ST. JOSEPH'S COLLEGE (AUTONOMOUS), DEVAGIRI, CALICUT

Syllabus

for

M.Sc. BOTANY

Under

CHOICE BASED CREDIT SEMESTER SYSTEM-PG-2019

(With effect from 2019 admission onwards)

M.Sc. Programme in Botany (CBCSS) (from 2019 admissions onwards)

Programme, structure of courses and distribution of credits

Semester I				
		Credits		
Course	**Title**	**Internal**	**External**	**Total Credits**
FBOT1C01	Phycology, Bryology, Pteridology and Gymnosperms	20%	80%	5
FBOT1C02	Mycology and Lichenology, Microbiology and Plant Pathology	20%	80%	5
FBOT1C03	Angiosperm Anatomy, Angiosperm Embryology, Palynology and Lab Techniques	20%	80%	5
FBOT1L01	Practicals of Phycology, Bryology, Pteridology, Gymnosperms, Mycology, Microbiology	20%	80%	2*
FBOT1L02	Practicals of Lichenology, Plant Pathology, Angiosperm Anatomy, Angiosperm Embryology, Palynology and Laboratory Technique	20%	80%	2*
Semester II				
FBOT2C04	Cell biology, Molecular biology, and biophysics	20%	80%	5
FBOT2C05	Biostatics, Genetics, Plant breeding and Evolution	20%	80%	5
FBOT2C06	Environmental biology, Phytogeography and Forest botany	20%	80%	5
FBOT2L03	Practicals of Cell Biology, Molecular Biology, Biophysics and Biostatistics	20%	80%	3
FBOT2L04	Practicals of Genetics, Plant Breeding, Environmental biology, Phytogeography and Forest Botany	20%	80%	3
Semester III				
FBOT3C07	Plant Physiology, Metabolism and Biochemistry	20%	80%	5
FBOT3C08	Angiosperm Morphology, Taxonomy and Plant resources	20%	80%	5
FBOT3C09	Biotechnology and Bioinformatics	20%	80%	5
FBOT3L05	Practicals of Plant Physiology, Metabolism, Biochemistry and Angiosperm Morphology	20%	80%	2**

FBOT3L06	Practicals of Plant Resources, Angiosperm Taxonomy, Biotechnology and Bioinformatics	20%	80%	2**
Semester IV				
	Elective I	20%	80%	5
	Elective II	20%	80%	5
FBOT4L07	Practicals of Electives	20%	80%	3
FBOT4D01	Dissertation	20%	80%	5
FBOT4V01	Viva voce	0%	100%	3
TOTAL				80 credits
Audit Courses (To be completed within the first three semesters by the students)				
FBOT1A01	Ability Enhancement Course: **Scientific Documentation and Report writing**	100%	0%	4
FBOT2A02	Professional Competency Course: **Intellectual Property Rights**	100%	0%	4
(The credits earned through the audit courses will not be added for SGPA/CGPA)				
Duration of Theory Examinations (External) as well as Practical Examinations (External) will be 3 hours				
1 credit = 1.25 hours of teaching; There will be no regular classes/workload for audit courses.				
theory/dissertation hour= 1.5 hours of workload; 1 practical hour= 1 hour of workload				

*Exam at the end of Second semester

**Exam at the end of Fourth semester

Programme Specific Outcome

PSOs	PROGRAMME SPECIFIC OUTCOMES
PSO1	After completing the PG course in Botany, the students will be able to acquire competency in the area of plant biology.
PSO2	Will be competent in differentiating the diverse groups of plants and microbes
PSO3	Will be well versatile in understanding the importance of nature and natural ecosystems along with sustainable utilization of natural resources for the betterment of humankind.
PSO4	Will have a sound understanding in the cultivation process of crop plants, its diseases and managing the diseases.
PSO5	Will be trained in acquiring the problem solving skills in environmental monitoring and pollution control measures
PSO6	Understand the importance of biodiversity conservation
PSO7	Gain knowledge in understanding the importance of research, its methodology, use of library & digital resources
PSO8	The use of sophisticated equipment's and to demonstrate analytical ability to tackle the scientific research problems and also to maintain a high level of botanical research.
PSO9	Acquire the ability to understand life processes at cellular as well as molecular level
PSO10	Acquire core competency in distinguishing the internal structure of various groups of plants and knows the concept, process, physiology of plant development

SEMESTER-I

FBOT1C01 : PHYCOLOGY, BRYOLOGY, PTERIDOLOGY AND GYMNOSPERMS

(1.5+1+1.5+1.5 = 5.5 hours per week)

COs	COURSE OUTCOMES
CO1	Provide knowledge on the occurrence and evolution of plant groups like Algae, Bryophytes, Pteridophytes and Gymnosperms.
CO2	Develop understanding on the classification, nomenclature, diversity and distribution in these plant groups with up-to-date research knowledge.
CO3	Develop understanding on the range of variation in their structural and life cycle patterns, cellular organization and ecological / economic importance as separate plant groups
CO4	Develop hands-on approaches to study algae, Bryophyte, Pteridophyte and Gymnosperm populations and their growth forms in the surrounding environment • Understand and distinguish the diverse group of algae • Infer the economic value of different types of algae • Outline the ecological significance of algae • Build the skills for collection, identification and artificial culture of algae. • Interpret different groups of Bryophytes and Pteridophytes • Analyze the different theories regarding the origin of both Bryophytes and Pteridophytes and develop ideas regarding their evolution. • Compare the structural evolution of gametophytes and sporophytes in both Bryophytes and Pteridophytes. • Clarify organization of different types of steles, sori and sporangial characters in an evolutionary perspective • Validate the ecological and economical roles played by both Bryophytes and Pteridophytes. • Understand the classification of Gymnopserms • Make use of the economic value of Gymnosperms • Acquire the skills for field identification of Gymnosperms

PHYCOLOGY [1.5 hour per week]

1. **Classification of Algae**-comparative Survey of important systems - Fritsch-Smith-Round. Criteria for algal classification - Phylogenetic considerations.
2. **Thallus Structure:** General account of thallus structure, cell ultra-structure, reproduction, relationships and evolutionary trends in the following groups: Chlorophyta, Xanthophyta, Bacillariophyta, Phaeophyta, And Rhodophyta.
3. **Pigments**: General account of energy sources and pigments in algae
4. **Reproduction**-Different types of life cycles in algae.
5. **Algal cytology**-Basic ideas of cell features-Electron microscopic studies of algal cell, cell wall, flagella, chloroplast, pyrenoid, eyespot- their importance in classification
6. **Economic importance** of algae-Role of algae in soil fertility, algae in industry-Biological importance of phytoplanktons and water blooms.

References:

1. Fritsch, F.E. 1945. The structure and Reproduction of Algae.
2. Smith, G.M. 1950. Manual of Phycology
3. Round, F.E, 1965. The Biology of Algae.
4. Bold and Wyane. 1978. Introduction of Algae.

BRYOLOGY [1hour per week]

1. **General characters** and systems of classifications of Bryophytes
2. General account of the anatomy, reproduction, life history and phylogeny of Sphaerocarpales, Marchantiales, Jungermanniales, Calobryales, Anthocerotales, Sphagnales, Andreales, Funariales and Polytrichales
3. **Origin and evolution of Bryophytes-** gametophytic and sporophytic.
4. **Fossil Bryophytes**: A general account of fossil Bryophytes and their affinities.
5. **Economic importance** of Bryophytes.

References

l. Watson E.V. The structure and life of Bryophytes. Hutchinson Univ. Press, London.
2. Cavers F. The interrelationship of Bryophytes. New Phytologist.
3. Kashyap S.R., The Liverworts of Western Himalaya and the Punjab Plains, Vol.l&II. Chronica Botanica
4. Smith G.M. Cryptogamic Botany. McGraw Hill Book Co., N.Y.
5. Parihar N.S. An introduction of Embryophyta: Bryophyta. General Book House, Allahabad.
6. Verdoon, F.M. Manual of Bryology. Ashor & Co., Amsterdam.
7. Shaw, J. and Goffinet, B. 2000. Bryophyte Biology. Cambridge University Press.

PTERIDOLOGY [1.5hours per week]

1. General characters and life history of Pteridophytes.
2. Comparative morphology, ecology and phylogeny of the following:

a) Psilopsida : Rhyniales; (*Rhynia*), Psilophytales; (*Psilophyton*) and Psilotales;(*Psilotum*)

b) Lycopsida: Lycopodiales; (*Lycopodium*) and lsoetales; (*Isoetus*)

c) Sphenopsida: Hyeniales, Pseudobomiales, Sphenophyllales (*Sphenophyllum*), Calamitales (*Calamites*), and Equisetales, (*Equisetum*)

d) Filicopsida: General account: Primofilicales, Ophioglossales (*Ophioglossum, Botrychium*), Marattiales; (*Angiopteris*), Osmundales (*Osumda*), Schizaeales (*Lygodium*), Cyatheales (*Cyathea*), Gleicheniales (*Gleichenia*), Marsileales (Marsilea) and Salviniales (*Salvinia, Azolla*).

3. Cytology of Pteridophytes- Chromosome number and polyploidy.
4. Structure and evolution of stele in Pteridophytes.
5. Origin and evolution of Sporangium.
6. Heterospory and seed habit.
7. Development and evolutionary trends in the Gametophytes of Pteridophytes.
8. Apogamy, Apospory and Parthenogenesis.
9. Classification of Pteridophytes: Holttum, Pichi-Sermolli.
10. Economic importance of Pteridophytes-Medicinal, Horticulture, Biofertilizer, weeds.

References

1. Bierhost, D.W. 1971 . Morphology of Vascular Plants. Mac Millen Co., New York.
2. Dyer, A.C. 1979. The Experimenial Biology of Ferns. Academic Press, London.
3. Jermy, A.C.1973 (Ed.): The phylogeny and Classification of Ferns.
4. Kramer, K.U. and Green, P.S. 1991. The Families and Genera of Vascular Plants. Narosa, New Delhi.

GYMNOSPERMS [1.5hours per week]

1. Introduction - Classification of gymnosperms by Chamberlain (1935) and Sporne (1965).
    a. Geological horizon, distribution, morphology, anatomy, reproduction and interrelationships of the following orders (Study of families and genera not required).
    b. Pteridospermales
    c. Glossopteridales
    d. Caytoniales
    e. Cycadeodiales
    f. Pentoxylales
    g. Cycadales
    h. Ginkgoales
    i. Cordaitales
    j. Coniferales
    k. Taxales
    l. Ephedrales
    m. Welwitschiales
2. Gnetales

3. Economic importance of gymnosperms

References

Bhatnagar S.P. and Moitra A. (1997) Gymnosperms. New Age India publishers, New Delhi.
Biswas C. and Johri B.M. (1997) The Gymnosperms. Narosa Publishing House, New Delhi.
Chamberlain C.J. (1998) Gymnosperms : Structure and evolution. CBS Publishers, New Delhi.
Arnold C. A. (1947) An Introduction to Paleobotany. McGraw Hill Book company, New York.
Coulter J.M. and Chamberlain C.J. (1991) Morphology of Gymnosperms. Central Books, Allahabad.
Singh V.P. (2006) Gymnosperms. Sarup &Sons, New Delhi.
Sporne K.R. (1994) The morphology of gymnosperms. BI Publications Pvt. Ltd. New Delhi
Vasishta P.C. (2004) Gymnosperms. S. Chand & Company, New Delhi.

FBOT1C02 : MYCOLOGY & LICHENOLOGY, MICROBIOLOGY AND PLANT PATHOLOGY (2.5+2.5+1 = 6 hours per week)

COs	COURSE OUTCOMES
CO1	Develop understanding of the major groups of organisms like fungi, lichens and microorganisms, their occurrence, distribution and systematic classification
CO2	Acquaint with the basic understanding of plant diseases, causative organisms, mode of action and measures for their control
CO3	Acquire practical knowledge on fungi, lichens, micro-organisms, plant pathogens and mode of their growth in specific habitats
CO4	Develop understanding on the ecological and economic significance of the above groups of organisms. • Understand the diversity of fungi. • Classify fungi based on different classification system and recognize recent trends in classification of • fungi • Distinguish fungal group with their characteristic features • Understands the interaction of fungi with other living organisms. • Understands economic importance of different fungal groups • Identify the different types of fungi with reason. • Develop the understanding of the concept of microbial nutrition • Classify viruses based on their characteristics and structure • Examine the general characteristics of bacteria and their reproduction • Enhance their awareness and appreciation of human friendly viruses, bacteria and their economic value • Understand the basic principles of plant pathology and plant protection • Identify the different plant diseases and their quarantine measure. • Familiarize with the basic skills and techniques related to mycology and plant pathology

MYCOLOGY [2.5 hours per week]

1. General characters of Fungi: cell-ultra structure, unicellular and multicellular organization, hyphal growth, cell wall composition, nutrition (saprobic, biotrophic, symbiotic, predacious) reproduction (vegetative, asexual, sexual), heterothallism,parasexuality.
2. Classification of fungi by Ainsworth & Bisby (1983), Alexopoulos et al. (1996)-Phylogeny of fungi- Characters used in classification.
3. General account of Myxomycota, Mastigomycota, Zygomycota, Ascomycota, Basidiomycota and mitosporic fungi. Different kinds of spores and their dispersal.
4. Fungi as saprophytes: details of the fungal decomposition of organic matter, coprophilous fungi, lignin degrading fungi, role of fungi in degradation of pesticides.
5. Fungi as symbionts: Mycorrhiza – ectotrophic, orchidaceous and Ericoid mycorrhiza, Vesicular Arbuscular Mycorrhiza - their distribution and significance. Endophytes.
6. Lichenology: General account and systematics of lichens, thallus structure,nreproductive bodies, ecological significance and economic importance of lichens.

References:

1. Alerxopoulos C.J., Mims, C.W. & Blackwell, M. (1996). lntroductory Mycology. 4th edition. John Wiley& Sons lnc.
2. Ainsworth, G.C., Sparrow, K.F.& Susmann, A.S.(Eds.) (1973).The Fungi – An Advanced Treatise. Vol 1-4. Academic Press.
3. Burnett, J.H. (1970). Fundamentals of Mycology. Edward Amolds.
4. Cariile, M. J. & Watkinson S.C. (1994). The Fungi. Academic Press.
5. Deacon, J.W. (1988). Introduction to Modem Mycology. Blackwell.
6. Dubey, H.C. (1990). An lntroduction to Fungi. 2nd Edition. Vikas Publishers, NewDelhi.
7. Hale Mason, E. (1983). The Biology of Lichens. 3rd Ed. Edward Arnold, London.
8. Jennings, D.H. & Lysek, G. (1999). Fungal |Biology. Bios Scientific Publishers.

9. Mehrotra, R.S. & Aneja, K.R. (1990). An lntroduction to Mycology. New Age International Publishers.
10.Landecker, Elizabeth Moore. (1996). Fundamentals of Fungi. 4th Ed. Prentice Hall.
11. Nair, M.C. & Balakrishnan, S. (1986). Beneficial fungi and their utilization. Scientific Publishers, Jodhpur.
12.Nash, T.H. (1996). Lichen Biology. Cambridge University Press.
13.Webster, John (1980). Introduction to Fungi. Cambridge University Press.

MICROBIOLOGY [2.5 hours per week]

1. Introduction: Relevance of Microbiology; Brief History of Microbiology

2. Bacteria: Morphology, ultrastructure, nutrition, cultivation, Plasmids and their characterization Bacterial recombination , Economic importance of bacteria.

3. Cyanobacteria: salient features, morphology, ultrastructure, classification and economic importance

4. Mycoplasmas and Actinomycetes: General features and economic Importance

5. Viruses: General account of plant viruses. Detailed study of TMV and TBSV Replication of plant viruses. Classification of plant viruses. Bacteriophages – types, classification, structure and replication. Viroids and virusoides.

6. Prions: concept, theories and important diseases caused by the viruses.

7. Microbial ecology: microbiology of rhizosphere. Sewage disposal. Bioremediation and water purification.

8. Food microbiology: food spoilage and preservation methods. Microbiology of fermented foods. Dairy products. . Microorganisms as sources of food.

9. Industrial microbiology: production of alcohol, vinegar, antibiotics, vitamin, steroids, vaccines, organic acids and amino acids.

References:

1. Adams, M R & Moss, M.O. (1996). Food Microbiology. New Age International Publishing Ltd., New Delhi.
2. Brock, T. D. (1996). Biology of Microorganisms. Prentice Hall.
3. Campbell, R. (1987). Microbiology. ELBS-Edward Arnold, London.
4. Carpenter, P.L. (1967). Microbiology. W.B. Sunders &Company, Philadelphia.
5. Dubey, R.C. & Maheswari, D.K.(2000) A text book of Microbiology. S. Chand.
6. Goodfellow, M. et.al. (1993). The Biology of Actinomycetes. Academic press.

7. Kumar, H.D. & Swati Kumar (1998). Modern Concepts of Microbiology.
8. Mathew, R.E.F. (1981). Plant Virology, Academic press.
9. Pelozar, M.J., Chan, E.C.S. & Krieg, N.R. (1986). Microbiology. Tata Mc Graw Hill.
10.Sharma, P.D. (1999). Microbiology & Plant Pathology. Rastogi Publishers, Meerut.

PLANT PATHOLOGY [1 hour per week]

1. **Principles of Plant Pathology-** Causal agents of plant diseases - Biotic causes (fungi, bacteria, virus, mycoplasma, nematodes, angiospermic parasites. Abiotic causes (nutrient and mineral deficiencies, pollutants).
2. **Symptoms**: Details of different symptoms of plant diseases with emphasis on tropical crops.
3. **Process of infection** - Entry and establishment of pathogens in the host tissues. Mechanical, physiological and biochemical means of the infection process.
4. **Host- parasite interaction.** Enzymes and toxins in pathogenesis. Defense mechanisms in plants (structural, physiological and biochemical).
5. **Transmission of plant diseases.** Zoochory, Anthropochory, Hydrochory. Anemochory, -
6. **Plant disease management -** protection, exclusion and eradication of pathogens. Physical, chemical and biological control of pathognes. Integrated approach in disease management
7. **Study of tropical crop diseases.** (Symptoms, causal organisms, disease cycle and control measures): Bunchy top of banana, Bacterial blight of paddy, Bud rot of coconut, Mahali of Arecanut, Powdery mildew of rubber, Abnormal leaf fall of rubber, tikka disease of Ground nut, Late blight of potato, Blister blight of tea, wheat rust, coffee rust, grey leaf spot of coconut, *Phytophthora* foot rot of pepper, rhizome rot of ginger , angiosperm parasites - *Viscum*, *Dendropthoe*.

References

1. Agrios, G. N. (1997). Plant pathology. 4th Ed., Academic Press.
2. Bilgrami, K.H. & Dube, H C. A Text Book of Modern Plant Pathology. Vikas Publishers, New Delhi.
3. Chaube, H.S. & Ramji Singh (2001). Introductory Plant Pathology. Lnternational Book Distributing Co., Lucknow.
4. Gareth-Jones, D. (1983). Plant Pathology: Principles and Practice. Open University Press.
5. Lucas, J. A.. (l998). Plant Pathology and Plant pathogens. Blackwell.
6. Manners, J.G. (1993) Principles of Plant Pathology. Cambridge Univ Press.
7. Mehrotra, R.S. (1980). Plant Pathology. Tata Mc Graw Hill.
8. Pandey, B. P. (1999). Plant Pathology -pathogen and plant disease. S. Chand & Co.
9. Rangaswami, G. (1999). Diseases of Crop Plants of lndia. Prentice Hall lndia.
10.Tarr, S.A. J. (1972). The Principles of Plant Patholgy. Winchester Press.
11.Wheeler, H. (1975). Plant Pathogenesis. Springer Verlag.
12.Wood, R.K.S. (1978). Physiological Plant Pathology. Blackwell

FBOT1C03: ANGIOSPERM ANATOMY, ANGIOSPERM EMBRYOLOGY, PALYNOLOGY AND LAB TECHNIQUES

[2+1.5+1+1= 5.5 hours per week]

COs	COURSE OUTCOMES
CO1	Develop understanding of the structural composition and functional organization in major land plants
CO2	Acquire knowledge on the reproduction and developmental processes associate with major land plants
CO3	Understand the significance of pollen studies in developmental process and the recent developments in palynology
CO4	Practical knowledge on cell and tissue organization, developmental stages and process associated with the reproduction in major land plants • Retrieve different types of tissues, non-living inclusions in plant cells. • Interpret structure, function and roles of vascular cambium and cork cambium. • Categorize different types of Anomalous secondary growth and their anatomical peculiarities and • adaptational significance. • Illustrate significance and properties of wood &fibres used commercially. • Analyze leaf initiation, types of stomata and trichomes and appraise anatomical peculiarities in C3, C4 • and CAM plants. • Compare Nodal anatomy , Floral anatomy and their evolutionary significance • Illustrate the organogenesis in plants • Acquire the basic concepts of developmental biology • Summarize the embryogenesis in plants • Familiarizes with biological instrumentation and plant micro technique

ANGIOSPERM ANATOMY [2 hours per week]

1. **Cell wall and its development.** Chemistry of cell wall- cellulose, hemicellulose, polysaccharides, cell wall proteins, water. Organisation of primary wall. Cytokinesis and growth. Plasmodesmata. Secondary wall chemical Constituents- lignin, suberin, callose; organisation of secondary wall.

3. **Cambium**: Development of vascular cambium.and cork cambium in root and stem; cell types in vascular cambium, seasonal variations in cambial activity; role of cambium in wound healing and grafting. Conversion of fusiform initials in to ray initials; cambium in arborescent monocotyledons (Liliflorae).

4. **Development and differentiation:** The structure of specialized cells. Vascular differentiation (procambium, residual meristem, interfascicular and intrafascicular cambia); acropetal and basipetal differentiation in leaves, stem and roots. Sieve tube differentiation. Control of phloem differentiation. Tracheary elements differentiation. Ultra structure of phloem and xylem, brief account of transfer cells. Secondary wall thickening, cytoplasmic changes and autolysis.

lnduction of vessel elements. lnduction of secondary xylem structure in relation to function in water conduction.
5. **Secondary thickening in stem and Root.** Stelar and extrastelar secondary growth in dicot stem and root.
6. **Anomalous secondary growth:** Concepts; modification of the common type of vascular cambium, unequal activity of the vascular cambium. Successive cambia. Anomalous placement of vascular cambium. Discontinuous, unidirectional and bidirectional activity of cambium.
6. Node anatomy - nodal patterns: Unilacunar, trilacunar, multilacunar and split lateral. .Phylogenetic considerations. Leaf trace and branch trace- origin, departure; effect on stele and pith. Secondary growth in leaf traces.
7. **Leaf anatomy:** Unifacial, bifacial and centric leaf (onion); structure of epidermis, stomatal types; foliar sclerieds; oil cells; crystal idioblasts.
8. **Anatomy in relation to taxonomy.**

References

1. Cutter, E.G. & Edward, E., 1978. Plant Anatomy: Experiment and Interpretations Part I and II.
2. Easu, K- 1983. Plant Anatomy - Wiley Eastern Limited.
3. Fahn, A. 1977 – Plant Anatomy. Pergamon Press.
4. Forester,A.S. l960. Practical Plant Anatomy. D. Van Nostrand Company lnc.
5. Mauseth, J.D. 1988. Plant Anatomy - The Benjamin Cumming Publishing Co.
6. Roberts, L.W. 1976. Cytodifferentiation in Plants - Cambridge University Press, Cambridge.

ANGIOSPERM EMBRYOLOGY [1.5 hours per week]

1. **Introduction** to angiosperm embryology - structure of dithecous and monothecous anther.
2. **Microsporogenesi**s: Structure and function of wall layers, role of tapetum in pollen development
3. **Male gametophyte**: Pollen mitosis, division of generative cells, heterospory.
4. **Megasporogenesis**: Megaspore triad, dyad, coenomegaspore.
5. **Embryo sac** - different types- ultra-structure of components- synergid and antipodal. embryo sac theories of the morphological nature of embryo sac
6. **Pollination** -Artificial pollination - ultra-structural and dis-ultrastructural and histochemical nature of sigma. Significance of pollen - pistil interaction. Role of pollen wall proteins and stigma. *In vitro* pollination and fertilization.
7. **Fertilization**: Role of synergids - Filiform apparatus, heterospermy and triple fusion.
8. **Embryo**: Structure and development of typical dicot and monocot embryos- structure and function of suspensor.
9. **Endosperm**: classification and type- ruminate endosperm- mosaic endospermendosperm haustoria. Physiology and cytology of endosperm.
10. **Polyembryony** – Classification – Practical value.
11. **Apomixes** – General account =- Genetics of Apomixis
12. **Parthenocarpy** – seedless fruits – induction of parthenocarpy.
13. **Embryology** in relation to taxonomy

Reference

1. Bouman F. Ovule Initiation, Ovule Development, and Seed Coat Development in Angiosperms, Today and Tomorrow Publishers, New Delhi
2. Bhojwani S S and Bhatnaragar S S Embryology of Angiosperms Vikas Publishers, New Delhi
3. Davis C.L. Systemic embryology of Angiosperms John Wiley.
4. Johanson D Plant Embryology, Waltham, Massachusetts.
5. John B D (Ed.) Embryology of Angiosperms, Springer Verlag.
6. Maheswari P. An Introduction to the Embryology of Angiosperms. McGraw Hill.
7. Wardlaw C W. Embryogeneisi in Plants, Methusen, London.

PALYNOLOGY (1 hour per week)

1. **Introduction**:- Importance of Palynology.
2. **Pollen Morphology**:- Preparation of pollen for morphological studies – Pollen morphological characters:- Polarity, Symmetry, Size, Shape, Aperture, Exine Stratification & Exine Ornamentation.
3. **Pollen wall**:- Structure of pollen wall - Development of pollen wall.
4. **Pollen Chemistry**:- Carbohydrates, Mineral matter, Organic acids, Amino acids, Pigments, Vitamins, Hormones, Sporopollenin.
5. **Aeropalynology**:- Introduction - Collection of aerospora - Analysis of aerospora - Pollen seasons - Distance dissemination of pollen - Altitudinal dissemination - Rate of pollen fall - Factors affecting pollen dispersion - Applications of Aeropalynology.
6. **Melittopalynology**:- Introduction - Pollen collection by bees - Analysis of pollen from honey - Unifloral and multifloral honey - Nutritional and medicinal value of honey.
7. **Applied Palynology**:- Forensic palynology, Paleopalynology, Pollen and allergy, Pollen and exploration of fossil fuels.
8. **Palynology in relation to Taxonomy**:- Brief account of Eurypalynous and Stenopalynous taxa.

References:

Bhattacharya, K., Majumdar, M.R. and Bhattacharya, S.G. (2006) A Textbook of Palynology. New Central Book Agency (P) Ltd. New Delhi.
Nair, P.K.K. (1970) Pollen Morphology of Angiosperms. Vikas Publications, New Delhi.
Nair, P.K.K. (1985) Essentials of Palynology. Today & Tomorrow Printers and Publishers , New Delhi.
Shivanna, K.R. and Rangaswamy, N.S. (1992) Pollen Biology –A Laboratory Manual. Narosa Publishing House, New Delhi.

LABORATORY TECHNIQUES [1hour per week]

1. **Study of the following instruments** - their uses and principles:
    a. Microscope: microscopic measurements - camera lucida, micrometry.
    b. Microtomes- Sledge, Rocking, Rotary.
2. **Killing**, **fixing and staining of plant tissues:**
    a. Important reagents and chemicals used in the preparation of fixatives and their properties.

b. Fixatives - FAA, Carnoy's fluid, chrome acetic, Nawaschins fluid, Craf, Flemingscomposition, preparation and specific uses.

c. Dehydrating agents, clearing agents, mounting media. Examples and brief description.

d. Stains - classification, composition and specific uses - safranin, crystal violet, cotton blue, fast green, orange - G, hematoxylin, carmine.

e. Brief account of vital staining.

f. Staining techniques - Double staining.

i. Saffranin - Fast green

ii. Crystal violet – Orange G

iii. Methods of embedding plant materials in paraffin wax - TBA method; embedding for Electron microscopy.

iv. Sectioning of embedded paraffin wax materials using Rotary Microtome.

v. Double staining of microtome serial sections embedding in paraffin wax - Saffranin - fast green; Crystal violet - Orange G / Erythrosin.

vi. Whole mounts - general account

vii. Maceration, smears

viii. Histochemical tests –

(a) PAS Test - insoluble polysaccharides.

(b) Sudan black -lipids

(c) Fuelgen reaction - Nucleic Acids.

References:

1. Peter Gray. Hand book of Basic microtechnique. Mcgraw – Hill.
2. Johansen, D.A. 1940. Plant Microtechnique, McGraw-Hill Book Company, Inc. New York.
3. Grimstone A. V. and R.J. Saker A guide book to microscopical methods., Cambridge
4. John E. Sass. Botanical Microtechnique, Oxford & IBH Publishing Co.
5. John R. Baker. Principles of Biological Microtechnique – Univ. press.
6. Krishnamurthy. . K.V. Methods in Plant Histochemistry.

FBOT1L01: PRACTICALS OF PHYCOLOGY, BRYOLOGY, PTERIDOLOGY, GYMNOSPERMS, MYCOLOGY, MICROBIOLOGY

[0.5+0.5+1+1+0.5+0.5= 4 hours per week]

COs	COURSE OUTCOMES
CO1	Provide practical knowledge on the collection and identification of members of Algae, Fungi and Lichens
CO2	Provide practical knowledge on the collection of plant groups like Bryophytes, Pteridophytes, Gymnosperms and assessment of their morphological and anatomical features through laboratory exercises

PHYCOLOGY [0.5 hour per week]

1. Collection, preservation and preparation of algal herbarium (5 numbers).

2. Collection and study of the types mentioned below and their identification up to generic level using algal monographs:

Chlorophyta: *Pediaistrum*, *Scenidesmus*, *Hydrodyctyon*, *Ulva*, *Cladophora*, *Pithophora*, *Bulbochaeta*,*Cephaleuros*, *Draparnaldiopsis*, *Bryopsis*, *Codium*, *Caulerpa*, *Halimeda*, *Desmids* (*Closterium*, *Cosmarium*), *Nitella*.

Xanthophyta: *Botrydium*.

Bacillariophyta: *Biddulphia*, *Coscinodiscus*, *Cymbella*.

Phaeophyta: *Ectocarpus*, *Dictyota*, *Padina*, *Turbinaria*.

Rhodophyta: *Batrachospermum*, *Gracilaria*, *Champia*..

BRYOLOGY (0.5 hour)

Morphorogical and structural study of representative members of the following types using whole mount preparations, dissections and transactions: *Asterella*, *Targionia*, *Cyathodium*, *Lunularia*, *Pallavicinia*, *Dumortiera*, *Porella*, *Anthoceros*, *Sphagnum* and *Bryum*.

PTERIDOLOGY [1 hour per week]

1. Study of vegetative and reproductive features of *Lycopodium*, *Ophioglossum*, *Angiopteris*, *Osmunda*, *Lygodium*, *Ceratopteris*, *Pteris*, *Asplenium*, *Blechnum*, *Cyathea*, *Gleichenia*, *Trichomanes*, *Salvinia* and *Azolla*.
2. Study of the following fossils: Rhynia, Lepidodendron, Sphenophyllum, Calamites, Calamostachys, Zygopteris and Anachoropteris.

3. Spore germination and development of prothallus in Knop's Agar medium.
4. A study of Pteridophytes in their natural habitats.

GYMNOSPERMS [1 hour per week]

1. Identification of petrifications, compressions and impressions of *Lyginopteris, Heterangium, Medullosa, Trignocarpus, Glossopteris, Caytonia, Pentoxylon, and Cordaites*.
2. Study of vegetative and reproductive structures of *Zamia, Ginkgo, Pinus, Cryptomeria, Cupressus, Araucaria, Agathis, Podocarpus, Cephalotaxus, Ephedra, & Gnetum.*

MYCOLOGY & LICHENOLOGY [0.5 hour per week]

Critical study of the following types with the help of fesh/preserved materials by making suitable micropreparations giving emphasis on systematic position, details of vegetative and reproductive structures: *Stemonitis, Saprolegnia, Phytophthora, Albugo, Mucor, Pilobolus, Saccharomyces, Xylaria, Chaetomium, Peziza, Puccinia, Auricularia, Polyporus, Ganoderma, Lycoperdon, Dictyophora, Geastrum, Cyathus, Aspergillus, Curvularia, Alternaria, Fusarium, ColIetotrichum, Parmelia, Usnea*.

MICROBIOLOGY [0.5 hour per week]

1. Test for the presence of coliform bacteria in contaminated water.
2. lsolation of Eubacteria and Cyanobacteria from soil by dilution plate method.
3. lsolation of pure bacterial culture by streak plate method.
4. Staining of bacteria (negative staining, Gram staining and spore staining).
5. Demonstration of bacterial motility by hanging drop method.
6. Morphological studies on *Scytonema, Aphanocapsa, Spirulina, Oscillatoria, Anabaena*.

FBOT1L02: PRACTICALS OF LICHENOLOGY, PLANT PATHOLOGY, ANGIOSPERM ANATOMY, ANGIOSPERM EMBRYOLOGY, PALYNOLOGY AND LABORATORY TECHNIQUE

[1+1+0.5+0.5+1= 4 hours per week]

COs	COURSE OUTCOMES
CO1	Provide practical knowledge on the collection, culturing and identification of microorganisms (general and pathogenic) from specific habitats and evaluation of their growth performances
CO2	Acquire hands-on experience on the tissue organization in major land plants.
CO3	Acquire practical knowledge in the reproductive structures of major land plants and the developmental processes associated with them

PLANT PATHOLOGY [1 hour per week]

1. Detailed lab study of the following diseases:
   Bunchy top of banana, Bacterial blight of paddy, Bud rot of coconut, Mahali of Arecanut, Powdery mildew of rubber, Abnormal leaf fall of rubber, tikka disease of Ground nut, Late blight of potato, Blister blight of tea, wheat rust, coffee rust, grey leaf spot of coconut, Phytophthora foot rot of pepper, rhizome rot of ginger and turmeric, angiospermic parasites- *Viscum* and *Dendropthoe*.
2. Technique of isolation and pure culture of pathogens.

ANGIOSPERM ANATOMY [1 hour per week]

1. Study of anomalous secondary growth in roots and stems of *Aristolochia*, *Strychnos*, *Amaranthus*, *Boerhaavia*, *Bignonia* / *Adenocalymna*, *Draceaena*
2. Nyctaginaceae, Bignoniaceae and Agavaceae.
3. Nodal anatomy of different types.
4. Leaf anatomy: epidermal peels and TS of lamina.

EMBRYOLOGY [0.5 hours per week]

1. Study of anther development of *Datura*.

2. Preparation of dissected whole mounts of microsporangium.

3. Study of megaspore mother cell, megaspore and embryo sac.

4. Study of the receptivity of stigma and in situ germination of pollen.

5. Dissection of stages in the development of embryo and endosperm.

6. Pollen germination using hanging drop technique.

7. Demonstration of intra ovarian pollination.

PALYNOLOGY [0.5 hours per week]

1. Analysis of honey for microscopic examination of pollen
2. Calculation of percentage of pollen viability using tetrazolium test.
3. Study of pollen morphology by acetolysis

LAB TECHNIQUES [1 hour per week]

1. Measurement of microscopic objects - Micrometry.

2. Camera lucida drawing - calculation of magnification

3. Double stained permanent sections - free hand section, Microtome serial sections.

4. Preparation of whole mounts, macerations and smears.

5. Submission of 10 permanent slides - which should include microtome serial sections, free hand sections, macerations, whole mounts and smears.

SEMESTER-II

FBOT2C04 : CELL BIOLOGY, MOLECULAR BIOLOGY, AND BIOPHYSICS

[2+2.5+1 = 5.5 hours per week]

COs	COURSE OUTCOMES
CO1	Develop the understanding on cells, their structural and functional organization and the systematic process of growth and development
CO2	Provide insight on various sub cellular materials in the molecular level and the processes associated with them, resulting in various metabolic activities
CO3	Develop understanding and skills on various Biophysical methods used in cellular studies and the processes associated with them • Get an idea of intracellular components and cell communication • Understand the life cycle of cell Page 19 of 47 • Infer various aspects of cytoskelton • Analyze the chromosome organization in eukaryotes • Familiarize the DNA replication, repair and recombination • Understand the basic concepts of mechanism of gene expression • Familiarize the control of gene expression • Familiarizes with biological instrumentation • Understand the better use of microscopes in biology

CELL BIOLOGY [2 hours per week]

1. **The nucleus:** Interphase nucleus, chromatin organization, nucleosomes, scaffold. Organization of eukaryotc chromosome. Heterochromatin - constitutive and facultative. Euchromatin. Satellite DNA. Karyotype- Concepts and its importance. Chromosome banding and its significance.
2. **Special Chromosomes:** Polytene and lamp-brush chromosomes. B Chromosomes.
3. **Cell reproduction:** Cell cycle. Specific events – G1, S, G2 and M phases and their significances. Mitosis.
4. **Meiosis:** types. Mechanism. Significance of meiosis. Genetic control and consequences of meiosis. Cell cycle regulation of meiotic events. Meiotic defects and human diseases.
5. **Numerical chromosome aberrations:** Aneuploids and euploids: effects of aneuploidy on phenotype. Transmission of monosomics and trisomics and their uses.
6. **Structural chromosome aberrations:** types and significance in evolution.
7. **Cancer:** carcinogenic agents, phenotypes of the transformed cells, genetic basis of malignant transformation. Cancer and cell cycle. Metastasis.

8. **Programmed cell death:** Pathways leading to cell death. Aging – Cellular and extra cellular

References

1. Cooper Jeffrey M. The Cell, A molecular approach,. ASM, Washington.
2. Karp Gerald. Cell Biology, John Wiley and Sons
3. DeRobertis and DeRobertis Cell and Molecular Biology Holt Rinehart & Winston
4. Pollard T D and Earn Shaw Cell Biology Saunders.
5. Lewis R. Human Genetics, Concepts and applications, WCB McGraw Hill.

MOLECULAR BIOLOGY [2.5 hours per week]

1. **Molecular Biology of Genes** – Structure of DNA. Repetitive DNA, C value paradox
2. **Replication of DNA** – enzymology of replication. Replication in prokaryotes and eukaryotes. Primosomes and replisomes. Telomerase and its function.
3. **Gene action,** One gene enzyme concept, one gene one protein concept, concept of colinearity.
4. **Protein synthesis,-** transcription, post transcriptional events, introns and exons, spliceosomes. Translation. Post translation modifications.
5. **Genetic code**, Deciphering the code, properties of the code.
6. **Gene regulation** Operon concept, attenuation, regulation at the level of translation. Gene regulation in eukaryotes. Role of environment. Internal factors, RNA interference. Enhancers and silencers,
7. **Mutation** – Classification. Molecular mechanism of mutation. Types and actions of mutagens. Mutation and cancer. DNA repair mechanisms.
8. **Molecular evolution;** Origin of genome, evolution of new genes, origin of eukaryotic genomes, application of molecular phylogenetics.

Reference

1. Benjamin Lewin Genes, Oxford University Press.
2. Brown T A. Genomes, John Wiley sons
3. Simmons M.J.and Snustad P. principles of Genetics, John Wiley and Sons.
4. James D Watson, Molecular Biology of the Gene, Pearson
5. David R Hyde, Genetics and Molecular Biology, Mcgraw Hill

BIOPHYSICS [1 hour per week]

1. **pH and Buffer Solutions**:- Dissociation of acids and bases - Hydrogen ion concentration and pH, Henderson-Hasselbalch equation - Measurement of pH using organic indicators molecule and potentiometric method - pH meter and principle of pH indication - Operation of pH meter - Buffers - Mechanism of buffer action - Significance of buffers in biological and biochemical research.
2. **Chromatography**:- Principles of chromatography, Types of chromatography:- Partition chromatography (Eg. Paper chromatography & Thin layer chromatography) Adsorption chromatography (Eg. Ion exchange chromatography) - Gel permeation chromatography - Use of automatic fraction collector.
3. **Electrophoresis**:- Electrophoretic mobility, Principles, Types of electrophoresis:- Moving boundary electrophoresis, Continuous electrophoresis and Zone electrophoresis - Paper electrophoresis - Cellulose acetate electrophoresis - Gel electrophoresis - PAGE & SDS-PAGE - Agarose gel electrophoresis - Use of Transilluminator & Gel documentation apparatus.
4. **Centrifugation**:- Theory of centrifugation, Centrifuge:- Clinical centrifuge, Refrigerated centrifuge, High speed refrigerated centrifuge, Ultracentrifuge and Analytical centrifuge - Methodology of centrifugation:- Differential centrifugation and Density gradient centrifugation. .
5. **Colorimetry and Spectrophotometry**:- Beer-Lambert's Law, Measurement of Transmittance and Absorbance - Components of Colorimeter and spectrophotometer. Working of colorimeter - Applications in biochemical research - Comparison between Colorimetry and spectrophotometry.
6. **Autoradiography**:- Tracer technique - Principle and procedure - Types of autoradiography - Application in biological research.
7. **Immunochemistry**:- Immune response - Cell involved in immunity - Key molecules involved in immunity:- Antigens & Antobodies - Types of antibodies - Structure of IgG - Immunochemical assays:- RIA & ELISA.
8. **Lyophilization**:- Principle - Application.

References

Asokan P (2002) Analytical Biochemistry. Chinnaa Publications, Tamil Nadu.

Barker K (2004) At the bench – A laboratory navigator. I.K. International Pvt.Ltd., New Delhi.

Freifelder D. (1976) Physical Biochemistry. W H Freeman and Company, San Francisco.

Plummer D.T. (1990) An introduction to practical biochemistry. Tata McGraw - Hill Publishing company, New Delhi.

Keith Wilson and John Walker (1994) Practical Biochemistry. Foundation Books, New Delhi.

Roskams J. and Rodgers L. (2004) LabRef. I.K. International Pvt.Ltd., New Delhi.

Cooper T. G. (2011) The tools of Biochemistry. Star Educational Book Distributors, New Delhi

Upadhyay A., Upadhyay K. and Nath N. (2003) Biophysical Chemistry – Principles and techniques. Himalaya Publishing House, Mumbai.

Veerakumari L. (2007) Bioinstrumentation. MPJ Publishers, Chennai.

FBOT2C05 : GENETICS, BIOSTATICS, PLANT BREEDING AND EVOLUTION

[2+1.5+1+1=5.5 hours per week]

COs	COURSE OUTCOMES
CO1	Acquaint with cells and chromosomes, their structural and functional attributes, diversity and resultant manifestation on organisms
CO2	Develop understanding of Mendelian Principles of Genetics
CO3	Impart knowledge on human genome
CO4	Provide an insight on the nature and type of data collection and its management
CO5	Develop skills in data analysis using varied statistical software • Understand the history of genetics • Familiarize the concepts of linkage and genetic mapping • Outline the basic concepts of quantitative genetics • Understand the genetics behind cancer • Familiarize the basic concepts of population genetics • Understand the basic statistical methods for biological research • Understand the basic concepts of plant breeding • Familiarize the mechanism of hybridization in plants • Outline the methods of breeding resistance in plants • Familiarize the modern plant breeding methods. • Infer the various theories of evolution • Understand the process of evolution of plants

GENETICS [2 hours per week]

1. **Evolution of Genetics-** A concise account of pre-Mendelian, Mendelian and post-Mendelian periods. A brief life history of Gregor Johann Mendel. A critical evaluation of Mendelism.
2. **Linkage and gene mapping-three** point test cross, linkage map, interference. Tetrad analysis and centromere mapping. Linkage in Humans. Pedigree analysis. Gene mapping in bacteria and bacteriophages.
3. **Transposons** – Transposable elements in bacteria – IS elements, composite transposons, Tn elements. Copia and P elements in *Drosophila*. Ac, Ds and Mu elements in maize. Retrotransposons. LINE. Molecular characteristics and significance in development and evolution.
4. **Quantitative genetics**: polygenic inheritance, heritability and its measurements, QTL mapping
5. **Population genetics**: The Hardy – Weinberg principle. Estimation of gene and genotypic frequencies. Factors affecting genetic equilibrium – natural selection, mutation, migration and genetic drift.

Reference

1. Snustad, Simmons and Jenkins. Principles of Genetics, John Wiley Sons.
2. Weaver and Hendrick. Genetics, Wm C. brown Publishers.
3. Stansfield W. Theory and Problems of Genetics, McGraw Hills
4. Goodenough U. Genetics Sanders, College, Publishers.
5. Strickberger Genetics, McMillan
6. Hartwell, N.H. and Hood, C. Genetics – From Genes to Genomes. McGraw Hill
7. Edward Edelson. Gregor Mendel and the Roots of Genetics, Oxford University Press
8. Sinnot, W.L.C. Dunn & J. Dobzhansky 1996. Principle of Genetics. Tata Mc Graw Hill Publishing Company Ltd., New Delhi.

BIOSTATISTICS [1.5 hours per week]

1. **The science of statistics** and its application in biological research.
2. **Types and collection of data**. Census, sampling – theory and methods.
3. **Tabulation and presentation of data** –diagrammatic and graphic presentation
4. **Analysis of data** – central tendencies.
5. **Measures of dispersion –** range, quartile deviation, mean deviation, standard deviation and standard error – relative errors of dispersion – coefficient of variation.
6. **Tests of significance** – formulation and testing of hypothesis, testing the probability of committing type 1 and type 2 errors. z test, t test, and chi-square test.
7. **Analysis of variance** – one way classification and two way classifications.F-test, F-value calculation. F table.
8. **Correlation and regression analysis** - Coefficient of correlation- significance testing, rank correlation, lines of regression, coefficient regression.
9. **Experimental designs**: designing an experiment, - CRD, RBD,LSD, factorial experiment.
10. **Probability:** application of the principles of probability – theorems of probability, probability distributions, binomial, multinomial, normal and Poisson distributions. Applications of probability.
11. **Statistical software** – SPSS, SPAR, MINITAB.

References

1. Chandal, S.R.S. A handbook of Agricultural statistics. Achal Prakashan Mandir, Kanpur.
2. Gupta, S.K. and Kapoor V.K. fundamentals of Mathematical Statistics. S.chand & sons, New Delhi
3. Gupta, C.B. An introduction to Statistical Methods. Vikas Publishing House.
4. Panse, V.G. and Sukatme, P. Statistical Methods for Agricultural Workers. ICAR, New Delhi.
5. Kempthorne, O. An Introduction to Genetic Statistics. John Wiley and Sons.
6. Mathur K and Links, J.L. Biometrical Genetics, Chapman and Hall, London.
7. Singh, P. and Narayanan, S.S. Biometrical Methods in Plant Breeding. Kalyani Publishers, New Delhi.

PLANT BREEDING [1 hour per week]

1. **Introduction**:- Definition of plant breeding - Basic activities in plant breeding.
2. **Domestication of wild plants**:- Changes under domestication.
3. **Plant introduction**:- Definition, Primary and secondary plant introduction , Principles of plant introduction - Procedure of plant introduction - Merits, demerits and achievements of plant introduction.
4. **Selection**:- Principles of selection - Factors affecting selection response - Mass selection:-Procedure of mass selection, Merits, demerits achievements of mass selection, Hallet's and Rimpau's modification of mass selection - Pureline selection:- Johannson's experiment, Concept of pureline, Procedure of pureline selection, Merits, demerits and achievements of pureline selection - Clonal selection:- Concept of clone, Procedure of clonal selection Merits, demerits and achievements of clonal selection - Recurrent selection:- Procedure.
5. **Hybridization**:- Objectives of hybridization - Procedure of hybridization - Guidelines in handling segregating population - Methods of handling segregating population:- Pedigree method and bulk method - Distant hybridization:- Interspecific and intergeneric hybridization, Barriers in distant hybridization - Applications and limitations of distant hybridization.

6. **Back crossing**:- Principle of back crossing - Procedure of back crossing:- Transfer of dominant gene, Transfer of recessive gene.
7. **Heterosis Breeding**:- Concept of heterosis - Procedure of heterosis breeding - Exploiting male sterility for the production of cross seeds - Achievements.
8. **Mutation Breeding**:- Procedure of mutation breeding - Modifications of the procedure - Merits, demerits and achievements.
9. **Polyploidy Breeding**:- Autopolyploidy breeding:- Production of autopolyploids, Applications and limitations - Allopolyploidy breeding:- Production of allopolyploids, Role allopolyploidy in evolution (Eg.Wheat & Brassica), Application and limitations - Aneuploidy breeding:- Production of aneuploids, Applications and limitations.
10. **Resistance breeding**:- Breeding for disease resistance:- Vertical and horizontal resistance, Gene for gene hypothesis, Source of genes, Breeding methods, Screening for disease resistance, Achievements - Breeding for pest resistance:- Mechanism of pest resistance, Source of genes, Breeding methods, Screening for pest resistance, Achievements - Breeding for drought resistance:- Basis of drought resistance, Source of genes, Breeding methods, Screening for drought resistance, Achievements - Breeding for salinity resistance:- Approaches in salinity resistance breeding, Source of genes, Breeding methods, Screening for salinity resistance, Achievements.
11. **Quality breeding**:- Definition of quality - Types of quality - Source of genes, Breeding methods, Achievements, Limitations.

References

Allard R.W. (1960) Principles of plant breeding. John Wiley and sons, New Delhi

Chahal G.S. and Gosal S.S. (2002) Principles and procedure of Plant breeding. Narosa Publishing House, New Delhi.

Chopra V.L. (1989) Plant Breeding. Oxford IBH publishing company, New Delhi.

Gupta P.K. (1998) Genetics and Biotechnology in crop improvement. Rastogi Publications, Meerut.

Kuckuck H., Koaabe G. and Wenzel G. (1993) Fundamentals of Plant Breeding. Narosa Publishing House, New Delhi.

Phundan Singh (1996) Essentials of plant breeding. Kalyani Publishers, Ludhiana.

Poehlman and Borthakur (1969) Breeding Asian field crops. Oxford IBH publishing company, New Delhi.

Roy D (2000) Plant Breeding – Analysis and exploitation of variation. Narosa Publishing House, New Delhi.

Singh, B.D. (2005) Plant Breeding. Kalyani Publishers, Ludhiyana

EVOLUTION [1 hour per week]

1. **The concept of evolution**: Progressive and retrogressive evolution. Evidences of evolution.
2. **Origin of life**: theories and experimental evidences, chemical evolution and biological evolution.
3. **Theories of evolution:** Pre - Darwinian, Darwinian and Post – Darwinian theories.
4. **Reproductive isolation** and origin of species.
5. **Modern synthetic theory** of evolution, Adaptive radiation.

References

1. Crick F., 1981 Life itself: Its origin and Nature. Simon and Schuster, New York.
2. Theodozius Dobzhansky 1970 Genetics of the Evolutionary Process. Columbia University press.
3. Ledyard Stebbins 1971 the Process of Organic Evolution, prentice Hall.
4. Dott R.H., Batten, 1981 Evolution of the earth 3rd end. McGraw Hill New York.
5. Fox S.W. and K. Dose, 1972 Molecular Evolution and the Origin of Life. W.H. Freeman& Co., San Francisco.
6. Strickberger, 1990 Evolution, Jones and Bastlett Publishers International, England.
7. Rastogi V B 2014 Organic Evolution. Medtec Publishers.

FBOT2C06 : ENVIRONMENTAL BIOLOGY, PHYTOGEOGRAPHY AND FOREST BOTANY

[4+1+1=6 hours per week]

COs	COURSE OUTCOMES
CO1	Familiarity with various types of ecosystems and the ecological principles operating in each ecosystem
CO2	Evaluate the threats associated with various ecosystems and an understanding of various management strategies for their conservation
CO3	Understand the nature and pattern of distribution of plant communities and the reasons underlying it
CO4	Understand the nature and type of forests; their ecological as well as economic contribution and strategies for their management • Have an idea about the major ecosystem of the world • Understand the population ecology and community ecology system in the world • Get meticulous knowledge in ecological succession and phytogeography • Get knowledge in environmental pollution, global environmental problems, their mitigation and remedies and to acquire knowledge about the importance of biodiversity conservation • Understand the concept of conservation of nature and natural resources • To understand the importance of plants in environmental quality • Understand the importance of forest and forest products

ENVIRONMENTAL BIOLOGY [4 hours per week]

1. **Habitat Ecology:** Salient features of terrestrial, wetland, freshwater, and marine habitats.
2. **Productivity and energy flow concepts**: limits and processes of primary production. Methods of productivity measurements. Global trends in primary productivity. Energy flow models.
3. **Population characteristics:** density, natality, mortality, distribution, biotic potential, carrying capacity. Aggregation and dispersal. Ecotone and edge effect.
4. **The environmental pollution:** Land, air and water pollution. Effect of pollution on living organisms. Control of pollution with emphasis on biological methods. Environmental hazards.
5. **Threats to the global environment**: Greenhouse effect, ozone depletion, El-Nino and La Nina effects.

6. **Environmental impact assessment** (EIA) and assessment of environmental hazards. Remote sensing.
7. **Problems of conservation:** Causes of threat to environment, human interference, deforestation, habitat destruction and overexploitation of resources.
8. **Identification of threatened plants:** the Red List categories – extinct, endangered, vulnerable, rare and out of danger. Extinction process. Hot spots, keystone species and flagship species.
9. **Strategies for conservation:** *in situ* and *ex situ* conservation. Biosphere reserve, national parks, wildlife sanctuaries, gene banks, cryopreservation, seed banks.
10. **Afforestation**: social forestry and agroforestry. International Biological Programme (IBP). Man and Biosphere Programme (MAB). IUCN. World Environmental Day. Wildlife Preservation Act (1972), Indian Forest Conservation Act (1980) and United Nations Environment Programme (UNEP).
11. **Biodiversity**: significance at local, national and global levels. Deep ecology. Ecotourism – positive and negative impacts

References

1. Ahluvalia V.K. Malhotra S. 2009. Environmental Science. Ane Books – New Delhi.
2. Ambasht R.S. 1988. A text book of Plant Ecology. Students Friends Co. Varanasi.
3. Beeby A. & Brennan A.M. First Ecology. Ecological Principles and Environmental Issues, International Student Edition.
4. Benon E. Plant Conservation Biotechnology. Taylor & Francis Ltd. II New Felter Lane, London, EC4P4EE,
5. Cunninghan W.P. and M.A. Cunnigham 2003. Principles of Environmental Science: Inquiry and Applications. Tata McGraw Hill Pub. N.D.
6. Dash.M.C. 1993. Fundamentals of Ecology. Tata McGraw Hill Publishing Company Ltd. New Delhi.
7. Dix J.H. 1989. Environmental Pollution. Atmosphere, Land, Water and Noise. Wiley Chichester.
8. Khitoliya R.K. 2007. Environmental Pollution – Management and Control for Sustainable development S. Chand and Company Ltd., New Delhi.
9. Kumar H.D. 1977. Modern Concepts of Ecology. Vikas Publications. New Delhi.

10. Michael S. 1996. Ecology. Oxford University Press, London.
11. Mishra D.D. 2008. Fundamental Concepts in Environmental studies. S. Chand & Co., New Delhi.
12. Mishra S.P. & S.N. Pandey 2008. Essential Environmental Studies. Ane Books Pvt. Ltd. Thiruvananthapuram.
13. Krebs, C.J. 1985. Ecology 3rd edn. Harper & Row New York.
14. Odum E.P. 1983, Basics of Ecology. Saunders International UN Edition.
15. Shukla.R.S. & P.S. Chandel 2005. A Text Book of Plant Ecology S. Chand & Co. Ltd. New Delhi.
16. Bharucha E. 2005. Text Book of Environmental Studies for UG courses. University Press (India) Private Limited Hyderabad.
17. . Sharma, P.D. 2008-2009. Ecology and Environment. Rastogi Publication.
18. . Shukla R.S. & P.S. Chandal 2008: Ecology and utility of plants' S. Chand & Company Ltd. New Delhi.

PHYTOGEOGRAPHY [1 hour per week]

1. Patterns of plant distribution – continuous distribution and discontinuous distribution. Migration and extinction, Endemism , Age and Area hypothesis.
2. Theory of continental drift, land bridges and glaciations.
3. Vegetational zones of India .and the world.

References

1. Ronald Good. The Geography of Flowering Plants, Longman Publishers
2. Hugget. R. J. Fundamentals of Biogeography, Routledge, London.
3. Brown, J.H. and Linolino, M.V Biogeography, Sinauer Associates.
4. Bharucha, F.R. A Textbook of Plant Geography of India. Oxford University Press.

FOREST BOTANY [1 hour per week]

1. Forest: Definitions. Study of various forest types of India and the World.
2. Forest Products: Major and minor forest products with reference to Kerala
3. Influence of forests on environment. Consequences of deforestation

References

1. Agarwal, A. P. Forests in India, Oxford and IBH
2. Gregorv, G.R. Forest Products, Production, Trade, Consumption, quantity and value of raw material requirements, Ford foundation, New Delhi.
3. Puri, G. S. Indian Forest Ecology I and II, Oxford IBH, New Delhi
4. Marcus Bernard Tropical Forest Jones & Bartlet Publishers

FBOT2L03 : PRACTICALS OF CELL BIOLOGY, MOLECULAR BIOLOGY, BIOPHYSICS AND BIOSTATISTICS

[1+0.5+1+1=3.5 hours per week]

COs	COURSE OUTCOMES
CO1	Demonstration of practical skills in the isolation of cell organelles and demonstration of cellular processes
CO2	Demonstration of practical skills in the isolation of genetic materials from cellular systems and to familiarize recent methods for their characterization
CO3	Develop abilities in the conduct of various experiments related to the physical and chemical separation of biochemical components
CO4	Demonstration of practical skills in the area of Cytogenetics and its logical reasoning
CO5	Develop skills in analyzing experiments related to the course materials, their interpretation and reporting

CELL BIOLOGY [1 hour per week]

1. Study of mitosis in root tip cells.
2. Study of meiosis in microspore mother cell (*Rhoeo*).
3. Chromosome study in root tips with colchicines / hydroxyquinone etc.
4. Study of polytene chromosomes, lamp brush and B chromosomes
5. Induction of polyploidy using colchicine.
6. Preparation of karyotype and ideogram of plant meristmatic cells.

MOLECULAR BIOLOGY [0.5 hours per week]

1. Working out problems from molecular genetics.

BIOPHYSICS [1 hour per week]

1. Preparation of buffers (acetate and phosphate)and measurement of pH using pH meter.
2. Determination of isoelectric pH.
3. Paper chromatography:- Separation of sugars.
4. Thin Layer Chromatography:- Separation of amino acid mixtures.
5. Colorimetric / spectrophotometric estimation of proteins by Biuret method.
6. Estimation of amino acids by ninhydrin method (Colorimetric).

BIOSTATISTICS [1 hour per week]

Problems from mean, standard deviation, coefficient of variation, tests of significance and correlation analysis have to be worked out and recorded. The students should acquire working ability in computer aided statistical analysis.

FBOT2L04 - PRACTICALS OF GENETICS, PLANT BREEDING, ENVIRONMENTAL BIOLOGY, PHYTOGEOGRAPHY AND FOREST BOTANY

[1.5+1+1+0.5+0.5=4.5 hours per week]

COs	COURSE OUTCOMES
CO1	Develop skills in the statistical analysis of data, both manually and using statistical software
CO2	Demonstration of practical skills in plant breeding and hybridization
CO3	Develop abilities in the conduct of various experiments related to ecosystems evaluation and characterization
CO4	Develop skills and abilities in assessing species composition and biotic interactions associated with heterogeneous ecosystems
CO5	Demonstration of skills in the identification of phytogeographic areas, with special reference to forest biome
CO6	Develop skills in evaluating the mandate of various organizations and their programmes in the priority areas specified in the course

GENETICS [1.5 hour per week]

Problems from linkage, tetrad analysis, quantitative genetics and population genetics have to be worked out and recorded.

PLANT BREEDING [1 hour per week]

1. Study of flower morphology of Rice, Pulses, Solanum, Capsicum.
2. Practice of hybridization technique in plants mentioned in (1).
3. Submission of certified report of visit to one plant breeding station in India.

ENVIRONMENTAL BIOLOGY [1 hour per week]

1. Determination of food chain and food web in aquatic systems
2. Determination of the Importance Value Index (IVI) of plant species in a community by quadrat method.
3. Comparative study of polluted and non-polluted aquatic systems
4. Visit to a meteorological station, sewage treatment facility, national park, or wild life sanctuary and the report shall be submitted at the time of practical examinations.
5. Estimation of dissolved oxygen content in the water sample by winkler's method
6. Determination of primary production in aquatic systems by dark and light bottle method
7. Determination of dissolved carbon dioxide content in water samples.

PHYTOGEOGRAPHY [0.5 hours per week]

Identification of the various floristic and vegetational regions of the world and India in maps

FOREST BOTANY [0.5 hours per week per week]

Study of the major and minor forest products of Kerala and their uses

SEMESTER III

FBOT2C07 : PLANT PHYSIOLOGY, METABOLISM AND BIOCHEMISTRY

[2+3.5 = 5.5 hours/week]

COs	COURSE OUTCOMES
CO1	Understand various physiological processes associate with plant systems
CO2	Understand various metabolic processes linked to biological systems
CO3	Acquire knowledge on the properties of biomolecules (primary and secondary) and to understand the biochemistry of their action • Get an idea about the plant water relations • Understand the transport of ions, solutes and other macromolecules • Infer various aspects of photosynthesis. • Understand respiratory metabolism in plants • Analyze the nitrogen metabolism in plants. • Familiarize the affects different types of stresses in plants • Outline the basic knowledge in sensory photobiology • Examine the various plant growth regulators • Understand the structure and function of biomolecules • Familiarize different types of secondary metabolites

PLANT PHYSIOLOGY [2 hours per week]

1. **Water and plant cells**: properties of water, hydrogen bonding, polarity, cohesion and adhesion. The concept of water potential. Water movement in cells and tissues. Soil-plant-atmosphere continuum. Transpiration, stomatal movement, modern theories of stomatal mechanism. The ascent of xylem water and the uptake of water by the roots. Absorption of mineral ions – absorption of solutes.
2. **Plants and nitrogen:** the nitrogen cycle, biological nitrogen fixation, symbiotic nitrogen fixation leguminous plants. Biochemistry of nitrogen fixation. Export of fixed nitrogen from nodules. Genetics of nitrogen fixation. Nitrogen assimilation. Assimilation of nitrate. Nitrogen nutrition – agricultural and ecological aspects. Biosynthesis of amino acids reductive amination and transamination. GDH and GOGAT pathway.
3. **Photosynthesis**: absorption and fate of light energy. Absorption spectra and action spectra. Photoreceptors – chlorophylls, carotenoids, phycobilins. Bioenergetics and the light dependent reactions of photosynthesis. Photosynthetic electron transport and photophosphorylation. The two pigment systems. Z scheme. Water oxidizing clock. The

photosynthetic carbon reduction cycle. C3, C2, C4 and CAM metabolism and ecological significance.

4. **Translocation and distribution of photoassimilates:** phloem transport. Sources and sinks. Mechanism of translocation. Phloem loading and unloading. Distribution of assimilates. Translocation of xenobiotic chemicals.
5. **Patterns in plant development:** growth differentiation and development. Genetic control and hormonal regulation of development. Seed germination. Physiology of hormones in plant development – auxins, gibberellins, cytokinins, abscissic acid and ethylene. Role of vitamins and nutrients in development.
6. **Photomorphogenesis**: Phytochrome – chemistry and physiological effects. Mechanism of phytochrome and gene action. Cytochromes and blue light effect.

References

1. William G. Hopkins, 1999. Introduction to Plant Physiology, 2nd edition, John Wiley A Sons, Inc.
2. Lincoln Taiz and Eduardo Zeige 2002. Plant Physiology 2nd edition, Sinauer Associates, Inc. Publishers Sunderland, Massachusetts.
3. Frank B. Salisbury and Cleon W.Ross 2002. Plant physiology 3rd edition CBS publishers and distributors.
4. Noggle G.R. and Fritz G. J.1986 Introductory Plant Physiology Prentice Hall.
5. Goodwin Y.W., and Mercer E.I. 2003 Introduction to Plant Biochemistry, 2nd edition. CBS Publishers and distributors.

BIOCHEMISTRY [3.5 hours per week]

1. **Introduction to Biochemistry**:- Chemical unity of living organisms and Molecular logic of life - Weak interaction in aqueous systems - Fitness of aqueous environment for living organisms.
2. **Carbohydrates**:- Classification of carbohydrates - Structure of monosaccharides (Glyceraldehyde, Diydroxy acetone, Erythrose, Eruthtulose, Ribose, Ribulose, Glucose, Galactose, Mannose, Fructose, Glucoheptose and Sedoheptulose) - Reactions of glucose and fructose (Oxidation, Reduction, Acetylation, HCN reaction, Osazone reaction and Oxamine

formation) - Isomerism of Monosaccharides (1. Structural isomerism Eg. Functional group isomerism 2. Stereoisomerism Eg. Optical isomerism – Enantiomers, Diastereoisomers, Anomers, Epimers) - Structure of Disaccharides (Maltose, Isomaltose, Cellobiose, Lactose, Sucrose and Trehalose) - Structure of Oligosaccharides (Raffinose, Gentianose, Stachyose and Verbascose) - Structure of polysaccharides (Starch, Glycogen, Cellulose, Chitin, Inulin, Hayluronic acid Chondrotin sulphate and Heparin) - Functions of Simple sugars and compound carbohydrates - Structure and functions of carbohydrate derivatives:- Glycosides, Deoxy sugars and Amino sugars.

3. **Lipids**:- Structure and properties of alcohol moiety in lipids - Classification, structure and properties of fatty acids - Classification of lipids by Bloor - Structure of simple lipids (Triglyceride, waxes) and Compound lipids (Phosphatidic acid, Lecithin, Cephalin Phosphatidyl inositol, Phosphatidyl serine, Plasmalogen, Sphingomylein and cerebroside) - Reactions of lipids (Saponification, Hydrogenation, Rancidity, Acid number and Iodine number) - Classification of lipids based on function - Brief account on steroids with emphasis on cholesterol.
4. **Amino Acids**:- General structure and properties - Classification based on the chemical composition of variable side chain - Structure of protein amino acids - Reactions of amino acids (Ninhydrin reaction, Sanger's reaction and Hydentoin formation) - Peptide bond and peptide formation (Dipeptides, Oligopeptides and Polypeptides) - Ionization of amino acids - Brief account on non-protein amino acids.
5. **Proteins**:- Structure of protein - Primary structure, Secondary structure (α helical & β pleated sheet structure), Tertiary structure and Quaternary structure - Bonds responsible for stability of protein structure - Denaturation of proteins - Concept of protein domines, motifs and folds - Biological functions of proteins.
6. **Nucleotides**:- Chemical composition of nucleotides - Structure of nitrogen bases (Adenine, Guanine, Cytosine, Uracil and Thymine) - Nitrogen base derivatives in food stuffs (Xanthine, Caffine, Theophylline, and Theobromine) - Structure of sugar moiety in nucleotides (Ribose and 2-deoxy ribose) - Structure of nucleosides - Structure of nucleotides - Functions of nucleotides - Nucleotide derivatives (NAD^+, $NADP^+$, FAD, FMN, Cyclic AMP and Cyclic GMP)

7. **Enzymes**:- Introduction - Nomenclature of enzymes - Classification of enzymes by IUB - Physico-chemical nature of enzymes - Mechanism of enzyme action:- Formation of ES complex, Transition state and energy of activation, Optimization of weak interactions, Lowering of energy of activation.

   Factors affecting enzyme activity:- a. Substrate concentration:- Concept of V_{max} and K_m Value, Michaelis-Menton equation, Lineweaver-Burk plot b. pH c. Temperature, d. Redox potential e. Enzyme inhibitors f. Enzyme concentration.

   Enzyme activation:- Activation of proenzyme, Activation of thio enzyme, Activation by cofactors and Allosteric activation - Enzyme inhibition:- Allosteric inhibition, Competitive inhibition and Non competitive inhibition - Enzyme specificity:- Group specificity, Cofactor specificity and Sterio specificity.
8. **Catabolism of carbohydrates**:- Glycolysis:- Two phases of glycolysis - Reactions of glycolysis - Energy yield and Energy balance sheet of glycolysis - Regulation of glycolysis - Fate of pyruvate under anaerobic and aerobic condition - Pentose Phosphate Pathway - Citric acid cycle:- Formation of active acetate - Reactions of citric acid cycle - Energy yield and Energy balance sheet of citric acid cycle - Amphibolic nature of citric acid cycle - Anapleurotic reactions of citric acid cycle - Regulation of TCA cycle
9. **Biosynthesis of carbohydrates**:- Reactions of Gluconeogenesis - Regulation of gluconeogenesis - Role of NTP sugars in carbohydrate biosynthesis.
10. **Catabolism of lipids**:- Hydrolysis of lipids - Fate of glycerol - Activation of fatty acids - α and β oxidation of fatty acids - Energy balance sheet.
11. **Biosynthesis of Lipids**:- Formation of saturated fatty acids in plants - Synthesis of triglycerides - Biosynthesis of phospholipids - Biosynthesis of isoprinoids.

12. **Catabolism of Proteins**:- Hydrolysis proteins to amino acids - Metabolic transformations of amino acid and entry into citric acid cycle.
13. **Biosynthesis of Nucleotides**:- Purine biosynthesis - PRPP and its significance - Pyrimidine biosynthesis - Conversion of NMP to NTP.
14. **Electron Transport Chain in mitochondria**:- Definition of ETC – Redox potential - Electron carriers - Multienzyme complex - Electron transport reactions - Energy transfer

sites and synthesis of ATP - Oxidative phosphorylation - Shuttle system - Chemiosmotic coupling hypothesis - Thermogenesis - Terminal oxidation.

15. **Secondary metabolism**:- A brief account of secondary metabolites - Link between primary and secondary metabolism.

References

Belitz, H.D., Grosch, W. and Schieberle,P. (2004) Food Chemistry. Springer,Berlin

Berg, J.M., Tymoczko, J.L. and Stryer, L. (2012) Biochemistry. W.H. Freeman and Company, New York.

Martin, D.W., Mayes, P.A. and Rodwell, V.W. (1983) Harper's Review of Biochemistry. Lang Medical Publication, Singapore.

Padmini, E. (2007) Biochemical calculation and Biostatistics. Books and allied (P) Ltd., Kolkata.

Plummer, D.T. (1990)An introduction to practical Biochemistry. Tata McGraw-Hill Publishing Company, New Delhi.

Sadasivam, S. and Manikam, A. (1996) Biochemical Methods. New Age International (P) Limited, New Delhi.

West, E.S., Todd, W.R., Mason, H.S. and Bruggen, J.T. (1955) Text book of Biochemistry. Oxford & IBH Publishing Company, New Delhi.

Wilson, K. and Walker, J. (1995) Principles and Techniques of Practical Biochemistry. Cambridge University Press, New York

FBOT2C08 : ANGIOSPERM MORPHOLOGY, TAXONOMY AND PLANT RESOURCES

[1+3.5+1 = 5.5 hours per week]

COs	COURSE OUTCOMES
CO1	Acquaint with the structure and organization of various plant organs and a detailed analysis on their origin and evolution
CO2	Understand various principles and practices of Plant Systematics
CO3	Acquire knowledge on the recent development in plant systematics and the institutions involved in it
CO4	Develop understanding on the history, occurrence, and botanical characteristics of various plant resources of commercial importance • Recognize concepts of taxonomic hierarchy and phylogeny of angiosperms. • Illustrate sources of taxonomic characters in solving taxonomic disputes. • Recall the principles, rules and recommendations of ICN in plant taxonomy • Conceptualize the plant classification system proposed by different taxonomists • Develop critical understanding of the different tools in taxonomy • Develop critical evaluation of taxonomic keys • Recognize the importance of digital resources of taxonomy and virtual herbarium • Enhance their observation capacity by dissecting different floral structures and to improve their taxonomic illustrations and floral imaging • Critically evaluate the interrelationships and evolutionary trends of angiosperm families • Understand the economic importance of plants and its commercial applications

MORPHOLOGY [1hour per week]

1. A critical study of the current ideas on the origin of angiosperms with special reference to their ancestral stock, time and place or origin.
2. The concept of primitive angiosperm flower. Origin and evolution of flower, co-evolution of flowers and their pollinators.
3. Origin and evolution of structure and morphology of stames, nectarines and nectar.
4. Origin and evolution of carpels, different types - concept of foliar origin of carpels, types of ovary; evolution of placental types, inferior ovary, foliar and axial concepts.
5. Role of floral anatomy in interpreting the origin and evolution of flower and floral parts.

Reference

1. Eames, E, J. Morphology of Angiosperms, McGraw Hill Publishers.
2. Meeuse, A.D.J. Some Fundamental Principles of Interpretive floral Morphology, International Science Publishers.
3. Sporne, K.R. The Morphology of Angiosperms, Hutchinson's University Press

TAXONOMY [3.5 hours per week]

1. **Principles of Taxonomy:** Scope and importance of Taxonomy. Systems of classification. – artificial, natural and phylogenetic systems. Phenetic versus phylogenetic systems. Cladistics in taxonomy
2. **Conceptual basis of classification**: Essentialism, nominalism, empiricism, phenotics and cladistics, phylogenetic and alternatives. Concepts of genus, family and interspecific categories.
3. Definition and terms: primitive and advanced; homology and analogy; parallelism and convergence; monophyly and polyphyly
4. **Taxonomic hierarchy:** concept of taxa – species genus and family – intrapecific categories.
5. **Plant nomenclature:** History of nomenclature, polynomial and binomial systems; detailed study of salient features and major provisions of the International Code of Botanical Nomenclature. Effective and valid publications. Rank of taxa. Rule of priority and its limitations. Typification. Author citation. Rejection of names and names of hybrids. A brief account of International code of Nomenclature of Cultivated Plants.
6. **Concepts of character:** definition, classification, classification of characters – analytic and synthetic; qualitative and quantitative; unit and multiple; good and bad. Correlation of characters. Character weighting.
7. **Modern trends** in Taxonomy: Cytotaxonomy, chemotaxonomy, biosystematics and numerical taxonomy. Molecular taxonomy. DNA bar-coding in plants.
8. **History and development of taxonomy in India.** Classification of taxonomic literature – general indices, floras, icons, monographs, reviews and journals.
9. **Herbarium**: Definition, steps involved in the development of herbarium. Utility of herbaria with special reference to CAL and MH.
10. **Botanical Survey of India:** Organization and functions.

11. **Botanical Gardens**: types of Gardens and importance of gardens in taxonomic studies. Important national and international botanical gardens. – Royal Botanical Garden, Kew; Indian Botanical Garden,Calcutta; National Botanical Garden, Lucknow and Tropical Botanical Garden, Trivandrum.

References

1. Cronquist, A. Evolution and Classification of Flowering Plants, Thomas and Nelson Co.
2. Graf, A.B. Tropica, Roechers Publ.Company
3. Lawrence, G.H.M. Taxonomy of Vascular Plants, Oxford and IBH.
4. Sivarajan V.V. Introduction to Principles of Plant Taxonomy, Oxford IBH.
5. Stace, C.A. Plant Taxonomy and Biosystematics, Edward Arnold, London.
6. Takhtajan, A.L. Diversity and Classification of Flowering Plants, Columbia University Press.
7. Simpson, M.G. Plant Systematics, Elsevier.
8. Stebbins, G. L. Flowering Plants, - Evolution Above Species Level, Edward Arnold.
9. Sporne, K. R. The Morphology of Angiosperms, Hutchinsons University Press.
10. Rendle A.E. Classification of .Flowering Plants.

PLANT RESOURCES [1 hour per week]

1. A study of history, occurrence and morphology of useful part and overall chemical composition of the following.
    a. Cereals and Millets: Rice, Wheat, maize, sorghum, finger millet, pearl millet
    b. Pluses: Bengal gram, cluster bean, common bean, horse gram, cow pea
    c. Sugar yielding plants: sugar cane, Beet root
    d. Starch yielding tubers: Potato, tapioca, arrow root, taro
    e. Fats and oils: ground nut, coconut, castor, gingelly, mustard, oil palm.
    f. Beverages: tea, coffee, cocoa
    g. Spice and condiments: pepper, ginger, turmeric, coriander, cumin, fennel, nutmeg, cloves, fenu-greek, cinnamon.
    h. Fiber yielding plants: cotton, jute, coir
    i. Rubber yielding plants: para rubber
    j. Timber yielding plants: teak, rose wood, *Artocarpus*, *Ailanthes*, *Xylia*

2. A. study of the following medicinal plants with reference to the chemical and pharmacognosic properties: neem, turmeric,*Adhathoda*, *Rauwolfia*, *Catharanthus*, *Bacopa*, Nux-*vomica*, sweet-flag, *Saraca*, wood apple, Indian Mirobalan

Reference

1. Wealth of India Series, CSIR
2. Kochar, S.L. Economic Botany of the Tropics. McMillan India
3. Chandel, K.P.S., Shukla, G and Sharma, N. Biodiversity in medicinal and aromatic plants in India. –conservation and utilization in India. NBPGR, New Delhi
4. Chirpeels, M.J. and Sadava, D. Plants, Food and People. W. Freeman and Co.
5. Albert F Hill. Economic Botany McGraw-Hill
6. Jain. S.K. Glimpses of Indian Economic Botany. Oxford
7. Baker. H.G. Plant and Civilization.
8. Jain. S.K. A Manual of Ethnobotany. Scientific Publishers, Jodhpur.
9. Cotton, C.M. Ethnobotany- Principles and Applications. Wiley and Sons.
10. Sambamurthy AVSS and Subramanyan N S 2000 Economic Botany of Crop Plants Asiatech publishers.

FBOT2C09 : BIOTECHNOLOGY AND BIOINFORMATICS

[3+3=6 hours per week]

COs	COURSE OUTCOMES
CO1	Understand the basic principles and practices and develop skills in the advanced areas of plant tissue culture
CO2	Acquire knowledge on the recent techniques and developments in Genetic Engineering and the legal procedures underlying genetic manipulation
CO3	Acquaint with the principles and applications of Bioinformatics and to acquire skills in the use of computer aided Bioinformatics tools • Get a thorough knowledge in plant tissue culture • Familiar with genetic engineering and advanced tools • Get knowledge in genomic and proteomics • Get basic knowledge in bioinformatics • The students will be able to familiarize with social issues in biotechnology

BIOTECHNOLOGY [3hours per week]

A. Plant Tissue Culture

1. **Basic concepts** and history
2. **General account** of laboratory facilities and management
3. **Media** for *in vitro* culture, composition and their preparation.
4. **Callus culture**, selection of explants and medium. types of callus.
5. **Cell culture**: isolation of single cells. Cell line selection through cell plating, Measurement of growth of cells , Growth profile of cells / callus. Viability tests.
6. **Organogenesis**: direct and indirect. Factors affecting organogenesis
7. **Organ culture**: Meristem, embryo, ovary, ovule, endosperm, anther, pollen and root cultures.
8. **Application of plant tissue culture**: clonal propagation, somatic hybridization, synthetic seeds, secondary metabolite production, germplasm conservation and cryopreservation.

B. Genetic Engineering

1. **Molecular analysis of gene and gene products**: Southern, Northern and Western blots – restriction maps-RAPD, RFLP and AFLP. FISH. PCR and its applications. DNA finger printing. DNA chips
2. **DNA sequencing:** Enzymatic method, Gilbert and Maxam method. Fluorescent detection and automation. The Human genome Project

3. **Transgenic plants:** Gene Cloning strategies in plants. Vector dependent and vector independent methods. . Identification and selection of transformed plants. The reporter enzyme technology. The objectives and achievements. – engineering for secondary metabolites. Resistance against herbicides, pests, pathogens and stress. Enhanced nutritional and agronomic qualities in plants. Plants as bioreactors. Phytopolymers and biodegradable plastics. Anti sense RNA and RNAi in transgenic plants. Transgene inactivation. Terminator and traitor technologies.
4. **Cloning**: Objectives. Creation of transgenic animals and other developments in cloning. Ethics of cloning.
5. **Gene piracy.** Causes and remedial measures.
6. **Ethics and biosafety -aspects of biotechnology.**

References

1. Walker J.M. and Rapley, R. Molecular Biology and Biotechnology, Panima publications.
2. Glick, B.R. and Pasternack, J. J. Molecular biotechnology – Principles and Applications of Recombinant DNA. ASM press, Washington
3. Brown, T.A. Gene Cloning and DNA Analysis, Blackwell Science
4. Primrose, S.B. Molecular Biotechnology, Panima Publications
5. Crispeels, M.J. and Sadava, D.E. Plants, Genes and Agriculture, Jones and Barlett.

BIOINFORMATICS [3 hours per week]

A. Computer Applications

1. **Computer in biological science -** scope and prospects.
2. **Information superhighway**: Internet, World Wide Web, Web browsers, HTTP, HTML, and URLs..Structure, organization and functioning of www.
3. **Online Publications in biology:** e-journals. E books and online archives.. Freedom of scientific information access. Free software movement. Free Software foundation. Web resources like Biomedcentral, Pubmedcentral The public library of science **References**

1. Evans, A *et al.* Informatics –Technology in Action, Pearson
2. Morley D.A. Fundamental of Computer Delmar Cengage Learning
3. Norton P. Introduction to Computer, McGraw Hill
4. Rajaraman V. Fundamentals of Computers, PHI

B. Bioinformatics

1. Introduction, history, importance and scope.
2. Biological databases
    a. Nucleic acid database.s: EMBL, GenBank,
    b. Protein sequence databases: PIR, SWISSPROT, TrEMBL
    Composite Protein databases: NRDB,
    Secondary Databases: PROSITE, PRINTS, BLOCKS, IDENTIFY
    Structure classification databases: SCOP, CATH
3. Database searching, analysis
    a. Sequence database searching - EST search.
    b. Sequence similarity, sequence assembly and sequence clustering.
    c. Pair wise alignment technique: comparison of sequences. Identity and similarity. Substitution matrices, BLOSUM, DOTPLOT and BLAST.
    d. Multiple sequence alignment technique: Clustal W.
4. Protein structure prediction:
    a. Secondary structure prediction: Chou-Fasman, J pred
    b. Tertiary structure prediction - comparative modeling: Modeller, Rasmol.
5. Application of Bioinformatics: DNA microarrays, functional genomics, comparative genomics, pharmaco genomics, chemoinformatics, medical Informatics.

References

1. Attwood, T.K and Parry-smith, D.J. Introduction to Bioinformatics, Pearson.
2. Sundararajan, S. and Balaji, R. Introduction to Bioinformatics, Himalaya Publishing House
3. Ignacimuthu 2010 Basic Bioinformatics Narosa Publishers, New Delhi

FBOT3L05 : PRACTICALS OF PLANT PHYSIOLOGY, METABOLISM, BIOCHEMISTRY AND ANGIOSPERM MORPHOLOGY

[1+2.5+0.5=4 hours per week]

COs	COURSE OUTCOMES
CO1	Develop skills in conducting / demonstrating experiments related to various physiological processes in plants
CO2	Demonstration of practical skills in the area of separation of biomolecules and their assays.
CO3	Develop abilities to test various biochemical components in plants using standard protocols.
CO4	Develop skills and abilities in assessing plant organs and to comment on their developmental processes.
CO5	Demonstration of skills in the collection, preservation and systematic elucidation of plant specimens to their respective families using conventional and modern methods

PLANT PHYSIOLOGY [1 hour per week]

1. Determination of water potential by tissue change method
2. Extraction of leaf pigments and preparation of absorption spectra of carotenoids and chlorophyll.
3. Demonstration of Hill Reaction.
4. Separation of leaf pigments by paper chromatography and column chromatography
5. Effects of light intensity on photosynthesis using Wilmot's bubbler
6. Determination of sugars and amino acids in germinating seeds by TLC
7. Extraction of seed proteins based on solubility
8. Analysis of proline in water stressed plants.
9. Testing seed viability by NBT method
10. Changes in reserve proteins in germinating seeds

BIOCHEMISTRY [2.5 hours per week]

1. Schematic qualitative analysis of monosaccharides, reducing sugars, aldoses, ketoses, starch, proteins and amino acids using suitable biochemical tests.
2. Quantitative estimation of proteins by Biuret test.
3. Quantitative estimation of DNA / RNA
4. Estimation of reducing sugar in germinating seeds
5. Determination of saponification number, Iodine number and Acid number of oils.
6. Extraction of enzymes (Any enzyme)

7. Determination of the pH dependant activity profile of an enzyme.
8. Carbohydrate metabolites of germinating seeds.

MORPHOLOGY [0.5 hours per week]

1. Preparation of cleared whole mounts of floral parts to show vasculature.
2. Examination of the following with the help of dissections and hand sections. Transmitting tissues/canals in style and stigma. Different types of ovaries. Different types of placentations. Vasculature in the androecium and gynoecium of special types of flowers

FBOT3L06 : PRACTICALS OF PLANT RESOURCES, ANGIOSPERM TAXONOMY, BIOTECHNOLOGY AND BIOINFORMATICS

[1.5+0.5+1+1=4 hours per week]

TAXONOMY [1.5 hour per week]

1. Study of two members each of following for their diagnostic features

Magnoliaceae	Boraginaceae
Ranunculaceae	Convolvulaceae
Menispermaceae	Sceophulariaceae
Nymphaeceae	Pedaliaceae
Plygalaceae	Verbenaceae
Caryophyllaceae	Nyctaginaceae
Clusiaceae	Euphorbiaceae
Sterculiaceae	Urticaceae
Meliacee	Casuarinaceae
Sapindaceae	Orchidaceae
Rosaceae	Zingiberaceae
Melastomaceae	Amryllidaceae
Rhizophoracee	Commelinaceae
Aizoaceae	Araceae
Rubiaceae	Cyperaceae
Sapotaceae	Poaceae
Gentianaceae	

2. Familiarization with local flora and construction of keys. Use of floras in identification up to species.
3. Dissection of at least two members of each family, making suitable sketches, formulating floral diagram and floral formula and describing them in technical terms and identifying them
4. Field study of five days (minimum three days in a locality of different ecological status) under the supervision of teachers and the submission of a field study report. Each student shall collect plants and prepare herbarium sheets in the standard procedure. The student

should submit a well indexed herbarium of not less than 50 sheets along with the field book at the time of examination.

5. Problems in bar coding

Plant Resources [0.5 hours per week]

The students should study the types mentioned in the syllabus viz. the common name, botanical name, family, morphology of the useful part and the uses. All these aspects should be recorded in a tabular form.

Biotechnology [1 hours per week]

A. Tissue culture

1. Preparation and sterilization of culture media
2. *In vitro* culturing of a suitable tissue
3. Estimation of cell growth in callus - fresh weight / dry weight method
4. Induction of multiple shoots using axillary and apical meristems as explants
5. Plant regeneration from callus

B. Genetic Engineering

Isolation of DNA

BIOINFORMATICS [1 hour per week]

1. Acquiring basic skill in web browsing and the use of software for word processing, spread sheet, presentation, image processing, page making etc using either Microsoft Office or free software such as Linux, Ubuntu etc.
2. Uses of statistical packages such as SPSS, Biostat, Origin etc.
3. Browsing of biological and bioinformatics websites of biological databases included in the theory syllabus - NCBI, SWISS PROT, PIR, PDB etc.

SEMESTER-IV

ELECTIVES

FBOT4E01: BIOTECHNOLOGY IN CROP IMPROVEMENT

[6 hours/week]

COs	COURSE OUTCOMES
CO1	Develop advanced understanding of various concepts in Plant Biotechnology
CO2	Provide insights on the applications of Biotechnology in crop improvement.
CO3	Develop hands-on skills in various Biotechnological applications for the development of crop varieties

1. **Introduction**:- History and present status of plant biotechnology in Indian and global context
2. **Crop Genetic resources**:- Definition - Components of crop genetic resources - Classification of crop genetic resources - Crop genetic resource activities:- Exploration, Conservation, Evaluation, Documentation and Utilization - Agencies involved in crop genetic resource activities:- IPGRI and NBPGR - Role of Biotechnology in conservation of crop genetic resources.
3. **ICAR & CSIR**:- Organizational setup - Research activities - Achievements.
4. **Plant type concept**:- Introduction - Steps in designing and breeding of model plant types - Example:- Wheat.
5. **Plant cell culture as an *in vitro* system for crop improvement**:- Cell culture systems - Cell plating and cell line selection - Incorporation of desirable agronomic traits such as salt tolerance, drought tolerance, disease resistance herbicide tolerance etc. Somaclonal variation and its significance
6. **Protoplasts in gene transfer system**:- Methods of isolation, culture and fusion of protoplasts - Selection of heterokaryons - Somatic hybrids and cybrids -
7. **Haploids in crop improvements**:- Anther, pollen and ovary culture for production of haploid plants and homozygous lines.
8. **Micropropagation**:- Fundamental and applied aspects of the methodology - Operation of commercial units in Indian and global context - Advantages and disadvantages.
9. **Immobolization technique**:- Definition and concept of immobilization - Enzyme and plant cell immobilization - Adsorption, cross linking, ionic bonding, entrapment - Advantages and disadvantages - Industrial applications of the technique.

10. **Post-harvest protection**:- Extending shelf life of fruits and flowers and post-harvest protection of cereals, millets and pulses using appropriate techniques.
11. **Bioreactor technology**:- Large scale production of commercially important compound using plant cells and hairy roots culture - Types of bioreactors: Stirred tank bioreactors, air lift bioreactors bubble column reactors etc. - Operational procedures and optimization of culture conditions.
12. **Application of biotechnology**:- Improvement of crop plants aimed at enhanced nutritional components such as carbohydrates, protein, fats etc., Improved growth rate and yield of wood in forest trees - Incorporation of stress tolerance: drought, salinity and frost tolerance.
13. **Modern concepts in crop improvement**:- (a)Decentralized participatory plant breeding:- Concept - Scientific basis - Advantages and disadvantages (b) Organic plant breeding:- Concept, Principles and need of organic plant breeding.
14. **Molecular plant breeding**:- Concept of markers - Marker assisted breeding - Types of markers:- Morphological markers, Enzyme based markers (Protein markers) & DNA based markers.
15. **Release and multiplication of varieties**:- Procedure of variety release - Production of improved seeds - Classes of seeds - The India Seed Act(1966) - Seed certification.
16. **Intellectual property rights**:- Definition - Introduction to IPR - Forms of intellectual property right:- (a)Copy right (b) Trade mark (c) Industrial designs (d) Layout design if IC (e) Geographical indication (f) Trade secrets (g) Patents:- Objectives of patent system - Conditions for patentability - History and evolution of patent laws in India - Patent Act (1970) and important amendments - Patent information and services by the patent office - Publications of the patent office - Types of patent application - Patent procedures - Precautions in filing patent application - Renewal of patents - Infringement problems - Harmonization of patent laws - Patent cooperation treaty.
17. **Intellectual property right over living organisms**:- Patenting of biotechnological innovations - Legal protection for microorganisms - Patenting of plants and animals - IPR in relation to crop improvement:- PPVFR - IPR on biological diversity - ICAR guidelines on IPR management.

18. **Globalization and Indian Agriculture**:- Plant variety protection - UPOV:- Organization and features - Functions.

BIOTECHNOLOGY IN CROP IMPROVEMENT-PRACTICALS

1. Determination of seed vigour and viability using **(a)** Paper piercing test **(b)** GADA test **(c)** Tetrazolium test **(d)** Seedling growth rate and seedling dry weight test **(e)** Germination test.
2. Determination of pollen viability using **(a)** *In vitro* germination test **(b)** *In vivo* germination and pollen tube growth test **(c)** Tetrazolium test.
3. Isolation of protoplast from cell cultures.
4. Determination of viability of cell cultures using dye exclusion method
5. Initiation of hairy root cultures using *Agrobacterium rhizogenes*.
6. Anther and pollen culture of *Datura* species.
7. Visit to any one institute carrying out crop improvement programmes and submission of the tour report.

References

Acquaah, G. (2007) Principles of Plant Genetics and Breeding. Blackwell Publishing House, USA

Allard, R.W (1960) Principles of plant breeding. John wiely and Sons, New York.

Briggs, F.N. and Knowles, P.F. (1967) Introduction to Plant Breeding. Reinhold Publishing Corporation, New York.

Chahal, G.S. and Gosal, S.S. (1994) Principles and procedure of plant breeding. Narosa publishing house, New Delhi.

Chopra, V.L. (1989) Plant Breeding. Oxford & IBH Publishing Company, New Delhi.

Chrispeels, M.J. and Sadava, D.E. (1994) Plants, Genes and Agriculture. Jones and Barlet publishers, Boston, USA.

Deberg, and Zimmerman (1997) Micropropagation - Technology and application. Kluwer Academic Publishers.

Ganguli, P. (1998) Gearing up for patents – The Indian scenario. Universities Press (India) Limited, Hyderabad.

Intellectual Property Laws (2011) Universal Law Publishing Company, New Delhi.

Kumar U 2000 Synthetic Seeds for commercial crop production Agrobios (India)

Misawa M. 1997 Plant tissue culture: an alternative for production of useful metabolites FAO Agricultural Service Bulletin Daya Publishing House New Delhi

Prakash J and Pierick RLM 1996 Plant Biotechnology: Commercial prospects and problems Oxford IBH New Delhi

Ramawat K. G. and Merillon J. M. 2000 Biotechnology Secondary Metabolites oxford and IBH Publishing New Delhi Calcutta

FBOT4E02 : ADVANCED ANGIOSPERM TAXONOMY

[6 hours/week)

COs	COURSE OUTCOMES
CO1	Develop advanced understanding on the history, importance, methods, and recent advancements in the area of Plant Taxonomy
CO2	Systematic elucidation of the characteristics of selected families cited in the syllabus with ecological / economic significance and interrelationships
CO3	Develop skills in the collection, processing and systematic elucidation of plant specimens, following standard procedures
CO4	Develop skills and abilities in undertaking tissue culture protocols
CO5	Acquire skills in floristic expeditions of areas having ecological significance

1. **Need and importance of taxonomy.** Aspects of taxonomy (identification, nomenclature, classification, systematics, molecular systematics, phases of taxonomy (exploration, consolidation, experiment or biosystematics, encyclopedic or holotaxonorny),
2. **Plant identification:** Methods, taxonomic keys- dichotomous (indented, bracketed), polyclave.
3. **Plant nomenclature**; ICBN- brief history, St. Louis Code (outline, principles, rules and recommendations, provisions for the governance of the code).
4. **History and systems of plant classification**:
   a. Ancient Greeks, Middle ages, Herbalists, Pre and Post Linnaean. Evolutionary and Phylogenetic systems
   b.Types of classification; systems developed by Bessy, Engler, Hutchinson, Cronquist.
5. **Botanical garden**: role, special types. Major botanical gardens of the world and India.
6. **Taxonomy as a synthetic subject:** taxonomy in relation to morphology, cytology, palynology, phytochemistry and serology
7. **Numerical taxonomy:** Principles, steps for the construction of taxonomic groups. Merits and demerits.
8. **Phonetic methods**: Brief study of the following: phonetic method, phyletic method. Floral imaging (digital photography).
9. **Phylogeny of angiosperms:** Evolutionary trends; transitional- combinational theory./'
10. **Electronic herbarium** and digital database preparation (DELTA).
11. . Geographical distribution of plant families, endemic families, dispersal of plants.,
12. Contributions of van Rheede, J D Hooker, Willam Roxburgh, Nathaniel Wallich, Richard Henry Beddome, E K Janaki Ammal, K M Mathew, Cecil J Saldanha, V V Sivarajan.

13. Study of the following families in detail giving importance to morphology of the modified parts, economic importance, interrelationships and evolutionary trends: Magnoliaceae, Cruciferae, Caryophyllaceae, Dipterocarpaceae, Tiliaceae, Malphigiaceae, Celastraceae, Rhamnaceae, Muringaceae, Droseraceae, Rhizophoraceae, Begoniaceae, Plumbaginaceae, Ebenaceae, Oleaceae, Lentibulariaceae, Bignoniaceae, Polygonaceae, Aristolochiaceae, Piperaceae, Loranthaceae, Dioscoriaceae, Pandanaceae, Typhaceae and Eriocaulaceae

ADVANCED ANGIOSPERM TAXONOMY-PRACTICALS

I. Preparation of checklist of a particular area.

2. Phenology of at least 10 species.

3. Programming DELTA of at least 20 species with images. 4. Study of at least two plants each of the above listed families.

5.Preparation of key to at least 10 species of any families studied in PG core course.,

6. Preparation of 50 herbarium sheets of plants of the above families.

7. Study tour to a forest or any other special ecosystem in South india and submission of tour report.

References

1. Singh Gurcharan. Plant Systematics. Oxford IBH.
2. Mondal A.K. Advanced Plant Taxonomy. Central Book Agency, Kolkatta. Sivarajan
3. V.V. and Robinson. Introduction to.the Principles of Plant Taxonomy. Oxford IBJ:I.
4. Greuter W. et. al. International Code of Botanical Nomenclature. st. LoUIS Code. Koeltz Scientific Books
5. Jain S.K. and Rao R.R. A hand book of Field and Herbarium Methods, Today & Tomorrow rJrblications, New Delhi.
6. Cronquist A. Evolution and Classification of Flowering Plants. New York Botanic Gardens, ronx, New York.
7. David P.H. and Heywood P.H. Principles of Angiosperm Taxonomy. Oliver & Boys, London. I Good R. The Geography of Flowering Plants. Longman, London.
8. Hutchinson J. Genera of Flowering Plants. Cambridge University Press, London.
9. Mayr E. This is Biology. University Press, Hyderabad.
10. Naik V.N. Taxonomy of Angiosperms. Tata Me Graw Hill, New Delhi. Mabberley DJ. The Plant Book. Cambridge University Press, London.

FBOT4E03: ENVIRONMENTAL BIOLOGY AND BIODIVERSITY CONSERVATION

[6 hours/week)

COs	COURSE OUTCOMES
CO1	Develop advanced understanding of various concepts and principles in Ecology and Environmental Biology
CO2	Provide insights on existing Environmental Challenges and analyze their future impacts due to increasing anthropogenic interferences
CO3	Enable students to acquire knowledge and analyze unique habitats with regard to their environmental settings, processes and threats
CO4	Develop hands-on skills to study environmental samples like soil and water and thereby its qualitative elucidation

1. **Population ecology:** Properties (concepts of rate, intrinsic rate of natural increase, carrying capacity, population fluctuations and cyclic oscillations, density independent and density dependent mechanisms of population regulation, patterns of dispersion, Allee principle of aggregation and refuging, home range and territoriality, energy partitioning and optimization, and K selection.
2. **Community ecology:** Types of interaction between two species, co-evolution, evolution of cooperation, group selection, inter specific competition and coexistence, positive and negative interactions, concepts of habitat, ecological niche and guild.
3. **Human population**: Expansion and its causes, rich and poor nations, consequences, dynamics, Cairo conference 1994.
4. **Major global environmental challenges:** Acid rain, Ozone depletion, climate disruption, deforestation, land degradation and desertification, freshwater degradation and shortage, marine fisheries decline, loss of biological diversity and excess nitrogen,
5. **Global initiatives**: Stockholm conference (1972), Rio (1992), Ramsar convention (1971), Kyoto (1997), lohannesburg 1(2002), Stockholm (2011).
6. **Environmental Law**- International and National: The Environment Protection Act & Rules 1986; Water (Prevention &Control of Pollution) Act 1974; Biodiversity Act (2002).
7. **Thoughts on ecology:** Contributions of Buddha, Rabindranatha Tagore, Mahatma Gandhi, Rachel Carson, Gro Herlem Brundpand, Vandana Siva, Edward O Wilson, Aldo Leopald.
8. **Biodiversity**: a). Genetic diversity, agrobiodiversity and cultivated taxa, causes of decline, value of wild species, conservation practices- traditional (upavana vinoda, sacred groves,

sthalavrikshas and modern (*in situ* and *ex situ*). b). Biodiversity information management and communication- libraries, databases.ttaxonomic database working groups for plant scienfic, data bases on biodiversity); distribution of biodiversity information, metadatabases, virtual libraries.

9. **Ecosystem capital-** use and restoration: Global perspective on biological systems; conservation, preservation and restoration. Biomes and ecosystems under pressure (forest biomes, ocean ecosystems).
10. **Habitat studies:** Wetlands (Ramsarsites),mangroves and forest types of Kerala.
11. **Brief study** of the following: Cybernetics, ecological foot print, sustainable development, deep ecology, Gaia hypothesis, conservation ethics, peoples' movements for biodiversity conservation, role of NGOs and educational institutions in biodiversity conservation, trade related IPR, ecotourism.
12. **Climate change** and its impacts- brief study.
13. **Disaster management**- basic aspects. ,

ENVIRONMENTAL BIOLOGY AND BIODIVERSITY CONSERVATION-PRACTICALS

1. Studies on the following and submission of reports: Waste water treatment plant, local environmental peculiarities (such as hillocks and forest patches), wet land ecosystem, alien invasive plants, degraded ecosystem, different forest types, effluent treatment system).
2. Physical and chemical analysis of soil and water: Particle size analysis of soil, estimation of particle density using relative density or volumetric flask; Air capacity analysis of soil by field method; Soil pH analysis of soil using pH meter. Water analysis for pH using pH meter, estimation of BOD by Winkler's method (dark and light bottles).
3. Study of community structure: Charting and mapping of vegetation, Raunkiaer's life forms, biological spectrum, profile diagram (soil).
4. Study of ecological succession: Different types of ecological successions.

References

1. Champion H.G. and Seth S.K. A Revised Classification of Forest Types of India. Govt. of India, New Delhi.
2. Gadgil Madhav. Ecological Journeys. Permanent Black, Delhi.
3. Jaiswal P.C. Soil Plant and Water Analysis. Kalyani Publishers, Ludhiana.

4. KrishnamurthyIK.V. An Advanced Text Book on Biodiversity Principles and Practice. Oxford IBH. Misra R. Ecology Workbook. Oxford IBH.
5. Odum E.P. and Barrett G. W. Fundamentals of Ecology. Thomson Books, Bangalore.
6. Palmer J.A. Fifty Thinkers on the Environment. Routledge, London.
7. Puri G.S. Indian Forest Ecology. Oxford IBH.
8. Pushpangadan P. and Nair K.S.S. Biodiversity and Tropical Forests- The Kerala Scenario. STEC, Thiruvananthapuram.
9. Sarngdharacharyar. (Translated by Vishnu B.). Vruksha Ayurvedam lanapriya Pusthakasala, Kottayam.
10. Speth Gustave James and Haas M. Peter. Global Environmental Governance. Pearson Longman, New Delhi.
11. Vijayalakshmi K . and Shyam Sundar K.M. Vrkshayurveda- An Introduction Indian Plan Science. Lok Swasthya Parampara Samardhan Samithi, Madras.

FBOT4E04: MOLECULAR BIOLOGY AND PHYTOCHEMISTRY

[6 hours/week]

COs	COURSE OUTCOMES
CO1	Develop advanced understanding of plant cell and cell organelles.
CO2	Develop advance understanding of various processes associated with the cells in a molecular basis.
CO3	Provide insights on various techniques used in plant molecular biology.
CO4	Develop skills in various processes and techniques in cell and molecular biology

Molecular Biology

1. **Plant genome organization and structure:** Nuclear genome organization, repetitive DNA. Organization of single copy genes in plants. Gene expression in plants.

2. **Gene expression in plants:** Regulation of plant tissue differentiation. Genetics of totipotency. RNA interference – miRNA regulation in plants. Expression of telomerase in plants. Riboswitch regulation in plants.

3. **Molecular genetics of photosynthesis:** organization, replication and expression of chloroplast DNA. Light regulation of nuclear encoded thylakoid proteins. Role of nuclear genes and chloroplast genes in photosynthesis.

4. **Molecular aspects of incompatibility**: Molecular diversity of self incompatibility Systems. Cell signaling and pollen recognition.

5. **Transposons** in plants: Classification. Major plant transposons. Mechanism of transposition. Plant retrotransposons and centromere. Transposons and genome evolution in plants.

Phytochemistry

1. **Introduction to Phytochemistry**: Primary and Secondary metabolites, Alkaloids, phenolics, flavonoids. Vitamin supplements, Essential oils and fatty acids, dietary fibers, Antioxidants, nutraceuticals.

2. **Phytochemical techniques**: Extraction method, different types of extraction, factors affecting the extraction, Preliminary phytochemical analysis, distillation of volatile oils, super critical extraction, extraction methods for alkaloids, phenolics and terpenoids.

3. **Chromatography:** Principles, Type – paper chromatography, thin layer chromatography, ion exchange chromatography, column chromatography, High Performance Liquid Chromatography (HPLC), Gas -liquid chromatography.

4. **Centrifugation**: Principle, types of centrifuges, Principles and applications of analytical and preparative centrifuges, density gradient and ultra centrifugation. Sub cellular fractionation of cellular components.

5. C**olorimetry and spectroscopy**: Colour and absorption spectra, Beer's law and Lambert's law, Spectroscopy – Properties of electromagnetic radiations, Instrumentation and applications of – UV Visible light spectroscopy, Infrared spectroscopy, Basic principle of NMR spectroscopy.

MOLECULAR BIOLOGY AND PHYTOCHEMISTRY-PRACTICAL

Molecular Biology

1. Spectrophotometer
2. DNA isolation (plant tissues)

Phytochemistry

1. Isolation and estimation of starch from potato (Anthrone method)
2. Estimation of total phenolics in plant extracts (Folin Ciocalteu Method)
3. TLC analysis of plant various plant extracts
4. Preliminary phytochemical Screening of plant extracts

References

1. Alberts B., Johnson A., Lewis J. Molecular Biology of the cell. NCBI.
2. Willard, Merrit, Dean and Seattle. Instrumental Methods of Analysis. CBS Publishers.
3. Phytochemistry-Volume I to IV, by Miller Jan,Nostrant Renhold
4. Sharma, B.K.2004. Instrumental Methods of Chemical Analysis, 24th Edition, Goel Publishing House, Meerut
5. Vinod D. Rangari Pharmacognosy and Phytochemistry. Part I and II

   Recent Advances in Phytochemistry-Volume I and IV , Scikel Remeckles Appleton century Crofts
6. Harborne JB, Phytochemical methods: A Guide to Modern techniques of plants Analysis. Chapman and Hall London, UK. 1998.

AUDIT COURSES

Audit Courses {To be completed within the first two semesters by the students- Evaluation is 100% internal based on Examination /Test (40%) + Seminar / Presentation (30%) + written assignment (30%)**}**

FBOT1A01: Ability Enhancement Course: Scientific Documentation and Report writing

COs	COURSE OUTCOMES
CO1	Provide insights on data collection, organizing research schedules, collection of databases and its interpretation, scientific writing and presentation of research findings on various platforms

- Collection of scientific literature from secondary and primary sources.
- Preparation of literature reviews and review papers- structure and components
- Preparation of research papers- structure and components
- Scientific conduct, ethics, authorship issues, plagiarism, citation and acknowledgement. Importance of language and effective communication.
- Presenting a paper in a scientific seminar- oral and poster presentation
- Preparation of oral presentations
- Preparation of scientific posters

FBOT2A02: Professional Competency Course: Intellectual Property Rights

COs	COURSE OUTCOMES
CO1	Develop understanding of various legal provisions for safeguarding intellectual contributions from getting misused / exploited

- Introduction to intellectual property right (IPR)- Concept and kinds. Economic importance. IPR in India and world. IPR and WTO (TRIPS, WIPO).
- Patents- Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents- Working of patents. Infringement.

- Copyrights- Introduction. Works protected under copyright law. Transfer of Copyright. Infringement. Trademarks- Objectives, Types, Rights. Protection of goodwill. Infringement.
- Geographical Indications- Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian position.
- Protection of Traditional Knowledge- Objective, Concept, Holders, Issues concerning, Bio-Prospecting and Bio-Piracy, Alternative ways, Protectability, Traditional knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library.
- Protection of Plant Varieties- Plant Varieties Protection-Objectives, Justification, International Position, Plant varieties protection in India. Rights of farmers, Breeders and Researchers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.
- Biotechnology and Intellectual Property Rights- Patenting Biotech Inventions: Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting Biotechnological inventions.