.H.FreemanandCo.,U.S.A.10thedition.
6. BruceAlbertsetal.2014.MolecularBiologyofthecellGarlandScience.6thEdition
7. C.B.Power(2017)CellBiology,HimalayaPublishingHouse,NewDelhi
8. AC.Sahu(2017).EssentialsofMolecularBiology,KalynaiPublishers,NewDelhi.

CorePaperIX

PLANTECOLOGY&PHYTOGEOGRAPHY

Unit-I

(i)IntroductionConceptofecology,Autoecology,Synecology,systemecology,Levelsoforganization.Inter-relationshipsbetweenthelivingworldandtheenvironment,thecomponentsofenvironment,conceptofhydrosphereandlithosphereanddynamism,homeostasis.

(ii)Light,temperature,windandfire:Variations;adaptationsofplantstotheirvariation.

Unit-II

(i)Soil:Formation;Composition;Physical;ChemicalandBiologicalcomponents;Soilprofile;Roleofclimateinsoildevelopment.

(ii)Water:Importance:Statesofwaterintheenvironment;Precipitationtypes;Hydrological Cycle;Waterinsoil;Watertable.

Unit-III

BioticinteractionsandPopulationecology:CharacteristicsandDynamics.

Plantcommunities:Conceptofecologicalamplitude;Habitatandniche;Characters:analyticalandsynthetic;Ecotoneandedgeeffect;Dynamics:succession–processes,types;climaxconcepts.

Unit-IV

(i)Ecosystems:Structure;Processes;Trophicorganisation;FoodchainsandFoodwebs;Ecologicalpyramids.

(ii)Functionalaspectsofecosystem:Principlesandmodelsofenergyflow;Productionandproductivity;Ecologicalefficiencies;Biogeochemicalcycles;CyclingofCarbon,NitrogenandPhosphorus.

(iii)Phytogeography:Principles;Continentaldrift;Theoryoftolerance;Endemism;PhytogeographicaldivisionofIndia;LocalVegetation.

PRACTICAL

1. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)
2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from soil samples by rapid field tests.
3. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
4. Study of morphological adaptations of hydrophytes, xerophytes, halophytes (two each).
5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).

6. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.

7. Field visit to familiarize students with the ecology of different sites.

Text Books:

1. Sharma, P.D. (2017). Fundamentals of Ecology. Rastogi Publications, Meerut, India.

Reference Books:

1. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
3. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
4. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.
5. Santra, S.C. (2015) Environmental Science. New Central Book Agency (P) Ltd. Kolkata.
6. M.C. Das and S.P. Das (2009). Fundamentals of Ecology. Tata McGraw Hill, New Delhi.
7. Shukla and Chandel (2016). A text book of Plant Ecology. S Chand Publication, New Delhi

Core Paper X

PLANT SYSTEMATICS

Unit-I

Plant identification, Classification, Nomenclature; Biosystematics. Identification: Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access

Unit-II

Taxonomic hierarchy: Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary).

Botanical nomenclature: Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.

Unit-III

(i) Systematics - an interdisciplinary science: Evidence from palynology, cytology, phytochemistry and molecular data.

(ii) Systems of classification: Major contributions of Theophrastus, Linnaeus, deCandolle, Hutchinson, Takhtajan and Cronquist; Classifications systems of Bentham and Hooker (upto series) and Hutchinson (upto series) with reference to merits and demerits; Brief reference of Angiosperm Phylogeny Group (APG III) classification.

Unit-IV

Phylogeny of Angiosperms: Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin & evolution of angiosperms; methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).

Families of Angiosperms: Descriptive studies of Magnoliaceae, Rubiaceae, Poaceae, Lamiaceae, Asclepiadaceae, Acanthaceae, Orchidaceae and Apocynaceae.

PRACTICAL

(i) Study of vegetative and floral characters of available materials of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification): Magnoliaceae, Rosaceae, Rubiaceae, Liliaceae, Poaceae, and Orchidaceae as per the theory syllabus (Identification upto species level).

(ii) Field visit, plant collection and herbarium preparation and submission. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book)

Text Books:

1. O.P. Sharma (2009) *Plant Taxonomy*, Tata McGraw Hill, New Delhi

Reference Books:

1. Singh, G. (2012). *Plant Systematics: Theory and Practice*. Oxford & IBHP vt. Ltd., New Delhi. 3rd edition.
2. Jeffrey, C. (1982). *An Introduction to Plant Taxonomy*. Cambridge University Press, Cambridge.
3. Judd, W.S., Campbell, C.S., Kellogg, E. A., Stevens, P.F. (2002). *Plant Systematics - A Phylogenetic Approach*. Sinauer Associates Inc., U.S. A. 2nd edition.
4. Saxena, H.O. and Brahma, M.. *The Flora of Orissa*, CSIR Publication.
5. T.K. Bose (2009). *Trees of the World*, Regional Plant Resource Centre, Bhubaneswar, Odisha, India
6. Radford, A.E. (1986). *Fundamentals of Plant Systematics*. Harper and Row, New York.
7. Hanes, H.H. (2009). *Botany of Bihar and Orissa*,

- 8.C.R.Mohanty(2017).TextBookofPlantSystematics,KalynaiPublisher,NewDelhi.
- 9.M.S.Subrahmainayam(2011)ModernPlantTaxonomy,VikashPublishingHouse,New Delhi
- 10.B.P.Pandey(2017).TaxonomyofAngiosperm.S.ChandPublication.

CorePaperXI

REPRODUCTIVEBIOLOGYOFANGIOSPERMS

Unit-I

(i)Introduction:Historyandscope.

(ii)Anther:Antherwall:Structureandfunctions,micro-sporogenesis,callosedepositionanditssignificance.

(iii)Pollenbiology:Micro-gametogenesis;Pollenwallstructure,MGU(malegermunit)structure,NPCsystem;Palynologyandscope(abriefaccount);Pollenwallproteins;Pollenviability,storageandgermination; Abnormalfeatures:Pseudomonads,polyads,massulae,pollinia.

Unit-II

Ovule:Structure;Types;Specialstructures– endothelium,obturator,aril,caruncleandhypostase;Femalegametophyte–mega-sporogenesisandmega-gametogenesis;Typesandultrastructureofmatureembryosac(DetailsofPolygonumtype).

Unit-III

(i)Pollinationandfertilization:Pollinationtypesandsignificance;adaptations;structureofstigmaandstyle;pathofpollentubeinpistil;doublefertilization.

(ii)Selfincompatibility:Basicconcepts;Methodstoovercomeself-incompatibility:mixedpollination,budpollination,stubpollination.

Unit-IV

(i)Endosperm:development,structureandfunctions

(ii)Embryo:Typesofembryogeny;Generalpatternofdevelopmentofdicotandmonocotembryo;Suspensor:structureandfunctions;Embryo-endospermrelationship;Nutritionofembryo.

(iii)Seed:Structure,importanceanddispersalmechanisms

(iv)Polyembryonyandapomixes:Introduction;Classification;Causesandapplications.

PRACTICAL

(i)Anther: Wallanditsontogeny;Tapetum(amoeboidandglandular);MMC,sporetetrads, uninucleate,bicelledanddehiscedantherstagesthroughslides/micrographs,malegermunit(MGU)throughphotographsandschematicrepresentation.

(ii)Pollengrains:Freshandacetolyzedshowingornamentationandaperture,psuedomonads, polyads, pollinia (slides/photographs,fresh material),ultrastructureofpollenwall(micrograph);Pollenviability:Tetrazoliumtest, Germination:Calculationofpercentagegerminationindifferent mediausinghangingdropmethod.

(iii) Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmie, bitegmie; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs). Female gametophyte through permanent slides/photographs: Types, ultrastructure of mature egg apparatus.

(iv) Embryogenesis: Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.

Text Books:

1. Singh, Pandey and Jain (2017). Reproductive Biology of Angiosperms, Rastogi Publications, Meerut

Reference Books:

1. PMaheswari (2009). Embryology of Angiosperms.
2. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
3. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
4. Johri, B.M.I (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.
5. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
6. B.K. Mishra (2017). Reproductive Biology of Angiosperms Kalynai Publishers, New Delhi.

Core Paper XII

PLANT PHYSIOLOGY

Unit-I

(i) Plant water relationship: Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap – cohesion-tension theory. Transpiration and factors affecting transpiration, anti-transpirants, mechanism of stomatal movement.

(ii) Translocation in the phloem: Experimental evidence in support of phloem as the site of sugar translocation. Pressure-Flow Model; Phloem loading and unloading; Source-sink relationship.

Unit-II

(i) Mineral nutrition: Essential and beneficial elements, macro and micronutrients, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents.

(ii) Nutrient Uptake: Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, and antiport.

Unit-III

Plant growth regulators: Discovery, chemical physiological roles of Auxin, Gibberellins, Brassinosteroids and Jasmonic acid.

nature (basic structure), bioassay and Cytokinin, Abscisic acid, Ethylene.

Unit-IV

(i) Physiology of flowering: Photoperiodism, florigen concept, vernalization, seed dormancy.

(ii) Phytochrome: Discovery, chemical nature, role of phytochrome in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.

PRACTICAL

1. Determination of osmotic potential of plant cells by plasmolytic method.
2. Determination of water potential of given tissue (potato tuber) by weight method.
3. Study of the effect of wind velocity and light on the rate of transpiration in excised twig/leaf.
4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of mesophyte and xerophyte.
5. To calculate the area of an open stoma and percentage of leaf area open through stomata in mesophyte and xerophyte (both surfaces).
6. To study the phenomenon of seed germination (effect of light).
7. To study the induction of amylase activity in germinating barley grains.
8. To demonstrate suction due to transpiration.

Text Books:

1. R. K. Sinha, (2015). Modern Plant Physiology, Narosa Publishing House, New Delhi.

Reference Books:

1. Hopkins, W. G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., Møller, I. M. and Murphy, A. (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
3. Bajracharya D. (1999). Experiments in Plant Physiology - A Laboratory Manual. Narosa Publishing House, New Delhi.
4. Salisbury, F. B. and Ross, C. W. Plant Physiology Wadsworth Publishing Company, California.
5. A. C. Sahoo (2018). Outlines of Plant Physiology Kalynai Publishers, New Delhi.
6. N. K. Srivastava (2017). Plant Physiology, Rastogi Publications, Meerut.
7. Pandey and Sinha (2011). Plant Physiology, Vikash Publishing House, New Delhi.

Core Paper XIII

PLANT METABOLISM

Unit-I

(i) Concept of metabolism: Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and Isozymes).

(ii) Mechanisms of signal transduction: Calcium, phospholipids, cGMP, NO. **Unit-**

II

Carbon assimilation: Historical background, photosynthetic pigments and its role, antennae molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, C₃, C₄ pathways; Crassulacean acid metabolism; Factors affecting CO₂ reduction. Photorespiration

Unit-III

(i) Carbon Oxidation: Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration, factors affecting respiration.

(ii) ATP-Synthesis: Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photo-phosphorylation), ATP synthase, Boyer's conformational model, Racker's experiment, Jagendorf's experiment; role of uncouplers.

Unit-IV

(i) Lipid metabolism: Synthesis and breakdown of triglycerides, β -oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α oxidation.

(ii) Nitrogen metabolism: Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and trans-amination.

PRACTICAL

1. Isolation and quantification of photosynthetic pigments.
2. Experimental demonstration of Hill's reaction.
3. To study the effect of light intensity on the rate of photosynthesis. 4. Effect of carbon dioxide on the rate of photosynthesis.
5. To compare the rate of respiration in different parts of a plant. 6. Demonstration of absorption spectrum of photosynthetic pigments.

Text Books:

1. S, K. Gupta (2017). Plant Metabolism, Rastogi Publication, Meerut. 22

Reference Books:

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A. (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
3. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.
4. A.C. Sahoo (2018). Outlines of Plant Metabolism, Kalynai Publishers, New Delhi.

Core Paper XIV**PLANT BIOTECHNOLOGY****Unit-I**

Plant Tissue Culture: Historical perspective; Aseptic tissue culture techniques, Composition of media; Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).

Unit-II

Recombinant DNA technology - I: Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pBR322, R plasmid, BAC); Lambda phage, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC and briefly PAC, MAC, HAC). Gene Cloning (Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR-mediated).

Unit-III

Recombinant DNA technology - II: Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; Probes - oligonucleotide, Methods of gene transfer

Agrobacterium-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics - selectable marker and reporter genes (Luciferase, GUS, GFP).

Unit-IV

Applications of Biotechnology: Pest resistant (Bt-cotton); herbicide resistant plants (Round Up Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moon dust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products - Human Growth Hormone; Humulin; Biosafety concerns.

PRACTICAL

- 1.a) Preparation of tissue culture (MS) medium.
(b) Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura*, *Brassica* etc.
2. Study of anther culture.
3. Preparation of artificial seeds.
4. Testing and study of Bt cotton.
5. Isolation of plasmid DNA.
6. Gel electrophoresis (demonstration).

Text Books:

1. H.S. Chawla (2010). Introduction to Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Reference Books:

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology - Principles and Applications of recombinant DNA. ASM Press, Washington.
3. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.
4. Y.P.S. Bajaj Series, Springer Verlag
5. B.D. Singh (2018). Plant Biotechnology Kalynai Publishers, New Delhi.
6. P.K. Gupta (2017). Plant Biotechnology, Rastogi Publication, Meerut.
7. R.C. Dubey (2017). Advanced Biotechnology, S, Chand Publication, New Delhi

Discipline Specific Elective Paper-1

ANALYTICAL TECHNIQUES IN PLANT SCIENCES

Unit-I

Imaging and related techniques: Principles of microscopy; Light microscopy; Fluorescence microscopy; Flow cytometry (FACS); Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

Unit-II

Cell fractionation: Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl₂ gradient, analytical centrifugation, ultracentrifugation. Radioisotopes: Use in biological research, autoradiography, pulse chase experiment. Spectrophotometry: Principle and its application in biological research.

Unit-III

Chromatography: Principle; Paper chromatography; Column chromatography, TLC, GLC, Ion-exchange chromatography; Molecular sieve chromatography. Characterization of proteins and nucleic acids: X-ray diffraction; X-ray crystallography; Electrophoresis: AGE, PAGE, SDS-PAGE

Unit-IV

Biostatistics: Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit. T-Test and correlation.

PRACTICAL

1. Study of different microscopic techniques for chromosome study
2. Study of PCR Demonstration.
3. To separate chlorophyll by paper chromatography.
4. To separate phytochemicals by thin layer chromatography.
5. To estimate protein concentration through Lowry's methods.
6. To separate proteins using PAGE.
7. To separate DNA (marker) using AGE.
8. Estimation of plant pigments.

Text Books:

1. C.S. Patil (2017). Advanced Analytical Techniques, ABE Books, New Delhi.

Reference Books:

1. Plummer, D. T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.
2. Ruzin, S. E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D. D., Seidman, J. G., Smith, J. A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
4. Zar, J. H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.
5. K. R. Aneja (2014). Laboratory manual of microbiology and biotechnology, Medtech, New Delhi

Discipline Specific Elective Paper-1I

NATURAL RESOURCE MANAGEMENT

Unit-I

- (i) Natural resources: Definition and types.
- (ii) Sustainable utilization: Concept, approaches (economic, ecological and socio-cultural).
- (iii) Land: Utilization (agricultural, horticultural, silvicultural); Soil degradation and management.
- (iv) Water: Freshwater (rivers, lakes, groundwater, water harvesting technology, rainwater storage and utilization).

Unit-II

Biological Resources: Biodiversity- definition and types; Significance; Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan).

Forests: Definition, Cover and its significance (with special reference to India); Major and minor forest products; Depletion; Management.

Unit-III

(i) Energy: Renewable and non-renewable sources of energy- solar, wind, tidal, geothermal and bioenergy resources.

(ii) Contemporary practices in resource management: EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint.

Unit-IV

Resource Accounting; Waste management. National and international efforts in resource management and conservation

PRACTICAL

(i) Estimation of solid waste generated by a domestic system (biodegradable and non-biodegradable) and its impact on land degradation.

(ii) Collection of data on forest cover of specific area.

(iii) Measurement of dominance of woody species by DBH (diameter at breast height) method.

(iv) Calculation and analysis of ecological footprint. (v)

Ecological modeling.

Text Books:

1. B. W. Pandey. 2005. Natural Resource Management. Mittal Publication, New Delhi

Reference Books:

1. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.

2. Singh, J. S., Singh, S. P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.

3. Rogers, P. P., Jalal, K. F. and Boyd, J. A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.

Discipline Specific Elective Paper-1II

HORTICULTURAL PRACTICES AND POST-HARVEST TECHNOLOGY

Unit-I

(i) Introduction: Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Importance in food and nutritional security; Urban horticulture and ecotourism.

(ii) Ornamental plants: Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental plants [rose, marigold, gladiolus, orchids, poppies, gerberas, tuberoses and succulents (*Opuntia* and *Agave*)].

Unit-II

(i) Fruit and vegetable crops: Production, origin and distribution; Description of plants and their economic products; Management and marketing of vegetable and fruit crops.

(ii) Horticultural techniques: Application of manure, fertilizers, nutrients and PGRs; Weed control; Biofertilizers, biopesticides; Irrigation methods (drip irrigation, surface irrigation, furrow and border irrigation); Hydroponics; Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation), Scope and limitations.

(iii) Landscaping and garden design: Planning and layout (parks and avenues); gardening traditions - Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry; policies and practices.

Unit-III

(i) Post-harvest technology: Importance of postharvest technology in horticultural crops; Evaluation of quality traits; Harvesting and handling of fruits, vegetables and cutflowers; Principles, methods of preservation and processing; Methods of minimizing losses during storage and transportation;

(ii) Disease control and management: Field and post-harvest diseases; Identification of deficiency symptoms; remedial measures and nutritional management practices; Crop sanitation; IPM strategies (genetic, biological and chemical methods for pest control); Quarantine practices;

Unit-III

(i) Post-harvest technology: Importance of postharvest technology in horticultural crops; Evaluation of quality traits; Harvesting and handling of fruits, vegetables and cutflowers; Principles, methods of preservation and processing; Methods of minimizing losses during storage and transportation;

(ii) Disease control and management: Field and post-harvest diseases; Identification of deficiency symptoms; remedial measures and nutritional management practices; Crop sanitation; IPM strategies (genetic, biological and chemical methods for pest control); Quarantine practices;

Unit-IV

Horticultural crops- conservation and management: Documentation and conservation of germplasm; Role of micropropagation and tissue culture techniques; Varieties and cultivars of various horticultural crops; IPR issues; National, international and professional societies and sources of information on horticulture.

PRACTICAL

Practical related to theory

Text Books:

1. K. V. Peter. (2009). Basics of Horticulture, Kalyani Publishers, New Delhi.

Reference Books:

1. Singh, D. & Manivannan, S. (2009). Genetic Resources of Horticultural Crops. Ridhi International, Delhi, India.
2. Swaminathan, M. S. and Kochhar, S. L. (2007). Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India. Macmillan Publishers, India.
3. NIIR Board (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi.
4. Kader, A. A. (2002). Post-Harvest Technology of Horticultural Crops. UCANR Publications, USA.
5. Capon, B. (2010). Botany for Gardeners. 3rd Edition. Timber Press, Portland, Oregon.
6. P. H. Pandey (2007). Principles and Practices of Post Harvest Technology, Kalyani Publishers, New Delhi.

Discipline Specific Elective Paper-1V

INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOG

Unit-I

- (i) Scope of microbes in industry and environment: Bioreactors/Fermenters and fermentation processes: Batch and continuous fermentations. Components of a typical bioreactor, Types of bioreactors-laboratory.
- (ii) Microbial production of industrial products: Microorganisms involved, media, fermentation conditions, downstream processing: Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration.

Unit-II

Microbialenzymesofindustrialinterestandenzymeimmobilization:Microorganismsforindustrial applicationsandhandsonscreeningmicroorganismsforcaseinhydrolysis;starchhydrolysis;cellulosehydrolysis.Methodsofimmobilization,advantagesandapplicationsofimmobilization.

Unit-III

Microbesandqualityofenvironment:Distributionofmicrobesinair;Isolationofmicroorganismsfromsoil,airandwater.

Microbialfloraofwater:Waterpollution,roleofmicrobesinsewageanddomesticwastewatertreatment systems.DeterminationofBOD,COD,TDSandTOCofwatersamples;Microorganismsasindicators ofwaterquality.

Unit-IV

Microbesinagricultureandremediationofcontaminatedsoils:Biologicalfixation;Mycorrhizae;Bioremediationofcontaminatedsoils.Isolationofrootnodulatingbacteria,arbuscularmycorrhizalcolonizationinplantroots.

PRACTICAL

- 1.Principlesandfunctioningofinstrumentsinmicrobiologylaboratory
- 2.Handsonsterilizationtechniquesandpreparationofculturemedia
- 3.Screeningmicroorganismsforindustrialuse.
- 4.Mycorrhiza,arbuscularmycorrhizalcolonizationinplantroots
- 5.DeterminationofBOD,COD,TDSandTOCofwatersamples;
- 6.Microorganismsasindicatorsofwaterquality

TextBooks:

- 1.P.D.Sharma.(2017)EnvironmentalMicrobiology.RastogiPublications,Meerut.

SuggestedReadings

- 1.Pelzar,M.J.Jr.,ChenE.C.S.,Krieg,N.R.(2010).Microbiology:Anapplication basedapproach.TataMcGrawHillEducationPvt.Ltd.,Delhi.
- 2.Tortora,G.J.,Funke,B.R.,Case.C.L.(2007).Microbiology.PearsonBenjaminCummings, SanFrancisco,U.S.A.9thedition.
- 3.PradiptaK.Mohapatra(2008).TextBookofEnvironmentalMicrobiology,I.K.InternationalPublishingHouse,NewDelhi
- 4.A.K.Rath(2018).IndustrialandEnvironmentalMicrobiology,KalyaniPublishers,NewDelhi.

OR

DISSERTATION/PROJECTWORK**

| Identification ofproblem | Reviewof Literature | Methodology | Findings | Analysis | Viva-Voce | Total |
|--------------------------|---------------------|-------------|----------|----------|-----------|-------|
| 10 | 10 | 10 | 25 | 25 | 20 | 100 |

**=Studentswhoscoremorethan $\geq 60\%$ inaggregateareeligibleforprojectwo

Generic Elective Paper I

BIODIVERSITY (MICROBES, ALGAE, FUNGI AND ARCHEGONIATE)

Unit-I

Microbes: Viruses–Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria–Discovery, General characteristics and cell structure; Reproduction–vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

Unit-II

(i) Algae: General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Morphology and life-cycles of the following: *Chlamydomonas*, *Oedogonium*, *Nostoc*, *Vaucheria* Economic importance of algae.

(ii) Fungi: Introduction-

General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi-

General characteristics, ecology and significance, life cycle of *Rhizopus* (Zygomycota) *Penicillium* (Ascomycota), *Puccinia* (Basidiomycota); Symbiotic Associations-Lichens:

Unit-III

(i) **Bryophytes**: General characteristics, adaptation to land habit, Classification, Range of thallus organization, Classification (upto family), morphology, anatomy and reproduction of *Marchantia* and *Funaria* (Developmental details not to be included). Ecology and economic importance of bryophytes.

(ii) **Pteridophytes**: General characteristics, classification, Early land plants *Rhynia* Classification (upto family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* (Developmental details not to be included). Heterospory and seed habit, stellar evolution. Ecological and economic importance of Pteridophytes.

Unit-IV

Gymnosperms: General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of *Cycas*, *Pinus* and *Gnetum*. (Developmental details not to be included). Ecological and economic importance.

PRACTICAL

1. Gram staining

2. Study of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas* (electron micrographs), *Oedogonium*, *Vaucheria*, and *Polysiphonia* through temporary reparations and permanent slides.

3. *Rhizopus* and *Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.

4. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.

5. *Marchantia*- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all 3 temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).

6. *Selaginella*- morphology, w. m. microsporophyll and (permanentslide). w. m. leaf with megasporophyll ligule, t. s. (temporary stem, w. m. slides), l. s. strobilus, strobilus

7. *Equisetum*- morphology, t. s. internode, l. s. strobilus, t. s. strobilus, w. m. sporangiophore, w. m. spores (wet and dry) (temporary slides); t. rhizome (permanentslide).

8. *Cycas*- morphology (coralloid roots, bulbil, leaf), t. s. coralloid root, t. s. rachis, v. s. leaflet, v. s. microsporophyll, w. m. spores (temporary slides), l. s. ovule, t. s. root (permanentslide).

9. *Pinus*- morphology (long and dwarf shoots, w. m. dwarf shoot, male and female), w. m. dwarf shoot, t. s. needle, t. s. stem, l. s. / t. s. male cone, w. m. microsporophyll, w. m. microspores (temporary slides), l. s. female cone, t. l. s. & r. l. s. stem (permanentslide).

Text Books:

1. Mitra, Mitra and Choudhury. Studies in Botany Volume 1. Moulik Publisher, Kolkata. Ninth Revised Edition

Reference Books:

1. Kumar, H. D. (1999). Introductory Phycology. Affiliated East-West Press Pvt. Ltd. Delhi. 2nd edition.
2. Tortora, G. J., Funke, B. R., Case, C. L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U. S. A. 10th edition.
3. Sethi, I. K. and Walia, S. K. (2011). Textbook of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
4. Alexopoulos, C. J., Mims, C. W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
5. Raven, P. H., Johnson, G. B., Losos, J. B., Singer, S. R., (2005). Biology. Tata McGraw Hill, Delhi, India.
6. Vashishta, P. C., Sinha, A. K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
7. Bhatnagar, S. P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
8. Parihar, N. S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.
9. B. P. Pandey (2017), Botany for degree studies (as per CBCS). S. Chand
10. B. S. Acharya and B. K. Mishra (2018). Plant Biodiversity, Kalyani Publishers, New Delhi.

Generic Elective Paper II

PLANT ECOLOGY AND TAXONOMY

Unit-I

(i) Ecological factors: Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation, optimal and limiting factors; Shelf for dwarf tolerance. Adaptation of hydrophytes and xerophytes

(ii) Plant communities: Characters; Ecotone and edge effect; Succession; Processes and types

Unit-II

(i) Ecosystem: Structure; Biotic and abiotic components, energy flow, trophic organisation; Food chains and food webs, Ecological pyramids, production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorus

(ii) Phytogeography: Principle biogeographical zones; Endemism

Unit-III

(i) Introduction to plant taxonomy: Identification, Classification, Nomenclature.

(ii) Identification: Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access

Unit-IV

(i) Taxonomic hierarchy: Ranks, categories and taxonomic groups

(ii) Botanical nomenclature: Principles and rules (ICN); ranks and names; binomial system, typification, author citation, valid publication, principle of priority and its limitations.

(iii) Classification: Types of classification - artificial, natural and phylogenetic. Bentham and Hooker (upto series), Hutchinson (upto series).

(iv) Taxonomic description of the families: Fabaceae, Magnoliaceae, Lamiaceae and Poaceae.

PRACTICAL

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH, and analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field test.
3. Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats.
4. (a) Study of morphological adaptations of hydrophytes and xerophytes (four each). (b) Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobancha*), Epiphytes, Predation (Insectivorous plants)
5. (a) Study of morphological adaptations of hydrophytes and xerophytes (four each). (b) Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobancha*), Epiphytes, Predation (Insectivorous plants)
6. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)

7. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
8. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification): Malvaceae, Caesalpiniaceae, Fabaceae, Apocynaceae, Asteraceae and Poaceae as in the theory syllabus.
9. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

Text Books:

1. Sharma, P.D. (2017). Fundamentals of Ecology. Rastogi Publications, Meerut, India.

Reference Books:

1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
2. Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
3. Simpson, M.G. (2006). *Plant Systematics*. Elsevier Academic Press, San Diego, CA, U.S.A.
4. Singh, G. (2012). *Plant Systematics: Theory and Practice*. Oxford & IBHPvt. Ltd., New Delhi. 3rd edition.
5. A.C. Sahu (2017). Plant Ecology and Phytogeography, Kalyani Publishers, New Delhi.
6. M.C. Das and S.P. Das (2009). Fundamentals of Ecology. Tata McGraw Hill, New Delhi.
7. Shukla and Chandel (2016). A text book of Plant Ecology. S Chand Publication, New Delhi
8. C.R. Mohanty (2017). Text Book of Plant Systematics, Kalynai Publisher, New Delhi.

Discipline Specific Core Paper I

Biodiversity (Microbes, Algae, Fungi and Archegoniate)

THEORY

Unit 1: Microbes:

Viruses—Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria—Discovery, General characteristics and cell structure; Reproduction—vegetative, asexual and recombination, Economic importance. **Algae:** General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Chlamydomonas*, *Oedogonium*, *Fucus*. Economic importance of algae.

Unit 2: Fungi

General characteristics of fungi, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi—General characteristics, ecology and significance, life cycle of *Rhizopus* (Zygomycota) *Penicillium*, *Alternaria* (Ascomycota), *Puccinia*, *Agaricus* (Basidiomycota); Symbiotic Associations—

Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.

Unit 3: Archegoniate and Bryophyte

Unifying features of archegoniates, Transition to land habit, Alternation of generations. General characteristics, adaptation to land habit, Classification, Range of thallus organization. Classification (upto family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

Unit 5: Pteridophytes & Gymnosperms

General characteristics, classification, Early land plants (*Cooksonia* and *Rhynia*). Classification (upto family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*. (Developmental details not to be included). Heterospory and seed habit, stelar evolution. Ecological and economic importance of Pteridophytes.

General characteristics, classification. Classification (upto family), morphology, anatomy and reproduction of *Cycas* and *Pinus*. (Developmental details not to be included). Ecological and economic importance.

PRACTICAL

1. EMs/Model of viruses – T-

Phage and TMV, Linedrawing/Photograph of Lytic and Lysogenic Cycle.

2. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium, Gram staining

3. Study of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas* (electron micrographs), *Oedogonium*, *Fucus* (Fucus*-Specimen and permanent slides)**

4. *Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.

5. *Puccinia*: Herbarium specimen of Black Stem Rust of Wheat and infected Barberry leaves; section/teasemounts of spores on Wheat and permanent slides of both the hosts.

6. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.

7. *Mycorrhiza*: ectomycorrhiza and endomycorrhiza (Photographs)

8. *Marchantia* & *Funaria*-

morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all temporary slides), v.s. of reproductive organ l.s. sporophyte.

9. *Selaginella* & *Equisetum*-

morphology, w.m. leaf with ligule, t.s. stem, t.s./l. of reproductive organ

10. *Cycas* & *Pinus*-

morphology (roots, bulbil, leaf), t.s. root, v.s. leaflet, whole mount or v.s. of reproductive organs

Text Books

1. Singh, Pandey and Jain (2017). Microbiology and Phycology, Rastogi Publication, Meerut.
2. B.K. Mishra (2017), Mycology and Phytopathology, Kalynai Publishers, New Delhi.
3. Singh, Pandey and Jain (2017). Archegoniate, Rastogi Publication, Meerut.

Suggested Readings

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press Pvt. Ltd. Delhi. 2nd edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
3. Sethi, I.K. and Walia, S.K. (2011). Textbook of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
7. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

\

Discipline Specific Core Paper II

Plant Ecology and Taxonomy

THEORY

Unit 1: Ecological factors

Introduction to plant ecology and taxonomy. Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation, optimal and limiting factors; Shelf for dwarf tolerance. Adaptation of hydrophytes and xerophytes.

Unit 2: Plant communities and Ecosystems

Characters; Ecotone and edge effect; Succession; Processes and types. Structure; energy flow, trophic organisation; Food chains and food webs, Ecological pyramids, production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorus

Unit 3: Phytogeography and Plant Taxonomy

Principle biogeographical zones; Endemism. Identification, Classification, Nomenclature. Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access, Taxonomic evidences from palynology, cytology, phytochemistry and molecular data. Taxonomic hierarchy: Ranks, categories and taxonomic groups

Unit 4: Classification & Botanical nomenclature

Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.

Classification: Types of classification - artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series). Biometrics, numerical taxonomy and cladistics: cluster analysis; phenograms, cladograms (definitions and differences).

PRACTICAL

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH, and analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and based deficiency by rapid field test.
3. (a) Study of morphological adaptations of hydrophytes and xerophytes (four each). (b) Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (Orobanchae), Epiphytes, Predation (Insectivorous plants)
4. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
5. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law
6. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification): Brassicaceae, Asteraceae, Solanaceae, Lamiaceae, Liliaceae
7. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

TextBooks

1.

Sharma, P.D. (2017). *Fundamentals of Ecology*. Rastogi Publications, Meerut, India. 2. O.P.S
Sharma (2009) *Plant Taxonomy*, Tata McGraw Hill, New Delhi

Suggested Readings

1. Kormondy, E.J. (1996). *Concepts of Ecology*. Prentice Hall, U.S.A. 4th edition.

2. Sharma, P.D. (2010) *Ecology and Environment*. Rastogi Publications, Meerut, India. 8th
edition.

3. Simpson, M.G. (2006). *Plant Systematics*. Elsevier Academic Press, San Diego, CA, U.S.A.

4. Singh, G. (2012). *Plant Systematics: Theory and Practice*. Oxford & IBHPvt. Ltd., New Delhi. 3rd
edition.