KUVEMPU UNIVERSITY

M.Sc. BOTANY

PROGRAMME (CBCS)

CHOICE BASED CREDIT SYSTEM

Course Curriculum and Scheme of Evaluation

2025-26

DEPARTMENT OF STUDIES AND RESEARCH IN

APPLIED BOTANY

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KUVEMPU  UNIVERSITY

M.Sc. BOTANY

PROGRAMME (CBCS)

Admission

The norms of admission as per the existing university regulations will be followed.

Duration of the Course: Four semesters (2 years)

Number of courses and credits

I Semester with 3 hardcore papers, II, III and IV semesters with two Hard Core and one Soft Core paper (three theory and three laboratory exercises), each with 4 credits. Second and III semester with one elective paper which is interdisciplinary in nature. In IV semester 2 Hard Core papers are offered with 8 credits and one project with dissertation with 4 credits, having viva voce examination. Three soft skill papers on communication and language skills with 3 credits each also offered.

Selection of subject for dissertation: A topic is to be selected by each student for dissertation based on the facilities available and the specializations of the supervising teachers.

Evaluation: Evaluation is to be carried out by internal continuous and terminal. Out of the total weightage for each course, 25 marks are to be given for internal continuous evaluation and 75 for semester end examination.

1. Internal continuous evaluation

Internal evaluation will be carried out by the teacher/ teachers offering the course. The marks will be displayed on the notice board of the department and the students shall be given a chance to redress grievances if any. Internal assessment will be calculated based on their performance in attendance, assignments, tests, seminars, regularity, involvement and dissertation work.

2. External terminal Evaluation

At the end of each semester, there will be external evaluation for each course. The pattern of theory question paper will be as per the general regulations of CBCS scheme. The pattern of practical question papers will be finalized by the concerned board of examiners. The answer scripts of each theory course will be valued by one member of the board of examiners constituted by the university for the purpose. The practical examination will be conducted by two members each of the board of examiners constituted by the university. Each dissertation will be valued by two examiners. The candidates will be presenting the salient features of their work and dissertation by way of power point presentation. One improvement chance will be given to the candidate in the case of each test. Theory examinations will be of 3 hours duration and practical examination of 3 hours duration with a break in between. The students will have to submit their practical records on the day of the practical examination.

Pass and overall grade: Pass and overall grade will be as per the general regulation of CBCS.

KUVEMPU UNIVERSITY

M. Sc. BOTANY Course Syllabus

Department of Applied Botany,

CHOICE BASED CREDIT SYSTEM (CBCS)

Semester-I

Course structure and scheme of Examination

Paper Code No	Titles of Theory Paper	Total Credits per week	Theory Examination marks	Internal Assessment marks	Total marks
BO1.1 Hard Core-1	Phycology and Mycology	04	75	25	100
BO1.2 Hard Core-2	Biology of Bryophytes, Pteridophytes and Gymnosperms	04	75	25	100
BO1.3 Hard Core-3	Plant Taxonomy , Phytogeography and Evolutionary Biology	04	75	25	100
BO1.4 Soft Core.1	Palaeobotany and Palynology	04	75	25	100
BO1.5 Soft Core-2	Bio fertilizers	04	75	25	100
BO1.6 Practical:HC-1	Phycology and Mycology	02	-	-	50
BO1.7 Practical:HC-2	Biology of Bryophytes, Pteridophytes and Gymnosperms	02	-	-	50
BO1.8 Practical:HC-3	Plant Taxonomy Phytogeography and Evolutionary Biology	02	-	-	50
BO1.9 Practical: SC.1	Palaeobotany and Palynology	02	-	-	50
BO1.10 Practical: SC.2	Bio-fertilizers	02	-	-	50
	Total marks for Theory Total Practical marks (I Sem) Grand Total marks for I Semester				400 200 600

Note: 1. HC-Hard Core paper, SC –Soft Core paper

2. Students shall choose on soft core paper

Semester-II

Paper Code No	Titles of Theory Paper	Total Credits per week	Theory Examination marks	Internal Assessment marks	Total marks
BO2.1 Hard Core-1	Plant Ecology and Environmental biology	04	75	25	100
BO2.2 Hard Core-2	Cell Biology, Genetics and Plant breeding	04	75	25	100
BO 2.3 Soft Core-1	Techniques in Plant Biology	04	75	25	100
BO 2.4 Soft Core-2	Plant Pathology	04	75	25	100
BO 2.5 Practical:HC.1	Plant Ecology and Environmental biology	02	-	-	50
BO 2.6 Practical:HC.2	Cell Biology, Genetics and Plant breeding	02	-	-	50
BO 2.7 Practical:SC.1	Techniques in Plant Biology	02	-	-	50
BO 2.8 Practical:SC.2	Plant Pathology	02	-	-	50
	Inter Disciplinary Elective(IDE) *				
BO.2.9	Floriculture	02	40	10	50
	Total marks for Theory				300
	Total Practical marks (II Sem)				150
	Grand Total marks for II Semester				500

1. Students shall choose on soft core paper

* Shall be chosen by other department students.

Semester-III

Paper Code No	Titles of Theory Paper	Total Credits per week	Theory Examination marks	Internal Assessment marks	Total marks
BO3.1 Hard Core-1	Plant Morphogenesis and Reproductive biology of Angiosperms	04	75	25	100
BO3.2 Hard Core-2	Plant Physiology and Biochemistry	04	75	25	100
BO3.3 Soft Core-1	Plant Diversity and Human Welfare	04	75	25	100
BO3.4 Soft Core-2	Plant Bio Technology	04	75	25	100
BO3.5 Practical Hard Core-1	Plant Morphogenesis and Reproductive biology of Angiosperms	02	-	-	50
BO3.6 Practical HardCore-2	Plant Physiology and Biochemistry	02	-	-	50
BO3.7 Practical Soft Core-1	Plant Diversity and Human welfare	02	-	-	50
BO3.8 Practical Soft Core-2	Plant Bio technology	02	-	-	50
	Inter Disciplinary Elective*				
BO3.9	Plants for Human Welfare	02	40	10	50
	Total marks for Theory				300
	Total Practical marks (III Sem)				150
	Grand Total for III Semester				500

*** Shall be chosen by other department students.**

Semester-IV

Paper Code No	Titles of Theory Paper	Total Credits per week	Theory Examination marks	Internal Assessment marks	Total marks
BO4.1 Hard Core-1	Ethnobotany, Medicinal plants, and Plant Resource conservation.	04	75	25	100
BO4.2 Hard Core-2	Molecular Biology and Genetic Engineering of plants.	04	75	25	100
BO4.3 Practical Hard Core-1	Ethnobotany, Medicinal plants, and Plant Resource conservation.	02	-	-	50
BO4.4 Hard Core-2	Molecular Biology and Genetic Engineering of plants.	02	-	-	50
BO4.5 Project Work	Dissertation	04	75	25	100
	Total marks for Theory Total marks for Practical Total marks for Project				200 100 100
	Grand Total marks for IV Semester				400

Total marks and credits semester wise:

Sl.No.	Semester	Total Marks	Total Credits
1	Total of I Semester	600	26
2	Total of II Semester	500	22
3	Total of III Semester	500	22
4	Total of IV Semester	400	12
5	Grand Total marks	2000	82

MASTER OF SCIENCE IN BOTANY

Semester I

Course Code: BO1.1 Hard Core-1

Phycology and Mycology

Marks: 150 (Theory final exam 75 + internal assessment 25 + Practical exam 50) Duration: 64 Hours.
Teaching hours: 16 Lectures/Unit

Course Objectives:

This course aims to introduce the students to understand the lower plant diversity and range of their thallus organization and reproduction and also to understand their role in ecosystem,genetic and cultural diversity, uses and their conservation.

Course learning outcomes:

The students will be learning

1. Classification of algae and fungi
2. Morphology and reproduction of lower plants such as algae, lichens and fungi
3. Variations and comparison among two groups
4. Understand ecology and economic importance of algae and fungi

Unit-1:

Historical perspectives and introduction, Classification of algae: position of algae in two, five, six & eight kingdom classification. **Diversity & Morphology:** cell structure and function, cell wall composition, Chemical nature of stored food, thallus organization and reproduction, Structure of flagella & flagellar roots, pattern of mitosis and cytokinesis. **Photosynthesis in algae:** Pigment Diversity, Efficient Light Trapping, occurrence of photosynthesis at varied location in chloroplast.

Unit-2:

Systematics of algae: subgroups & their interrelationships. **Structure and life cycle of different groups of algae:** cyanophyta, glaucophyta, rhodophyta, heterokontophyta, chlorarachniophyta, chlorophyta, chrysophyceae, parmophyceae, xanthophyceae, bacillariophyceae, raphidophyceae, dictyophyceae and phaeophyceae. **Economic, Ecological & Biotechnological importance of algae:** Algae as experimental system & as a source of colloidal polysaccharides, Nitrogenous compounds, Pharmaceuticals & nutraceuticals, biotechnological potential of symbiotic algae, genetic modification of algae, algae as efficient CO_2 fixers, algae for bioremediation & as bio-fertilizers.

Unit-3:

Position of fungi and modern systematics: Modern approaches towards classification of fungi, ultrastructural features of fungal cell wall, biochemical composition, tissue organization, modification of fungal hyphae and cell division.

Phylogeny & Diversity: General account & life cycle of major fungal groups- **Mastigomycotina:** A comprehensive knowledge with emphasis on occurrence of sex hormones and sporangia to conidia transition. **Ascomycotina:** A comprehensive knowledge with emphasis on types of ascocarps and methods of spore dispersal. **Basidiomycotina:** A comprehensive knowledge with emphasis on fruiting structures and methods of spore dispersal. **Deuteromycotina:** A general account with emphasis on sporulating structures with special reference to conidial ontogeny.

Unit-4:

Life cycle and basic pattern of sexuality in fungi: Sexual mechanism in different groups of fungi. Concept of parasexual cycle. **Fungal symbionts:** Concepts and applications of mycorrhizae. Beneficial uses of fungi in industrial production of alcohol and penicillin. **Edible mushrooms:** Cultivation technology, nutritional and medicinal properties of mushrooms. **Lichen:** Phycobiont and Mycobiont relationship, histology, biology and physiology of lichen thallus, and economic importance of lichens.

Suggested Laboratory Exercises:

Phycology:

1. Range of vegetative organization in algae with suitable examples.
2. Range of vegetative organization in cyanobacteria with examples.
3. Reproductive bodies of cyanobacteria.
4. Different types of asexual reproduction in algae.
5. Different types of sexual reproduction in algae.
6. Study on freshwater, marine and benthic planktons.
7. Collection & identification of different algal species from water, soil and other substratum's.
8. Separation of different pigments from collected algal samples.

Mycology:

1. Preparation of PDA, sterilization, inoculation and culturing of fungi.
2. Study on pure culture -identification of fungi based on conidia & mycelial morphology.
3. Study on asexual and sexual fungal fruiting bodies.
4. Study of fungal spore dispersal mechanism.
5. Study of VAM from root and soil samples.
6. Isolation of rhizosphere and rhizoplane fungi.
7. Isolation of cellulose and lignin degrading fungi from soils.
8. Isolation of fungi from pesticide contaminated soils.
9. Isolation of fungi from serial dilution technique.
10. Study on lichens and its mycorrhizal relationship with fungi.
11. Models / Charts / Photographs related to phycology and mycology.
12. Any other experiments related to phycology and mycology not listed here.

Suggested Readings:

1. Chase, M.W. and Reveal, J.L. 2009. A phylogenetic classification of the land plants to accompany APG III. Botanical Journal of the Linnean Society, 161: 122-127.
2. Kumar, H. D. 1984, Algal Cell Biology, East West Private Ltd., India
3. Smith, G. M. 1951, Manual of Phycology, Chronica Botanica, Publishers, Waltham, Mass.
4. Murthy, A.V.S.S. 2005. A text book of algae. IK International Pvt., Ltd., New Delhi.
5. Alexopoulos, C.J. Mims, C.W. and Blackwell, M. 2013. Introductory Mycology 4th edn. Wiley.
6. Robert E L. 2022. Text book of phycology. 5th ed. Cambridge University Press.
7. Supriya D. W. & Smita T. 2023. A Textbook of Botany: Microbiology, Phycology, Mycology, and Fungal Technology, Academic Guru Publishing House.
8. Paul Y S. 2026. Textbook of Mycology and Plant Pathology. Kalyani Publishers.
9. Laura Ramos-Sepulveda. 2025. Mycology Laboratory Manual. The Pennsylvania Alliance for Design of Open Textbooks.

Dept. of Applied Botany, Kuvempu University

Semester I

Course Code: BO1.2 HardCore-2

Biology of Bryophytes, Pteridophytes and Gymnosperms

Marks: 150 (Theory final exam 75 + internal assessment 25 + Practical exam 50) Duration: 64 Hours.
Teaching hours: 16 Lectures/Unit

Course Objectives:

This course aims to introduce to students to understand the lower plant diversity and range of their thallus organization and reproduction and also to understand their role in ecosystem, genetic and cultural diversity, uses and their conservation.

Course Learning Outcomes:

The students will be learning

1. Classification of Bryophytes, Pteridophytes and Gymnosperms
2. Morphology and reproduction of lower plants.
3. Variations and comparison among three groups.
4. Understand ecology and economic importance of these plant groups.

Course contents

Unit-1 :

Bryophytes: characters and classification, structural organization of gametophytes and sporophytes, thallus organization and reproductive features, morphology, anatomy, life cycle of Sphaerocarpus (Sphaerocarales), Marchantia (Marchantiales), Porella (Jungarmaniales), Anthoceros (Anthocerotales), Sphagnum (Sphagnales), Andrea (Andreales), Funaria (Funariales) and Polytrichum (Polytrichales).Evolution and affinities of the bryophytes, fossil bryophytes, origin of bryophytes, ecology and cytological aspects of bryophytes, bryophytes as the indicators of water and air pollution.

Unit-2 :

Pteridophytes: characteristics and classification, morphology, anatomy and reproduction in *Psilotum, Selaginella, Equisetum, Lycopodium, Pteridium* and *Salvinia*. origin of Pteridophytes, evolution of the pteridophyte taxa, fossil pteridophytes,Stelar evolution in pteridophytes, heterospory and seed habit.

Unit-3:

Economic importance of pteridophytes, rare, endangered and endemic pteridophytes with reference to India. *in situ* and *ex situ* conservation, horticultural importance of pteridophytes, problems of aquatic and terrestrial pteridophytes as weed to the ecosystem, medicinal and edible pteridophytes, *Azolla* as a biofertilizers, pteridophytes are as ecological indicators.

Unit-4 :

Gymnosperms: characteristics and classification, morphology, anatomy and reproduction in *Cycas, Pinus, Araucaria, Ginkgo, Ephedra* and *Gnetum*. General account on Pteridopsermopsida, Cycadofilicales, Glosso-pteridales and Caytoniales, economic importance of gymnosperms, affinities of gymnosperms to angiosperms with reference to Gnetum.

Suggested Laboratory Exercises

Bryophytes

1. Vegetative organization and morphology.
2. Anatomical structures.
3. Archegonia, antheridia and their organization.
4. Sporophytes of Bryophytes – A Comparative Study.

Pteridophytes

5. Structure of plant body (habit).
6. Anatomical organization of different parts of the plants.
7. Sporangia and their types.
8. Spores, structure, size and ornamentation.
9. Fossil pteridophytes.

Gymnosperms

10. Morphology and Anatomical Features.
11. Male and Female Reproductive Bodies / Organs/ Seeds.
12. Fossil Gymnosperms.
13. Models / Charts / Photographs related to this paper.
14. Any other experiments related to this paper not listed here.

Suggested Readings

1. Campbell, H.D. The Evolution of Land Plants. (Embryophyta).
2. Champman, V.J. Sea Weeds and their Uses.Methew and Co., London.
3. Dallimore, W. and Jackson, A.B. 1961. A Handbook of Coniferales and Ginkgoales.
4. Rashid, A. 1998. Introduction to Bryophyta. Vikas Publishing House Pvt., Ltd., New Delhi.
5. Sambamurthy, A.V.S.S. 2005. A Textbook of Bryophyta, Pteridophyta, Gymnosperms and Paleobotany. IK International Pvt., Ltd., New Delhi.
6. Smith, G.M. Cryptogamic Botany. Vol. I, McGraw Hill Book Company, New Delhi.
7. Sundarlingam, V.S. 1989. Marine Algae ; Morphology, Reproduction and Biology.Bishan Singh, Mahendrapal Singh Dehradun.
8. Trivedi and Pravin Chandra. 2001. Algal Biotechnology. Jaipur Pointer Publishers.
9. Vashista, P. C., et.al. Pteridophyta. 2005. S. Chand and Company, New Delhi.
10. Vashishta, P.C. 2008. Botany for Degree Students: Pteridophyta. S. Chand & Co. Ltd., New Delhi.
11. Sambamurty S. A. 2022. Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany, I.K. International Publishing House Pvt. Limited.
12. Bahoray S.N.2020. Modern textbook of botany: Bryophyta, pteridophyta, gymnosperms, Agra Universal publications.
13. Vipin Chandra and Sanjeev Lal. 2025. A Text Book of Pteridophytes, Gymnosperms and Angiosperms, P.K Publishers and Distributors.

Dept. of Applied Botany, Kuvempu University

Semester I

Course Code: BO1.3 Hard Core -3

Plant Taxonomy, Phytogeography and Evolutionary Biology

Marks: 150 (Theory final exam 75 + internal assessment 25 + Practical exam 50) Duration: 64 Hours.
Teaching hours: 16 Lectures/Unit

Course objectives:

This course aims to introduce the students to the advanced concepts and principles of taxonomy, evolutionary inference of important morphological characters, distribution of plants, important families of flowering plants, their classification and important characters.

Course Learning Outcomes:

The students will be learning

1. Classification of plants based on certain approaches.
2. Principles of nomenclature. How it is governed by the ICN?
3. What important morphological characters delineate flowering plant families and their classification.
4. Distribution patterns of plants.
5. Principles and theories of evolution of land plants.

Course contents:

Unit-1:

Plant Taxonomy: Historical background of plant classification: Major systems of classification: Artificial- Carolus Linnaeus, Natural– deJussieu, de Candolle and Bentham and Hooker; Phylogenetics-Engler and Prantle, Hutchinson, Armen Takhtajan and Cronquist; Angiosperm Phylogeny Group(APG). **Plant Molecular Systematics**: DNA sequence data and its types, Sequence alignment, Phylogenetic analysis - Parsimony, Maximum Likelihood, Bayesian approaches, Neighbor-Joining; DNA barcoding and its practical implications; Taxonomical evidences: Chemotaxonomy, Cyto taxonomy, Numerical taxonomy, palynology and embryological evidences.

Unit-2:

Literature in taxonomy: Classics, taxonomic indexes, floras, manuals, monographs, revisions, catalogues, review serials, periodicals, dictionaries, glossaries, maps, cartography and icons.

Botanical Nomenclature: ICN (ICBN) Principles, Names of taxa, type method, author citation, effective and valid publication, rejection of names, names of hybrids and cultivated plants, IAPT. **Herbarium:** Methods, importance and major herbaria of India and world; Botanical gardens and their importance, Botanical survey of India-its role in exploration of plant diversity.

Unit-3:

Study of the plant families with their phylogeny as per modern classification: Amborellaceae, Magnoliaceae, Ceratophyllaceae, Ranunculaceae, Juglandaceae, Myristicaceae, Apiaceae, Solanaceae, Velloziaceae, Lythraceae, Burseraceae, Loranthaceae, Viscaceae, Podostomaceae, Icacinaceae, Asteraceae, Alismataceae, Orchidaceae, Liliaceae, Zingiberacae, Cyperaceae, Poaceae.

Unit-4:

Phytogeography: Principles and importance, Phytogeographic regions of the world and India, detailed study of Indian vegetation; Plant distribution: Patterns and theories of distribution-Continental drift hypothesis, Factors involved in distribution-endemism, invasion, introduction, plant migration, vicariance and disjunction. **Evolution**: Development of Organic evolution: Direct evidences (Fossils), Indirect evidences (Taxonomy);Origin of plants, The evolutionary time scale: eons, eras, periods, epochs and ages, Major events in the evolutionary time scale; Molecular evolution. Concepts of darwinism and neo-darwinism.

Suggested Laboratory Exercises:

1. Introduction to literature in Plant taxonomy: Floras, Manuals, Monographs, Journals, Review articles.
2. Study of vegetative plant morphology-I: Typical Roots, Stems, and Leaves.
3. Study of vegetative plant morphology- II: Modified Roots, Stems, and Leaves.
4. Study of floral plant morphology –I: Inflorescence types
5. Study of floral plant morphology –II: Fruit types
6. Construction of floral diagrams and floral formulas two plants each from dicot and monocot plants.
7. Collection of plants and learning herbarium techniques.
8. Classification and identification of angiosperm plants which are available from plants from many local families.
9. Identification of plants in field through field experience.
10. Construction of dichotomous keys for identification of plants.
11. Identification of plants through online resources from computerized keys.
12. Critical comment on a research paper for reporting new species by taking a published research article.
13. Distribution of plants: mapping of distributions on world, India, and Karnataka maps.
14. Models / Charts / Photographs related to this paper.
15. Any other experiments related to this paper not listed here.

Suggested Readings

1. Bentham, G. and J.D. Hooker. 1862-83. Genera *Plantarum*. Vol.3. London.
2. Bhattacharya, B. and B.M. Johri. 1998. Flowering Plants-Taxonomy and Phylogeny.Narosa Pub. House, New Delhi. p. 753.
3. Cronquist, A. 1988. The Education and Classification of Flowering Plants. 2nd ed., Botanical Gardens, Bronx, New York.
4. Pulliah, T. 1998. Taxonomy of Angiosperms. Regency Publications, New Delhi.
5. Mondal, A.K. 2009. Advanced Plant Taxonomy. New Central Book Agency Pvt. Ltd., Kolkata, WB.
6. Singh, G. 1999. Plant Systematics : Theory and Practice. Oxford and IBH Co. Pvt. Ltd., New Delhi, Calcutta, pp. 359.
7. Walter S. judd. 2016. Plant systematic- A phylogenetic approach 4th edition. Oxford University press.
8. Bharati B. 2009. Taxonomy of flowering plants. Narosa Publishing House Pvt. Ltd, New Delhi.
9. Gamble G.S. 2013. Flora of the Presidency of Madras, Neeraj Publishing House, Delhi,
10. Pascal B. 2020. Molecular plant taxonomy : method & protocols, Springer.
11. Paria N. D. 2022. Plant taxonomy and biodiversity. Santra publishing pvt.ltd.

Semester-I

Course Code: BO1.4 Soft Core-1

Palaeobotany and Palynology

Marks: 150 (Theory final exam 75 + internal assessment 25 + Practical exam 50) Duration: 64 Hours.
Teaching hours: 16 Lectures/Unit

Course Objectives:

This course aims to introduce the students to study and understand paleobotany and pollen grains of higher plants. Available fossils detail to understand evolution of plants. Morphological variation and characters of pollen grains and importance.

Course Learning Outcomes:

The students will be learning

1. Processes of fossilization in ancient eras.
2. Prebiotic environment and origin of plant groups.
3. Concept of Gondwana land movements and continental drift.
4. Pollen morphology.
5. Uses of pollen grains in taxonomy, fossil fuel, honey and forensic palynological detection.

Course contents:

Unit 1:

History of Paleobotany in India. Contribution of Birbal Sahani to paleobotany, Paleobotany Institute of India. International Code of Botanical Nomenclature (ICBN) with special reference to the nomenclature of fossil plants. **Geological time scale**: fossization and types, carbon dating. **Origin and evolution of early life forms and colonization of land plants**: The prebiotic environments; antiquity of life; first prokaryotes and evolution of eukaryotes; geological records and ecological significance of algae (stromatolites, diatoms, dinoflagellates), fungi (endomycorrhiza, epiphyllous fungi), bryophytes and early ferns (Palaeozoic). Siluro-Devonian land floras; Permo-Carboniferous floral provinces; Devonian and Carboniferous floras of North-West India.

Unit 2:

Concept of Indian Gondwana flora of India: stratigraphy and correlation of Gondwana Sequence in Peninsular Indian basins, mega- and microfloristics of Peninsular Indian Gondwana formations; Indian Perigondwana floras. **Angiosperm paleofloristics**: Distribution of tertiary strata in India. Life as a fuel maker; sources of natural fuels; peat; coal and its varieties, constitution of coal, coal palynology; petroleum, its origin, migration and concentration, palynology in oil exploration. Archaeobotany of Indian cultivated plants.

Unit 3:

Palynology: Stenopalynous and Uripalynous pollen grains, Microspore tetrads and polarity of spores and pollen grains. **Spore-pollen morphology**: Symmetry, shape, size, aperture patterns, NPC System for numerical expression of aperture details, exine stratification, surface structures and sculptures of sporoderm stratification. Chemical nature of sporopollenin, development of pollen wall, pollen units, exine less pollen grains. **Exinous wall material**: perine, viscin-threads. pollen-kitt.

Unit 4:

Melissopalynology: Objectives of melissopalynological studies. Indian species of honey bees, importance of pollen grains as constituent of bee-bread, pollen-collecting mechanism of honey bees and honey sample in understanding bee forage. **Application of palynology**: taxonomic and phylogenetic studies. **Aeropalynology** with reference to aeroallergens, study of airspora, geo palynology, forensic palynology.

Suggested Laboratory Exercises

1. Pollen morphological studies of some pteriodophytes, gymnosperms, and angiosperms representing different morphological types using acetolysis / alkali maceration method.
2. Determination of Pollen viability test using Acetocarmine stain.
3. Extraction of pollen grains from honey sample and study of the frequency of different morpho-types.
4. Identification of Unifloral & Multifloral honey samples based on pollen grains.
5. Analysis of airborne spores by gravity slide/ Rotorod sampler method.
6. Study of *in vivo* and *in vitro* germination of pollen grains.
7. Morpho-anatomical study of stigma and style.
8. Study of the growth of pollen tube through stigma and style.
9. Study of Stenopalynous and Uripalynous pollen grains from plant families.
10. Study of some fossils (slide and megafossils).
11. Models / Charts / Photographs related to paleobotany and palynology.
12. Any other experiments related to paleobotany and palynology not listed here.

Suggested Readings:

1. R. Cuneo, S. Archangelsky (1986). "Feruglіocladaceae, a new conifer family from the Permian of Gondwana". Review of Palaeobotany and Palynology. 51 (1–3): 3–30.
2. Donoghue, Michael (1986). "Seed plant phylogeny and the origin of angiosperms: An experimental cladistic approach". The Botanical Review. **52** (4): 321–431.
3. Khanna, Sunita Khanna (2004). "The Man That Was" (PDF). Newsletter, BirbalSahni Institute of Paleobotany. **7**: 7.
4. Raghavan, V. (2000). Developmental Biology of Flowering Plants, Springer, Netherlands.
5. Shivanna, K.R. (2003). Pollen Biology and Biotechnology, Science Publishers.
6. Whitelam, G.C. and Halliday, K.J. (2007). Light and plant development; Blackwell Publishing; 325p; ISBN : 978-1-4051-4538-1.
7. Kashinath B, Manas R. M., Swati G. B. (2014). A Textbook of Palynology. New Central Book Agency (P), Limited, 2014. 352 pp. ISBN 16428 70471.
8. Cleal, C. J., & Thomas, B. A. (2019). Introduction to Plant Fossils (2nd ed.). Cambridge University Press.
9. Martinetto, E. Tschopp, E., and Gastaldo, R.A., ed., (2020). Nature Through Time: Springer Nature Switzerland, Cham, Switzerland.
10. Bandana S., Deepali T. (2024). Applications of Palynology in Stratigraphy and Climate Studies. Springer Nature.
11. Nan Crystal Arens., (2025). The Princeton Field Guide to Mesozoic Plants. Princeton University Press.

Semester-I

Course Code: BO1.5: Soft Core-2

Bio fertilizers

Marks: 150 (Theory final exam 75 + internal assessment 25 + Practical exam 50) Duration: 64 Hours.
Teaching hours: 16 Lectures/Unit

Course Objectives:

This course aims to introduce the students to study of bio fertilizers for ecofriendly crop productions.

Course Learning Outcomes: The students will be learning

1. Types of bio fertilizers.
2. Importance of soil microorganisms.
3. Symbiotic nitrogen fixation and assimilation.
4. Plant growth promoting fungi and Bacteria.
5. Importance of Mycorrhizae and commercial production of bio fertilizers.

Course Contents:

Unit-1:

Bio-fertilizers: definition, classification, method of production and role in crop improvement, agriculturally important beneficial microorganisms, factors affecting the activities of soil microorganisms; Algal, fungal, bacterial and pteridophytic biofertilizers: occurrence and agronomic significances; Symbiotic nitrogen fixers: Root nodules, organisms and their host specificity, role of Nif and Nod gene in biological nitrogen fixation.

Unit-2:

Nitrogen fixation: Nitrogenase, heterocyst differentiation, structural significance, physiological, biochemical adaptation; NR, NiR, GS, GOGAT, and AspAT enzyme biosynthesis, structure and their functions; Nitrogen fixation and photosynthesis relationship; Nitrate reduction, assimilation of organic nitrogen in algae- urea, amino acids and amides.

Unit- 3:

Rhizosphere- R: S ratio, Microbial inter-relationship in soil- beneficial and harmful; Microbial transformation of Phosphorus; Phosphobacteria- Plant Growth Promoting Rhizobacteria (PGPR),Phosphate solubilizing bacteria, siderophores and their importance, PGPF and its importance; Biofertilizers- *Rhizobium*, *Azospirillum, Azotobacter, Gluconacetobacter, Azorhizobium*; Production and quality control of bio-fertilizers.

Unit-4:

Mycorrhizae – introduction, biology of mycorrhizae, inoculation of mycorrhizae,kinds of mycorrhizae- ecto-mycorrhizae and endo-mycorrhizae - AM, Ericoid mycorrhizae, Orchid mycorrhizae, Arbutoid mycorrhizae; Mycorrhizal plant interaction and its importance in plant growth and biological control of plant pathogens.

Endosymbiosis: detection of endophytes of plants and their taxonomy, endophytic mutualism, Importance of *Trichoderma* spp., *Pseudomonas* spp. and *Bacillus* spp. as a biocontrol agent; Cross inoculation groups amongst Rhizobium, Methods used for the studying selection of efficient strain of Rhizobium, Strategies of Mass multiplication and marking and registration with CIB of bio agents and bio-pesticides; Bio-pesticides-Introduction, kinds of bio-pesticides and importance.

Suggested Laboratory Exercises

1. Enumeration of different kinds of microorganisms in soil – qualitative and quantitative methods.
2. Isolation of VAM fungi.
3. Isolation of rhizosphere and rhizoplane microorganisms.
4. Microdissection of Azolla to study symbiotic association.
5. Demonstartion of nitrogen fixing microorganisms- *Rhizobium, Azospirillum* and *Azotobacter.*
6. Bio fertilizers inoculant production – mother culture and starter culture – carrier materials – mixing and curing process.
7. Production of *Azolla* and BGA.
8. Production of commercial biofertilizers viz. *Rhizobium, Azotobacter, Azospirillum*and*Acetobacter*: selection of efficient strains, carriers and their sterilization, mother culture preparation, mass multiplication using shake culture method, mixing of culture and carriers and preparation of packets.
9. Production of carrier based and grain-based phosphate solubilizing biofertilizers.
10. Decomposition of organic matter by using different bioinoculants.
11. Models/ charts/photographs related to Biofertilizers.
12. Any other experiments related to Biofertilizers not listed here.

Suggested Readings:

1. Subba Rao, N.S. 1998. **Bio-fertilizers in Agriculture.** Oxford and IBH Publ. Co., New Delhi.
2. Deshmukh, A.M. 2003. **Bio-fertilizers and Bio-pesticides**. ABD Publishers, Jaipur. India.
3. Gaur, A.C., Neelakantan, S. and K.S. Dargan. 1984. **Organic manures.** 2nd ed., ICAR, New Delhi.
4. Cook, R.J. 1993. **Making greater use of introduced microorganisms for biocontrol of plant pathogens.** Annual Review of *Phytopathol.*, 31: 53-80.
5. Gupta, P.K. 1994. **Elements of biotechnology.** Rastogi and Campany. Meerut, India.
6. Dubey, R.C. 1996. **A textbook of Biotechnology.** S Chand and Company Ltd., New Delhi.
7. Trivedi *et al*. 1989. **In plant microbe interactions** (Biligrame, K.S. ed.), Focal theme (Botany), ISCA Symposium, Narendra Publication house, New Delhi.
8. Madhav, V., & Gangadhar, G. 2000. ***A text book of bio-fertilizer and organic farming.*** P.K. Publishers and Distributors.
9. Das, D., Ghosh, P., & Kadam, A. 2020. **Biofertilizers and biopesticides**. Academic Publications.
10. Giri, B., Prasad, R., Wu, Q.-S., & Varma, A. (Eds.). 2022. **Biofertilizers for sustainable agriculture and environment**. Springer.

Semester-II

Course Code BO2.1: HardCore - I

Plant Ecology and Environmental Biology

Marks: 150 (Theory final exam 75 + internal assessment 25 + Practical exam 50) Duration: 64 Hours.
Teaching hours: 16 Lectures/Unit

Course Objectives:

This course aims to introduce the students to the concepts and principles of ecology, biological diversity, conservation, sustainable development, population, community and ecosystem structure and function, application of these concepts to solve environmental problems.

Course Learning Outcomes:

The students will be learning

1. Limiting factors controlling distribution and growth of organisms.
2. Characteristics of organisms as population, community and ecosystems.
3. To know the ecosystem functions.
4. Applications of ecological knowledge of ecological successions.
5. Problems of pollution and its management.

Course Contents:

Unit-1:

The Environment: Biotic and abiotic environmental interactions: Habitat and Niche - Concept of habitat and niche, niche width and overlap, fundamental and realized niche; resource partitioning, character displacement; **Population Ecology:** Characteristics of a population, population growth curves, populationregulation, life history strategies (*r* and *K* selection) concept of metapopulation – demes and dispersal, interdemicextinctions, age structured populations.

Unit-2:

Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. **Community Ecology:** Nature of communities, community structure and attributes, levels of species diversity and its measurement, edges and ecotones. **Ecological Succession:** Types; mechanisms; changes involved in succession; concept of climax. Ecosystem Ecology: Ecosystem structureand function, energy flow and mineral cycling (C,N,P). **Primary production and decomposition:** structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, and estuarine).

Unit-3:

Water pollution: classification, physic-chemical properties, indicators of water pollution, pollution of water bodies, eutrophication, microbes in relation to water pollution, effects and management of water pollution. Air pollution: classification and properties of air pollutants, effects of air pollution – human health, vegetation and materialdamage, Greenhouse effect, smog, CFC, ozone depletion, acid rain; El Nino and La Nina effect; Remote sensing and GIS: Basic and fundamental concepts of remote sensing.

Unit-4:

Environmental Impact Assessment: Introduction, process and methods of impact analysis; Hazardous waste management- characteristics, types, sources and , composition;; Soil pollution - classification, effects and control measures, indicators of soil pollution; Solid waste: characteristic features, classification and disposal;Thermal, noise, radioactive pollution and their management; Microbial degradation and biotransformation, Pesticide pollution and degradation; International biological program: UNESCO, MAB, UNEP.

Suggested Laboratory Exercises

1. Analysis of water samples of lotic and lentic water bodies with reference to.
   a) Carbon dioxide
   b) Total hardness
   c) Sulphate
   d) Dissolved oxygen
   e) Phosphate
   f) Calcium
2. pH analysis of different soil samples.
3. Microscopic examination of different soil types.
4. Water holding capacity of different soil samples.
5. Determination of organic content, carbonates, exchangeable bases and oxidizable organic content of soils.
6. Study of vegetation by quadrat and transect method.
7. Ecological Instruments- Sunshine meter, Evaporation pan, Anemometer, Lux meter, Rain gauze, Max and min thermometer.
8. Visit to meteorological station.
9. Water purification methods – traditional and advanced.
10. Ecological adaptations in hydrophytes, xerophytes and halophytes.
11. Models/ charts/photographs related to this paper.
12. Any other experiments related to this paper not listed here.

Suggested Readings:

1. Vir singh 2024 Text book of Environment and Ecology , Springer.
2. Ernst-detlef Schulze, Erwin Beck and Michael Scherer-Lorenzen 2018, Plant ecology, Springer,Berlin, Heidelberg.
3. Bernhardsen, T. 1999. Geographic Information System : An Introduction. 02nd Edition, John Wiley and Sons.
4. Canter, L.W. 1996. *Environmental Impact Assessment.* McGraw Hill, New York.
5. Charan and Anil, K. 1992. Plant Geography.Rawat Publications. Jaipur.
6. Goel, P.K. 1997. Water Pollution Causes, Effects and Control. New Age International Pvt., Ltd., New Delhi.
7. Shukla, S.K. and P.R. Srivastava. 1992. Concepts in Environmental Impact Analysis. Common Wealth Publishers, New Delhi.
8. Tripathy, D.P. 1999. Noise Pollution. A P H Publishing Corporation, New Delhi.
9. Verma. P.S. and Agarwal, V.K. 1992. Principle of Ecology. Published by S. Chand and Company Ltd., New Delhi.
10. Williams, I. 2001. Environmental Chemistry. John Wiley and Sons, Ltd., New York.
11. Anji Reddy M. 2006. "A Textbook of Remote Sensing and Geographical information System". 3rd Edition B.S. Publications.
12. Botkin, D.B. and E.A. Keller. 2004. Environmental Science. 5th ed. John Wiley and Sons.
13. Cunningham, W. P., & Cunningham, M. A. 2018. Principles of environmental science: Inquiry and applications (2nd ed.). Tata McGraw Hill.
14. Ehleringer, J. R., & Monson, R. K. 2025. Plant ecology in a changing world. CRC Press.

Dept. of Applied Botany, Kuvempu University

Semester-II

Course Code BO2.2: HardCore-2

Cell Biology, Genetics and Plant Breeding

Marks: 150 (Theory final exam 75 + internal assessment 25 + Practical exam 50) Duration: 64 Hours.
Teaching hours: 16 Lectures/Unit

Course Objectives:

This paper is aimed at understanding the basic concepts of cell studies helping the students to develop their analytical, quantitative and problem-solving skills of genetics and plant breeding.

Course Learning Outcomes:

The students will be learning

1. Membrane structure and function.
2. Structural organization and function of intracellular organelles
3. Structure chromosomes and gene, regulation of cell cycle.
4. Laws of inheritance.
5. Experimental methods in genetics and plant breeding.

Course Contents:

Unit-1:

Membrane structure and function: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes. **Structural organization and function of intracellular organelles:** Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.

Unit-2:

Organization of genes and chromosomes: Operon concept, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons. **Cell division and cell cycle:** Mitosis and meiosis, their regulation, steps in cell cycle,regulation and control of cell cycle. **Introduction and scope of genetics:** Laws of Inheritance (Diploid organism- Pea, Haploid organisms- *Chlamydomonas* and *Neurospora*), **Interaction of Genes:** Multiple alleles, multigene inheritance and cytoplasmic inheritance.

Unit-3:

Classical gene concept: Fine structure of genes, Split genes-Introns and Exons, overlapping genes. Linkage, maps, genetic and cytological mapping of chromosomes. **Chromosome number**: Euploidy, monoploidy, polyploidy- autopolyploidy, and alloploidy. **Sex linked inheritance:** characteristics of sex linked inheritance, examples of X-linked gene inheritance and Y-linked gene inheritance.**Extra nuclear inheritance:** Variegation in 4 'O' clock plant, Lojop in Maize, Poky in *Neurospora*, and Petite in *Sacharomyces.*

Unit-4:

Breeding systems in crop plants: Techniques and methods of plant breeding. Breeding of Self-pollinated and cross-pollinated crops by introduction, selection, and hybridization. **Methods of breeding:** Hybridization- pedigree method, bulk method, back cross, advantages of incompatibility, male sterility, barriers to cross sterility. Breeding for disease and insect resistance. **Mutation breeding:** classification of mutation and mutagens, procedure for mutation breeding in self-pollinated crop, cross-pollinated crops. **Heterosis or hybrid vigour:** Types of heterosis, causes of heterosis. Techniques of production of hybrid seed.

Suggested Laboratory Exercises

1. Mendelian Genetics: Problems on monohybrid, Dihybrid and tri hybrid crosses. Multiple alleles, cytoplasmic inheritance, epistasis, sex linked inheritance. Laboratory exercises in probability and chi-square; Demonstration of genetic principles using laboratory organisms; Chromosome mapping using three-point test cross; Tetrad analysis; Induction and detection of mutations through genetic tests.
2. Selfing and hybridization techniques in Bajra, maize and Sorghum.
3. Floral biology of Bajra and Maize.
4. Estimation of pollen viability and pollen size.
5. To study stigmatal receptivity and pollination period in self-pollinated crops.
6. To determine LD 50 value for certain chemical mutagens.
7. To test seed viability by TTC method.
8. B-chromosomes and polytene chromosomes.
9. Mitosis and Meiosis
10. Self-pollination, cross pollination,emasculation, bagging,breeders kit.
11. Models/ charts/photographs related to this paper.
12. Any other experiments related to this paper which are not listed here.

Suggested Readings:

1. Watson, J.P. 1975. **Molecular Biology of the Gene.** 3rd Ed., Benjamin, New York.
2. Henry, R.J. 1997. **Practical Applications of Plant Molecular Biology.** Chapman & Hall, London, UK.
3. Chawla, H.S. 2002. **Plant biotechnology.** 2nd Ed., Oxford IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Pierce, B. A. 2012. Genetics: A conceptual approach. WH Freeman. USA.
5. Peter J. Russell. 2009.. iGenetics A Molecular Approach. Pearson Ltd. USA. Swanson, C.P., Mertz, T. and W.J. Yound. 1988. **Cytogenetics**. 2nd Englewood Cliff,New Jersey.
6. Tobin, A.K. 1992. Plant **organelles compartmentation of Metabolism in Photosynthetic tissue**. Cambridge University, Press.Bhamaah, H.S. 1990. Molecular cell Biology. Anmol Publication, New Delhi.
7. RogerlMiesfeld. 1999. **Applied Molecular Genetics**. Wiley's Liss Publication.
8. Shanmugam, G. 1998. Cell Biology Lab Manual. MacMillan India Ltd., Madras.

9. Sharad Srivastava. 1997. **Molecular Genetics**, Anmol Publication, New Delhi.
10. Madhusudan W Pandit. 2007. **Scientonic Tell-Tale of Genome and DNA**. International publishing.
11. David A. Micklos. 2005. **DNA Science: A First Course,** Second Edition V
12. Michael Wink. 2006. **An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology**. Springer Publishing Company.
13. Rakesh K. Mishra. 2009. **Chromosomes to Genome**. I.K. International Publishing.
14. Alberts, heald, Jhonson,Morgan, Raff, Robets and walker. 2022**. Molecular biology of the cell** 7th edition.
15. Geoferrey.M. Cooper and Robert.E.Hausman. 2018 .The Cell, **A molecular approach,** 8th edition.
16. Alberts, Heald, Johnson, Morgan, Raff, Roberts, Walker. 2022. **Molecular biology of the cell** 7th edition.

Semester-II
Course Code BO2.3 Soft Core-1

Techniques in Plant Biology

Marks: 150 (Theory final exam 75 + internal assessment 25 + Practical exam 50) Duration: 64 Hours.
Teaching hours: 16 Lectures/Unit

Course Objectives:

This paper is aimed at understanding the biological techniques used in industries for the production of certain biological compounds. Methods of plant transformations, production of pathogen free and stress free plants. Students will be learning high end laboratory Instruments and their applications.

Course Learning Outcomes:

The students will be learning

1. Cell, tissue and organ culture of important plants.
2. Crop improvement methods through biotechnological methods.
3. Production transgenic plants.
4. *In vitro* technology and pharma industries requirements.
5. Experimental methods in biosynthetic pathways and elicitation of compounds

Course Contents:

Unit 1:

SI System of measurement: Fundamental and derived units. **Preparations of solutions**: Molar, normality, and molarity, stock solutions and dilutions, preparation of media and reaction mixtures, pH measurements and preparation of buffers. **Radioactive techniques**: Isotopes and their half-life, Specific activity of radioisotopes, making radioisotope solutions, detection and measurement of radioactivity - radiation counters, liquid scintillation counters, autoradiography. Isolation of DNA, RNA and protein their sequencing analysis by gel-doc.

Unit 2:

Microtomy: Principle of tissue fixation, types of microtome, serial sectioning and staining. **Microscopy and microscopic techniques**: Light, phase contrast, fluorescence, electron, confocal microscopy. Micrometry and Flow cytometry. **Spectroscopic techniques**: Visible, UV, IR spectrophotometry, spectrofluorimetry, NMR and ESR spectroscopy, circular dichroism, atomic absorption and mass spectroscopy.

Unit 3:

Chromatographic techniques: Paper, thin layer and column chromatography, gel filtration, ion exchange and affinity chromatography, high pressure liquid chromatography, gas chromatography. **Electrophoretic techniques**: Supports, ecto and endo osmosis, electrophoresis native PAGE, dissociating and denaturing conditions, isoelectric focusing, staining, activity staining. 2-D electrophoresis, MALDI-TOF.

Unit 4:

Immunological techniques: Immune response. Antibodies and their specificity, antigen-antibody interactions, immune diffusion and immune electrophoresis techniques, immunoassays, western blotting. **Centrifugation techniques**: High speed centrifuges, rotors, ultra-centrifugation, density gradient centrifugation. **Electrochemical techniques**: Construction and working principles of equipment for measurement of electrical conductivity, and pH meter.

Suggested Laboratory Exercises

1. Demonstration, working principles and applications:
   A) SEM, B) TEM, C) PCR unit,
   D) Gel doc, E) PAGE, E) ELISA and F) Blotting techniques.
2. Estimation of protein by biurette / lowry's / barford method.
3. Estimation of amino acids by ninhydrin method.
4. Paper chromatography for separation of plant pigments.
5. Isolation of DNA from plant sources.
6. Paper chromatography for amino acids analysis.
7. Column chromatography for separation of plant pigments.
8. Study of chromatograms (HPLC, NMR, IR, MS).
9. Extraction & isolation of secondary metabolites from plant materials and detection of antimicrobial activity.
10. Models / Charts / Photographs related to Techniques in plant biology.
11. Any other experiments related to Techniques in plant biology not listed here.

Suggested Readings

1. David L. Nelson, Michael M. Cox. 2013. Lehninger Principles of Biochemistry; W. H. Freeman 6th edition.2013.
2. David M Freifelder Physical Biochemistry: 1983. Applications to Biochemistry and Molecular Biology (Life Sciences/Biochemistry, W. H. Freeman; 2nd Revised edition.
3. Jeremy M. Berg, John L. Tymoczko, LubertStryer Biochemistry, W. H. Freeman.
4. Ashhara, A., Crozier, A. and Komamine, A. 2011. Plant Metabolism and Biotechnology. John Wiley and Sons, England (UK).
5. George, E.F., Hall, M.A. and De Klerk, G.J. 2008. Plant Propagation by Tissue Culture (3rd Edition), Springer, Netherlands.
6. Butenko, R.G. 2000. Plant Cell Culture, University Press of Pacific.
7. Davies, P.J. 2004. Plant Hormones, Kluwer Academic Publishers, Netherlands.
8. Buchanan, B.B., Gruissem, W. and Jones, R.L. 2015. Biochemistry and molecular biology of plants. John Wiley and Sons Ltd., UK.
9. Ch Mohan, Juleri M. U., Pullaiah T. 2021. Principles and Methods in Plant Biology. Daya Publishing House.
10. Shylaja, M. R. Deepu Mathew, and Peter, K. V. 2022. Techniques in Molecular Biology and Plant Biotechnology. New India Publishing Agency.
11. Sumira J., Gowhar H. B. 2025. Analytical Methods in Plant Sciences. Springer Singapore.

Dept of Applied Botany, Kuvempu University

Semester-II

Course code -BO2.4 Soft Core-2

Plant Pathology

Marks: 150 (Theory final exam 75 + internal assessment 25 + Practical exam 50) Duration: 64 Hours.
Teaching hours: 16 Lectures/Unit

Course Objectives:

This paper is aim at understanding the plant pathogens diversity and disease of crop plant and their management techniques. Students will be learning to identify the different plant pathogenic microbes, their morphology, structure, reproduction, life cycle and possible crop loss/yield loss and their economic importance.

Course learning outcomes:

The students will be learning -

1. General characters of plant pathogens
2. Classification of various plant pathogens and different plant diseases.
3. Genetic mechanisms in plant pathogenic adaptations
4. Disease epidemiology.
5. Management of various plant/crop diseases caused by different plant pathogens.

Unit-1:

Introduction, Scope and significance of plant pathology, significant contributions of plant pathologists, Koch's postulates, **Classification and methods of studying plant disease:** Traditional diagnostic methods, Epidemiological methods and Modern technological methods. Plant disease and world crop production and yield loss.

Unit-2:

Pathogenesis: Mode of transmission of pathogens by seed, air, soil, water, vectors and contagious animals. **Penetration:** Direct penetration of pathogens by adhesion, appressorium formation,enzymatic action, mechanical pressure and invasion (mainly by fungi and nematodes), Indirect entry of pathogens through natural openings, wounds, root hairs, buds. **Role of toxins in pathogenesis:** Introduction, Host-related toxins, Non-Host selective toxins, control of toxin biosynthesis. **Disease epidemiology:** Effect of environmental factors on disease development and disease forecasting with examples.

Unit-3:

Detection and Diagnosis of plant pathogenesis: Introduction of host range and symptomatology, morphology of causal organisms, selective media, biochemical markers-substrate metabolism, fatty acid profiles (FAME analysis),protein analysis, choice of diagnostic techniques like serological and nucleic acid techniques.

Unit-4:

Study of important crop/plant diseases and their management -

a. **Fungal diseases**: Blast of paddy, Wheat rust, Grain smut of sorghum, Downy mildew of sorghum, Leaf rust of coffee, Smut of maize, Anthracnose of beans, Leaf spot of chilli, Powdery mildew of cucurbits, Frog eye spot and Leaf spot of tobacco.
b. **Bacterial diseases:** Leaf blight of paddy, Citrus canker, Angular leaf spot of cotton.

c. Viral diseases: Tobacco Mosaic, Leaf curl of chilli, Pepper wilt, Bunchy top of banana, Katte disease of cardamom.

d. Mycoplasma diseases: Little leaf of brinjal, Grassy shoot of sugarcane.

e. Nematodal diseases: Root knots of brinjal/Tomato.

f. Angiospermic parasites diseases: Loranthus, Viscum, Cuscuta, Striga.

Management of plant diseases: by conventional, physical, chemical and biological methods. Development of disease resistant crops through genetic modification.

Suggested Laboratory Exercises

Plant Pathology

1. Isolation, culture and identification of fungi based on conidia and mycelial morphology.
2. Studying of following diseases-
   a. **Fungal diseases**: Blast of paddy, Wheat rust, Grain smut of sorghum, Downy mildew of sorghum, Leaf rust of coffee, Smut of maize, Anthracnose of beans, Leaf spot of chilli, Powdery mildew of cucurbits, Frog eye spot and Leaf spot of tobacco.
   b. **Bacterial diseases:**Leaf blight of paddy, Citrus canker, Angular leaf spot of cotton.
   c. **Viral diseases:**Tobacco Mosaic, Leaf curl of chilli, Pepper wilt, Bunchy top of banana, Katte disease of cardamom.
   d. **Mycoplasma diseases:** Little leaf of brinjal, Grassy shoot of sugarcane.
   e. **Nematodal diseases:** Root knots of brinjal/Tomato
   f. **Angiospermic parasites diseases:** Loranthus, Viscum, Cuscuta and Striga
3. Disease assessment of infected leaves.
4. Spore release by wash-off method.
5. Fungicide evaluation by agar well /disc diffusion method.
6. Effect of fungicide on seed borne fungi.
7. Testing of antagonism by dual culture plate method.
8. Observation of diseased specimens, sections and slides.
9. Models / Charts / Photographs related to plant pathology.
10. Any other experiments from plant pathology which are not listed here.

Suggested Readings:

1. Singh, R.S. 1973. Plant Disease. Oxford and IBH Pub. Co., New Delhi.
2. Agrios, G.N. 1994. Plant Pathology. 2nd Edn. Academic Press New York.
3. Johnston, A. and Both, C. 1983. Plant Pathologists Pocket Book. 2* Edn.Commonwealth Mycological Institute, Oxford and IBH Pub. Co., Calcutta.
4. Rangaswamy, G. and Mahadevan, A. 2018. Diseases of Crop Plants in India.Prentice Hall of India Pvt.Ltd., New Delhi.
5. Mehrotra RS and Agarwal A. 2003. Plant Pathology by second edition, Tata McGrawHill Education.
6. Sinha AK and Tripathi DP. 2011. Fundamentals of plant pathology, Kalyani Publishers.
7. Mann, S. K., Kashyap, P. L., & Kang, S. S. 2023. Plant pathology: A competitive vision. Kalyani Publishers.
8. Singh, P. K., Singh, B., Sinha, D., & Singh, K. P. 2025. Text book of fundamental of plant pathology. Scientific International Publishing House.
9. Sambamurty, A. V. S. S. 2024. A textbook of plant pathology. I. K. International Publishing House.

Semester-II

Course Code: BO2.9: IDE: Inter Discipline Elective

Floriculture

Marks: 50 (Theory final exam 40 + internal assessment 10) Duration: 32 hours.
Teaching hours: 8 Lectures/Unit.

Course Objectives:

This paper is aimed at importance of flower diversity and focus on cultivation and marketing opportunities in India and abroad.

Course Learning Outcomes:

The students will be learning

1. General nature of ornamental flowers.
2. Commercial flower production in India.
3. Management of flower cultivation.
4. Management of diseases and pests of flower production.

Unit-1:

Introduction to floriculture science –principles, floriculture industry, characteristics and its importance; Plant nomenclature – Structure, fragranceand geneticsin flower; cutand wild flowers.

Unit-2:

World cut flower industry – overview, international trade, export and import, products, international and domestic consumption; Cut flower industry - commercial cut flowers of India and Karnataka (area, production, yield and value of certain commercial flowers in Karnataka):Floriculture industries/companies in India, governmental support -NABARD, NHB, APEDA.

Unit-3:

General cultivation practices of floriculture: Soil and fertilizers application: soil properties, fertilizer requirements; Plant propagation – asexual and sexual means; Seed production; Nursery production – planting material, soil, and other media, containers, irrigation and fertilization.

Unit-4:

Pest and disease management – common pests of ornamental plants and flowers, their damage to plants/flowers;Diseases caused by different agents, damage and their control, Integrated Pest Management and Weeds and their management; Floriculture in green house: facilities, operation and management; **Post-harvest handling of flowers** :collection, grading, packing, preservation, protection, transportation and delivery.

Suggested Readings:

1. Prasad S and Kumar U 1998. **Commercial Floriculture.** AgroBotanica, Bikaner, India.
2. Alex Laurie and Victor, H.R. 2001. **Floriculture-Fundamental Practices.**Agrobios, Jodhpur, India.
3. Anon. 2004. **Horticultural Crop Statistics of Karnataka State at a Glance.** Directorate of Horticulture, Karnataka State Govt. Bangalore.
4. Van Slyke, L.L. 1932. **Fertilizers and Crop Production**. Orange Judd Publish. Co. Inc., New York.
5. Reddy, Y.T.N., Janakiram, T. and Satyanarayana Reddy, D. 2001. **Scientific Nursery Management (Fruit and Ornamental Plants).** The House of Sarpan (Media), Bangalore.
6. Singh, A. K. 2017. **Text book of floriculture and landscaping**. Asha Book House.
7. Desh Raj. 2025. **Floriculture at a glance**. Kalyani publishing house.

Dept. of Applied Botany, Kuvempu University

Semester-III

Course Code: BO3.1: Hard Core-1

Plant Morphogenesis and Reproductive Biology of Angiosperms

Marks: 150 (Theory final exam 75 + internal assessment 25 + Practical exam 50) Duration: 64 Hours.
Teaching hours: 16 Lectures/Unit

Course Objectives:

This paper is aimed at understanding the growth and development of plants. The students have to look into the various aspects of plant growth, development and reproduction. This course aims at making the students acquainted with the fundamentals and present understanding of the mechanisms associated with the development and differentiation of various plant organs and embryological details.

Learning Outcomes: Students will be able to

1. Understand a shoot apical meristem transforms into an inflorescence and floral meristems and how these domains developmentally maintained.
2. How the male and female germ lines are established and how a variety of tissues coordinate to form gametes?
3. How seed development is accomplished and what are the mechanisms by which rejection reaction occurs during the progamic phase?
4. Understand fertilization necessary for a seed formation. How does a fertilized egg and central cells lead to embryo and endosperm formation?

Course Contents:

Unit-1:

Plant growth and development: Introduction, key concepts, plant growth vs animal growth, Positive and negative regulatory networks; coordination of growth, isotropic and anisotropic growth, polarity, proliferation and termination of growth, Growth and development of three-dimensional structures, developmental plasticity. Meristems: Different types, RAM, SAM, Cell fate determination, lineage decisions, developmental patterning.

Unit-2:

Differentiation of cells: Cell Differentiation – Mechanism & Factors Influencing cell differentiation, Redifferentiation, dedifferentiation and regeneration in Acetabularia and *Arabidopsis thaliana*. **Development of organs:** organ identity, key regulatory mechanisms in development of size and shape of specific organs such as leaf, stem, shoot and root, trichomes, stomata, tracheary elements.

Unit-3:

Development and evolution of plants form and its diversity: Plant architecture - growth of main stem and lateral organs, branching patterns, apical dominance, root and shoot architecture, phyllotaxy and types, determinate and indeterminate growth; **Transition to flowering**; formation of inflorescence and floral meristems; Physiology and chemistry of flowering; Floral homeotic mutations in *Arabidopsis*, *Antirrhinum* and *Petunia.*

Unit-4:

Regulation of anther and ovule development: Microsporogenesis–microgametogenesis, pollen wall development, role of tapetum,; Megasporogenesis, megagametogenesis megasporagium (ovule) development; Progamic phase -*in vitro* pollen germination, pollen tube growth and guidance, double fertilization, self-incompatibility mechanisms, incongruity; Polarity during embryogenesis, pattern mutants, *in vitro* fertilization, endosperm development, apomixis, polyembryony, embryogenesis(monocot and dicot grass); Parthenocarpy; Special structure of seed (Nucellus, Perisperm,Caruncle, Operculum and Aril).

Suggested Laboratory Exercises

1. Study of stem cells in plants: shoot apical meristem and root apical meristem in *Ceratophyllum* and *Hydrilla* species.
2. Study to show polarity in stem cuttings in lower and higher plants.
3. Preparation of pollen grains to study external morphology by acetolysis method.
4. Pollen grain germination studies in *Balsam, Delonix, Hibiscus*and *Ipomea* plants.
5. Micro dissection and endosperm mounting: *Cucumissativus, Grevelliarobusta*
6. Dissection and embryo mounting: *Crotalaria*
7. Study to demonstrate regeneration in succulents (*Byrophyllum)*and Phyllotaxy: Alternate, opposite decussate, whorled and spiral.
8. Microsporangium: Slides: anther sac, wall layers; tapetum; two-celled & three-celled pollen; pollen tetrads.
9. Megasporangium: Slides –different types of embryo sacs, 4-nucleate8- nucleate stages; mature embryo sac.
10. Embryo: Slides: Monocot and dicot plants.
11. Observation of seed appendages: operculum, caruncle, aril of nutmeg, perisperm.
12. Models / Charts / Photographs related to this paper.
13. Any other experiments related to these papers which are not listed here.

Suggested Readings:

1. Beck, C.B. (2010). An Introduction to Plant Structure and Development, II edition
2. Pua, E-C. and Davey, M.R. (2010). Plant Developmental Biology-Biotechnological perspectives
3. Fosket, D.E. (1994). Plant, Growth and Development: A Molecular Approach, Academic Press.
4. Hopkins, W.G. (2006). The Green World: Plant Development, Chelsea House Publication
5. Leyser, O. and Day, S. (2003). Mechanism of Plant Development, Blackwell Press, 241p.
6. University Press. 9.Raghavan, V. (2000). Developmental Biology of Flowering Plants, Springer, Netherlands
7. Shivanna, K.R. (2003). Pollen Biology and Biotechnology, Science Publishers.
8. Whitelam, G.C. and Halliday, K.J. (2007). Light and plant development; Blackwell Publishing; 325p; ISBN : 978-1-4051-4538-1
9. Wolpert, L., Jessell, T., Meyerowitz, E., Robertson, E. and Smith, J. (2007). Principles of Development; Oxford, Oxford University Press.
10. Mangla, Y., Khanduri, P., & Gupta, C. K. (2022). Reproductive biology of angiosperms: Concepts and laboratory methods. Cambridge University Press.
11. Singh, B. P. (2023). Reproductive biology of angiosperms. Springer Nature.

Semester-III

Course Code: BO.3.2 Hard Core-2

Plant Physiology and Biochemistry

Marks: 150 (Theory final exam 75 + internal assessment 25 + Practical exam 50) Duration: 64 Hours.
Teaching hours: 16 Lectures/Unit

Course Objectives:

The course aims to educate students on concept to physiology of nutrient uptake, photosynthesis and nitrogen metabolism. This course also aims to educate students on concepts of proteins, enzymes, basic plant signaling mechanisms, sensory photobiology.

Course Learning Outcomes:

1. The course will deal with various phytohormones and their role in physiology of plant growth and development, it also introduce students to physiological advances in sensory photobiology.
2. Students will gain the knowledge on reproductive strategies in higher plants along with physiology of flowering, molecular and hormonal basis of flowering mechanism.
3. Students will be taught about proteins, their biosynthesis, folding into specific structures, post translational modifications and degradation mechanisms.
4. Students also able to understand carbohydrate and amino acid metabolism.

Course Contents:

Unit-1:

Water relations: Internal factors: environmental, cytoplasmic, and gametic. **Transpiration**: factors affecting transpiration, transpiration control and anti transpirants, and stomatal movement. Mechanism of ion uptake, transportation and accumulation, Donnan's equilibrium, translocation of solutes. Mineral nutrition, mineral deficiency diseases.

Unit-2:

Photosynthesis: Light harvesting complexes, mechanisms of electron transport; **photoprotective mechanisms**; CO_2 fixation-C_3, C_4 and CAM pathways. **Respiration and photorespiration**: Citric acid cycle; plant mitochondrial electron transport and ATP synthesis, alternate oxidase, photo respiratory pathway. **Nitrogen metabolism**: Nitrate and ammonium assimilation, amino acid biosynthesis.

Unit-3:

Plant hormones: Biosynthesis, storage, breakdown and transport, physiological effects and mechanisms of action (Auxins, Gibbirllines, and Cytokinin). **Sensory biology:** Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropism; photoperiodism and biological clocks. **Secondary metabolites**: Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles. **Stress physiology**: Abiotic stress: Water stress, Mineral nutrition stress, temperature stress, salinity stress and UV stress. Biotic stress: (pathogen and insects), mechanisms of abiotic and biotic stresses for improvement of plants.

Unit-4:

Structure of atoms, molecules and chemical bonds. **Biomolecules**: Composition, structure and functions of carbohydrates, lipids, proteins, nucleic acids and vitamins. **Stabilizing interactions:** Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc. **Principles of biophysical chemistry**: pH, buffer, reaction kinetics, thermodynamics, colligative properties. **Bioenergetics:** glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers. **Principles of catalysis:** enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, coenzymes, isozymes. **Confirmation of proteins:** Ramachandran plot structure of protiens, domains, motif and folds.

Suggested Laboratory Exercises

1. Measurement of water potential.
2. Effect of temperature on permeability of cell membrane.
3. Paper chromatographic separation of chloroplast pigments.
4. Calculation of stomatal index (Xerophytes, mesophytes and hydrophytes).
5. Experiments to demonstrate the Crassullacean acid metabolism.
6. Demonstration of carbon dioxide fixation by estimating the dry matter yield.
7. Quantitative estimation of proteins by Folin-Ciocalteau reagent.
8. Quantitative estimation of amino acids by ninhydrin method.
9. Quantitative estimation of carbohydrate by spectrophotometric method using Anthrone reagent.
10. Quantitative estimation of reducing sugar by 3, 5, -dinitrosalicylic acid .
11. Models / Charts / Photographs related to Plant physiology and Biochemistry.
12. Any other experiments related to Plant physiology and Biochemistry not listed here.

Suggested Readings

1. Salisbury F. B. & C.W Ross, Plant Physiology, Wadsworth Publishing Co., 1986.
2. Stupf, P.K.&E.E. Conn (Editors in Chief). The Biochemi-stry of Plant. Vol. 1-8, 1981. academic press.
3. Thompson W. W. J. B. Mudd& m. Gibbs, Biosynthesis and Function of Plant Lipids. Amer. Soc. Plant Physiol., 1983.
4. Bewley J. B. & M. Black, Physiology and Biochemistry of seeds in relation to germination. Vol. 1-2. Springer-Verlag, 1982-83.
5. Buchanan, B.B. Gruissem, W. and Jones, R.L. 2004. Biochemistry and Molecular Biology of plants. I.K. International PVT., New Delhi.
6. Buchanan, B. B., Gruissem, W., & Jones, R. L. (Eds.). 2015. Biochemistry and Molecular Biology of Plants (2nd ed.). Wiley-Blackwell.
7. Hans-W. Heldt, Birgit P. 2021. Plant Biochemistry. Academic Press, 2021. 628 pp. ISBN 01282 27133.
8. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. 2022. Plant Physiology and Development (7th ed.). Oxford University Press.
9. Singhal, R. K., Chauhan, J., & Bose, B. 2025. A Quick Approach to Plant Physiology, Biochemistry and Biotechnology (3rd ed.). Jain Brothers.
10. Heilman, D., Woski, S., Voet, D., Voet, J. G., & Pratt, C. W. 2024. Fundamentals of biochemistry: Life at the molecular level (6th ed.). John Wiley & Sons.

Semester-III

Course Code: BO3.3: Soft core -1

Plant Diversity and Human Welfare

Marks: 150 (Theory final exam 75 + internal assessment 25 + Practical exam 50) Duration: 64 Hours.
Teaching hours: 16 Lectures/Unit

Course Objectives:

The course aims to have understanding of plant diversity, significance of diversity, need of classification, bases of classification, plant adaptations, distribution of plants, curious plants, and indicator species.

Course Learning Outcomes:

The students will be learning

1. What is the significance of plant diversity?
2. What are the adaptations in plants in relation to habitat conditions?
3. Plant diversity at different levels.
4. Geographic indications.

Unit 1:

Plant diversity: Classification, Levels of biodiversity, various divisions of plants (Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms), present status in India: Indigenous people and plant diversity, traditional plant conservation practices, plants in Indian tradition and culture, plant- animal interactions.

Unit 2:

Ecosystem services: Human food and plant diversity, terrestrial, marine, inland, rain forest and landscape plant diversity; plant resource economy in India, Indicator plants of metals and resources, vertical gardening, green buildings, plants in bioterrorism and biosecurity.

Unit 3:

Biodiversity Hotspots: Species types - umbrella species, priority species (keystone and flagship species), indicator species; Threats to plant diversity: human population growth, diseases, desertification, fire and plant invasion, loss of plant diversity; Endangered plants, Endemic plants of Western Ghats and Eastern Himalayas plant restoration.

Unit 4:

Taming of wild plants by man: Beginning of agriculture- when, where and how; Story of transforming wild plants to modern day crops; Role of plants in evolution of human civilization; Influence of plants on language, religious and cultural practices, folklore and fine arts. Plant diversity and Politics: specific plants/plant related issues; *Amaranthus* in indigenous civilizations of Mesoamerica and Spanish invasion- consequences; Vavilovs, Lysenkoism; Indigo revolt and origin of India non-violent struggle for independence, Chipko movement,Green revolution and its impact on Indian agriculture, Contributions of Norman Borlaug and M.S. Swaminathan.

Suggested Laboratory Exercises

1. Determination of density, abundance, frequency in plant communities.
2. Assessment of basal area of a small patch of forest.
3. Determination of species diversity (α- diversity) index in plant community.
    a. Shannon–weisner
    b. Simpson etc.
4. Measurement of similarity index (β- diversity) in two different plant communities by a) Jaccard measure (Qualitative), 2) Morista Horn (Quantitative)
5. Determination of Importance Value Index (IVI) of plant species in plant community by quadrate, line and belt transect methods.
6. Sacred plants and indigenous practices (Language, religion, culture, folklore, fine arts)
7. Mapping of hot spots of India and the world.
8. Plant related issues such as turmeric, basmati rice, bt- brinjal and such other plants.
9. Observation of endemic plants of Western Ghats areas.
10. Models / Charts / Photographs related to this paper.
11. Any other experiments related to this paper which is not listed here.

Suggested Readings:

1. Kumar, U. and Sharma, A.K. 2001. Plant biotechnology and Biodiversity conservation. Agrobios, Jodhpur.
2. Dobson, A. 1996. Conservation and Biodiversity. Palgrave MacMillan
3. Levin, S.A. 2001. Encylopedia of Biodiversity Vol 1 to 5. Academic Press New York
4. Groombridge, B. and Jenkins, M.D. 2002. World Atlas of Biodiversity, Earth living resources in the 21st Century. University of California Press
5. Singh, J.S., Singh, S.P. and Gupta, S.R. 2008. Ecology, Environment and Resource conservation. Anamaya Publications, New Delhi
6. Krishnamurthy, KV. 2003. Text Book of Biodiversity. Science Publishers
7. Mapes, Christina and Eduardo Espitia, 2001, Amaranth, in *The Oxford Encyclopedia of Mesoamerican Cultures*, vol. 1, edited by David Carrasco, Oxford University Press. pp: 13-14
8. Sauer, Jonathan D., 1967. The Grain Amaranths and Their Relatives: A Revised Taxonomic and Geographic, *Annals of the Missouri Botanical Garden*.
9. Sharangi, A. B. 2021. Aromatic plants (2nd ed.): The technology, human welfare and beyond. Nova Science Publishers.
10. Behera, R. K., Samal, B. P., Rout, U. K., & Sahoo, D. K. 2024. A text book on plant resources utilization and conservation. Laxmi Book Publication.
11. Serger Volis. 2018. Plant Conservation , The role of habitate restoration, Cambridge University.
12. Usha Kumara, Gouthami R. 2026. Text book of plant genetic resources conservation. Kalyani publishers.

Semester-III

Course Code: BO3.4: Soft core -2

Plant Biotechnology

Marks: 150 (Theory final exam 75 + internal assessment 25 + Practical exam 50) Duration: 64 Hours.
Teaching hours: 16 Lectures/Unit

Course Objectives:

This course would provide students with an understanding of principles and techniques of plant tissue culture, concepts and methods associated with development and analysis of transgenic plants, and their applications in basic and applied research. In addition, students would be exposed to the economic importance and current research paradigms in various categories of commercially cultivated plants.

Course Learning Outcomes:

The students will learn about

1. Concepts, tools and techniques related to *in vitro* propagation of plants.
2. Various case studies related to basic and applied research in plant sciences using biotechnology.
3. Principles and methods used for phenotypic, genetic and molecular analysis of transgenic plants
4. Uses and current research paradigms in various plants of economic value.

Course contents

Unit 1:

Scope and importance of tissue culture techniques: Basic aspects of plant tissue culture, tissue culture media components, growth regulators, growth retardants, explants, sterilization, inoculation, sub-culturing. Different types of cultures, callus formation, different types of suspension cultures, single cell culture; **organogenesis-**different types, factors affecting organogenesis; **Micropropagation:** different stages of micropropagation, rooting and establishments in herbs & woody plants; Restoration of degraded land through micropropagation, and development of stress tolerant plants.

Unit 2:

Somaclonal and Gametoclonal variation and their importance: Somatic embryogenesis - different methods, factors affecting embryo maturation, application of somatic embryogenesis; **Synthetic seeds**: Production and its significance. Protoplast isolation and culture, factors affecting, Protoplast fusion, somatic hybridization, fusion methods, fusion products, cybrids and hybrids, applications of protoplast fusion; **Haploids plant production**- anther and pollen culture and its significance in crop improvement; ovary, ovule, endosperm and embryo culture and its importance, *in vitro* fertilization and its significance.

Unit 3:

Applications of genetic transformation – case studies on use of transgenic technology for basic studies and crop/plant improvement. Phenotypic, genetic and molecular analysis of transgenic plants. Factors influencing transgene expression, transgene silencing. **Marker-free transgenics** - genome editing for crop improvement; environmental, social and legal issues.

Unit 4:

Production of pathogen free plants: Different methods, meristem culture and its importance in commercialization, development of disease-free tissue culture plants. **Different types of secondary metabolites:** production, factors affecting yield; biotransformation, different types with examples, immobilization techniques and advantages, biosensor and biochips, secondary metabolites production centers in India.

Suggested Laboratory Exercises

1. Basic tissue culture laboratory organization, principles and techniques: Instruments: a) Hot air oven, b) Autoclave, c) pH meter, d) Laminar air flow, e) Culture racks, f) Inverted microscope, g) Filtration unit and h) Accessories
2. Preparations of different types of media for plant tissue culture.
3. Media and explant sterilization
4. Preparation and inoculation of Monocot/ Dicot explant.
5. T/S of root and shoot primordia
6. Preparation of synthetic seeds
7. Isolation of protoplasts from various plant tissues and testing their viability.
8. Biochemical analysis of secondary metabolites from plant tissue culture.
9. Micropropagation – stem, leaf, meristem, flower bud, haploid culture (anther), embryo culture.
10. Demonstration of protoplast fusion employing PEG.
11. Organogenesis and somatic embryogenesis using appropriate explants.
12. Demonstration of androgenesis in *Datura.*
13. Instruments/ models/ charts/photographs related to Plant Biotechnology.
14. Other experiments which are not listed here pertaining to this paper.

Suggested Readings:

1. Adrian, S., Nigel, W.S. and Mark, R.F. (2008). Plant Biotechnology: The genetic manipulation of Plants, Oxford University Press.
2. Buchanan, B.B., Gruissem, W. and Jones, R.L. (2015). Biochemistry and Molecular Biology of Plants, John Wiley and Sons Ltd., UK.
3. Davies, P.J. (2010). Plant Hormones, Kluwer Academic Publishers, Netherlands.
4. Halford, N. (2006). Plant Biotechnology - Current and future applications of genetically modified crops, John Wiley and Sons, England.
5. Primrose, S.B. and Twyman, R.M. (2016). Principles of Gene Manipulation, 8th edition, John Wiley and Sons Ltd., Chicester, UK.
6. Ricroch, A., Chopra, S. and Fleischer, S.J. (2014). Plant Biotechnology: Experiences and future prospects, Springer International Publishing AG, Springer, Switzerland.
7. Shylaja, M. R. Deepu Mathew, and Peter, K. V. (2022). Techniques in Molecular Biology and Plant Biotechnology. New India Publishing Agency.
8. Sumira J., Gowhar H. B. (2025). Analytical Methods in Plant Sciences. Springer Singapore.

Semester-III

Course Code: BO3.9: Inter Disciplinary Elective

Plants for Human Welfare

Marks: 50 (Theory final exam 40 + internal assessment 10 (Credits-2) Duration: 32 Hours.
Teaching hours: 8 lectures/Unit

Course Objectives:

The course aims to introduce the plant resources that help human society to sustain and benefit from their use, Knowledge of biodiversity and its importance, Agricultural diversity and biodiversity loss and biodiversity management.

Course Learning Outcomes:

The students will be learning

1. The useful plants to human society.
2. Identification features of useful plant resources.
3. The students would be able to judge the value of biodiversity and its role in stabilizing the climate and economy. They would know the causes and consequences of loss of biodiversity and planning of conservation strategies.

Course Contents:

Unit- 1

A general overview of economically important plants and their role in human welfare as food, oil, drugs, nutraceuticals, beverages, fibre, timber, biofuels, ornamental and as environment protection through carbon sequestration. **Food crops:** Cereals; Origin, cultivation and food values of important crops e.g.,wheat, rice, maize, grain legumes (Pulses).

Unit-2:

Medicinal and nutraceuticals: Traditional plants as source of drugs used against several serious diseases such as cancer, diabetes, malaria, dengue, psoriasis, etc. Characterization of bioactive metabolites, elicitation of secondary metabolites from anticancerous plants such as *Podopyllum, Taxus, Catharanthus, Psoralia, Nardostachys*. Nutraceuticals and functional foods; Important plants such as *Aloe vera, Moringa, piper* spp

Unit-3:

Edible and non-edible oils: Classification of oils, Oil yielding plants, processing and purification of different edible oils such as mustard, olive, sunflower oil, and safflower peanut oil; **Non-edible oils:** such as Jojoba (*Simmondsiachinensis), Sesam* oil, Linseed oil and castor oil. **Essential oils:** *Citrus*, Lavender, rosemary, almond, clove, cinnamomum, and *Eucalyptus* oils.

Unit-4:

Plants as a source of timber: e.g., *Tectona grandis, Salix* sp*., Dalberia sisso* (sheesham) and fuel wood, type and resources. **Fibre yielding plants:** Cotton (*Gossypium* sp.), Jute (*Corchorus*sp.), sun-hemp (*Crotalaria* sp). Plants used for Horticulture, floriculture & ornamental values: Brief introduction of different type of horticultural and ornamental plants (Gerbera, Carnation, Anthurium, Chrysanthemum, Orchids, etc.) and their commercial aspects.

Suggested readings:

1. Kochhar, S.L. (2016). Economic Botany. Fifth Edition. Cambridge University Press, UK. ISBN 978-1-316-63822-4. 664pp.
2. Nakar, R.N., Dhaduk, H.L. and Chovatia, V.P. (2016). Medicinal plants-Cultivation and Uses, Daya Publishing House, India.
3. Prakash, J. and Pierik, R.L.M. (1991). Horticulture - New Technologies and Applications (Current Plant Science and Biotechnology in Agriculture). Kluwer Academic Publishers.
4. Kayser, O. and Quax, W.J. (2007). Medicinal Plant Biotechnology, From Basic Research to Industrial Applications, Vol. I &II. Wiley-VCH, Weinheim.
5. Watt, G. (2014). A Dictionary of Economic Products of India.v.5, Linum to Oyster.
6. Wink, M. (2011). An Introduction to Molecular Biotechnology. Wiley Blackwell, Germany.
7. Sharangi, A. B. (2021). Aromatic plants (2nd ed.): The technology, human welfare and beyond. Nova Science Publishers.
8. Behera, R. K., Samal, B. P., Rout, U. K., & Sahoo, D. K. (2024) A text book on plant resources utilization and conservation. Laxmi Book Publication.
9. Serger Volis. (2018). Plant Conservation, The role of habitate restoration, Cambridge University.
10. Usha Kumara, Gouthami R. (2026). Text book of plant genetic resources conservation. Kalyani publishers.

Semester-IV

Course Code: BO4.1: Hard Core-1

Ethnobotany, Medicinal Plants and Plant Resource Conservation

Marks: 150 (Theory final exam 75 + internal assessment 25 + Practical exam 50) Duration: 64 Hours.
Teaching hours: 16 Lectures/Unit

Course Objectives:

This course would provide students with an understanding of principles and methods of ethno-botany and traditional knowledge of plants. Students will know important medicinal plants of India and their conservation. In addition, students would be exposed to the economic importance and conservation of natural resources.

Course Learning Outcomes:

The students will learn about:

1. Ethno-botanical knowledge.
2. Importance of medicinal plants, their diversity, and treating various diseases.
3. Recent knowledge and status of medicinal plants.
4. Natural resources and their conservation.
5. Uses and current research prospects on various plants of economic value.

Unit 1:

Ethnobotany: Collection, preparation and preservation of ethnobotanical specimen, Current scope and potential applications; Traditional botanical knowledge: Diagnostic features, identification tools and techniques, Doctrine of Signature; Ethnobotanical food and medicinal plants-cultural, ethical and practical consideration; Plants in human affairs; Ethnopharmacology and drug discovery, new medicine from ancient wisdom; Applied ethnobotany; commercialization, sustainable utilization and conservation; Ethnobotanical information resources - Books, Journals, and related websites.

Unit 2:

Classification and nomenclature of medicinal plants: Classification based on origin (plant, animals, and minerals), nature (medicinal, poisonous and aromatic plants); Commercial medicinal plants in therapeutics-*Catharanthus roseus, Aconitum ferox, Rauwolfia serpentina, Styrchnosnux-vomica, Withania somnifera, Vetiveria zizinoides.* Reasons for commercialization, curative aids and chemical nature; Plant based medicines, overexploitation and consequences; Medicinal Plant Research Institutes- CIMAP, NBRI, CDRI; **Aromatic plants as medicine -** extraction and processing, export potential and medicinal uses, eg.,*Santalum album, Cinnamomum camphora, Cymbopogon* spp*., Eucalyptus* spp*, Jasminum*spp., *Lavendula officinalis, Rosa damascena, Pogostemon perilloides, Rosmarinus officinalis*.

Unit 3:

Conservation of plant resources: concept, ethics and philosophy of conservation; Plant diversity in India - a brief account of diversity of major groups of plants (Algae, Fungi, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms); **Levels of diversity:** ecosystem, species and genetic diversity.

Unit 4:

Threats to natural resources: Human population growth, habitat loss, pollution, introduced species, fires, diseases; Impact of GMOs on local biodiversity, strategies of conservation *Ex-Situ* and *In-Situ*.; Hotspots of biodiversity; International organizations for biodiversity conservation- IUCN, Species Survival Commission (SSC), Convention on Biological Diversity (CBD), CITES, TRAFFIC, WWF; **Plant genetic resources:** Conservation, gene bank- methods, types, NBPGR, TKDL and IPGR.

Suggested Laboratory Exercises

1. Study of medicinal plants
   1) *Clerodendron infortunatum* 2) *Cassia mimosoids*
   3) *Solanum xanthocarpum* 4) *Argyria cuneata*
   5) *Lantana crenulata* 6) *Santalum album*
   7) *Lawsonia inermis* 8) *Holarrhenaantidysenterica*
   9) *Aloe berbadensis* 10) *Centella asiatica*
   11) *Morinda tinctoria* 12) *Plumbago zeylanica*
   13) *Gymnema sylvestre* 14) Other plants
1. Study of commercial medicinal plants.
2. Determination of density, abundances, and frequency of some medicinal plants by Quadrat/Transact methods.
3. Assessment of basal area of a small patch of forest.
4. Determination of Importance Value Index (IVI) of plant species in plant community.
5. Determination of species diversity (α- diversity) index in plant community.
   a. Shannon–wiener **b**. Simpson etc.
6. Measurement of similarity index (β- diversity) in two different plant communities by a) Jaccard measure (Qualitative), b) Morista Horn (Quantitative).
7. Vegetative propagation techniques.
8. Diseases and pests of medicinal plants.
9. Mapping of biodiversity hot spots of the world, India and Karnataka.
10. Survey of ethnobotanical information by standard questionnaire method.
11. Ethnobotanical studies - Doctrine of Signature.
12. Visit to meteorological station, sanctuary, National parks, MPCA and submission of reports.
13. Models / Charts / Photographs related to this paper.
14. Other experiments which are not listed here pertaining to this paper.

Suggested Readings

1. Aggarwal V.S. and Ghosh B 1985, Drug plants of India (Root Druga) Kalyani publishers, New Delhi,
2. Ambasta, S.P. 1988 (ed). The useful plants of India. CSIR, New Delhi.
3. Bajaj YPS Ed. 1986. Biotechnology in agricultre and forestry. Springer verlag.
4. C.K.Kokatae, A.R.Purohit, S.B.Gokhale,D.K.Furia. (1990). Pharmocognosy. Niraliprakashan, Pune.
5. Cotton C M (1996). Ethnobotany, Principles and applications, John Wiley, New York.
6. Gopalan C, Ramasastri B V and Balasubramanian S C (1985). Nutritive value of Indian foods. National institute of nutrition, Hyderabad.
7. Iyengar.M.A.(1991), Study of crude drugs, Director and publishers, KMC Manipal.
8. Jain, S.K. (ed) 1981. Glimpses of Indian Ethnobotany, Oxford & IBH, New Delhi.
9. Jain, S.K. (ed) 1989. Methods and Approaches in Ethnobotanists, Lucknow.
10. Jain,S.K., Sinha,B.K.andGupta,R.C.(1991), Notable plants in ethno medicine of India. Deepa Publications, New Delhi.
11. K.D. Tripathi. (1985). Essentials of medical pharmacology. Jaypee Brothers medical publishers (P) ltd. Daryaganj. NewDelhi.
12. Singh, B., & Sharma, Y. P. (Eds.). (2021). Plants for Novel Drug Molecules: Ethnobotany to Ethnopharmacology (1st ed.) New India Publishing Agency.
13. Adnan, M., Patel, M., & Snoussi, M. (Eds.). (2023). Ethnobotany and Ethnopharmacology of Medicinal and Aromatic Plants: Steps towards Drug Discovery (1st ed.) Taylor & Francis. CRC Press.
14. Sangode, V. K., Somkuwar, S. R., & Kalbande, R. B. (2024). An International Textbook on Medicinal Plants of India: An Ethnobotanical Research (1st ed.). IIP Proceedings / Edu Focus.

Dept. of Applied Botany, Kuvempu University

Semester-IV

Course Code: BO4.2: HardCore-2

Molecular Biology and Genetic Engineering of Plants

Marks: 150 (Theory final exam 75 + internal assessment 25 + Practical exam 50)
Duration: 64 Hours. Teaching hours: 16 lectures/Unit

Course Objectives:

This course would provide students with an understanding of principles and techniques of molecular biology, analysis of transgenic plants, and their applications in basic and applied research. In addition, students would be exposed to the economic importance and current research paradigms in various categories of commercially cultivated plants.

Course Learning Outcomes:

The students will learn about-

1. Concepts, tools and techniques related to molecular techniques.
2. Different methods used for genetic transformation of plants, use of *Agrobacterium* as a vector for plant transformation, components of a binary vector system.
3. Various case studies related to basic and applied research in plant sciences using transgenic technology.
4. Principles and methods used for phenotypic, genetic and molecular analysis of transgenic plants.
5. Uses and current research paradigms in various plants of economic value.

Course Contents:

Unit 1:

Organization, structure and functions of plant genome: Nuclear, chloroplast and mitochondrial genomes, evolution of mitochondrial and chloroplast genomes. **Information transfer:** introduction to nucleic acids- models, evidences to prove DNA and RNA as genetic material, DNA replication. Transcription and translation, post-translation modifications of proteins. Regulation of gene action in prokaryotes and eukaryote, operon concept (lac and trp).

Unit 2:

Eukaryotic genome and gene structure: Nuclear genome, genomic components, Coding (protein /RNA coding) and non-coding regions. **Gene and Promoter structure:** introns and exons, and function, enhancers, insulators, silencers and UTRs. **Recombinant DNA and Gene cloning:** Cloning and expression vectors, plasmids, phages, cosmids, viruses, transposons, YAC, MAC. Molecular probes. Restriction enzymes for cloning, cloning in bacteria and eukaryotes. Molecular markers used in genetic engineering.

Unit 3:

Genomics and Proteomics: Structural Genomics- Genome anatomy of prokaryote and eukaryote, tools and strategy to decipher genome. **Functional Genomics:** Regulation of Genomic activity, Genome profiling, Microarray, Genome Projects (*Arabidopsis* & Human). **Proteomics:** Basic principles and application, 2D gel analysis. **Molecular probes:** southern, northern and western blotting, dot and slot blots, construction and screening of genomic and c DNA libraries, and chromosome walking.

Unit 4:

Principles and methods of genetic transformation: Introduction, direct gene transfer methods- particle bombardment, electroporation, PEG-mediated and floral-dip, marker and reporter genes. ***Agrobacterium* biology and biotechnology:** Plant and *Agrobacterium* interactions. **Applications of genetic transformation:** Case studies on use of transgenic technology for basic studies and crop/plant improvement, phenotypic, genetic and molecular analysis of transgenic plants; genome editing for crop improvement, environmental, social and legal issues.

Suggested Laboratory Exercises

1. Colorimetric estimation of RNA using orcinol.
2. Colorimetric estimation of DNA using diphenylamine.
3. Isolation of plant DNA from onion/cauliflower/ coconut endosperm.
4. Preparation of tissue culture media, sterilization and inoculation of plant material.
5. Demonstration of techniques of *in vitro* culture of various explants.
6. Chromosome banding technique.
7. Gel electrophoresis study of plant genetic DNA.
8. PCR amplification on selected DNA fragment extracted from plant material.
9. Restriction digestion of genomic DNA and construction of restriction map.
10. Transformation of *E. coli* by suitable plasmids, transposon mutagenesis.
11. Micropropagation and induction of embryogenesis (Somatic and Gametic).
12. Demonstration of sophisticated instruments: Ultracentrifuge, fraction collector, Gel documentation, HPLC, PCR, and AAS.
13. Models / Charts / Photographs related to Molecular Biology and Genetic Engineering of Plants.
14. Other experiments which are not listed here pertaining to this paper.

Suggested Readings:

1. Gerald Karp, 2020, The Cell, Cell and Molecular Biology-Concept and Experiments 9th editon.
2. Buchanan, B.B., Gruissem, W. and Jones, R.L. (2015). Biochemistry and Molecular Biology of Plants, John Wiley and Sons Ltd., UK.
3. E D P De Robertis , E M F De Robertis, Jr. 2017.Cell and Molecular biology, 8th edition.
4. Davies, P.J. (2010). Plant Hormones, Kluwer Academic Publishers, Netherlands.
5. Jocelyn .E. KREBS, Elliott.S. , Goldstein, Stephen.T.Kilpatrick, Lewin's. 2017. Genes IIIrd ,XII edition.
6. Kirakosyan, A. and Kaufman, P.B. (2016). Recent Advances in Plant Biotechnology, Springer, UK.
7. J.M. Walker and R Rapley. 2021.Molecular Biology and Biotechnology, 5th edition.
8. Wilson and walker 2023. Principles and techniques of Biochemistry and molecular Biology CAMBRIDGE UNIVERSITY PRESS Cambridge, New York.

Semester-IV

Course Code: BO4.5

Project Dissertation

Marks: 100 (Dissertation 75 + Viva Voce examination 25) **Duration:** 4 months.

Student shall select a topic from the subject and continue research under a supervisor for 4 months and submit the dissertation. The VIVA-VOCE examination will be conducted by inviting external examiner and research supervisor and be evaluated.

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Model Question Paper

M.Sc. First semester Examination-20----------

(CBCS Scheme)

Subject- Botany

PAPER- Hard Core-1- PHYCOLOGY AND MYCOLOGY

Note: 1. Answer All Questions.
2. Write diagram wherever necessary.

Time: 3 hours **Max. Marks: 75**

I. Define/explain the following **02 x 10 = 20**

1. from unit 1
2. from unit 2
3. from unit 3
4. from unit 4
5. from unit 5
6. from unit 6
7. from unit 7
8. from any units
9. from any units
10. from any units

II. Write Short notes on any Five of the following **05 x 5 = 25**

11. from unit 1
12. from unit 2
13. from unit 3
14. from unit 4
15. from unit 5
16. from unit 6
17. from unit 7

III. Answer any Three of the following **03 x 10 = 30**

18. from unit 1
19. from unit 2
20. from unit 3
21. from unit 4
22. from remaining units

Model Question Paper

M. Sc. First semester Examination-20----------

(CBCS Scheme)

Subject- Botany

Paper- Soft - Core-2: BIOFERTILIZERS

Note : 1. Answer All Questions.

2. Write diagram wherever necessary.

Time: 3 hours **Max. Marks: 75**

I. Define/explain the following **02 x 10 = 20**

1. from unit 1
2. from unit 2
3. from unit 3
4. from unit 4
5. from unit 5
6. from unit 6
7. from unit 7
8. from any units
9. from any units
10. from any units

II. Write Short notes on any Five of the following **05 x 5 = 25**

11. from unit 1
12. from unit 2
13. from unit 3
14. from unit 4
15. from unit 5
16. from unit 6
17. from unit 7

III. Answer any Three of the following **03 x 10 = 30**

18. from unit 1
19. from unit 2
20. from unit 3
21. from unit 4
22. from remaining units

Model Question Paper

M. Sc. First semester Examination-20----------

(CBCS Scheme)

Subject- Botany

PAPER-Course Code: BO3.3: Soft core -1

Plant Diversity and Human welfare

Note : 1. Answer All Questions.

2. Write diagram wherever necessary.

Time: 3 hours **Max. Marks: 75**

I. Define/explain the following **02 x 10 = 20**

1. from unit 1
2. from unit 2
3. from unit 3
4. from unit 4
5. from unit 5
6. from unit 6
7. from unit 7
8. from any units
9. from any units
10. from any units

II. Write Short notes on any Five of the following **05 x 5 = 25**

11. from unit 1
12. from unit 2
13. from unit 3
14. from unit 4
15. from unit 5
16. from unit 6
17. from unit 7

III. Answer any Three of the following **03 x 10 = 30**

18. from unit 1
19. from unit 2
20. from unit 3
21. from unit 4
22. from remaining units

Model Question Paper

I Semester M.Sc., Practical Examination, May 20-----

Subject- Botany

PAPER-BO1.1. Hard Core-1: Phycology and Mycology

Time: 3h (10 am to 1 pm) **Max. Marks: 50**

1. Conduct the given experiment 'A', write down the procedure and tabulate the result and leave for evaluation. 10 marks
2. Conduct the given experiment ' B ' and comment on the results. 5 marks
3. Identify and Comment on the specimens 'C , D and E'. 15 marks
4. Observe the slides F G H and comment on them. 15 marks
5. Class record 5 marks

III Semester M.Sc., Practical Examination, May 20-----

Subject- Botany

PAPER- Course Code: BO3.3: Soft core -1

Plant Diversity and Human Welfare

Time: 3h (10 am to 1 pm) **Max. Marks: 50**

1. Conduct the given experiment 'A', write down the procedure and tabulate the result and leave for evaluation. 10 marks
2. Conduct the given experiment 'B' and comment on the results. 5 marks
3. Identify and Comment on the specimens 'C, and E'. 15 marks
4. Observe the slides 'F' 'G' 'H' and comment on them. 15 marks
5. Class records 5 marks
