



ANDHRA KESARI UNIVERSITY :: ONGOLE

Model Syllabus for 4-Year UG Honours in B.Sc. (Botany) as Major in consonance with Curriculum framework w.e.f. AY 2025-26

COURSE STRUCTURE (for Semester I to VI)

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits	
I	I	1	Diversity of Microbes	3	3	
			Diversity of Microbes -Practical	2	1	
		2	Diversity of Thallophytes	3	3	
			Diversity of Thallophytes -Practical	2	1	
	II	3	Diversity of Archegoniates	3	3	
			Diversity of Archegoniates -Practical	2	1	
		4	Anatomy and Embryology of Angiosperms	3	3	
			Anatomy and Embryology of Angiosperms - Practical	2	1	
	II	III	5	Morphology and Taxonomy of Angiosperms	3	3
				Morphology and Taxonomy of Angiosperms - Practical	2	1
6			Plant resources and Utilization	3	3	
			Plant resources and Utilization -Practical	2	1	
7			Plant Ecology, Biodiversity and Phytogeography	3	3	
			Plant Ecology, Biodiversity and Phytogeography -Practical	2	1	
IV		8	Cell and Molecular biology	3	3	
			Cell and Molecular biology -Practical	2	1	
		9	Genetics and Plant breeding	3	3	
			Genetics and Plant breeding -Practical	2	1	
10	Plant Physiology and Metabolism	3	3			
	Plant Physiology and Metabolism -Practical	2	1			
III	V	11	Plant Biotechnology	3	3	
			Plant Biotechnology -Practical	2	1	

R. V. Kumar
10/09/2025

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits				
		12 A	Ethnobotany and Phytomedicines	3	3				
			Ethnobotany and Phytomedicines -Practical	2	1				
		OR							
		12 B	Bioinstrumentation Techniques	3	3				
			Bioinstrumentation Techniques -Practical	2	1				
		OR							
		12 C	Concepts of Horticulture	3	3				
			Concepts of Horticulture-Practical	2	1				
		13 A	Traditional Systems of Medicine	3	3				
			Traditional Systems of Medicine -Practical	2	1				
		OR							
		13 B	Plant Genetic Engineering	3	3				
			Plant Genetic Engineering-Practical	2	1				
		OR							
		13 C	Gardening and Landscaping	3	3				
			Gardening and Landscaping-Practical	2	1				
		VI		14 A	Herbal Technology	3	3		
					Herbal Technology-Practical	2	1		
				OR					
				14 B	Bioinformatics and Computational Biology	3	3		
					Bioinformatics and Computational Biology-Practical	2	1		
				OR					
14 C	Plant Propagation Techniques			3	3				
	Plant Propagation Techniques-Practical			2	1				
15 A	Pharmacognosy and Phytochemistry			3	3				
	Pharmacognosy and Phytochemistry-Practical			2	1				
OR									
15 B	Omics in Plant Sciences			3	3				
	Omics in Plant Sciences-Practical			2	1				
OR									
15 C	Ornamental Horticulture and Commercial Floriculture			3	3				
	Ornamental Horticulture and Commercial			2	1				

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
			Floriculture-Practical		

Note: In the III Year (during the V and VI Semesters), students are required to select a pair of electives from one of the Three specified domains. For example: if set 'A' is chosen, courses 12 to 15 to be chosen as 12 A, 13 A, 14 A and 15 A. To ensure in-depth understanding and skill development in the chosen domain, students must continue with the same domain electives in both the V and VI Semesters.

SEMESTER-III

COURSE 5: MORPHOLOGY AND TAXONOMY OF ANGIOSPERMS

Theory Credits: 3 3 hrs/week

I. Learning Objectives: By the end of this course the learner has:

1. To understand the vegetative and reproductive morphology of Angiospermic plant.
2. To acquire knowledge of the taxonomic aids and classification systems.
3. To read the vegetative and floral characteristics of some forms of angiospermic families along with their economic value.
4. To study the significance of other branches of botany in relation to plant taxonomy.

II. Learning Outcomes: On completion of this course students will be able to:

1. Illustrate the vegetative and reproductive morphology of angiosperms
2. Discuss about some Taxonomic aids and their applications in plant systematics.
3. Compare and contrast the vegetative and floral characteristics of some angiospermic families
4. Evaluate the economic value of plant species from the families under the study.
5. Defend the utility of evidences from different branches of botany in solving the taxonomic lineages of some species.

III. Syllabus of Theory:

Unit-1: Vegetative morphology

10Hrs.

1. Parts of an angiospermic plant-root system and shoot system
2. Root -Characteristics, types of root system, modification of root
3. Stem-Characteristics, modification of stem (Aerial, sub aerial and underground)
4. Leaf-Parts of leaf, venation-types, phyllotaxy-types, leaf modifications

Unit-2: Reproductive morphology

8Hrs.

1. Inflorescence: Types of inflorescences; Racemose and its types, Cymose and its types and special types of inflorescences
2. Flower in general: Parts of a flower, structure of a flower, symmetry of a flower, position of gynoecium on thalamus, nature of flower based on perianth, aestivation-types.
3. Flower in detail: Calyx, corolla, Androecium (parts of stamen, attachment of filament to anther. length of stamens, union of stamens and dehiscence of anthers); Gynoecium-Number of carpels, fusion of carpels, number of locules in ovary, placentation, style-types.
4. Fruits: True and false fruits; simple fruits-types; aggregate fruits and composite fruits

Unit-3: Principles of Plant Taxonomy

10 Hrs.

1. Aim and scope of taxonomy, species concept, taxonomic hierarchy-major and minor categories.
2. Plant nomenclature: Binomial system, ICBN- rules for nomenclature.
3. Herbarium and its techniques, BSI herbarium and Kew herbarium; concept of digital herbaria.
4. Bentham and Hookers system of classification; a brief account of APG-IV classification.

Unit-4: Descriptive Plant Taxonomy**10Hrs.**

Systematic description and economic importance of the following families:

1. Polypetalae: (a) Annonaceae (b) Fabaceae (c) Curcubitaceae
2. Gamopetalae: (a) Asteraceae (b) Asclepiadaceae
3. Monochlamydae: (a) Amaranthaceae (b) Euphorbiaceae
4. Monocotyledonae: (a) Orchidaceae (b) Poaceae

Unit-5: Evidences for Plant systematics**7Hrs.**

1. Anatomy and embryology in relation to plant systematics.
2. Cytology and cytogenetics in relation to plant systematics.
3. Phytochemistry in relation to plant systematics.
4. Numerical taxonomy

IV. Text Books:

1. Singh, G. (2019). Plant systematics: Theory and practice (3rd ed.). Oxford & IBH Publishing Co. Pvt. Ltd.
2. Stuessy, T. F. (2009). Plant taxonomy: The systematic evaluation of comparative data (2nd ed.). Columbia University Press.
3. Simpson, M. G. (2019). Plant systematics (3rd ed.). Academic Press (Elsevier).
4. Naik, V. N. (1984). Taxonomy of angiosperms. Tata McGraw-Hill Publishing Company.

V. Reference Books:

1. Pandey, B. P. (2022). Taxonomy of Angiosperms (Latest Ed.). S. Chand & Company Pvt. Ltd.
2. Heywood, V. H. (2007). Flowering plant families of the world. Kew Publishing.
3. Judd, W. S., Campbell, C. S., Kellogg, E. A., Stevens, P. F., & Donoghue, M. J. (2016). Plant systematics: A phylogenetic approach (4th ed.). Sunderland, MA: Sinauer Associates.

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Botanical field trip and collecting plant specimens for herbarium.

Evaluation method: Attendance in field trip and submission of field note book and herbarium sheets with filled in labels.

Unit-2: Activity: Making good models or drawings or collection of photographs of some important plant species from the families included in the syllabus.

Evaluation method: Authorize the quality of the work and conferring reward.

Unit-3: Activity: Collection of scientific literature on solving taxonomic problems by taking evidences from other branches of Botany.

Evaluation method: Validation of the collection submitted along with summary.

Unit-4: Activity: Field visit to identify plants belong to various families included in syllabus.

Evaluation method: Evaluating the field note book data, plant specimens collected and herbarium made.

Unit-5: Activity: Collection of literature on evidences from different branches of Botany useful for plant systematics.

Evaluation method: Evaluating the quality of report made using a rubric.

SEMESTER-III

COURSE 5: MORPHOLOGY AND TAXONOMY OF ANGIOSPERMS

Practical

Credits: 1

2 hrs/week

- I. Course Outcomes:** On successful completion of this practical course, student shall be able to:
1. Make systematic classification of plant species using vegetative and floral characters.
 2. Identify angiosperm plant species and make herbarium specimens.

II Laboratory/field exercises:

1. Technical description of an Angiosperm plant
- II. Technical description of locally available plant species from the following angiosperm families:
 - (a) Annonaceae (b) Fabaceae (c) Curcubitaceae (d) Asteraceae (e) Asclepiadaceae
 - (f) Amaranthaceae (g) Euphorbiaceae (h) Orchidaceae (i) Poaceae

III. Demonstration of herbarium techniques.

IV. Field trip to a local floristic area/forest (Submission of 30 number of Herbarium sheets of wild plants with the standard system are mandatory).

SEMESTER-III

COURSE 6: PLANT RESOURCES AND UTILIZATION

Theory

Credits: 3

3 hrs/week

I. Learning Objectives: By the end of this course the learner has to:

1. Identify different plants domesticated by humans and utility of their products.
2. Gain knowledge on commercial and timber products obtained from plants.
3. Know the facts on economic value of plants products in relation to human welfare.

II. Learning Outcomes: On successful completion of the course, the students will be able to

1. Explain the significance of plants in human nutrition
2. List out different plant products used by human beings
3. Evaluate the commercial plant products and their utilization
4. Discuss the uses of medicinal and aromatic plants for human health care.
5. Appraise the importance of timber and non-timber products for value added products

III. Syllabus of Theory:

Unit-1: Field crops (Cereals, Millets and Pulses)

9 Hrs.

1. Centers of origin (diversity) of crop plants and their domestication.
2. A general account of cereals, millets and pulses.
3. A brief account of Botany (origin, distribution, botanical name, family and morpho- logical description only) and economic significance of: Cereals -Rice and Maize; Millets -Sorghum and finger millet; Pulses-Chickpea and Red gram

Unit-2: Oilseeds and Commercial field and horticultural crops

9 Hrs.

1. A general account of oilseed crops and vegetable oil yielding trees.
2. A brief account of Botany (origin, distribution, botanical name, family and morpho- logical description only) and economic significance of Oilseeds (Groundnut and Sesame) and Sugarcane.
3. Botanical name, family, nutritional value of major tropical and temperate fruits and nuts.
4. Botanical name, family, nutritional value of vegetable crops (root and tuber crops, cucurbits, cruciferous, solanaceous and leafy vegetables).

Unit-3: Fiber crops, Spices, Condiments; Beverages and Narcotics

9 Hrs.

1. Classification of plant fibers: A brief account of Botany (origin, distribution, botanical name and family) and economic importance of fiber crops (Cotton, Jute, Flax and Hemp)
2. Botanical name, family and economic importance of :Spices (Cinnamon, Cloves, Cardamom and Pepper); Beverages (Coffee, Tea and Cocoa);Plants used as fumitories, masticatories and narcotics.

Unit-4: Medicinal and aromatic plants-their products

9 Hrs.

1. Traditional and modern uses of some medicinal plants of India.
2. Botanical name, family and economic importance of *Rauwolfia*, *Withania*, *Emblica*, *Andrographis*, *Senna*.
3. Essential oils and their uses; aromatic plants in perfumery and cosmetics.
4. Botanical name, family and economic importance of rubber, latex, gums, resins and dye yielding plants.

Unit-5: Timber yielding plants and energy plantations 9 Hrs.

1. A general account on important timber yielding plants of India with an emphasis on Sal, Arjun, babul, Mahogany
2. Uses of wood: Wood as a construction and manufacturing material and other uses of wood
3. Energy Plantations and biofuels
4. Bamboos, Eucalyptus, Casuarina - generation of paper industry raw material.

IV. Textbooks:

1. Kochhar, S. L. (2016). Economic Botany in the Tropics (4th ed.). Macmillan Publishers India.
2. Sambamurty, A. V. S. S. (2005). Textbook of Economic Botany. Wiley Eastern Ltd.
3. Rao, K. N., & Rao, G. R. (2012). A Textbook of Economic Botany. McGraw Hill Education.
4. Sundara Rajan, S. (2002). Introduction to Economic Botany. Popular Book Depot.

V. Reference Books:

1. Hill, A. F. (1952). Economic Botany: A Textbook of Useful Plants and Plant Products (2nd ed.). McGraw-Hill Book Company Inc.
2. Wickens, G. E. (2001). Economic Botany: Principles and Practices. Springer.
3. Simpson, B. B., & Ogorzaly, M. C. (2015). Economic Botany: Plants in Our World (4th ed.). McGraw Hill.
4. Jain, S. K., & DeFilipps, R. A. (1991). Medicinal Plants of India. Reference Publications Inc.
5. Heywood, V. H. (1999). Use and Potential of Wild Plants in Farm Households. FAO, Rome.

VI Suggested activities and evaluation methods:

Unit-1: Activity: A critical assignment on origin of crop plants.

Evaluation method: Evaluate the extent and quality of data collected to support the assignment's arguments.

Unit-2: Activity: Group discussion on various plant products and their source plants.

Evaluation method: Assess the logical flow and coherence of the group's discussion based on a grading scale.

Unit-3: Activity: A survey report on commercial plant products available in local markets.

Evaluation method: Evaluate the clarity and comprehensibility of the survey questions.

Unit-4: Activity: A case study report on phytomedicines used in human health care.

Evaluation method: Examine the depth and coherence of the discussion and interpretation based on a rubric.

Unit-5: Activity: A field trip to timber depots and silviculture plantations in their locality.

Evaluation method: Evaluate the level of student engagement and active participation during the trip based on a grading scale.

SEMESTER-III

COURSE 6: PLANT RESOURCES AND UTILIZATION

Practical

Credits: 1

2 hrs/week

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Characterize various plant products based on morphological and microscopic observations.
2. Identify economically valuable plants and their products.
3. Categorize distinct plant products utilized by humans.

II. Laboratory/field exercises:

1. Identification of following plant resources mentioned in the theory syllabus
 - a) Food crops
 - b) Oilseeds and Commercial field and horticultural crops
 - c) Fibre crops, Spices, Condiments; Beverages and Narcotics
 - d) Medicinal and aromatic plant products
 - e) Timber yielding plants and energy plantations
2. Collection of different types of locally available rice varieties
3. Submission of any five economically important useful plant parts
4. Collection of different cereals and pulses.

SEMESTER-III

COURSE 7: PLANT ECOLOGY, BIODIVERSITY AND PHYTOGEOGRAPHY

Theory

Credits: 3

3 hrs/week

I. Learning Objectives: By the end of this course the learner has to:

1. Figure-out the components of ecosystem and energy flow among different trophic levels.
2. Apprise the characteristics of autecology and synecology.
3. Understand the climatic change and associated impacts on biotic components.
4. Discern the value of biodiversity, threats and conservation strategies.
5. Know the distribution of various plant groups in different geographical areas.

II. Learning Outcomes: On completion of this course students will be able to:

1. Explain the interactions among the biotic and abiotic components in an ecosystem.
2. Summarize the characteristics of a population and a community.
3. Anticipate the environmental problems arising due to climate change.
4. Assess the value of biodiversity and choose appropriate conservation strategy.
5. Make a survey on the distribution of various plant groups in a specified geographical area.

III. Syllabus of Theory:

Unit-1: Basic concepts in ecology

10 Hrs.

1. Ecology: definition, branches and significance; relation with other sciences.
2. Structure and functions of ecosystems- abiotic and biotic components; flow of energy.
3. Cycling of materials: water, carbon, nitrogen and phosphorus; trophic pyramids, food chains and food webs.
4. Plants and environment: Climatic (light and temperature) and edaphic.
5. Interactions among plants; interactions between plants and animals.

Unit-2: Population and community ecology

10Hrs.

1. Population ecology: definition, characteristics -natality, mortality, and growth curves; ecads and ecotypes
2. Community ecology: characteristics -frequency, density, cover, life forms, competition, biological spectrum, methods of studying plant communities.
3. Ecological succession: Hydrosere and Xerosere; ecological adaptations of plants.
4. Concepts of productivity: GPP, NPP and Community Respiration; Secondary production, P/R ratio and Ecosystems.

Unit-3: Climate change-impacts

8Hrs.

1. Soil degradation – causes, consequences and management strategies.
2. Deforestation, forest fires – causes, consequences and management strategies.
3. Global warming, ozone layer depletion, acid rains, ocean acidification – causes and effects.
4. Carbon foot prints, carbon credits and carbon sequestration; The Montreal and the Kyoto protocol; Plant indicators and their role in environmental monitoring.

Unit-4: Concepts of Biodiversity

10Hrs

1. Biodiversity: Basic concepts, Convention on Biodiversity - Earth Summit.
2. Value of Biodiversity; types and levels of biodiversity and Threats to biodiversity
3. Biodiversity Hot spots in India: North Eastern Himalayas and Western Ghats.
4. Ex situ and In situ conservation methods, IUCN threat-categories, RED data book
5. Role of NBPGR and NBA in the conservation of Biodiversity.

Unit-5: Phytogeography 7 Hrs.

1. Principles of Phytogeography, Distribution (wides, endemic, discontinuous species)
2. Endemism – types and causes.
3. Phytogeographic regions of World; phytogeographic regions of India.
4. Vegetation types in Andhra Pradesh.

IV. Text Books:

1. Odum, E. P., & Barrett, G. W. (2005). Fundamentals of ecology (5th ed.). Brooks/Cole.
2. Kormondy, E. J. (2012). Concepts of ecology (4th ed.). Pearson Education.
3. Shukla, R. S., & Chandel, P. S. (2020). Plant ecology and soil science (20th ed.). S. Chand & Company Pvt. Ltd.
4. N.S.Subrahmanyam & A.V.S.S. Sambamurty (2008) Ecology Narosa Publishing House, New Delhi
5. Sharma, P.D. (2012) Ecology and Environment. Rastogi Publications, Meerut, India.
6. Chaudhuri, A. B. (2012). *Biodiversity and conservation*. Oxford University Press.
7. Krishnamurthy, K. V. (2003). *Textbook of biodiversity*. Science Publishers.

V. Reference Books:

1. Primack, R. B. (2014). *Essentials of conservation biology* (6th ed.). Sinauer Associates.
2. Begon, M., J.L. Harper & C.R. Townsend (2003) Ecology, Blackwell Science Ltd., U.S.A.
3. Eugene P. Odum (1996) Fundamentals of Ecology, Natraj Publishers, Dehradun
4. Kumar, H.D. (1992) Modern Concepts of Ecology (7th Edn.), Vikas Publishing Co., New Delhi.
5. Newman, E.I. (2000): Applied Ecology Blackwell Scientific Publisher, U.K.
6. Kumar H.D. (2000) Biodiversity & Sustainable Conservation Oxford & IBH Publishing Co Ltd. New Delhi.
7. Cox, C. B., & Moore, P. D. (2010). Biogeography: An ecological and evolutionary approach (8th ed.). Wiley-Blackwell.
8. Ambasht, R.S., & Ambasht, N. K. (2023). A Textbook of Plant Ecology (16th ed.). CBS Publishers & Distributors.

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Field visit to local ecosystems and making a report on biotic and abiotic components and their interactions.

Evaluation method: Valuation of record of attendance and report submission with conclusions

Unit- 2: Activity: Case studies on population and community ecologies and making a comprehensive report

Evaluation method: Assessing the report and awarding grade

Unit -3: Activity: Case studies on global and local climatic changes and their impacts, preparing a comprehensive report.

Evaluation method: Assessing the report and awarding grade.

Unit- 4: Activity: Making a survey in their locality to identify endangered and threatening species.

Evaluation method: Assessing the survey report and assigning a grade based on a rubric. **Unit-**

5: Activity: Collection of data on flora of their locality and preparing a project report.

Evaluation method: Assessing the project report and awarding a grade.

SEMESTER-III

COURSE 7: PLANT ECOLOGY, BIODIVERSITY AND PHYTOGEOGRAPHY

Practical

Credits: 1

2 hrs/week

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Handle instruments used in ecological studies.
2. Perform experiments and collect data on autecology and synecology.
3. Identify various plant groups based on their morphological and anatomical adaptations.
4. Collect data on biodiversity and phytogeography.

II. Laboratory/field exercises:

1. Study of instruments used to measure microclimatic variables;
 - a. Soil thermometer, b. Maximum and minimum thermometer,
 - c. Anemometer, d. Rain gauge, e. Lux meter.
2. Visit to the nearest/local meteorology station where the data is being collected regularly and record the field visit summary for the submission in the practical.
3. Study of morphological and anatomical adaptations of any two hydrophytes.
4. Study of morphological and anatomical adaptations of any two xerophytes.
5. Quantitative analysis of herbaceous vegetation in the college campus for frequency, density and abundance
6. Identification of vegetation/various plants in college campus and comparison with Raunkiaer's frequency distribution law.
7. Find out the alpha-diversity of plants in an area
8. Mapping of biodiversity hotspots of the world and India.
9. Mapping of phytogeographical regions of the globe and India.

SEMESTER-IV

COURSE 8: CELL AND MOLECULAR BIOLOGY

Theory

Credits: 3

3 hrs/week

I. Learning Objectives: By the end of this course the learner has:

1. To look into the ultra-structure of plant cell and its organelle
2. To know the morphology and functions of chromosomes
3. To understand the principles of autocatalysis and heterocatalysis of DNA

II. Learning Outcomes: On completion of this course students will be able to:

1. Sketch the ultra-structural aspects of plant cell and its components.
2. Hypothesise the role of chromosomes in inheritance.
3. Justify the role of genes in inheritance of characters by descent.
4. Correlate the functions of the nucleic acid with their structure.
5. Explain molecular mechanisms of DNA replication, transcription, translation, and gene regulation.

III. Syllabus of Theory:

Unit-1: Cell and its organelle

8 Hrs.

1. Cell theory; prokaryotic vs eukaryotic cell; animal vs plant cell; a brief account on ultra-structure of a plant cell.
2. Ultra-structure and functions of cell wall.
3. Ultra-structure and functions of plasma membrane and various models on its organization.
4. Polymorphic cell organelles (Plastids); ultra-structure of chloroplast, plastid DNA.
5. Ultrastructure of mitochondria, mitochondrial DNA.

Unit-2: Chromosomes

8 Hrs.

1. Nucleus-Nuclear membrane, nuclear pore complex
2. Prokaryotic vs eukaryotic chromosome; morphology of a eukaryotic chromosome.
3. Euchromatin and Heterochromatin; Karyotype and ideogram.
4. Organization of DNA in a chromosome (nucleosome and solenoid models).
5. Special types of chromosomes-Lampbrush chromosomes, polytene chromosomes, B chromosomes

Unit-3: Cell cycle and its regulation

10 Hrs.

1. Cell cycle-phases of cell cycle, amitosis.
2. Mitosis-Phases of mitosis and significance of mitosis.
3. Meiosis-phases of meiosis and significance of meiosis
4. Cell cycle check points, apoptosis

Unit-4: Nucleic acids

10 Hrs.

1. Primary structure of DNA, Watson and Crick model of DNA, types of DNA
2. Experimental evidences for DNA as genetic material
3. Methods of DNA replication, mechanism of DNA replication
4. DNA damage and repair
5. Structure, functions and types of RNA.

Unit-5: Transcription and Translation

9 Hrs.

1. Transcription: Mechanism of transcription in prokaryotes and eukaryotes
2. RNA processing –Post transcriptional changes
3. Genetic code: Nature of Genetic code, essential features of genetic code
4. Translation: Process of translation, post translational modifications, protein trafficking and sorting
5. Regulation of gene expression-Lac, Trp operons

IV. Text Books:

1. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., & Matsudaira, P. (2021). *Molecular Cell Biology* (9th ed.). W.H. Freeman.
2. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2019). *Molecular Biology of the Cell* (6th ed.). Garland Science.
3. Karp, G. (2021). *Cell and Molecular Biology: Concepts and Experiments* (9th ed.). Wiley.
4. De Robertis, E. D. P., & De Robertis, E. M. F. (2006). *Cell and Molecular Biology* (8th ed.). Lippincott Williams & Wilkins.
5. Cooper, G. M., & Hausman, R. E. (2019). *The Cell: A Molecular Approach* (8th ed.). Oxford University Press.
6. Verma, P. S., & Agarwal, V. K. (2020). *Cell Biology*. S. Chand & Company Ltd.

V. Reference Books:

1. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2020). *Lewin's Genes XII* (12th ed.). Jones & Bartlett Learning.
2. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2013). *Molecular Biology of the Gene* (7th ed.). Pearson Education.
3. Pollard, T. D., Earnshaw, W. C., & Lippincott-Schwartz, J. (2017). *Cell Biology* (3rd ed.). Elsevier.
4. Kleinsmith, L. J. (1995). *Principles of Cell and Molecular Biology* (2nd ed.). HarperCollins College Publishers.
5. Robert H. Tamarin (2002) *Principles of Genetics*, Tata McGraw –Hill Publishing Company Limited, New Delhi.
6. Gardner, E.J., M. J. Simmons & D.P. Snustad (2004) *Principles of Genetics*, John Wiley & Sons Inc., New York
7. Micklos, D.A., G.A. Freyer & D.A. Cotty (2005) *DNA Science: A First Course*, I.K.International Pvt. Ltd., New Delhi

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Group discussion on different types of cells and their components.

Evaluation method: Identifying the best group or performer and giving a reward.

Unit-2: Activity: Making nucleosome model

Evaluation method: Selecting the best and assigning a grade.

Unit-3: Activity: Observation of cell division in online root tip

Evaluation method: Selecting the best for any stage of cell division.

Unit-4: Activity: Making models of nucleic acids.

Evaluation method: Selecting the best and assigning a grade.

Unit-4: Activity: Making model for operons

Evaluation method: Selecting the best and assigning a grade.

SEMESTER-IV

COURSE 8: CELL AND MOLECULAR BIOLOGY

Practical

Credits: 1

2 hrs/week

I Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Identify the stages of mitotic and meiotic cell divisions.
2. Infer the structure and functions of nucleic acids.

II Laboratory/field exercises:

1. Study of ultra structure of a plant cell and its organelles using electron microscopic photographs /models.
2. Demonstration of mitosis in *Allium cepa*/*Aloe vera* roots using squash technique.
3. Observation of various stages of mitosis in permanent slides.
4. Demonstration of meiosis in P.M.C.s of *Allium cepa* flower buds using squash technique.
5. Observation of various stages of meiosis in permanent slides.
6. Study of structure of DNA and RNA molecules using models.

SEMESTER-IV

COURSE 9: GENETICS AND PLANT BREEDING

Theory

Credits: 3

3 hrs/week

I. Learning Objectives: By the end of this course the learner has:

1. To look into the ultra-structure of plant cell and its organelle
2. To know the morphology and functions of chromosomes
3. To understand the principles of genetics, structure and functions of gene

II. Learning Outcomes: On completion of this course students will be able to:

1. Sketch the ultra-structural aspects of plant cell and its components.
2. Hypothesise the role of chromosomes in inheritance.
3. Justify the role of genes in inheritance of characters by descent.
4. Correlate the functions of the nucleic acid with their structure.
5. Explain the discoveries led to understand the fine structure of a gene.

III. Syllabus of Theory:

Unit-1: Mendelian and non-Mendelian Genetics

10 Hrs.

1. Mendel's laws of inheritance- Law of Dominance, Law of segregation, and Law of independent assortment, Test cross and back cross.
2. Incomplete dominance and co-dominance; Multiple allelism.
3. Complementary, supplementary and duplicate gene interactions (plant-based examples are to be dealt).
4. Gene and alleles: Classical, and modern concepts of gene, structure of a gene

Unit-2: Linkage and crossing over

9 Hrs.

1. Linkage: Coupling phase and repulsive phase, chromosomal theory of linkage and kinds of linkage
2. Crossing over: Mechanism of crossing over, theories of crossing over, tetrad analysis
3. Construction of chromosomal maps: 2 point and 3 point test cross.

Unit-3: Mutations

9 Hrs.

1. Mutation: Types of mutations, mutagens. Gene mutations and types.
2. Chromosomal aberrations-variation in chromosomal number and structure.
3. Transposons: types, structure and mechanism of transposition.

Unit-4: Basic concepts of plant breeding

8 Hrs.

1. Definition, aim, objectives and scope of plant breeding; concepts in plant breeding: genetic variation, heritability, and selection
2. Self-incompatibility in plants – Definition, heteromorphic and homomorphic systems; exploitation of self-incompatibility in hybrid production.
3. Male sterility- Genetic, cytoplasmic and cytoplasmic-genetic sterility, utilization in plant breeding.

Unit-5: Breeding methods in plants

9 Hrs.

1. Plant introduction-objectives plant introduction agencies in India, procedure, merits and demerits
2. Selection-natural and artificial selection; pureline, clonal and mass selection, advantages, disadvantages and achievements
3. Hybridization-objectives, procedure, advantages, disadvantages and achievements, Heterosis.
4. Mutational breeding –method, advantages, limitations and achievements
5. DNA markers and their applications in plant breeding: RFLP, RAPD

IV. Text Books:

1. Griffiths, A. J. F., Wessler, S. R., Carroll, S. B., & Doebley, J. (2020). Introduction to Genetic Analysis (12th ed.). W. H. Freeman and Company.
2. Snustad, D. P., & Simmons, M. J. (2019). Principles of Genetics (7th ed.). Wiley.
3. Klug, W. S., Cummings, M. R., Spencer, C. A., & Palladino, M. A. (2022). Concepts of Genetics (12th ed.). Pearson Education.
4. Acquaah, G. (2021). Principles of Plant Genetics and Breeding (3rd ed.). Wiley-Blackwell.
5. Singh, B. D. (2020). Plant Breeding: Principles and Methods (11th ed.). Kalyani Publishers.
6. Allard, R. W. (1999). Principles of Plant Breeding (2nd ed.). Wiley.

V. Reference Books:

1. Hartl, D. L., & Ruvolo, M. (2020). Genetics: Analysis of Genes and Genomes (9th ed.). Jones & Bartlett Learning.
2. Strickberger, M. W. (2012). Genetics (3rd ed.). PHI Learning Pvt. Ltd.
3. Gardner, E. J., Simmons, M. J., & Snustad, D. P. (2006). Principles of Genetics (8th ed.). Wiley India Pvt. Ltd.
4. Chaudhari, H. K. (2022). Elementary Principles of Plant Breeding (Oxford & IBH).
5. Sharma, J. R. (2015). Principles and Practice of Plant Breeding. Tata McGraw-Hill Education.
6. Jain, H. K., & Kharkwal, M. C. (Eds.). (2004). Plant Breeding: Mendelian to Molecular Approaches. Narosa Publishing House.

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Solving the problems on classical genetics.

Evaluation method: Assessing the accuracy in solving the problems and awarding a grade.

Unit-2: Activity: Construction of chromosomal maps

Evaluation method: Selecting the best and assigning a grade.

Unit-3: Activity: Hands on activity of making models for chromosomal aberrations

Evaluation method: Selecting the best and assigning a grade.

Unit-4: Activity: Field trip to an agriculture or a horticulture research station to learn hybridization techniques.

Evaluation method: Active participation and learning skills on production of hybrid plants.

Unit-5: Activity: Case studies of modern applications of molecular techniques in crop improvement.

Evaluation method: Based on a rubric with specified criteria and performance levels of the learner.

SEMESTER-IV

COURSE 9: GENETICS AND PLANT BREEDING

Practical

Credits: 1

2 hrs/week

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Apply Mendelian principles to solve genetic problems and analyze segregation and independent assortment using monohybrid and dihybrid crosses.
2. Conduct experiments to determine linkage, recombination, and gene mapping using test cross and three-point test cross data.
3. Perform emasculation and artificial hybridization techniques in self-pollinated and cross-pollinated crops.

II. Laboratory/field exercises:

1. Solving problems on monohybrid, dihybrid, back and test crosses.
2. Solving problems on gene interactions (at least one problem for each of the gene interactions in the syllabus).
3. Chromosomes mapping using problems of 3-point test cross data.
4. Floral biology in a self and a cross pollinated plant species.
5. Practicing emasculation technique.
6. Practicing selfing and crossing techniques.

SEMESTER-IV

COURSE 10: PLANT PHYSIOLOGY AND METABOLOSM

Theory

Credits: 3

3 hrs/week

I. Learning Objectives: By the end of this course the learner has to:

1. Understand the concept of Soil-Plant-Atmosphere continuum based on plant-water relations.
2. Discuss the anabolic and catabolic processes in plants.
3. Explain the role of plant growth regulators on growth, development and flowering.

II. Learning Outcomes: On successful completion of this course, the students will be able to:

1. Comprehend the importance of water in plant life and mechanisms for transport of water and solutes in plants.
2. Explain the role of minerals in plant nutrition and their deficiency symptoms.
3. Hypothesize the light reactions and carbon assimilation processes responsible for synthesis of food in plants.
4. Analyze the biochemical reactions in relation to Nitrogen and lipid metabolisms.
5. Evaluate the physiological factors that regulate growth, development and flowering in plants.

III. Syllabus of Theory:

Unit – 1: Plant-Water relations

8 Hrs.

1. Importance of water to plant life, physical properties of water, diffusion, imbibition, osmosis. water potential, osmotic potential, pressure potential.
2. Absorption and lateral transport of water; Ascent of sap
3. Transpiration: stomata structure and mechanism of stomatal movements (K^+ ion flux).
4. Mechanism of phloem transport; source-sink relationships.

Unit – 2: Mineral nutrition, Enzymes and Respiration

10 Hrs.

1. Essential macro and micro mineral nutrients and their role in plants; symptoms of mineral deficiency
2. Absorption of mineral ions; passive and active processes.
3. Characteristics, nomenclature and classification of Enzymes. Mechanism of enzyme action, enzyme kinetics.
4. Respiration: Aerobic and Anaerobic; Glycolysis, Krebs cycle; electron transport system, mechanism of oxidative phosphorylation, Pentose Phosphate Pathway (HMP shunt).

Unit – 3: Photosynthesis and Photorespiration

10 Hrs.

1. Photosynthesis: Photosynthetic pigments, absorption and action spectra; Red drop and Emerson enhancement effect
2. Concept of two photosystems; mechanism of photosynthetic electron transport and evolution of oxygen; photophosphorylation
3. Carbon assimilation pathways (C_3 , C_4 and CAM).
4. Photorespiration - C_2 pathway

Unit – 4: Nitrogen and lipid metabolism **9 Hrs.**

1. Nitrogen metabolism: Biological nitrogen fixation – asymbiotic and symbiotic nitrogen fixing organisms. Nitrogenase enzyme system.
2. Lipid metabolism: Classification of Plant lipids, saturated and unsaturated fatty acids.
3. Anabolism of triglycerides, β -oxidation of fatty acids, Glyoxylate cycle.

Unit – 5: Plant growth - development **8Hrs.**

1. Growth and Development: Definition, phases and kinetics of growth.
2. Physiological effects of Plant Growth Regulators (PGRs) - auxins, gibberellins, cytokinins, ABA, ethylene and brassinosteroids.
3. Physiology of flowering: Photoperiodism, role of phytochrome in flowering.
4. Seed germination and senescence; physiological changes during seed germination.

IV. Text Books:

1. Pandey, B.P. (2013) College Botany, Volume-III, S. Chand Publishing, New Delhi
2. Ghosh, A. K., K. Bhattacharya & G. Hait (2011) A Text Book of Botany, Volume III, New Central Book Agency Pvt. Ltd., Kolkata

V. Reference Books:

1. Hans Mohr & P. Schopfer (2006) Plant Physiology, Springer (India) Pvt. Ltd., New Delhi
2. Hopkins, W.G. & N.P.A. Huner (2014) Introduction to Plant Physiology, Wiley India Pvt. Ltd., New Delhi
3. Noggle Ray & J. Fritz (2013) Introductory Plant Physiology, Prentice Hall (India), New Delhi
4. Salisbury, Frank B. & Cleon W. Ross (2007) Plant Physiology, Thomson & Wadsworth, Australia & U.S.A
5. Taiz, L. & E. Zeiger (2003) Plant Physiology, Panima Publishers, New Delhi.
6. Verma, V. (2007) Text Book of Plant Physiology, Ane Books India, New Delhi.

VI. Suggested activities and evaluation method

Unit-1: Activity: Observe and tabulate the water content of different plant parts and justify the importance of the water based on the morphological nature.

Evaluation method: Assess the report and assign the grade points based on a rubric.

Unit-2 Activity: Survey report on various inorganic and organic fertilizers available in the local markets.

Evaluation method: Assess the record and award the grades on a specified point scale.

Unit-3 Activity: Identify the C₄ plants from their locality and make a report.

Evaluation method: Assessing the clarity, organization, and effectiveness of the report's presentation and communication based on a rubric.

Unit-4 Activity: Group discussion on various Nitrogen fixing microbes. **Evaluation method:** Assessing the group members' ability to think critically and analyze the topic being discussed.

Unit-5 Activity: A critical assignment on photoperiodic responses in plants in their locality.

Evaluation method: Evaluating the logical coherence and reasoning in the assignment.

SEMESTER-IV

COURSE 10: PLANT PHYSIOLOGY AND METABOLISM

Practical

Credits: 1

2 hrs/week

I. Course outcomes: On successful completion of this practical course, students shall be able to:

1. Conduct lab and field experiments pertaining to plant physiology.
2. Estimate the quantities and qualitative expressions using experimental results and calculations
3. Interpret the factors responsible for growth and development in plants.

II. Laboratory/field exercises:

Major experiments:

1. Determination of osmotic potential of plant cell sap by plasmolytic method using *Rhoeo/ Tradescantia* leaves.
2. Calculation of stomatal index and stomatal frequency of a mesophyte, a hydrophyte and a xerophyte.
3. Determination of rate of transpiration using Cobalt chloride method / Ganong's potometer (at least for a dicot and a monocot).
4. Effect of temperature on membrane permeability by colorimetric method.
5. Study of mineral deficiency symptoms using plant material/photographs.
6. Demonstration of amylase enzyme activity and study the effect of substrate and Enzyme concentration.
7. Separation of chloroplast pigments using paper chromatography technique.
8. Demonstration of Polyphenol oxidase enzyme activity (Potato tuber or Apple fruit)
9. Anatomy of C3, C4 and CAM leaves.

Minor experiments:

1. Osmosis
2. Arc-auxonometer
3. Ascent of sap through xylem