

**Department of Botany**  
**Framework of B Sc Botany NEP -2020**  
**(1<sup>st</sup> - 4<sup>th</sup> semester)**

**Semester 1**

- |    |                  |                                                                 |             |
|----|------------------|-----------------------------------------------------------------|-------------|
| 1. | Core paper I:    | DIVERSITY OF LOWER PLANTS<br>(THEORY and PRACTICAL)             | (6 CREDITS) |
| 2. | Additional ID-1: | (AID-1 LOWER PLANT DIVERSITY: PART I)<br>(THEORY and PRACTICAL) | (4 CREDITS) |
| 3. | Skill-1          | MUSHROOM CULTIVATION TECHNOLOGY                                 | (2 credits) |
| 4. | VAC              | Connecting to Environment                                       | (2 credits) |

**Semester 2**

- |    |                  |                                                                   |             |
|----|------------------|-------------------------------------------------------------------|-------------|
| 1. | Core paper II:   | MICROBIOLOGY AND PLANT PATHOLOGY<br>(THEORY and PRACTICAL)        | (6 CREDITS) |
| 2. | Additional ID-2: | (AID-2: Microbiology & Plant pathology)<br>(THEORY and PRACTICAL) | (4 CREDITS) |
| 3. | Skill- 2         | Floriculture                                                      | (2 credits) |
| 4. | VAC              | Lifeskill and Personality Development                             | (2Credits)  |

**Semester 3**

- |    |                  |                                                                      |             |
|----|------------------|----------------------------------------------------------------------|-------------|
| 1. | Core paper III:  | PLANT PHYSIOLOGY AND BIOCHEMISTRY<br>(THEORY and PRACTICAL)          | (6 CREDITS) |
| 2. | Additional ID-3: | (AID-3: Plant physiology and Biochemistry)<br>(THEORY and PRACTICAL) | (4 CREDITS) |
| 3. | Skill-1          | MUSHROOM CULTIVATION TECHNOLOGY                                      | (2 credits) |
| 4. | VAC              | IKS/AMDC                                                             | (2 Credits) |

**Semester 4**

- |    |                  |                                                                      |             |
|----|------------------|----------------------------------------------------------------------|-------------|
| 1. | Core paper IV:   | PLANT TAXONOMY AND PLANT EMBRYOLOGY<br>(THEORY and PRACTICAL)        | (6 CREDITS) |
| 2. | Additional ID-4: | (AID-4: Taxonomy and Embryology of Plants)<br>(THEORY and PRACTICAL) | (4 CREDITS) |
| 3. | Skill- 2         | Floriculture                                                         | (2 credits) |
| 4. | VAC              | IKS/AMDC                                                             | (2 credits) |

- Note:**
1. ADD ID (1,2,3,4) will be opted by those students who don't have Botany as core paper ( Reduce the syllabus to 70 %)
  2. Skill paper will be opted by Botany students only in 2 semesters (either 1-2 or 3-4)
  3. IKS will be in any one semester and AMDC in other.

# Syllabus of Botany Courses as per National Education Policy-2020

## Department of Botany & Microbiology

### H.N.B. Garhwal University

#### B.Sc. Botany

#### First Year- Semester I

#### 1. Core Paper-1 Theory

**Code:** SOLS/BOT/ C (T) -1 (MM: 30+70)  
**Title of Paper:** DIVERSITY OF LOWER PLANTS (THEORY)  
**Total No. of Lectures:** 60 **Credits:** 4

#### Unit 1: 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 2: Fungi (14 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*, *Alternaria* (Ascomycota), *Puccinia*, *Agaricus* (Basidiomycota); Symbiotic Associations- **Lichens:** General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance

#### Unit 3: Introduction to Archegoniate (14 Lectures)

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

Bryophytes: General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Riccia*, *Anthoceros*, *Marchantia* and *Funaria*. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

#### Unit 4: Pteridophytes (12 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 5: Gymnosperms (8 Lectures)

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

## First Year- Semester I

### 1. Core Paper-1 Practical

**Code:** SOLS/BOT/ C (P) -1 **(MM: 30+70)**

**Title of Paper:** DIVERSITY OF LOWER PLANTS (PRACTICAL)

**Credits: 2**

1. Study of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas* (electron micrographs), *Oedogonium*, *Vaucheria*, *Fucus*\* and *Polysiphonia* through temporary preparations and permanent slides. (\* *Fucus* - Specimen and permanent slides)
2. *Rhizopus* and *Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.
3. *Alternaria*: Specimens/photographs and tease mounts.
4. *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.
5. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.
6. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
7. Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs)
8. *Marchantia*, *Riccia* and *Anthoceros*- 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).
9. *Funaria*- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
10. *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).
11. *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).
12. *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).
13. *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).
14. *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

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw

Hill, Delhi, India.

6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
7. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad

## 2. **Additional Inter Disciplinary-1 (T)\***

**Code:** SOLS/BOT/ AID (T)-1 (MM: 30+70)  
**Title of Paper:** (AID-1) LOWER PLANTS DIVERSITY (THEORY)  
**Total No. of Lectures:** 40 **Credits:** 4

### **Unit 1: Algae** (08 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 2: Fungi** (08 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* (Basidiomycota); Symbiotic Associations- **Lichens**: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance

### **Unit 3: Introduction to Bryophytes** (08 Lectures)

Bryophytes: 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).

### **Unit 4: Pteridophytes** (08 Lectures)

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

### **Unit 5: Gymnosperms** (08 Lectures)

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

Practical based on Theory:

## **Additional Inter Disciplinary-1(P)**

**Code:** SOLS/BOT/ AID (P)-1 (MM: 30+70)  
**Title of Paper:** (AID-1p) LOWER PLANTS DIVERSITY (THEORY)  
**Credits:** 2

**\* Additional Interdisciplinary paper will be opted by those students who do not have Botany as a Core subject.**

### 3. Botany Skill-1 \*

**Code:** SOLS/BOT/ Skill-1 **(MM: 30+70)**  
**Title of Paper:** MUSHROOM CULTIVATION TECHNOLOGY  
**Total No. of Lectures: 30** **Credits: 2**

#### **Unit 1:** (5 Lectures)

Introduction, history. Nutritional and medicinal value of edible mushrooms;  
Poisonous mushrooms. Types of edible mushrooms available in India - *Volvariella volvacea*, *Pleurotus ostreatus*, *Agaricus bisporus*.

#### **Unit 2:** (5 Lectures)

Cultivation Technology : Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag.

#### **Unit 3:** (7 Lectures)

Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation - Low cost technology, Composting technology in mushroom production.

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

Storage and nutrition : Short-term storage (Refrigeration – up to 24 hours) Long term Storage (canning, pickles, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.

#### **Unit 5:** (5 Lectures)

Food Preparation\_: Types of foods prepared from mushroom. Research Centres - National level and Regional level.\_Cost benefit ratio - Marketing in India and abroad, Export Value.

#### **Suggested Readings**

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

### 4. VAC-1 **Connecting to Environment** **(2 credits)**

**(Common to all)**

## First Year- Semester II

### 1. Core Paper-2 Theory

**Code:** SOLS/BOT/ C (T) -2 (MM: 30+70)  
**Title of Paper:** MICROBIOLOGY & PLANT PATHOLOGY (THEORY)  
**Total No. of Lectures:** 60 Credits: 4

**Total No. of Lectures: 60**

#### Unit 1: (8 Lectures)

History and scope of Microbiology

General account, distribution and classification of microorganisms.

#### Unit 2: (12 Lectures)

Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance;

#### Unit 3: (12 Lectures)

Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance. Role of microorganisms in Nitrogen metabolism

#### Unit 4: (14 Lectures)

History of Plant Pathology. Modes of Infection and general symptoms, physiology of parasitism, defense mechanism in plants, role of environment in disease development. Control measures of plant diseases. Disease resistance in plants.

#### Unit 5: (14 Lectures)

General symptoms and control measures for the following plant diseases: Citrus canker, TMV, wilt of tomato, bacterial blight of rice, mosaic of sugarcane and little leaf of brinjal. Late blight of potato, Wilt of *Cajanus cajan*, Loose smut of Wheat, Covered smut of Barley, Green ear disease of bajra, downy mildew of crucifers, rusts of pea and linseed, smut of bajra,

### PRACTICAL (Credits 2)

**Code:** SOLS/BOT/ C (P) -2 (MM: 30+70)  
**Title of Paper:** MICROBIOLOGY & PLANT PATHOLOGY (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; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
3. Gram staining
4. Study of plant diseases with help of infected plant specimen - TMV, citrus canker, little leaf of brinjal, loose smut of wheat, downy mildew of crucifers, rust of pea, smut of bajra.

### **Suggested Readings**

1. Brock Biology of Microorganisms, 13th edition (2012)
2. Stainier, R.Y. General Microbiology 5th edition (2009) Mc Millan Press Ltd., Hound Mills
3. Talaro, K.P., Chess, B., 2011. Foundation in Microbiology. 8th edition. McGraw-Hill
4. Prescott, Harley and Klein's Microbiology 7th edition (2008). Mc GRAW Hill. Singapore
5. Agrios, G.N., 1988. Plant Pathology, Academic Press, London.
6. Lucas, John, A., 1998. Plant Pathology and Plant Pathogens, Wiley-Blackwell, CRC Press.
7. Singh, R.S. Plant diseases, 9th edition (2009). Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi



**2. Additional ID-2: (AID-2: Introductory Microbiology & Plant pathology)**  
**(THEORY) (2 CREDITS)**  
**Code: SOLS/BOT/ AID (T)-2 (MM: 30+70)**

**Total No. of Lectures: 40**

**Unit 1:** (8 Lectures)

History and scope of Microbiology

General account, distribution and classification of microorganisms.

**Unit 2:** (8 Lectures)

Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance;

**Unit 3:** (8 Lectures)

Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

**Unit 4:** (8 Lectures)

History of Plant Pathology. Modes of Infection and general symptoms, physiology of parasitism, defense mechanism in plants, role of environment in disease development. Control measures of plant diseases. Disease resistance in plants.

**Unit 5:** (8 Lectures)

General symptoms and control measures for the following plant diseases: Citrus canker, TMV, wilt of tomato, bacterial blight of rice, mosaic of sugarcane and little leaf of brinjal. Late blight of potato, Loose smut of Wheat, rusts of pea and linseed, smut of bajra,

**Additional ID-2: (AID-2: Introductory Microbiology & Plant pathology)**  
**(Practical) (2 CREDITS)**  
**Code: SOLS/BOT/ AID (P)-2 (MM: 30+70)**

**Practical will be conducted Based on Theory paper**

### 3. Botany Skill-2 \*

<b>Code:</b>	<b>SOLS/BOT/ Skill-2</b>	<b>(MM: 30+70)</b>
<b>Title of Paper:</b>	<b>FLORICULTURE</b>	
<b>Total No. of Lectures: 30</b>		<b>Credits: 2</b>

#### **Unit 1:** (2 Lectures)

Introduction: History of gardening; Importance and scope of floriculture and landscape gardening.

#### **Unit 2:** (8 Lectures)

Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators.

#### **Unit 3:** (4 Lectures)

Ornamental Plants: Flowering annuals; Herbaceous perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and Selaginellas; Cultivation of plants in pots; Indoor gardening; Bonsai.

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

Principles of Garden Designs: English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden. Some Famous gardens of India. Landscaping Places of Public Importance: Landscaping highways and Educational institutions.

#### **Unit 5:** (8 Lectures)

Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Marigold, Rose, Liliium, Orchids). Diseases and Pests of Ornamental Plants.

#### **Suggested Readings**

1. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

## Second Year- Semester III

### 1. Core Paper-3 Theory

**Code:** SOLS/BOT/ C (T) -3 (MM: 30+70)

**Title of Paper:** PLANT PHYSIOLOGY AND BIOCHEMISTRY (THEORY)

**Total No. of Lectures:** 60 **Credits:** 4

#### 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; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps. Sugar translocation

##### Unit 3: 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 4: Respiration (10 Lectures)

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

##### Unit 5: Plant growth regulators (12 Lectures)

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

##### Unit 6: (10 Lectures)

Biologically important molecules: Carbohydrates, Amino acids, Proteins and Lipids.

Enzymes: Structure and properties; Mechanism of enzyme action, coenzymes, allosteric enzyme, isozymes, enzyme inhibition.

### Practical:

**Code:** SOLS/BOT/ C (P) -3 (MM: 30+70)

**Title of Paper:** PLANT PHYSIOLOGY AND BIOCHEMISTRY (PRACTICAL  
(Credits 2)

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Demonstration of Hill reaction.
5. To study the effect of light intensity and bicarbonate concentration on O<sub>2</sub> evolution in photosynthesis.
6. Comparison of the rate of respiration in any two parts of a plant.
7. Separation of amino acids by paper chromatography.

8. Demonstration experiments (any four)
- (i) Bolting.
  - (ii) Effect of auxins on rooting.
  - (iii) Suction due to transpiration.
  - (iv) R.Q.
  - (v) Respiration in roots.

**Suggested Readings**

1. Taiz, L., Zeiger, E., (2010). Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.
2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.
3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.
4. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007) Biochemistry (Sixth Edition) W.H. Freeman & Company, New York.
5. Cox, M.M. and Nelson DL (2004) Lehninger Principle of Biochemistry (Third Edition) MacMillan Worth Publishers.
6. Dennis, D.T. & Turpin, D.H. (1993) Plant Physiology, Biochemistry and Molecular Biology. Longman Scientific & Technical, England.

## 2. Additional Inter Disciplinary-3 (T)

**Code:** SOLS/BOT/ AID (T)-3 (MM: 30+70)  
**Title of Paper:** (AID-1) Introductory plant physiology and Biochemistry (THEORY)

**Total No. of Lectures: 40**

**Credits: 4**

### Unit 1:

#### **Plant-water relations** (6 Lectures)

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

#### **Unit 2: Mineral nutrition** (6 Lectures)

Essential elements, macro and micronutrients; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps. Sugar translocation

#### **Unit 3: Photosynthesis** (8 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 4: Respiration** (6 Lectures)

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

#### **Unit 5: Plant growth regulators** (7 Lectures)

Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene. Plant response to light and temperature, Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure) Vernalization.

#### **Unit 6:** (7 Lectures)

Biologically important molecules: Carbohydrates, Amino acids, Proteins and Lipids.

Enzymes: Structure and properties; Mechanism of enzyme action, coenzymes, allosteric enzyme, isozymes, enzyme inhibition.

### Practical:

**Code:** SOLS/BOT/ C (P) -3 (MM: 30+70)  
**Title of Paper:** INTRODUCTORY PLANT PHYSIOLOGY AND BIOCHEMISTRY (PRACTICAL (Credits 2)

Based on Theory Paper.

- |    |                |                                                               |                    |
|----|----------------|---------------------------------------------------------------|--------------------|
| 3. | <b>Skill-1</b> | <b>MUSHROOM CULTIVATION TECHNOLOGY</b><br>(Same as Semester I | <b>(2 credits)</b> |
| 4. | <b>VAC</b>     | <b>IKS/AMDC</b>                                               | <b>(2 Credits)</b> |

## Second Year- Semester IV

### 1. Core Paper-4 Theory

**Code:** SOLS/BOT/ C (T) -4 (MM: 30+70)  
**Title of Paper:** PLANT TAXONOMY AND PLANT EMBRYOLOGY  
(THEORY)  
**Total No. of Lectures: 60** Credits: 4

#### **Unit 1: Introduction to plant taxonomy (10 Lectures)**

Identification, Classification, Nomenclature. Taxonomic hierarchy, Ranks, categories and taxonomic groups Identification

Functions of Herbarium, important herbaria and botanical gardens of the world and India;

Documentation: Flora, Keys: single access and multi-access

Taxonomic evidences from palynology, cytology, phytochemistry and molecular data.

#### **Unit 2: Botanical nomenclature (12 Lectures)**

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

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

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

#### **Unit 3: Taxonomy, important distinguishing characters, classification, and economic importance of the following families: (10 Lectures)**

Ranunculaceae, Papaveraceae, Caryophyllaceae, Malvaceae, Brassicaceae, Rutaceae, Fabaceae, Apiaceae, Asteraceae, Solanaceae, Apocyanaceae, Asclepidiaceae, Acanthaceae, Lamiaceae, Euphorbiaceae, Orchidaceae, Liliaceae, Poaceae.

#### **Unit 4: Structural organization of flower (14 Lectures)**

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

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

#### **Unit 5: Embryo and endosperm (14 Lectures)**

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

Apomixis and polyembryony: Definition, types and practical applications.

## 2 Core Paper-4 Practical

Code: SOLS/BOT/ C (P) -4

Title of Paper: PLANT TAXONOMY AND PLANT EMBRYOLOGY

(MM: 30+70)

PRACTICAL

(Credits 2)

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, Alyssum / Iberis; Asteraceae - Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax; Solanaceae - Solanum nigrum, Withania; Lamiaceae - Salvia, Ocimum; Liliaceae - Asphodelus / Lilium / Allium; Poaceae - Wheat/ Rice/ Barley/ Maize
2. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book; 15 plant specimens minimum).
3. Taxonomic treatment of plant species belonging to families mentioned in the syllabus.
4. Study of taxonomic terminology
5. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
6. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/campylotropous.
7. Female gametophyte: Polygonum (monosporic) type of Embryo sac Development (Permanent slides/photographs).
8. Ultrastructure of mature egg apparatus cells through electron micrographs.
9. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
10. Dissection of embryo/endosperm from developing seeds.
11. Calculation of percentage of viable germinated pollen in a given medium.

### Suggested Readings

1. Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A.
2. Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.
3. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.

### 3 Additional ID-4 (Theory)

**Code:** SOLS/BOT/ AID-4 (T) (MM: 30+70)  
**Title of Paper:** TAXONOMY AND EMBRYOLOGY PLANTS (THEORY)  
**Total No. of Lectures: 40** Credits: 2

#### Unit 1: Introduction to plant taxonomy (8 Lectures)

Identification, Classification, Nomenclature. Taxonomic hierarchy, Ranks, categories and taxonomic groups Identification

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

#### Unit 2: Botanical nomenclature (8 Lectures)

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

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

Biometrics, numerical taxonomy and cladistics Characters; variations; cluster analysis; phenograms, cladograms (definitions and differences).

#### Unit 3: Taxonomy, important distinguishing characters, classification, and economic importance of the following families: (8 Lectures)

Ranunculaceae, Papaveraceae, Caryophyllaceae, Malvaceae, Brassicaceae, Rutaceae, Fabaceae, Apiaceae, Asteraceae, Solanaceae, Apocyanaceae, Asclepidiaceae, Acanthaceae, Lamiaceae, Euphorbiaceae, Orchidaceae, Liliaceae, Poaceae.

#### Unit 4: 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. Pollination and fertilization: Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.

#### Unit 5: Embryo and endosperm (8 Lectures)

Endosperm types, structure and functions; Dicot and monocot embryo; Embryo endosperm relationship. Apomixis and polyembryony: Definition, types and practical applications.

### Practical

**Code:** SOLS/BOT/ AID-4 (P) (MM: 30+70)  
**Title of Paper:** TAXONOMY AND EMBRYOLOGY OF PLANTS PRACTICAL (Credits 2)

Based on Theory Paper

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|----|----------|---------------------------------------|-------------|
| 3. | Skill- 2 | Floriculture<br>(Same as semester II) | (2 credits) |
| 4. | VAC      | IKS/AMDC                              | (2 credits) |