S.S. JAIN SUBODH P.G. COLLEGE, (AUTONOMOUS)

JAIPUR

(Affiliated to University of Rajasthan)

SYLLABUS

SCHEME OF EXAMINATION AND COURSES OF STUDY

As per NEP Scheme
Session 2026-27
FACULTY OF SCIENCE
DEPARTMENT OF BOTANY

Three/Four Years Course
Bachelor of Science Specialization
Subject: Botany

B.Sc. Botany course structure and Examination Scheme under CBCS and NEP

Semester	Theory/Practical	Course Title	Credit	Marks	External EoSE	Internal CIA 1
Sem.I	Theory	Paper I Cell Biology, Genetics and Plant Breeding	4	100	70	30
	Theory	Paper-II Diversity of Plant Kingdom	4	100	70	30
	Botany Practical	Practical I	2	50	30	20
		Practical II	2	50	30	20
Sem.II	Theory	Paper-I Plant Biochemistry and Physiology	4	100	70	30
	Theory	Paper-II Ecology and Plant Resource Utilization	4	100	70	30
	Botany Practical	Practical I	2	50	30	20
		Practical II	2	50	30	20

B.Sc. Sem-I

Paper I- Cell Biology, Genetics and Plant Breeding

Objectives of the Course

- To understand the structural organization of cells.
- To understand structure and functions of different organelles in the cell.
- To understand the concept of cell division, mutations and chromosomal aberrations.
- To understand basic laws of inheritance and variations.
- To understand various gene interactions.
- To understand basics of plant breeding methods and other crop improvement strategies.

Course Learning Outcomes:

At the completion of the course, the student would be able to learn:

- Learn, understand and develop skill and hands on training in basics of cell biology, genetics and plant breeding.
- The functions and structural properties of different types of cells and their organelles.
- Cycle of cell division, gene interactions, DNA damage and repair mechanisms.
- Principles of crop improvement strategies.
- The structural and functional aspects of cells and cellular organelles.
- Various stages of cell cycle and cell division.
- Inheritance and various types of gene interactions. Basics methods of plant breeding and crop improvement.
- Variations in functions of cell organelles.
- Concept of cell cycle, functions of cell membrane, chromosomal alterations. Possibilities of mutations and mutagens.
- Role of gene interactions in phenotype development.
- Implying of plant breeding methods for crop improvement.

UNIT I

Ultrastructure of Cell and Cell Organelles: Eukaryotic and Prokaryotic cell structure; Ultrastructure and functions of different cell organelles (Cell wall, Plasma membrane, Nucleus, Mitochondria, Chloroplast, Ribosome, Peroxisomes, Lysosome, Golgi bodies and Endoplasmic Reticulum); Basic idea of Mitochondrial and Chloroplast genome. Gene and DNA: Genome, Gene, Double helical structure of DNA, DNA supercoiling, Gene structure. Chromosome organization: chromatin Structure and chromosome organization, Chromosome Morphology, Specialized types of chromosomes: Sex chromosomes, Lambrush and Polytene chromosomes. 15 hrs

UNIT II

Cell Division: Basic idea of Cell cycle; Different stages of mitosis; Different stages of Meiosis I and Meiosis II, synaptonemalc omplex, chiasmata formation and crossing over. Structural and numerical aberrations in human chromosomes and ploidy in plants: Deletion, Duplication, Translocation, Inversion, Aneuploidy and Polyploidy. Genetic material: DNA as genetic material (Griffith's transformation experiment and Hershey and Chase blender experiment); structure of DNA (Watson

and Crick Model); Structure and function of different types of RNA (rRNA, m RNA, tRNA, sn RNA). Mutations: Types of Mutations, Spontaneous and induced Mutations, Physical and Chemical mutagens. 15 hrs

UNIT III

Genetic inheritance: Mendel's laws of inheritance and their exceptions; allelic (incomplete dominance, co-dominance, lethality) and non-allelic interactions (complementary genes, epistasis and duplicate genes); Multiple allelism (ABO blood groups in men); Quantitative inheritance (Grain color in wheat). Cytoplasmic inheritance: Plastid inheritance (different types of leaves in *Mirabilis jalapa*); Mitochondrial inheritance (Cytoplasmic male sterility in plants). DNA damage and repair: Causes of DNA damage and molecular mechanisms of repair - excision repair system in bacteria, base excision, recombination repair systems and SOS repair. Plant breeding: History and objectives of plant breeding. Types of plant reproduction (vegetative, asexual and sexual); Modes of pollination (Self and Cross); relevance of mode of reproduction to plant breeding; their effect on generating and fixing genotypic variation. Types of crop plants for plant breeding (self-pollinated, cross-pollinated and vegetatively propagated crop plants). **15 Hrs**

UNIT IV

Plant introduction and acclimatization: Purpose, Types (primary and secondary), Procedure, merits and demerits and achievements. Plant introduction agencies in India (NBPGR, FRI, BSI). Famous Indian and International plant breeders and their contributions. National and International agricultural research institutes. Inbreeding: Pure and inbred lines, methods of inbreeding, its genetic effects (inbreeding depression), its practical applications. Hybridization: Meaning, objectives, types, procedure, various methods of emasculation, genetic effects (hybrid vigor), its practical applications. Role of mutation and polyploidy in plant breeding (with examples). Methods of plant improvement: Selection (Pureline and mass selection); hybridization methods in self-pollinated plants (Pedigree and Bulk method) and in cross-pollinated crops (single and double cross); Interspecific hybridization. Plant breeding work done on wheat and rice in India, Green revolution. **15 Hrs**

Suggested Laboratory Exercises:

1. Study of cell structure from Onion, Hydrilla and Spirogyra.
2. Study of cyclosis in Tradescantia spp.
3. Study of plastid for pigment distribution in Lycopersicom, Cassia and Capsicum. Study of electron microphotographs of eukaryotic cells for various cell organelles. Study of electron microphotographs of virus, bacteria and eukaryotic cells for comparative study of cellular organization.
4. Study of different stages of mitosis and meiosis in root-tip cells and flower buds, respectively of onion.
5. To solve genetic problems based upon Mendel's laws of inheritance: Monohybrid, Dihybrid, Back cross and test cross.
6. Permanent slides/photographs of different stages of mitosis and meiosis, sex chromosomes, polytene chromosome and salivary gland chromosomes, Emasculation, bagging & tagging techniques
7. Permanent slides/photographs of different stages of mitosis and meiosis, sex chromosomes, Polytene chromosome and Lampbrush chromosomes.
8. Genetic Problems on Monohybrid cross.
9. Genetic Problems on Dihybrid cross.
10. Genetic Problems on Non-Mendelian Interactions.
11. Demonstration of Emasculation and hybridization.
12. Study of Famous Indian and International plant breeders and their contributions. Study of

National and International agricultural research institutes.

Suggested Books and References: -

1. Albert B., Johnson A., Lewis J., Raff M., Roberts K. and Walter P. 2014. Molecular biology of the cell. Garland Sciences, 6th edition.
2. Gupta P.K. 1999. A textbook of cell and molecular biology, Rastogi publication, Meerut.
3. Lodish and Darnell J. 2000. Molecular cell (4th edition). W.H. Freeman & Co. New York, USA.
4. Cooper G. 2018. The Cell: A molecular approach. Sinauer Associates Inc, 8th edition.
5. De Roberts E. D. P. and De Roberts E. M. F. 2010. Cell and Molecular Biology. Walters Kluwer, 8 th edition.
6. Karp G., Iwasa J. and Marshall W. 2018. Cell Biology. Wiley publication., 8th edition.
7. Pollard. T. D. and Earnshaw, W.C. 2002. Cell Biology. Saunders, 3rd edition.
8. Pierce, B. A. (2012). Genetics: a conceptual approach. Macmillan publication.
9. Snustad, D. P., & Simmons, M.J. (2015). Principles of genetics. John Wiley & Sons.
10. Gupta, P.K. (2010). Cytogenetics. Rastogi Publications, Meerut, India.
11. Lewin, B., Krebs, J., Kilpatrick, S. T., & Goldstein, E. S. (2011). Lewin's genes X. Jones & Bartlett Learning.
12. Choudhary, H.K. Elementary Principles of Plant Breeding. Oxford and IBM Publishing Co., New Delhi, 1989.
13. Miglani, GS.: Advanced Genetics, Narosa Publishing House, New Delhi (2000). 14.Russel, PI Genetics. The Benjamins/Cummings Publishing Co., Inc. U.S.A. (1998).
14. Singh, B. D.: Plant Breeding-Principles and methods, Kalyani Publishers, New Delhi (1990)
15. Shukla, R.S. and Chandel, P.S.: Cytogenetics, Evolution and Plant Breeding, S. Chand & Co. Ltd., New Delhi (2000).
16. Singh, R. B.: Text Book of Plant Breeding, Kalyani Publishers, Ludhiana (1999).
18. Lodish,HF.Berk,A.Kaiser,CA,Krieger, M.Bretscher, A.Ploegh, H.Aman, A. Martin, K. (2016). Molecular Cell Biology (8th Ed.). New York.

B. Sc. Sem - I
Paper- II, Diversity of Plant Kingdom

Objectives

- To understand microscopic to macroscopic view of the plants.
- To differentiate algal members from different class of the kingdom Algae.
- To understand structure and reproduction in bryophytes.
- To understand difference between Hepaticopsida, Anthocerotopsida and Bryopsida.
- To interpret structure, reproduction, life cycle and economic importance of Lichens.

Course learning outcomes

- To make students aware of the diversity of plants present on various habitats.
- To understand microscopic to macroscopic view of the plants.
- To interpret the amphibious to symbiotic relationship of the plants.
- To learn Diagrammatic representation of the algae, bryophytes and lichens.
- To understand habit, habitat, thallus organization of various members.

- To understand typical type of life cycles found in algae and bryophytes.
- To understand economic importance of algae, bryophytes and lichens.
- To identify algae, bryophytes and lichens microscopically.

UNIT-I

Algae: general characters, classifications (Fritsch) up to classes. Diverse Habitat. Range of thallus structure. Reproduction (Vegetative, Asexual, Sexual). Types of the life cycle. Type studies of: Chlorophyceae- *Volvox, Chara*; Xanthophyceae- *Vaucheria*; Phaeophyceae- *Ectocarpus*; Rhodophyceae- *Polysiphonia*. Lichens- General characters, habitat, morphology and reproduction.

Fungi: General characteristics; Thallus organization; types of fruiting bodies; cell wall composition; Heterokaryosis and parasexuality; Nutrition; Classification (Alexopoulos); reproduction, economic importance. Type studies: Oomycota: *Phytophthora*, Zygomycota: *Rhizopus*, Ascomycota: *Peziza*, Basidiomycota: *Agaricus*. **15 Hrs**

UNIT-II

Bryophytes: General characters, Origin, and evolution of Bryophyta. Classification (Rothmaler), Habitat, Range of thallus structure, Reproduction (Vegetative and Sexual), Alternation of generations and Economic importance. Study of Morphology, Anatomy, Reproduction, Gametophytes and Sporophytes of Riccia, *Marchantia and Funaria*. **15 Hrs**

UNIT-III

Pteridophytes: General characters of pteridophytes, affinities with bryophytes and gymnosperms, classification, economic importance, study of life histories of fossil Pteridophytes – *Rhynia*. Type studies Life histories of *Selaginella*- (Heterospory and seed habit), *Equisetum, Pteris, Lycopodium*. **15 Hrs**

UNIT- IV

Gymnosperms: General Characters, classification, Gymnosperms: Type studies Life histories of *Cycas* and *Pinus*, economic importance of gymnosperms. Angiosperms: General characters, Differences between Monocotyledons and Dicotyledons, Typical life cycle of Angiosperm. **15 Hrs**

Suggeted Laboratory Exercises:

- Visit Local Garden/fieldstudy of plants.
- Study of anatomy by making suitable temporary slides and study of permanent slides of *Volvox, Chara, Vaucheria, Ectocarpus, Polysiphonia* (vegetative and reproductive).
- *Lichens*: Study of growth forms of lichens (Crustose, foliose and fruticose)
- *Rhizopus*: Study of asexual stage from temporary mounts and sexual characters through permanent slides. *Peziza*: ascospores; *Agaricus*: specimens of button stage and full-grown mushroom; sectioning of gills of *Agaricus.*
- Bryophytes- methodology of vegetative and reproductive stages of *Riccia, Marchantia,* and *Funaria*.

- Pteridophytes- study of vegetative and reproductive stages of *Selaginella* – (Heterospory and seed habit), *Equisetum, Pteris, Lycopodium*

- study of vegetative and reproductive stages of *Cycas* and *Pinus* using temporary and permanent slides.

- Study of monocot and dicot flowers and seeds.

Suggested Readings:

- Alexopoulos, C. J. and Mims, C. W.; Introductory Mycology, John Wiley and Sons, New York, 2000.

- Dube, H. C. : Fungi, Rastogi Publication, Merrut, 1989.

- Vashishtha, B. R. Botany for Degree Students – Fungi, S. Chand & Co., New Delhi 2001.

- Gilbart, M. Smith: Cryptogamic Botany, Vol. I & II (2nd Ed.) Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1985.

- Kumar, H. D.: Introductory Phycology, Affiliated East-West Press Ltd. New York, 1988.

- Puri, P.: Bryophytes, Atmaram & Sons. Delhi, Lucknow, 1985.

- Aneja, K. R.: Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International (P) Ltd. Publishers, New Delhi 2003.

- Pandey, B. P. 2022. Algae, Bryophytes and Lichens. S. Chand Publication.

B. Sc. Sem-II
Paper-I, Plant Biochemistry and Physiology

Objectives of the course:

- Provide students with learning experiences that help in deep interests in learning plant biochemistry and physiology.
- Develop broad and balanced knowledge and understanding of biomolecules, key biochemical concepts, principles and theories related to biochemistry.
- Equip students with appropriate tools of analysis and with theoretical, technical and analytical skills to tackle issues and problems in the field of biochemistry and plant physiology.
- Understand the plant nutrient uptake and translocation, photosynthesis, respiration and nitrogen metabolism.
- Understand the effects of various factors on the growth and development of plants.

Course Learning Outcomes:

After completing this course, the learner will be able to:

- Demonstrate foundational knowledge of biochemistry, including water properties, amino acids, proteins, enzymes, carbohydrates, lipids, and nucleic acids.
- Explain and analyze plant–water relations, mineral nutrition, and mechanisms of uptake, transport, and translocation in plants.
- Describe and evaluate the processes of photosynthesis and respiration (aerobic, anaerobic,

fermentation), including energy transformations and regulatory factors.

- Interpret nitrogen metabolism pathways and the physiological role of major plant growth regulators in plant growth and development.
- Explain phases of growth, seed dormancy, germination, biological rhythms, photoperiodism, vernalisation, and flowering mechanisms (florigen and phytochrome).
- Integrate biochemical and physiological concepts to understand plant life processes and apply them in experimental, analytical, and applied biological contexts.

Unit – I

Overview of Biochemistry: Definition, scope, and significance of Biochemistry. Important discoveries in Biochemistry. A summary of elements, chemical reactions, and biomolecules in living organisms. Properties of water: Molecular structure of water, physico-chemical properties of water. Its effect on biomolecules, its importance to plant life, and the concept of water potential. Proteins: Amino acids-structure, electrochemical properties, peptide bonds, chemical bonds and nomenclature, structure and classification of proteins, physical and chemical properties. Enzymes: Structure, nomenclature & classification of enzymes. Characteristics of enzymes, mechanism of action, multi-enzyme system, and regulation of enzyme activity. **15 Hrs.**

Unit – II

Carbohydrates: Introduction, importance, nomenclature, classification, molecular structure & functions of mono, di, and polysaccharides, their properties, glycosidic linkages, and glycoproteins. Lipids: Introduction, nomenclature, classification, molecular structure & functions. Importance of fatty acids (saturated and unsaturated). Alpha and Beta oxidation. Nucleic acids: DNA: Composition, Nucleosides and nucleotides. Chargaff's rule. Watson and Crick model of DNA. Melting of DNA (Tm). RNA: Composition, types (mRNA, rRNA, and tRNA), secondary structures of tRNA – clover leaf model. Chemical reactions of RNA and DNA with acids and alkali. **15 Hrs.**

Unit – III

Plant-water relations: Absorption and Transport of water, Ascent of sap, Transpiration and its significance; factors affecting transpiration; root pressure and guttation. Mineral nutrition: role of essential elements; transport of ions across cell membrane, active and passive transport, carriers, channels and pumps. Transport of organic substances: Mechanisms of phloem transport, factors regulating the translocations of nutrients. Photosynthesis: Pigments, Photosynthetic apparatus, light reaction, photosystem I & II, Z scheme, photophosphorylation, C3 (Calvin cycle), C4 cycle, and factors affecting the photosynthesis. Respiration: Aerobic and anaerobic respiration, RQ (Respiratory Quotient), Krebs' cycle, electron transport system, oxidative phosphorylation, and factors affecting the process. Fermentation. **15 Hrs**

Unit-IV

Nitrogen metabolism: Biological nitrogen fixation; nitrate and ammonia assimilation. Plant growth regulators: Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene. Phases of growth and development: Seed dormancy and germination, plant movement, Biological clocktheir regulatory factors. Photoperiodism &vernalization; physiology and mechanism of action, concept of florigen and phytochrome. **15 Hrs**

Suggested Laboratory Exercises:

1. To separate amino acids in a mixture by paper chromatography.
2. To prepare the standard curve of protein. 3. To demonstrate the tests for proteins in the unknown samples.
4. To demonstrate the enzyme activity – Catalase, peroxidase and amylase.
5. To demonstrate the tests for different types of carbohydrates and lipids.
6. Conductometric titration of strong acid against strong base.
7. Conductometric titration of weak acid (amino acid) against strong base.
8. Carbohydrates – Molisch, Benedict's / Fehling's, picric acid, Barfoed's, Bial's, Selivanoff's, osazone tests. Glucose, fructose, lactose, maltose and sucrose.
9. Proteins – Precipitation reactions of proteins, colour reactions of proteins -Biuret, xanthoproteic, Millon's,
10. Colour reactions of amino acids like tryptophan, tyrosine, cysteine, methionine, arginine, proline and histidine.

11. Lipids – sulphide, acrolein test, Salkowski test, Liebermann-Burchard test.
12. Qualitative tests for nucleic acid.
13. To determine the osmotic potential of vacuolar sap by plasmolytic method.
14. To study the permeability of plasma membrane using different concentrations of organic solvents.
15. To study the effect of temperature of permeability of plasma membrane.
16. To separate chloroplast pigments by solvent method.
17. To separate chloroplast pigments using paper chromatography. 18. Bioassay of growth hormone (auxin, cytokinin, gibberellin).
19. Demonstration of phenomenon of osmosis by use of potato osmometer.
20. To demonstrate root pressure.
21. To demonstrate rate of transpiration by use of potometers.
22. Photosynthesis by inverted funnel method, Moll's experiment.
23. To demonstrate anaerobic and aerobic respiration.
24. R. Q. by Ganong's respirometer.
25. Measurement of growth using auxanometer.

Suggested Books and References:

1. Buchanan, B., Gruissem, G. and Jones, R. (2000). Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, USA.
2. Davies P. J. (2004). Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, the Netherlands.
3. Hopkins, W. G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley and Sons, U.S.A. 4th Edition.
4. Nelson, D.L., and Cox, M.M. (2008). Lehninger Principles of Biochemistry (5th Ed.).
5. W.H. Freeman & Co., New York. Parashar, A. N. and Bhatia, K. N.: Plant physiology. Trueman Book Company, 1985.

Suggested E-resources: nptel.ac.in

B.Sc. Sem-II
Paper- II Ecology and Plant Resource Utilization

Objectives of the Course:

- To make students understand ecology and basic ecological concepts.
- To gain the knowledge on the economically important plants.
- To study interrelation between the living world and environment.
- To make aware about environmental issues.
- To understand plant part used of economic plants.
- To understand processing of plant part used as economic importance.
- To interpret the application of ethnobotany

Course Learning Outcomes:

At the completion of the course, the student would be able to:

- Explain ecological factors, plant adaptations, ecosystem structure, energy flow, and biogeochemical cycles.
- Analyze vegetation types, biogeographic regions, and evaluate environmental issues such as pollution, biodiversity loss, and climate change.
- Apply principles of environmental management, sustainable development, and conservation policies at local, national, and global levels.
- Demonstrate knowledge of the origin, cultivation, processing, and economic uses of cereals, pulses, spices, condiments, medicinal, and other economically important plants.
- Assess the ethnobotanical significance of plants, particularly in Rajasthan, and evaluate their cultural, economic, and ethical dimensions.
- Integrate ecological, biochemical, and ethnobotanical knowledge to address contemporary

challenges in plant sciences and sustainable resource use.

UNIT-I

Environment and plant: Ecological factors; Atmosphere (four distinct zone), light (photosynthetically active radiation, zonation in water bodies, photoperiodism, heliophytes and sciophytes), temperature (Raunkier's classification of plant: megatherm, mesotherm, microtherm, hekiotherm, thermoperiodicity and vernalisation), soil (development, soil profile, properties). Ecological adaptations of hydrophytes, xerophytes, epiphytes and halophytes. Population ecology: growth curve, ecotypes, ecads. Population interaction among organisms (neutralism, amensalism, allelopathy), competition, predation, parasitism and mutualism. Frequency, density, cover, life forms, biological spectrum, ecological succession. Ecosystem: Structure, components, food chain, food web, energy flow, trophic levels and ecological pyramids, primary and secondary productivity, biogeochemical cycle of carbon and phosphorus. **15 Hrs.**

UNIT-II

Biogeographic regions and vegetation types of India: Forest grassland with special reference to Rajasthan. Environmental pollution- air, water and soil, WWF, chipko movement, greenhouse effect, ozone depletion, loss of biodiversity and extinction of species, red data book. Concept and principles of environmental management: Principle of optimized use and sustainable development, threats to sustainable development, ecological footprint, National Environmental Policy, management of forest and degraded lands, concepts and principles of environmental management, efforts to control these effects (Vienna Convention, Montreal Protocol, Earth summit, Kyoto Protocol, World Summit on sustainable development, 2002. Carbon trade). IPCC. **15 Hrs.**

UNIT-III

Origin of Cultivated Plants: Concept of centres of origin, their importance with reference to Vavilov's work. History, origin, distribution, cultivation, and processing of cereals: wheat, maize, rice, and bajra. General account of pulses: pea, chana, and moong. Identification and medicinal value of locally available medicinal plants. General account and identification of spices and condiments of Rajasthan, Characteristics and uses of timber yielding plants: teak and sal, dyes (Indigo and Lawsonia), beverages (tea and coffee), fumigators and masticatories, fat and oil yielding plants (Brassica and Cocos). **15 Hrs**.

Unit-IV

General account and identification of locally available fruits, vegetable and ornamental plant, History, cultivation, processing and economic use of sugar and rubber, fiber yielding plants (cotton and jute). Ethnobotany and its concepts and relevance: Ethnobotanical areas of Rajasthan, ethnic groups in India and ethnobotanical study of any tribal area of Rajasthan. Ethical aspect of ethnobotany. **15 Hrs.**

Suggested Laboratory Exercises:

1. Study of adaptive anatomical and morphological features of Hydrophytes, Epiphytes and Xerophytes using plant material.
2. Study of soil pH, soil moisture in relation to depth, bulk density, porosity and water holding capacity of different soil samples.
3. Determination of requisite size and number of quadrat for the study of plant community.
4. Study of structure of plant community by determining frequency, density and abundance of quadrat method.
5. To study different statistical methods: mean, median and mode, standard error, standard deviation.
6. Regression analysis and application of statistical tests in environmental problems.
7. Study and Submission of economically important plants and plant products (cereals, pulses, spices, fibers, condiments, fat and oils, tea, coffee, wood, dyes, tobacco).
8. Study of wood specimens with special reference to: Botany of the economically important plant. Processing if any involved. Specimens of cereals, pulses, fibres, spices, beverage (tea, coffee), sugar, oil yielding plants and medicinal plants (mentioned in theory).
9. Microchemical test for starch, sugar, oils, proteins, fat, carbohydrate, lignin using wheat, maize, soyabean. Chana, sweet potato, clove, ground nut, mustard and match sticks.
10. Study of starch grains in potato and pea.
11. Field trip to economically important place.
12. Collection, description and submission of at least 5 plants of ethnobotanical importance.

Suggested Books and References:

1. Koromondy, E.J.1996. Concepts of Ecology. 4th Edition Prentice-Hall of India Pvt. Ltd., New Delhi.
2. Misra, K.C. 1988. Manuals of Plant Ecology. (3rd Edition) Oxford and IBH Publishing Co., New Delhi.
3. Odum, E.P. 1983. Basic Ecology. 5th Edition Thomson Business International, USA.
4. Odum, E.P. 2008. Ecology. Oxford and IBH Publisher.
5. Sharma, P.D. 2010. Ecology and Environment, (8th Edition) Rastogi Publications, Meerut.
6. Singh, J.S., Singh, S.P. and Gupta, S. 2006. Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
7. Gupta, S.K. and Kaushik, M.P. 1973. An Introduction to Economic Botany. K Nath and Co., Meerut.
8. Hill, A.F. 1952. Economic Botany. McGraw Hill Book Co., New York.
9. Jain, S.K. 1981. Glimpses of Indian Ethnobotany. Oxford and IBH, New Delhi.
10. Jain, S.K. 1997. A Manual on Ethnobotany. Scientific Publisher, Jodhpur.
11. Prakesh, G., Sharma, K. 1975. Introductory Economic Botany. Jai Prakash Nath & Co., Meerut.
12. Sambamurty, A.V.S.S. and Subrahmanyam, N.S.1989. A Text Book of Economic Botany. Wiley Eastern Ltd., New Delhi.
13. Sen, S.1992.Economic botany. New Central Book Agency, Calcutta.
14. Singh, V.P. and Pandey, P.C. and Jain, D.K.1999. Economic Botany. Rastogi publications, Meerut.
15. Verma, V. 1974.A Textbook of Economic Botany. Enkay Publications, New Delhi

Suggested E-resources:

Online Lecture Notes and Course Materials, Vidhya Mitra Integrated E-Content Portal, eGyanKosh, NPTEL

B.Sc. Botany course structure and Examination Scheme under CBCS and NEP

Semester	Theory/Practical	Course Title	Credit	Marks	External EoSE	Internal CIA l
Sem.III	Theory	Paper I Microbiology	4	100	70	30
	Theory	Paper-II Molecular Biology	4	100	70	30
	Botany Practical	Practical I	2	50	30	20
		Practical II	2	50	30	20
Sem.IV	Theory	Paper-I Fundamentals of Plant Pathology	4	100	70	30
	Theory	Paper-II Morphology and Anatomy of Angiosperms	4	100	70	30
	Botany Practical	Practical I	2	50	30	20
		Practical II	2	50	30	20

B. Sc. Sem - III
Paper - I Microbiology

Objectives of the Course:

- The objective of the course is to make students aware of the diversity, distribution and characteristic features of various microorganisms.
- The course also aims to make students aware of the indispensable role of microorganisms in the environment, biotechnology, fermentation, medicine and other industries important to human welfare.
- In addition to this, the course shall also prepare students for higher education in microbiology-related disciplines.

Course Learning Outcomes:

- To understand about general characteristics and structural details of various microbes.
- To understand about various microbiological techniques including sterilization, media preparation, maintenance of
- microbial culture and staining.
- Students will learn about various parameters required for optimum growth of microbes.
- To understand various commercial applications of microbiological techniques.
- Economic importance of Microbes
- Acquire skills in several laboratory methods
- Study of gram staining, microscopy, and biochemical assays.

UNIT-I

History of Microbiology: History of development of microbiology, Spontaneous generation versus biogenesis, major contributions of Anton von Leeuwenhoek, Edward Jenner, Louis Pasteur, Robert Koch, Alexander Fleming, and contribution of Indian microbiologists.

Virus: Characteristics and Classification of Viruses (Baltimore), Cryptograms, structure with special reference to TMV, Bacteriophage, Multiplication of Viruses (Lytic and Lysogenic). Viroids, Virusoids, Prions.

15 Hrs.

UNIT-II

Bacteria: General Characteristics, Classification by Bergey's Manual, Cell structure, Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, mechanism of Gram's staining, endospore formation, Asexual Reproduction and Sexual Recombination (Conjugation, Transformation and Transduction), Archaebacteria and Eubacteria.

Mycoplasma: General Characteristics, Morphology, and Reproduction. **15 Hrs.**

UNIT-III

Microbial Nutrition and Growth: Nutritional types of microorganisms, growth factors, culture media-synthetic and complex, types of media; isolation of pure cultures, growth curves, mean growth rate constant, generation time; influence of environmental factors on growth of microbes: effect of pH, temperature, solute, oxygen concentration, pressure and radiations. Sterilization, disinfection and antiseptics. Use of physical methods (heat, low temperature, filtration, radiation) and chemical agents (phenolics, halogens, heavy metals, sterilizing gases) in microbial control.

15 Hrs.

UNIT-IV

ApplicationsofMicrobiology: Importance of Microbes in Agriculture and Food Industries.Basicdesign of fermenter,continuous and discontinuous culture. Preparation of fermented food products (yogurt, curd and cheese). Preparation of alcoholic beverages (wine and beer). Treatment of waste water (Municipal treatment plant) and Sewage, Bioremediation.

15 Hrs.

Suggested Laboratory Exercises:

1. Preparation of the liquid culture media for the growth of microorganisms.
2. Preparation of the solid culture media for the growth of microorganisms

3. Study of physical methods of sterilisation.
4. Study of chemical methods of sterilisation.
5. Study of bacterial cultures using the streak plate culture method.
6. Study of bacterial cultures using the pour plate culture method.
7. Study of bacterial cultures using the serial dilution method.
8. Simple staining of bacteria.
9. Perform Gram staining.
10. Demonstration of antibiotic resistance in bacteria.
11. Study of the growth curve of bacteria.
12. Study of the effect of pH and temperature on bacterial growth.
13. Measurement of microbial cells using micrometry.
14. Study of different shapes of TMV, Bacteriophage, Viroids, Bacteria, Mycoplasma using permanent slides/pictographs.
15. Any other exercise based on the theory syllabus.

Suggested Books and References:

1. Pelczar, M. J. (2001) **Microbiology,** 5th edition. New Delhi, Delhi: Tata McGraw-Hill Co. J.Willey,
2. L.Sherwood&C.Woolverton.(2017).**Prescott's Microbiology**. Mc Graw Hill international.
3. M. J Chan, ECS Krieg & NRPelczar. (2004). **Microbiology,** McGraw-Hill. International. J. G. Cappuccino and N. Sherman. (2013). **Microbiology: A Laboratory Manual**, Benjamin/Cummings.
4. M.T. Madigan, J. M. Martinko & D. A. Stahl , Brock. (2010). **Biology of Microorganisms,** Pearson Education International.
5. Latest research articles/review articles relevant to the respective topics will be provided to the students by the concerned faculty.

Suggested E-resources:

Online Lecture Notes and Course Materials:

1. Vidhya Mitra Integrated E-Content Portal
2. E Gyan Kosh-Introductions to Microbiology
3. e-Krishi Shiksha-Introduction Microbiology

NPTEL::Biotechnology-Microbiology

Paper-II Molecular Biology

Objectives of the Course

- To understand structure of nucleic acid (DNA and RNA).
- To understand DNA organization in chromosomes and the mechanism of DNA replication.
- To understand the genetic code and structure of gene.
- To understand molecular mechanism of transcription and translation.
- To understand gene regulation at all levels, and the structure-function relationships of nucleic acids and proteins.
- To provide the students practical skills in molecular biology.

Course Learning Outcomes:

At the completion of the course, the student would be able to:

- Develop sufficient knowledge about the characteristics of the genetic material and structure of DNA and RNA.
- Recognize DNA organization in chromosomes and molecular mechanism of DNA replication, and transcription.
- Understand characteristic and importance of genetic code and molecular mechanism of translation.
- Understand molecular structure of the gene and regulatory mechanisms for gene expression.
- Understand the structure, function, and variations in DNA and RNA.
- Have insights into the various models for chromatin organisation.
- Understand step-wise processes of replication, transcription and translation.
- Develop knowledge and understanding of the operon concept and gene regulation mechanisms.
- Understand the role of protein and its modification in DNA packaging.
- Have knowledge about the differentiation of the molecular mechanism of replication, transcription and translation.
- Understand the role of protein/transcriptional factor in gene regulation.
- Develop acumen about the variation in gene regulation processes.
- Use scientific methods, and critical thinking skills to ask questions and solve problems.

Unit-I

Nucleic Acids: Discovery of Nuclein by Fredrich Miescher. Nucleic Acids as genetic material; Experiments by Griffith, Hershey and Chase,Avery, McLeod and McCarty. Building blocks of nucleic acid: Nucleotide, Nucleoside, Ribose sugar, Purine, Pyrimidine, phosphate.

DNA and RNA :Structure of DNA and RNA, Watson and Crick's model of DNA,DNA types(A,B,Z type), RNA structure and functions (tRNA, mRNA, rRNA, miRNA and siRNA). **15** Hrs

Unit-II

Nucleosome: Chromatin structure; Euchromatin and Heterochromatin.

DNA Replication: Semi-conservative mode of DNA replication; bidirectional and semi-discontinuous replication. Various models of DNA replication including rolling circle, D-loop (mitochondrial), theta mode of replication, replication of linear ds-DNA, replicating the 5'end of linear chromosome. Okazaki fragments. Enzymes involved in DNA replication. **15 Hrs**

Unit-III

Central Dogma of Life: Concept of Central dogma; Salient features of the genetic code, deciphering the genetic code (Contribution of Nirenberg and H.G. Khorana). Gene, ORF, Intron, Exon, Gene expression. Prokaryotic and eukaryotic gene structure.

Transcription in prokaryotes: mechanism, initiation, elongation, and termination. Introduction to split genes, splicing and Ribozymes. **15 Hrs.**

Unit-IV

Translation in prokaryotes: Ribosome structure and assembly, charging of tRNA, aminoacyl tRNA synthetases; Mechanism; initiation, elongation and termination. Inhibitors of protein synthesis. *Gene regulation in Prokaryotes:* Operon concept: inducible and repressible operon; regulation of lactose (lac) and tryptophan (trp) in Escherichia coli; attenuation regulation.

15 Hrs.

Suggested Laboratory Exercises:

1. Preparation of LB medium and raising E. Coli.
2. Isolation of DNA from bacterial or plant samples.
3. DNA estimation by diphenylamine reagent/UV Spectrophotometry.
4. Separation of DNA using Agarose gel electrophoresis.
5. Determination of DNA fragment size comparing with DNA marker using Agarose gel electrophoresis.
6. Perform or digitally demonstrate DNA amplification by PCR.
7. Perform or digitally demonstrate Southern Blot Hybridization.
8. Perform or digitally demonstrate Northern Blotting.
9. Perform or digitally demonstrate Western Blotting.
10. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments).
11. Study of semiconservative replication of DNA through micrographs/schematic representations.
12. Any other exercise based on theory syllabus.

Suggested Books and References:

1. Watson, J.D., Baker, T.A., Bells'., Gann, A., Levine, M., Losick, R.(2007). **Molecular Biology of the Gene,** Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. **Cell and Molecular Biology**. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Karp, G. 2010. Cell and Molecular Biology**: Concepts and Experiments.** 6th edition. John Wiley & Sons. Inc.
4. Snustad, D. P. and Simmons, M. J. (2010). **Principles of Genetics.** John Wiley and Sons Inc., U.S.A. 5th edition.
5. **The World of the Cell.** 7th edition. Pearson Benjamin Cummings Publishing, San

Francisco.
6. Klug, W. S., Cummings, M. R., Spencer, C. A. (2009**). Concepts of Genetics.** Benjamin Cummings.U.S.A.9th edition.
7. Russell, P.J. (2010**). i-Genetics- Molecular Approach.** Benjamin Cummings,U. S. A. 3rd edition.
8. Griffiths, A. J. F., Wessler, S. R., Carroll, S. B., Doebley, J. (2010). **Introduction to Genetic Analysis.** W.H. Freeman and Co., U.S.A. 10th edition.
9. Latestresearcharticles/reviewarticlesrelevanttotherespectivetopicswillbe providedtothestudentsbythe concerned faculty.

B.Sc. Semester IV

Paper-I Fundamentals of Plant Pathology

Objectives of the Course

- To acquire an understanding of plant pathogens.
- To explore the relationships between plants and microorganisms.
- To understand the factors contributing to disease development and methods of control.
- To recognize the economic disadvantages of the important crops due to pathogens.
- To understand the need to protect important crops from pathogens.

Course learning outcomes:

- Understand various pathogens.
- Understanding the diagnosis of plant diseases, understanding their causes, and implementing management strategies
- to control and/or prevent them.
- Understand and perform different laboratory exercises to further understand microorganisms.
- Understand the role of biotic and abiotic factors in disease development
- Understand host-pathogen interaction and its effects on plants.
- Symptomology, disease cycle, and control of different pathogens causing diseases.
- Acquire proficiency in various laboratory techniques, such as culturing microorganisms, Gram staining, microscopy,
- and identification of plant diseases.
- Develop further interest in agricultural research, crop protection, and pest management to improve crop yield and
- quality.
- Work in disease prevention and control, focusing on plant diseases that impact food safety and public health.

UNIT-I

Concepts of Plant Pathology: History of plant pathology, Definitions (Primary and Secondary inoculum; Infection, Pathogenicity, Pathogenesis, Disease Cycle), biotic and abiotic factors, General symptoms caused by Viruses, Viroids, Bacteria, Fungi, Mycoplasma, Nematodes, Insects (smut, rust, mildews, canker, mosaic, vein clearing, spots, lesion, nodules, galls).

15 Hrs

UNIT-II

Host-Pathogen interaction: Disease triangle, recognition of host by pathogens, mode of host penetration, role of enzymes, toxins, growth regulators, and polysaccharides in disease development.

Plant Defense: Strategies-Physical and biochemical (preformed and post-infectional). Induced Systemic Resistance (ISR) and Systemic Acquired Resistance (SAR), Physiological changes in the host after infection. **15 Hrs**

UNIT-III

Viral, Viroidal, Mycoplasmal and Bacterial diseases: Occurrence, disease symptoms, Etiology, treatment & control of the following plant diseases: - Tobacco Mosaic, Bunchy top of Banana, Coconut Cadang Cadang, Little leaf of Brinjal, Citrus canker and Angular leaf spot of Cotton.

Diseases caused by insects and nematodes: Brief account and histopathology of root knot of vegetables (tomato), Ear Cockle of Wheat, leaf gall of *Pongamia*. **15 Hrs**

UNIT-IV

Fungal Diseases: Occurrence, Disease symptoms, Etiology, Treatment & Control of the following plant diseases with special reference to Rajasthan: White rust of crucifers, Downy mildew/green ear disease of Bajra, Black /stem rust of Wheat, Loose and covered smut of Barley, Smut of Bajra, Early blight of Potato,

Control Methods: Quarantine, Cultural practices, Physical methods, Chemical methods, Biological control (Antibiosis, Hyper-parasitism, Predation), Integrated Pest Management.

15 Hrs

Suggested Laboratory Exercises:

1. Study of morphology and symptomology of TMV, Viroids, Mycoplasma, Bacteria, Nematode, Insects, Mites, and other causal organisms mentioned in the syllabus. (Photographs/3D Models)
2. Study of Bacteria by Gram Staining, Negative Staining)
3. Preparation of Liquid and solid media for culturing microbes from infected plant tissues (Nutrient Agar/ Broth, Potato Dextrose Agar).
4. Histological study of different plant defense structures with the help of charts/ 3D models/farm or field visits.
5. Study of symptoms of plant diseases (specimen/permanent slide)- Downy mildew/green ear disease of Bajra, Tobacco Mosaic, Citrus canker, Little leaf of Brinjal,
6. Study of spores of Alternaria from Early Blight of Potato.
7. Study of histopathology using temporary slide preparation of the infected part of the root knot of tomato.
8. Study of histopathology using temporary slide preparation of the Leaf gall of Pongamia.
9. Study and identification of spores from temporary slide preparation from infected plant material:- white rust of crucifers (conidia stage).
10. Study and identification of spores from temporary slide preparation from infected plant material, Blackstem rust of Wheat (all stages).
11. Demonstration and application of basic control techniques such as soil solarization and roguing in the field.
12. Demonstration of biocontrol of diseases using Trichoderma viridae/Bacillus thuringiensis and other biocontrol microorganisms**.**
13. Comparative quantification of biomolecules in diseased v/s normal plants.
14. Any other exercise based on the syllabus.

Suggested Books and References:

1. Alexopolus, C.J., Mims, C.W., And Blackwell, M.1996.Introductory Mycology, John Wiley & Sons, John Wiley & Sons, New York
2. Agrios, G. N. (2004) Plant Pathology,5th Edition, Academic Press, New Delhi
3. PandeyB.P.(2001) Plant Pathology (Pathogen and PlantDisease), S. Chand Publishing
4. Sharma, P. D. (2014). Plant Pathology, Rastogi Publications, Meerut, UP
5. Mehrotra, R. S. and Aggarwal, A. 2007. Plant Pathology. Tata Mc Graw-Hill Publishing Co. Ltd., New Delhi
6. Singh, R. S. 1996. An Introduction to Principles of Plant Pathology.Oxford&IBH, New Delhi.
7. Singh,R.S.(2021).Plant Diseases, 10th revised edition, Medtech, New Delhi.
8. Nene Y.L. and Thapliyal, P.N. 1993. Fungicides in Plant Disease Control. 3rd Edn. Oxford & IBH published Co. Pvt. Ltd., New Delhi.
9. Gupta, V.K. and Sharma, R.C. (2020). Integrated Disease Management and Plant Health, Scientific Publishers, India.
10. Latestresearcharticles/reviewarticlesrelevanttotherespectivetopicswillbeprovidedto thestudentsbythe concerned faculty.

Suggested E-resources:

OnlineLectureNotesandCourseMaterials:

1. https://www.pdfdrive.com/fundamentals-of-plant-pathology-e42642753.html
2. https://onlinecourses.swayam2.ac.in/cec21_bt16/preview
3. https://www.pdfdrive.com/plant-pathology-concepts-and-laboratory-exercises-e179105354.html

B.Sc. Sem-IV

Paper—II Morphology and Anatomy of Angiosperms

Objectives of the Course

- To understand the basic body plan and structure of dicot and monocot plants.
- To understand themodifications of root, stem, leaves and their significance in plant life.
- To understand the tissues and their types in plants.
- To understand different tissue systems and their function in plant body.
- To be able to comprehend RAM and SAM.
- To understand the difference between primary and secondary growth in plants.
- To explicate general anatomy of root, stem and leaf (dicot and monocot
- To be able to know about abnormal secondary growth in plants and its reasons.

Course Learning Outcomes:

After the course, the student would be able to:

- Learn, understand and develop difference between dicots and monocots.
- Acquire basic knowledge of plant body, life forms and modular growth.
- Learn and understand modifications of root, stem and leaf.
- Understand the basics of plant tissue system and functions.
- Gain knowledge about the anatomy of different parts of dicot and monocot plants.
- Able to differentiate primary and secondary growth and understand their role in plant life.
- Learn about anomalous growth in plants.
- Comprehend about wood and dendrochronology.
- Promote shared learning through practical classes, presentations and assignments.

Unit-I

Basic body plan of a typical dicot and monocot plant, Plant Diversity based on habitat, habit (longevity), Body forms. Monopodial and sympodial branching, branching pattern, Canopy architecture in trees, Modular growth. Stem: modifications, Root: modifications. Leaf: types, phyllotaxy, and modifications.Types of inflorescence and fruits. **15 Hrs**

Unit-II

Tissues: Classification and function of tissues; Meristematic and Permanent tissues. Simple, Complex and Secretory tissues.

Plant tissue systems: Epidermal, Ground and Vascular tissue systems. Trichomes, Stomata, Hydathodes.

15 Hrs

Unit-III

Shoot Apical Meristem (SAM) and Root Apical Meristem (RAM): Organizational Theories. Types of vascular bundles. Primary growth in plants: Anatomy of root, stem and leaf of dicot and monocot plants. Kranz anatomy. **15 Hrs**

Unit-IV

Secondary growth in plants: Vascular cambium: structure and functions. Secondary growth in the root and stem. Wood: formation, Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Cork Cambium, Periderm and its significance, Dendrochronology. Abnormal secondary growth in plants. **15 Hrs**

Suggested Laboratory Exercises:

1. Study of commonly occurring dicotyledonous plant to understand the body plan and modular type of growth.
2. Life forms exhibited by flowering plants (by visit to a forest or a garden).
3. L.S. of shoot tip to study the organisation of meristem (demonstration).
4. Modifications: root, stem and leaf (demonstration).
5. Anatomy of primary and secondary growth in monocots and dicots using hand-cut sections of *Helianthus, Maize,* Cucurbita stem and root.
6. Monocot- maize (root, stem and leaf).
7. Dicot-*Helianthus* (root, stem and leaf).
8. Anomalous secondary growth in stem: *Salvadora, Bignonia, Bougainvillaea, Boerhaavia, Nyctanthes, Leptadenia, Dracaena*.
9. Study of stomatal types, inflorescence and fruits.
10. Study of distribution and types of parenchyma, collenchyma and sclerenchyma, Xylem: Tracheary elements- tracheids, vessel elements. Phloem: Sieve tubes-sieve plates; companion cells.

Suggested Books and References:

1. Cutter, E. G. 1971. Plant Anatomy: Experiment and Interpretation. Part II Organs. Edward Arnold, London.
2. Esau, K.1977. Anatomy of seed plants,2nd edition, John Wiley and Sons NewYork.
3. Fahn, A. 1974. Plant anatomy 2nd edition. Pergamon press. Oxford.
4. Crang, R. et al ,2018. Plant anatomy: a concept based approach to the structure of seed plants.

B.Sc. Botany course structure and Examination Scheme under CBCS and NEP

Semester	Theory/Practical	Course Title	Credit	Marks	External EoSE	Internal CIA l
Sem V	Theory	Paper I Plant Bio-technology	4	100	70	30
	Theory	Paper-II Plant Systematics	4	100	70	30
	Botany Practical	Practical I	2	50	30	20
		Practical II	2	50	30	20
Sem.VI	Theory	Paper-I Embryology of Angiosperms	4	100	70	30
	Theory	Paper-II Biostatistics and Evolution	4	100	70	30
	Botany Practical	Practical I	2	50	30	20
		Practical II	2	50	30	20

B.Sc. Semester V
Paper I – Plant Biotechnology

Objectives of the Course:

- To teach the core principles of plant tissue culture, cellular totipotency, and micropropagation.
- To explain methods of transferring foreign genes into plants to introduce desirable traits (e.g., Agrobacterium-mediated transformation).

- To train students to design agricultural strategies to protect crops against biotic (pests, pathogens) and abiotic (drought, salinity) stressors.
- To build hands-on skills in setting up plant tissue culture labs, operating bioreactors, and conducting molecular biology assays.

Course Learning Outcomes:

Upon successful completion of the course, students will be able to:

- Successfully execute micropropagation, somatic embryogenesis, and protoplast isolation to produce disease-free and commercially important plant varieties.
- Construct recombinant DNA vectors, formulate gene constructs, and assist in the development of genetically modified (GM) crops and plant-derived pharmaceuticals.
- Evaluate and apply biofertilizers, biopesticides, and integrated pest management to improve soil health and crop yields with minimal environmental impact.
- Utilize modern bioinformatics tools and molecular markers for plant genome mapping and crop improvement

UNIT I

Biotechnology: Functional definition. Basic aspects of Plant tissue culture, Basal medium, Media preparation, and aseptic culture technique. Concept of cellular totipotency, Differentiation and morphogenesis. Micropropagation and synthetic seeds.
15 Hrs.

UNIT II

Protoplast isolation, culture and Somatic cell hybridisation, Androgenesis and its importance, Gynogenesis, Somaclonal variation, Somatic embryogenesis, Clonal propagation, Applications of Plant tissue culture.

15 Hrs.

UNIT III

Recombinant DNA technology: Techniques used in rDNA technology. Restriction enzymes. Vectors for gene transfer. Plasmids and Cosmids. Genomic and c-DNA library, RFLP, RAPD, AFLP, Transgenic plants, Application of transgenic plants: Bt cotton, Golden rice, Selectable markers and reporter genes, method of gene delivery, Agrobacterium-mediated gene transfer.

15 Hrs.

UNIT IV

Medical Biotechnology: Disease diagnosis - Infectious diseases and genetic diseases; Therapeutics-Antisense oligonucleotides, RNAi as therapeutics; Endogenous therapeutics - insulin, somatostatin, interferons, vaccines, gene therapy, stem cells and their relevance, Industrial Biotechnology: Large scale production of alcohol and antibiotics.
15 Hrs.

Suggested Laboratory exercises:

1. Preparation of Murashige and Skoog (MS) media.
2. Preparation of artificial seeds.
3. Estimation of soluble protein from a selected plant and separation by SDS-PAGE.
4. Isolation of plasmid DNA together from *E. coli.*

5. Demonstration of gel electrophoresis.
6. Organ Culture
7. Callus propagation, organogenesis, and transfer of plants to soil
8. Anther Culture and Production of Haploids
9. Cytologic examination of regenerated plants
10. Isolation of protoplasts from various plant tissues and testing their viability
11. Demonstration of PCR
12. Hairy root cultures
13. Extraction of alkaloids and flavonoids from plant materials and their separation using TLC

Suggested Readings:

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. Brown, T. A. 2010. Gene cloning and DNA analysis: An Introduction. Blackwell Publication, USA.
2. Buchanan, B., Gruissem, W. and Jones, R. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists., USA.
3. Chrispeel, M.J. and Sadava, D.E. 1994. Plants, Genes and Agriculture. Jones and Barlett Publishers, USA.
4. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5 ASM Press and Sunderland, Washington, D.C. Sinauer Associates, MA. th edition.
5. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology 8th edition. Lippincott Williams and Wilkins, Philadelphia.
6. Glick, B.R. and Pasternak, J.J. 2003. Molecular Biotechnology: Principles and Applications of recombinant DNA. ASM Press, Washington.
7. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6 th edition. John Wiley and Sons. Inc. New Jersey, USA.
8. Mascarenhas, A.F. 1988. Handbook of Plant Tissue Culture. Publication and information. Div., ICAR, New Delhi.
9. Purohit, S.S. and Mathur, S.K. 1996. Biotechnology Fundamental and Application. Agro Botanical Publisher, Bikaner.
10. Razdan, M.K., 1993. An introduction to Plant tissue culture. Publication and Information Div., ICAR, New Delhi.
11. Rana, S.V.S. 2012. Biotechnology theory and practice. (Third Ed.) Rastogi Publication, Meerut. Rastogi,
12. V.B. 2008. Fundamentals of Molecular Biology. Ane Books, Meerut, India.
13. Smith, R. H. 2000. Plant Tissue Culture: Techniques and Experiments. 2 nd edition, Academic Press, USA.
14. Upadhyaya, A. and Upadhayaya, K. 2005. Basic Molecular Biology. Himalaya Publishers. New Delhi.

B. Sc. Sem - V
Paper – II Systematics of Angiosperms

Objectives of the Course

- To understand the principles, tools, and modern approaches in the taxonomy
- To understand the systematics of angiosperms, including classification systems, taxonomic literature.
- To make the students learn interdisciplinary evidence from molecular biology, embryology, cytology, and phytochemistry.
- To provide detailed knowledge of the diversity of plants by plant family studies.
- To provide basic knowledge on importance of plants.

Course Learning Outcomes:

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

- Apply knowledge of plant diversity to identify plant species and interpret their phylogenetic significance
- Understand the process of plant nomenclature.

- Analyze various systems of classification for angiosperms.
- Identify the local flora with the help of flora and e-resources.
- Understand, evaluate and analyze the diagnostic characteristics of families.
- Comparison in pollen grains of different plants and analyze the diversity of their structures.
- Understand the process of herbarium sheet preparation.
- Illustrate and interpret floral formula and floral diagram.

Unit-I

Introduction of Taxonomy: History of taxonomy, Botanical Nomenclature, International Code of Botanical Nomenclature: principles, rules and recommendations, Concept of BioCode and PhyloCode, Botanical Gardens, Taxonomic hierarchy. Plant identification, Herbarium: concept, tools &techniques; Taxonomic Keys: Single Access and Multi-access. **15 Hrs.**

Unit-II

Concept and systems of classification with special emphasis on Bentham and Hooker, Engler and Prantl system. Systematic evidences: Evidence from palynology, embryology, cytology, phytochemistry and molecular biology. Origin and Evolution of Angiosperms, Basal Living Angiosperms. Taxonomic literature: Flora, E-flora, Monographs, Icones, Journals& E-journals. **15 Hrs.**

Unit-III

Diversity of flowering plants illustrated by members, diagnostic characters and importance of families: Ranunculaceae, Brassicaceae, Papaveraceae, Malvaceae, Fabaceae, Caryophyllaceae, Cucurbitaceae, Apiaceae, Rubiaceae, Asteraceae and Apocynaceae. **15 Hrs.**

Unit-IV

Diversity of flowering plants illustrated by members, diagnostic characters and importance of families: Asclepiadiaceae, Convolvulaceae, Solanaceae, Acanthaceae, Lamiaceae, Chenopodiaceae, Euphorbiaceae, Liliaceae, Arecaceae and Poaceae. **15 Hrs.**

Suggested Laboratory Exercises:

1. Familiarization with Taxonomic Tools: Use of taxonomic keys (Single-access and Multi-access) Study of herbarium sheets, floras, monographs, and electronic resources
2. Plant Identification Using Flora: Identification of local plants using regional floras or e-resources
3. Herbarium Preparation: Collection, pressing, drying, mounting, and labeling of plant specimens
4. Field Visit to Botanical Garden or Natural Habitat: Field observation, note-making, ecological data collection, and sample documentation
5. Comparative Study of Classification Systems: Classification of selected plants as per Bentham & Hooker and Engler & Prantl systems
6. Palynology Practical: Microscopic examination of pollen grains from fresh flowers.
7. Study of Embryological Features: Observation of permanent slides of embryo sacs, anther cross sections, etc.
8. Floral Dissection and Description: Dissection of flowers from representative families, Preparation of floral formula and floral diagram
9. Diagnostic Features of Selected Families: Identification based on key morphological characters such as leaf arrangement, inflorescence type, floral parts, ovary position, etc.
10. Any other exercise related to the syllabus.

Suggested Books and References –

1. Singh, G. (2019). Plant Systematics: Theory and Practice (3rd ed.). Oxford & IBH Publishing Co. Pvt. Ltd.
2. Pandey, B. P. (2010). Taxonomy of Angiosperms. S. Chand & Company Ltd.

3. Judd, W. S., Campbell, C. S., Kellogg, E. A., Stevens, P. F., & Donoghue, M. J. (2015).
4. Plant Systematics: A Phylogenetic Approach (4th ed.). Sinauer Associates, Oxford University Press.
5. Lawrence, G. H. M. (1951). Taxonomy of Vascular Plants. Macmillan.

B.Sc. Semester VI

Paper-I Embryology of Angiosperms

UNIT I

Course Objectives

- To understand the morphology and functional development of plant reproductive organs, specifically the structure of anthers and ovules.
- To study the processes of microsporogenesis and megasporogenesis, leading to the formation of male and female gametophytes.
- To learn the mechanisms of pollination, pollen-pistil interactions, and the critical event of double fertilization.
- To explore the developmental sequences of endosperm, embryogenesis, and seed/fruit formation

Course Learning Outcomes:

- Upon completing this course, students will be able to:
- Elaborate on the anatomical and structural features of reproductive organs and different types of ovules and embryo sacs.
- Outline the sequential events of plant life cycles, including gamete formation, fertilization, and seed development.
- Apply embryological concepts to fields like crop improvement, taxonomy, and plant breeding.
- Design and execute laboratory experiments in plant embryology, such as pollen viability tests and making anatomical slides of reproductive tissues.

UNIT I

Typical angiosperm flower, structure of anther, microsporogenesis, microgametogenesis, palynology and scope. Pollen wall protein; pollen viability and abnormal features; polyads, masslae, pollinia.

15 Hrs

UNIT II

Structure and types of ovules, special structures- aril, obturator etc., megasporogenesis, megagametogenesis (monosporic, bisporic and tetrasporic types), structure of typical embryo sac, (Polygonum, Allium and Adoxa type). **15 Hrs**

UNIT III

Pollination types, significance adaptations; compatibility and incompatibility; basic concepts. Pollen tube entry, syngamy and triple fusion, double fertilization, development, type and function of endosperm.

15 Hrs.

UNIT IV

Six types of Embryogeny; General pattern of development of dicot and monocot embryo; suspensor structure and function, embryo-endosperm relationship; nutrition of embryo, apomixis, polyembryony, fruit-development and maturation. **15 Hrs.**

Suggested Laboratory Exercises:

1. Study different types of placentation, ovules and special structures of ovule through permanent slides, specimens or photographs.
2. Study of female gametophyte through permanent slides/ photographs: types and ultra structure of mature embryo sac.
3. Study of pollen grains: fresh and acetolyzed showing ornamentation and aperture, pseudomonads, pollinia

(slides/photographs/ fresh materials).
4. Study of the different stages of anther development.
5. Study of pollen morphology of available plants.
6. Pollen germination test. In vitro germination using a. sugar solution b. Tetrazolium test
7. Study of monocotyledons and dicotyledons embryo of angiosperms through slides/photographs.
8. Dissect and display embryo at various developmental stages using mustard seeds.
9. Dissection of developing seeds for endosperm with free nuclear haustoria.

Suggested Books and References:

1. Bhojwani, S.S. and Bhatnagar, S.P. 2004.
2. The Embryology of Angiosperms. Vikas Publishing House, New Delhi.
3. Davis, C.L. 1965. Systematic Embryology of Angiosperms. John Wiley, New York.
4. Johri, B. D. 1984. Embryology of Angiosperms. Springer Verlag, Berlin.
5. Johri, B. M. 1984. Embryology of Angiosperms. Springer-Verlag, Netherlands.
6. Maheswari, P. 1985. Introduction to Embryology of Angiosperms. Mac Graw Hill House (P) Ltd., New York.
7. Raghavan, V. 2000. Developmental Biology of Flowering plants. Springer, Netherlands.
8. Trivedi, P.C. Sharma, N. and Sharma, J. L. 2003. Structure, Development and reproduction in Flowering Plants. Ramesh Book Depot, Jaipur.

B. Sc. Sem - VI
Paper-II Biostatistics and Evolution

Course Objectives:

- To teach students how to collect, summarize, and visually represent raw biological and health-related data.
- To provide foundational knowledge in sampling methods, and hypothesis testing (e.g., \(t\)-test, Chi-square) to draw accurate research conclusions.
- To explore the evolutionary history of Earth and the mechanisms behind genetic variation, microevolution, and adaptation.
- To introduce students to mathematical models of evolution, such as allele frequency tracking and the Hardy-Weinberg equilibrium.
- To bridge the gap between pure biological observation and rigorous scientific validation through applied modelling.

Course Learning Outcomes:

Upon successful completion, students will be able to:

- Apply statistical software (e.g., R, SPSS) and computational tools to extract meaningful patterns from complex biological datasets.
- Trace the phylogenetic relationships of species, reconstruct evolutionary timelines, and understand the driving forces of natural selection.
- Design scientific experiments and evaluate whether results are statistically significant, minimizing errors and bias.
- Analyze allele frequencies to predict how environmental pressures affect genetic drift, mutation rates, and speciation over time.
- Translate statistical and evolutionary evidence into tangible solutions for public health, epidemiology, and biodiversity conservation.

Unit - I

Introduction to Biostatistics, Definition, Statistical terms - Population, sample, primary and secondary data, qualitative and quantitative data, variables, discrete and continuous variables and statistical error. Sampling Techniques, Introduction, Methods of Sampling – Serial, Random Sampling and Stratified Sampling.

15 Hrs.

Unit - II

Diagrammatic and Graphic Representation of Data, Introduction, Diagrammatic representation of data - Bar diagram and Pie diagram, Measures of Central Tendency, Introduction, Calculation of arithmetic mean, median, and mode in an ungrouped data**,** Standard deviation and standard error**.**

15 Hrs.

Unit-III

Emergence of evolutionary thoughts: Lamarck, Darwin- concepts of variation, adaptation, struggle, fitness and natural selection, Mendelism, spontaneity of mutations. Origin of cells and unicellular evolution: Origin of basic biological molecules, abiotic synthesis of organic monomers and polymers, concept of Oparin and Haldane, Experiment of Miller (1953), The first cell, Evolution of prokaryotes, Origin of eukaryotic cells, Evolution of unicellular eukaryotes. **15 Hrs**

Unit-IV

Paleontology and Evolutionary History: The evolutionary time scale, Eras, Periods and Epochs. Major events in the evolutionary time scale, Population Genetics: Populations, Gene pool, Gene frequency, Hardy-Weinberg law, concepts and rate of change in gene frequency through natural selection, Migration and random genetic drift, Adaptive radiation, Isolating mechanisms, Allopatric and Sympatric Speciation. **15 Hrs.**

Suggested Laboratory Exercises:

1. Classification of data into qualitative and quantitative variables.
2. To study different statistical methods: mean, median and mode.
3. To calculate standard error and standard deviation for the data
4. Depict the data and illustrate it in suitable bar diagram, pie chart, line graph and histogram.
5. Study and verification of the Hardy-Weinberg Law by chi-square analysis.

Suggested Books and References:

1. Pranab Kumar Banerjee, Introduction to Biostatistics.
2. Khan and Khanum, Fundamentals of Biostatistics.
3. Mahajan, B. K., Methods in Biostatistics for medical students and research workers.
4.Parikh, M. N. and Nithya Gogtay, ABC of Research Methodology and Applied Biostatistics.
5.K. Viswesara Rao, Biostatistics in Brief.
6. Wayne W. Daniel, Biostatistics - Basic Concepts and Methodology for the Health Sciences.
7. Agarwal, B. L., Basic Statistics.
8. B. Antonisamy, Soloman Chrostopher and P. Prasanna Samuel, Biostatistics - Principle and Practice
9. Sundar Rao, P.S.S. and Richards J, Introduction to Biostatistics and Research Methods.
10. Neil A. Weiss, Introductory Statistics.
11. Rastogi, V. B. Organic Evolution (Evolutionary Biology).
11. Evolutionary Genetics, John Maynard Smith, Oxford University Press, New York, 1998
12. Genes and Evolution, A.P. Jha, McGraw-Hill Publishers, New Delhi, 1993