NOWGONG COLLEGE
(AUTONOMOUS)

SYLLABUS

DEPARTMENT OF BOTANY

Learning Outcomes-based Curriculum Framework (LOCF) of

Undergraduate Programme

BACHELOR OF SCIENCE IN BOTANY

(Effective from Academic Year 2020-21)

Syllabus as approved by Academic Council, Nowgong College (Autonomous)

Details of Courses in the Programme of Department of Botany, Nowgong College (A)

Honours Course

Ability Enhancement Compulsory Course (AECC) papers

ENGL/ASSA/HIND/BENG -AEC-1014 ……. (Theory)
ENST-AEC-2014 …….. (Theory)

Honours Core Course (HCC) papers

BOTA-HCC-1016 Phycology and Microbiology (Theory+ Practical)
BOTA -HCC-1026 Biomolecules and Cell Biology (Theory+ Practical)
BOTA -HCC-2016 Mycology and Phytopathology (Theory+ Practical)
BOTA -HCC-2026 Archegoniate (Theory+ Practical)
BOTA -HCC-3016 Anatomy of Angiosperms (Theory+ Practical)
BOTA -HCC-3026 Economic Botany (Theory+ Practical)
BOTA -HCC-3036 Genetics (Theory+ Practical)
BOTA -HCC-4016 Molecular Biology (Theory+ Practical)
BOTA -HCC-4026 Plant Ecology and Phytogeography (Theory+ Practical)
BOTA -HCC-4036 Plant Systematics (Theory+ Practical)
BOTA -HCC-5016 Reproductive Biology of Angiosperms (Theory+ Practical)
BOTA -HCC-5026 Plant Physiology (Theory+ Practical)
BOTA -HCC-6016 Plant Metabolism (Theory+ Practical)
BOTA -HCC-6026 Plant Biotechnology (Theory+ Practical)

Discipline Specific Elective Papers
BOTA -HDS-5016 Horticulture Practices and Post-Harvest Technology (Theory+ Practical)
BOTA -HDS-5026 Biostatistics (Theory+ Practical)
BOTA -HDS-6016 Natural Resource Management (Theory+ Practical)
BOTA -HDS-6026 Dissertation (Work+ Presentation)

Honours Generic Elective Papers [HGE] (to be offered to other Departments/Disciplines)
BOTA-HGE-1016 Biodiversity (Microbes, Algae, Fungi and Archegoniate) (Theory+ Practical)
BOTA-HGE-2016 Plant Ecology and Taxonomy (Theory+ Practical)
BOTA-HGE-3016 Plant Anatomy and Embryology (Theory+ Practical)
BOTA-HGE-4016 Plant Physiology and Metabolism (Theory+ Practical)

Skill Enhancement Courses (Students will select 2 papers from the pool table)
XXXX-SEC-3014 (Theory+ Practical/Presentation)
XXXX-SEC-4014 (Theory+ Practical/Presentation)

Regular Core Course (RCC)
Ability Enhancement Compulsory Course (AECC) papers
ENGL/ASSA/HIND/BENG-AEC-1014 ……. (Theory)
ENST-AEC-2014 …… (Theory)

Regular Core Papers
BOTA-RCC-1016 Biodiversity (Microbes, Algae, Fungi and Archegoniate) (Theory+ Practical)
BOTA -RCC-2016 Plant Ecology and Taxonomy (Theory+ Practical)
BOTA -RCC-3016 Plant Anatomy and Embryology (Theory+ Practical)
BOTA -RCC-4016 Plant Physiology and Metabolism (Theory+ Practical)

Discipline Specific Elective Papers
BOTA -RDS-5016 Horticulture Practices and Post-Harvest Technology (Theory+ Practical)
BOTA -RDS-6016 Natural Resource Management (Theory+ Practical)
Skill Enhancement Courses (Students will select 4 papers from the pool table)
XXXX-SEC-3014 (Theory+ Practical/Presentation)
XXXX-SEC-4014 (Theory+ Practical/Presentation)
XXXX-SEC-5014 (Theory+ Practical/Presentation)
XXXX-SEC-6014 (Theory+ Practical/Presentation)
Offered papers from the department – (2 nos.)
XXXX-SEC-5014 Nursery and Gardening (Theory+ Practical/Presentation)
XXXX-SEC-6014 Plant Diversity and Human Welfare (Theory+ Practical/Presentation)

Honours Core Course

SEMESTER-I

PAPER CODE: BOTA-HCC-1016
(Phycology and Microbiology)

PAPER CREDIT:06 (4T+2P)

Total No. of Lectures: 60 + 30 (L+P) **Total marks=100 (T60 + IA20 + P20)**

Objective: To enrich knowledge on the different aspects of Phycology and Microbiology

Learning Outcome: Students will learn about viruses, bacteria, cyanobacteria and algal groups along with their role in environment and industry.

CONTENTS

1.

1.1 THEORY

Unit 1: ***Introduction to microbial world*** **(10 lectures)**

Scope of microbes in industry and environment; Microbial nutrition, growth and metabolism [Only an overview of microbial metabolism- the concept of anabolism (Biosynthesis) and catabolism (ATP-generating Pathways-Respiration and Fermentation)].

Unit 2: ***Viruses*** **(7 lectures)**

Discovery, physiochemical and biological characteristics; classification (Baltimore),

general structure with special reference to viroids 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 3: *Bacteria* **(7 lectures)**

Discovery, general characteristics; Types-archaebacteria, eubacteria, actinomycetes, mycoplasma, rickettsia, chlamydiae and sphaeroplasts); 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 (Alcohol and Antibiotic production).

Unit 4: *Algae* **(10 lectures)**

General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; methods of reproduction; Classification; Evolutionary significance of *Prochloron*; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups); Role of algae in the environment, agriculture, biotechnology and industry, Economic importance of Diatoms.

Unit 5: *Cyanophyta and* Xanthophyta **(8 lectures)**

Ecology and occurrence; Range of thallus organization; Cell structure; Reproduction, Morphology and life-cycle of *Nostoc* and *Vaucheria.*

Unit 6: *Chlorophyta, Charophyta and Bacillariophyta* **(10 lectures)**

General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Volvox, Oedogonium, Coleochaete, Chara.* General Account of Bacillariophyta.

Unit 7: *Phaeophyta and Rhodophyta* **(8 lectures)**

Characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Ectocarpus*, *Fucus* and *Polysiphonia.*

1.2 PRACTICAL

Microbiology

1. Electron micrographs/Models of viruses – T-Phage and TMV/ Line drawings/ Photographs of Lytic and Lysogenic Cycle.
2. Types of Bacteria to be observed from temporary/permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation, root nodule.

3. Gram staining – Preparation of slides.
4. Isolation of soil microflora.
5. Endospore staining with malachite green using the endospores of bacteria.

Phycology

1. Study of vegetative and reproductive structures of *Nostoc, Volvox*, *Oedogonium, Chara, Vaucheria, Ectocarpus, Fucus* and *Polysiphonia, Procholoron* through electron micrographs, permanent slides.

Suggested Readings: -

1. Studies in Botany: Debabrata Mitra, Jibesh Ghua & Salil Chowdhury, Vol. I & II, Moulik Library.
2. Botany for Degree Students: A.C. Dutta (Revised by T.C. Dutta), 6th Edition, Oxford Publisher.
3. Life Sciences: Fundamentals and Practice, Pranab Kumar and Usha Mina, Vol. I & II, Pathfinder Publication.
4. Botany for Degree Students: Algae, B.R Vashishta, Dr. A. K Sinha and Dr. Adarsh Kumar, S Chand & Company; 2nd edition (1 December 2010).
5. Textbook of Algae, O.P. Sharma (Tata McGraw-Hill Education, 2011).
6. Mycology and Microbiology (A Textbook for UG and PG Courses) (K.V.B.R. Tilak, K.V. Mallaiah, C. Manoharachary, I.K. Kunwar; Scientific Publishers (India); Edition: 1, 2016.
7. Microbiology and Phycology; Amit Jain; Mahaveer Publications.
8. A Textbook of Microbiology; D K Maheshwari and R C Dubey; S Chand Publishing.

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SEMESTER-I

PAPER CODE: BOTA-HCC-1026
(Biomolecules and Cell Biology)

PAPER CREDIT:06 (4T+2P)

Total No. of Lectures: 60 + 30 (L+P) **Total marks=100 (T60 + IA20 + P20)**

Objective: To enrich knowledge on the different aspects of Molecules and Cell Biology

Learning Outcome: Students will learn about biomolecules, bioenergetics, enzymes, cell organelles and cell division.

CONTENTS

2.

2.1 THEORY

Unit 1: *Biomolecules* (20 lectures)

Types and significance of chemical bonds; Structure and properties of water; pH and buffers.

Carbohydrates: Nomenclature and classification; Monosaccharides; Disaccharides; Oligosaccharides and Polysaccharides.

Lipids: Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; Triacyl glycerols structure, functions and properties; Phosphoglycerides.

Proteins: Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quarternary; Protein denaturation and biological roles of proteins.

Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, C, D, Z types of DNA; Types of RNA.

Unit 2: *Bioenergenetics* (4 lectures)

Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as a energy currency molecule.

Unit 3: *Enzymes* (6 lectures)

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.

Unit 4: *The cell* (4 lectures)

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

Unit 5: *Cell wall and plasma membrane* (4 lectures)

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 6: *Cell organelles* (16 lectures)

Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.

Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament.

Chloroplast, Mitochondria and Peroxisomes: Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast.

Endomembrane system: Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing; Smooth ER and lipid synthesis, export of proteins and lipids; Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Lysosomes

Unit 7: *Cell division* (6 lectures)

Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle-checkpoints, Role of protein kinases.

2.2 PRACTICAL

1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
2. Study of plant cell structure with the help of epidermal peel mount of Onion/*Rhoeo/Crinum*.
3. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* and *Vallisnaria* leaf.
4. Counting the cells per unit volume with the help of haemocytometer. (Yeast/Pollen grains).
5. Cytochemical staining of DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique.
6. Study the phenomenon of plasmolysis and de-plasmolysis.
7. Study different stages of mitosis and meiosis (Demonstration).

Suggested Readings: -

1. A Textbook of Plant Physiology, Biochemistry and Biotechnology; S K Verma and Mohit Verma; S Chand Publication. (1995).
2. Plant Physiology and Biochemistry; H. S. Srivastava and N. Shankar; Rastogi Publications (2005).
3. Biochemistry and Physiology of Plant Hormones; Thomas C. Moore; Springer.
4. Plant Physiology and Biochemistry; B.V. Pandey and P. Verma; Ram Prasad Publication (2019).
5. A Quick Approach to Plant Physiology, Biochemistry and Biotechnology; B.Bose, R.K. Singhal and J. Chauhan; Jain Brothers.
6. Developments in Physiology, Biochemistry and Molecular Biology of Plants: Vol. 1; Bandana Bose and A. Hemantaranjan (Editor); New India Publishing Agency (2005).

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SEMESTER-II

PAPER CODE: BOTA-HCC-2016
(Mycology and Phytopathology)

PAPER CREDIT:06 (4T+2P)

Total No. of Lectures: 60 + 30 (L+P) **Total marks=100 (T60 + IA20 + P20)**

Objective: To enrich knowledge on the different aspects of Mycology and Phytopathology

Learning Outcome: Students will learn about 'true fungi' including Chytridiomycota and Zygomycota, Ascomycota, Basidiomycota, Allied fungi, Oomycota; symbiotic association, - lichen and mycorrhiza; applied mycology and details of some plant diseases along with etiology.

CONTENTS

3.

3.1 THEORY

Unit 1: Unit 1: Introduction to true fungi **(6 lectures)**

General characteristics; Affinities with plants and animals; Thallus organization; Cell wall composition; Nutrition; Classification.

Unit 2: Chytridiomycota and Zygomycota **(5 lecture)**

Characteristic features; Ecology and significance; Thallus organisation; Reproduction; Life cycle with reference to *Synchytrium, Mucor*.

Unit 4: Ascomycota **(10 lectures)**

General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Heterokaryosis and parasexuality; Life cycle and classification with reference to *Saccharomyces, Penicillium, Alternaria, Neurospora* and *Peziza.*

Unit 5: Basidiomycota **(8 lectures)**

General characteristics; Ecology; Life cycle and Classification with reference to Black stem rust on wheat, *Puccinia* (Physiological Specialization), loose and covered smut (symptoms only);

Agaricus: Bioluminescence; Fairy Rings and Mushroom Cultivation.

Unit 6: Allied Fungi (3 lectures)

General characteristics; Status of Slime molds; Classification; Occurrence; Types of plasmodia;

Types of fruiting bodies.

Unit 7: Oomycota (4 lectures)

General characteristics; Ecology; Life cycle and classification with reference to *Phytophthora,*

Albugo.

Unit 8: Symbiotic associations (4 lectures)

Lichen – Occurrence; General characteristics; Growth forms and range of thallus organization;

Nature of associations of algal and fungal partners; Reproduction; Economic and Ecological importance; Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance.

Unit 9: Applied Mycology (10 Lectures)

Role of fungi in food industry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Mycoproteins); Agriculture (Biofertilizers); Mycotoxins; Biological control (Mycofungicides,

Mycoherbicides, Mycoinsecticides, Myconematicides); Secondary metabolites

(Pharmaceutical preparations).

Unit 10: Phytopathology (10 lectures)

Terms and concepts; General symptoms; Geographical distribution of diseases; Etiology;

Symptomology; Host-Pathogen relationships; Disease cycle and Environmental relation;

Prevention and Control of plant diseases, and Role of quarantine.

Bacterial diseases – Citrus canker. Viral diseases – Tobacco Mosaic viruses, vein clearing. Fungal diseases – Early blight of potato, Black stem rust of wheat, White rust of crucifers.

3.2 PRACTICAL

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

2. *Mucor*: study of asexual stage and sexual structures.

3. *Penicillium*: study of asexual stage and sexual stage.

4. *Peziza*: Study of reproductive structure; sectioning through ascocarp.

5. *Alternaria:* Study of reproductive structure.

6. *Puccinia*: Herbarium specimens of Black Rust on wheat stem and in infected Barberry leaves; Sections through infected part/ mounts of spores.

7. *Agaricus*: Specimens of button stage and fullgrown mushroom; sectioning of gills of *Agaricus*.

8. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides. Mycorrhizae: ectomycorrhiza and endomycorrhiza.

11. Phytopathology: Herbarium specimens of bacterial diseases - Citrus Canker; Viral diseases - TMV, Vein clearing; Fungal diseases – Ring spot of cabbage, Black stem rust of wheat.

Suggested Readings: -

1. Plant Pathology; R.S. Mehrotra and Ashok Aggarwal (2017).
2. Introduction To Principles of Plant Pathology; R S Singh; Medtech (2017).
3. Plant Pathology at a Glance; R P Singh; Daya Publishing House.
4. Mycology and Microbiology (A Textbook for UG and PG Courses) (K.V.B.R. Tilak, K.V. Mallaiah, C. Manoharachary, I.K. Kunwar; Scientific Publishers (India); Edition: 1, 2016.
5. An Introduction to Fungi (4^{th} Edition): H C Dubey. Scientific Publishers, India
6. Botany for Degree Students: Fungi-B R Vashishta, A K Singha and Anil Kumar.S Chand Publication
7. Illustrated Glossary of Mycology: Vaidya Jitendra. Career Publications
8. Physiology of Fungi: K. S. Bilgrami and R. N. Verma. Scientific Publishers Journals Dept Publication

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SEMESTER-II

PAPER CODE: BOTA-HCC-2026
(Archegoniate)

PAPER CREDIT:06 (4T+2P)

Total No. of Lectures: 60 + 30 (L+P) **Total marks=100 (T60 + IA20 + P20)**

Objective: To enrich knowledge on the different aspects of Archegoniate

Learning Outcome: Students will learn about bryophytes, pteridophytes and gymnosperms in respect to morphology, classification, reproduction and economic importance.

CONTENTS

4.

4.1 THEORY

Unit 1: Introduction **(4 lectures)**

General account, classification, morphology, anatomy, reproduction, ecology and economic importance of archegoniates; Transition to land habit; Alternation of generations.

Unit 2: Bryophytes **(6 lectures)**

General characteristics; Adaptations to land habit; Classification; Range of thallus organization.

Unit 3: Type Studies- Bryophytes **(12 lectures)**

Morphology, anatomy and reproduction of *Riccia, Marchantia, Anthoceros, Sphagnum and Polytrichum*; Reproduction and evolutionary trends in *Riccia, Marchantia, Anthoceros, Sphagnum* and *Polytrichum* (developmental stages not included). Ecological and economic importance of bryophytes.

Unit 4: Pteridophytes **(6 lectures)**

General characteristics; Classification; Early land plants (*Cooksonia* and *Rhynia*).

Unit 5: Type Studies- Pteridophytes **(14 lectures)**

Morphology, anatomy and reproduction of *Psilotum*, *Selaginella*, *Equisetum* and *Pteris* (Developmental details not to be included). Apogamy, and Apospory,

Heterospory and seed habit, Telome theory, Stelar evolution; Ecological and Economic importance.

Unit 6: Gymnosperms **(18 lectures)**

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

4.2 PRACTICAL

1. *Marchantia*- Morphology of thallus, vertical section of thallus, vertical section of Antheridiophore and Archegoniophore.

3. *Anthoceros*- Morphology of thallus/sporophyte.

4. *Polytrichum*- Morphology of thallus and reproductive structures – antheridia, archegonia, capsule and protonema.

5. *Psilotum*- Morphology, transverse section of synangium.

6. *Selaginella*- Morphology, Strobilis, Microsporophyll and megasporophyll.

7. *Equisetum*- Morphology, Strobilus, Sporangiophore, Rhizome.

8. *Pteris*- Morphology, Sporophyll, Sporangium, Prothallus with sex organs and young sporophyte.

9. *Cycas*- Morphology (coralloid roots, bulbil, leaf), Anatomy of leaflet, microsporophyll and ovule.

10. *Pinus*- Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and female cones), Anatomy of needle, male cone and female cone.

11. *Gnetum*- Morphology (stem, male & female cones), Anatomy of stem and ovule.

Suggested Readings: -

1. A Text Book of Archegoniate (For CBCS 2nd Sem Honours), Akhil Baruah, Ashok Publications, Guwahati, Assam, India, 2021.

2. A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany; A. V. S. S. Sambamurty; 30 December 2013.

3. Pteridophyta, O.P.Sharma; McGraw Hill Education;1 July 2017.

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SEMESTER-III

PAPER CODE: BOTA-HCC-3016
(Anatomy of Angiosperms)

PAPER CREDIT:06 (4T+2P)

Total No. of Lectures: 60 + 30 (L+P) **Total marks=100 (T60 + IA20 + P20)**

Objective: To enrich knowledge on the different aspects of internal structures of flowering plants.

Learning Outcome: Students will learn about the structure and development of plant body of flowering plants; role of anatomy in evolution, and application of anatomy in classification of angiosperms.

CONTENTS

5.

5.1 THEORY

Unit 1: Introduction and scope of Plant Anatomy **(4 Lectures)**

Applications in systematics, forensics and pharmacognosy**.**

Unit 2: Structure and Development of Plant Body **(6 Lectures)**

Internal organization of plant body: The three tissue systems, types of cells and tissues.

Development of plant body: Polarity, Cytodifferentiation and organogenesis during embryogenic development.

Unit 2: Tissues **(12 Lectures)**

Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances. Hydathodes, cavities, lithocysts and laticifers.

Unit 3: Apical meristems **(15 Lectures)**

Evolution of concept of organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, continuing meristematic residue, cytohistological zonation); Types of vascular

bundles; Structure of dicot and monocot stem. Origin, development, arrangement and diversity in size and shape of leaves; Structure of dicot and monocot leaf, Kranz anatomy. Organization of root apex (Apical cell theory, Histogen theory, Korpe-Kappe theory); Quiescent centre; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin of lateral root.

Unit 4: Vascular Cambium and Wood (15 Lectures)

Structure, function and seasonal activity of cambium; Secondary growth in root and stem. Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology. Development and composition of periderm, rhytidome and lenticels.

Unit 5: Adaptive and Protective Systems (8 Lectures)

Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni and multicellular, glandular and non-glandular), Stomata (structure and types); Adcrustation and incrustation; Anatomical adaptations of xerophytes and hydrophytes.

5.2 PRACTICAL

1. Preparation of temporary slides/ permanent slides/ macerations and museum specimens.
2. Apical meristem of root and shoot; Vascular cambium through permanent slides/photographs.
3. Xylem: Tracheary elements-tracheids, vessels; thickenings; perforation plates; xylem fibres.
5. Wood: Ring porous, diffuse porous; Tyloses; Heartwood and sapwood.
6. Phloem: Sieve tubes-sieve plates; Companion cells; Phloem fibres.
7. Epidermal system: Cell types, Stomata types; Trichomes - non-glandular and glandular.
8. Secondary growth of monocot and dicot roots.
9. Primary, secondary and anomalous growth of monocot and dicot stem.
10. Leaf: isobilateral, dorsiventral, C_4 leaves.
11. Adaptive Anatomy: xerophytes and hydrophytes.
12. Secretory tissues: cavities, lithocysts and laticifers.

Suggested Readings:

1. Plant Anatomy and Embryology (2020) Ranjit Nath Bhattacharya. Kalyani Publishers, India

2. Plant Anatomy and Embryology. S. N. Pandey and A. Chadha. Vikas Publishing House.

3. Anatomy and Embryology of Angiosperms. V Singh, P. C. Pande and D. K. Jain. Rastogi Publications.

4. A text book of Botany; Angiosperms. B. D. Pandey. S. Chand Publication.

5. Integrative Plant Anatomy. W. C. Dickison (2000). Harcourt Academic Press, USA.

6. Plant Anatomy. A. Fahn (1974). Pergmon Press. USA.

7. Plant Anatomy. J. D. Mauseth. The Benjammin Cummings Publishers, USA.

8. Esau's Plant Anatomy: Meristems, cells and tissues of the Plant Body: Their structure, function and development. John Wiley & Sons, Inc.

9. A Text Book of Plant Anatomy and Embryology (2021). Akhil Baruah. Ashok Book Stall, Panbazar, Guwahati, Assam.

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SEMESTER-III

PAPER CODE: BOTA-HCC-3026
(Economic Botany)

PAPER CREDIT:06 (4T+2P)

Total No. of Lectures: 60 + 30 (L+P) **Total marks=100 (T60 + IA20 + P20)**

Objective: To enrich knowledge on the different aspects of economic botany.

Learning Outcome: Students will know about the origin of cultivated plants, plant introduction and crop domestication, plant groups on the basis of utilization by human, some important industrially important plants & products and their cultivation and processes.

CONTENTS

6.

6.1 THEORY

Unit 1: Origin of Cultivated Plants (6 lectures)

Concept of Centres of origin, their importance with reference to Vavilov's work. Plant introduction; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.

Unit 2: Cereals (6 lectures)

Origin, morphology, processing & uses of Rice and Wheat; Brief account of millets.

Unit 3: Legumes (6 lectures)

Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes. Importance to man and ecosystem.

Unit 4: Sources of sugars and starches (4 lectures)

Morphology and processing of sugarcane, products and by-products of sugarcane industry.

Potato – morphology, propagation & uses.

Unit 5: Spices (6 lectures)

Listing of important spices, their family and part(s) used. Economic importance with special reference to fennel, saffron, clove and black pepper.

Unit 6: Beverages **(4 lectures)**

Morphology, processing & uses of Tea and Coffee.

Unit 7: Sources of oils and fats **(10 lectures)**

General description, classification, extraction, their uses and health implications. Botanical name, family & uses of groundnut, coconut, linseed, soybean and mustard. Essential Oils:

General account, extraction methods, comparison with fatty oils & their uses.

Unit 8: Natural Rubber **(3 lectures)**

Para-rubber: tapping, processing and uses.

Unit 9: Drug-yielding plants **(8 lectures)**

Therapeutic and habit-forming drugs with special reference to C*inchona, Digitalis, Papaver* and

Cannabis; Tobacco (Morphology, processing, uses and health hazards).

Unit 10: Timber plants **(3 Lectures)**

General account with special reference to teak and sal.

Unit 11: Fibers **(4 lectures)**

Classification based on the origin of fibers; Morphology, extraction and uses of Cotton, Coir and Jute.

6.2 PRACTICAL

1. Cereals: Wheat and Rice (habit sketch, grain, starch grains, micro-chemical tests).

2. Legumes: Chick pea, Pigeon pea, and Soybean (habit, fruit, seed structure, micro-chemical tests).

3. Sources of sugars and starches: Sugarcane and potato (habit sketch; cane juice-micro-chemical tests, starch grains in tuber.

4. Spices: Black pepper, Fennel and Clove (habit Sketch).

5. Beverages: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).

6. Sources of oils and fats: Coconut, Groundnut and Mustard: plant specimen, seeds/fruit, tests for fats.

7. Rubber: Specimen – plant & natural rubber, samples of rubber products.

8. Fiber-yielding plants: Cotton (structure of seed – lint & fuzz and test for cellulose), Jute (structure of fibre and test for lignin).

Suggested Readings:

1. A Text Book of Plant Resource Utilization (2016). Akhil Baruah Assam Book Dipot, India

2. A Hand Book of Plant Resource Utilization and Conservation (2015). Bijan Bihari Dutta. Authorspress, India.

3. Economic Botany – A Profile, Akhil Baruah, Eastern Book House, Guwahati, Assam, India, 2012.

4. Economic Botany. B. P. Pandey. S. Chand & Co Ltd.

5. Economic Botany. Bhabananda Baruah. Kalyani Publishers. India.

6. A Text Book of Economic Botany. A Narsimha Reddy, K. Shailaja and A. Rajani.

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SEMESTER-III

PAPER CODE: BOTA-HCC-3036

(Genetics)

PAPER CREDIT:06 (4T+2P)

Total No. of Lectures: 60 + 30 (L+P) **Total marks=100 (T60 + IA20 + P20)**

Objective: To enrich knowledge on the different aspects of genetics.

Learning Outcome: Students will learn about the concept of Mendelian genetics, inheritance, linkage, crossing over, chromosome mapping, mutation, genetics in evolution and application of genetics in plant breeding.

CONTENTS

7.

7.1 THEORY

Unit 1: Mendelian genetics and its extension (14 lectures)

Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Pleiotropy, Penetrance and Expressivity, Devitions of Mendelism: Incomplete dominance and Codominance; Lethal alleles, Epistasis (Dominant and recessive), Complementary and Inhibitory factors; Numericals; Multiple alleles, Polygenic inheritance.

Unit 2: Extrachromosomal Inheritance (6 lectures)

Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast; Maternal inheritance and Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in Paramecium.

Unit 3: Linkage, crossing over and chromosome mapping (12 lectures)

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 4: Variation in chromosome number and structure (8 lectures)

Euploidy (Polyploidy: autoploidy and alloploidy) and Aneuploidy Deletion, Duplication, Inversion, Translocation, Position effect,

Unit 5: Gene mutations (8 lectures)

Types of mutations; Molecular basis of Mutations: Frame shift and Substitution mutation (Transition and Transversion), Mutagens – physical and chemical (Base analogs, deaminating, alkylating and

intercalating agents); Detection of mutations: ClB method. Role of Transposons in mutation. DNA damage and repair mechanisms.

Unit 6: Fine structure of gene (4 lectures)

Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism; Structure of Phage T4, rII Locus.

Unit 7: Population and Evolutionary Genetics (4 lectures)

Gene pool, Gene frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.

Unit:8 Plant Breeding (4 lectures)

Principles and methods of plant breeding: Introduction, Selection, Hybridization and Back cross method; Mutation breeding; Heterosis and inbreeding depression and Male sterility

7.2 PRACTICAL

1. Meiosis through temporary squash preparation.
2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
3. Chromosome mapping using point test cross data.
4. Pedigree analysis for dominant and recessive autosomal and sex-linked traits.
5. Incomplete dominance and gene interaction - seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4)
6. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes (Photographs).
7. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.
8. Study of human genetic traits (photograph): Sickle cell anemia, Xeroderma Pigmentosum, Albinism, Red-green Colour blindness, Widow's peak, Rolling of tongue, Hitchhiker's thumb and Attached ear lobe.
9. Hybridization techniques: Selection and preparation of parents, floral biology study, emasculation, bagging, tagging and pollination.
10. Study of pollen morphology, measurement and viability.

Suggested Readings:

1. Fundamentals of Genetics (2017). B.D. Singh and Payal Bansal; Kalyani Publishers.
2. Principles of Genetics; Gardner E.J., M. J. Simmons and D. P. Snustad (1991); John Wiley & Sons India; 8th Edition (2015).
3. Cell Biology, Genetics, Molecular Biology; Verma P.S.; S Chand & Co Ltd.
4. Cytology, Genetics, Evolution and Plant Breeding; P.K Gupta (1996). Rastogi Publications.
5. Genetics and Biostatistics (2011). R. P. Meyyan. Saras Publication, Kanyakumari, India.

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SEMESTER-IV

PAPER CODE: BOTA-HCC-4016
(Molecular Biology)

PAPER CREDIT:06 (4T+2P)

Total No. of Lectures: 60 + 30 (L+P) **Total marks=100 (T60 + IA20 + P20)**

Objective:
This paper aims to study the different aspects of Molecular Biology and its related knowledge.

Learning outcome:
After successful completion of the course, students will learn about detail knowledge on architecture of nucleic acids, organization of DNA in organisms, models of replication, factors, transcriptional and post transcriptional events in a cell, translation of proteins. Students also acquire knowledge of isolation and quantification of DNA from plant, and about the RNA polymerase and RNA modification machinery.

CONTENTS

8.
8.1 THEORY

UNIT 1: Nucleic acids: Carriers of genetic information (4 lectures)

Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment.

UNIT 2: The Structures of DNA and RNA / Genetic Material (10 lectures)

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves; Organization of DNA- Prokaryotes, Viruses, Eukaryotes. RNA Structure Organelle DNA -- mitochondria and chloroplast DNA. The Nucleosome Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.

UNIT 3: The replication of DNA (10 lectures)

Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semi-conservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA, replication of the 5'end of linear chromosome; Enzymes involved in DNA replication.

UNIT 4: Central dogma and genetic code (2 lectures)

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

UNIT 5: Transcription (18 lectures)

Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E. coli.* Eukaryotes: transcription factors, heat shock proteins, steroids and peptide hormones; Gene silencing.

UNIT 6: Processing and modification of RNA (8 lectures)

Split genes-concept of introns and exons, removal of introns, gene splicing, alternative splicing eukaryotic mRNA processing (5′ cap, 3′ polyA tail); Ribozymes; RNA editing and mRNA transport

UNIT 7: Translation (8 lectures)

Ribosome structure and assembly, mRNA; 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.

8.2 PRACTICAL

1. DNA isolation from any plant material (Demonstration)
2. DNA estimation by diphenylamine reagent/UV Spectrophotometry (Demonstration)
3. Study of DNA replication mechanisms through photographs/picture (Rolling circle, Theta replication and semi-discontinuous replication).
4. Study of structures of rRNA, mRNA and tRNA through photographs.
5. Study of the following through photographs: DNA and RNA polymerase, Spliceosome machinery; Splicing mechanism, Ribozyme and Alternative splicing.

Suggested Readings:-

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. Russell, P. J. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
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.

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PAPER CODE: BOTA-HCC-4026

(Plant Ecology and Phytogeography)

PAPER CREDIT:06 (4T+2P)

Total No. of Lectures: 60 + 30 (L+P) **Total marks=100 (T60 + IA20 + P20)**

Objectives: This paper aims to build up a clear knowledge on various aspects of plant ecology, the interaction among biotic and abiotic components of the system and phytogeography.

Learning outcome:

1. Knowledge on origin, formation and properties of abiotic components of the ecosystem, interactions and adaptation of plants with biotic and abiotic factors.
2. Knowledge on properties of communities in a population and trophical and habitat organization in an ecosystem.
3. Practical knowledge on property analysis of abiotic components of the ecosystem.
4. Practical knowledge on vegetation study and different ecological sites.

CONTENTS

9.

9.1 THEORY

UNIT 1: Introduction **(4 lectures)**

Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis.

UNIT 2: Soil (8 lectures)

Importance, Origin, Formation, Composition – Physical, Chemical and Biological components; Soil profile; Role of climate in soil development.

UNIT 3: Water (4 lectures)

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

UNIT 4: Light, temperature, wind and fire **(6 lectures)**

Variations; adaptations of plants to their variation.

UNIT 5: Biotic interactions **(2 lectures)**

Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; ecological pyramids; biomass, standing crop.

UNIT 6: Population ecology and plant communities (12 lectures)

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

UNIT 7: Ecosystems and Functional aspects (12 lectures)

Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids; Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.

UNIT 8: Phytogeography (12 lectures)

Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Local Vegetation.

9.2 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 of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)
3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
4. Determination of organic matter of different soil samples by Walkley & Black rapid titration method.
5. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.
6. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
7. (a). Study of morphological adaptations of hydrophytes and xerophytes (four each).
   (b). Study of biotic interactions of the following: Stem parasite (Cuscuta), Root parasite (Orobanche) Epiphytes, Predation (Insectivorous plants).
8. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
9. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
10. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.
11. Field visit to familiarise students with ecology of different sites.

Suggested Readings:-

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. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
5. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

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PAPER CODE: BOTA-HCC-4036

(Plant Systematics)

PAPER CREDIT:06 (4T+2P)

Total No. of Lectures: 60 + 30 (L+P) **Total marks=100 (T60 + IA20 + P20)**

Objectives: This paper aims to build up a clear knowledge on various aspects of plant systematics and its application to explore the plant world.

Learning outcome:

1. Knowledge of plant identification, nomenclature and classification systems.
2. Knowledge on phylogenetic and evolutionary relationships of angiosperms.
3. Practical knowledge on foliar morphology and taxonomical study of angiosperms.

CONTENTS

10.

10.1 THEORY

UNIT 1: Significance of Plant systematics (12 lectures)

Introduction to systematics; Plant identification, Classification, Nomenclature. Evidences from palynology, cytology, phytochemistry and molecular data. 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 2: Taxonomic hierarchy (6 lectures)

Concept of taxa (family, genus, species); Categories-major and minor; taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary).

UNIT 3: Botanical nomenclature (10 lectures)

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 4: Systems of classification (12 lectures)

History of plant classification systems; Classification systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series); Brief reference of Angiosperm Phylogeny Group (APG III) classification.

UNIT 5: Biometrics, numerical taxonomy and cladistics (10 lectures)

Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences).

UNIT 6: Phylogeny of Angiosperms (12 lectures)

Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).

10.2 PRACTICAL

1. 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):

Ranunculaceae	-	*Ranunculus, Delphinium*
Brassicaceae	-	*Brassica, Nustersium*
Myrtaceae	-	*Psidium, Syzygium*
Umbelliferae	-	*Coriandrum Foeniculum*
Asteraceae	-	*Sonchus/Launaea, Vernonia/Ageratum, Eclipta*
Solanaceae	-	*Solanum nigrum/Solanum virginianum*
Lamiaceae	-	*Salvia/Ocimum*
Malvaceae	.	Sida sp.
Euphorbiaceae	-	*Euphorbia hirta/ E.milii, Jatropha*
Liliaceae	-	*Lilium/Allium*
Poaceae	-	*Triticum/Oryza/Avena/Poa*
Verbenaceae	:	*Lantena / Lippia /Duranta*
Musaceae	:	*Musa* sp.
Orchidaceae		: *Dendrobium, Aerides, Rynchosylis ratusa*

2. Field visit (local) – Subject to the convenience of the department.
3. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

Suggested Readings: -

1. Singh, (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-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.
4. Maheshwari, J.K. (1963). *Flora* of Delhi. CSIR, New Delhi.
5. Radford, A.E. (1986). Fundamentals of *Plant Systematics*. Harper and Row, New York.

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SEMESTER-V

PAPER CODE: BOTA-HCC-5016
(Reproductive Biology of Angiosperms)

PAPER CREDIT:06 (4T+2P)

Total No. of Lectures: 60 + 30 (L+P) **Total marks=100 (T60 + IA20 + P20)**

Objective:
This paper aims to study the different aspects of reproductive biology of flowering plants.

Learning outcome:
After successful completion of the course, students will have:

1. Knowledge on detailed morphological and anatomical study of reproductive structures of angiospermic plants.
2. Knowledge on embryology and embryological abnormalities in angiosperms.
3. Structural documentation of reproductive structures of angiosperms.
4. Practical knowledge on developmental biology of embryo and endosperm.

CONTENTS

11.
11.1 THEORY

UNIT 1: Introduction **(4 lectures)**

History and scope of reproductive biology of angiosperms.

UNIT 2: Reproductive development **(6 lectures)**

Induction of flowering; flower as a modified determinate shoot. Flower development: genetic and molecular aspects.

UNIT 3: Anther and pollen biology **(10 lectures)**

Anthar: Structure and functions, microsporogenesis, callose deposition and its significance. Microgametogenesis; 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 4: Ovule **(10 lectures)**

Structure; Types; Special structures–endothelium, obturator, aril, caruncle and hypostase; Female gametophyte– megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of *Polygonum* type); Organization and ultrastructure of mature embryo sac.

UNIT 5: Pollination and fertilization **(6 lectures)**

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

UNIT 6: Self incompatibility **(10 lectures)**

Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination; Intra-ovarian and *in vitro* pollination; Modification of stigma surface, parasexual hybridization; Cybrids, *in vitro* fertilization.

UNIT 7: Embryo, Endosperm and Seed **(10 lectures)**

Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in *Paeonia*. Seed structure, importance and dispersal mechanisms

UNIT 8: Polyembryony and apomixis **(6 lectures)**

Introduction; Classification; Causes and applications.

11.2 PRACTICAL

1. 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.

2. 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.

3. Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs).
4. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus.
5.
6. Intra-ovarian pollination; Test tube pollination through photographs.

7. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.

8. 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.

Suggested Readings:-

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

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.

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PAPER CODE: BOTA-HCC-5026
(Plant Physiology)

PAPER CREDIT:06 (4T+2P)

Total No. of Lectures: 60 + 30 (L+P) **Total marks=100 (T60 + IA20 + P20)**

Objective:
This paper aims to study the different aspects of plant physiology.

Learning outcome:
After successful completion of the course, students will have:

1. Knowledge on mechanisms of water, minerals and nutrient absorption of plants.
2. Knowledge on roles of plant hormones and mechanism of flowering in plants.
3. Practical knowledge on effects of growth regulators on plant parts.
4. Practical knowledge determination of osmotic and water potential.

CONTENTS

12.

12.1 THEORY

UNIT 1: Plant-water relations (10 lectures)

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, antitranspirants, mechanism of stomatal movement.

UNIT 2: Mineral nutrition (8 lectures)

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.

UNIT 3: Nutrient Uptake (8 lectures)

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, antiport.

UNIT 4: Translocation in the phloem (8 lectures)

Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship.

UNIT 5: Plant growth regulators (14 lectures)

Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid.

UNIT 6: Physiology of flowering (6 lectures)

Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy.

UNIT 7: Phytochrome, crytochromes and phototropins (6 lectures)

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

12.2 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 effect of different concentrations of IAA on *Avena* coleoptile elongation (IAA Bioassay).
8. To study the induction of amylase activity in germinating barley grains.

Demonstration experiments

1. To demonstrate suction due to transpiration.
2. Fruit ripening/Rooting from cuttings (Demonstration).
3. Bolting experiment/*Avena* coleptile bioassay (demonstration).

Suggested Readings:-

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.

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SEMESTER-VI

PAPER CODE: BOTA-HCC-6016

(Plant Metabolism)

PAPER CREDIT:06 (4T+2P)

Total No. of Lectures: 60 + 30 (L+P) **Total marks=100 (T60 + IA20 + P20)**

Objective:
This paper aims to study the different aspects of plant metabolism.

Learning outcome:
After successful completion of the course, students will have:

5. Detailed knowledge of metabolic events of photosynthesis and nutrient metabolism.
6. Knowledge of signaling molecules and pathways in the plant cell.
7. Practical knowledge on different types of chromatographic techniques.

CONTENTS

13.
13.1 THEORY

UNIT 1: Concept of metabolism (6 Lectures)

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

UNIT 2: Carbon assimilation (14 Lectures)

Historical background, photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO_2 reduction, photorespiration, C_4pathways; Crassulacean acid metabolism; Factors affecting CO_2 reduction.

UNIT 3: Carbohydrate metabolism (2 Lectures)

Synthesis and catabolism of sucrose and starch.

UNIT 4: Carbon oxidation (10 Lectures)

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, cyanide-resistant respiration, factors affecting respiration.

UNIT 5: ATP-synthesis (8 Lectures)

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

UNIT 6: Lipid metabolism (8 Lectures)

Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilization of lipids during seed germination, α oxidation.

UNIT 7: Nitrogen metabolism (8 Lectures)

Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.

UNIT 8: Mechanisms of signal transduction (4 Lectures)

Receptor-ligand interactions; Second messenger concept, Calcium calmodulin, MAP kinase cascade.

13.2 PRACTICAL

1. Chemical separation of photosynthetic pigments.
2. To study the effect of light intensity on the rate of photosynthesis.
3. Effect of carbon dioxide on the rate of photosynthesis.
4. To compare the rate of respiration in different parts of a plant.
5. To study the activity of lipases in germinating oilseeds and demonstrate mobilization of lipids during germination.

DEMONSTRATION

1. Demonstration of Hill's Reaction
2. Demonstration of fluorescence by isolated chlorophyll pigments.
3. Demonstration of absorption spectrum of photosynthetic pigments.

Suggested readings:-

1. Dey, P. M. and Harborne, J. B. (1997). Plant Biochemistry. Elsevier Publication.
2. Taiz, L., Zeiger, E., Moller, I. M. and Murphy, A (2015). Plant Physiology and Development (6^{th} edition). Sinauer Associates Inc. USA.
3. Verma, S. K. and Verma, M. (2008). A Textbook of Plant Physiology, Biochemistry & Biotechnology. S. Chand & Sons. New Delhi.
4. Bhatla, S. C. and Lal, M. A. (2018). Plant Physiology, Development and Metabolism. Springer Publication, N.Y.
5. Pandey, B. V. and Verma, P. (2017). Plant Physiology and Biochemistry (2^{nd} Edn.). Ram Prasad Publication, Agra, U. P.

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PAPER CODE: BOTA-HCC-6026

(Plant Biotechnology)

PAPER CREDIT:06 (4T+2P)

Total No. of Lectures: 60 + 30 (L+P) **Total marks=100 (T60 + IA20 + P20)**

Objective:
This paper aims to study the different aspects of plant biotechnology.

Learning outcome:
After successful completion of the course, students will have:

1. Detailed knowledge on applications of tissue culture techniques, construction of recombinant DNA and transformation into hosts, construction of DNA libraries.
2. Knowledge on development of transgenic plants for agricultural use
3. Preparation of media for tissue culture techniques.

CONTENTS

14.
14.1 THEORY

UNIT 1: Plant Tissue Culture **(16 lectures)**

Historical perspective; Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); 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 2: Recombinant DNA technology **(12 lectures)**
Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC).

UNIT 3: Gene Cloning **(10 lectures)**
Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR-mediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR

UNIT 4: Methods of gene transfer **(8 lectures)**
Agrobacterium-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP).

UNIT 5: Applications of Biotechnology (14 lectures)

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

14.2 PRACTICAL

1. (a) Preparation of 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, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.
3. Isolation of protoplasts.
4. Construction of restriction map of circular and linear DNA from the data provided.
5. Study of methods of gene transfer through photographs: *Agrobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
6. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.
7. Isolation of plasmid DNA.
8. Restriction digestion and gel electrophoresis of plasmid DNA.

Suggested Readings:-

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. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.

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Regular Core Course / Honours Generic Course

SEMESTER-I

PAPER CODE: BOTA-RCC/HGE-1016
(Biodiversity - Microbes, Algae, Fungi and Archegoniate)

PAPER CREDIT: 06 (4T+2P)

Total No. of Lectures: 60 + 30 (L+P) **Total marks = 100 (T60+IA20+P20)**

Objective: To enrich knowledge on the different aspects of biodiversity of microbes, algae, fungi and archegoniate.

Learning Outcome: Students will learn about microbes, algae, fungi, bryophytes, pteridophytes and gymnosperms.

CONTENTS

1.

1.1 THEORY

Unit 1: ***Microbes*** (10 Lectures)

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 2: ***Algae*** (12 Lectures)

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

Unit 3: ***Fungi*** (12 Lectures)

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*, *Agaricus* (Basidiomycota); ***Symbiotic Associations***- Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.

Unit 4: ***Introduction to Archegoniate*** (2 Lectures)

Unifying features of archegoniates, Transition to land habit, Alternation of generations.

Unit 5: ***Bryophytes*** (10 Lectures)

General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to 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 6: *Pteridophytes* (8 Lectures)

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

Unit 7: *Gymnosperms* (6 Lectures)

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

1.2 PRACTICAL

1. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
2. Types of Bacteria from temporary/permanent slides/photographs; Binary Fission; Conjugation; Structure of root nodule.
3. Gram staining.
4. Study of vegetative and reproductive structures of Nostoc, Chlamydomonas (electron micrographs), Oedogonium, Vaucheria, Fucus* and Polysiphonia through temporary preparations and permanent slides.
5. *Rhizopus and Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.
6. *Puccinia:* Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
7. *Agaricus:* Specimens of button stage and full grown mushroom; Sectioning of gills of Agaricus.
8. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
9. Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs)
10. *Marchantia*- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).
11. *Funaria*- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
12. *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).
13. *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 (permanent slide).
14. *Pteris*- morphology, t.s. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores (temporary slides), t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).
15. *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).

16. *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).

Suggested Readings: -

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SEMESTER-II

PAPER CODE: BOTA-RCC/HGE-2016

(Plant Ecology and Taxonomy)

PAPER CREDIT: 06 (4T+2P)

Total No. of Lectures: 60 + 30 (L+P) **Total marks = 100 (T60+IA20+P20)**

Objective: To enrich knowledge on the different aspects of plant ecology and taxonomy.

Learning Outcome: Students will learn about ecological factors, compositions, ecological processes on earth, importance and impact of ecology in plant growth & development and the distribution of plants on earth. They will identify the causes of environmental changes and effectively apply the basic knowledge of plant ecology. They also can address the various issues related to natural environment in a thoughtful manner.

The student will develop understanding about the classification of higher plants. Learners will be capable to identify plant and relationship among the groups of angiosperms.

2.

2.1 THEORY

Unit 1: ***Introduction to Plant Ecology*** (2 Lectures)

Definition, Concept, Scope, Relation with other disciplines and Importance.

Unit 2: ***Ecological factors*** (10 Lectures)

Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes.

Unit 3: ***Plant communities*** (6 Lectures)

Characters; Ecotone and edge effect; Succession; Processes and types.

Unit 4: ***Ecosystem*** (8 Lectures)

Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous.

Unit 5: ***Phytogeography*** (4 Lectures)

Principal biogeographical zones; Endemism

Unit 6: ***Introduction to Plant Taxonomy*** (2 Lectures)

Identification, Classification, Nomenclature.

Unit 7: ***Identification*** (4 Lectures)

Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora and Manual, Keys: single access and multi-access.

Unit 8: Taxonomic evidences from palynology, cytology, phytochemistry and molecular data. (6 Lectures)

Unit 9: ***Taxonomic hierarchy*** (2 Lectures)

Ranks, categories and taxonomic groups

Unit 10: ***Botanical nomenclature*** (6 Lectures)

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

Unit 11: ***Classification*** (6 Lectures)

Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series), Concept of APG system of classification with recent modifications.

Unit 12: ***Biometrics, numerical taxonomy and cladistics*** (4 Lectures)

Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).

2.2 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 from soil and water samples.
3. Study of morphological adaptations of hydrophytes and xerophytes (two each).
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): Euphorbiaceae, Asteraceae, Verbenaceae, Solanaceae, Lamiaceae, Malvaceae
7. Mounting of a properly dried and pressed specimen of any four wild plants with herbarium label.

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SEMESTER-III

PAPER CODE: BOTA-RCC/HGE-3016

(Plant Anatomy and Embryology)

PAPER CREDIT: 06 (4T+2P)

Total No. of Lectures: 60 + 30 (L+P) **Total marks = 100 (T60+IA20+P20)**

Objective: To enrich knowledge on the different aspects of internal structures and embryology of flowering plants.

Learning Outcome: Students will learn about the internal structures of plant body and processes & consequences of embryo development.

3.

3.1 THEORY

Unit 1: ***Meristematic and permanent tissues*** (8 Lectures)

Root and shoot apical meristems; Simple and complex tissues.

Unit 2: ***Organs*** (4 Lectures)

Structure of dicot and monocot root stem and leaf.

Unit 3: ***Secondary Growth*** (8 Lectures)

Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood).

Unit 4: ***Adaptive and protective systems*** (8 Lectures)

Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.

Unit 5: ***Structural organization of flower*** (8 Lectures)

Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac.

Unit 6: ***Pollination and fertilization*** (8 Lectures)

Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.

Unit 7: ***Embryo and endosperm*** (8 Lectures)

Endosperm types, structure and functions; Dicot and monocot embryo; Embryo- endosperm relationship.

Unit 8: ***Apomixis and polyembryony*** (8 Lectures)

Definition, types and practical applications.

3.2 PRACTICAL

1. Preparation of temporary slides and permanent slides

2. Study of meristematic and permanent tissues (parenchyma, collenchyma and sclerenchyma).

3. Anatomical study of Stem (monocot and dicot): Primary and secondary growth.

4. Anatomical study of Root (monocot and dicot): Primary and secondary growth.

5. Anatomical study of Leaf (monocot and dicot).

6. Adaptive anatomy: Xerophyte (*Nerium*/*Aloe vera* leaf); Hydrophyte (*Eichorrnia* petiole/*Hydrilla* stem)

7. Structure of anther (young and mature).

8. Study of different types of ovules.

9. Female gametophyte: Polygonum (monosporic) type of Embryo sac Development.

10. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle).

11. Dissection of embryo/endosperm from developing seeds.

12. Calculation of percentage of germinated pollen in a given medium.

Suggested Readings:

1. Plant Anatomy and Embryology (2020) Ranjit Nath Bhattacharya. Kalyani Publishers, India

2. Plant Anatomy and Embryology (2021). Namita Nath and Dharmeswar Barman, Ashok Book Stall, Panbazar, Guwahati, Assam. (Assamese Version)

3. A Text Book of Plant Anatomy and Embryology (2021). Akhil Baruah. Ashok Book Stall, Panbazar, Guwahati, Assam.

4. Anatomy and Embryology of Angiosperms. V Singh, P. C. Pande and D. K. Jain. Rastogi Publications.

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SEMESTER-IV

PAPER CODE: BOTA-RCC/HGE-4016

(Plant Physiology and Metabolism)

PAPER CREDIT: 06 (4T+2P)

Total No. of Lectures: 60 + 30 (L+P) **Total marks = 100 (T60+IA20+P20)**

Objectives:

The aim of this paper is to provide a picture of plant physiology and metabolism and different physiological and metabolic phenomena takes place within a plant body with practical and demonstration.

Learning Outcome:

After successful completion of the course, students will have a clear picture of plant water relations, mineral nutrition uptake in plants, translocation in phloem, photosynthesis, respiration, enzymes, nitrogen metabolism, plant growth regulators for growth and development of plants and flowering physiology.

CONTENTS

4
4.1 THEORY

UNIT 1: Plant-Water Relations (8 Lectures)

Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

UNIT 2: Mineral Nutrition (8 Lectures)

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.

UNIT 3: Translocation in Phloem (6 Lectures)

Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading

UNIT 4: Photosynthesis (12 Lectures)

Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation; Photorespiration.

UNIT 5: Respiration (6 Lectures)

Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate,Oxidative Pentose Phosphate Pathway.

UNIT 6: Enzymes **(4 Lectures)**

Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

UNIT 7: Nitrogen Metabolism **(4 Lectures)**

Biological nitrogen fixation; Nitrate and ammonia assimilation.

UNIT 8: Plant Growth Regulators **(6 Lectures)**

Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

UNIT 9: Plant Response to Light and Temperature **(6 Lectures)**

Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far-red light responses on photomorphogenesis; Vernalization.

4.2 PRACTICAL

1. Determination of osmotic potential of plant cell sap by plasmolyticmethod.
2. To study the effect of different environmental conditions (Temperature, wind and light) on transpiration by excised twig.
3. Calculation of stomatal index and stomatal frequency.
4. To study the effect of carbondioxide (CO_2) concentration on O_2 evolution in photosynthesis.

DEMONSTRATION

1. Bolting.
2. Effect of auxins on rooting.
3. Suction due to transpiration.
4. R.Q.

SUGGESTED READINGS

1. Hopkins, W.G.and Huner, A.(2008).Introduction to Plant Physiology .John Wiley and Sons. U.S.A. 4th edition.
2. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.
3. Buzarbarua, A. (2000). A Textbook of practical plant chemistry. S. Chand & Co. Ltd., College Road, Panbazar, Guwahati-1.
4. Jain, V. K. (2017). Fundamentals of Plant Physiology (Reprint). S. Chand Publication, New Delhi.
5. Srivastava, H. S. (2018). Plant Physiology and Biochemistry (7thEdn.). Rastogi Publication, Meerut, U.P.

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Discipline Specific Elective

SEMESTER - V

PAPER CODE: BOTA-HDS/RDS-5016

(Horticultural Practices and Post-Harvest Technology)

PAPER CREDIT:06 (4T+2P)

Total No. of Lectures: 60 + 30 (L+P) **Total marks=100 (T60 + IA20 + P20)**

Objective:
This paper aims to study the different aspects of horticultural practices and post-harvest technologies.

Learning outcome:
After successful completion of the course, students will have:

1. Basic understandings on horticultural science and its importance.
2. Classification of horticultural crops.
3. Knowledge on horticultural techniques, landscaping and gardening.
4. Practical knowledge post-harvest technology, disease management and germplasm management.

CONTENTS

1.

1.1 THEORY

UNIT 1: Introduction **(4 lectures)**

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

UNIT 2: Ornamental plants **(4 lectures)**

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)] Ornamental flowering trees (Indian laburnum, gulmohar, Jacaranda, Lagerstroemia, fishtail and areca palms, semul, coraltree).

UNIT 3: Fruit and vegetable crops **(4 lectures)**

Production, origin and distribution; Description of plants and their economic products; Management and marketing of vegetable and fruit crops; Identification of some fruits and vegetable varieties (citrus, banana, mango, chillies and cucurbits).

UNIT 4: Horticultural techniques (8 lectures)

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.

UNIT 5: Landscaping and garden design (6 lectures)

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

UNIT 6: Floriculture (6 lectures)

Cut flowers, bonsai, commerce (market demand, supply); Importance of flower shows and exhibitions.

UNIT 7: Post-harvest technology (10 lectures)

Importance of post harvest technology in horticultural crops; Evaluation of quality traits; Harvesting and handling of fruits, vegetables and cut flowers; Principles, methods of preservation and processing; Methods of minimizing loses during storage and transportation; Food irradiation - advantages and disadvantages; food safety.

UNIT 8: Disease control and management (8 lectures)

Field and post-harvest diseases; Identification of deficiency symptoms; remedial measures and nutritional management practices; Crop sanitation; IPM strategies (genetic, biological andchemical methods for pest control); Quarantine practices; Identification of common diseases andpests of ornamentals, fruits and vegetable crops.

UNIT 9: Horticultural crops - conservation and management **(10 lectures)**

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.

1.2 PRACTICAL

Suggested Readings: -

Singh, D. & Manivannan, S. (2009). Genetic Resources of Horticultural Crops. Ridhi International, Delhi, India.

1. Swaminathan, M.S. and Kochhar, S.L. (2007). Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India. Macmillan Publishers, India.
2. NIIR Board (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi.
3. Kader, A.A. (2002). Post-Harvest Technology of Horticultural Crops. UCANR Publications, USA.
4. Capon, B. (2010). Botany for Gardeners. 3rd Edition. Timber Press, Portland, Oregon.

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SEMESTER - V

PAPER CODE: BOTA-HDS-5026

(Biostatistics)

PAPER CREDIT: 06 (4T+2P)

Total No. of Lectures: 60 + 30 (L+P) **Total marks=100 (T60 + IA20 + P20)**

Objective:
This paper aims to study the different aspects of statistical analysis of biological data.

Learning outcome:
After successful completion of the course, students will have:

1. Basic understandings on statistical analysis of data sets.
2. Knowledge on different concepts of biostatistics and its application.

CONTENTS

2.

2.1 THEORY

UNIT 1: Biostatistics **(12 lectures)**

Definition - statistical methods - basic principles. Variables - measurements, functions, limitations and uses of statistics.

UNIT 2: Collection of data primary and secondary **(12 lectures)**

Types and methods of data collection procedures - merits and demerits. Classification - tabulation and presentation of data - sampling methods.

UNIT 3: Measures of central tendency **(14 lectures)**

Mean, median, mode, geometric mean - merits & demerits. Measures of dispersion - range, standard deviation, mean deviation, quartile deviation - merits and demerits; Co- efficient of variations.

UNIT 4: Correlation **(12 lectures)**

Types and methods of correlation, regression, simple regression equation, fitting prediction, similarities and dissimilarities of correlation and regression

UNIT 5: Statistical inference **(10 lectures)**

Hypothesis - simple hypothesis – student 't' test - chi square test.

2.2 PRACTICAL

1) Calculation of mean, standard deviation and standard error
2) Calculation of correlation coefficient values and finding out the probability 3) Calculation of 'F' value and finding out the probability value for the F value.

Suggested Readings:-

1. Biostatistic, Danniel, W.W., 1987.New York, John Wiley Sons.

2. An introduction to Biostatistics, 3rd edition, Sundarrao, P.S.S and Richards, J. Christian Medical College, Vellore

3. Statistical Analysis of epidemiological data, Selvin, S., 1991. New York University Press. 4. Statistics for Biology, Boston, Bishop, O.N. Houghton, Mifflin.

5. The Principles of scientific research, Freedman, P. New York, Pergamon Press.

6. Statistics for Biologists, Campbell, R.C., 1998.Cambridge University Press.

SEMESTER – VI

PAPER CODE: BOTA-HDS/RDS-6016
(Natural Resource Management)

PAPER CREDIT:06 (4T+2P)

Total No. of Lectures: 60 + 30 (L+P) **Total marks=100 (T60 + IA20 + P20)**

Objective:
This paper aims to study the different aspects of natural resource management.

Learning outcome:
After successful completion of the course, students will have:

1. Comprehensive knowledge on different types of natural resources and their ecological, economical and socio-cultural values.
2. Basic understanding of land, water and forest resources.
3. Overall knowledge on resource degradation, their judicious use and management for sustainability.
4. Knowledge on biodiversity-its importance, management and bioprospecting.
5. Knowledge on global arena of resource management, conservation and benefit sharing.

CONTENTS

3.
3.1 THEORY

UNIT 1: Natural resources **(2 lectures)**

Definition and types.

UNIT 2: Sustainable utilization **(8 lectures)**
Concept, approaches (economic, ecological and socio-cultural).

UNIT 3: Land **(8 lectures)**
Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management.

UNIT 4: Water **(8 lectures)**
Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.

UNIT 5: Biological Resources **(12 lectures)**
Biodiversity-definition and types; Significance; Threats; Management strategies; Bio-prospecting; IPR; CBD; National Biodiversity Action Plan).

UNIT 6: Forests **(6 lectures)**

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

UNIT 7: Energy **(6 lectures)**

Renewable and non-renewable sources of energy

UNIT 8: Contemporary practices in resource management **(8 lectures)**

EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management.

Unit 9: National and international efforts in resource management and conservation **(4 lectures)**

3.2 PRACTICAL

1. Estimation of solid waste generated by a domestic system (biodegradable and non- biodegradable) and its impact on land degradation.
2. Collection of data on forest covers of specific area.
3. Measurement of dominance of woody species by DBH (diameter at breast height) method.
4. Calculation and analysis of ecological footprint.
5. Ecological modeling.

Suggested Readings:-

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.

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SEMESTER – VI

PAPER CODE: BOTA-HDS-6026
(Dissertation)

PAPER CREDIT:06 (4T+2P)

Total No. of periods (equalized time): 90 **Total marks=100 (W80 + P20)**

Report Preparation

A report of dissertation work shall be prepared following heads given below (as applicable) –

Title

Abstract

Keywords

Introduction

Review of Literature

Materials & Methods / Methodology

Result / Experimental Findings

Discussion

or - Result and Discussion

Photo plates

Conclusion

Summary

Acknowledgement

References/ Bibliography

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Skill Enhancement Course

SEMESTER -V

PAPER CODE: BOTA-SEC-5014
(Nursery and Gardening)

PAPER CREDIT:06 (4T+2P)

Total No. of Lectures: 60 + 30 (L+P) **Total marks=100 (T60 + IA20 + P20)**

Objectives:

i) To get acquaint with nursery techniques.

ii) To know about seed as next generation propagules.

iii) To understand the techniques for vegetative propagation.

iv) to study the gardening operations.

Learning outcome:

i) Different nursery techniques are familiarized.

ii) Knowledge on seed types, seed production technology, certification, storage and marketing are gained by the learners.

iii) Various techniques of vegetative propagation are learned by the pupil.

iv) Learners are exposed to know about different types of gardening.

CONTENTS

1.

1.1 THEORY

UNIT 1: Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants. **(6 Lectures)**

UNIT 2: Seed: Structure and types - Seed dormancy; causes and methods of breaking dormancy. Seed storage: Seed banks, factors affecting seed viability, genetic erosion - Seed production technology - seed testing and certification. Sowing/raising of seeds and seedlings - Transplanting of seedlings -

Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots – Storage and marketing procedures. **(12 lectures)**

UNIT 3: Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants - green house - mist chamber shed root, shade house and glass house. **(10 Lectures)**

UNIT 4: Gardening: definition, objectives and scope - different types of gardening - landscape and home gardening - parks and its components - plant materials and design - computer applications in landscaping - Gardening operations, soil laying, manuring, watering, management of pests and diseases and harvesting. **(12 Lectures)**

PRACTICAL / PRESENTATION

1. Report on different types of gardens.

2. Methods of seed storage in your locality.

3. Study on cutting and layering techniques.

4. Field study/ visit to Nursery/Garden.

SUGGESTED READINGS:

1. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
2. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
3. Kumar, N., 1997, Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
4. Agrawal, P.K. 1993, Hand Book of Seed Technology, Dept. of Agriculture and Cooperation , National _Seed Corporation Ltd. , New Delhi.
5. Sujit Chakrabarty 2018. Organic Home Gardening Made Easy. Notion Press. ISBN 978-1643240855
6. Arun Kr. Singh and Abhinav Kumar 2020. Plant Propagation and Nursery Management. Bhavya Books (BET) New Delhi. ISBN 978-9383992539
7. Suzana Bashir and Shabana Gulzar 2020. Nursery and Gardening: Principle and Practices. Walnut Publication. ISBN 978-939026175-8

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SEMESTER -VI

PAPER CODE: BOTA-SEC-6014
(Plant Diversity and Human Welfare)

PAPER CREDIT:06 (4T+2P)

Total No. of Lectures: 60 + 30 (L+P) **Total marks=100 (T60 + IA20 + P20)**

Objectives:

i) To know the plants and their importance.

ii) To identify causes of loss of biodiversity and to gain concept of biodiversity management.

iii) To understand the different kinds of biodiversity conservation practices.

iv) To recognise significance of plants on human life through studying in different categories.

Learning outcome:

i) Learners are exposed to plant biodiversity and its uses including values since ages.

ii) Learners shall aware of causes of biodiversity loss and management practices. Different international and national agencies working on conservation issues are familiarized to the learners.

iii) Various conservation types and approaches are introduced to the learners.

iv) People will know the importance of plants in human life

CONTENTS

THEORY

UNIT 1: Plant diversity and its scope: Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Agro-biodiversity and cultivated plant taxa, wild taxa. Values and uses of Biodiversity: Ethical and aesthetic values, Precautionary principle, Methodologies for valuation, Uses of plants, Uses of microbes. **(10 lectures)**

UNIT 2: Loss of Biodiversity: Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agro-biodiversity, Projected scenario for biodiversity loss, Management of Plant Biodiversity: Organizations associated with biodiversity management, Methodology for execution: IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations, Biodiversity information management and communication. **(10 lectures)**

UNIT 3: Conservation of Biodiversity: Conservation of genetic diversity, species diversity and ecosystem diversity, *In situ* and *ex situ* conservation, Social approaches to conservation, Biodiversity awareness programmes, Sustainable development. **(10 lectures)**

UNIT 4: Role of plants in relation to Human Welfare: a) Importance of forestry their utilization and commercial aspects b) Avenue trees, c) Ornamental plants of India. d) Alcoholic beverages through ages. Fruits and nuts: Important fruit crops their commercial importance. Wood and its uses. **(10 lectures)**

PRACTICAL / PRESENTATION **(20 Lectures)**

1. Study of 10 plants with their values in human life.

2. Conservation approaches at personal level (Any one)

3. Visit/ Field study to a site of plant conservation (Garden/Nursery etc.)

SUGGESTED READINGS:

1. Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.

2. Akhil Baruah 2016. A text book of plant resource utilization. Assam Book Dipot

3. Bijan Bihari Dutta 2015. A Hand Book of Plant Resource Utilization and Conservation. Authorspress.

4. O. P. Sharma (2016). Plants and Human welfare. A Pragati Edition.

5. Farishta Yasmin and Saurav Kumar Baruah (2016). Green Urban Biodiversity. Nowgong College Publication, India.

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