

MIZORAM UNIVERSITY

Department of Botany



Under Graduate Course: Choice Based Credit System

Course Structure under CBCS

Sem ester	Course Opted	Course Name	Credits				Marks	End Sem Exam.	Total
			L	T	P	Total			
I	Core Course- 1-	Cryptogams-Theory	3	1	0	4	40	60	100
	Core Course-2-	Cryptogams-Practical	0	0	0	2	40	60	100
	Elective Subject I: Course-1: Theory		-	-	-	4	40	60	100
	Elective Subject I: Course-2: Practical		-	-	-	2	40	60	100
	Elective Subject II: Course -1: Theory		-	-	-	4	40	60	100
	Elective Subject II: Course -2: Practical		-	-	-	2	40	60	100
	Foundation Course- I	English	4	1	0	5	40	60	100
					23	280	420	700	
II	Core Course- 3: Theory	Phanerogams - Theory	3	1	0	4	40	60	100
	Course Course-4: Practical	Phanerogams-Practical	0	0	0	2	40	60	100
	Elective Subject I: Course-3: Theory		-	-	-	4	40	60	100
	Elective Subject I: Course -4: Practical		-	-	-	2	40	60	100
	Elective Subject II: Course-3: Theory		-	-	-	4	40	60	100
	Elective Subject II: Course-4: Practical		-	-	-	2	40	60	100
	Foundation Course- II	Gender Sensitization	2	1	0	3	40	60	100
Open Elective -I	OE-I : (students from other departments can also opt)	0	0		2	40	60	100	
					23	320	480	800	
III	Core Course-5: Theory	Plant Physiology, Biochemistry, Ecology- Theory	3	1	0	4	40	60	100
	Core Course-6: Practical	Plant Physiology, Biochemistry, Ecology- Practical	0	0	0	2	40	60	100
	Elective Subject I Course-5: Theory		-	-	-	4	40	60	100

	Elective Subject I Course-6: Practical		-	-	-	2	40	60	100
	Elective Subject II Course-5: Theory		-	-	-	4	40	60	100
	Elective Subject II Course-6: Practical		-	-	-	2	40	60	100
	Foundation Course-III	History of Science	2	1	0	3	40	60	100
	Open Elective-II	OE-II (Students from other departments can also opt)	0	0	0	2	40	60	100
						23	320	480	800
IV	Core Course-7: Theory	Microbiology, Cytology, Genetics, Evolution- Theory	3	1	0	4	40	60	100
	Core Course-8: Practical	Microbiology, Cytology, Genetics, Evolution- Practical	0	0	2	2	40	60	100
	Elective Subject I Course-7: Theory		-	-	-	4	40	60	100
	Elective Subject I Course-8: Practical		-	-	-	2	40	60	100
	Elective Subject II Course-7: Theory		-	-	-	4	40	60	100
	Elective Subject II Course-8: Practical		-	-	-	2	40	60	100
	Foundation Course-IV	Environmental Studies	4	1	0	5	40	60	100
						23	280	420	800
V	Core Course-9: Theory	Fungi, Plant pathology, Biostatistics- Theory	3	1	0	4	40	60	100
	Core Course-10: Practical	Fungi, Plant pathology, Biostatistics- Practical	0	0	2	2	40	60	100
	Core Course-11: Theory	Algae, Lichen and Bryophytes- Theory	3	1	0	4	40	60	100
	Core Course-12: Practical	Algae, Lichen and Bryophytes- Practical	0	0	2	2	40	60	100
	Core Course-13: Theory	Cytogenetics, Plant Breeding and Bioinformatics- Theory	3	1	0	4	40	60	100
	Core Course-14: Practical	Cytogenetics, Plant Breeding, Bioinformatics- Practical	0	0	2	2	40	60	100

	Core Course-15: Theory	Environmental Biology and Ethnobotany- Theory	3	1	0	4	40	60	100
	Core Course-16: Practical	Environmental Biology and Ethnobotany- Practical	0	0	2	2	40	60	100
						24	320	480	800
VI	Core Course-17: Theory	Pteridophytes, Gymnosperms, Paleobotany and Palynology- Theory	3	1	0	4	40	60	100
	Core Course-18: Practical	Pteridophytes, Gymnosperms, Palaeobotany, Palynology- Practical	0	0	2	2	40	60	100
	Core Course-19: Theory	Angiosperm taxonomy, Anatomy and Embryology- Theory	3	1	1	4	40	60	100
	Core Course-20: Practical	Angiosperm taxonomy, Anatomy, Embryology- Practical	0	0	2	2	40	60	100
	Core Course-21: Theory	Plant Metabolism, Biochemistry, Thermodynamics- Theory	3	1	0	4	40	60	100
	Core Course-22: Practical	Plant Metabolism, Biochemistry and Thermodynamics- Practical	0	0	2	2	40	60	100
	Core Course-23: Theory	Plant Biotechnology, Experimental Embryology- Theory	3	1	0	4	40	60	100
	Core Course-24: Practical	Plant Biotechnology, Experimental Embryology- Practical	0	0	2	2	40	60	100
							24	320	480
						140	1840	2760	4600

BOT/I/EC/01 Theory : Cryptogams

Unit 1:

General classification and distinguishing characteristics of various groups of cryptogams (algae, fungi, bryophytes and pteridophytes).

Unit 2:

Algae: Main characteristics of Chlorophyceae, Xanthophyceae, Rhodophyceae, Pheophyceae and Cyanophyceae; Study of structure, reproduction and life history of *Volvox*, *Oedogonium*, *Ectocarpus*, *Polysiphonia*, *Nostoc*.

Unit 3:

Fungi: Main characteristics of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Dueteromycotina; Study of structure, reproduction and life history of *Rhizopus*, *Peziza*, *Puccinia*, *Alternaria*.

Unit 4:

Bryophyte: General characteristics of Hepaticopsida, Anthocerotopsida, Bryopsida; Thallus structure, reproduction, and life history of *Marchantia*, *Anthoceros* and *Funaria*.

Unit 5:

Pteridophytes: General characteristics Psilopsida, Lycopsida, Sphenopsida, Filicopsida; Various types of stele; Study of morphology, reproduction and life history of *Psilotum*, *Selaginella* and *Pteris*.

Suggested readings:

- 1 Alexopoulos, C.J., Mims, C.W. and Blackwell, M. (1996). Introductory Mycology, 4th Ed., John Wiley and sons (Asia) Singapore.
- 2 Bold, H.C. & Wayne, M.J. 1996 (2nd Ed.) Introduction to Algae. Cambridge Univ. Press.
- 3 Mukherji, H. (2005). Plant groups. New Central Book Agency, Calcutta.
- 4 Pandey, B.P. (2009). College Botany Vol-I. S.Chand & Co. New Delhi
- 5 Sharma, U.P., (2006) A text book of Pteridophyte. Macmillan Publishers, India
- 6 Vashista, B.R., Botany (2002) Botany (for degree student), part III, Bryophyte. S.Chand & Co. New Delhi.

BOT/I/EC/02 : Cryptogams- Practical

1. Study of vegetative and reproductive structures of different classes of Algae (Temporary)
2. Study of vegetative and reproductive structures of different classes of fungi (Temporary)
3. Study of vegetative and reproductive structures of *Marchantia*, *Anthoceros* and *Funaria*.
4. Study of vegetative and reproductive structures of *Psilotum*, *Selaginella* and *Pteris*.

BOT/II/EC/03 : Phanerogams - Theory

Unit 1:

Gymnosperms: General characteristics; Classification; Morphology and reproduction in *Cycas*, *Pinus*, and *Gnetum*.

Unit 2:

Angiosperm: Bentham and Hooker's system of classification; Distinguishing features of the following families: Ranunculaceae, Rosaceae, Cucurbitaceae, Rubiaceae, Acanthaceae, Solanaceae, Lamiaceae, Malvaceae, Brassicaceae, Asteraceae and Poaceae.

Unit 3:

Anatomy: Structure of stem, leaf and root; Anatomy of following plants showing anomalous structures: *Mirabilis*, *Bignonia* and *Dracaena*.

Unit 4:

Embryology: General account of microsporangium and microsporogenesis, megasporangium and megasporogenesis; Male and female gametophyte; Double fertilization; Different types of endosperm developments; Development of typical monocot and dicot embryo.

Unit 5:

Economic botany: cereals (rice, wheat, maize), pulses (gram, lentil, soybean), fibers (jute and cotton), fats and oils (Mustard, sunflower, coconut), spices (cumin, coriander, cardamom), beverages (tea and coffee), timbers yielding plants (teak, sal, *Michelia*).

Suggested Readings:

1. Bhojwani, S.S. and Bhatnagar, S.D. (2004). The Embryology of Angiosperms. Vikas Publishing House, New Delhi.
2. Katherine Esau (1991). Plant Anatomy. Wiley Eastern University Ed.
3. Singh, V. and Jain, D.K. (2010). Taxonomy of Angiosperms. Rastogi Publications, Meerut.
4. Taik, V.N. (1984). Taxonomy of Angiosperms. Tata Mc Graw Hill Pub. Co. Ltd. New Delhi.
5. Vasistha, B.R. (1998) Economic Botany. S. Chand & Co. Ltd. New Delhi.
6. Vasistha, P.C. (1996). Botany for Degree Students Vol V (Gymnosperms) S. Chand & Co. Ltd. New Delhi.

BOT/II/EC/04 : Phanerogams - Practical

1. Study of vegetative and reproductive structures of *Cycas*, *Pinus*, *Gnetum*
2. Taxonomic studies of angiospermic plants belonging to the families mentioned in Unit II.
3. Study of dicot and monocot embryo (Permanent slides)
4. Anatomical study of stem, root, leaf (Primary structure)
5. Anatomical study of anomalous growth.

BOT/III/EC/05 : Plant Physiology, Biochemistry, Ecology - Theory

Unit 1:

Water potential, water absorption, loss of water; Transport of solutes: Micro and macronutrients, Photosynthesis: Light and dark reaction, electron transport, C₄ and CAM pathways of carbon fixation, photorespiration;

Unit 2:

Respiration: structure of mitochondria, glycolysis, TCA cycle, electron transport, oxidative phosphorylation; Nitrogen metabolism: Biological nitrogen fixation, assimilation of nitrate and ammonia; Enzymes: classification, nomenclature, mechanism of action (binding to substrate, lowering of activation energy).

Unit 3:

Plant growth hormones: physiological role of auxins, gibberellins, cytokinins, abscisic acid and ethylene; Phytochrome: structure and function; Photoperiodism; Vernalization; Seed dormancy; Senescence

Unit 4

Amino acids: classification and structure; Protein Synthesis and DNA replication, transcription, translation; Lipids: general structure; Structure and classification of carbohydrate (mono-, oligo- and polysaccharides).

Unit 5:

Environments and environment factors; Population characteristics: ecotypes and ecads; Community characteristics: frequency, density, cover, life forms; Ecosystem structure (abiotic and biotic components, food chain, food web, ecological pyramids); Ecosystem function (energy flow, biogeochemical cycles of carbon and phosphorus); Ecological succession: types and pattern; Causes and control of Air and Water pollution.

Suggested Readings:

1. Cone, E.E., Stumpf, P.K. and Bruening, G.(2006). Outline of Biochemistry 4th Ed. John Wiley and Sons Inc.
2. Hopkins, W.G. and Huner, D.A.(2008) Introduction to Plant Physiology. John Wiley and Sons.
3. Kochhar, D.L.(1994) A text book of Plant Physiology. Atma Ram & sons.
4. Kormondy, F.J.(1986). Concept of Ecology. Prentice Hall of India, New Delhi.
5. Odum, E.P.(2000) Fundamentals of Ecology. W.B. Saunders, Philadelphia.
6. Salisburg, F.B. and Ross, C.W.(1991). Plant Physiology. Wadsworth Publishing Co. Ltd.

BOT/III/EC/06 : Plant Physiology, Biochemistry, Ecology - Practical

1. To determine the osmotic potential of cell sap by plasmolytic method. Estimation of R.Q. by Ganong's respirometer.
2. Study of root nodules with reference to biological nitrogen fixation.
3. Study of soil pH, moisture, and temperature.
4. Study of structure of plant community by determining frequency, density and abundance by quadrat method.

BOT/IV/EC/07 : Microbiology, Cytology, Genetics, Evolution - Theory

Unit 1:

History and scope of Microbiology; Classification of bacteria (morphological, nutritional); Structure of a bacterial cell: A brief account of genetic recombination (transformation, conjugation, transduction). Structure of bacteriophages; Lysogenic and lytic cycles.

Unit 2:

Role of microorganisms in cycling of carbon and nitrogen. Microorganisms and the production of alcoholic beverages, antibiotics; Microbes and fermented foods; Microbes in water; Microbial production of enzymes; microbes as biofertilizers.

Unit 3:

Ultrastructure of plant cell: Nucleus, cytoskeleton; Cell cycle: interphase nucleus: euchromatin and heterochromatin, mitosis, Mendel's laws of inheritance; deviations from Mendel's laws (Neo-Mendelism); Interaction of genes: intragenic and intergenic interactions, incomplete dominance, lethal genes, complementary genes, duplicate genes, epistatic genes.

Unit 4:

Linkage and crossing over: Interrelationships and importance, crossing over and meiosis, cytological basis of crossing over, crossing over and linkage maps, Sex determination: chromosome theory of sex determination.

Unit 5:

Theories of organic evolution: Theory of inheritance of acquired characters (Lamarckism), theory of natural selection (Darwinism), de Vries Mutation theory.

Suggested readings:

1. De Robertis, E.D.P. and De Robertis, E.M.F. (2006) Cell and molecular Biology. 8th Ed. Lippincott Williams and Wilkins, Philadelphia.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (1975). Cell Biology 6th Ed. W.B. Saunders Co, Philadelphia.
3. Gupta, P.K. Genetics (2004). Rastogi Publications. Meerit.
4. Pelczar, M.J. (2001) Microbiology. 5th Ed. Tata Mc Graw Hill Co, New Delhi.
5. Prescott, L., Harley, J. and Klein, D. (2005). Microbiology. 6th Ed. Tata Mc Graw Hill Co, New Delhi.
6. Verma, P.S. & Agarwal, V.K. (2000). Concept of Cell biology. S Chand & Co. Ltd. New Delhi.

BOT/IV/EC/08 : Microbiology, Cytology, Genetics, Evolution - Practical

1. Study of mitosis and meiosis.
2. Separation of amino acids by paper chromatography.
3. Study of monohybrid using seed samples.
4. Study of different types of Bacteria (Permanent slides).
5. Study of chromosome structure and aberrations from permanent slides.

BOT/V/CC/09 : Fungi, Plant pathology, Biostatistics- Theory

Unit1:

General features of fungi and their classification (Ainsworth's system); Comparative study of structure, reproduction and life cycle of representative classes of fungi; Types of fungal spores and their liberation;

Unit2:

Various modes on nutrition in fungi; Evolutionary trends in fungi; Economic importance of fungi; Heterothalism and parasexuality in fungi.

Unit 3:

History and scope of plant pathology; Infection and host-pathogen interactions; Transmission and spread of pathogens; Methods of plant disease control (chemical and biological); Plant defense mechanism(physical and chemical)

Unit 4:

Diseases: Symptoms, cycle and control measures of late and early blight of potato, Rusts and smuts of wheat ; Downy and powdery mildew of crucifers; Red rot of sugarcane; Citrus canker.

Unit 5:

Mean, Mode and Median; Standard Deviation and Error; Co relation, Coefficient of Variation; Test of significance: t test and chi square test.

Suggested readings:

1. Agrois,G.N.(2006) Plant Pathology.5th Ed. Elsevier Academic Press. USA.
2. Dube, H.C.(1983). An Introduction to Fungi. Vikas Publishing House, New Delhi.
3. Geon,A.M., Gupta,B. and Dasgupta,B.(1997) Basic Statistics. The World Press Pvt. Ltd, Calcutta.
4. Rangaswamy,G. and Mahadevan,A.(1998). A Disease of Crop Plants in India. Prentice Hall India. Pvt. Ltd.
5. Sharma,P.D.(2003). Microbiology and Plant Pathology. Rastogi Publications, Meerut.
6. Webster,J. and Webster,R.(2007). Introduction to fungi. Vikas Publishing House, New Delhi.

BOT/V/CC/10 : Fungi, Plant pathology, Biostatistics - Practical

1. Study of vegetative and reproductive structure of important representatives of each class of Fungi.
2. Study of disease specimens prescribed in theory papers by temporary preparations and with the help of permanent slides.
3. Test of significance of difference between mean using t- test and test of goodness of fit using chi- square test.
4. Preparation of fungal media (PDA) and Sterilization process.
5. Isolation of pathogens from diseased leaf.

BOT/V/CC/11 : Algae, Lichen, Bryophytes – Theory

Unit 1:

Classification (Fritsch's system) of algae and general characteristics of major classes; Pigmentation and storage products; Spores and resting phases; flagellation

Unit 2:

Reproduction and life history types with reference to Chlorophyceae, Phaeophyceae, Rhodophyceae and Cyanophyceae; Alternation of generation; Economic importance of algae.

Unit 3:

Lichens: Distribution, general characteristics; types and reproduction; Economic importance.

Unit 4:

General features and classification of Bryophyta (Smith's system); Comparative study of life histories of bryophytes with reference to *Riccia*, *Pellia*, *Sphagnum* and *Polytrichum*

Unit 5:

Bryophytes: Origin; Evolution of Sporophyte; Comparative structure of antheridia and archegonia.

Suggested readings:

1. Kumar, H.D. (1999). Introductory phycology. Aff. East- West Press Pvt. Ltd. New Delhi
2. Lee, R.E. (2008). Phycology. 5th Ed. Cambridge University Press. USA.
3. Parihar, N.S. (1986). Bryophyta. Central Book Depot, Allahabad.
4. Reddy, S.M. (1996). University Botany-I. New Age International Publishers Ltd. New Delhi.
5. Vander Hoek, C., Mann, D.J. and Jahns, H.M. (1995). Algae: An introduction to Phycology. Cambridge University Press.
6. Webster, J. and Webster, R. (2007). Introduction to fungi. Vikas Publishing House, New Delhi.

BOT/V/CC/12 : Algae, Lichen, Bryophytes - Practical

1. Study of vegetative and reproductive structure of *Anabaena*, *Volvox*, *Oedogonium*, *Chara*, *Ectocarpus*, *Polysiphonia*.
2. Study of vegetative and reproductive structure of *Riccia*, *Pellia*, *Sphagnum* and *Polytrichum*.
3. Study of vegetative and reproductive structure of Lichens.
4. Study of permanent fossil slides (Bryophytes).

BOT/V/CC/13: Cytogenetics, Plant Breeding, Bioinformatics - Theory

Unit – 1

Structure and chemical composition of chromosome; Cytoskeleton; Chromosome structural aberrations: Deletion, duplication, inversion, translocation, cytological and genetical consequences.

Unit – 2

Numerical changes in chromosome: Aneuploidy: monosomics, trisomics, nullisomics, polyploidy: utopolyploidy, allopolyploidy, segmental allopolyploidy, autoallopolyploidy, sources and consequences of chromosomal anomalies

Unit – 3

Concept and components of karyotype, karyotype in systematics and evolution of species; Mapping of genes on chromosomes: Physical and Genetic maps, multiple allelism, Self sterility in plants, quantitative inheritance: enhancer and suppresser genes; Non-Mendelian inheritance and organellar genetics: plastid inheritance in *Mirabilis jalapa*, kappa particles in *Paramecium*. Cytoplasmic male sterility.

Unit – 4

Types of mutation, molecular basis of mutation, physical and chemical mutagens and mechanism of their action; Heterosis, theories of hybrid vigour; Plant breeding: principles; pureline and mass selection; Technique and procedure of Hybridization

Unit – 5

Bioinformatics: Basic concept about data and information (binary, bits and bytes); Biological data base(DNA and protein data); Introduction to BLAST, search tools; DNA sequence,alignment and analysis.

Suggested Readings:

1. Chaudhary, R.C. (1993) Introduction to plant breeding. Oxford & IBH Publishing Co., New Delhi.
2. Cooper G.M. and Hausman, R.F. (2009). The cell. 5th edition. ASM Press and Sunderland, Washington DC.
3. Gardner, E.J., Simmons, M.J. and Snustad, D.P. (2008). 8th Edition. Principles of Genetics, Wiley India.
4. Ghosh, Z and Bibekanand, M. (2008). Bioinformatics: Principles and Applications. Oxford University Press. New Delhi.
5. Karp, G (2010). Cell and Molecular Biology: Concepts and experiments. 6th Edition. John Wiley & Sons. Inc.
6. Russell, P.J. (2009). Genetics 3rd Edition, Benjamin Cummings.

BOT/V/CC/14: Cytogenetics, Plant Breeding, Bioinformatics – Practical

1. Study of dihybrid ratio using seed samples.
2. Calorimetric estimation of RNA and DNA.
3. To study the general techniques in plant breeding, emasculation and bagging.
4. Study of polyploidy in onion root tip by colchicine treatment.
5. Internet browsing for scientific repositories.

BOT/V/CC/15: Environmental Biology, Ethnobotany - Theory

Unit – 1

Concept of biosphere; Dynamic nature of environment and interactions among various environmental factors; Renewable and Non renewable natural resources; Biogeochemical cycles; Biological diversity – Concept of level and Indices (Shannons,Shimson dominance index).

Unit – 2

Greenhouse effect; Acid rain; Ozone layer depletion; Photochemical smog ; Non biodegradable pollutants and biomagnification; Radioactive waste management

Unit -3

Conservation of soil and water resources; Biodiversity loss and *ex-situ* and *in-situ* conservation; Environmental Laws and Acts; IPR and Patent.

Unit – 4

Endemism; Hotspots; Phytogeographical division of India; Vegetation types of India.

Unit – 5

Ethno botany: Scope in India; Ethno botany with special reference to food, fruit, fodder, fiber and medicinal plants.

Suggested Readings:

1. Asthana, D.K. (2006). A textbook of environmental studies. S Chand and Co. Ltd.
2. Erach Bharucha (2006). Textbook of environmental studies. Orient Longman, New Delhi.
3. Jain, S.K. (1987). A manual of ethno botany. Scientific Publishers, Jodhpur.
4. Joseph, B. (2004). Environmental studies. Tata McGraw Hill, New Delhi.
5. Michael Allabay (2001). Basics of environmental science. Routledge Press.
6. Trivedi, P.R. (1999). Natural resources conservation. S Chand and Co. Ltd. New Delhi.

BOT/V/CC/16: Environmental Biology, Ethnobotany – Practical

1. Field visit to National Park/Sanctuary.
2. To determine B.O.D of different water samples.
3. To determine soil organic matter content by Walkley and Black's rapid titration method.
4. Study of ethno botanically important specimens.
5. Submit a project report based on any topic mentioned in the theory paper.

BOT/VI/CC/17: Pteridophytes, Gymnosperms, Palaeobotany, Palynology - Theory

Unit – 1

Comparative study of morphology, anatomy, reproduction, and life histories of *Adiantum*, *Ophioglossum*, *Marselia*. Characteristics, distribution of *Rhynia*, *Lepidodendron* and *Calamites*.

Unit - 2

Classification of Gymnosperms and general account of morphology and reproduction of the following: Ginkgoales (*Ginkgo*), Coniferales (*Taxus*) and Gnetales (*Ephedra*).

Unit – 3

Distribution of living Gymnosperms in India; Phylogenetic trends in Gymnosperms; Structure and evolution of ovule; General account of archegonia (without development); Economic importance of gymnosperms

Unit – 4

Paleobotany: Fossil: formation and types; Geological time scale; Main characters of pteridospermales; *Gondwana* flora; Features of *Lyginopteris*; *Cordaites*

Unit – 5

Palynology: Pollen production; Dispersal in time and space; Pollen/spore morphology and its role in taxonomy; Pollen Allergy

Suggested Readings:

1. Bhatnagar, S.P. and Moitra, A. (1996) Gymnosperm. New Age International (P) Ltd. Publishers, New Delhi.
2. Bhattacharya, K., Majumdar, M.R, Bhattacharya, S.G. (2006). A textbook of Palynology. New Central Book Agency (P) Ltd. Kolkata.
3. Mayen, S.V. (1987). Fundamentals of paleobotany, Chapman and Hall, London.
4. Parihar, N.S. (1996). The biology and morphology of pteridophytes. Central book Depot, Allahabad.
5. Sambamurty, K. (2008). A textbook of pteridophyta, gymnosperm and paleobotany. IK International Publishers, New Delhi.
6. Vashishta, B.R. (2002). Pteridophyta. S Chand and Co., New Delhi.

BOT/VI/CC/18: Pteridophytes, Gymnosperms, Palaeobotany, Palynology – Practical

1. Study of morphology and reproductive structure of *Adiantum*, *Ophioglossum*, *Marselia*.
2. Study of permanent fossil slides of *Rhynia*, *Lepidodendron*, *Calamites*.
3. Study of morphology and reproductive structure of *Ginkgo*, *Cedrus* and *Gnetum*.
4. Study of permanent fossil slides of *Lyginopteris*, and *Cordaites*.
5. Study of permanent slides of Pollen.

BOT/VI/CC/19: Angiosperm taxonomy, Anatomy, Embryology- Theory

Unit – 1

Classification of Angiosperms and general account of numerical and chemotaxonomy; Comparative study of classification of Bentham & Hooker, Engler & Prantle and Hutchinson.

Unit – 2

Herbarium preparation and management; Important herbaria and Botanical gardens of the world and India; ICBN (Rules and Recommendation), Evolution of Angiosperm.

Unit – 3

Distinguishing characters of the following families and their economic importance: Magnoliaceae, Fabaceae, Rutaceae, Convolvulaceae, Scrophulariaceae, Verbenaceae, Polygonaceae, Euphorbiaceae, Zingiberaceae, Liliaceae, Cyperaceae, Orchidaceae.

Unit – 4

Cambium activity and Secondary growth in Stem, Root; (Stelar & Exstelar) Anomalous secondary growth ; Root stem transition; Anatomical features of Hydrophytes and Xerophytes.

Unit – 5

Megagametogenesis (bisporic and tetrasporic types of embryosacs); Pollination; Development, structure and function of Endosperm; Different types of Embryo; Polyembryony.

Suggested Readings:

1. Cronquist, A. (1981). An integrated system of classification of flowering plants. Columbia University Press, New York.
2. Esau, K. (1977). Anatomy of seed plants. Wiley Publishers, UK.
3. Maheshwari, P. (1985). An introduction to embryology of angiosperms. Tata McGraw Hill, New Delhi.
4. Simpson, M.C. (2006). Plant systematic. Elsevier, Amsterdam.
5. Sprone, K.R. (1977). The morphology of angiosperm. B.I. Publication pvt., Mumbai.
6. Stussy, T.F. (1990). Plant taxonomy. Columbia University Press, USA.

BOT/VI/CC/20: Angiosperm taxonomy, Anatomy, Embryology- Practical

1. Preparation of herbaria.
2. Taxonomic studies of angiospermic plants belonging to the families mentioned in unit 3
3. Studies of anomalous secondary growth.
4. Study of anatomical ecological adaptations in hydrophytes and xerophytes.
5. Dissection of endosperm, embryo and study of permanent slides and germination of pollen grains.

BOT/VI/CC/21: Plant Metabolism, Biochemistry, Thermodynamics - Theory

Unit – 1

Synthesis of starch, cellulose, lipids; Nitrogen metabolism: Biological nitrogen fixation: Synthesis of amino acids; Nucleic acids: Biosynthesis of purine and pyrimidines, DNA replication

Unit – 2

Protein structure and synthesis: Basic aspects of protein conformation; Enzymes: Mechanism of enzyme action, coenzymes, allosteric enzyme, isozymes, enzyme kinetics.

Unit – 3

Biosynthesis and mode of action of Auxins, Gibberellins, Cytokinins, Abscisic acid, Ethylene

Unit – 4

Photosynthetic apparatus, harvestation of light energy; reaction centers; Cyclic and Non-Cyclic Electron transport; ATPase Chemo-Osmotic theory of ATP synthesis : C₂ Cycle, Pentose phosphate pathway.

Unit – 5

Laws of thermodynamics: first, second and third; Concept of internal and free energy; enthalpy and entropy change .

Suggested readings:

1. Bonner, J. and Varner, J.E. (1976). Plant biochemistry. Academic press New York.
2. Dutta, S.C. (1989). Plant physiology. Central Book Depot, Allahabad.
3. Devlin, R.N. (1969). Plant Physiology. Affiliated East West, New Delhi.
4. Jellinck, P.H.(1991). Biochemistry. Holt, Rinechard & Winston Ltd. Canada.
5. Lehninger, A.L. (1978). Biochemistry. Kalyani Publishers, Ludhiana.
6. Tiaz, L. and Zeiger, E. (2006). Plant physiology. 4th Edition. Sinauer Associates Inc. MA, USA.

BOT/VI/CC/22: Plant Metabolism, Biochemistry, Thermodynamics - Practical

1. Preparation of protein standard curve and estimation of soluble protein in plant material by Bradford test.
2. Study of transpiration rate in dorsiventral leaves by Garreau's putometer.
3. To study the effect of light and Carbon dioxide concentration on the rate of photosynthesis using bubble count method.
4. Extraction and separation of plant pigments by paper chromatography.
5. Effect of temperature and substrate concentration on urease activity.

BOT/VI/CC/24: Plant Biotechnology, Experimental Embryology

Unit – 1

Biotechnological tools and techniques: Cloning vectors restriction enzymes, ligases, methylase; recombinant DNA techniques, Basics of PCR.

Unit – 2

Enzymes used in molecular cloning: reporter gene in plants; gene gun; Agro bacterium mediated transformation ; transgenic plant production.

Unit – 3

Plant cell, tissue and organ culture; Cryopreservation and synthetic seeds. Nutrient; Media, Sterilization; Development of Protocols; Ex-plants; Totipotency.

Unit – 4

Biotechnology in Agriculture: Transgenic Cotton, tomato, golden rice, plantibodies.

Unit – 5

Micropropagation; Somatic Embryogenesis, isolation and Culture of Protoplast, protoplast fusion, Cybrid, Embryo culture.

Suggested Readings:

1. Bojwani, S.S. (1990). Plant tissue culture: Application and limitation. Elsevier, Amsterdam.
2. Dubey, R.C. (1996). Textbook of biotechnology. S Chand and Comp. New Delhi.
3. Gupta, P.K. (2004). Biotechnology and Genomics. Rastogi Publications, New Delhi.
4. Kumar, (2000). Modern concept of biotechnology. Vikas Publishing House Pvt. Ltd. New Delhi.
5. Slater, A., Scott, N.W and Fowler, M.R. (2008). Plant Biotechnology. Oxford University Press, UK.
6. Smith, R. (2000). Plant tissue culture techniques. 2nd edition. Academic Pvt.

BOT/VI/CC/25: Plant Biotechnology, Experimental Embryology

1. Study of tissue culture techniques. Preparation of media MS (1962) Nistch (1969).
2. Study of genetic engineering techniques (photographs).
3. Demonstration of Southern, Northern and Western blotting.
4. Study of steps of genetic engineering techniques from photographs (Bt cotton, golden rice).
5. Submit a project report based on any topic mentioned in the theory paper.