ANDHRA PRADESH STATE COUNCIL OF HIGHER EDUCATION

Model Syllabus for Botany (Minor) in consonance with Curriculum framework w.e.f. AY 2025-26

COURSE STRUCTURE

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
II	III	1	Non-vascular Plants	3	3
			Non-vascular Plants-Practical	2	1
	IV	2	Vascular Plants	3	3
			Vascular Plants-Practical	2	1
III	V	3	Anatomy and Embryology of Angiosperms	3	3
			Anatomy and Embryology of Angiosperms-Practical	2	1
		4	Plant Ecology, Biodiversity and Phytogeography	3	3
			Plant Ecology, Biodiversity and Phytogeography-Practical	2	1
	VI	5	Cell Biology and Genetics	3	3
			Cell Biology and Genetics-Practical	2	1
		6	Plant Physiology and Metabolism	3	3
			Plant Physiology and Metabolism-Practical	2	1

SEMESTER-III

COURSE 1: NON-VASCULAR PLANTS

(ALGAE, FUNGI, LICHENS AND BRYOPHYTES)

Theory **Credits: 3** **3 hrs/week**

I. Learning Objectives: By the end of this course the learner has:
1. To realize the characteristics and diversity of non-vascular plants.
2. To recognize the ecological and economic value of algae, fungi, lichens and bryophytes.
3. To inquire the habit, habitat, morphological features and life cycles of selected genera of non-vascular plants.

II. Learning Outcomes: On completion of this course students will be able to:
1. Compile the general characteristics of algae and their significance in nature.
2. Compare and contrast the characteristics of different groups of algae.
3. Summarize the important features of fungi and their economic value.
4. Distinguish the characteristics of different groups of fungi.
5. Elaborate the features and significance of amphibians of plant kingdom
6. Explain the diversity among non-vascular plants.

III. Syllabus of Theory:

Unit-1: Introduction to Algae **8Hrs.**
1. General Characteristics of algae: Occurrence and distribution, cell structure, pigments, flagella and reserve food material.
2. Classification of algae: F.E.Fritsch (1935) and Lee (2008)
3. Thallus organization and life cycles in algae.
4. Ecological and economic importance of algae.

Unit-2: Biology of selected Algae **10Hrs.**
1. Occurrence, structure, reproduction and life cycle of:
(a) Chlorophyceae: *Spirogyra* (b) Phaeophyceae: *Ectocarpus*
(c) Xanthophyceae: *Vaucheria* (d) Rhodophyceae: *Polysiphonia*
2. A brief account of Bacillariophyceae
3. Culture and cultivation of *Chlorella*

Unit-3: Introduction to Fungi **8Hrs.**
1. General characteristics of fungi and Ainsworth (1973) classification.
2. Thallus organization and nutrition in fungi.
3. Reproduction in fungi (asexual and sexual); Heterothallism and parasexuality.
4. Ecological and economic importance of fungi.

Unit-4: Biology of selected Fungi **10Hrs.**
1. Occurrence, structure, reproduction and life cycle of:
(a) Mastigomycotina: *Phytophthora* (b) Zygomycotina: *Rhizopus*
(c) Ascomycotina: *Penicillium* (d) Basidiomycotina: *Puccinia*
2. Occurrence, structure and reproduction of lichens; ecological and economic importance of lichens.

Unit-5: Biology of Bryophytes **9Hrs.**

1. General characteristics of Bryophytes; Rothmaler (1951) classification.
2. Occurrence, morphology, anatomy, reproduction (developmental details are not needed) and life cycle of (a) Hepaticopsida: *Marchantia* (b) Anthoceratopsida: *Anthoceros* (c) Bryopsida: *Funaria*
3. General account on the evolution of sporophytes in Bryophyta.

IV. Text Books:

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

V. Reference Books:

1. Fritsch, F.E. (1945) The Structure & Reproduction of Algae (Vol. I & Vol. II) Cambridge University Press Cambridge, U.K.
2. Bold, H.C.& M. J. Wynne (1984) Introduction to the Algae, Prentice-Hall Inc., New Jersey
3. Robert Edward Lee (2008) Phycology. Cambridge University Press, New York
4. Van Den Hoek, C., D.G.Mann & H.M.Jahns (1996)Algae : An Introduction to Phycology. Cambridge University Press, New York.
5. Alexopoulos, C.J., C.W.Mims & M.Blackwell (2007) Introductory Mycology, Wiley& Sons, Inc., New York
6. Mehrotra, R.S.& K. R. Aneja (1990) An Introduction to Mycology. New Age International Publishers, New Delhi.
7. Kevin Kavanagh (2005) Fungi; Biology and Applications John Wiley& Sons, Ltd., West Sussex, England.
8. John Webster & R. W. S. Weber (2007) Introduction to Fungi, Cambridge University Press, New York.
9. Shaw, A.J.& B.Goffinet (2000) Bryophyte Biology .Cambridge University Press, New York.

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Algae specimen collection from any water bodies in their locality, recording the characteristics, identification and classifying them according to Fritsch system.
Evaluation method: Evaluating the presentation or report summarizing findings.

Unit-2: Activity: Microscopic observations and recording distinguishing characters of any six algal forms excluding the genera in the syllabus.
Evaluation method: Conducting a Quiz or an exam/ evaluating the chart or drawings or summarized data on similarities and differences.

Unit-3: Activity: Collection or laboratory culture of fungi and reporting the important features.
Evaluation method: Evaluating the report/conducting JAM/Quiz/Group discussion.

Unit-4: Activity: Microscopic observations and summarizing the salient features of the fungal genera and lichen forms in the syllabus.
Evaluation method: Conducting a Quiz or an exam/ evaluating the chart or drawings or concise data on similarities and differences.

Unit-5: Activity: Collection, characterization, identification and classification of any four bryophytes from their native locality or college campus.
Evaluation method: Assessment of observations and documentation accuracy/presentation or report summarizing findings based on a rubric.

SEMESTER-III

COURSE 1: NON-VASCULAR PLANTS

(ALGAE, FUNGI, LICHENS AND BRYOPHYTES)

Practical **Credits: 1** **2 hrs/week**

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

1. Identify some algal and fungal species based on the structure of thalli and reproductive organs.
2. Decipher the lichens and Bryophytes based on morphological, anatomical and reproductive features.

II. Laboratory/field exercises:

Study/ microscopic observation of vegetative, sectional/anatomical and reproductive structures of the following using temporary or permanent slides/ specimens/ mounts:

1. **Algae:** *Spirogyra, Ectocarpus, Vaucheria* and *Polysiphonia*; a centric and a pennate diatom.
2. Demonstration of culture and cultivation of *Chlorella*
3. Identification of some algal products available in local market.
4. **Fungi:** *Phytophthora, Rhizopus, Penicillium* and *Puccinia*
5. Identification of some fungal products available in the local market.
6. **Lichens:** Crustose, foliose and fruiticose
7. **Bryophyta:** *Marchantia, Anthoceros* and *Funaria.*

SEMESTER-IV

COURSE 2: VASCULAR PLANTS

(PTERIDOPHYTES, GYMNOSPERMS AND TAXONOMY OF ANGIOSPERMS)

Theory **Credits: 3** **3 hrs/week**

I. Learning Objectives: By the end of this course the learner has:
1. To recognize the morphology, anatomy, and reproduction in two groups of archegoniates.
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 and their economic value.
4. To study the significance of other branches of botany with plant taxonomy.

II. Learning Outcomes: On completion of this course students will be able to:
1. Infer the evolution of vasculature, heterospory, and seed habit in Pteridophytes.
2. Illustrate the general characteristics of Gymnosperms along with their uses
3. Discuss about some Taxonomic aids and their applications in plant systematics.
4. Compare and contrast the vegetative and floral characteristics of some angiospermic families
5. Evaluate the economic value of plant species from the families under the study.
6. Defend the utility of evidences from different branches of botany in solving the taxonomic lineages of some species.

III. Syllabus of Theory:

Unit-1: Pteridophytes **10Hrs.**
1. General characteristics of Pteridophyta; Smith (1955) classification.
2. Occurrence, morphology, anatomy, reproduction (developmental details are not needed) and life history of: (a) Lycopsida: *Lycopodium* and (b) Filicopsida: *Marsilea*
3. Stelar evolution in Pteridophytes; Heterospory and seed habit.
4. Ecological and economic importance of Pteridophytes.

Unit-2: Gymnosperms **10Hrs.**
1. General characteristics of Gymnosperms; Sporne (1965) classification.
2. Occurrence, morphology, anatomy, reproduction (developmental details are not needed) and life history of:(a) Cycadopsida: *Cycas* and (b) Gnetopsida: *Gnetum*
3. Ecological and economic importance of Gymnosperms.

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 Hooker system of classification; Brief account of APG-IV classification.

Unit-4: Descriptive Plant Taxonomy **8 Hrs.**

Systematic description and economic importance of the following families:
1. Polypetalae: (a) Annonaceae (b) Fabaceae (c) Curcurbitaceae
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; Origin and evolution of angiosperms.

IV. Text Books:

1. Acharya, B.C., (2019) Archchegoniates, Kalyani Publishers, New Delhi
2. Bhattacharya, K., G. Hait&Ghosh, A. K., (2011) A Text Book of Botany, VolumeII, New Central Book Agency Pvt. Ltd., Kolkata
3. Hait,G., K.Bhattacharya&A.K.Ghosh (2011) A Text Book of Botany, Volume-I,New Central Book Agency Pvt. Ltd., Kolkata
4. Pandey, B.P. (2013) College Botany, Volumes-I&II, S. Chand Publishing, New Delhi

V. Reference Books:

1. Smith, G.M. (1971) CryptogamicBotanyVol. II., Tata McGraw Hill, New Delhi
2. Sharma,O.P.(2012) Pteridophyta. Tata McGraw-Hill, New Delhi
3. Sporne, K.R. (1971) The Morphology of Gymnosperms.Hutchinsons Co. Ltd.,London
4. Coulter, J.M. & C.J.Chamberlain(1910) Morphology of Gymnosperms,The University of Chicago Press, Chicago, Illinois
5. Bhatnagar, S.P. & Alok Moitra (1996) Gymnosperms. New Age International, New Delhi
6. Sambamurty, A.V.S.S. (2005) Taxonomy of Angiosperms I.K. International Pvt. Ltd., New Delhi
7. Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt.Ltd., NewDelhi.
8. Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A.

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Making temporary slides/models/drawings of Pteridophytes in the syllabus.
Evaluation method: Assessment of the temporary slides/model/drawing.

Unit-2: Activity: Study of wood elements in locally available Gymnosperms and making temporary slides.
Evaluation method: Validation of prepared slides submitted by the learner.

Unit-3: 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-4: 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-5: 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.

SEMESTER-IV

COURSE 2: VASCULAR PLANTS

(PTERIDOPHYTES, GYMNOSPERMS AND TAXONOMY OF ANGIOSPERMS)

Practical **Credits: 1** **2 hrs/week**

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

1. Distinguish the Pteridophytes and Gymnosperms based on their morphological, anatomical and reproductive structures.
2. Make systematic classification of plant species using vegetative and floral characters.
3. Identify angiosperm plant species and make herbarium specimens.

II Laboratory/field exercises:

I. Study/ microscopic observation of vegetative, sectional/anatomical, and reproductive structures of the following using temporary or permanent slides/specimens/ mounts:

1. Pteridophyta: *Lycopodium* and *Marselia*
2. Gymnosperms: *Cycas* and *Gnetum*

II. Technical description of locally available plant species from the following angiosperm families:

1. Annonacae 2.Fabaceae 3. Cucurbitaceae 4. Asteraceae 5. Asclepiadaceae
6. Amaranthaceae 7. Euphorbiaceae 8. Orchidaceae 9. 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-V

COURSE 3: ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS

Theory **Credits: 3** **3 hrs/week**

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

1. Deliberate about various types of tissues in plants and their organization.
2. Explain anomalous secondary growth in plants and economic value of woods.
3. Debate on structure of anther and development of male gametophyte in plants.
4. Discuss the structure of ovules and process of fertilization.
5. Explain the embryo development and seed structure in monocots and dicots.

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

1. Categorize various tissues and evaluate their role in plants.
2. Explain anomalous secondary growth in some plants and justify the value of timber plants.
3. Summarize the events in micro-sporogenesis and development of male gametophyte.
4. Illustrate the events in mega-sporogenesis and development of female gametophyte.
5. Propose the incidents in embryogenesis and structure of seeds in angiosperms.

III. Syllabus of Theory:

Unit – 1: Tissues in plants **8 Hrs.**

1. Meristematic tissues: Definition, classification, structure and functions.
2. Apical meristems: Generalized structure of shoot apex, theories on organization of Shoot Apical Meristem (SAM) - Apical cell theory, Tunica-Corpus theory and Histogen theory.
3. Permanent tissues (simple and complex); a brief account of plant secretory tissues/cells.

Unit-2: Anomalous growth in plants **10Hrs.**

1. Tissue systems–Epidermal, ground and vascular.
2. Anomalous secondary growth in root of *Beta vulgaris;* anomalous secondary growth in stems of *Boerhaavia* and *Dracaena*
3. Study of timbers of economic importance - Teak, Red-sanders and Rosewood; applications of anatomy forensics and pharmacognosy.

Unit-3: Anther and pollen **10Hrs.**

1. Anther: Structure and functions of anther wall, micro-sporogenesis.
2. Pollen wall structure, NPC system; development of male gametophyte, MGU (male germ unit).
3. Pollen wall proteins; pollen viability, storage and germination; abnormal features: Pseudomonads and polyads; Nemec phenomenon.
4. A brief account of palynology and its scope.

Unit-4: Ovules, fertilization and endosperm **10Hrs.**

1. Structure and types of ovules, megasporogenesis; monosporic (*Polygonum*), bisporic (*Allium*) and tetrasporic (*Peperomia*) types of embryo sacs.
2. Pollination: types of self and cross pollination – contrivances; agents of pollination.
3. Double fertilization in angiosperms – process and consequences.
4. Perisperm; endosperm – types (free nuclear, cellular, helobial and ruminate) and biological importance.

Unit-5: Embryogeny and seeds **7Hrs.**

1. Embryo development in dicot (*Capsella bursa-pastoris*) and monocot (*Sagittaria sagittifolia*) plants.
2. Seed structure in monocot and dicot; importance of seed and seed dispersal mechanisms.
3. Polyembryony and apomixes: Introduction, classification, causes and applications.

IV. Text Books:

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

V. Reference Books:

1. Esau, K. (1971) Anatomy of Seed Plants. John Wiley and Son, USA.
2. Fahn, A. (1990) Plant Anatomy, Pergamon Press, Oxford.
3. Cutler, D.F., T. Botha & D. Wm. Stevenson (2008) Plant Anatomy: An Applied Approach, Wiley, USA
4. Paula Rudall (1987) Anatomy of Flowering Plants: An Introduction to Structure and Development. Cambridge University Press, London
5. Bhojwani, S. S. and S. P. Bhatnagar (2000) The Embryology of Angiosperms (4th Ed.),Vikas Publishing House, Delhi.
6. Pandey, A. K. (2000) Introduction to Embryology of Angiosperms. CBS Publishers & Distributors Pvt. Ltd., New Delhi
7. Maheswari, P. (1971) An Introduction to Embryology of Angiosperms. McGraw Hill Book Co., London.
8. Johri, B.M. (2011) Embryology of Angiosperms. Springer-Verlag, Berlin

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Microscopic observations on different tissues in plants and recording characteristics.
Evaluation method: Judgement of the report/seminar on comparative and contrasting features of various tissues in plants.
Unit-2: Activity: Visits to timber depots and furniture shops and making a report on various woods.
Evaluation method: Assessment of report submitted with data, photographs and summary.
Unit-3: Activity: Study of pollen structure, germination and viability in some local plant species.
Evaluation method: Evaluating the report/seminar presentation with collected data.
Unit-4: Activity: Group discussion/quiz on endosperm types and functions. Evaluation method: Assessment of the best performing group.
Unit-5: Activity: Drawings of embryogeny in some angiosperms and making comparative report.
Evaluation method: Evaluating the best drawings and comparative report.

SEMESTER-V

COURSE 3: ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS

Practical **Credits: 1** **2 hrs/week**

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

1. Conduct dissections of various plant organs and study the internal structures by staining.
2. Explain the embryological characteristics from sex organs to seeds in angiosperms.
3. Demonstrate skills in studying anatomical and embryological features of angiosperms.

II. Laboratory/field exercises:

1. Observation of meristems in dicot and monocot plants.
2. Tissue organization in shoot apices using permanent slides.
3. Anomalous secondary growth in root of *Beta vulgaris*
4. Anomalous secondary growth in stems of *Boerhaavia* and *Dracaena.*
5. Study of anther and ovules using permanent slides/photographs.
6. Study of pollen germination and pollen viability.
7. Dissection and observation of embryo sac haustoria in *Santalum* or *Argemone*.
8. Structure of endosperm (nuclear and cellular) using permanent slides/photographs.
9. Dissection and observation of endosperm haustoria in *Crotalaria* or *Coccinia*.
10. Developmental stages of dicot and monocot embryos using permanent slides/photographs

SEMESTER-V

COURSE 4: 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-V

COURSE 4: 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 gauze, 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-VI

COURSE 5: CELL BIOLOGY AND GENETICS

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: 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 of cell wall.
3. Ultra-structure of plasma membrane and various theories 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. Prokaryotic vs eukaryotic chromosome; morphology of a eukaryotic chromosome.
2. Euchromatin and Heterochromatin; Karyotype and ideogram.
3. Brief account of chromosomal aberrations - structural and numerical changes
4. Organization of DNA in a chromosome (nucleosome and solenoid models).

Unit-3: Mendelian and non-Mendelian Genetics **10 Hrs.**
1. Mendel's laws of inheritance. Incomplete dominance and co-dominance; Multiple allelism.
2. Complementary, supplementary and duplicate gene interactions (plant-based examples are to be dealt).
3. A brief account of linkage and crossing over; Chromosomal mapping - 2 point and 3 point test cross.
4. Concept of maternal inheritance (Corren's experiment on Mirabilis jalapa).

Unit-4: Structure and function of DNA **10 Hrs.**
1. Watson and Crick model of DNA. Brief account on DNA Replication (Semiconservative method).
2. Brief account on transcription, types and functions of RNA.
3. Genetic code and a brief account of translation.
4. Regulation of gene expression in prokaryotes - Lac Operon.

Unit-5: Gene concept and Sex determination 9 Hrs.

1. Evolution of gene concept: classical vs molecular concepts of gene.
2. Cis–Trans complementation test for functional allelism, gene as unit of function, mutation and recombination.
3. Pattern of sex determination in plants.
4. Allele and genotype frequencies, Hardy-Weinberg law.

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
3. A.V.S.S. Sambamurty (2007) Molecular Genetics,Narosa Publishing House, New Delhi
4. S. C. Rastogi (2008) Cell Biology,New Age International (P) Ltd. Publishers, New Delhi

V. Reference Books:

1. P. K. Gupta (2002) Cell and Molecular biology, Rastogi Publications, New Delhi
2. B. D. Singh (2008) Genetics,Kalyani Publishers, Ludhiana
3. Cooper, G.M. & R.E. Hausman (2009) The Cell – A Molecular Approach, A.S.M. Press, Washington
4. Becker, W.M., L.J. Kleinsmith& J. Hardin (2007) The World of Cell, Pearson, Education, Inc., New York
5. De Robertis, E.D.P. & E.M.F. De Robertis Jr. (2002) Cell and Molecular Biology, Lippincott Williams & Wilkins Publ., Philadelphia
6. Robert H. Tamarin (2002) Principles of Genetics, Tata McGraw –Hill Publishing Company Limited, New Delhi.
7. Gardner, E.J., M. J. Simmons & D.P. Snustad (2004) Principles of Genetics, John Wiley & Sons Inc., New York
8. 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: Observation of chromosomal aberrations in Allium cepa root cells exposed to industrial effluent/ heavy metals
Evaluation method: Validation of report and assigning a grade based on a rubric.

Unit-3: Activity: Solving the problems on classical genetics.
Evaluation method: Assessing the accuracy in solving the problems and awarding a grade.

Unit-4: Activity: Making models of nucleic acids.
Evaluation method: Selecting the best and assigning a grade.

Unit-5: Activity: Making a comprehensive report on sex determination in plants by collecting scientific literature.
Evaluation method: Validation of report and assigning a grade based on a specified point scale.

SEMESTER-VI

COURSE 5: CELL BIOLOGY AND GENETICS

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.
3. Predict the consequences of a particular genetic condition.

II. Laboratory/field exercises:

1. Study of ultra-structure of 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.
7. Solving problems on monohybrid, dihybrid, back and test crosses.
8. Solving problems on gene interactions (at least one problem for each of the gene interactions in the syllabus).
9. Chromosomes mapping using problems of 3- point test cross data.

SEMESTER-VI

COURSE 6: 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 (C3, C4 and CAM).
4. Photorespiration - C2 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, VolumeIII, 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, Thomsen & Wadsworth, Austalia&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-VI

COURSE 6: 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:

Osmosis, Arc-auxonometer, ascent of sap through xylem, cytoplasmic streaming