VIKRAM DEB AUTONOMOUS COLLEGE

JEYPORE, KORAPUT, ODISHA

COURSE OF STUDIES
OF

BACHELOR DEGREE SCIENCE

UNDER CBCS

Subject: BOTANY

(With effect from: 2021-2022 Admission batch)

Published by

VIKRAM DEB (AUTONOMOUS) COLLEGE
JEYPORE, KORAPUT, ODISHA
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Aims of Bachelor's degree programme in Botany

The broad aims of bacheleors degree programme in Botany are:

- To provide an environment that ensures cognitive development of students in a holistic manner. A dialogue about plants and its significance is fostered in this framework,ratherthandidacticmonologuesonmeretheoreticalaspects.
- To provide the latest subject matter, both theoretical as well as practical, such a waytofostertheircorecompetencyanddiscoverylearning.Abotanygraduateas envisioned in this framework would be sufficiently competent in the field to undertake further discipline-specific studies, as well as to begin domain-related employment.
- To mould a responsible citizen who is aware of most basic domain-independent knowledge, including critical thinking andcommunication.
- To enable the graduate prepare for national as well as international competitive examinations,especiallyUGC-CSIRNETandUPSCCivilServicesExamination

Program Learning Outcomes

- The student graduating with the Degree B.Sc (Honours) Botany should be able toacquire
- **Core competency:** Students will acquire core competency in the subject Botany, and in allied subjectareas.
- The student will be able to identify major groups of plants and comparethecharacteristicsoflower(e.g.algaeandfungi)andhigher (angiosperms and gymnosperms)plants.Students will be able to use the evidence based comparative botany approach to explain the evolution of organism and understand the genetic diversity on theearth.
- The students will be able to explain various plant processes and functions,metabolism,conceptsofgene,genomeandhoworganism's functionisinfluencedatthecell,tissueandorganlevel.
- Students will be able to understand adaptation, development and behavior of different forms oflife.
- The understanding of networked life on earth and tracing the energy pyramidsthroughnutrientflowisexpectedfromthestudents.

- ❖ Students will be able to demonstrate the experimental techniques and methods of their area of specialization inBotany.

Analytical ability:

- ❖ The students will be able to demonstarte the knowledge in understanding research and addressing practicalproblems.
- ❖ Applicationofvariousscientificmethodstoaddressdifferentquestions by formulating the hypothesis, data collection and critically analyze thedatatodecipherthedegreetowhichtheirscientificworksupports theirhypothesis.

Critical Thinking and problem solving ability:

- ❖ An increased understanding of fundamental concepts and their applications of scientific principles is expected at the end of this course. Students will become critical thinker and acquire problem solvingcapabilities.

Programme Specific Outcomes :

By the completion of the course the students will be able to :

1. Understanding the nature and basic concepts of all the plant groups, their classification, anatomical details of higher plants, metabolism, components at the molecular level, biochemistry and ecology.
2. The course will make them aware of natural resources and environment and the importance of conservation.
3. Understanding biotechnology and genetic engineering for the improvement of plants.
4. Identifying the bacteria, viruses, plant pathogens and their economic importance.
5. Analyze the cell organelles and application of genetics, molecular biology in plant breeding and crop improvement.
6. Hands on training in various fields will develop practical skills, handling equipments and laboratory use along with collection and interpretation of biological materials and data.

COURSE STRUCTURE

Semester-I

Course	Course Name	Credit	Total Marks
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)	Plant Diversity (Microbes,Algae, Fungi & Archegoniate)	4	75
GE -1A(Practical)	Plant Diversity (Microbes, Algae, Fungi & Archegoniate)	2	25
Total Credit- 22			**Total Marks- 400**

Semester-II

Course	Course Name	Credit	Total Marks
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
GE -2A (Theory)	Plant Physiology & Metabolism	4	75
GE -2A(Practical)	Plant Physiology & Metabolism	2	25
Total Credit- 22			**Total Marks- 400**

Semester-III

Course	Course Name	Credit	Total Marks
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
Total Credit- 28		**Total Marks- 500**	

Semester-IV

Course	Course Name	Credit	Total Marks
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)	Plant Ecology & Phytogeography	2	25
C-10 (Theory)	Plant Systematics	4	75
C-10 (Practical)	Plant Systematics	2	25
SEC - II	-	4	100
GE-2B (Theory)	Plant Anatomy, Embryology & Biotechnology	4	75

GE-2B (Practical)	Plant Anatomy, Embryology & Biotechnology	2	25
Total Credit- 28		**Total Marks- 500**	

Semester-V

Course	Course Name	Credit	Total Marks
C-11 (Theory)	Reproductive Biology OfAngiosperms	4	75
C-11 (Practical)	Reproductive Biology of Angiosperms	2	25
C-12 (Theory)	Plant Physiology	4	75
C-12 (Practical)	Plant Physiology	2	25
DSE - 1 (Theory)	Analytical Techniques in Plants Sciences	4	75
DSE - 1 (Practical)	Analytical Techniques in Plants Sciences	2	25
DSE - 2 (Theory)	Natural Resource Management 4 75	4	75
DSE - 2 (Practical)	Natural Resource Management	2	25
Total Credit- 24		**Total Marks- 400**	

Semester-VI

Course	Course Name	Credit	Total Marks
C-13 (Theory)	Plant Metabolism	4	75
C-13 (Practical)	Plant Metabolism	2	25
C-14 (Theory)	Plant Biotechnology	4	75
C-14 (Practical)	Plant Biotechnology	2	25
DSE - 3 (Theory)	Horticulture Practices & Post HarvestTechnology	4	75
DSE-3 (Practical)	Horticulture Practices & Post Harvest Technology	2	25
DSE – 4 Project	work Project Work	6	100
Total Credit- 24		**Total Marks- 400**	

Semester – 1st to 6thSemester

Total Credit- 148 Total Marks- 2600

BOTANY

HONOURS PAPERS:Core course – 14 papers

Discipline Specific Elective – 4 papers

Generic Elective for non-Botany students – 4 papers. In case University offers 2 subjects asGE, then papers 1 and 2 will be the GE paper. The students has the option of taking any two.

Marks per paper–Mid term:15 marks,End term:60 marks (Theory)+ 5 marks (Practical),

Total – 100 marksCredit per paper – 6

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

Core Paper - I

MICROBIOLOGY AND PHYCOLOGY

Learning outcomes

On completion of this course, the students will be able to:

- Developunderstandingontheconceptofmicrobialnutrition
- Classifyvirusesbasedontheircharacteristicsandstructures
- Developcriticalunderstandingofplantdiseasesandtheirremediation.
- Examine the general characteristics of bacteria and their cell reproduction/ recombination
- Increase the awareness and appreciation of human friendly viruses, bacteria, algae and their economicimportance
- Conduct experiments using skills appropriate tosubdivisions

Unit-I

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

Unit–II

(i) Bacteria: - Discovery, general characteristics, types- archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts), cell structure, nutritional types,reproduction-vegetative, asexual and recombination (conjugation,transformation and transduction). Economic importance of bacteria withreference 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 ofNostoc. General characteristics of prochlorophyceae, Evolutionary significance ofProchloron.

Unit–III

(i) Algae:- General characteristics; Ecology and distribution; range of thallusorganization; Cell structure and components; cell wall, pigment system, reservefood (of only groups represented in the syllabus), flagella and methods ofreproduction, classification; criteria, system of Fritsch, and evolutionaryclassification of Lee (only upto groups); Role of algae in the environment,agriculture, biotechnology and industry.

(ii) Chlorophyta:-General characteristics, occurrence, range of thallus organization, cellstructure and reproduction. Morphology and life-cycles of *Chlamydomonas, Volvox,Oedogonium and Coleochaete*.

Unit-IV

(i) Charophyta:-General characteristics; occurrence, morphology, cell structure andlife-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* and *Fucus*.

(iv)Rhodophyta:-General characteristics, occurrence, cell structure and 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 bacterial culture by Gram's staining method.

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

Phycology

Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas* (electronmicrographs), *Volvox,Oedogonium,Coleochaete, Chara, Vaucheria, Ectocarpus, Fucusand Polysiphonia, Procholoron, Diatoms* through, temporary preparations and permanent
slides.

Text Books:

1. Singh, V., Pandey, P.C., and Jain, D.K. (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. 8thedition.
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, M.J., Chan, E.C.S., Krieg, N.R. (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. Vasistha B.R. (2017) Botany for Degree student, Algae, S. Chand Publication, NewDelhi.
8. Mishra B. K. (2018) Microbiology and Phycology, Kalyani Publishers, New Delhi.

Core Paper II

BIOMOLECULES AND CELL BIOLOGY

Learning outcomes

On completion of this course, the students will be able to:

- Develop understanding on chemical bonding amongmolecules
- Identifytheconceptthatexplainschemicalcompositionandstructureo fcellwall andmembrane
- Classifytheenzymesandexplainmechanismofactionandstructure
- Comparethestructureandfunctionofcells&explainthedevelopmentofcells
- Describetherelationshipbetweenthestructureandfunctionofbiomolecules

Unit-I

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

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

(iii) Carbohydrates: Nomenclature, classification, structure and function of Monosaccharides, Disaccharides, Oligosaccharides and polysaccharides

Unit –II

(i) Lipids: Definition and major classes of storage and structural lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions andproperties.

(ii) Proteins: Structure and classification of amino acids; Peptide bonds; Levels of proteinstructure-primary, secondary, tertiary and quarternary; Isoelectric point; Proteindenaturation and biological roles of proteins.

(iii) 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.

Unit –III

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

(ii) 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.

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

Unit-IV

(i) Cytoskeleton: Role and structure of microtubules, microfilaments and intermediaryfilament.

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

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

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/pollengrains).
(v) Study the phenomenon of plasmolysis and deplasmolysis.
(vi)Study of different stages of mitosis and meiosis using aceto carmine and aceto orcine method from Onion root tip and bud respectively.

Text Books:

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

Reference Books:

1. Sahoo, K. (2017) Biomolecules and Cell Biology, Kalyani Publishers, New Delhi.
2. Tymoczko, J.L., Berg, J.M. and Stryer, L. (2012) Biochemistry: A short course, 2nd ed., W.H. Freeman
3. Nelson, D.L. and Cox, M.M. (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

Learning outcomes

On completion of this course, the students will be able to;

- Identifytruefungianddemonstratetheprinciplesandapplicationofplantpathology in the control of plantdisease.
- Demonstrateskillsinlaboratory,fieldandglasshouseworkrelatedtomycologyand plantpathology.
- Developanunderstandingofmicrobes,fungiandlichensandappreciatetheir adaptivestrategies
- Identifythecommonplantdiseasesaccordingtogeographicallocations anddevice controlmeasures

Unit-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 withreference to Rhizopus.

(iii) Ascomycota: General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Heterokaryosis and parasexuality; life cycle and classification with reference to *Saccharomyces, Aspergillus, Penicillium,and Neurospora*.

(iv)Basidiomycota: General characteristics; Ecology and Classification; Life cycle of *Puccinia and Agaricus*.

Unit-II

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

(ii) Oomycota: General characteristic; Ecology; Life cycle and classification with reference to Phytophthora, and *Albugo*.

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

Unit-III

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

Unit-IV

Phytopathology: Terms and concepts; General symptoms; Geographical distribution of diseases; etiology; symptomology; Host- Pathogen relationships; disease cycle andenvironmental 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, Vein Clearing. Fungal diseases – Early blight ofpotato, 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) *Aspergillus, Penicillium and Saccharomyces* : study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs.
(iv) *Puccnia :* Study of different stages from temporary mounts and permanent slides.
(v) *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*, and fairy rings are to be shown.
(vi) *Albugo*: Study of symptoms of plants infected with *Albugo*; asexual phase study Through section/ temporary mounts and sexual structures through permanent slides.
(vii) Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Viraldiseases: Mosaic disease of ladies finger, papaya, cucurbits, moong, black gram,Fungal diseases: Blast of rice, Tikka disease of ground nut, powdery mildew of locallyavailable plants and White rust of crucifers.

Text Books:

1. Mishra, B. K. (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, JohnWiley &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). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
6. Mehrotra, R. S.(2011). Plant Pathology. Tata Mc Graw-Hill Publishing Company Limited, New Delhi

Core Paper IV

ARCHEGONIATAE

Learning outcomes

On completion of this course, the students will be able to:

- Demonstrateanunderstandingofarchegoniatae,Bryophytes,Pteri dophytesand Gymnosperms
- Developcriticalunderstandingonmorphology,anatomyandrepro ductionof Bryophytes, Pteridophytes andGymnosperms
- Understanding of plant evolution and their transition to landhabitat.
- Demonstrateproficiencyintheexperimentaltechniquesandmethodsof appropriate analysis of Bryophytes, Pteridophytes,Gymnosperms

Unit-I

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

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

Unit-II

Pteridophytes: General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of *Psilotum*, *Selaginella*, Equisetum, Pteris and *Marsilea*. Apogamy, and apospory, heterospory and seed habit, telome theory, stellar evolution and economic importance.

Unit-III

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

Unit-IV

Palaeobotany: Geological time scale, fossils and fossilization process. Morphology, anatomy and affinities of *Rhynia, Calamites, Lepidodendron, Lyginopteris, Cycadeoidea and Williamsonnia*.

PRACTICAL

(i) Morphology, anatomy and reproductive structures of Riccia, Marchantia, Anthoceros,Funaria.
(ii) Psilotum- Study of specimen, transverse section of synangium (permanent slide).
(iii) 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).

(iv) 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).

(v) Study of temporary preparations and permanent slides of Marsilea.

(vi) Pteris- Morphology, transverse section of rachis, vertical section of sporophyll, wholemount of sporangium, whole mount of spores (temporary slides), transverse section ofrhizome, whole mount of prothallus with sex organs and young sporophyte (permanentslide).

(vii)Cycas- Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll and megaspore, T.S root, leaflet, rachis

(viii) 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.

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

(x) Study of some fossil slides / photographs as per theory.

Text Books:

1. Vasistha, B. R. (2017) Botany for Degree student, Bryophyta, S. Chand Publication, NewDelhi.

2. Singh, V., Pandey, P.C. and Jain, D.K. (2017). Archegoniate, Rastogi Publication,Meerut.

Reference Books:

1. Acharya, B. S. (2017), Archegoniate, Kalyani 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) LtdPublishers, New Delhi, India.

4. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGrawHill, Delhi.

Core Paper V

ANATOMY OF ANGIOSPERMS

Learning outcomes

On completion of this course, the students will be able to:

- Developanunderstandingofconceptsandfundamentalsofplantanatomy
- examine the internal anatomy of plant systems andorgans
- Developcriticalunderstandingontheevolutionofconceptoforganizatio nofshoot and rootapex.
- Analyze the composition of different parts of plants and theirrelationships
- Evaluate the adaptive and protective systems ofplants

Unit-I

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

(ii) Tissues: Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiationof tracheary elements and sieve elements; Pits and plasmodesmata;Cell wall ingrowths and transfer cells, adcrustation and incrustation, Ergasticsubstances.

Unit-II

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

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

Unit-III

(i) Root: Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappetheory); 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;Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuseporous 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, lithocysts and laticifers.

(iii) Mechanical tissue system.

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 (normal and anomalous); periderm; lenticels.
6. Leaf: isobilateral, dorsiventral, C_4 leaves (Kranz anatomy).
7. Ecological anatomy.

Text Books:

1. Singh, V., Pandey, P.C. and Jain, D.K. (2017). Anatomy of Angiosperms, Rastogi Publication, Meerut.

Reference Books:

1. Eames, A.J. and Mc Daniels, L.H., (1953). An introduction to plant anatomy, Tata McGrow Hills, New Delhi
2. Esau, K. (1977). Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi.
3. Tayal, M. S. (2012) Plant Anatomy Rajpal and Sons, New Delhi
4. Mishra, B. K. (2017). Anatomy of Angiosperms, Kalyani Publishers, New Delhi.
5. Pandey, B. P. (2017) Plant Anatomy, S. Chand Publication, New Delhi.

Core Paper VI

ECONOMIC BOTANY

Learning outcomes

On completion of this course, the students will be able to:

- Understand core concepts of Economic Botany and relate with environment, populations, communities, andecosystems
- Develop critical understanding on the evolution of concept of organization of apex new crops/varieties, importance of germplasm diversity, issues related to access and ownership
- Develop a basic knowledge of taxonomic diversity and important families of useful plants
- Increase the awareness and appreciation of plants & plant products encountered in everydaylife
- Appreciatethediversityofplantsandtheplantproductsinhumanuse

Unit-I

(i) Origin of Cultivated Plants: Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.

(ii) Cereals: Cultivation and brief account of Wheat, Rice and millets.

(iii) Legumes: General account, importance to man and ecosystem.

(iv)Sugars & Starches: Morphology, cultivation and processing of sugarcane, productsand by-products of sugarcane industry. Potato – morphology, cultivation, propagation& uses.

Unit-II

(i) Spices: Listing of important spices, their family and part used, economic importancewith 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 toCinchona, 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.

(ii) 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: Soya bean/moong bean/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 crushedseeds.
(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 sectionof 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, A.V.S.S. and Subrahmanyam, N.S. (2011). Text Book of Modern Economic Botany, CBS Publishers and Distributors, New Delhi.
3. Hill, Albert F. Economic Botany, Tata Mc Grow Hill Publishing Company, Ltd. NewDelhi.
4. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer AcademicPublishers, The Netherlands.
5. Singh, V., Pandey, P.C. and Jain, D.K. (2017). Economic Botany, Rastogi Publication, Meerut.
6. Baruah, B. (2017). Economic Botany, Kalyani Publishers, New Delhi.

Core Paper VII

GENETICS

Learning outcomes

On completion of this course, the students will be able to:

- Haveconceptualunderstandingoflawsofinheritance,geneticbasisoflociand alleles and theirlinkage.
- Comprehendtheeffectofchromosomalabnormalitiesinnumerical aswellas structural changes leading to geneticdisorders.
- Developcriticalunderstandingofchemicalbasisofgenesandtheirinteractionsat population and evolutionarylevels.
- Analyze the effect of mutations on gene functions anddosage.
- Examine the structure, function and replication ofDNA.

Unit-I

(i) Mendelian genetics and its extension Mendelism: History; Principles of inheritance;Chromosome theory of inheritance; Autosomes and sex chromosomes; Incompletedominance and codominance; Multiple alleles, Lethal alleles, Interaction of genes,Pleiotropy, Recessive and Dominant traits, Polygenic inheritance.

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

Unit-II

Linkage, crossing over and chromosome mapping: Linkage and crossing over-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. DNArepair 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. Analysis of allelic and genotypic frequencies.
2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-squareanalysis.
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(through photographs).

Text Books:

1. Singh B. D. (2017). Fundamental of Genetics, Kalyani Publishers, New Delhi.
2. Gupta P. K. (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, E.W., Dunn, L.C. and Dobzhansky, T. (1985) Principles of Genetics, Tata Mc Grow Hill, New Delhi
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. BenjaminCummings, 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, M.W. Genetics, Pearson Publishers, 3rd Edition
6. Rastogi V. B. (2017). Genetics, Kedar Nath & Ram Nath, Meerut

Core Paper VIII

MOLECULAR BIOLOGY

Learning outcomes

On completion of this course, the students will be able to;

- Analyse the structures and chemical properties of DNA and RNA through various historicexperiments.
- Differentiate the main types of prokaryotes through their grouping abilities and their characteristic
- Evaluatetheexperimentsestablishingcentraldogmaandgeneticcode.
- Gainanunderstandingofvariousstepsintranscription,proteinsynthesisa ndprotein modification.

Unit-I

Nucleic acids: Carriers of genetic information: Historical perspective; DNA as thecarrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod &McCarty), Types of genetic material, denaturation and renaturation, cot curves.Organization of DNA and structure of RNA- Prokaryotes, Viruses, Eukaryotes,Fraenkel-Conrat's experiment. Organelle DNA - mitochondria and chloroplast DNA.

The Nucleosome -Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.

Unit-II

(i) The replication of DNA: Chemistry of DNA synthesis (Kornberg's discovery);General principles – bidirectional, semi-conservative and semi discontinuousreplication, RNA priming; Various models of DNA replication, including rollingcircle, θ (theta) mode of replication, replication of linear ds-DNA, replication of the

5′ end of linear chromosome; Enzymes involved in DNA replication.

(ii) Central dogma and genetic code: Key experiments establishing-The Central Dogma(Adaptor hypothesis and discovery of mRNA template), Genetic code (deciphering& salient features)

(iii) Processing and modification of RNA: Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I & group II intron splicing, alternative splicing eukaryotic mRNA processing (5′ cap, 3′ polyA tail); Ribozymes, exon shuffling; RNA editing and mRNA transport.

Unit-III

Mechanism of Transcription: Transcription in prokaryotes and eukaryotes;

Regulation of transcription in prokaryotes and eukaryotes: Principles of transcriptionalregulation; Prokaryotes: Operon concept- Regulation of lactose

metabolism andtryptophan synthesis in E.coli. Eukaryotes: transcription factors, heat shock proteins,steroids and peptide hormones; Gene silencing

Unit-IV

Translation (Prokaryotes and eukaryotes): Ribosome structure and assembly; Charging of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis; Post-translational modifications of proteins.

PRACTICAL

1. Preparation of LB medium and raising E. coli.
2. Isolation of genomic DNA from suitable plant material.
3. RNA estimation by orcinol method.
4. DNA estimation by diphenylamine reagent/UV Spectrophotometry.
5. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel &Conrat's experiments)
6. Study of Barr body from buccal smear preparation.

Text Books:

1. Gupta P. K. (2017). Molecular Biology, Rastogi Publication, Meerut.

Reference Books:

1. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.
4. Sheeler, P. and Bianchi, D.E. (2009) Molecular Biology of the Cell, Willey Publisher, New Delhi
5. 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.
6. Alberts, B. et al. 2014. Molecular Biology of the cell Garland Science. 6th Edition
7. Power, C. B. (2017) Cell Biology, Himalaya Publishing House, New Delhi 18
8. Sahu, A.C. (2017). Essentials of Molecular Biology, Kalynai Publishers, New Delhi.

Core Paper IX

PLANT ECOLOGY & PHYTOGEOGRAPHY

Learning outcomes

On completion of this course, the students will be able to:

- Understand core concepts of biotic andabiotic
- Classifythesoilsonthebasisofphysical,chemicalandbiologicalcomponents
- Analysis the phytogeography or phytogeographical division ofIndia
- Evaluate energy sources of ecologicalsystem
- Assesstheadaptationofplantsinrelationtolight,temperature,water,windandfire.
- Conduct experiments using skills appropriate tosubdivisions

Unit-I

(i) Introduction Concept of ecology, Autoecology, Synecology, system ecology, Levelsof organization. Inter-relationships between the living world and the environment,the components of environment, concept of hydrosphere and lithosphere anddynamism, homeostasis.

(ii) Light, temperature, wind and fire: Variations; adaptations of plants to their variation.

Unit-II

(i) Soil: Formation; Composition; Physical; Chemical and Biological components; Soilprofile; Role of climate in soil development.

(ii) Water: Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table.

Unit-III

Biotic interactions and Population ecology: Characteristics and Dynamics.

Plant communities: Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types;climax concepts.

Unit-IV

(i) Ecosystems: Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids.

(ii) Functional aspects of ecosystem: Principles and models of energy flow; Productionand productivity; Ecological efficiencies; Biogeochemical cycles; Cycling ofCarbon, Nitrogen and Phosphorus.

(iii) Phytogeography: Principles; Continental drift; Theory of tolerance;Endemism; Phytogeographical division of India; Vegetation of Odisha.

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 two 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, halophyles (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 frequency, density and abundance in the college campus.

7. Field visit to familiarize students with 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., NewDelhi. 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. Das M. C. and Das S. P. (2009). Fundamental of Ecology. Tata MGrow Hill, New Delhi.

7. Shukla R.S. and Chandel P.S. (2016). A Text Book of Plant Ecology. S Chand Publication, New Delhi

Core Paper X

PLANT SYSTEMATICS

Learning outcomes

On completion of this course, the students will be able to:

- Classify Plant systematics and recognize the importance of herbarium and Virtual herbarium
- Evaluate the Important herbaria and botanicalgardens
- Interpret the rules of ICN in botanicalnomenclature
- Assess terms and concepts related to PhylogeneticSystematics
- GeneralizethecharactersofthefamiliesaccordingtoBentham&Hooker'ssystemof classification

Unit-I

Plant identification, Classification, Nomenclature; Biosystematics. Identification: Fieldinventory; Functions of Herbarium; Important herbaria and botanical gardens of the worldand 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 taxonomichierarchy; Species concept (taxonomic, biological, evolutionary).

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

Unit-III

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

(ii) Systems of classification: Major contributions of Theophrastus, Bauhin, Tournefort,

Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist;

Classification systems of Bentham and Hooker (up to series) and Hutchinson (up to series); Brief reference of Angiosperm Phylogeny Group (APG III) classification.

Unit-IV

Phylogeny of Angiosperms: Terms and concepts (primitive and advanced, homology andanalogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades).Origin& evolution of angiosperms; co- evolution of angiosperms and animals; methods ofillustrating evolutionary relationship (phylogenetic tree, cladogram).Families of Angiosperms : Descriptive studies of Magnoliaceae, Rosaceae, Rubiacae,Poaceae, Orchidaceae, Musaceae, Acanthaceae, Apocynaceae, Asclepiadaceae, Lamiaceae.

PRACTICAL

(i) Study of vegetative and floral characters of available materials of the families included in theory syllabus (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification).

(ii) Field visit, plant collection and herbarium preparation and submission. Mounting ofproperly dried and pressed specimen of at least fifteen wild plants with herbarium label (to be submitted in the record book)

Text Books:

1. Sharma O. P. (2009) Plant Taxonomy, Tata Mc Grow Hill, New Delhi

Reference Books:

1. Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi.3rdedition.
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-APhylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.
4. Saxena, H. O. and Brahman, M..The Flora of Orissa, CSIR Publication.
5. Bose T. K. (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. Mohanty, C. R. (2017). Text Book of Plant Systematics, Kalynai Publisher, New Delhi.
9. Subrahmainayam, M. S. (2011) Modern Plant Taxonomy, Vikash Publishing House,New Delhi
10. Pandey, B. P., (2017). Taxonomy of Angiosperm. S. Chand Publication.

Core Paper XI

REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

Learning outcomes:

At the end of the course the students will be able to;

- Understandthefundamentalconceptsofembryology
- Analyzeandrecognizethedifferentorgansofplantandsecondarygrowth.
- Evaluatethestructuralorganizationofflowerandtheprocessofpollinationand fertilization

Unit-I

(i) Introduction: History and scope.

(ii) Anther: Anther wall: Structure and functions, micro-sporogenesis, callose deposition and its significance.

(iii)Pollen biology: Micro-gametogenesis; Pollen wall structure, MGU (male germ unit)structure, NPC system; Palynology and scope (a brief account); Pollen wall proteins;Pollen viability, storage and germination; Abnormal features: Pseudomonads,polyads, massulae, pollinia.

Unit-II

Ovule: Structure; Types; Special structures–endothelium, obturator, aril, caruncle andhypostase; Female gametophyte– mega-sporogenesis and mega-gametogenesis; Types andultrastructure of different mature embryo sacs (Details of Polygonum type), Developmentalpattern of mono-, bi- and tetrasporic embryo sacs.

Unit-III

(i) Pollination and fertilization: Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.

(ii) Self incompatibility: Basic concepts; Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination; Intraovarian and in vitro pollination; Modification of stigma surface.

Unit-IV

(i) Endosperm: development, structure and functions

(ii) Embryo: Types of embryogeny; General pattern of development of dicot andmonocot embryo; Suspensor: structure and functions; Embryo-endospermrelationship; Nutrition of embryo; Embryo development in Paeonia.

(iii) Seed: Structure, importance and dispersal mechanisms

(iv)Polyembryony and apomixes: Introduction; Classification; Causes and applications.

PRACTICAL

(i) Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.
(ii) Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs, fresh material), ultrastructure of pollen wall (micrograph); Pollen viability: Tetrazolium test, Germination: Calculation of percentage germination in different media using hanging drop method.
(iii) Ovule: Types-anatropous, orthotropous, amphitropous/ campylotropous, circinotropous, unitegmic, bitegmic; 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/photographs; dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.
(v) Tracing the path of pollen tube.
(vi)Study of haustorial endosperm.

Text Books:

1. Singh, V., Pandey, P.C, and Jain, D.K. (2017). Reproductive Biology of Angiosperms,Rastogi Publications, Meerut

Reference Books:

1.Maheswari, P. (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. l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

5. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, VikasPublishing House. Delhi. 5th edition.

6.Mishra, B. K. (2017). Reproductive Biology of Angiosperms, Kalyani Publishers, New Delhi.

Core Paper XII

PLANT PHYSIOLOGY

Learning outcomes

On completion of this course, the students will be able to;

- UnderstandWaterrelationofplantswithrespecttovariousphysiologicalprocesses.
- Explain chemical properties and deficiency symptoms inplants
- Classify aerobic and anaerobicrespiration
- Explain the significance of Photosynthesis andrespiration
- Assess dormancy and germination inplants

Unit-I

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

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

Unit-II

(i) Mineral nutrition: Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, 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 nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene. Brassinosteroids and Jasmonic acid.

Unit-IV

(i) Physiology of flowering: Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy. Senescence: Types and causes.

(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 cell sap 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 a mesophyte and xerophyte.
5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a 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.
9. Measurement of relation between transpiration and transpiring surface.
10. Measurement of cuticular resistance to transpiration.

Text Books:

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

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., MOller, 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. Sahoo, A. C. (2018). Outlines of Plant Physiology Kalynai Publishers, New Delhi.
6. Srivastava, N. K.. (2017). Plant Physiology, Rastogi Publications, Meerut.
7. Pandey and Sinha (2011). Plant Physiology, Vikash Publishing House, New Delhi

Core Paper XIII

PLANT METABOLISM

Learning outcomes

On completion of this course, the students will be able to:

- Differentiate anabolic and catabolic pathways ofmetabolism
- Recognize the importance of Carbon assimilation inphotorespiration
- Explain theATP-Synthesis
- Interpret the Biological nitrogen fixation inmetabolism

Unit-I

(i) Concept of metabolism: Introduction, anabolic and catabolic pathways, regulation ofmetabolism, 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, role of photosynthetic

pigments, Red drop and Emerson Enhancement Effect, antenna molecules and reactioncentres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, C_3, C_4pathways; Crassulacean acid metabolism; Factors affecting CO_2 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, amphibolic role, anaplerotic reactions, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation, cyanideresistantrespiration, factors affecting respiration.

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

Unit-IV

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

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

PRACTICAL

1. Isolation and quantitization 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.
7. Assay of the enzyme Catalase.
8. Photoreduction of dye by isolated chloroplasts.

Text Books:

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

Reference Books:

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wileyand Sons. U.S.A. 4th edition.

2. Taiz, L., Zeiger, E., Moller, 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. Sahoo, A. C. (2018). Outlines of Plant Metabolism, Kalynai Publishers, New Delhi.

Core Paper XIV

PLANT BIOTECHNOLOGY

Learning outcomes

On the completion of the course the students will be able to

- Understand the core concepts and fundamentals of plant biotechnology and genetic engineering
- Develop their competency on different types of plant tissueculture
- Analyze the enzymes and vectors for geneticmanipulations
- Examinegenecloningandevaluatedifferentmethodsofgenetransfer
- Criticallyanalyzethemajorconcernsandapplicationsoftransgenictechnology

Unit-I

Plant Tissue Culture: Historical perspective; Aseptic tissue culture techniques, Compositionof media; Nutrient and hormone requirements (role of vitamins and hormones). Totipotency;Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture andfusion; 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, biologicalrole and application); Restriction Mapping (Linear and Circular); Cloning Vectors:Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC and briefly PAC, MAC,HAC).Gene Cloning (Recombinant DNA, Bacterial Transformation and selection ofrecombinant clones, PCR-mediated gene cloning).

Unit-III

Recombinant DNA technology-II: Gene Construct; construction of genomic and cDNAlibraries, screening DNA libraries to obtain gene of interest by genetic selection;complementation, colony hybridization; Probes-oligonucleotide, heterologous, Methods ofgene transfer- Agrobacterium-mediated, Direct gene transfer by Electroporation,Microinjection, Microprojectile bombardment; Selection of transgenics– selectable markerand reporter genes (Luciferase, GUS, GFP).

Unit-IV

Applications of Biotechnology: Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (FlavrSavrtomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role oftransgenics 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 another culture through photographs.
3. Preparation of artificial seeds.
4. Study of Bt cotton through photographs.
5. Isolation of plasmid DNA.
6. Gel electrophoresis (demonstration).

Text Books:

1. Chawla, H. S. (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. Singh, B. D. (2018). Plant Biotechnology Kalynai Publishers, New Delhi.
5. Gupta, P. K. (2017). Plant Biotechnology, Rastogi Publication, Meerut.
6. Dubey, R. C. (2017). Advanced Biotechnology, S, Chand Publication, New Delhi

Discipline Specific Elective Paper-I

ANALYTICAL TECNIQUES IN PLANT SCIENCES

Learning outcomes:

On completion of this course the students will be able to:

- Develop conceptual understanding of cell wall degradation enzymes and cell fractionation.
- Classify different types of chromatographytechniques.
- Explain the principles of Light microscopy, compound microscopy, Fluorescence microscopy and confocalmicroscopy
- Applysuitablestrategiesindatacollectionsanddisseminatingresearchfindings.

Unit-I

Imaging and related techniques: Principles of microscopy; Light microscopy; Fluorescencemicroscopy; 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 densitygradient, $CsCl_2$gradient, analytical centrifugation, ultracentrifugation. Radioisotopes: Use in biological research, auto-radiography, pulse chase experiment.Spectrophotometry: Principle and its application in biological research.

Unit-III

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

Unit-IV

Biostatistics: Statistics, data, population, samples, variables, parameters; Representation ofData: Tabular, Graphical; Measures of frequency and central tendency: Arithmetic mean,mode, median; Measures of dispersion: Range, mean deviation, variance, standard deviation;Chi-square test for goodness of fit. Test of significance: comparison of large, small and pairedsamples (T-Test) and correlation.

PRACTICAL

1. Study of different microscopic techniques for chromosome study
2. Study of PCR Demonstration.
3. To separate pigments by paper chromatography.
4. To separate phytochemicals by thin layer chromatography.
5. To estimate protein through Lowry's methods.
6. To separate proteins using PAGE.
7. To separate DNA (marker) using AGE.
8. Spectrometric estimation of total sugar by Anthrone method.
9. Chi-square analysis of mendelian ratio.
10. T-Test.

Text Books:

1. Patil, C. S. (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 Micro technique 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. Aneja, K. R. (2014). Laboratory manual of microbiology and biotechnology, Medtech, New Delhi

Discipline Specific Elective Paper-II
NATURAL RESOURCE MANAGEMENT

Learning outcomes:

At the end of the course the students will be able to,

- Understandtheconceptofdifferentnaturalresourcesandtheirutilization.
- Criticallyanalyzethesustainableutilizationland,water,forestandenergyresources.
- Evaluate the management strategies of different naturalresources.
- Reflect upon the different national and international efforts in resource management and theirconservation

Unit-I

(i) Natural resources: Definition and types.

(ii) Sustainable utilization :Concept, approaches (economic, ecological and sociocultural).

(iii) Land: Utilization (agricultural, horticultural, silvicultural); Soil degradation and management.

(iv)Water: Fresh water (rivers, lakes, groundwater, water harvesting technology, rainwater storage and utilization.

Unit-II

Biological Resources: Biodiversity-definition and types; Significance; Threats; Managementstrategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan).Forests: Definition, Cover and its significance (with special reference to India); Major andminor 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 ResourceAppraisal, Ecological Footprint with emphasis on carbon footprint.

Unit-IV

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

PRACTICAL

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

ii. Collections 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.

vi. Estimation of soil moisture content and soil texture.

vii. Estimation of soil porosity

viii. Estimation of soil water-holding capacity.

ix. Estimation of soil organic matter and soil carbon

Text Books:

1. Pandey, B. W. 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 ResourceConservation. 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-III

HORTICULTURAL PRACTICES AND POST-HARVEST TECHNOLOGY

Learning outcomes:

At the end of the course the students will be able to:

- Understand the concept of different types of horticultural crops, their conservation andmanagement
- Examine the various branches of horticulture, fruit and vegetable crops, floriculture, medicinal and aromaticplants.
- Critically evaluate different cultivation practices and diseasemanagement
- Reflect upon different Landscaping practices and gardendesign

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, carnations, orchids, poppies, gerberas, tuberose, sages, cacti and succulents(Opuntia, Agave and spurges)]

Unit-II

(i) Fruit and vegetable crops: Production, origin and distribution; Description of plantsand 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 andlimitations.

(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 post harvest technology in horticultural crops;Evaluation of quality traits; Harvesting and handling of fruits, vegetables and cutflowers; Principles, methods of preservation and processing; Methods of minimizingloses during storage and transportation;

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

Unit-IV

Horticultural crops - conservation and management: Documentation and conservation ofgermplasm; 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

i. Identification and description of salient features of ornamental plants included in the syllabus.
ii. Horticultural techniques (Drip irrigation, surface irrigation, furrow and border irrigation).
iii. Study of practice of asexual propagation methods (grafting, cutting, layering, budding)
iv. Planning and layout of parks and avenues
v. Handing of harvested fruits, vegetables and cut flowers
vi. Methods of fruit preservation
vii. Basic tissue cultures technique

Text Books:

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

Reference Books:

1. Singh, D. &Manivannan, S. (2009). Genetic Resources of Horticultural Crops. RidhiInternational, Delhi, India.
2. Swaminathan, M.S. and Kochhar, S.L. (2007). Groves of Beauty and Plenty: An Atlasof 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. Pandey, P. H. (2007). Principles and Practices of Post Harvest Technology, KalyaniPublishers, New Delhi.

Discipline Specific Elective Paper-IV

DISSERTATION / PROJECT WORK

Identificationof problem	-	10
Review ofLiterature	-	10
Methodology	-	10
Findings	-	25
Analysis	-	25
Viva-Voce	-	20
Total	-	100

** = Students who score more than ≥60% in aggregate are eligible for project work

Generic Elective Paper I A

PLANT DIVERSITY (MICROBES, ALGAE, FUNGI AND ARCHEGONIATES)

Learning outcomes:

At the end of the course the students will be able to

- Understandthefundamentalconceptsrelatedtomicrobes,alga e,fungiand embryophytes
- Analyze the discovery and general structure ofviruses
- Examinethemorphologyandlife-cyclesoftrentepohlia,ulva,kappaphycus, sargassum, turbinaria, grailaria,porphyra
- Evaluate the significance of fungi and its differenttypes
- AnalyzetheanatomyandreproductionofCycasandPinusalongwiththeire cological and economicalimportance

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 andrecombination (conjugation, transformation and transduction); Economic importance.

Unit-II

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

(ii) Fungi : Introduction- General characteristics, ecology and significance, range of thallusorganization, cell wall composition , nutrition, reproduction and classification; TrueFungi- General characteristics, ecology and significance, life cycle of Rhizopus (Zygomycota) Penicillium (Ascomycota), Puccnia, Agaricus Basidiomycota); SymbioticAssociations-Lichens

Unit-III

(i) **Bryophytes:** General characteristics, adaptations to land habit, Classification, Range ofthallus organization, Classification (up to family), morphology, anatomy andreproduction of Marchantia and Funaria (Developmental details not to be included).

(ii) **Pteridophytes:** General characteristics, classification, early land plants (Rhynia).Classification (up to family), morphology, anatomy and reproduction of Selaginella,Equisetum and Pteris (Developmental details not to be included).Heterospory and seedhabit, stellar evolution. Ecological and economical importance of Pteridophytes.

Unit-IV

Gymnosperms: General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of Cycas, Pinus and Gnetum. (Developmental detailsnot to be included).Ecological and economical importance.

PRACTICAL

1. Gram staining
2. Study of vegetative and reproductive structures of Nostoc, Chlamydomonas, Oedogonium, Vaucheria, Fucus and Polysiphonia through temporary preparations and permanent slides.
3. Rhizopus and Penicillium: Asexual stage from temporary ounts and sexual structures through permanent slides.
4. Puccinia and Agaricus: Specimens of button stage and full grown mushroom; Sectioning of gills of Agaricus.
5. Marchantia and Funaria- morphology of thallus, w.m. rhizoids and scales, v.s. thallusthrough gemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore,archegoniophore, l.s. sporophyte (all permanent slides).
6. Selaginella- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus,w.m.microsporophyll and megasporophyll (temporary slides), l.s. strobilus(permanent slide).
7. Equisetum- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m.sporangiophore, w.m. spores (wet and dry)(temporary slides); t.s 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 (permanent slide).
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 (permanent slide).

Text Books:

1. Mitra, J.N., Mitra, D. and Choudhury, S.K. 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, PearsonBenjamin Cummings, U.S.A. 10th edition.
3.Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, Mac Millan 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 McGrawHill, 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) LtdPublishers, New Delhi, India.
8.Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central BookDepot, Allahabad.
9.Pandey, B. P. (2017), Botany for degree studies (as per CBCS). S. Chand
10. Acharya, B. S. and Mishra, B. K. (2018). Plant Biodiversity, Kalyani Publishers, New Delhi.

Generic Elective Paper IIA

PLANT PHYSIOLOGY AND METABOLISM

Learning outcomes

On completion of this course, the students will be able to;

- UnderstandWaterrelationofplantswithrespecttovariousphysiologicalprocesses.
- Explain chemical properties and deficiency symptoms inplants
- Classify aerobic and anaerobicrespiration
- Explain the significance of Photosynthesis andrespiration
- Assess dormancy and germination inplants

Unit-I

(i) Plant-water relations: Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

(ii) Mineral nutrition: Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

(iii) Translocation in phloem.: Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading

Unit-II

(i) Photosynthesis: Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C_3, C_4 and CAM pathways of carbon fixation.

(ii) Respiration: Glycolysis, anaerobic respiration, TCA cycle; Oxidative Phosphorylation.

Unit-III

(i) Enzymes: Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

(ii) Nitrogen metabolism: Biological nitrogen fixation; Nitrate and ammonia assimilation.

Unit-IV

(i) Plant growth regulators: Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

(ii) Plant response to light and temperature: Photoperiodism (SDP, LDP, Day neutralplants); Phytochrome (discovery and structure), red and far red light responses onhotomorphogenesis; Vernalization.

PRACTICAL

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. To study the effect of two environmental factors (light and wind) on transpiration byexcised twig.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Demonstration of Hill reaction.
5. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.
6. To study the effect of light intensity and bicarbonate concentration on O_2 evolution inphotosynthesis.
7. Comparison of the rate of respiration in any two parts of a plant.

Text Books:

1. A. C. Sahu (2018). Plant Physiology and Metabolism. Kalyani Publishers, New Delhi.

Reference Books:

1. Taiz, L., Zeiger, E., MOller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley &Sons, U.S.A. 4th Edition.
3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.
4. H. S. Srivatava. Plant Physiology, Rastogi Publications, New Delhi.
