

UNIVERSITY OF KALYANI

COURSE STRUCTURE FOR 4 YEAR (8 SEMESTER) UNDERGRADUATE PROGRAM IN BOTANY UNDER NEP 2020

SEMESTER I (REVISED)

| Course Code | Course Title | Name of the Course | Credit of Course | Class hours per week | Evaluation | Internal Assessment | Total |
|----------------|---|---------------------------------------|------------------|----------------------|------------|---------------------|------------|
| BOT-MJ-CC-T-01 | Origin , Life Processes & Diversity of Plant groups | Major (Theory) | 4 | 4 | 40 | 15 | 75 |
| BOT-MJ-CC-P-01 | Do | Major (Practical) | 2 | 4 | 20 | | |
| | | | | | | | |
| BOT-MI-CC-T-01 | Biodiversity of Microbes, Algae, Fungi and Bryophytes | Minor (Theory) | 3 | 3 | 25 | 10 | 50 |
| BOT-MI-CC-P-01 | Do | Minor (Practical) | 1 | 2 | 15 | | |
| | | | | | | | |
| BOT-MDC-T-01 | Plant Diversity and Morphology | Multidisciplinary Course (Theory) | 2 | 2 | 25 | 10 | 45 |
| BOT-MDC-P-01 | Do | Multidisciplinary Course (Practical) | 1 | 1 | 10 | | |
| | | | | | | | |
| BOT-SEC-T-01 | Course title: A. Biofertilizers | Skill Enhancement Course (Theory) | 2 | 2 | 25 | 10 | 45 |
| | Course title: B. Plant Diversity and Human Welfare | | | | | | |
| BOT-SEC-P-01 | Do | Skill Enhancement Course (Practical) | 1 | 2 | 10 | | |
| | | | | | | | |
| | Environmental Education | Value Added Course | 4 | 4 | 40 | 10 | 50 |
| TOTAL | | | 20 | 24 | | | 265 |

SEMESTER II

| Course Code | Course Title | Name of the Course | Credit of Course | Class hours per week | Evaluation | Internal Assessment | Total |
|----------------|---|--------------------------------------|------------------|----------------------|------------|---------------------|------------|
| BOT-MJ-CC-T-02 | Biomolecules and Cell Biology | Major (Theory) | 4 | 4 | 40 | 15 | 75 |
| BOT-MJ-CC-P-02 | Do | Major (Practical) | 2 | 4 | 20 | | |
| | | | | | | | |
| BOT-MI-CC-T-01 | Biodiversity of Microbes, Algae, Fungi and Bryophytes | Minor (Theory) | 3 | 3 | 25 | 10 | 50 |
| BOT-MI-CC-P-01 | Do | Minor (Practical) | 1 | 2 | 15 | | |
| | | | | | | | |
| BOT-MDC-T-01 | Plant Diversity and Morphology | Multidisciplinary Course (Theory) | 2 | 2 | 25 | 10 | 45 |
| BOT-MDC-P-01 | Do | Multidisciplinary Course (Practical) | 1 | 1 | 10 | | |
| | | | | | | | |
| BOT-SEC-T-02 | Course title A: Floriculture | Skill Enhancement Course (Theory) | 2 | 2 | 25 | 10 | 45 |
| | Course title B: Medicinal botany | | | | | | |
| BOT-SEC-P-02 | Do | Skill Enhancement Course (Practical) | 1 | 2 | 10 | | |
| | | | | | | | |
| | Communicative English | Ability Enhancement Course | 4 | 4 | 40 | 10 | 50 |
| | | Summer Internship Course | 4 | | | | |
| TOTAL | | | 24 | 24 | | | 265 |

SEMESTER III

| Course Code | Course Title | Name of the Course | Credit of Course | Class hours per week | Evaluation | Internal Assessment | Total |
|----------------|---|---------------------------------------|------------------|----------------------|------------|---------------------|------------|
| BOT-MJ-CC-T-03 | Phycology and Lichen. | Major (Theory) | 4 | 4 | 40 | 15 | 75 |
| BOT-MJ-CC-P-03 | Do. | Major (Practical) | 2 | 4 | 20 | | |
| | | | | | | | |
| BOT-MI-CC-T-02 | Vascular plants, Morphology & Taxonomy of Angiosperms | Minor (Theory) | 3 | 3 | 25 | 10 | 50 |
| BOT-MI-CC-P-02 | Do | Minor (Practical) | 1 | 2 | 15 | | |
| | | | | | | | |
| BOT-MDC-T-01 | Plant Diversity and Morphology | Multidisciplinary Course (Theory) | 2 | 2 | 25 | 10 | 45 |
| BOT-MDC-P-01 | Do | Multidisciplinary Course (Practical) | 1 | 1 | 10 | | |
| | | | | | | | |
| BOT-SEC-T-03 | Course Title: A. Mushroom Culture | Skill Enhancement Course (Theory) | 2 | 2 | 25 | 10 | 45 |
| | Course Title: B. Intellectual Property Rights | | | | | | |
| BOT-SEC-P-03 | Do | Skill Enhancement Course (Practical) | 1 | 2 | 10 | | |
| | | | | | | | |
| | | Value Added Course | 4 | 4 | 40 | 10 | 50 |
| TOTAL | | | 20 | 24 | | | 265 |

SEMESTER IV

| Course code | Course Title | Name of the course | Credit of Course | Class hours per week | Evaluation | Internal Assessment | Total |
|----------------|---|----------------------------|------------------|----------------------|------------|---------------------|------------|
| BOT-MJ-CC-T-04 | Bryophytes and Pteridophytes | Major (Theory) | 4 | 4 | 40 | 15 | 75 |
| BOT-MJ-CC-P-04 | Do | Major (Practical) | 2 | 4 | 20 | | |
| BOT-MJ-CC-T-05 | Gymnosperm and Palaeobotany | Major (Theory) | 4 | 4 | 40 | 15 | 75 |
| BOT-MJ-CC-P-05 | Do | Major (Practical) | 2 | 4 | 20 | | |
| | | | | | | | |
| BOT-MI-CC-T-02 | Vascular Plants, Morphology & Taxonomy of Angiosperms | Minor (Theory) | 3 | 3 | 25 | 10 | 50 |
| BOT-MI-CC-P-02 | Do | Minor (Practical) | 1 | 2 | 15 | | |
| | | | | | | | |
| | | Ability Enhancement Course | 4 | 4 | 40 | 10 | 50 |
| | | | | | | | |
| | | Summer Internship Course | 4 | | | | |
| TOTAL | | | 24 | 25 | | | 265 |

B.SC. BOTANY 4 YEAR SYLLABUS

MAJOR

| | |
|----------------------|--|
| SEMESTER I | BOT-MJ-CC-T & P-01; Origin, Life Processes & Diversity of Plant groups. |
| SEMESTER II | BOT-MJ-CC-T & P 02; Biomolecules and Cell Biology. |
| SEMESTER III | BOT-MJ-CC-T& P 03; Phycology and Lichen. |
| SEMESTER IV | BOT-MJ-CC-T& P 04; Bryophytes and Pteridophytes; BOT-MJ-CC-T& P 05; Gymnosperm and Palaeobotany. |
| SEMESTER V | BOT-MJ-CC-T& P 06; Plant Systematics, Morphology and Anatomy; BOT-MJ-CC-T& P 07; Reproductive biology of plants. |
| SEMESTER VI | BOT-MJ-CC-T& P 08; Plant Physiology & Biochemistry, BOT-MJ-CC-T& P 09; Plant Metabolism, BOT-MJ-CC-T& P 10; Genetics, Biometry and Plant Breeding. |
| SEMESTER VII | BOT-MJ-CC-T& P 11; Microbiology, BOT-MJ-CC-T& P 12; Fungi and Plant Pathology, BOT-MJ-CC-T& P 13; Plant Molecular Biology and Biotechnology. |
| SEMESTER VIII | BOT-MJ-CC-T& P 14; Plant Ecology, Biodiversity and Conservation; BOT-MJ-CC-T& P 15; Economic Botany and Pharmacognosy; BOT-MJ-CC-T& P 16; Analytical Techniques in Plant Science. [BOT-MJ-CC-T& P 17; Research Methodology, BOT-MJ-CC-T& P 18; Stress Biology (for Honours without research)] |

MINOR

| | |
|------------------------|---|
| SEMESTER I/II | BOT-MI-CC-T & P 01: Biodiversity of Microbes, Algae, Fungi & Bryophytes |
| SEMESTER III/IV | BOT-MI-CC-T & P 02: Vascular Plants, Morphology & Taxonomy of Angiosperms |
| SEMESTER V | BOT-MI-CC-T & P 03: Cytogenetics, Anatomy & Embryology. |
| SEMESTER VII | BOT-MJ-CC-T & P 04: Plant physiology & Ecology |

SEMESTER I-MAJOR

COURSE CODE: BOT-MJ--CC-T-01 (THEORY) & BOT-MJ-CC-P-01 (PRACTICAL)

COURSE TITLE: ORIGIN, LIFE PROCESSES AND DIVERSITY OF PLANT GROUPS

CREDIT: 6 [4 (THEORY) + 2 (PRACTICAL)]

FULL POINTS: 75 [40 (THEORY) + 20 (PRACTICAL) + 15 (INTERNAL ASSESMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- understand the concept of origin of life, origin of land plant and plant evolution
- describe general characteristics of viruses, bacteria, algae, fungi and archegoniate with special reference to their classification, morphology, reproduction and ecology.
- explain their role in environment, human welfare and in industrial applications;
- apply this knowledge in understanding the evolutionary significance of these organisms.

COURSE CONTENT (THEORY) COURSE CODE: BOT-MJ-CC-T-01

Unit 1: Origin of Life (4)

What is life? Theories of origin of life; role of water in life process; origin of land plants.

Unit 2: Microbes (5)

Viruses- Discovery, general structure; economic importance;
Bacteria- Discovery, general characteristics and cell structure; economic importance.

Unit 3: Algae (6)

General characteristics; salient features of Cyanophyceae, Chlorophyceae, Charophyceae, Phaeophyceae, Rhodophyceae and Bacillariophyceae; ecology and distribution of algae; economic importance of algae.

Unit 4: Fungi (5)

Introduction – General characteristics, salient features of Myxomycota, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina; fungi- nutrition and reproduction; ecology and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza; Lichens- general account.

Unit 5: Introduction to Archegoniate (3)

Unifying features of Archegoniates; transition to land habit; alternation of generations.

Unit 6: Bryophytes

(5)

General characteristics, salient features of Hepaticopsida, Anthocerotopsida and Bryopsida. Adaptation to land habitat, adaptation to land habitat; ecological and economic importance of Bryophytes.

Unit 7: Pteridophytes

(4)

General characteristics, salient features of Psilophyta, Lycophyta, Sphenophyta and Filicophyta; ecological and economical importance.

Unit 8: Gymnosperms

(4)

General characteristics; salient features of Cycadophyta, Coniferophyta and Gnetophyta.; ecological and economic importance.

Unit 9 : Angiosperms

(4)

Floral characteristics, affinity with Gymnosperms; Herbarium; Botanical Garden.

COURSE CONTENT (PRACTICAL)

COURSE CODE: BOT-MJ--CC-P-01

Identification of the following from Preserved or Fresh Specimen/Permanent slides/Photographs:

1. **Bacterial forms:** Coccus, Bacillus, Spirillum, Vibrio
2. **Algae:** *Nostoc*, *Lyngbya*, *Spirogyra*, *Oedogonium*
3. **Fungi:** *Rhizopus* (Vegetative structure with sporangium/ zygospore) , *Aspergillus* (vegetative structure with conidia), *Ascobolus* (Fruit body, L.S of *Ascobolus* fruit body), *Agaricus* (Fruit body, L.S of gills).
4. **Bryophytes:** *Riccia* (Entire thallus, T.S of thallus showing sporophyte), *Marchantia* (V.S of archegoniophore & antheridiophore, sporophyte), *Funaria*, (Plant body, L.S of capsule).
5. **Pteridophytes:** *Lycopodium* (Plant body, L.S of strobilus), *Pteris* (T.S of leaflet).
6. **Gymnosperms:** Megasporophyll and microsporophyll of *Cycas*, external morphology of *Pinus* female cone; L.S of male and female cone of *Pinus*.
7. **Angiosperms:** *Polyanthes tuberosa*, *Crysopogon aciculatus*, *Tridax procumbens*, *Oldenlandia corymbosa*, *Solanum nigrum*

SUGGESTED READINGS/REFERENCES

1. Introductory Phycology by H. D. Kumar. East West Press Pvt. Ltd., New Delhi 1999.
2. General Microbiology by R.Y. Stanier. , J.L. Ingraham. , M.L. Wheelis. and P.R. Painter. International Edition(5th). 1999.
3. Introductory Mycology by C.J. Alexopoulos. , C.W. Mims. And M. Blackwell. John Wiley and Sons (Asia), Singapore. Ed. 4th. 1996.
4. An Introduction to Embryophyta by N.S. Parihar. Central Book Depot, Allahabad. Vol. I. 1991.
5. Pteridophyta by P.C. Vashishta. , A.K. Sinha. And A. Kumar. S.Chand, Delhi. 2010.
6. Gymnosperms by S. P. Bhatnagar and A. Moitra. New Age international Pvt Ltd., New Delhi, 1996
7. Angiosperm: morphology, anatomy, taxonomy, evolution by S. K. Sachdeva, Kalyani Publishers, New Delhi, 1990

SEMESTER I/II- MINOR
(INSTRUCTION: Candidate may opt either in Semester I & III or Semester II & IV)

COURSE CODE: BOT-MI-CC-T-01(THEORY) & BOT-MI-CC-P-01(PRACTICAL)

COURSE TITLE: BIODIVERSITY OF MICROBES, ALGAE, FUNGI AND BRYOPHYTES

CREDIT:4 [3 (THEORY) + 1 (PRACTICAL)]

FULL POINTS:50 [25 (THEORY) + 15 (PRACTICAL) + 10 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- describe general characteristics of viruses, bacteria, algae, fungi and bryophytes with special reference to their classification, morphology, reproduction.
- explain their role in environment, human welfare and industrial applications.
- apply this knowledge in understanding the evolutionary significance of these organisms.

COURSE CONTENT (THEORY)
COURSE CODE (THEORY): BOT-MI-CC-T-01

Unit 1: Microbes **(7)**

Virus- General structure, replication (general account), DNA virus (T-phage); Lytic and Lysogenic cycle, RNA virus (TMV); Economic importance.

Bacteria- General characteristics and cell structure; Reproduction- conjugation, transformation and transduction; Economic importance.

Unit 2: Algae **(6)**

General characteristics: reproduction; Classification of algae by Fritsch (1935); Economic importance of algae.

Unit 3: Fungi **(6)**

Introduction: General characteristics, cell wall composition, reproduction and classification (Alexopoulos, Mims and Blackwell, 1996); Symbiotic associations- Lichens: General account; Mycorrhiza: ectomycorrhiza and endomycorrhiza.

Unit 4: Bryophytes

(6)

General characteristics; adaptations to land habit; classification following Smith G.M. (1955); Economic importance of bryophytes with special mention of *Sphagnum*.

COURSE CONTENT (PRACTICAL) COURSE CODE- BOT–MI-CC-P-01

1. **EMs/Models of viruses** -T-Phage and TMV.
2. **Types of Bacteria** -from temporary/permanent slides/photographs.
3. **Gram staining.**
4. **Algae- (Study from permanent slides/ permanent slide/preserved specimen) -**
Nostoc, Oedogonium, Chlamydomonas and *Fucus*
5. **Fungi- (Study from permanent slides/ permanent slide/preserved specimen)-**
Rhizopus and *Penicillium, Agaricus* (Section of gills).
6. **Lichens:** Study of growth forms of Lichens (crustose, foliose and fruticose).
7. **Mycorrhiza:** ectomycorrhiza and endomycorrhiza (Photographs).
8. **Bryophyte: (Study from permanent slides/ permanent slide/preserved specimen)-**
Marchantia (morphology of thallus, VS of antheridiophore, archegoniophore), *Funaria*
(morphology, LS of capsule).

SUGGESTED READING/REFERENCE:

1. Introductory Phycology by H. D. Kumar. East West Press Pvt. Ltd., New Delhi 1999.
2. Botany for degree students Fungi by Vashishta B.R., Sinha A.K. S. Chand,
3. Botany for degree students Bryophyta by Vashishta B.R., Sinha A.K. S. Chand.

BOTANY (MULTIDISCIPLINARY COURSE)
(Candidates will opt only once either in Semester I, II or III)

COURSE TITLE: PLANT DIVERSITY AND MORPHOLOGY

COURSE CODE; BOT-MDC-T-01 (THEORY) & BOT-MDC-P-01 (PRACTICAL)

COURSE CREDIT= 3 [2(THEORY) +1(PRACTICAL)]

FULL POINTS = 45 [25(THEORY) +10(PRACTICAL) + 10 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- describe general characteristics of viruses, bacteria, algae, fungi, bryophyte, pteridophyte, gymnosperm and angiosperm with special reference to their classification, morphology, reproduction and ecology.
- explain their role in environment, human welfare and in industrial applications.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-MDC-T-01

1. General characteristics of virus, bacteria, algae, fungi, bryophyte, pteridophyte, gymnosperm and angiosperm; economic and ecological importance of virus, bacteria, algae, fungi, bryophytes, pteridophytes & gymnosperm. (8)
2. Morphology of leaves (Types, phyllotaxy, modification of leaves, stipules). (4)
3. Morphology of inflorescence (Types and examples). (2)
4. Morphology of flower (Parts of flower, types of flowers, modification of calyx, aestivation, floral formula and diagram, adhesion & cohesion of floral parts, types of placentation. (7)
5. Morphology of fruits & seeds (Types and dispersal). (4)

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-MDC-P-01

1. Identification from preserved/fresh specimen or permanent slides. [Coccus, Bacillus, *Nostoc*, *Agaricus*, *Funaria*, female cone of *Pinus*, any five angiosperms (at least one from monocot)].
2. Identification with reasons: stipules, inflorescence, flower & fruits.

SUGGESTED READING/REFERENCE:

1. Introductory Phycology by H. D. Kumar. East West Press Pvt. Ltd., New Delhi 1999.
2. Botany for degree students Fungi by Vashishta B.R., Sinha A.K. S. Chand.
3. Botany for degree students Bryophyta by Vashishta B.R., Sinha A.K. S. Chand.
4. Pteridophyta by P.C. Vashishta., A.K. Sinha. And A. Kumar. S.Chand, Delhi. 2010.
5. Gymnosperms by S. P. Bhatnagar and A. Moitra. New Age international Pvt Ltd., New Delhi, 1996.
6. Angiosperm: morphology, anatomy, taxonomy, evolution by S. K. Sachdeva, Kalyani Publishers, New Delhi, 1990.

COURSE CODE: BOT-SEC-T-01(THEORY) & BOT-SEC-P-01(PRACTICAL)

COURSE CREDIT- 3 [2(THEORY) +1(PRACTICAL)]

FM=45[25(THEORY) +10(PRACTICAL) + 10 (INTERNAL ASSESMENT)]

COURSE TITLE: A. BIOFERTILIZERS

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- elucidate different types of fertilizers using biological organisms;
- apply the knowledge gained in utilization of biofertilizers in organic farming.

**COURSE CONTENT (THEORY)
COURSE CODE: BOT-SEC-T-01-A**

Unit 1: (3)

General account about the microbes used as biofertilizer - *Rhizobium* - isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.

Unit 2: (7)

Azospirillum: isolation and mass multiplication - carrier based inoculants, associative effect of different microorganisms. *Azotobacter*: classification, characteristics - crop response to *Azotobacter* inoculum, maintenance and mass multiplication.

Unit 3: (3)

Cyanobacteria (blue green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation.

Unit 4: (7)

Mycorrhizal association, types of mycorrhizal association, taxonomy, Occurrence and distribution, phosphorus nutrition, growth and yield - colonization of AM - isolation and inoculum production of AM, and its influence on growth and yield of crop plants.

Unit 5: (5)

Organic farming - Green manuring and organic fertilizers, recycling of biodegradable municipal, agricultural and industrial wastes - biocompost making methods, types and method of vermicomposting- field application

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-SEC-P-01-A

1. Isolation of *Rhizobium* from leguminous root nodule
2. Isolation of *Azotobacter*, *Azospirillum*
3. Isolation of BGA from water and soil samples
4. Production of *Azolla* in trays
5. Study of different types of mycorrhizal association from permanent slides/photographs
6. Visit to areas where organic farming, bio composting, vermicomposting are practiced.

SUGGESTED READINGS/ REFERENCES:

1. Dubey, R.C. (2005). A Text book of Biotechnology. S.Chand and Co, New Delhi.
2. Kumaresan, V. (2005). Biotechnology, Saras Publications, New Delh.
3. John Jothi Prakash, E. (2004). Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
4. Sathe, T.V. 5. Subha Rao, (2004). N.S. Vermiculture and Organic Farming. Daya Publishers.
5. Subha Rao, N.S.. (2000). Soil Microbiology, Oxford and IBH Publishers, New Delhi.
6. Vayas, S.C, Vayas, S. and Modi, H.A. (1998). Bio-fertilizers and organic farming. Akta , Prakashan, Nadiad.

COURSE TITLE: B. PLANT DIVERSITY AND HUMAN WELFARE

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- explain the concept and value of biodiversity, threats to biodiversity, need for conservation and environmental stewardship;
- apply and implement conservation strategies for biodiversity management.

COURSE CONTENT (THEORY)
COURSE CODE: BOT-SEC-T-01-B

Unit 1: Plant diversity and its scope.

(7)

Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Agrobiodiversity 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.

Unit 2: Loss and Management of Biodiversity: (7)

Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agrobiodiversity, Projected scenario for biodiversity loss, Management of Plant Biodiversity: Organizations associated with biodiversity management- Methodology for IUCN, UNEP, UNESCO, WWE, NBPGR; Biodiversity legislation and conservations, Biodiversity information management and communication.

Unit 3: Conservation of Biodiversity: (6)

Conservation of genetic diversity, species diversity and ecosystem diversity, *in situ* and *ex situ*, conservation, Social approaches to conservation, Biodiversity awareness programmes. Sustainable development.

Unit 4: Role of plants in relation to Human Welfare: (5)

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.

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-SEC-P-01-B

1. Study plant diversity in urban, rural and in a different phytogeographic region.
2. Visit to botanical garden, herbarium (ex situ conservation); national park/sanctuaries/biosphere reserve (in situ conservation).
3. Identification of some important microbes (*Aspergillus niger*, *Penicillium notatum*, *Lactobacillus*, Yeast, *Chlorella*, *Spirulina*) and their uses.

SUGGESTED READINGS/ REFERENCES:

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

SEMESTER-II MAJOR

COURSE CODE: BOT-MJ-CC-T-02 (THEORY) & BOT-MJ-CC-P-02 (PRACTICAL)

COURSE TITLE: BIOMOLECULES AND CELL BIOLOGY

CREDIT – 6 [4 (THEORY) + 2 (PRACTICAL)]

FULL POINTS – 75 [40(THEORY) +20 (PRACTICAL)+ 15 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- describe the types, nomenclature and structures of biomolecules;
- explain the function and structure of cells including their metabolic reactions that occur in cells;
- elucidate the laws of thermodynamics and translate reaction mechanisms within cells into their final expressions;
- discuss the origin of eukaryotic cell;
- explain the process of cell division and inheritance.

COURSE CONTENT (THEORY) COURSE CODE: BOT-MJ--CC-T-02

Unit 1: Biomolecules (18)

- A. Types and significance of chemical bonds; Structure and properties of water; pH and buffers.
- B. Carbohydrates: Nomenclature and classification; Monosaccharides; Disaccharides; Oligosaccharides and Polysaccharides.
- C. Lipids: Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; Triacyl glycerol structure, functions and properties; Phosphoglycerides.
- D. Proteins: Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quaternary; Protein denaturation and biological roles of proteins.
- E. Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of t RNA.

Unit 2: Bioenergetics (3)

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

Unit 3: Enzymes (5)

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 factor affecting enzyme activity.

Unit 4: The cell (2)

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

Unit 5: Cell wall and plasma membrane (3)

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 (7)

- A. Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.
- B. Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament.
- C. Chloroplast, Mitochondrion, and Peroxisome: Structural organization; Function; Semiautonomous nature of mitochondrion and chloroplast.
- D. Endomembrane system: Endoplasmic Reticulum (ER) – 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; Lysosome
- E. Organelle without membranes: Ribosomes – structure and function

Unit 7: Cell division (2)

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

COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-MJ--CC-P-02

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 *Allium cepa*/ *Rhoeo*/ *Crinum*.
3. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.
4. Measurement of cell size by the technique of micrometry.
5. Counting the cells per unit volume using haemocytometer (Yeast/pollen grains).

6. Study of cell and its organelles with the help of electron micrographs.
7. Cytochemical staining of: DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schiff's (PAS) staining technique (Demonstration only).
8. Study the phenomenon of plasmolysis and deplasmolysis.
9. Study different stages of mitosis and meiosis.

SUGGESTED READINGS/ REFERENCES:

1. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009) The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Berg J.M., Tymoczko J.L and Stryer L. (2011) Biochemistry, W.H. Freeman and Company.
3. Campbell, M.K. (2012) Biochemistry, 7th ed., Published by Cengage Learning.
4. Campbell, P.N. and Smith A.D. (2011) Biochemistry Illustrated, 4th ed., Published by ChurchillLivingstone.
5. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
6. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
7. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
8. Nelson D.L. and Cox M.M. (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company
9. Tymoczko J.L., Berg J.M. and Stryer L. (2012) Biochemistry: A short course, 2nd ed., W.H. Freeman.

COURSE CODE: BOT-SEC-T-02(THEORY) & BOT-SEC-P-02(PRACTICAL)

COURSE; CREDIT- 3 [2(THEORY) + 1(PRACTICAL)]

FM=45[25(THEORY) + 10(PRACTICAL) + 10 (INTERNAL ASSESMENT)]

COURSE TITLE A: FLORICULTURE

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- ♣ apply the assimilated knowledge and skills in production, processing, and distribution of flowers, cut flowers, foliage, and related plant materials;
- ♣ prescribe best management practices in field and greenhouse production of flowers and related plant materials and the arrangement of plant materials for ornamental purposes.

COURSE CONTENT (THEORY)

UG-H-BOT-SEC-T-02-A

Unit 1: (3)

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

Unit 2: (5)

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: (5)

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: (5)

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.

Unit 5: (2)

Landscaping Places of Public Importance: Landscaping highways and Educational institutions.

Unit 6: (4)

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).

Unit 7: (1)

Diseases and Pests of Ornamental Plants.

**COURSE CONTENT (PRACTICAL)
UG-H-BOT-SEC-P-02-A**

1. Make a comprehensive study about the landscape of your college and your opinion to improve it.
2. Write about the flowering plants in your college campus and your role in maintaining at least five ornamental plants.

SUGGESTED READINGS/ REFERENCES:

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

COURSE TITLE B: MEDICINAL BOTANY

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- ♣ discuss the history, scope and importance of plants as sources of medicines;
- ♣ describe methods for sustainable utilization of plant herbal resources;
- ♣ apply the knowledge gained in utilizing plants used as traditional/ folk medicines and strategize their conservation.

**COURSE CONTENT (THEORY)
UG-H-BOT-SEC-T-02-B**

Unit 1: (8)

History, Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences; Definition and Scope - Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e- tabiya, tumors treatments/ therapy, polyherbal formulations.

Unit 2:**(8)**

Conservation of endangered and endemic medicinal plants. Definition: endemic and endangered medicinal plants, Red list criteria; *in situ* conservation: Biosphere reserves, sacred groves, National Parks; *ex situ* conservation: Botanic Gardens, Ethnomedicinal plant Gardens. Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding.

Unit 3:**(9)**

Ethnobotany and Folk medicines. Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany. Folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, blood pressure and skin disease.

**COURSE CONTENT (PRACTICAL)
UG-H-BOT-SEC-P-02-B**

1. Make a field report on the important medicinal plants (at least 10) used by local inhabitants.

SUGGESTED READINGS/ REFERENCES:

1. Purohit, S.S. and Vyas, S.P. (2008). Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. Agrobios, India.
2. Trivedi P.C. (2006). Medicinal Plants: Ethnobotanical Approach, Agrobios, India.

SEMESTER III-MAJOR

COURSE CODE: BOT-MJ--CC-T-03 (THEORY) & BOT-MJ-CC-P-03 (PRACTICAL)

COURSE TITLE: PHYCOLOGY AND LICHENS

CREDIT: 6 [4 (THEORY) + 2 (PRACTICAL)]

FULL POINTS: 75 [40 (THEORY) + 20 (PRACTICAL) + 15 (INTERNAL ASSESMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- to understand the relevance of algae with special to their classification, morphology, reproduction, distribution and ecology;
- explain their role in environment, human welfare and in industrial applications;
- apply this knowledge in understanding the evolutionary significance of these organisms.
- to perceive an idea about lichen.

COURSE CONTENT (THEORY) COURSE CODE: BOT-MJ--CC-T-03

Unit 1: Relevance of studying algae: (7)

Diversity and distribution; Range of thallus organization, Ecology; Criteria for classification (cell wall, pigment system, reserve food, flagella); Reproduction and life cycle patterns; Classification up to groups (Lee, 2008); Algal bloom and Toxin; Evolution of sex.

Unit 2: Cyanophyceae (Blue-Green Algae): (3)

Occurrence; Cell structure; Heterocyst (structure and function); Morphology, reproduction, life-cycle and symbiotic relationships of *Nostoc* and *Anabaena*. Economic importance of Cyanophyceae.

Unit 3: Chlorophyceae (Green Algae): (6)

Occurrence; Cell structure; Morphology, reproduction and life-cycle of *Chlamydomonas*, *Volvox*, *Chlorella*, *Ulva*, *Oedogonium*, *Coleochaete*; *Chara*; Structure and evolutionary significance of *Prochloron*, Economic importance of Chlorophyceae.

Unit 4: Xanthophyceae (Yellow-Green Algae): (3)

Occurrence; Morphology, reproduction, and life-cycle of *Vaucheria*, Economic importance of Xanthophyceae.

Unit 5: Bacillariophyceae: (3)

Diatoms and Dinophyceae (Dinoflagellates)

Occurrence, morphology, unique features, Economic importance of Diatoms.

Unit 6: Phaeophyceae (Brown Algae): (3)

Occurrence; Morphology, reproduction, and life-cycle of *Ectocarpus*, *Polysiphonia* and *Sargassum*, Economic importance of Phaeophyceae.

Unit 7: Rhodophyceae (Red Algae): (3)

Occurrence; Morphology, reproduction, and life-cycle of *Gracilaria*, Economic importance of Rhodophyceae.

Unit 8: Algal Biotechnology: (8)

Cultivation of microalgae-*Spirulina* and *Dunaliella*; . Algal products- Food and Nutraceuticals, Feed stocks, food colorants; fertilizers, aquaculture feed; therapeutics and cosmetics; medicines; dietary fibres, SCP. Role of algae in climate change, biofuel production and acidification of oceans.

Unit 9- Lichen: (4)

Occurrence; General characteristics; growth forms and range of thallus organisation; nature of symbiosis, reproduction, role in environment and ecology; Economic importance.

COURSE CONTENT (PRACTICAL)

COURSE CODE: BOT-MJ--CC-P-03

1. Study of vegetative and reproductive structures of *Nostoc*, *Oedogonium*, *Chara*, *Vaucheria*, *Ectocarpus*, and *Polysiphonia* through temporary preparations, *Fucus*, *Chlamydomonas*, *Coleochateae* through preserved specimens and permanent slides and *Prochloron* through electron micrographs.
2. Study of lichen forms- Photographs/preserved specimens

SUGGESTED READINGS/ REFERENCES:

1. Bold, H.C. and Wynne, M.J. (1985). Introduction to the Algae: Structure and Reproduction, 2nd edition. Prentice-Hall International INC.
2. Kumar, H.D. (1999). Introductory Phycology, 2nd edition. Affiliated East-West Press, New Delhi.
3. Lee, R.E. (2018). Phycology, 4th edition: Cambridge University Press, Cambridge.
4. Sahoo, D. and Seckbach, J. (2015). The Algae World. Springer, Dordrecht.
5. Sahoo, D. (2000). Farming the Ocean: Seaweed Cultivation and Utilization. Aravali Book International, New Delhi.

COURSE CODE: BOT-SEC-T-03 (THEORY) & BOT-SEC-P-03 (PRACTICAL)

COURSE; CREDIT- 3 [2(THEORY)+1(PRACTICAL)]

FM=45[25(THEORY)+10(PRACTICAL) + 10 (INTERNAL ASSESMENT)]

COURSE TITLE: A. MUSHROOM CULTURE

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- ♣ describe nutritional and medicinal values of edible mushrooms and their cultivation strategies;
- ♣ apply the knowledge gained in storage and food preparation.

**COURSE CONTENT (THEORY)
UG-H-BOT-SEC-T-03-A**

Unit 1: (6)

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

Unit 2: (8)

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. 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 3: (6)

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 4: (5)

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.

COURSE CONTENT (PRACTICAL)
UG-H-BOT-SEC-P-03-A

1. Aseptic inoculation technique.
2. Demonstration of spawning technique, bed preparation.

SUGGESTED READINGS/ REFERENCES:

1. Bahl, N. (1984-1988). Hand book of Mushrooms, II Edition, Vol. I & Vol. II.
2. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991). Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
3. Swaminathan, M. (1990). Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
4. Tewari, P. and Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
5. Datta B (2023) Mushroom cultivation, 1st edition, Global Net Publication.

COURSE TITLE: B. INTELLECTUAL PROPERTY RIGHTS

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- ♣ identify different types of Intellectual Properties (IPs), right of ownership, scope of protection of IP and ways to create and extract value from IP;
- ♣ recognize the role of IP in different sectors for promoting product and technology development;
- ♣ identify activities that constitute IP infringements and the remedies available to the IP owner and describe the steps to be taken to prevent infringement of such rights in products and technology development;
- ♣ discuss the processes and various approaches of Intellectual Property Management (IPM).

COURSE CONTENT (THEORY)
UG-H-BOT-SEC-T-03-B

Unit 1: Introduction to intellectual property rights (IPR) (2)

Concept and kinds. Economic importance. IPR in India and World. Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO).

Unit 2: Patents (2)

Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, Working of patents. Infringement.

Unit 3: Copyrights (2)

Introduction, works protected under copyright law, rights, transfer of copyright, infringement.

Unit 4: Trademarks (2)

Objectives, types, rights, protection of goodwill, infringement, passing off, defences, domain name.

Unit 5: Geographical Indications (2)

Objectives, justification, international position, multilateral treaties, national level, Indian position.

Unit 6: Protection of Traditional Knowledge (4)

Objective, concept of traditional knowledge, holders, issues concerning, bio-prospecting and bio-piracy, alternative ways, protectability, need for a Sui-Generis regime, traditional knowledge on the International arena, at WTO, at national level, Traditional Knowledge Digital Library.

Unit 7: Industrial Designs (3)

Objectives, rights, assignments, infringements, defences of design Infringement.

Unit 8: Protection of Plant Varieties (4)

Plant Varieties Protection- objectives, justification, International position, Plant varieties protection in India. Rights of farmers, breeders and researchers. National gene bank, benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.

Unit 9: Information Technology related Intellectual Property Rights (2)

Computer Software and Intellectual Property, Database and Data Protection, Protection of Semiconductor chips, Domain Name Protection.

Unit 10: Biotechnology and Intellectual Property Rights (2)

Patenting Biotech Inventions: objective, applications, concept of novelty, concept of inventive step, microorganisms, moral issues in patenting biotechnological inventions.

**COURSE CONTENT (PRACTICAL)
UG-H-BOT-SEC-T-03-B**

One seminar lecture has to be delivered on any one of the topics mentioned in the syllabus to aware the public.

SEMESTER III - MINOR

COURSE CODE: BOT-MI-CC-T-02(THEORY) & BOT-MI-CC-P-02(PRACTICAL)

COURSE TITLE: VASCULAR PLANTS, MORPHOLOGY & TAXONOMY OF ANGIOSPERMS

CREDIT:4 [3(THEORY) + 1(PRACTICAL)]

FULL POINTS:50 [25 (THEORY) + 15 (PRACTICAL) + 10 (INTERNAL ASSESSMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- describe general characteristics of pteridophytes, gymnosperms with special reference to their morphology, anatomy and reproduction.
- describe the morphology and taxonomy of angiosperms.

COURSE CONTENT (THEORY) COURSE CODE (THEORY): BOT-MI-CC-T-02

Unit 1: Pteridophytes:

(4)

General characteristics; Early land plants (*Cooksonia* and *Rhynia*); Systematic position, morphology, anatomy and reproduction of *Lycopodium*, *Selaginella* and *Pteris* (developmental details not to be included); Heterospory and seed habit; Economical importance.

Unit 2: Gymnosperms:

(3)

General characteristics; Systematic position, morphology, anatomy and reproduction of *Cycas* and *Pinus* (developmental details not to be included); Economic importance.

Unit 3: Morphology of Angiosperms:

(5)

Types of leaves; phyllotaxy; types of inflorescence; morphology of flowers – types of flowers, aestivation, floral formula and floral diagram, adhesion and cohesion of floral parts, placentation types; types of fruits and seeds.

Unit 4: Introduction to angiosperm taxonomy:

(13)

Identification, Classification, Nomenclature. Taxonomic hierarchy; Botanical nomenclature-Principles and rules (ICN); binominal system, typification, author citation; Types of classification - artificial, natural and phylogenetic. Outline of Bentham and Hooker (up to series) classification with merits and demerits. Salient features, Systematic position (Bentham & Hooker), economically important plants of

the following families-

Monocotyledon: Poaceae; Orchidaceae. Dicotyledon: Fabaceae (*sensu stricto*); Malvaceae; Solanaceae; Lamiaceae; Asteraceae. Functions of Herbarium, important herbaria and botanical gardens of India;

CO URSE CONTENT (PRACTICAL)
CO URSE CODE (THEORY): BOT-MI-CC-P-02

Unit 1:

Lycopodium- morphology, WM of strobilus, (temporary slides), LS of strobilus (permanent slide).

Selaginella- morphology, WM of strobilus, WM of microsporophyll and megasporophyll (temporary slides), LS of strobilus (permanent slide).

Pteris- morphology, TS of leaflet.

Unit 2:

Megasporophyll of *Cycas* (from preserved specimen); pollen grain of *Pinus* (from permanent slide).

Unit 3:

Study of vegetative and floral characters of the following families of the available genera distributed locally according to Bentham and Hooker's system of classification: Dicotyledon: Fabaceae (*sensu stricto*); Malvaceae; Solanaceae; Lamiaceae; Asteraceae.

Spot identification (Scientific name and Family) of common wild plants from families included in theory syllabus.

Field visits (2 local) and submission of properly preserved herbarium specimens of at least 15 common wild plants with herbarium label, proper field record and field notes. The herbarium specimens should be submitted during end term examination.

SUGGESTED READING/REFERENCE:

1. Vashishta P.C., Sinha A.K., Kumar A. (2006). Pteridophyta, S. Chand. Delhi, India.
2. Simpson M.G. (2006). Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A.
3. Singh G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition. Gymnosperms by S. P. Bhatnagar and A. Moitra. New Age international Pvt. Ltd., New Delhi, 1996.

SEMESTER IV - MAJOR

COURSE CODE: BOT-MJ--CC-T-04 (THEORY) & BOT-MJ-CC-P-04 (PRACTICAL)

COURSE TITLE: BRYOPHYTES AND PTERIDOPHYTES

CREDIT: 6 [4 (THEORY) + 2 (PRACTICAL)]

FULL POINTS: 75 [40 (THEORY) + 20 (PRACTICAL) + 15 (INTERNAL ASSESMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- will perceive a general idea of bryophytes and pteridophytes with special to their classification, morphology, reproduction, distribution and ecology;
- explain their role in environment, human welfare and in industrial applications;
- apply this knowledge in understanding the evolutionary significance of these organisms.

COURSE CONTENT (THEORY) COURSE CODE: BOT-MJ--CC-T-04

Unit 1: Classification of Bryophytes (2)

Modern concepts in bryophyte classification with special reference to Shaw and Goffinet (2000).

Unit 2: Type Studies of Bryophyte (8)

Range of thallus organisation; Systematic position, morphology, anatomy and reproduction of *Riccia*, *Marchantia*, *Pellia*, *Anthoceros*, *Sphagnum* and *Funaria*.

Unit 3: Origin and Evolution of Bryophytes (8)

Origin of bryophytes; Origin of alternation of generation (Homologous and Antithetic theories); Evolution of sporophyte (Progressive and Regressive concepts). Evolutionary trends in *Riccia*, *Marchantia*, *Anthoceros* and *Funaria*.

Unit 4: Basic concepts of Pteridophytes (3)

Life cycle patterns of homosporous and heterosporous pteridophytes; Apospory and Apogamy; Habitat diversity.

Unit 5: Classification of Pteridophytes (3)

Classification of pteridophytes by Smith *et. al.* (2006) with diagnostic features and example.

Unit 6: Type Studies of Pteridophytes

(8)

Systematic position, morphology, anatomy and reproduction of *Psilotum*, *Lycopodium*, *Selaginella*, *Equisetum*, *Ophioglossum*, *Pteris* and *Marsilea*.

Unit 7: Origin and Evolution of Pteridophytes

(8)

Origin of pteridophytes; Telome concept in land plant evolution; Structural features, geological and geographical distributions and evolutionary trends in early land plants *Cooksonia*, *Rhynia*, *Lepidodendron* and *Calamites*.

COURSE CONTENT (PRACTICAL) COURSE CODE: BOT-MJ—CC-P-04

Unit 1. *Riccia*

Morphology of thallus. T.S. of thallus and sporophyte.

Unit 2. *Marchantia*

Morphology of thallus, whole mount of rhizoids and Scales, vertical section of thallus through Gemma cup (all temporary slides), vertical section of Antheridiophore, Archegoniophore, longitudinal section of Sporophyte.

Unit 3. *Anthoceros*

Morphology of thallus, vertical section of thallus and sporophyte (permanent slide).

Unit 4. *Pellia*

Whole mount of thallus showing leaf arrangement and sporophyte (Permanent slides).

Unit 5. *Sphagnum*

Whole mount of leaf and sporophyte (L.S.) (permanent slides).

Unit 6. *Funaria*

Morphology, whole mount of plant (temporary slides); permanent slides showing longitudinal section of capsule.

Unit 7. *Psilotum*

Morphology, transverse section of synangium (permanent slide)

Unit 8. *Lycopodium*

Morphology, transverse section of stem, whole mount of sporophyll (temporary slides), longitudinal

section of strobilus.

Unit 9. *Selaginella*

Morphology, whole mount of leaf with ligule, transverse section of stem, whole mount of microsporophyll and megasporophyll (temporary slides), longitudinal section of strobilus.

Unit 10. *Equisetum*

Morphology, transverse section of node and internode, longitudinal section of strobilus, transverse section of strobilus.

Unit 11. *Pteris*

Morphology, transverse section of leaflet showing sporangium.

SUGGESTED READINGS/ REFERENCES:

Bryophytes

1. Chopra, R.N. and Kumar, P.K. (1988). Biology of Bryophyta, Wiley Eastern.
2. Parihar, N.S. (1959). Introduction to Embryophyta (Vol. 1 Bryophyta), Central Book Distributors
3. Puri, P. (1980). Bryophyte. Atmaram & Sons.
4. Rashid, A. (1998). An Introduction to Bryophyta, Vikas Publishing House.
5. Ray, S. & Bhattacharya, S. (2016). Manual for Bryophytes: Morphotaxonomy, diversity, spore germination, conservation. Levants Books, Sarat Book Distributors, Kolkata.
6. Schofield, W.B. (2001). Introduction to Bryology, Blackburn Press.
7. Shaw, A. Jonathan and Goffinet Bernard (2009). Bryophyte Biology, Cambridge University Press.
8. Smith, A.J.E. (ed.) (1982). Bryophyte Ecology, Chapman and Hall.
9. Vanderpoorten, A. and Goffinet, B. (2009). Introduction to Bryophytes, Cambridge University Press.
10. Vashista, B.R. (2001). Bryophyta, S. Chand & Company.

Pteridophytes

1. Gifford, E. M. and Foster, A. S. (1998). Morphology & Evolution of Vascular Plants (3rd ed.), Freeman and Co.
2. Mukherjee, R.N. and Chakraborty, K.A. (1995). Introduction to Vascular Cryptogams (Pteridophyta) Kalyani Publications.
3. Parihar, N.S. (1989). The Biology & Morphology of Pteridophytes (2nd ed.), Central Book Distributors.
4. Rashid, A. (1998). An Introduction to Pteridophyta, Latest Ed., Vani Educational Books.
5. Sporne, K.R. (1962). The Morphology of Pteridophyte, Latest Ed., Hutchinson & Co. Ltd.
6. Vashista, P.C. (2006). Pteridophyta. S. Chand & Company Pvt. Ltd.

COURSE CODE: BOT-MJ--CC-T-05 (THEORY) & BOT-MJ-CC-P-05 (PRACTICAL)

COURSE TITLE: GYMNOSPERM AND PALAEOBOTANY

CREDIT: 6 [4 (THEORY) + 2 (PRACTICAL)]

FULL POINTS: 75 [40 (THEORY) + 20 (PRACTICAL) + 15 (INTERNAL ASSESMENT)]

COURSE OBJECTIVES:

After completion of the course the learners will be able to:

- determine the concept of progymnosperms and its significance in plant evolutionary history
- describe general characteristics of gymnospermous plant group with special reference to their classification, morphology, reproduction, distribution, and ecology;
- explain their role in environment, and their economic importance;
- apply this knowledge in understanding their evolutionary significance;
- describe primordial life forms and their evolution through geological ages;
- explain the rate of diversification and extinction of plant species;
- determine the age of sediments and fossils;
- translate plant fossil evidences to study plant evolution.

COURSE CONTENT (THEORY) COURSE CODE: BOT-MJ--CC-T-05

Unit 1: Progymnosperms (2)

Development of Progymnosperm concept; Diagnostic features of Progymnospermophyta.

Unit 2: Classification (2)

Classification of gymnosperm by Gifford and Foster (1989) with diagnostic features and examples (from division Pteridospermophyta to Gnetophyta).

Unit 3: Type Studies of Gymnosperms (8)

Systematic position, vegetative and reproductive morphology of sporophyte, wood anatomy, development of gametophyte, and embryogeny of *Cycas*, *Pinus*, *Ginkgo*, *Ephedra*, *Gnetum*; Indian distribution of each taxa.

Unit 4: Origin and Evolution of Gymnosperms (5)

Origin and evolution of seed habit; Structural features, geological and geographical distribution, evolutionary trends in reconstructed genera *Lyginopteris*, *Williamsonia*, *Cordaites*

Unit 5: Introduction to Palaeobotany (2)

Definition of Palaeobotany and Fossil; Uses of fossils.

Unit 6: Plant fossil & their age determination (6)

Rocks containing plant fossils; Environments for fossilization; Modes of preservation (after James M. Schopf, 1975); Perfection of preservation; Geological ages in time scale; Radiometric dating method for age determination of fossil with special reference to radiocarbon dating.

Unit 7: Study of plant fossil records (4)

Common form of evidences used in reconstruction of plant fossils with examples; Nomenclature of plant fossils and their problems; Appearance of major plant groups through geological ages as evidenced from plant fossil records.

Unit 8: Evolutionary theories (5)

Mass extinction and the plant fossil record Evolutionary theories- Phyletic gradualism and Punctuated equilibrium; Patterns of evolutionary change in the plant fossil records; Definition of mass extinction and five big mass extinction events in Earth's history; Causes of no mass extinction in the plant fossil records.

Unit 9: Gondwana land and plant fossil (Glossopteris) (6)

Concept of Gondwana land and their geological and geographical distributions; Brief idea of Glossopteris plant and its importance in establishing existence of Gondwana land; A brief account of three-fold classification of Indian Gondwana system and major mega-fossil assemblages.

**COURSE CONTENT (PRACTICAL)
COURSE CODE: BOT-MJ--CC-P-05**

Unit 1: Gymnosperms

Cycas- T.S. of leaflet, morphology of microsporophyll and megasporophyll, L.s. of ovule.

Pinus- Transverse section of needle, longitudinal section of male cone, longitudinal section of female cone (permanent slide), study of pollen from permanent slide.

Gnetum- Longitudinal section of stem, vertical section of ovule (permanent slide).

Ephedra- Longitudinal section of stem, vertical section of ovule (permanent slide).

Unit 2: Palaeobotany

Study of external and internal morphology of fossils as representative of major plant groups through

geological ages (*Rhynia*- t.s. of stem, *Lepidodendron*- t.s. of stem, *Calamites*- t.s. of stem, *Glossopteris*- leaf, *Ptilophyllum*- leaf, *Cordaites*- leaf, *Lyginopteris*- t.s. of stem, *Williamsonia*- fructification, any angiosperm leaf (from available specimens or photographs)

SUGGESTED READING/REFERENCE:

Gymnosperms

1. Bhatnagar, S.P. and Moitra, A. (1997). Gymnosperm, New Age International.
2. Biswas, C. and Johri, P.M. (1997). The Gymnosperm, Narosa Publishing House.
3. Dutta, S.C. (1984). An Introduction to Gymnosperms (3rd ed.), Kalyani Publishers.
4. Friedman, W.E. (1996). Biology and Evolution of the Gnetales, University of Chicago Press.
5. Gifford, E.M. and Foster, A.S. (1989). Morphology and Evolution of Vascular Plants (3rd ed.), Freeman and Co.
6. Norstog, J. and Nicholls. T.J. (1997). The Biology of the Cycads, Cornell University Press.
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