

# Indira Gandhi National Tribal University

(A Central University)

Amarkantak (M.P.)



**SYLLABI**

(Based on NEP-2020)

**Department of Botany**

**Faculty of Science**

**Undergraduate Programme in Botany**

*(Effective from 2024-2025)*

## Undergraduate Course Structure

### Semester - I

Course Code	Category	Title	Credits
BOT-MT-103	Major	Origin of Life & Evolution	3
BOT-MP-103		Laboratory work based on BOT-MT-103	1
BOT-MI-102	Minor	Microbes & Plants	3
BOT-MP-102		Laboratory work based on BOT-MI-102	1
BOT-SECT-104	SEC	Biofertilizer	2
BOT-SECP-104		Laboratory work based on BOT-SECT-104	1
MDC-FSC-100	MDC	General Biology	3

### Semester - II

Course Code	Category	Title	Credits
BOT-MT-203	Major	Cell & Biomolecules	3
BOT-MP-203		Laboratory work based on BOT-MT-203	1
BOT-MI-202	Minor	Cytology & Genetics	3
BOT-MP-202		Laboratory work based on BOT-MI-202	1
BOT-SECT-204	SEC	Mushroom cultivation	2
BOT-SECP-204		Laboratory work based on BOT-SECT-204	1
MDC-FSC-200	MDC	General Biology	3

### Semester - III

Course Code	Category	Title	Credits
BOT-MT-303	Major 1	Microbial Diversity	3
BOT-MP-303		Laboratory work based on BOT-MT-303	1
BOT-MT-304	Major 2	Plant Diversity	3
BOT-MP-304		Laboratory work based on BOT-MT-304	1
BOT-MI-302	Minor	Biology of Flowering Plants	3
BOT-MP-302		Laboratory work based on BOT-MI-302	1
BOT-SECT-304	SEC	Floriculture	2
BOT-SECP-304		Laboratory work based on BOT-SECT-304	1

**Discipline: Major**  
**Course Code (BOT-MT-103)**  
**Origin of Life & Evolution**  
**(Credits: 3)**

**Learning outcomes:**

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

- Demonstrate the ability of critical thinking about the concepts of evolution and identify the flaws in the Counter arguments.
- Analyze and synthesize data from various sources and deal with problems and situations that don't have simple solutions or in a real-world context.
- Students will develop the capability to develop proper research hypotheses and design research proposals.

**Unit 1: Diversity and Evolution of Life**

Chemosynthetic Theory of Origin of Life (Oparin-Haldane theory, Miller and Urey experiment), theory of Spontaneous Generation, biogenesis, Probable stages in the origin of life, Atmosphere of Earth in Early phase, Origin of basic biological molecules.

**Unit 2: Theory of Organic Evolution**

Evidence of organic evolution (Morphological evidence, Embryological evidence, Palaeontological evidence, Molecular evidence). Elemental Forces of Organic Evolution: (Variation, Natural Selection, Isolation, adaptive radiation)

**Unit 3: Mechanism of Evolution**

Theory of Inheritance of acquired characters (Lamarck), Theory of mutation (Hugo De Vries), Theory of Natural selection (Darwin), Modern synthetic theory, origin of life and astrobiology.

**Unit 4: Geological and Evolutionary History**

Time scale, Era, Periods and Epoch, Evolution of plant forms through geological periods, evolutionary history of vertebrates through geological periods.

**Unit 5: Evolution of genes and Genomes**

Understanding Hardy-Weinberg Equilibrium to relate genetics and evolution, Co- Evolution, Altruism, Kin selection, Genetic drift.

**Course Code (BOT-MP-103)**  
**Laboratory work / Practicum**  
**(Credits: 1)**

1. Survey of adaptive features in local surroundings
2. Study of Natural Selection through different models
3. Numericals based on Hardy-Weinberg Law

**Suggested Readings:**

- 1: Evolution, Barton, N. H., Briggs, D. E.G., Eisen, J. A., Goldstein, A. E., Patel, N. H., Cold Spring Harbor Laboratory Press, New York, USA
2. Evolution by Bergstrom CT, Dugatkin LA, W. W. Norton & Company ;
3. Evolution by Futuyma DJ, Kirkpatrick M, Sinauer Associates, Inc., Sunderland, USA
4. Strickberger's Evolution by Hall BK, Hallgrímsson B, Jones & Bartlett Learning

**Discipline: Minor**  
**Course Code (BOT-MI-102)**  
**Microbes & Plants**  
**(Credits: 3)**

**Learning outcomes:**

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

- Understand the fundamental concepts related to microbes, algae, fungi and embryophytes
- Analyze the discovery and general structure of viruses
- Examine the morphology and life-cycles of some aquatic autotrophs
- Evaluate the significance of fungi and its different types
- Analyze the anatomy and reproduction of some flowerless seed bearing plants

**Unit 1: Bacteria & Viruses**

Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

**Unit 2: Fungi**

General characteristics, range of thallus organization, cell wall composition, nutrition, reproduction and classification; 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: Algae**

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 4: Bryophytes**

General characteristics, Classification, morphology, anatomy and reproduction of *Marchantia* *Anthoceros* and *Funaria*. Ecology and economic importance of bryophytes

**Unit 5: Pteridophytes & Gymnosperms**

General characteristics, classification, morphology, anatomy and reproduction of *Rhynia*, *Selaginella*, *Equisetum* and *Pteris*. Heterospory and seed habit, stelar evolution. Ecological and economical importance of Pteridophytes.

General characteristics, classification. morphology, anatomy and reproduction of *Cycas* and *Pinus*. Ecological and economical importance.

**Course Code (BOT-MP-102)**  
**Laboratory work / Practicum**  
**(Credits: 1)**

1. Study of bacterial cell from permanent slides/photographs
2. Gram staining technique
3. Study of vegetative and reproductive structures of *Oscillatoria*, *Nostoc*, *Chlamydomonas*, *Oedogonium*, diatoms through temporary preparations and permanent slides.
4. Specimens/photographs and tease mounts of *Rhizopus*, *Penicillium*, *Alternaria*, *Puccinia*, *Agaricus*,
5. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
6. Temporary / permanent slides of *Marchantia* / *Plagiochasma* / *Funaria*
7. Morphology and Temporary / permanent mount of *Selaginella*, *Equisetum*, *Pteris*.
8. *Cycas* (coralloid roots, rachis, leaflet (temporary slides) ovule, root (permanent slide).
16. *Pinus*- morphology (long and dwarf shoots), t.s. needle, stem, Cones

**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.

**Discipline: Skill Enhancement Course**

**Course Code: (BOT-SECT-102)**

**Biofertilizers**

**(Credits: 2)**

**Learning outcomes:**

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

- Develop their understanding on the concept of bio-fertilizer
- Identify the different forms of biofertilizers and their uses
- Compose the Green manuring and organic fertilizers
- Develop the integrated management for better crop production by using both nitrogenous and phosphate bio fertilizers and vesicular arbuscular mycorrhizal (VAM).
- Interpret and explain the components, patterns, and processes of bacteria for growth in crop production

**Unit I:**

Introduction to biofertilizer Definition and history; General account about the microbes used as biofertilizer; Working principles and role of biofertilizers in sustainable agriculture; Concept of synthetic microbial communities (SynCom); Current status of biofertilizer production in India and world – challenges and constraints.

**Unit II:**

Bacterial biofertilizer Isolation, identification, mass multiplication, carrier based inoculants of Rhizobium, Azospirillum, and Azotobacter. Cyanobacteria (blue green algae) as biofertilizer; cyanobacteria and Azolla in rice cultivation; Strain selection and mass production of Anabaena and Nostoc.

**Unit III:**

Fungal biofertilizer Mycorrhizal association; Types of mycorrhizal association; Taxonomy, occurrence and distribution; Colonization of Arbuscular Mycorrhizal (AM) fungi - isolation and inoculum production of AM fungi, and its influence on growth and yield of crop plants.

**Course Code (BOT-SECP-102)**  
**Laboratory work / Practicum**  
**(Credits: 1)**

1. Isolation of *Rhizobium* spp. from root nodules.
2. Isolation and detection of N-fixing and P-solubilizing isolates from rhizosphere.
3. Identification of bacterial biofertilizers: colony morphology, Gram staining and flagella staining etc.
4. Collection and identification of *Nostoc*, *Anabaena* spp. etc.
5. Collection and identification of *Azolla* spp.
6. Isolation and identification of ectomycorrhiza.
7. Photographs of arbuscules and vesicles.
8. Procedures for Quality Control of Biofertilizer – Mother culture test, Broth test, Peat test

**Suggested Readings:**

1. Deshmukh, A. M., Khobragade, R. M., and Dixit, P. P. (2007). Handbook of biofertilizers and biopesticides. Oxford Book Company.
2. Dubey, R.C. (2005). A Text book of Biotechnology. S. Chand & Co, New Delhi.
3. John Jothi Prakash, E. (2004). Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
4. Subha Rao, N.S. (2000). Soil Microbiology. Oxford & IBH Publishers, New Delhi.
5. Vayas, S.C, Vayas, S., and Modi, H.A. (1998). Bio-fertilizers and organic Farming Akta Prakashan, Nadiad.

**Discipline: Multidisciplinary Course**

**Course Code: (MDC-FSC-100)**

**General Biology**

**(Credits: 3)**

**Learning Outcome**

On the completion of this course, the students can demonstrate the ability to think critically

- About the biological meaning of life,
- Students will have a basic framework to identify the living systems from non living systems and identify the flaws in the counterarguments.
- Analyze and synthesize data from various sources and deal with problems and situations that don't have simple solutions or in a real-world context.
- Students will develop an appreciation for the biological world and a scientific temper.

**Unit I: Origin of Life**

Origin of the Universe and the Earth; Abiotic origin of life and Miller's experiment; Origin of polymers; Working definition of life; The first cell.

**Unit II: Basic Chemistry**

Elemental composition of biomolecules; Properties of Water; Hydrogen bonding and its biochemical properties; Concept of pH, pKa, and buffers; Basic structure and function of Biological Macromolecules.

**Unit III: Biological Organization**

Cell and Cell theory; Tissue and their types in animal and plants; System; Organs; Body Plan; Body Symmetry.

**Unit IV: Plant Diversity**

Salient features of Algae, Fungi, Bryophyta, Pteridophyta, Gymnosperm, and angiosperms

**Unit III: Animal Diversity**

Salient features of Protozoa, Porifera, Coelenterata, Platyhelminthes, Aschelminthes, Annelida, Mollusca, Arthropoda, Echinodermata, Protochordates, and Chordates

**Suggested Readings:**

1. Barnes RSK., Calow P, Olive PJW., Golding DW., Spicer JI., (2002): The Invertebrates: A New Synthesis, 3rd Edition, Blackwell Science.
2. Life: The Science of Biology (2012) Sadava et al., W.H. Freeman & Co. Ltd.
3. Biology, NCERT, New Delhi (PDF can be downloaded from the NCERT website).
4. Walter HE., Sayles LP., Biology of the Vertebrates, Macmillan.

**Discipline: Major**  
**Course Code (BOT-MT-203)**  
**Cell & Biomolecules**  
**(Credits: 3)**

**Learning outcomes**

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

- Develop understanding on chemical bonding among molecules
- Identify the concept that explains chemical composition and structure of cell wall and membrane
- Compare the structure and function of cells & explain the development of cells
- Describe the relationship between the structure and function of biomolecules
- Classify the sugars and fats and explain their structure

**Unit-I: The Cell**

History and scope of cell biology, Cell as a unit of structure and function; Universal features of cells; Characteristics of prokaryotic and eukaryotic cells - common and distinguishing features between them; Origin of eukaryotic cell (Endosymbiotic theory); Ultra-structure of plant and animal cells.

**Unit-II: Cell organelles and functions**

Structural organization, semiautonomous nature and function of Mitochondria and Chloroplast; Structures and roles of Endoplasmic reticulum, Golgi apparatus, Lysosomes, Peroxisomes, Vacuole, Glyoxisomes, and Ribosomes; Structure and functions of cytoskeleton; Nucleus and its organization.

**Unit-III: Cell wall and Cell membrane**

Chemistry, structure and function of plant and bacterial cell wall; Structure and function of plasma membrane; Models of membrane structure; Membrane transport; Endocytosis and exocytosis.

**Unit- IV: The molecules of cell**

Elemental composition of cells; Properties of water, hydrogen bonding and its biochemical properties; Biological macromolecules – Definition and types; Chemical bonds in biomolecules; Structure, classification and biological functions of carbohydrates and lipids.

**Unit-V: Nucleic acids and Proteins**

Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids. Proteins: Structure of amino acids; Levels of protein structure - primary, secondary, tertiary and quaternary; Biological roles of proteins.

**Course Code (BOT-MP-203)**  
**Laboratory work / Practicum**  
**(Credits: 1)**

1. Microscopic observation of prokaryotic cell (bacteria).
2. Study of plant cell structure with the help of epidermal peel mount of onion.
3. Study of cell and its organelles with the help of electron micrographs.
4. Measurement of cell size by the technique of micrometry.
5. Counting the cells per unit volume with the help of haemocytometer.
6. Cytochemical staining of DNA - Feulgen staining technique.
7. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.

**Suggested Readings:**

1. Gupta, P.K. (1999). A Text book of Cell and Molecular Biology. Rastogi Publications, Meerut, India.
2. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
3. Alberts B., Johnson A., Lewis J., Raff M., Roberts K., Walter P. (2008) Molecular Biology of the Cell. 5th edition. Garland Science, New York.
4. 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.

**Discipline: Minor**  
**Course Code (BOT-MI-202)**  
**Cytology & Genetics**  
**(Credits: 3)**

**Learning outcomes**

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

1. Understand the basics of genetics and Mendel's work.
2. Analyze patterns of inheritance and genetic variation.
3. Comprehend the mechanisms of chromosomal aberration and their consequences.
4. Know about the mechanisms of cell division and differentiation.

**Unit 1: Cell Cycle and Division**

Comparison of prokaryotic and eukaryotic cells

1. Cell Cycle Phases: Interphase (G<sub>1</sub>, S, G<sub>2</sub>, M phases)
2. Mitosis and Meiosis: Stages of mitosis / meiosis; Mechanisms and their significance

**Unit 2: Fundamentals of Genetics**

Contributions of Gregor Mendel and the development of classical genetics

1. Mendelian Genetics Mendel's laws of inheritance, Monohybrid and dihybrid crosses (Punnett squares, Test cross and Back cross).
2. Concept of dominance, segregation, and independent assortment

**Unit 3: Extension of Mendelian Genetics**

Incomplete dominance and codominance

Multiple alleles and gene interactions

Epistasis, pleiotropy, and polygenic inheritance

**Unit 4: Chromosomal Basis of Inheritance**

Chromosome theory of inheritance; Sex-linked inheritance

Chromosomal abnormalities (aneuploidy, euploidy, polyploidy, structural changes)

**Unit 5: Chromosome Structure and Function**

Types of chromosomes; Karyotypes and Ideograms

Sex chromosomes and sex determination

Concept of linkage and recombination

Chromosomal Aberrations: Types of chromosomal mutations (deletions, duplications, inversions, translocations), Causes of mutations

**Course Code (BOT-MP-202)**  
**Laboratory work / Practicum**  
**(Credits: 1)**

1. Mitosis, and study of chromosome morphology through squash preparation, including effect of chemicals on mitosis.
2. laws through seed ratios. Laboratory exercises in probability and chi-square.
3. Blood Typing: ABO groups & Rh factor.
8. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes.
9. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.
10. Study of human genetic traits: Sickle cell anemia, Xeroderma Pigmentosum, Albinism, red-green Color blindness, Widow's peak, Rolling of tongue, Hitchhiker's thumb and Attached earlobe.

**Suggested Readings:**

1. "Molecular Biology of the Cell" by Alberts et al.
2. "Genetics: Analysis and Principles" by Robert J. Brooker
3. "Essential Cell Biology" by Alberts et al.
4. "Principles of Genetics" by Snustad and Simmons

**Discipline: Skill Enhancement Course**

**Course Code: (BOT-SECT-202)**

## **Mushroom Cultivation**

**(Credits: 2)**

### **Learning outcomes:**

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

- Recall various types and categories of mushrooms.
- Demonstrate various types of mushroom cultivating technologies.
- Examine various types of food technologies associated with mushroom industry.
- Value the economic factors associated with mushroom cultivation
- Device new methods and strategies to contribute to mushroom production.

### **Unit 1:**

Introduction, history. General morphology and distinguishing characteristics, Nutritional and medicinal value of edible mushrooms, Poisonous mushrooms. Types of edible mushrooms available in India –*Volvariella volvacea*, *Pleurotus citrinopileatus*, *Agaricus bisporus* .

### **Unit 2:**

Diseases of mushrooms and their management.

### **Unit 3:**

Mushroom Cultivation Technology : Infrastructure required, Mushroom Substrate selection, substrate soaking, pasteurization bagging, spawning, culture rack, Mushroom bed (preparation and types), mushroom unit (Thatched house) incubation and harvesting, Storage marketing and Economics of Mushroom cultivation.

**Course Code (BOT-SECP-202)**  
**Laboratory work / Practicum**  
**(Credits: 1)**

1. Different parts of a typical mushroom & variations in mushroom morphology.
2. Sterilization of glassware, equipments, and culture media used in mushroom cultivation.
3. Preparation of culture media: Potato Dextrose medium, Richards medium.
4. Preparation of spawn: Grain spawn, Straw spawn, Sawdust spawn.
5. Preparation of compost and known compost formulations.
6. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves.
7. Cultivation of White button mushroom.
8. Cultivation of Paddy straw mushroom.
9. Cultivation of Oyster mushroom.
10. Nutrient profiling and Medicinal value of mushrooms.
11. Hands on training in Mushroom cultivation farm.
12. Visit to regional Mushrooms farms/labs.

**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, P. and Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Bahl, N. (1984-1988). Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

**Discipline: Multidisciplinary Course**

**Course Code: (MDC-FSC-200)**

**Ecology & Environment**

**(Credits: 3)**

**Learning outcomes:**

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

- Comprehend the basic concepts of plant ecology and environment
- Analyze the characteristics of different plant communities.
- Examine the structure and functions of eco-system.

**Unit: 1 Introduction**

Introduction to the environment; nature of the environment; Environmental problems; Human relationship with the environment; Need of awareness; Definition, scope, and importance of Environmental Science.

**Unit – II: Basics of Environment**

Factors -Abiotic and biotic factors; Components of Environment and their interactionsatmosphere, hydrosphere, lithosphere, and biosphere.

**Unit - III: Ecology**

Definition; Autecology and Synecology; Habitat; Population, Community, Ecological succession.

**Unit -IV: Ecosystem**

Definition, structure, functions, and types of ecosystems; Food chain and food webs:Energy flow;Ecological pyramids.

**Unit - V: Biogeochemical cycles**

Definition and types, Gaseous Cycle and Sedimentary Cycle (detail study with suitable examples).

**Suggested Readings:**

1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4 edition. Hall, U.S.A.
2. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India.
3. Singh, J.S., Singh, S.P. and Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
4. Ambasht R. S. and Ambasht P. K. (1999) Environment and Pollution. C. B. S. Publishers & Distributers, New Delhi.
6. Verma, P.S. and Agrawal, V. K. (2010). Environmental Biology. S. Chand and Company Ltd., New Delhi.

**Discipline: Major**  
**Course Code (BOT-MT-303)**  
**Microbial Diversity**  
**(Credits: 3)**

**Learning Outcomes**

After completion of this course, the student shall be able to:

- Describe the fundamental concepts and terminology of taxonomic organization and parameters used in classifying bacteria, viruses, fungi and lichens.
- Explain the evolutionary relationships and molecular phylogenetics that underpin microbial diversity.
- Evaluate the importance of microbial diversity in biotechnology, agriculture, health, and climate change.
- Demonstrate bacteria count by serial dilution and identify different types of bacteria using various media.
- Analyze microbes microscopically using staining methods.

**Unit-I: Introduction to Microbial World**

History of development of microbiology; Systematic approach to microbial world; Types of microorganisms - Acellular and Cellular microorganisms (Prokaryotic and Eukaryotic), and their general characters with examples; Economic importance of microbial diversity.

**Unit-II: Bacteria & Archaea**

A brief account of bacteria and archaea; Cellular organization: cell size, shape and arrangement, capsule and slime, flagella, and pili; Cell wall - composition and structure of Gram-positive and Gram-negative cell walls, cell wall of archaea, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms; Cell membrane - structure, function and chemical composition of bacterial and archaeal cell membranes; Genetic material, plasmid; Nutrition, growth, and reproduction.

**Unit-III: Acellular microorganisms**

Viuses: Discovery, general structure, classification (Baltimore), replication (general account); Bacteriophages – lytic and lysogenic cycle, RNA virus (TMV), Economic importance of viruses. Viroids, Virusoids and Prions.

**Unit-IV: Fungi**

Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; life cycle of *Synchytrium* (Chytridiomycota), *Rhizopus* (Zygomycota), *Penicillium*, *Alternaria* (Ascomycota), *Puccinia*, *Agaricus* (Basidiomycota), Mycorrhiza.

**Unit-V: Lichens**

**General Characteristics: Habit and habitat of Lichens.** Types: Crustose, Foliose, Fruticose, Squamulose, Leprose etc. Classifications: Hawksworth and Hill (1984), Alexopoulos and Mims (1979), Zahlbruckner (1926), Modern Molecular Phylogenetic Classification. Lichen Structure: Internal, external, and specialized structures. Lichen Reproduction: Vegetative, asexual, and Sexual. Importance: Economics, Industrial, and Ecological uses.

**Course Code (BOT-MP-303)**  
**Laboratory work / Practicum**  
**(Credits: 1)**

1. Microscopic observation of prokaryotic cell (bacteria).
2. Gram-staining of bacteria.
3. Electron micrographs/Models of viruses: T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
4. *Rhizopus* and *Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.
5. *Alternaria*: Specimens/photographs and tease mounts.
6. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat, Section/tease mounts of spores on Wheat and permanent slides of the host.
7. *Agaricus*: Specimens of button stage and full grown mushroom, Sectioning of gills of *Agaricus*.
8. Mycorrhiza: ectomycorrhiza and endomycorrhiza (Photographs)
9. Lichens: Study of growth forms of lichens.

**Suggested Readings:**

1. Wiley, J.M, Sherwood, L.M. and Woolverton, C.J. (2013). Prescott's Microbiology. 9th Edition. McGraw Hill International.
2. Sharma T.A., Dubey, R.C. and Maheshwari, D.K. (1999). A Text Book of Microbiology. S Chand and Co, New Delhi.
3. Pelczar, M.J. (2001). Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
4. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
5. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4<sup>th</sup> edition.

**Discipline: Major**  
**Course Code (BOT-MT-304)**  
**Plant Diversity**  
**(Credits: 3)**

**Learning outcomes**

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

- Demonstrate an understanding of algae and archegoniatae
- Develop critical understanding on morphology, anatomy and reproduction of Algae, Bryophytes, Pteridophytes and Gymnosperms
- Understanding of plant evolution and their transition to land habitat.
- Demonstrate proficiency in the experimental techniques and methods of appropriate analysis of Bryophytes, Pteridophytes, Gymnosperms

**Unit 1: Introduction**

Introduction to Plant Kingdom: Thallophytes; Archegoniates, Cryptogams, Tracheophytes, Spermatophytes, etc.

**Unit 2: Algae**

General characteristics; Ecology and distribution; Range of thallus organization; reproduction and life cycle patterns; Classification of algae (proposed by F.E. Fritsch and G.M. Smith); Morphology and life-cycles of the following genera: *Nostoc*, *Chlamydomonas*, *Oedogonium*, *Ectocarpus*, *Polysiphonia*; Economic importance of algae.

**Unit 3: Bryophytes**

General characteristics; Ecology; Alternation of generation; Affinities with algae and pteridophytes; Classification of Bryophytes; Gametophytic and sporophytic organizations in *Riccia*, *Marchantia*, *Anthoceros*, *Sphagnum*, and *Funaria* (Developmental details not to be included); Economic importance of bryophytes.

**Unit 4: Pteridophytes**

Characteristic features, Affinities with bryophytes and gymnosperms, classification (A.J. Eames & Tippo, and Smith), morphology, anatomy, and reproduction in *Rhynia*, *Selaginella*, *Equisetum*, and *Pteris* (Developmental details not to be included). Heterospory and seed habit, Origin and type of Steles in pteridophytes.

**Unit 5: Gymnosperms**

General characters, Affinities with pteridophytes and angiosperms, Classification, Morphology, anatomy, and reproduction in *Cycas* and *Pinus* (Developmental details not to be included). Economic importance of gymnosperms.

**Course Code (BOT-MP-304)**  
**Laboratory work / Practicum**  
**(Credits: 1)**

1. Microscopic observation of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas*, *Volvox*, *Oedogonium*, *Coleochaete*, *Chara*, *Vaucheria*, *Sargassum* / *Ectocarpus*, *Fucus* and *Polysiphonia* through temporary preparations and permanent slides.
2. *Riccia*/ *Marchantia*/ *Plagiochasma*- Morphology of thallus, whole mount of rhizoids and Scales, VS of thallus (temporary slide), VS of Antheridiophore, Archegoniophore, LS of Sporophyte (all permanent slides).
3. *Anthoceros*- Morphology of thallus, dissection of sporophyte (temporary slide), VS of thallus (permanent slide).
4. *Bryum* /*Funaria*- Morphology, whole mount of leaf, rhizoids, sporophyte (temporary slides); permanent slides showing antheridial and archegonial heads, LS of capsule.
5. *Selaginella*- Morphology, whole mount of leaf with ligule, TS of stem, whole mount of strobilus, whole mount of microsporophyll and megasporophyll (temporary slides), LS of strobilus (permanent slide).
6. *Equisetum*- Morphology, TS of internode, LS of strobilus, whole mount of sporangiophore, whole mount of spores (temporary slide), TS of rhizome
7. *Pteris*- Morphology, TS of rachis, VS of sporophyll, whole mount of sporangium, whole mount of spores (temporary slides), TS of rhizome, whole mount of prothallus with sex organs and young sporophyte (permanent slide).
8. *Cycas*- Morphology (coralloid roots, leaf), TS of coralloid root, TS of rachis, VS of leaflet, whole mount of spores (temporary slides), LS of ovule, TS of root (permanent slide).
9. *Pinus*- Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and female cones), TS of needle, TS of stem, whole mount of Microspores (temporary slides)

### **Suggested Readings**

1. Singh, Pande, Jain (2022), A Text Book of Botany, Vth Edition, Rastogi Publication, Meerut.
2. Bhattacharya, Hait, Ghosh (2018), A Text Book of Botany, Vol-I, New Central Book Agency (NCBA), Kolkata
3. Vashishta B.R., Sinha A.K. and Singh V. P. (2008). Botany for Degree Students: Algae. S Chand and Co, New Delhi.
4. Campbell, N.A., Reece, J.B., Urry, L.A., Cain, M.L., Wasserman, S.A., Minorsky P.V. and Jackson, R.B. (2008). Biology, 8<sup>th</sup> edition. Pearson Benjamin Cummings, USA.
5. Vashishta, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.
6. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International Publishers, New Delhi, India.
7. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot, Allahabad.
8. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, New Delhi.

**Discipline: Minor**  
**Course Code (BOT-MI-302)**  
**Biology of Flowering Plants**  
**(Credits: 3)**

**Learning outcomes:**

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

- Understand the fundamental concepts of plant anatomy, morphology, embryology, taxonomy and botanical nomenclature
- Analyze and recognize the different organs of plant and secondary growth.
- Evaluate the structural organization of flower and the process of pollination and fertilization.
- Evaluate the significance of herbarium

**Unit 1: Morphology**

**History:** plant morphology. Classification of plants, Technical terms related to plant morphology.

**Leaf:** parts, functions, types, duration, venation, shape, arrangement, leaf insertion, margin, stipules (types), Phyllotaxy, Heterophylly, modifications of leaf; **Stem:** Forms, Types and modifications (aerial, sub aerial and underground, special); **Root:** parts, types, and modifications; **Flower:** parts, floral whorls (Calyx, Corolla: forms, aestivation; androecium, gynoecium, pistil; **Fruit:** Classification (simple, aggregate, composite), Fruit and seed dispersal

**Unit 2: Anatomy**

Classification of tissues (Simple and complex)

Root and shoot apical meristems, Organization of shoot and root apex (Apical cell theory, Histogen theory, Tunica Corpus theory, Korper-Kappe theory), Quiescent centre, Root cap, Epidermis, cuticle

Structure of dicot and monocot root, stem and leaf, Primary vs. secondary growth, Secondary growth in root and stem, Sapwood and heartwood, Early and latewood, Tyloses, Lenticels.

**Unit 3: Embryology**

Flower composition; Structure of anther and microsporogenesis, Structure and germination of Pollen grains; Megasporangium (ovule) and their types; Development of embryo sac (Monosporic, bisporic, tetrasporic); Polination, and their types; Double fertilization and triple fusion; Endosperm, Development of embryo

**Unit 4: Botanical Nomenclature**

ICBN and ICN; Rules and recommendation of botanical nomenclature; Taxonomic hierarchy; Classification types and outline of Bentham and Hooker's system of classification

**Unit 4: Taxonomy**

Economic importance, systematics, vegetative and floral characters of some dicot and monocot families (Brassicaceae, Papaveraceae, Solanaceae, Fabaceae, Asteraceae, Poaceae)

**Course Code (BOT-MP-302)**  
**Laboratory work / Practicum**  
**(Credits: 1)**

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma), Macerated xylary elements, Phloem (Permanent slides, photographs)
3. Stem: Monocot and Dicot (Temporary/Permanent slides).
4. Root: Monocot and Dicot (Temporary/Permanent slides).
5. Leaf: Monocot and Dicot (Temporary/Permanent slides).
6. Adaptive anatomy: Xerophyte/Hydrophyte.
7. 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*
  - Papaveraceae – *Argemone*
  - Myrtaceae – *Callistemon*
  - Asteraceae - *Sonchus/Ageratum/Marigold*
  - Solanaceae – *Datura*
  - Poaceae- *Triticum*
8. Field visit (local or outside depending on situation) –
9. Mounting of a properly dried and pressed specimen of any 20 wild plant with Herbarium label (to be submitted in the record book).

**Suggested Readings**

1. 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.
2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.
3. Principle of Angiospermic Taxonomy, PH Davis, VH Heywood (1991), Today & Tomorrow Publications, New Delhi
4. Fundamentals of Plant Systematics, AE Radford (1986), Harper & Row Publications, USA.
5. Principles of Plant Taxonomy, VVSivarajan (1999), Oxford & IBH Publishing Co., New Delhi.
6. Contemporary Plant Systematics, DW Woodland (1991) Prentice Hall, New Jersey
7. Plant Taxonomy, OP Sharma (2009) Tata McGraw Hill, Mumbai
8. Taxonomy of Angiosperms, BP Pandey (2007) S Chand & Co., New Delhi
9. Plant Systematics - Theory and Practices, Gurucharan Singh, Oxford and I.B.H. Publishing Co. New Delhi
10. Bhojwani & Bhatnagar (2022), Vikas Publication, New Delhi

**Discipline: Skill Enhancement Course**

**Course Code: (BOT-SECT-302)**

## **Floriculture**

**(Credits: 2)**

### **Learning outcomes:**

After completing this course the learner will be able to;

- Develop conceptual understanding of gardening from historical perspective
- Analyze various nursery management practices with routine garden operations.
- Distinguish among the various Ornamental Plants and their cultivation
- Evaluate garden designs of different countries
- Appraise the landscaping of public and commercial places for floriculture.

### **Unit I**

Importance and scope of floriculture and landscape gardening; 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 II**

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 fern allies; Indoor plants; Bonsai.

### **Unit III**

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.

Commercial Floriculture: Factors affecting flower production; Diseases and Pests of Ornamental Plants.

**Course Code (BOT-SECP-302)**  
**Laboratory work / Practicum**  
**(Credits: 1)**

1. Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolus, Marigold, Rose, Lilium, Orchids).
2. Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting.
3. Sowing/raising of seeds and seedlings, Transplanting of seedlings

**Suggested Readings**

1. Randhawa, G.S. and Mukhopadhyay, A. (1986). Floriculture in India. Allied Publishers.
2. Adams, C., M. Early and J. Brrok (2011). Principles of Horticulture. Routledge, U.K.
3. Kumar, N. (1997) Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.