



গৌড়বঙ্গ বিশ্ববিদ্যালয়

**UNIVERSITY OF GOUR BANGA**

(Established under West Bengal Act XXVI of 2007)  
Recognised by UGC u/s 2f & 12B  
N.H.-34 (Near Rabindra Bhawan), P.O.: Mokdumpur,  
Dist.: Malda, West Bengal, Pin-732 103

**UG SYLLABUS OF BOTANY  
(SEMESTER SYSTEM)[NEP-2020]**

**MAJOR / BOT-DC-MJ**

**DRAFT**

**w.e.f. Academic session 2023**

**REVISED & CODED 2024**

**SEMESTER: I - V**

## SEMESTER- I

### Major Course / BOT-DC-MJ-101 : Diversity of Cryptogams [4 credits]

#### **Topic content of THEORY part [03Credits] (Teaching hour = 45)**

- [1] **Algae:** General characteristic features, cell structures, range of thallus, ecological and economic importance.
- [2] **Fungi:** General characteristic features, cell structure, fruiting bodies, similarities with plants and animals, ecological and economic importance.
- [3] **Lichen:** General characteristic features, cell structure, fruiting bodies, ecological and economic importance.
- [4] **Bryophytes:** General characteristic features, adaptation to land habit, difference between liverworts and hornworts, ecological and economic importance.
- [5] **Pteridophytes:** General characteristic features, differences among fern and non-fern plants, ecological and economic importance.

#### **Topic content of PRACTICAL part [01Credit] (Teaching hour = 15)**

- [1] **Algae:** Identification of- *Nostoc* sp., *Oedogonium* sp., *Chara* sp., *Polysiphonia* sp.
- [2] **Fungi:** Identification of- *Penicillium* sp., *Rhizopus* sp., *Ascobolus* sp. *Agaricus* sp,
- [3] **Lichen:** Identification of types- Crustose, Foliose and Fruticose.
- [4] **Bryophytes:** Identification of- *Riccia* sp., *Marchantia* sp., *Funaria* sp..
- [5] **Pteridophytes:** Identification of- *Lycopodium* sp., *Selaginella* sp., *Marselia* sp.  
[Identification with emphasis on reproductive structure]

#### Suggested Readings

- Bold, H.C. & Wynne, M.J. ....Introduction to Algae: Structure & Reproduction [Prentice Hall]
- Ganguly, H.C. & Kar, A.K.....College Botany Vol.-II [New Central Book Agency]
- Hoek, C., Mann, D.G. & Jahns, H.M. 1995 .....Algae: an..... [Cambridge Univ. Press]
- Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
- Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
- Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
- Kershaw, K.A. (1985), Physiological ecology of lichens, Cambridge University Press, Cambridge.
- Smith, G.M. ....Cryptogamic Botany Vol. 1 [McGraw Hill]
- Puri, P. ....Bryophyte [Atmaram & Sons]
- Rashid, A. ....An Introduction to Bryophyta [Vikas Publishing House]
- Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.

## SEMESTER-II

### Major Course / BOT-DC-MJ-201 : Diversity of Phanerogams [4 credits]

#### **Topic content of THEORY part [03Credits] (Teaching hour = 45)**

- [1] **Gymnosperm:** General characteristic features, difference between cycads and conifers, distribution in India, ecological and economic importance. (wood character with special reference to timber)
- [2] **Angiosperm:** General characteristic features, difference between dicots and monocots, plant forms- herbs, shrubs, trees & climbers, ecological and economic importance ( with special reference to food crops ).
- [3] **Morphology of Angiosperm:** General structures, types and functions of- Leaf, Stem, Root, Flower and Fruits. Pollen grains with types (porate, colpate,colporate)
- [4] **Plant Nomenclature:** Brief idea of binomial nomenclature.
- [5] **Contribution of Eminent Botanists:** John Ray, Carl Linneaus, George Benthum & Joseph Dalton Hooker, Gregor Johann Mendel, Charles Darwin, James D. Watson & Francis Crick, N.I. Vavilov, Norman Borlaug, Jagadish Chandra Bose, Birbal Sahni, Panchanan Maheswari, M.S. Swaminathan, Arun Kumar Sharma.

#### **Topic content of PRACTICAL part [01Credit] (Teaching hour = 15)**

- [1] **Gymnosperm:** Identification of- male and female reproductive structures of *Cycas* sp. and *Pinus* sp., Wood characters-manoxyllic and pycnoxylic.
- [2] **Angiosperm:** To study phyllotaxy & variations in leaf venations in dicots and monocots (atleast two specimens each), Identification of inflorescence types –cymose and racemose; Identification of fruit types- drupe, pepo, berry, caryopsis and lomentum, Dissection of Flower-*Hibiscus* sp., *Catharanthus* sp., *Sida* sp., *Solanum* sp., *Leucas* sp., Identification of pollen grains (porate, colpate,colporate)

#### Suggested Readings

- Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
- Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
- Vasishta, P.C. ....Gymnosperms [S. Chand & Co.]
- Mukherjee, S. ....College Botany Vol. III [New Central Book Agency]
- Mitra, D., Guha, J. & Chowdhury, S.K...Studies in Botany, Vol. I [Moulik Library]
- Heywood, V.H. ....Flowering Plants of India [Oxford University Press]

## SEMESTER-III

### Major Course / BOT-DC-MJ-301 : Gymnosperm & Palaeobotany [ 04 Credit ]

**Topic content of THEORY part [03 Credits] (Teaching hour = 45)**

#### **Gymnosperm and Palaeobotany**

##### **Gymnosperms**

- [1] General characters and classification by Stewart and Rothwell, 1993 (up to order)
- [2] Ecological and economic importance of Gymnosperms.
- [3] Vegetative morphology, anatomy and reproductive structures, development of gametophytes and embryogeny of *Cycas* sp., *Pinus* sp. and *Gnetum* sp.
- [4] Fossil gymnosperms: Structural features, geographical and geological distribution of reconstructed genera: *Lyginopteris* sp., *Williamsonia* sp. and *Cordaites* sp.

##### **Paleobotany**

- [1] Fossil: types and modes of preservation (Schopf, 1975), conditions of preservations, fossilization process.
- [2] Geological time scale and major events of plant life through geological ages.
- [3] Gondwana – an overview of Indian Gondwana flora.
- [4] Importance of study of fossil.

#### **Topic content of PRACTICAL part [01 Credit]**

#### **Gymnosperm and Palaeobotany**

##### **Gymnosperms:**

1. Anatomical study of leaflet of *Cycas* sp. and *Pinus* sp. needle.
2. Morphological studies of reproductive structure of the genera mentioned in the theoretical syllabus. *Cycas* sp. (Megasporophyll and Microsporophyll) *Pinus* sp.- (male and female cones), *Gnetum* sp. (male and female cones)

##### **Paleobotany:**

1. Morphological study: *Glossopteris* sp. leaf fossils, *Ptilophyllum* sp.
2. Study from permanent slides / micrograph: T.S. of stem of *Lepidodendron* sp., *Calamites* sp., *Lyginopteris* sp.

### Suggested Readings

- Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
- Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
- Vasishta, P.C. ....Gymnosperms [S. Chand & Co.]
- Bhatnagar, S.P. & Moitra, A. ....Gymnosperms [New Age International]
- Arnold, C.R. ....An Introduction to Paleobotany [Agrobios India]
- Andrews, Jr. H.N. ....Studies in Paleobotany [John Wiley & Sons Inc.]
- Agashe, S.N. ....Palaeobotany [Oxford & IBH]
- Taylor, T.N. ....Paleobotany-An introduction to fossil plant biology [McGraw Hill]
- Meyen, S.V. ....Fundamentals of Paleobotany [Chapman & Hall]

### Major Course / BOT-DC-MJ-302 : Plant Anatomy and Plant Ecology [ 04 Credit ]

**Topic content of THEORY part [03 Credits] (Teaching hour = 45)**

#### **Plant Anatomy and Plant Ecology**

##### **Plant Anatomy**

**[1] Introduction and scope of Plant Anatomy:** Applications in systematics, forensics and pharmacognosy.

**[2] Structure and Tissues system:** 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.

**[3] Apical meristems:** Meristematic and permanent tissues: Organization of shoot apex (Tunica-carpus concept) and organization of root apex (Körper-Kappe concepts); Structure of dicot and monocot leaf, Kranz anatomy. Structure of Xylem and Phloem tissue; Types and evolution of stele; Vascular bundle -types and function. Root-Stem transition and its significance;

**[4] Vascular Cambium and Wood:** Basic concepts 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; Normal and Anomalous secondary growth (citing examples of *Dracaena* sp. stem, *Bignonia* sp. stem, *Tinospora* sp. root, Orchid root), different types of wood. Concept and application of Dendrochronology.

**[5] Adaptive and Protective Systems:** Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni- and multicellular, glandular and nonglandular, two examples of each), stomata (classification); Development and composition of periderm, rhytidome and lenticels. Adcrustation and incrustation; Anatomical adaptations of xerophytes and hydrophytes.

## Plant Ecology

[1] **Introduction:** Basic concepts; Levels of organization. Inter-relationships between the living world and the environment.

[2] **Soil and Water:** Importance; Origin, Formation; Composition; Physical; Chemical and Biological components; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil (concept only); Water table.

[3] **Light, temperature, wind and fire:** Variations; adaptations of plants to their variation.

[4] **Biotic interactions:** Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; biomass, standing crop.

[5] **Population ecology:** Characteristics and Dynamics, Ecological Speciation

[6] **Plant communities:** Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts.

[7] **Ecosystems:** Structure; Processes; Food chains and Food webs; Ecological pyramids.

[8] **Functional aspects of ecosystem:** Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.

## Topic content of PRACTICAL part [01 Credit]

### Plant Anatomy and Plant Ecology

#### Plant Anatomy

1. Study of anatomical details through permanent slides/temporary stain mounts/museum specimens/micrographs with the help of suitable examples: Apical meristem of root, shoot and vascular cambium. Xylem: Tracheary elements-tracheids, vessel elements; perforation plates; xylem fibres; Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
2. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
3. Root: monocot, dicot, secondary growth.
4. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.
5. Anomalous growth (*Dracaena* sp. stem, *Bignonia* sp. stem, *Tinospora* sp. root, Orchid root).
6. Secretory tissues: cavities, lithocysts and laticifers.

#### Plant Ecology

1. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)
2. Study of morpho-anatomical adaptations of hydrophytes and xerophytes.
  - a. Hydrophyte: *Eichhornia* sp., *Nymphaea* sp., *Hydrilla* sp..
  - b. Xerophyte: *Nerium* sp., *Casuarina* sp., *Opuntia* sp., *Euphorbia tirucauli*.
3. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
4. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
5. Botanical excursion: Field visit to familiarize students with ecology of different sites.

### Suggested Readings

- Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
  - Fahh, A. (1974). Plant Anatomy. Pergmon Press, USA.
  - Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.
  - Evert, R.F. (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc.
  - Odum, E.P. ....Fundamentals of Ecology [Saunders]
  - Ambasht, R.S and Ambasht, N.K .....A Text book of plant Ecology [CBS Publ.]
  - Sukla, R.S. & Chandal, P.S. ....Plant Ecology [S. Chand & Co.]
  - Verma, P.S. & Agarwal, V.K. ....Concept of Ecology [S. Chand & Co.]
  - Kumar, H.D. ....Modern Concept of Ecology [Vikas Pub House]
  - Dhaliwal, G.S., Sangha, G.S. and Ralhan, P.K. ....Fundamentals of Environmental Sciences [Kalyani Pub.]
  - Asthana, D.K. and Asthana M. ....Environmental Problems and Solutions[S. Chand & Co.]
  - Cox, C.B.& Moore, P.D. ....Biogeography –An Ecological and Evolutionary Approach [Blackwell Scientific Publ.]
  - Mani, M.S. ....Biogeography of India [Springer-Verlag]
  - Mitra, D., Guha, J. & Chowdhury, S.K.....Studies in Botany Vol. II[Moulik Library]
  - Sharma, P.D. ....Elements of Ecology [Rastogi Publ.]
- 
- Odum, E.P. ....Fundamentals of Ecology [Saunders]
  - Ambasht, R.S and Ambasht, N.K .....A Text book of plant Ecology [CBS Publ.]
  - Kumar, H.D. ....Modern Concept of Ecology [Vikas Pub House]
  - Mukherjee, S. ....College Botany Vol. III [New Central Book Agency]
  - Mitra, D., Guha, J. & Chowdhury, S.K...Studies in Botany, Vol. I [Moulik Library]
  - Heywood, V.H. ....Flowering Plants of India [Oxford University Press]
  - Stace, C.A. ....Plant Taxonomy and Biosystematics [Arnold Publishers]
  - Prain, D. ....Bengal Plants Vol. I & II [Bishen Singh, Mahendra Pal Singh]
  - Sivarajan, V.V. ....Introduction to Principles of Plant Taxonomy [Oxford & IBH]

## SEMESTER-IV

### Major Course / BOT-DC-MJ-401 : Plant Physiology [ 04 Credit ]

**Topic content of THEORY part [03 Credits] (Teaching hour = 45)**

#### **Plant Physiology**

[1] **Plant-water relations:** 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; Cavitation and embolism.

[2] **Mineral nutrition:** Essential and beneficial elements, macro and micronutrients.

[3] **Nutrient Uptake:** Transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption. proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.

[4] **Carbon assimilation:** photosynthetic pigments and their role (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, CO<sub>2</sub> reduction, photorespiration, C<sub>4</sub> pathways; CAM and its ecological significance. Factors affecting CO<sub>2</sub> reduction.

[5] **Carbon Oxidation:** Glycolysis and its significance, fate of pyruvate, oxidative pentose phosphate pathway, TCA cycle, mitochondrial electron transport, oxidative phosphorylation, factors affecting respiration.

[6] **Translocation in the phloem:** Phloem loading and unloading; Source–sink relationship.

[7] **Transpiration: Stomata** – Transpiration, factors affecting transpiration, antitranspirants, mechanism of stomatal movement. Role and significance of CO<sub>2</sub>, K<sup>+</sup> - ion, blue light & abscisic acid in stomatal movement; Anti-transpirant.

[8] **Plant growth regulators:** Introduction to Plant growth hormones/regulators. Types of plant growth regulators (natural and synthetic). Physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid. Commercial Plant Growth Hormones examples and uses.

[9] **Physiology of flowering:** Photoperiodism, flowering stimulus, florigen concept, vernalization.

[10] **Phytochrome, cryptochromes and phototropins:** Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR)

[11] **Seed Dormancy:** Types, causes and methods of breaking seed dormancy.



## Topic content of PRACTICAL part [01 Credit]

### Plant Physiology

#### MC-7-P (01): Plant Physiology (Practical, Credit 01) Full Marks 15

1. Determination of stomatal frequency and rate of transpiration per stomata per hour.
2. Comparison of imbibition of water by starchy, proteinaceous and fatty seeds.
3. Rate of photosynthesis under varying HCO<sub>3</sub><sup>-</sup> concentration (using bicarbonate) in aquatic plants.
4. Measurement of oxygen uptake by respiring tissue (per gram / hr.) by germinating seeds.
5. Determination of water potential/Osmotic pressure of given tissue (potato tuber) by weight method.

#### Suggested Readings

- Jain, V.K. ....Fundamentals of Plant Physiology [S. Chand & Co.]
- Lehninger, A.L., Nelson, D.L. & Cox, M.M. ....Principles of Biochemistry [CBS]
- Mukherji, S. & Ghosh, A. ....Plant physiology [New central Book Agency]
- Pandey, S.N & Sinha, B.K. ....Plant Physiology [Vikas Publ. House]
- Salisbury, F.B. & Ross, C.W. ....Plant Physiology [Wordsworth Publ. Co.]
- Sinha, R.K. ....Modern Plant Physiology [Narosa Publishing House]
- Taiz, L & Zeiger, E. ....Plant Physiology [Sinauser Associates Inc. Publishers]
- Verma, S.K ....A Text book of Plant Physiology & Biochemistry [S. Chand & Co.]

## Major Course / BOT-DC-MJ-402 : Microbes & Algae [4 credits]

### Topic content of THEORY part [03Credits] (Teaching hour = 45)

#### Microbes & Algae

##### Microbes

[1] Introduction to microbial world: Discovery, general characteristics; Types-archaeobacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts); Cell structure: Flagella (ultrastructure) & Pili; Cell wall – chemical structure and differences between Gram +ve & Gram – ve bacteria; Bacterial genome and plasmid; Endospore - formation, structure and function.

[2] Bacterial reproduction: Vegetative and asexual; Genetic Recombination (a) Transformation – with special emphasis on Natural and Induced competence and DNA uptake, (b) Conjugation – F- factor, F<sup>+</sup> x F<sup>-</sup>, Hfr x F<sup>-</sup>, concept of F', (c) Transduction–Generalised and specialized.

[3] Viruses: Discovery, physiochemical and biological characteristics; classification (Baltimore), general, structure with special reference to viroids and prions; replication (general account).

[5] 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

## Algae

[1] General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food, flagella; methods of reproduction and uses. (Cyanophyta, Chlorophyta, Charophyta, Bacillariophyta, Phaeophyta & Rhodophyta)

[2] Classification; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups)

[3] Cyanophyta: cell structure and function with special reference to heterocyst & akinete. Life history of – *Anabaena* sp.

[4] Chlorophyta: cell structure and function with special reference to chloroplast types. Life history of – *Oedogonium* sp.

[5] Charophyta: cell structure and function with special reference to corticated cells, globule and nucleole of *Chara* sp. Life history of *Chara* sp.

[6] Bacillariophyta (diatoms): cell structure and function, cell division, auxospore formation & classification with respect to cellular symmetry (pinnate & centric diatoms).

[7] Phaeophyta: cell structure and function. Life history of *Ectocarpus* sp.

[8] Rhodophyta: cell structure and function with reference to cell to cell connection and phycocolloids. Life history of – *Polysiphonia* sp.

## Topic content of THEORY part [01Credit] (Teaching hour = 15)

### Microbes & Algae

#### Microbes

[1] Preparation of heat fixed and single-stained bacterial smear of bacteria from curd.

[2] Gram staining technique of bacteria using bacterial inoculum (mixed or pure culture).

**NOTE:** Students will perform Gram staining procedure (differential staining) upto the Safranin step and comment on their observation based on supplied bacterial sample only.

Reference strain concept may be demonstrated but not mandatory for examination purpose.

#### Algae

[1] Preparation of semi-permanent slide using lactophenol as mounting medium and cotton blue as stain of – *Anabaena* sp., *Oedogonium* sp., *Chara* sp., *Ectocarpus* sp. & *Polysiphonia* sp. and camera lucida drawing of selected portion of thallus mentioning proper magnification.

#### Suggested Readings

- Bold, H.C. & Wynne, M.J. ....Introduction to Algae: Structure & Reproduction [Prentice Hall]
- Ganguly, H.C. & Kar, A.K. ....College Botany Vol.-II [New Central Book Agency]
- Hoek, C., Mann, D.G. & Jahns, H.M. 1995 .....Algae: an..... [Cambridge Univ. Press]
- Kumar, H.D. & Singh, H.N. ....Introductory Phycology [East-West Press Pvt. Ltd]
- Lee, R.E. Phycology [Cambridge Univ. Press]
- Vashistha, B.R., Singh, A.K. & Singh, V.P. ....Algae [S. Chand & Co. Pvt. Ltd.]
- Atlas, R.M. Principles of Microbiology [McGraw Hill]
- Banerjee, A.K. & Banerjee, N. ...Fundamentals of Microbiology and Immunology [New Central Book Agency]
- Pelczar, M.J., Chan, P.C.S. & Krieg, N.R. ....Microbiology [Tata McGraw Hill]

- Stanier, R.Y., Ingraham, J.L., Wheelis, M.L. & Painter, P.R. .General Microbiology [Macmillan Education Ltd.]
- Tortora, G.J., Funke, B.R. & Case, C.L. .Microbiology - An Introduction [Dorling Kindersley India Pvt. Ltd. for Pearson Education]
- Willey, M.J., Sherwood, L.M. & Woolverton, C.J.....Prescott, Harley and Klein's Microbiology [McGraw Hill]

**Major Course / BOT-DC-MJ-403 : Fungi and Plant Pathology**  
**[ 04 Credit ]**

**Topic content of THEORY part [03 credits] (Teaching hour = 45)**

**Fungi and Plant Pathology**

**Fungi**

[1] Introduction to true fungi; General characteristics; Nutrition; Thallus organization; Cell wall composition; Teleomorphic and Anamorphic; Degeneration of sex in fungi; Life Cycle Patterns; Parasexuality.

[2] Classification (Ainsworth 1973) up to sub-division diagnostic characters with examples.

[3] Characteristic features; Ecology and significance; Thallus organisation; Reproduction; Life cycle with reference to *Rhizopus* sp., *Ascobolus* sp., *Agaricus* sp. and *Penicillium* sp.

[4] Symbiotic associations: Lichen – Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction and ecological role. Mycorrhiza- Ectomycorrhiza, Endomycorrhiza, Significance and role in Agriculture.

[5] Applied Mycology: Role of fungi in biotechnology; Application of fungi in food industry. Fungi as Biocontrol agents; Mycotoxins.

[6] Industrial production of Cheese, Ethanol, Baker's yeast, Amylase and Rivo flavin.

**Plant Pathology**

[1] Introduction to plant pathology; Plant pathology in India and Global prospective; Concept of Disease in Plants and Types of Diseases.

[2] Terms and definitions: Disease concept, Symptoms, Etiology, Inoculum and Infection, Pathogenesis, Disease triangle and Disease cycle, Epidemic and Endemic, Sporadic and Pandemic Disease. Koch's postulate.

[3] Mechanism of infection (Pre-penetration, Penetration and Post-Penetration), Plant defense responses with reference to Phytoalexins and PR proteins. Signal transduction leading to SAR and ISR.

[4] Concept of plant disease management:, Chemical, Biological and Quarantine. Concept of crop rotation. Integrated Pest Management (IPM).

[5] Symptoms, Causal organism, Disease cycle and control measures of: Bacterial diseases – Citrus canker, Viral diseases – Tobacco Mosaic Disease. Fungal diseases – Late blight of potato and Black stem rust of wheat.

## Topic content of PRACTICAL part [01 credit] (Teaching hour = 15)

### Fungi and Plant Pathology

#### Fungi

[1] Study of asexual stage from temporary mounts, drawing and microscopic measurement: *Penicillium* sp., *Rhizopus* sp., *Ascobolous* sp. *Schizophyllum* sp and *Agaricus* sp.

[2] Study from permanent slides: Sexual stage in *Rhizopus* sp., Conidia of *Penicillium* sp., *Aspergillus* sp.

#### Plant Pathology

[1] Study from temporary mounts (Histopathology): Late Blight of Potato, Stem rot of Jute, Leaf rust of *Justicia*.

[2] Study from permanent slides: Uredial, Telial, Pycnidial and Aecial stages of *Puccinia graminis*.

[3] Herbarium specimens of viral, bacterial, fungal and nematode diseases (maximum 20 herbarium sheets or vials with field reports).

#### Suggested Readings

- Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
- Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
- Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
- Kershaw, K.A. (1985), Physiological ecology of lichens, Cambridge University Press, Cambridge.
- Negi, H.R.; Kareem, A., Lichens: The Unsung Heroes.
- Negi, Hans Raj, Lichens: A valuable bioresource for environmental monitoring and sustainable development, Resonance. India, 2003,8(1), 51-58
- Seaward, M.R.D. (1977) (Ed.), Lichen ecology, Academic Press, London.
- Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.
- Agrios, G.N. (1997) Plant Pathology, 4th edition, Academic Press, U.K.
- Melhotra R.S and Aggarwal-Ed. Plant Pathology, Mc.Graw Hill Education

## SEMESTER-V

### Major Course / BOT-DC-MJ-501:Evolution of Early Land Plants [ 04 Credit]

**Topic content of THEORY part [03 Credits] (Teaching hour = 45)**

#### **Bryophytes and Pteridophytes-**

[1] Introduction / Evolutionary emergence of land plants: Evolution from thallophyta to early land plants and gradual progression from aquatic habit to land habit, Evolution and complexity of sporophyte (telome theory); Alternation of generations.

[2] **Bryophytes:** General characteristics; Adaptations to land habit; Classification (Proskauer, 1957) up to class. Range of thallus organization. Ecological and economic importance of bryophytes with special reference to *Sphagnum* sp.

[3] Type Studies- Bryophytes: Morphology, anatomy and reproduction and sporophyte development and alternation of generation of *Marchantia* sp, *Porella* sp., *Anthoceros* sp., *Sphagnum* sp. *Funaria* sp. and *Pogonatum* sp. (Developmental details not to be included).

[4] **Pteridophytes:** General characteristics; Classification up to class (Sporne, 1975); Concept of heterospory and origin of seed habit; Apogamy, and apospory; Stellar evolution. Ecological and economic importance of pteridophytes. Early land plants *Rhynia* sp. and *Lepidodendron* sp. (Reconstructed).

[5] Type Studies- Pteridophytes: Morphology, anatomy and reproduction of *Psilotum*, *Lycopodium* sp., *Selaginella* sp., *Equisetum* sp. *Polypodium* sp., *Pteris* sp. and *Marsilea* sp. (Developmental details not to be included).

**Topic content of PRACTICAL part [01 Credit] (Teaching hour = 15)**

#### **Bryophytes and Pteridophytes-**

##### **1. Bryophytes**

- i. Morphology of thallus and permanent slide preparations of the following
- ii. *Marchantia* sp.: Work out of Antheridiophore, Archegoniophore.
- iii. *Anthoceros* sp.: - Dissection of sporophyte (to show stomata, spores, pseudoelaters, columella).
- iv. *Funaria* sp.: - Whole mount of leaf, rhizoids, operculum, peristome, annulus, spores and longitudinal section of capsule.

##### **2. Pteridophytes**

- i. Morphology and permanent slide preparations of the following
- ii. *Selaginella* sp. and *Lycopodium* sp. :, Whole mount of strobilus, longitudinal section of strobilus.
- iii. *Equisetum* sp -Longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore.
- iv. *Pteris* sp - Transverse section of sporophyll, whole mount of sporangium.

### **Suggested Readings**

- Smith, G.M. ....Cryptogamic Botany Vol. 1 [McGraw Hill]
- Puri, P. ....Bryophyte [Atmaram& Sons]
- Rashid, A. ....An Introduction to Bryophyta [Vikas Publishing House]
- Vashishta, B.R. ....Bryophyta [S. Chand & Co.]
- Vashishta, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.
- Gifford, E.M. & Foster, A.S. ....Morphology and Evolution of Vascular Plants [Freeman & Co.]
- Mukherjee, R.N. & Chakraborty, K. ....An Introduction to Vascular Cryptogams (Pteridophytes) [Kalyani Publishers]
- Rashid, A. ....An Introduction to Pteridophyta [Vikas Publishing House]

## **Major Course / BOT-DC-MJ-502: Morphology and Taxonomy of Angiosperms** **[ 04 Credit]**

**Topic content of THEORY part [03 Credits] (Teaching hours = 45)**

### **Plant Morphology and Plant Systematics-**

#### **Plant Morphology**

- [1] Introduction to angiospermic morphology, Palynology and Anatomy, scope and applications in systematics, forensic and pharmacognosy.
- [2] Leaf: Types, Margin, Base, Venation and Phyllotaxy, Petiole and modifications.
- [3] Inflorescence: types with examples;
- [4] Flower: Floral parts, Thalamus and insertion of floral parts, Calyx, Corolla, Aestivation, Perianth, floral diagram and floral formula. Stamen: Types and anther shape. Carpel : types, placentation-types, ovule structure and types;
- [5] Fruit types with examples.

#### **Plant Systematics-**

- [1] Significance of Plant systematics: Introduction to systematics; Plant identification, Classification, Nomenclature. Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys.
- [2] Taxonomic hierarchy: Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary).
- [3] Botanical nomenclature: Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.

[4] Systems of classification: Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Outline of classification systems of Linnaeus (1753), Bentham and Hooker (1862-1883) upto series and brief reference of Angiosperm Phylogeny Group (APG III) classification.

[5] Biometrics, numerical taxonomy and cladistics : Characters; Variations; OTUs, character weighting and coding.

[6] Phylogeny of Angiosperms: 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).

[7] Diagnostic features of Families: **Dicotyledons**- Ranunculaceae, Brassicaceae, Malvaceae, Leguminosae (sensu lato), Apocynaceae, Solanaceae, Lamiaceae, Cucurbitaceae, Rubiaceae, Euphorbiaceae, Asteraceae. **Monocotyledons**-Alismataceae, Poaceae, Zingiberaceae and Orchidaceae.

### Topic content of PRACTICAL part [01 Credit] (Teaching hours = 15)

#### Plant Morphology and Plant Systematics

[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):

Brassicaceae- *Brassica* sp. / *Iberis* sp.

Malvaceae- *Sida* sp. / *Urena* sp.

Leguminosae (sensu lato)- *Cassia* sp. / *Crotalaria* sp.

Apocynaceae – *Catharanthus* sp.

Solanaceae- *Solanum* sp / *Physalis* sp / *Nicotiana* sp .

Lamiaceae- *Ocimum* sp / *Leucas* sp / *Leonurus* sp.

Cucurbitaceae: *Cephalandra* sp./ *Mukia* sp.

Rubiaceae: *Dentella* sp. / *Oldenlandia* sp./ *Spermacoce* sp.

Euphorbiaceae: *Jatropha* sp / *Croton* sp / *Acalypha* sp.

Poaceae – *Triticum* sp. / *Hordeum* sp. / *Avena* sp.

[2] Mounting of a properly dried and pressed specimen of at least 10 collected Angiospermic plants with herbarium label and arranged according to Bentham and Hookers system of classification.

[3] Botanical excursion: Enlistment of plants observed in the field and submission of field note book with 15 photographs with ecological notes on the plants observed.

[4] Morphology: Morphological studies (No working out):

- Different types of phyllotaxy in plants;
- Types of special inflorescence;

- Aestivations,
- Anther types
- Placentation;
- Different types of fruits- DRUPE, FIBROUS DRUPE, BERRY, PEPO, POME, HESPERIDIUM, SYCONUS, SOROSIS, CARYOPSIS, CREMOCARP, LOMENTUM.

### Suggested Readings

- Eames, A.J. ....Morphology of Angiosperms [McGraw Hill]
- Ganguly, H.C. & Kar, A.K. ....College Botany Vol. I [New Central Book Agency]
- Lawrence, G.H.M..... (Glossary) Taxonomy of Vascular Plants [Oxford & IBH]
- Datta, S.C. ....Systematic Botany [Wiley Eastern]
- 3. Mukherjee, S. ....College Botany Vol. III [New Central Book Agency]
- 4. Mitra, D., Guha, J. & Chowdhury, S.K...Studies in Botany, Vol. I [Moulik Library]
- 5. Naik, V.N. ....Taxonomy of Angiosperms [Tata McGraw Hill]
- 6. Heywood, V.H. ....Flowering Plants of India [Oxford University Press]
- 7. Stace, C.A. ....Plant Taxonomy and Biosystematics [Arnold Publishers]
- 8. Prain, D. ....Bengal Plants Vol. I & II [Bishen Singh, Mahendra Pal Singh]
- 9. Sivarajan, V.V. ....Introduction to Principles of Plant Taxonomy [Oxford & IBH]

## Major Course / BOT-DC-MJ-503: Cell Biology and Plant Breeding [ 04 Credit]

**Topic content of THEORY part [03 Credits] (Teaching hours = 45)**

### **Cell Biology and Plant Breeding**

#### **Cell biology**

[1] **The cell:** Cell as a unit of structure and function, Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).

[2] **Cell wall and membrane:** Plant cell wall, plasma membrane, models of membrane structure (fluid mosaic model), endocytosis and exocytosis.

[3] **Cell organelles (structure and function):** Nucleus, chloroplast, mitochondria, Endomembrane system, peroxisome, Lysosome.

[4] **Cytoskeleton:** microtubules, microfilaments and intermediary filament.

[5] **Cell division:** Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle-checkpoints, role of protein kinases.

#### **Plant Breeding**

[1] Basic concept of plant breeding, significance and role in crop improvement.

[2] Green Revolution (History, Basic concepts and significance).



[3] Selection methods in plant breeding: Mass Selection, Pure-line Selection, Pedigree Selection, Bulk Selection and hybridization.

[4] Outline idea about Male sterility, Heterosis, Hybrid Vigor.

[5] Seed bank, Gene Bank, Germplasm- Importance and role in plant breeding.

**Topic content of PRACTICAL part [01 Credit] (Teaching hours = 15)**  
**Cell Biology and Plant Breeding**

1. Study of plant cell structure with the help of epidermal peel mount of *Allium/Rhoeo/Crinum*
2. Chromosome preparation: Pre-treatment, Fixation, Staining, Squash and Smear preparation, Preparation of permanent slides. Study of Mitotic Chromosomes: Metaphase chromosome preparation, free hand drawing, determination of 2n number and comment on chromosome morphology of *Allium cepa*.
3. Determination of mitotic index in pre-fixed root tips of *Allium cepa*.
4. Identification of cell organelles with the help of electron micrographs (Chloroplast, ER, Golgi Apparatus); Stages of cell division from permanent slide or electron micrographs.
5. Demonstration of Emasculation and hybridization techniques in self and cross-pollinated crops.

**Suggested readings**

1. Cooper, G.M. ....The Cell - A Molecular Approach [ASM Press]
2. De Robertis, E.D.P. & De Robertis, E.M.M. ....Cell and molecular Biology [Waverly Pvt. Ltd. for Lea & Fabiger]
3. Karp, G. ....Cell and Molecular Biology: Concepts and Experiments [John Wiley & Sons. Inc]
4. Powar, C.B. ....Cell Biology [Himalaya Publishing House]
5. Verma, P.S. & Agarwal, V.K. ....Concept of Cell Biology [S. Chand & Co.]
6. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
7. Allard, R.W. ....Principles of Plant Breeding [John Wiley]
8. Chawdhuri, H.K. ....Elementary Principles of Plant Breeding [Oxford & IBH]
9. Poehlman, J.M. & Barthakur, D. ....Plant Breeding [Oxford & IBH]
10. Singh, B.D. ....Plant Breeding: Principles and Methods [Kalyani Publishers]

**Major Course / BOT-DC-MJ-504 : Palynology and Reproductive  
Biology of Angiosperms  
[ 04 Credit ]**

**Topic content of THEORY part [03 Credits] (Teaching hours = 45)  
Palynology and Reproductive Biology of Angiosperms**

**Palynology**

[1] **Palynology and scope:** a brief account

[2] **Pollen morphology:** Pollen morphology, units, polarity, symmetry, shape, size, aperture; NPC system for numerical expression of apertural details; evolution of aperture types.

[3] **Pollen Viability and Storage:** Pollen Viability and Storage: Estimation; variations; responsible factors; short- and long-term storage; significance.

[4] **Branches of Palynology & Application:** Branches of palynology & application: Branches of palynology; palynology in taxonomic & phylogenetic deductions; palynology in academic & applied aspects including melissopalynology, medical palynology, forensic palynology, entomopalynology&copropalynology.

**Reproductive Biology of Angiosperms**

[1] **Reproductive development:** Induction of flowering; flower as a modified determinate shoot. Flower development: genetic and molecular aspects.

[2] **Anther and pollen biology:** Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance. microgametogenesis, male germ unit

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

[4] **Pollination and fertilization:** Pollination types, agents and adaptations; pollen germination; path of pollen tube in pistil; double fertilization.

[5] **Embryo, Endosperm and Seed:** 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.

**Topic content of PRACTICAL part [01 Credit] (Teaching hours = 15)  
Palynology and Reproductive Biology of Angiosperms**

1. Slides/Micrographs of Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehiscent anther stages and Male Germ Unit.
2. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, pseudomonads, polyads, pollinia (slides/photographs, fresh material), ultrastructure of pollen wall (micrograph).

3. Pollen fertility and Pollen germination: Fertility, Germination: Calculation of percentage germination in different media using hanging drop method.
4. Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (Permanent slides/specimens/photographs, Micrographs).
5. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus.
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. .... The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
2. Shivanna, K.R. .... Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
3. Raghavan, V.....Developmental Biology of Flowering plants, Springer, Netherlands.
4. Johri, B.M. I ..... Embryology of Angiosperms, Springer-Verlag, Netherlands.
5. Mehra, P.N. ....Evolution of spore through the ages [Palynological Society of India, National Botanic Garden, Lucknow]
6. Nair, P.K.K. ....Pollen Morphology of Angiosperms [Scholar Publication]
7. Erdtman, G. ....Pollen Morphology and Plant Taxonomy [Jelden: E.G. Brill]
8. Faegri, K. & Iverson, J. ....Text Book of Pollen Analysis [Oxford: Blackwell Scientific Publication]