C. M. S. COLLEGE
KOTTAYAM
KERALA

SYLLABUS FOR UNDERGRADUATE PROGRAMME IN

BOTANY

(EFFECTIVE FROM 2018 ADMISSIONS)

RECOMMENDED BY:

BOARD OF STUDIES, BOTANY

C. M. S. COLLEGE, KOTTAYAM

B. Sc. BOTANY PROGRAMME

PROGRAMME DESIGN

The UG programme in Botany must include
(a) Common Courses*,
(b) Core Courses
(c) Complementary Courses
(d) Open Course
(e) Choice based Course and
(f) Projectwork.

No course shall carry more than 5 credits. The student shall select one Open course in Semester V offered by different departments in the same institution. The number of courses for the programme should contain 12 compulsory core courses,1 open course,1 elective course from the frontier area of the core courses, 6 core practical courses, 1project work, 8 complementary courses and 2 complementary practical courses. There should be 10 common courses,or otherwise specified, which includes the first and second language of study.

PROGRAMME STRUCTURE: SUMMARY OF COURSES AND CREDITS

Sl. No.	Coursetype	No.of courses	Total credits
1	Common course I-English	6	22
2	Common course II– Additionallanguage	4	16
3	Core + Practical	12 + 6	46
4	ComplementaryI+ Practical	4 + 2	14
5	ComplementaryII+ Practical	4 + 2	14
6	Opencourse	1	3
7	Programme elective	1	3
8	Project work	1	2
Total		**43**	**120**
Totalcredits		120	
Programme duration		6 Semesters	
Minimum attendance required		75%	

***Course:** a segment of subject matter to be covered in a semester. Each course is designed variously under lectures /tutorials /laboratory or fieldwork /seminar /project /practical training /assignments /evalution etc., to meet effective teaching and learning needs.

B. Sc. BOTANY PROGRAMME

SEMESTER-WISE DISTRIBUTION OF COURSES AND CREDITS

CourseTitle	Hrs/ week	Credits	CourseTitle	Hrs/ week	Credits
SEMESTER I			**SEMESTER II**		
Common course– English 1	5	4	Common course– English3	5	4
Common course– English 2	4	3	Common course– English4	4	3
Common course– Additionallanguagecourse 1	4	4	Common course– Additionallanguagecourse2	4	4
Core course 1 + Practical	4	3	Corecourse 2 + Practical	4	3
1st Complementarycourse – Zoologycourse 1+ Practical	4	3	1st Complementarycourse – Zoologycourse 2+ Practical	4	3
2nd Complementarycourse – Chemistry/Biochemistrycourse1 + Practical	4	3	2nd Complementarycourse - Chemistry/Biochemistrycourse 2 + Practical	4	3
Total	**25**	**20**	**Total**	**25**	**20**
SEMESTER III			**SEMESTER IV**		
Common course– English5	5	4	Common course– English6	5	4
Common course– Additionallanguagecourse3	5	4	Common course– Additionallanguagecourse4	5	4
Core course 3 + Practical	5	4	Corecourse 4 + Practical	5	4
1st Complementarycourse – Zoologycourse 3+ Practical	5	4	1st Complementarycourse – Zoologycourse 4+ Practical	5	4
2nd Complementarycourse – Chemistry/Biochemistrycourse3 + Practical	5	4	2nd Complementarycourse – Chemistry/Biochemistrycourse 4+Practical	5	4
Total	**25**	**20**	**Total**	**25**	**20**
SEMESTER V			**SEMESTERVI**		
Corecourse 5 + Practical	5	4	Corecourse 9 + Practical	5.5	4
Corecourse 6 + Practical	5.5	4	Corecourse 10 +Practical	5	4
Corecourse 7 + Practical	5.5	4	Corecourse 11 +Practical	6.5	4
Corecourse 8 + Practical.	5	4	Corecourse 12 +Practical	5	4
Opencourse	4	3	Programmeelective-Choicebasedcorecourse	3	3
Total	**25**	**19**	Projectwork	--	2
			Total	**25**	**21**

B. Sc. BOTANY PROGRAMME

COMBINATION OF CORE AND COMPLEMENTARY COURSES AND SEMESTER-WISE DISTRIBUTION

Sem.	Course category	Course code	Course title	Instr.hrs.*		Credits
				Th.	Pr.	
I	Core	BO1CRT01	Methodology of Science and an Introduction to Botany	36	36	2 +1
II	Core	BO2CRT02	Microbiology, Mycology and Plant Pathology	36	36	2 + 1
III	Core	BO3CRT03	Phycology and Bryology	54	36	3 + 1
IV	Core	BO4CRT04	Pteridology, Gymnosperms and Paleobotany	54	36	3 + 1
V	Core	BO5CRT05	Anatomy, Reproductive Botany, Microtechnique	54	36	3 + 1
	Core	BO5CRT06	Research Methodology, Biophysics and Biostatistics	54	45	3 + 1
	Core	BO5CRT07	Plant Physiology and Biochemistry	54	45	3 + 1
	Core	BO5CRT08	Environmental sciences and Human Rights	54	36	3 + 1
	Open	BO5OPT01	Agri-based Microenterprises	72	--	4
VI	Core	BO6CRT09	Genetics, Plant Breeding and Horticulture	54	45	3 + 1
	Core	BO6CRT10	Cell and Molecular Biology	54	36	3 + 1
	Core	BO6CRT11	Angiosperm morphology, Taxonomy and Economic Botany	72	45	4 + 1
	Core	BO6CRT12	Biotechnology and Bioinformatics	54	36	3 + 1
	Elective	BO6PET01	Agribusiness	54	--	3
	Project	BO6PRT01	Investigatory project work done individually or in groups	--	--	2
I	Compl. 1	BO1CMT01	Cryptogams,Gymnosperms and Plant Pathology	36	36	2 + 1
II	Compl. 2	BO2CMT02	Plant Physiology	36	36	2 + 1
III	Compl. 3	BO3CMT03	Angiosperm Taxonomy and Economic Botany	54	36	3 + 1
IV	Compl. 4	BO4CMT04	Anatomy and Applied Botany	54	36	3 + 1

* 18 instructional hours is equal to one teaching hour per week

SEMESTER I

Core Course 1; Code: BO1CRT01
METHODOLOGY OF SCIENCE AND AN INTRODUCTION TO BOTANY
(Theory 36 hrs; 2 Credits)

Aim To lay a strong foundation for the study in Botany

Objectives:

- Understand the universal nature of science
- Demonstrate the use of scientific method
- Impart an insight into the different types of classifications in the living kingdom.
- Appreciate the world of organisms and its course of evolution and diversity.
- Develop basic skills to study Botany in detail.

Module 1
Methodology of Science

Unit 1: Introduction to science and the methodology of science (4 hrs) Scientific method: steps involved - observation and thoughts, formulation of hypothesis; inductive reasoning - testing of hypothesis; deductive reasoning - experimentation - formulation of theories and laws.
Unit 2: Experimentation in science (4 hrs) Selection of a problem - searching the literature – designing of experiments - selection of variables, study area, and a suitable design. Need of control, treatments and replication. Mendel's experiments as an example of moving from observations to questions, then to hypothesis and finally to experimentation. Ethics in science.
Unit 3: Origin and evolution of life (10 hrs) Origin of life on earth from molecules to life - Oparin,,s hypothesis, Haldane,,s hypothesis, Miller-Urey experiment, Panspermia, origin of cells and the first organisms. Evolutionary history of Biological diversity – fossil record; geological time scale – major events in each era. Evidences of evolution; theories of evolution - Lamarck, Wallace, Charles Darwin, Hugo De Vries. Neo-Darwinism – major postulates - isolation, mutation, genetic drift, speciation.

Module 2
Introduction to botany

Diversity of life and its classification (12 hrs)
Diversity of life: two kingdom classification (Carolus Linnaeus, 1735); phylogenetic classification (August W Eichler, 1878); five kingdom classification (R H Whittaker, 1969). Three domains, six kingdom classification, (Carl Woese, 1990) – criteria for classification, general characters of each kingdom. The three domains of life: Archaea, Bacteria, Eucarya – general characters of each. Diversity of plants: study the salient features of algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms.

Module 3
Basic Botanical skills (6 hrs)
Light microscope: dissection and compound microscope – parts and uses. Preparation of specimens for light microscopy - collection and preservation of plant specimens; killing and fixing; killing agents - formalin, ethyl alcohol; fixing agents - Carnoys fluid, Farmer"s fluid, FAA; herbarium (brief study only). Whole mounts and sections – hand sectioning – TS, TLS, RLS. Staining of plant tissues: Purpose; Stains - safranine, acetocarmine, and crystal violet. Temporary and permanent mounts, mountants.

PRACTICAL (36 hrs; 1 Credit)

1. Design an experiment to verify a given hypothesis.
2. Conduct a survey-based inquiry on a given topic (To test the validity of a given hypothesis. E.g., all angiosperm parasites are Dicot plants).
3. Select an important classical experiment and find out the different elements of the methodology of science (e.g., Robert Koch experiment).
4. Conduct field surveys to identify and collect plant specimens to appreciate the diversity of plant kingdom. Submit five preserved specimens (in bottles and/or herbarium) belonging to diverse groups.
5. Identification of plants with vascular elements, plants which produce flowers, fruits, seeds, cone, sporophyll, embryos and study their salient features.
6. Prepare temporary, stained hand sections (TS, TLS, RLS) of plant specimens appropriate for light microscopic studies.

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15. Prasad M K, Krishna Prasad M, 1986. Outlines of microtechnique. Emkay Publishers, New Delhi.
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SEMESTER II

Core Course 2; Code: BO2CRT02
MICROBIOLOGY, MYCOLOGY AND PLANT PATHOLOGY (Theory 36 hrs; 2 Credits)

Aim To study the evolutionary importance of Microbes in the origin of life

Objectives:

- Understand the world of microbes, fungi and lichens
- Appreciate the adaptive strategies of the microbes, fungi and lichens
- To study the economic and pathological importance of microorganisms

Module 1
Microbiology (Theory 9 hrs)

Unit 1
Introduction (1 hr)
Introduction to microbiology, scope of microbiology.
Unit 2
Bacteria (4 hrs)
Bacteria: general characters and classification based on staining, morphology and flagellation. Ultra structure of bacteria. Reproduction - binary fission. Genetic recombination in bacteria - conjugation, transformation and transduction. Economic importance of bacteria.
Unit 3
Viruses (2 hrs)
General characters of viruses, viriods and prions. Structure of TMV and Bacteriophage (λ). Multiplication of λ phage – lytic and lysogenic cycle.
Unit 4
Applied microbiology (2 hrs) Isolation and culture of bacteria; media used – general purpose and selective media, applications of bacterial culture (brief study only). Role of microbes: in producing antibiotics, vine, vinegar, curd – role in N_2 fixation, as biofertilizers – role in food spoilage (Brief study only).

Module 2
Mycology (Theory 18 hrs; Practical 18 hrs)
Unit 1
Introduction, classification and types of fungi (13 hrs)
General characters of fungi. Classification of fungi - Ainsworth (1973). Distinguishing characters of the different classes of fungi with special reference to reproductive structures and life history of the genera mentioned in each group: Myxomycotina – *Physarum*; Mastigomycotina – *Albugo*; Zygomycotina - *Rhizopus*; Ascomycotina – Hemiascomycetes - *Saccharomyces*; Plectomycetes - *Penicillium*; Pyrenomycetes – *Xylaria*; Discomycetes - *Peziza*; Basidiomycotina – Teliomycetes – *Puccinia*; Hymenomycetes – *Agaricus*; Deuteromycotina – *Fusarium.* **Unit 2**
Economic importance of fungi (3 hrs) Useful and harmful effects of fungi - medicinal, industrial, agricultural, food, genetic studies, spoilage, fungal toxins and diseases. Mycorrhiza: ecto- and endomycorrhiza, significance.
Unit 3
Lichens (2 hrs) General characters, types, general internal structure. Economic and ecological significance of lichens. Structure, reproduction and life cycle of *Parmelia.*

Module 3
Plant Pathology (Theory 9 hrs)
Unit 1
Plant disease development (3 hrs) History of plant pathology. Classification of plant diseases on the basis of causative organism and symptoms. Host parasite interaction - defence mechanisms in host, mechanism of infection, transmission and dissemination of diseases.
Unit 2
Common plant diseases (4 hrs) Study of following diseases with emphasis on symptoms, cause, disease cycle and control: Bunchy top of Banana, Bacterial blight of Paddy, Root wilt of Coconut, Abnormal leaf fall of Rubber, Root knot disease of Pepper, Leaf mosaic disease of Tapioca, Citrus canker.
Unit 3
Control of diseases (2 hrs) Prophylaxis - quarantine measures, seed certification; Therapeutic - physical therapy, chemotherapy; Biological control and its significance. Fungicides - Bordeaux mixture. Tobacco and Neem decoction (Brief study only).

PRACTICAL (36 hrs; 1 Credit)

Microbiology (9 hrs)
1. Gram staining - curd, root nodules. 2. Isolation of microbes from soil through serial dilution and streak plate method. 3. Demonstrate the culture of bacteria. 4. Microbes and type of fermentation - vine, vinegar, curd.

Mycology (18 hrs.)
1. Micropreparation and detailed microscopic study of *Rhizopus, Albugo, Saccharomyces, Penicillium, Xylaria, Peziza, Puccinia, Fusarium* and *Parmelia.*
2. Staining and microscopic observation of endomycorrhizal fungus.
3. Investigation of fungal succession on cow dung.

Plant Pathology (9 hrs)
1. Identify the diseases mentioned in the syllabus with respect to causative organisms and symptoms
2. Submit herbarium preparations of any three of the diseases mentioned.
3. Learn the technique of preparing Bordeaux mixture, Tobacco and Neem decoction.

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SEMESTER III

Core Course 3; Code: BO3CRT03

PHYCOLOGY AND BRYOLOGY (Theory 54 hrs; 3 Credits)

Aim To study the evolutionary importance of Algae as progenitors of land plants

Objectives:

- Understand the unique and general features of Algae and Bryophytes and familiarize it
- To study the external morphology, internal structure and reproduction of different types of Algae and Bryophytes
- Realize the application of Phycology in different fields

Module 1
Phycology (Theory36 hrs)
Unit 1
Introduction and Classification of Algae (9 hrs)

Introduction: General characters, habitat diversity, range of thallus structure and pigments in algae; structure of algal flagella. Different types of life cycle and alternation of generations in algae.

Classification by Fritsch (1945); Brief introduction to the modern classification by Lee(2009) [uptodivisions].

Unit 2
Type Study (18hrs)

Salient features, thallus structure and reproduction of algae in the following groups with special reference to the type(s) mentioned: Cyanophyceae - *Nostoc*; Chlorophyceae-*Volvox, Oedogonium, Cladophora, Chara;* Xanthophyceae–*Vaucheria;* Bacillariophyceae-*Pinnularia*; Phaeophyceae–*Ectocarpus, Sargassum*; Rhodophyceae-*Polysiphonia*.

Module 2
Artificial culture and Economic importance of Algae (9hrs)

Algal culture: isolation, cultivation and preservation of micro and macro algae. Economic importance of algae:algae as food,SCP,fodder,green manure,role in N_2fixation, medicine and biofuels.Commercial productsfromAlgae-carrageenin,agar-agar,alginates anddiatomaceous earth.Role of algae in pollution studies:as indicators of pollution and as bioremediation agents.Eutrophication–algal bloom; harmful and toxic algal blooms– neurotoxins and parasitic algae.

Module 3
Bryology (Theory18 hrs)
Unit 1
General introduction and Classification of Bryophytes (4 hrs)

Introduction, general characters and classification of bryophytes by Rothmaler (1951);a very brief account of systems by Goffinet *etal* (2008).

Unit 2

Type Study (12hrs)

Distribution, morphology, anatomy, reproduction and life cycle of the following types (developmental details are not required):Hepaticopsida - *Riccia, Marchantia*; Anthocerotopsida - *Anthoceros*; Bryopsida -*Funaria*. Evolution of gametophyte and sporophyte among Bryophytes.

Module 4

Economic importance (2hrs)

Economic importance of Bryophytes – biological, Ecological, medicinal and as potting material.

PRACTICAL (36hrs; 1 Credit)

Phycology

1. Conduct a field visit to any one of the ecosystems rich in Algae to experience algal diversity. Submit a report with photographs.
2. Make micropreparations of vegetative and reproductive structures of the types mentioned in the syllabus.
3. Algal Culture: isolation and cultivation of micro and macro-algae in suitable growth media (Demonstration only).
4. Familiarizing the technique of algal collection preservation.

Bryology

1.Study the habit , anatomy of thallus and reproductive structures of *Riccia*, *Marchantia, Anthoceros*, and *Funaria*.

REFERENCES

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SEMESTER IV

Core Course 4; Code: BO4CRT04

PTERIDOLOGY, GYMNOSPERMS AND PALEOBOTANY

(Theory 54 hrs; 3 Credits)

Aim To understand the diversity in habits, habitats and organization of various groups of plants.

Objectives:

- Impart an insight into the modern classifications in lower forms of plants.
- Understand the evolutionary trends in Pteridophytes and Gymnosperms.
- Study the anatomical variations in vascular plants.
- Understand the significance of Paleobotany and its applications.

Module 1

Pteridology (Theory: 27 hrs)

Unit 1

General introduction and classification of Pteridophytes (5 hrs)

Introduction, general characters and classification of Pteridophytes upto classes by Smith (1955) and a very brief account of the classification by Christen husz *eta*l., 2011.

Unit2

Type Study (18hrs)

Study the distribution, morphology, anatomy, reproduction, life cycle and affinities of the following types (Developmental details are not required): Psilophyta -*Psilotum*; Lycophyta- *Lycopodium, Selaginella;* Sphenophyta- *Equisetum;* Pterophyta- *Pteris, Marsilea.* Stelar evolution in Pteridophytes; Heterospory and seed habit.

Unit 3

Economic importance (4hrs)

Importance of Pteridophytes: medicinal, ornamental, as biofertilizer.

Module 2

Gymnosperms (Theory: 18 hrs.)

Unit 1

General introduction and Classification of Gymnosperms (5 hrs)

Introduction, Generalcharacters ,classification of Gymnosperms by Sporne (1965) and a very brief account of the classification by Christenhusz *etal*(2011).

Unit 2

Type Study (11hrs)

Distribution, morphology, anatomy, reproduction, lifecycle and affinities of the following types (Developmental details are not required): Cycadopsida–*Cycas*; Coniferopsida–*Pinus*; Gnetopsidae – *Gnetum.*Affinities of Gymnosperms with Pteridophytes and Angiosperms.

Unit 3

Economic importance of Gymnosperms (2 hrs)

Uses of Gymnosperms: as food , medicine, in industry and as ornamental plants.

Module 3
Paleobotany (Theory: 9hrs)
Unit 1

Fossils (6hrs)

Introduction to Paleobotany and its significance. Fossil formation, types of fossils. Study of fossil Bryophyte-*Naiadita lanceolata;* fossil Pteridophytes–*Rhynia, Calamites;* fossil Gymnosperm–*Williamsonia.* Applied aspects of Paleobotany- exploration of fossil fuels.

Unit 2

Paleobotany in India (3 hrs)

Brief study of the fossil deposits in India. Important Indian Paleobotanical Institutes, Contributions of Indian Paleobotanists-Birbal Sahni.

PRACTICAL (36 hrs.; 1 Credit)

Pteridology

1. Habit, T. S. of stem, L S of strobilus and sections of special structures of the following types: *Psilotum, Lycopodium, Selaginella, Equisetum, Pteris, Marsilea.*

Gymnosperms

1. Study of the habit, T S of leaf and stem,morphology of reproductive structures of *Cycas*, *Pinus* and *Gnetum.*

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SEMESTER V

Core Course 5; Code: BO5CRT05

ANATOMY, REPRODUCTIVE BOTANY AND MICROTECHNIQUE
(Theory 54 hrs; 3 Credits)

Aim To Impart an insight into the internal structure and reproduction of the most evolved group of plants, the Angiosperm.

Objectives:

- Understand the individual cells and tissues simultaneously
- Understand the structural adaptations in plants growing in different environment.
- Understand the morphology and development of reproductive parts.
- Get an insight into the fruit and seed development.
- Understand the techniques used to preserve and study plant materials.

Module 1
Anatomy (Theory: 27hrs.)
Unit 1
Structure and composition of plant cells (8 hrs)
Cell wall: structure of cell wall; sub-microscopic structure- cellulose,micelle,microfibril and macrofibril;structure and function of plasmodesmata, simple and bordered pits; different types of cell wall thickening in treachery elements ; extra cell wall thickening materials.Growth of cell wall-apposition, intussusception.Non-living inclusions in plant cells:food products, secretory products,excretory (waste) products -nitrogenous and non nitrogenous.
Unit 2
Organization of Tissues (9 hrs)
Tissues: meristematic tissue–characteristicfeatures, functions and classification.Theories on apical organization-apical cell theory , histogen theory, tunica-corpus theory. – Structure and function of simple and complex tissues. Secretory tissues: external secretory tissue-glands and nectaries; internal secretory tissues-laticifers.
Tissue systems: epidermal tissue system- epidermis, cuticle, trichome; stomata–structure,types; bulliform cells. Ground tissue system-cortex, endodermis, pericycle,pith and pith rays.Vascular tissue system-structure of xylem and phloem, different types of vascular bundles and their arrangement in root and stem.
Unit 3
Plant body structure (6hrs)
Primary structure of stem, root and leaf (dicot and monocot). Normal secondary growth in dicot stem and root. Periderm: structure and development-phellum, phellogen, phelloderm, bark, and lenticels. Anomalous secondary thickening: *Bignonia* stem, *Boerhaavia* stem and *Dracaena* stem.
Unit 4
Wood anatomy(4 hrs)
Basic structure of wood-heart wood,sap wood;hard wood,soft wood;growth rings and dendrochronology ;porous and non-porous wood; ring porous and diffuse porous wood, tyloses. Reaction wood: tension wood and compression wood.

Module 2
Reproductive Botany (Theory 18 hrs)

Unit 1
Introduction (2hrs)
Introduction to embryology, floral morphology-parts of flower.
Unit 2
Microsporangium and male gametophyte (4 hrs)
Microsporangium: structure and development of anther, microsporogenesis, dehiscence of anther, structure of pollen.Malegametophyte development.
Unit 3
Megasporangium and female gametophyte (6hrs)
Megasporangium: typesof ovules– anatropous, orthotropous, amphitropous, campylotropous, Megasporogenesis–female gametophyte–structure of a typical embryosac,types ofembryo sacs-monosporic (*Polygonum* type), bisporic (*Allium* type) and tetrasporic (*Peperomia* type).
Unit 4
Fertilization (2hrs)
Mechanism of pollination, agents of pollination, germination of pollen grains; double fertilization.
Unit 5
Endosperm and Embryo (4hrs)
Endosperm: types–cellular, nuclear and helobial. Embryogeny, structure of dicot and monocot embryo, seed formation. Polyembryony.

Module 3
Microtechnique (Theory 9 hrs)
Preservation of plant specimens, sectioning and mounting (9hrs)
Introduction to microtechnique: killing and fixing - purpose. Dehydration - purpose, agents used-ethyl alcohol.Sectioning: handsections, serialsection; Microtome-rotary, sledge (applicationonly). Staining technique: principle of staining; stains- hematoxylin, fastgreen, acetocarmine; vital stains-neutral red, Evans blue ; mordants- purpose with examples. Types of staining-single staining, double staining. Mounting and mounting media–purpose, mounting media-glycerine, DPX, Canada balsam.Use of permanent whole mounts; permanent sections; maceration, smear and squash preparation.

PRACTICAL (36 hrs; 1 Credit)

Anatomy

1. Studyof cel ltypes and tissues.
2. Non-living inclusions-starch grains, cystolith, raphides, aleurone grains.
3. Primary structure of stem, root and leaf-Dicots and Monocots.
4. Dissect and identify the stomatal types-anomocytic,anisocytic,paracytic and diacytic.
5. Secondary structure of dicot stem and root.
6. Anomalous secondary structure of *Bignonia* stem, *Boerhaavia* stem, and *Dracaena* stem.

Reproductive Botany

1. Dissect and display parts of different types of flowers.
2. Identification of C.S.of anther, embryo sac and embryo.
3. Identification of various anther types-monothecous, dithecous.
4. Identifythe different types of ovules.

Microtechnique

1. Familiarize preparation and use of stains, fixatives and mounting media.
2. Preparation of smears and squash.
3. Demonstration of microtome sectioning.
4. Maceration and identification of tracheary elements.
5. Preparation of single stained hand sections (Permanent– demonstrationonly).

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Core Course 6; Code: BO5CRT06
RESEARCH METHODOLOGY, BIOPHYSICS AND BIOSTATISTICS
(Theory: 54 hrs; 3 Credits)

Aim To equip the students to conduct independent research and prepare research reports.

Objectives:

- Acquaint students with different tools and techniques used in research work.
- Equip students with basic computer skills necessary for the conduct of research.
- Enable students to have enough numerical skills necessary to carry out research.

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Module 1
Unit 1
Research Methodology (Theory 18 hrs.)
Introduction(4hrs) -
Objectives of Research, Types of research - pure and applied. Identification of research problem. Review of literature: purpose, literature sources– names of reputed National and International journals in lifescience (2 international &3 National); reprint acquisition- INSDOC,INFLIBNET.
Unit 2
Process of research (7hrs)
Conduct of Research: define the problem, identify the objective, design the study,collection of data,analysis and interpretation. Preparation of research report: preparation of dissertation- IMRAD system-preliminary pages, introduction and review of literature, materials and methods, results, discussion, conclusion and bibliography.
Unit 3
Use of computer in Research (7 hrs)
Introduction to MS-WINDOWS and LINUX, application of MS WORD-word Processing, editing tools (cut, copy, paste), formatting tools. MS EXCEL-creating worksheet , data entry, sorting data. Statistical tools (SUM, MEAN, MEDIAN and MODE). Preparation of graphs and diagrams (Bardiagram, piechart, linechart, histogram).MS POWERPOINT - presentation based on a biological topic; inserting tables, charts, pictures.Open source and free alternatives to MS Office:Libre Office,Open Office (brief study). Search engines: Google.com; metasearchengine–dogpile.com; academicsearch –Google scholar.Educational sites related to biological science-Scitable,DNAi.

Module 2
Biophysics (Theory 18hrs)
Unit 1
Introduction (2hrs)
Introduction to biophysics
Branches of biophysics - Molecular, Cellular, Membrane
Scope of Biomedical instrumentation
Unit 2
Biophysical instrumentation (16hrs)
Principle, working and applications of the following:
Microscopy: compound microscope, phase-contrast microscope and electron microscope–SEM. Colorimeter, Spectrophotometer. Centrifuge: ultracentrifuge. Chromatography: Paper, Thin layer and Column. Electrophoresis, PAGE. pH meter.Haemocytometer.

Module 3

Biostatistics (Theory 18 hrs)

Introduction

Introduction, statistical terms and symbols (Brief study only). Sampling: concept of sample, sampling methods-random and non random sampling.Collection and representation of data:diagrammatic and graphic representation-line diagram, bar diagram, pie diagram, histogram, frequency curve. Measures of central tendency: mean, median, mode, (discrete and continuous series). Measures of dispersion: standard deviation. Distribution patterns: normal distribution, binomial distribution.Tests of significance: Chi-square test-uses, procedure.

PRACTICAL (45 hrs; 1 Credit)

Research Methodology (18 hours)

1. Prepare out line of a dissertation (IMRAD system).
2. Prepare a list of references (not less than10) on a topic in biological science.
3. Review the literature on a given topic.
4. Collect information on a topic related to biological science using the internet.
5. Make a report based on the collected information from the internet (usingMS-WORD).
6. Prepare tables/charts/graphs using EXCEL.
7. Prepare a worksheet using a set of data collected and find out the SUM.
8. Prepare a PowerPoint presentation based on the report in Experiment4.

Biophysics (9 hours)

1. Measurement of pH and adjusting pH using pH meter.
2. Separationof plantpigmentsusingTLC.
3. Determination of the concentration of a sample solution using colorimeter.
4. Demonstration of column chromatography.
5. Count the number of cells/spores using Haemocytometer

Biostatistics (18 hours)

1. Collectnumericaldata, tabulate and represent in different types of graphs and diagrams mentioned in the syllabus.
2. Problems related to mean, median, mode ,standard deviation and Chi-square test.

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Core Course 7; Code: BO5CRT07

PLANT PHYSIOLOGY AND BIOCHEMISTRY
(Theory 54 hrs; 3 Credits)

Aim To acquire the basic knowledge required for proper understanding of the functioning of plants.

Objectives:

- Familiarizewiththebasicskillsandtechniquesrelatedto plantphysiology.
- Understandtherole, structureandimportanceof the biomoleculesassociatedwithplantlife.

Module1
Plant Physiology (Theory 36 hrs)
Unit 1
Water Relations (6hrs)
Plant water relations - diffusion, imbibition, osmosis, OP, DPD, TP; water potential –concepts and components (pressure potential, gravity potential, osmotic potential and matric potential). Absorption of water-active and passive, pathway of water movement-apoplastic and symplastic pathway. Ascent of sap- cohesion- tension theory.Transpiration - types, mechanism, theories (Starch-sugar, Proton-K+ ion exchange), significance; antitranspirants. Guttation.
Unit 2
Mineral Nutrition (3 hrs)
Role of major and minor elements in plant nutrition, deficiency symptoms of essential nutrients; mineral uptake (ion exchange) – passive and active (carrier concept).
Unit 3
Plant Growth and Development (5 hrs)
Plant hormones: thei rphysiological effect and practical applications-auxins, gibberellins, cytokinins, ABA, and ethylene. Plant movements: tropic movements – geotropism and phototropism; nastic movements – seismonastic and nyctinastic movements. Physiology of flowering - phytochrome, photoperiodism, vernalization.
Unit 4
Stress Physiology (2 hrs)
Concepts of plant responses to abiotic stresses (water, salt, temperature), biotic stress (pathogens) and Allelopathy.

Module 2
Plant Metabolism
Unit 1
Photosynthesis (12 hrs)
Photosynthetic pigments, photoexcitation - fluorescence, phosphorescence; red drop and Emerson enhancement effect. Photosystems – components and organization; cyclic and non-cyclic photophosphorylation; carbon assimilation pathways - C3, C4 plants - kranz anatomy, CAM. Photorespiration. Factors affecting photosynthesis - Blackmann‟s law of limiting factors.
Translocation of solutes: pathway of phloem transport, mechanism- pressure flow,mass flow hypothesis;phloem loading and unloading.

Unit 2

Respiration (8hrs)

Respiration: anaerobic and aerobic; glycolysis, Kreb's cycle, mitochondrial electron transport system - components, oxidative phosphorylation, ATPase, chemiosmotic hypothesis. RQ - significance. Factors affecting respiration.

Module 3

Biochemistry (Theory: 18 hours)

Unit 1

Water (3 hrs)

Physical and chemical properties of water, acids and bases; pH-definition, significance ;measurement of pH – colorimetric,electrometric (brief study only). Buffers: buffer action,uses of buffers.

Unit 2

Carbohydrates (3 hrs)

General structure and functions; classification – mono (glucose and fructose), di (maltose and sucrose) and polysaccharides (starch and cellulose).

Unit 3

Proteins (4 hrs)

General structure and classification of amino acids – peptide bond; structural levels of proteins - primary,secondary,tertiaryand quaternary; functions of proteins.

Unit 4

Lipids (2 hrs)

General features and roles of lipids, types of lipids; fatty acids – saturated and unsaturated; fatty acid derivatives - fats andoils;compound lipids(brief study only).

Unit 5

Enzymes (6hrs)

Classification and nomenclature, mechanism of action. Enzyme kinetics, Michaelis – Menten constant (brief study only). Regulation of enzyme action. Factors affecting enzyme action.

PRACTICAL (27 hrs)

Core Experiments (any four compulsory):

1. Determination of osmotic pressure of plant cell sap by plasmolytic/weighing method.
2. Compare the stomatal indices of hydrophytes, xerophytes and mesophytes (anytwo).
3. Separation of plant pigments by TLC/Paper chromatography.
4. Measurement of photosynthesis by Wilmott's bubbler/any suitable method.
5. Estimation of plant pigments by colorimeter.

Demonstrationexperiments:

1. Papaya petiole osmoscope.
2. Demonstration of tissue tension.
3. Relation between transpiration and absorption.
4. Necessity of chlorophyll, light and CO_2 in phytosynthesis.
5. Simple respiroscope.
6. Respirometer and measurement of RQ.
7. Fermentation.
8. Measurement of transpiration rate using Ganong's potometer/Farmer's potometer.

PRACTICAL(18 hrs)

1. General test for carbohydrates – Molischs test, Benedicts's tests, Fehling's test.
2. Colour test for starch - Iodine test.

3. Colour tests for proteins in solution – Xanthoproteic test, Biuret test, Million's test, Ninhydrin test.
4. Action of various enzymes in plant tissues: peroxidase,dehydrogenase.
5. Quantitative estimation of protein using colorimeter.

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Core course 8; Code: BO5CRT08
ENVIRONMENTAL SCIENCE AND HUMAN RIGHTS
(Theory 54 hrs; 3 Credits 3)

Aim To acquaint the student about the significance of Environmental Science.

Objectives:

- Make the students aware about the extent of the total biodiversity and the importance of their conservation.
- Help the student to design novel mechanisms for the sustainable utilization of natural resources.
- Enable the students to understand the structure and function of the ecosystems.
- Enable the students to understand various kinds of pollution in the environment,their impacts on the ecosystem and their control measures
- Make the students aware about various environmental laws in India and the role of various movements in the protection of nature and natural resources.

Module 1
Unit 1
Multidisciplinary nature of environmental studies (2 lectures)
Definition, scope and importance, Need for public awareness.
Unit 2
Natural Resources - Renewable and non-renewable resources (8 lectures)
Natural resources and associated problems –
a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.
b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.
c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
e) Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources.Case studies.
f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources, Equitable use of resources for sustainable lifestyles.
Unit 3
Ecosystems (6 lectures)
Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystems
a. Forest ecosystem,
b. Grassland ecosystem,
c. Desert ecosystem,
d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Module 2
Unit 1
Biodiversity and its conservation (8 lectures)
Introduction – Definition: genetic, species and ecosystem diversity, Biogeographical classification of

India, Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels, Inida as a mega-diversity nation, Hot-spots of biodiversity, Threats to biodiversity : habitat loss, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.

Unit 2

Global conservation efforts (4 hours)

Rio Earth summit - Agenda 21, Kyoto protocol, COP15 (15th Conference of the parties under the UN framework convention on climate change) and Paris protocol - major contributions. Conservation strategies and efforts in India and Kerala. Organizations, movements and contributors of environmental studies and conservation: organizations - WWF, Chipko, NEERI; contributors - Salim Ali, Sunder Lal Bahuguna, Madhav Gadgil, Anil Agarwal, Medha Patkar, Vandana Siva (brief account only).

Unit 3

Environmental Pollution (8 lectures)

Definition. Cause, effects and control measures of :- a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards, Solid waste Management : Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution, Pollution case studies. Disaster management : floods, earthquake, cyclone and landslides.

Unit 4

Social Issues and the Environment (7 lectures)

From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns. Case Studies, Environmental ethics: Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Case Studies, Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation, Public awareness.

Module 3

Human Population and the Environment (6 lectures)

Population growth, variation among nations, Population explosion – Family Welfare Programme, Environment and human health, Human Rights, Value Education, HIV/AIDS, Women and Child Welfare, Role of Information Technology in Environment and human health, Case Studies.

Field work (5 lectures)

- Visit to a local area to document environmental assets - river/forest/grassland/hill/mountain
- Visit to a local polluted site-Urban/Rural/Industrial/Agricultural
- Study of common plants, insects, birds.
- Study of simple ecosystems-pond, river, hill slopes, etc.

PRACTICAL (36hrs; 1 Credit)

1. Estimation of CO_2,Cl,and alkalinity of water samples (Titrimetry)
2. Determination of pH of soil and water.
3. Assessment of diversity, abundance, and frequency of plant species by quadrat method (Grasslands, forests).
4. Study of the most probable number (MPN) of Coliform bacteria in water samples.
5. EIA studies in degraded areas (Sampling, Line transect, Quadrat).
6. Ecological adaptations in xerophytes, hydrophytes, epiphytes, halophytes and mangroves.

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OPENCOURSES

Open Course; Code: BO5OPT01
AGRI – BASED MICROENTERPRISES
(Theory 72 hrs; 3 Credits)

Aim To provide basic information about the business opportunities in plant sciences.

Objectives:

- Inform the student about sustainable agriculture and organic farming.
- Inculcate an enthusiasm and awareness about ornamental gardening, nursery management and mushroom cultivation.

Module 1
Unit 1
Organic farming and composting techniques (9 hrs)
Advantages of organic manures and fertilizers. Composition of fertilizers – NPK content of various fertilizers. Common organic manures – bonemeal, cowdung, poultrywaste, oilcakes, organic mixtures and compost. Preparation of compost – aerobic and anaerobic – advantages of both; vermicompost - preparation, vermiwash. Biofertilizers: definition, types– *Trichoderma, Rhizobium,* PGPR. Biopesticides – Tobacco and Neem decoction. Biological control.
Unit 2
Horticulture and Nursery management (18 hrs)
Soil components. Preparation of potting mixture. Common Garden tools and implements. Methods of plant propagation – by seeds – advantage and disadvantages.Vegetative propagation - advantages and disadvantages. Natural methods of vegetative propagation. Artificial methods - cutting, grafting,
Budding and layering. Use of growth regulators for rooting. Gardening – types of garden -ornamental, indoor garden, kitchen garden, vegetable garden for marketing.

Module 2
Food spoilage and preservation techniques (9 hrs)
Causes of spoilage. Preservation techniques - asepsis, removal of microorganisms, anaerobic conditions and special methods – by drying, by heat treatment, by low temperature storage and by chemicals (Food Additives). Preparation of wine, vinegar and dairy products.

Module 3
Unit 1
Mushroom cultivation and Spawn production (9 hrs)
Types of mushrooms – button mushroom, oyster mushroom and milky mushroom, poisonous mushroom – methods of identification. Spawn – isolation and preparation. Cultivation milky mushrooms – using paddy straw and saw dust by polybag. Value added products from mushroom – pickles, candies, dried mushrooms.

Unit 2

Plant tissue culture and micropropagation (9 hrs)

Concept of totipotency. Micropropagation: different methods–shoot tip, axillary bud and meristem culture; organogenesis, somatic embryogenesis. Infrastructure of a tissue culture laboratory. Solid and liquid media – composition and preparation. Sterilization techniques. Explant - inoculation and incubation techniques. Stages of micropropagation –hardening and transplantation. Packaging and transportation of tissue culture regenerated plantlets.

Module 4

Hands on Training (18 hrs)

1. Prepare a chart showing the NPK composition of minimum 6 manures and fertilizers.
2. Identification and familiarization of the following organic manures: cow dung(dry), Coconut cake,Vermicompost, neem cake,organic mixture,bone meal.
3. Preparation of potting mixture.
4. Make a vermicompost pit/pot in the campus/house of the student.
5. Familiarization of common garden tools and implements.
6. Estimation of germination percentage of seeds
7. Demonstrate the effect of a rooting hormone on stem cutting.
8. Demonstration of 'T' budding and air layering on live plants.
9. Familiarization of garden components from photographs.
10. Preparation of vinegar/dairy product (any two) in class or home.
11. Familiarization of different mushrooms and preparation of a polybag of *Pleurotus* using straw/sawdust.
12. Visit to a well established tissue culture lab, nursery and mushroom cultivation unit.

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SEMESTER VI

Core Course 9; Code: BO6CRT09
GENETICS, PLANT BREEDING AND HORTICULTURE
(Theory 54 hrs; 3 Credits)

Aim To impart an insight into the principles of heredity

Objectives:

- Understand the patterns of inheritance in different organisms
- Understand the inheritance pattern of nuclear and extranuclear genes
- Understand the methods of crop improvement
- Understand the importanceof horticulture in human welfare
- Develop skill in gardening technique among students

Module 1
Genetics (Theory 27 hrs)
Unit 1
Origin and development of Genetics (3 hrs)
Genetics as a science: origin-experiments of Mendel with *Pisum sativum*, general terminology use dingenetics. Principles of inheritance, Mendelian laws-monohybrid and dihybrid cross, test cross and back cross.
Unit 2
Exceptions to Mendelism (10 hrs)
Modification of Mendelian ratios: incomplete dominance-*Mirabilis*; Co-dominance-MN blood group in man; Lethalgenes– pigmentation in Snapdragon..
Genetic interaction: epistasis, (a) Dominant-fruit colour in summer squashes (b) Recessive-coat colour in mice; Complementary genes- flower colour in sweet pea. Non-epistasis-comb patternin Fowls. Multiplealleles – ABO blood groupsin man; self sterility in *Nicotiana*.
Unit 3
Linkage of genes (3 hrs)
Linkage and crossing over: chromosome theory of linkage; crossing over - types of crossing over, mechanism of crossingover. Linkage map - 2 point cross, interference and coincidence.
Unit 4
Determination of sex(6 hrs)
Sex determination: sex chromosomes and autosomes; chromosomal basis of sex determination; XX-XY, XX - XO mechanism; sex determination in higher plants (*Melandrium album*). Sex linked inheritance: X – linked - Morgan's experiment e.g. eye colour in *Dorsophila*, Haemophilia in man; Y-linked inheritance; sex limited and sex influenced inheritance. Pedigree analysis.
Unit 5
Quantitative inheritance (2 hrs)
Quantitative characters: polygenic inheritance, continuous variation - kernel color in wheat, ear size in maize.

Unit 6

Extra-chromosomal inheritance (2 hrs)

Extrachromosomal inheritance: chloroplast mutation –variegation in 4O'clock plant; mitochondrial mutations in yeast. Maternal effects – shell coiling in snail; infective heredity – kappa particles in *Paramecium*.

Unit 7

Population genetics (1 hr)

Concept of population, gene pool, Hardy – Weinberg principle (brief).

Module 2

Plant Breeding (Theory 13 hrs)

Unit 1

Introduction to plant breeding (1 hr)

Introduction and objectives of plant breeding. Plant breeding centers in Kerala, their achievements – CPCRI, CTCRI, RRII.

Unit 2

Plant introduction (2hrs)

Plant introduction: domestication – centers of origin – procedure of plant introduction - quarantine regulations,acclimatization,agencies of plant introduction in India, major achievements.

Unit 3

Selection (2 hrs)

Plant Selection: mass, pure-line, clonal.

Unit 4

Hybridization (4hrs)

Hybridization: types, procedure, important achievements. Heterosis in plant breeding, in breeding depression, genetics of heterosis and inbreeding depression. Handling segregating generation-pedigree method, bulk method, backcross method. Disease resistance breeding.

Unit 5

Mutation breeding and polyploidy breeding (2hrs)

Mutation breeding: methods, applications and important achievements. Polyploidy breeding: methods and applications.

Unit 6

Tissue culture as a method in plant breeding (2hrs)

Application of meristem culture, embryo culture and pollen culture in plant breeding. Role of tissue culture in the creation of transgenic plants.

Module 3

Horticulture (Theory 14 hrs)

Unit 1

Introduction (3hrs)

Introduction to horticulture - Definition, History, Classification of horticultural plants. Disciplines of horticulture - pomiculture, olericulture, floriculture, arboriculture.

Garden implements- budding knife, secateurs, hedgeshear, hand cultivator, sprayers, lawn mower, garden rake, spade.

Irrigation methods: surface, sub, drip and spray irrigations; mist chambers – advantages and disadvantages.

Unit 2:

Plant propagation (5 hrs)

Seed propagation: seed testing and certification, seed bed preparation, seedling transplanting, hardening of seedling; advantages and disadvantages of seed propagation. Vegetative propagation: natural and artificial; artificial methods - cutting, layering,graftingandbudding,micro-propagation;advantages anddisadvantages of vegetativepropagation.

Unit 3

Gardening (6 hrs)

Types of garden: brief study on ornamental garden, indoor garden, kitchen garden, aquatic garden, vertical garden, medicinal garden, terrace garden, terrarium.

Garden designing: garden components-lawns, shrubs and trees, borders, topiary, hedges, edges, walks, drives.

Physical control of plant growth: training and pruning. Bonsai – selection of plant – bonsai containers and method of bonsai formation.

Plant growing structures: green house, orchidarium, conservatory; Potting mixture– components.

PRACTICAL (45 hrs; 1 Credit)

Genetics

Students are expected to work out at least two problems each from: monohybrid, dihybrid, back-cross and test cross; all types of modifiedMendelian ratios mentioned in the syllabus.

Plant Breeding (9 hrs)

1. Emasculation and bagging.
2. Demonstration of hybridization in plants.
3. Estimation of pollen sterility/viability.

Horticulture (18 hrs)

1. Approach grafting (demonstration only), budding (T, patch), air layering.
2. Identification of different garden tools and their uses.
3. List out the garden components in the photograph of the garden given.
4. Visit to established horticultural/agricultural/ornamental/kitchen gardens and observe the components there.

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Core Course 10; Code: BO6CRT10

CELL AND MOLECULAR BIOLOGY
(Theory 54 hrs; 3 Credits)

Aim To understand the ultrastructure and functioning of cell in the sub - microscopic and molecular levels.

Objectives:

- Get an idea of origin, concept of continuity and complexity of life activities.
- Familiarization of life processes.
- Understand the basic and scientific aspect of diversity.
- Understand the cytological aspects of growth and development.
- Understand DNA as the basis of heredity and variation.

Module 1
Cell Biology (Theory 27 hrs)
Unit 1
Ultrastructure of cell components (8hrs)
Cell biology through ages: a brief history of cell biology. Cytosol-chemical composition .Composition, structure and function of plasmamembrane-fluid mosaic model.
Theultra-structure of a plant cell with structure andfunction of the following organelles: Endoplasmic reticulum, chloroplasts, Mitochondria, Ribosomes , Dictyosomes, Microbodies-peroxisomes and glyoxisomes, lysosomes and vacuole. Cytoskeleton - microtubules and microfilaments.
Ultrastructure of nucleus: nuclear envelope – detailed structure of pore complex, nucleoplasm - composition, nucleolus.
Unit 2
Chromosomes (6 hrs)
Chromosomes: introduction, chromosome number, autosomes and allosomes, morphology-metacentric, submetacentric, acrocentric and telocentric. Structure-chromatid, chromonema, chromomere, centromere and kineto chor , telomere, secondaryconstriction and nucleolar organizer. Chromatin fibres: heterochromatin and euchromatin. Karyotype and Ideogram.
Chemical composition of chromatin: histones and non-histones, arrangement of proteins and DNA in chromatin - the10 nm fibre (nucleosome model), 30nm fibre (solenoid model) and central axis with radial loops of 300 nm fibre.
Special type of chromosomes: giant chromosomes (salivary gland chromosomes, Lampbrush chromosomes), supernumerary chromosomes (B chromosome).
Unit 3
Cell division (6hrs)
Cell cycle - definition, different stages – interphase (G1, S and G2) and division phase. Mitosis: karyokinesis and cytokinesis, significance of mitosis. Meiosis: stages - first meiotic division (reduction division) and second meiotic (equational division), structure and function of synaptonemal complex, significance of meiosis; comparison of mitosis and meiosis.
Unit 4
Chromosomal aberrations (4 hrs)
Numerical: heteroploidy; euploidy – haploidy; polyploidy –autopolyploidy, allopolyploidy (*Raphanobrassica*); an euploidy-monosomy, trisomy (Fruit morphology in Datura), nullisomy (*Triticum*). Numerical chromosomal abnormalities in man: Down's syndrome, Klinefelter's syndrome,

Turner's syndrome.

Structural: deletion (Cri-du-chat syndrome), duplication (Bareye in Drosophila), inversions (paracentric and pericentric) and Translocations (Robertsonian translocation).

Unit 5

Mutation (3hrs)

Mutation: definition, importance. Types of mutations: somatic and germinal; spontaneous and induced; chromosomal and gene o point mutations. Molecular basis of mutation: frame shift, transition, transversion and substitution. Mechanism of mutation induction: base replacement, base alteration, base damage, errors in DNA replication. Mutagens: physical – non – ionizing and ionizing radiations; chemical – base analogs, alkylating agents, deaminating agents.

Module 2

Molecular Biology (Theory 27hrs)

Unit 1

The genetic material (8 hrs)

Molecular biology: a brief historical prelude. Identification of DNA as genetic material: direct evidences – transformation experiment by Avery *etal*.; Hershey and Chase Experiment. Evidences for RNA as genetic material in some viruses.

Nucleicacids: DNA and RNA, important features of Watson and Crick model of DNA ; Chargaff's rule. Alternate forms of DNA – comparison of A, B and Z forms. Structure and function of different types of RNA - tRNA, mRNA, rRNA, snRNA, miRNA.

Unit 2

Replication of DNA (4 hrs)

Semi conservative replication of DNA – Messlson and Stahl's experiment; process of semiconservative Replication with reference to the enzymes involved in each step.

Module 3

Unit 1

Gene expression (8 hrs)

Gene expression: concept of gene, split genes, one gene one enzyme hypothesis, one gene one polypeptide hypothesis, the central dogma, reverse transcription. Details of transcription in prokaryotes and eukaryotes; mRNA, splicing, release of mRNA. Translation - initiation, elongation and termination. Genetic code and its features,wobble hypothesis.

Unit 2

Regulation of gene expression (5 hrs)

Regulation of gene expression in prokaryotes: operon concept, indicible and repressible systems, negative control and positive control. Lacoperon, catabolic repression. Tryptophan operon, attenuation. Regulation in eucaryotes (brief account only).

Unit 3

Genetics of cancer(2 hrs)

Genetic basis of cancer – brief description of proto-oncogenes and oncogenes, tumour suppressor genes; characteristics ofcancer cells.

PRACTICAL (36 hrs; 1 Credit)

Cell Biology

1. Make acetocarmine squash preparation of onion root tip to identify mitotic stages.
2. Study the mitotic index of onion root tip cells (Demonstration only).
3. Study of the different stages of meiosis and identification of different substages of prophaseI using

4. photomicrographs or pictures.

Identify and study the chromosomal anomalies, patterns and karyotype in man such as Down's syndrome,Turner's syndrome and Klinefelter's syndrome.

Molecular Biology (9 hrs)

Work out elementary problems based on DNA structure, replication, transcription and translation and genetic code.

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Core course 11; Code: BO6CRT11
ANGIOSPERM MORPHOLOGY, TAXONOMY AND ECONOMIC BOTANY
(Theory 72 hrs; 3 Credits)

Aim To acquaint students about the significance of Plant taxonomy.

Objectives:

- Identify the common species of plants growing in Kerala and their systematic position.
- Develop inductive and deductive reasoning ability.
- Impart the basic technique of herbarium preparation to students.
- Familiarize students with the plants that are economically important.

Angiosperm Morphology
Module 1
Leaf, Inflorescence and Fruit morphology (13 hrs)
Leaf Morphology: types, venation, phyllotaxy. Morphology of flower: flower as modified a shoot; detailed structure of flowers – floral parts - their arrangement, relative position -symmetry, aestivation and placentation types –cohesion and adhesion. Floral diagram and floral formula. Inflorescence: racemose types – simple raceme, corymb, umbel, spike, spadix, head and catkin; cymose types-simple cyme; monochasial – scorpoid and helicoid, dichasial and polychasial; special type - cyathium, hypanthodium, verticillaster, thyrsus and panicle. Fruits: simple - fleshy, dry-dehiscent, schizocarpic, indehiscent, aggregate, multiple (sorosis and syconus).

Module 2
Taxonomy
Unit 1
Principles of Plant systematics (12hrs)
Aim, scope, significance and components of taxonomy.Types of classification – artificial (brief account), natural Bentham and Hooker (Detailed account) and Phylogenetic (Brief account). Angiosperm phylogeny group system (introduction only). Plant nomenclature -binomial, ICBN/ICN Cytotaxonomy and Chemotaxonomy. Herbarium technique–importance of herbarium; preparation of herbarium and their preservation. Important herbaria in India, BSI.
Unit 2
Detailed study of families (30 hrs)
Study the following families of Bentham and Hooker's system with special reference to their vegetative and floral characters; special attention should be given to common and economically important plants within the families: Annonaceae, Nymphaeaceae, Malvaceae, Rutaceae, Anacardiaceae, Leguminosae (Mimosaceae,Caesalpiniaceae and Fabaceae), Combretaceae, Myrtaceae, Cucurbitaceae,Umbelliferae (Apiaceae), Rubiaceae, Compositae (Asteraceae), Sapotaceae, Apocynaceae, Asclepiadaceae, Solanaceae, Convolvulaceae, Scrophulariaceae, Acanthaceae, Verbenaceae, Labiatae (Lamiaceae), Amaranthaceae, Euphorbiaceae, Orchidaceae, Palmae (Arecaceae), Graminae (Poaceae).
Principles - rule of priority and author citation. Interdiciplinary approach in taxonomy

Module 3

Economic botany (12 hrs)

Study the following groups of plants with special reference to the botanical name, family and morphology of the useful part and uses: Cereals - Rice, Wheat; Millets Ragi; Pulses –Green gram, Bengal gram, Black gram; Sugar yielding plants – Sugarcane; Fruits-Apple, Pineapple, Orange, Mango and Banana; Vegetables- Bittergourd, Ladiesfinger, Carrot and Cabbage; Tuber crops -Tapioca; Beverages - Tea, Coffee; Oil yielding plants - Groundnut, Coconut, Gingelly; Spices –Cardamom, Pepper, Cloves, Ginger; Timber yielding plants – Teakwood and Rosewood; Fibre yielding plants - Coir, Jute, Cotton; Rubber yielding plants - Pararubber; Gums and Resins –White damer, Gum Arabic, Asafoetida; Insecticide yielding Plants – Tobacco and Neem.

Module 4

Ethnobotany (5 hrs)

Introduction, scope and significance of ethnobotany. Study of the following plants used in daily life by tribals and village folks for food, shelter and medicine: Food – *Artocarpus heterophylla*, *Corypha*; Shelter - *Bambusa*, *Ochlandra* and *Calamus*; Medicine –*Curcuma longa*, *Trichopus zeylanicus* and *Alpinia galanga.*

PRACTICAL (45hrs; 1 Credit)

1. Identify the following inflorescence and fruits with reference to their morphological specialities: (a) Inflorescence - simple raceme, spike, corymb, head, simple cyme, cyathium and hypanthodium.(b) Fruits – simple - (fleshy) – berry drupe, pepo, hespiridium. Dry indehiscent - nut. Drydehiscent - legume, capsule (loculicidal). Aggregate.
2. Preparation of floral formula and floral diagram from floral description (of families studied).
3. Identify the families mentioned in the syllabus by noting their vegetative and floral characters.
4. Students must describe the floral parts, draw the L.S., floral diagram and write the floral formula of atleast one flower from each family.
5. Prepare herbarium of 25 plants with field notes.
6. Conduct field work for a period of not less than 5days under the guidance of a teacher and submit field report.
7. Study the finished products of plants mentioned in the syllabus of economic botany with special reference to the morphologyof the useful part, botanical name and family.
8. Identify and describe the ethnobotanical uses of the items mentioned in the syllabus.

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Core Course 12; Code: BO6CRT12
BIOTECHNOLOGY AND BIOINFORMATICS
(Theory 54 hrs; 3 Credits)

Aim To understand the current developments in the field of Biotechnology and Bioinformatics.

Objectives:

- Equip students to carry out plant tissue culture.
- Introduce the vast repositories of biological data knowledge.
- Equip students to access and analyze the data available in the databases.

Module 1
Biotechnology (36 hrs)
Unit 1
Plant Tissue culture (6 hrs)

Biotechnology – an overview; plant tissue culture – basic concepts, totipotency, differentiation, de-differentiation and redifferentiation. Tissue culture media: components, role of plant growth regulators in tissue culture. Preparation of MS medium; sterilization of equipments, glassware and culture medium, surface sterilization of explants.

Unit 2

Applications of plant tissueculture (10 hrs)

Micropropagation, methods – axillary bud proliferation, adventitious regeneration –shoot organogenesis and somaticembryogenesis - direct and indirect; meristem culture. Stages of micropropagation, hardening and transplantation. Advantages and disadvantages of micropropagation - Somaclonal variations. Embryo culture, callus and cell suspension culture, *invitro* production of haploids - anther and pollen culture;uses of haploids. Protoplast culture: isolation of protoplast, culture methods, applications; protoplast fusion – cybrids. Artificial seeds, advantages and disadvantages. *Invitro* production of secondary metabolites; cell immobilization, bioreactors (brief study only).

Unit 3

Recombinant DNA technology and its applications (10 hrs)

Steps in Rdna technology, cloning vectors and their desirable properties; plasmids, cosmids, phage vectors, Phasmids, YAC and BAC; structure and applications of pBR 322, M13 and Ti plasmid. Cutting and joining of DNA molecules – Restriction endonucleases and ligases –ligation techniques. Transformation and selection of transformants – using antibiotic resistance markers and complementation.

Achievements of recombinant DNA technology: in medicine (Human insulin and gene therapy) ;in agriculture – Bt cotton; in environmental cleaning - super bugs.

Unit 4

Techniques in rDNA technology (10 hrs)

DNA isolation, agarose gel electrophoresis ,southern hybridization, autoradiography. DNA fingerprinting and its applications. PCR and its applications. DNA sequencing by Sanger's dideoxy method. Uses of refrigerated centrifuges, UV trans-illuminator, gel documentation system and Laminar Air Flow chamber (brief account only).

Module 2

Genomics (4 hrs)

A brief account on genomics and proteomics; major findings of the following genome projects – *E.coli*, Human, *Arabidopsis thaliana.*

Module 3

Unit 1

Basic Bioinformatics (7 hrs)

An introduction to bioinformatics, objectives and applications of bioinformatics. Biological databases : types - primary, secondary and composite databases; nucleotide sequence databases –NCBI (GenBank), EMBL, DDBJ; Protein Sequence databases - SWISS-PORT, PIR; Protein structure database – PDB; bibliographic database – PubMed.

Unit 2

Sequence analysis and molecular phylogeny (7 hrs)

Sequence analysis tools – BLAST and FASTA, Molecular visualization tool – RASMOL (basic commands), Sequence alignment –Scoring matrices, global and local alignment, Pairwise and multiple sequence alignment; common software used in alignment –CLUSTALW & CLUSTALX. Molecular phylogeny - homologs, orthologs and paralogs; phylogenetic tree – rooted and unrooted tree, advantages of phylogenetic tree, use of PHYLIP software.

PRACTICAL (36 hrs; 1 Credit)

1. Preparation of nutrient medium– Murashige and Skoog medium(Demonstration only).
2. Sterilization and inoculation of plant tissue inculture media.
3. Establishing shoot tip, axillary bud cultures (Demonstration only).
4. Immobilization of whole cells or tissues in sodium alginate.
5. Isolation of DNA from plant tissue.
6. Agarose gel elecotrophoresis of the isolated DNA (Demonstration only).
7. Familiarise the instruments included in the syllabus such as Autoclave, laminar air flow chamber, UV-trans-illuminator, PCR machine, Electrophoresis apparatus, centrifuge etc.and prepare short notes with diagrammatic sketch or photographs.
8. Familiarizing GENBANK, DDBJ, ENA, SWISS-PORT and PDB databases (Demonstration only).
9. Analysis of structural features of proteins using RASMOL.
10. Localalignmentof sequences using BLAST (Demonstrationonly).
11. Retrieving a few research papers related to genetic engineering from PubMed (Demonstration only).

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PROGRAMME ELECTIVE COURSE

Programme Elective course; Code: BO6PET01
AGRIBUSINESS
(Theory 54 hours; 3 Credit)

Aim To inculcate and impart an idea about the business opportunities in the field of plant sciences.

Objectives:

- Develop an entrepreneurial mindset among students while sticking on to the core subject Botany
- Give an idea about the need of sustainable development and organic farming.
- Harness the opportunities and potentials in the field of ecotourism, processing technology and food sciences.

Module 1
Unit 1
Entrepreneurship (2 hrs)
Basic qualities of an Entrepreneur. Financialassistance from Banks, role of Institutions like MSME Training Institute, Khadi and village industries board, selfhelp groups, Co-operative sector, Kudumbasree projects and microenterprises.
Unit 2
Value added food products (8hrs)
Preparation and preservation techniques, causes of spoilage of food. Principles of preservation -asepsis, removal of microorganisms, anaerobic situation and special methods - drying, thermal processing-pasteurization , sterilization and canning – low temperature, use of chemical preservatives and food additives. Preparation of wine, vinegar, pickles, jam ,jelly, syrups, sauce, dryfruits, dairy products - cheese, butter, yoghurt, paneer.
Unit 3
Processing techniques (8 hrs)
Processing of latex: centrifuged latex products and galvanized rubber products. Processing, storage and marketing of Cocoa, Coconut (Copra,Coirander, Tender coconut), Rice(parboiled, raw rice and rice flour), Pepper, Cardamom, Ginger, Arrowroot, Tapioca, Cashew , Mango, Jackfruit, Guava, Grapes, Lemon, Papaya, Musa, Garcinia.

Module 2
Nursery Management (6hrs)
Preparation of potting mixtures, polybags. Plant growing structures – green houses, shaded houses, poly shed, mist chamber, sprinkling system, drip irrigation. Modern strategies in propagation by root initiation of cutting, layering technique, budding and grafting technique; micropropagation. Planting, transplanting and hardening of seedling , aftercare of seedlings. Packing and transport of seedlings.

Module 3

Unit 1

Organic farming and composting techniques (6 hrs)

Organic manures and fertilizers, composition of fertilizers. NPK content of various fertilizers and preparation of fertilizer mixtures. Common organic manures -bonemeal, cowdung, poultry waste, oil cakes, organic mixtures and compost. Preparation of compost – aerobic and anaerobic-advantages and limitations.Vermicompost-preparation; Vermi wash - preparation. Biofertilizers-definition and preparation of different types -Trichoderma, Rhizobium, PGPR, PSB, mycorrhiza. Application of biofertilizers. Biopesticides, Tobacco and Neem decoction.Biological control of disease and pests.

Unit 2

Cultivation of vegetables, fruits and medicinal plants (6hrs)

Types home gardening, market gardening and truck gardening. Packing and transporting of vegetables. Organic farming of frui crops – packing and transporting of fruits.Inductionoff lowering and weed control. Cultivation of medicinal and aromatic plants of common use and great demand.

Unit 3

Floriculture and Apiculture (6 hrs)

Floriculture: problems and prospects of floriculture in Kerala. Scope of growing Anthurium, Orchids and Jasmine in Kerala . Common cut flowers-Rose, Gerbera, Gladiolus, Aster, *Chrysanthemum*, Anthurium and Orchids. Common leaves used in flower arrangement -*Cyprus, Podocarpus*, *Asparagus*, Palms, Cycads and Ferns.

Apiculture: scope and significance. Structure, installation and maintenance of an Apiarium. Extraction, processing, preservation and marketing of honey.

Unit 4

Flower arrangement (4hrs)

Types- Western, Eastern (Japanese/Ikebana) and modern. Vases, flower holders and floral foam.

Vaselife of flowers and leaves. Aftercare of flower arrangements – Bouquets. Packing and maintenance off lower and leaves.

Unit 5

Ornamental garden designing (4hrs)

Garden component . Lawn preparation by seeds, seedling and turfing. Maintenance of garden by Irrigation, Pruning, Repotting. Disease and Pest control.

Module 4

Mushroom Cultivation and farming (4 hrs)

Mushrooms: significance, nutritive value. Types of Mushrooms – Button –*Pleurotus, Volvorella*. Spawn production, storage and marketing. Growth of Mushrooms on paddy straw and saw dust by polybag. Mushroom growing structures and maintenance of humidity. Pests and defects of mushrooms.Storage,transporting and marketing of mushrooms.

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COMPLEMENTARY COURSES FOR MODEL I B.Sc. ZOOLOGY

SEMESTER I

Complementary course 1; Code: BO1CMT01
CRYPTOGAMS, GYMNOSPERMS AND PLANT PATHOLOGY
(Theory 36 hrs; 2 Credits)

Aim To impart fundamental knowledge in plant science and help the student to understand that Botany is an integral part of human life and development.

Objectives:

- Foster and encourage an attitude of curiosity, appreciation and enquiry of various life forms of plants.
- Understand the identifying characters of the different types included in the syllabus.
- Understand the diversity of plants with respect to Algae, Fungi, Lichens, Bryophytes, Pteridophytes and Gymnosperms.

Module 1

Unit 1
Algae (13 hrs) General characters of algae and their classification up to classes (F E Fritsch); range of thallus variation in Algae. Reproduction and life history of the following groups with reference to the types mentioned: Cyanophyceae - *Nostoc*; Chlorophyceae - *Oedogonium* (*Volvox*, *Spirogyra*, *Cladophora* - vegetative features only); Phaeophyceae – *Sargassum;* Rhodophyceae – *Polysiphonia.* Economic importance of Algae: food, industry, medicine, biofertilizers; algal bloom.
Unit 2
Fungi and lichens (9 hrs) General characters and outline on the classification of fungi by Ainsworth. General characters, thallus structure, reproduction and life history of the following groups with reference to the types mentioned: Zygomycotina – Rhizopus; Ascomycetes – *Xylaria;* Basidiomycetes – *Puccinia.* Economic importance of Fungi: as food, industry, decomposition of organic matter. Fungal toxins and human health. Lichens: Classification based on thallus morphology. Usnea - morphology and anatomy of vegetative and reproductive structure. Economic importance of lichen: food, industry, medicine.
Unit 3
Bryophytes (2 hrs)
General characters of Bryophytes. Morphology, anatomy, reproduction and life cycle of *Riccia*.
Unit 4
Pteridophytes (3 hrs)
General characters of Pteridophytes. Morphology, anatomy (stem), reproduction and life cycle of *Selaginella*.

Module 2
Gymnosperms (4 hrs)
General characters of Gymnosperms. Morphology, anatomy (leaf let), reproduction and life cycle of *Cycas*.

Module 3
Plant pathology (5 hrs)
Plant diseases (5 hrs)
Classification of plant diseases on the basis causative organism and symptoms. Study the following diseases with special emphasis on causative organism, symptoms and control measures: (i) Nut fall of Arecanut (ii) Bacterial blight of Paddy (iii) Leaf mosaic of Tapioca.

PRACTICAL (36 hrs; 1 Credit)

1. Micropreparation and identification preparation of the following:

i. Algae: vegetative structure of *Nostoc*, *Volvox*, *Spirogyra*, *Oedogonium*, *Cladophora*, *Polysiphonia*. vegetative and reproductive structure of *Sargassum*.
ii. Fungi: vegetative and reproductive structure of *Rhizopus*, *Xylaria*, *Puccinia*.
iii. Lichen: morphology of Usnea thallus and Apothecium.
iv Bryophytes: *Riccia* thallus anatomy.
v Pteridophytes: *Selaginella* - anatomy of stem and morphology of strobilus
vi Gymnosperms: *Cycas* - Anatomy of leaflet, morphological features of megasporophyll, microsporophyll and ovule.

2. Identify plant diseases mentioned in the syllabus.

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SEMESTER II

Complementary course 2; Code: BO2CMT02

PLANT PHYSIOLOGY (Theory 36 hrs; 2 Credits)

Aim To impress upon students the importance of Physiological processes in plants

Objectives:

- Make students aware about the physiological processes that take place in plants.
- Understand the mechanism of various physiological processes related to plant life.

Module 1
Water relations (11 hrs)
Plant water relations: Physical aspects of water absorption - Diffusion, DP, DPD. Imbibition. Osmosis - OP, Exosmosis, Endosmosis, Plasmolysis. Water potential and its components. Mechanism of water absorption by root - active and passive absorption. Movement of water towards xylem by apoplast and symplast pathway. Ascent of sap – theories - transpiration pull theory, root pressure theory; guttation.
Transpiration: types, mechanism of transpiration and stomatal movement (K^+ - ABA theory), significance and factors affecting transpiration, antitranspirants.

Module 2
Mineral nutrition (4 hrs)
account on Micro and macro nutrients. Absorbable form, function and deficiency symptoms of the following mineral nutrients: N, P, K, Mg, B, Fe, Zn.

Module 3
Photosynthesis and translocation of photosynthate (15 hrs)
Basic requirements of Photosynthesis: Light - PAR; organs and site of photosynthesis; chloroplast. Photosynthetic pigments, photosynthetic unit; red drop and Emerson,,s enhancement effect; two pigment systems. Mechanism of photosynthesis: light dependent reaction - cyclic and non cyclic photo phosphorylation. Light independent reaction (dark reactions) C3 cycle, brief account on C4 and CAM Cycles. Factors affecting photosynthesis. Photorespiration (brief study only). Translocation of photosynthate and organic solutes: path of translocation, mechanism of translocation (Pressure Flow Hypothesis).

Module 4
Growth and Development (6 hrs) Seed dormancy - causes of seed dormancy - methods of breaking dormancy. Germination of seeds - physiological changes. Growth: Phases of growth, plant growth regulators - auxins, gibberellins, cytokinins, abscissic acid and ethylene and their physiological role (brief study only). Photoperiodism - definition, short day plants, long day plants, day neutral plants. Vernalization.

PRACTICAL (36 hrs; 1 Credit)

Core Experiments:
1. Demeonstration of osmosis using potato tuber osmoscope/Papaya petiole osmoscope.
2. Separation of leaf pigments by paper chromatography.
3. Compare the stomatal indices of hydrophytes and xerophytes.

Demonstration experiments:

1. Measure the rate of transpiration by Ganong's potometer.
2. Relationship between transpiration and absorption.
3. Measurement of growth using Arc Auxanometer.
4. Demonstration of geographic curvature using Clinostat.
5. Evolution of oxygen during photosynthesis.
6. Mohl's half leaf experiment.
7. Light screen experiment

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SEMESTER III

Complementary Course 3; Code: BO3CMT03
ANGIOSPERM TAXONOMY AND ECONOMIC BOTANY
(Theory 54 hrs; 3 Credits)

Aim To acquaint the student with the objectives and components of Taxonomy

Objectives:

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- Help the student to understand the systems of classification of angiosperms.
- Help the student to identify the common angiosperm species of Kerala.
- Familiarize the student with plants of immense economic importance.

Module1
Morphology (10 hrs)
Leaf - simple, compound; venation and phyllotaxy.Flower as a modified shoot, structure of flower-floral parts, their arrangement, relative position; cohesion and adhesion of floral parts, symmetry of flowers;types of aestivation and placentation; floral diagram and floral formula. Inflorescence: racemose - simple, spike, spadix, catkin, corymb, umbel and head; cymose - simple, monochasial – helicoid and scorpoid; special types – cyathium, verticillaster. Fruits: outline of the classification; Simple: Fleshy - drupe, berry, hesperidium; Dry – Dehiscent - legume, capsule; Indehiscent - Caryopsis, Cypsella, Schizocarpic - lomentum, carcerulus, regma, cremocarp with examples. Aggregate. Multiple: sorosis, syconus. (Examples should be from families prescribed in the syllabus).

Module 2
Plant classification and Herbarium techniques (8hrs)
Importance of plant classification, types of classification -artificial, natural and phylogenetic (brief account only); binomial nomenclature; ICBN (Brief account only). Bentham and Hooker's system of classification (upto series) and its merits and demerits. Cytotaxonomy and chemotaxonomy (brief account only). Herbarium techniques; importance of herbarium.

Module 3
Angiosperm families (18 hrs)
Study of the following families of Bentham and Hookers system of classification with special reference to major identifying characters and economic importance: Annonaceae, Malvaceae, Rutaceae, Leguminosae (Mimosaceae, Caesalpiniaceae and Fabaceae), Apiaceae (Umbelliferae), Rubiaceae, Asteraceae (Compositae), Apocynaceae, Lamiaceae (Labiatae), Euphorbiaceae, Arecaceae (Palmae), Poaceae (Gramineae).

Module 4
Economic botany (18 hrs)
Unit 1
Classes of economically important plants (10hrs)
Classification of economically important plants based on their uses. Study of the following groups of

plants with special reference to their botanical name, family, morphology of useful part, economic products and uses: Cereals - Paddy, Wheat; Pulses - Green gram, Bengal gram; Tuber crops - Tapioca; Spices - Pepper, Cardamom; Beverages - Tea, Coffee; Oil yielding plants - Coconut, Groundnut; Fibre yielding plants - Cotton, Coir; Timber yielding plants - Teak, Rosewood; Latex yielding plants - Pararubber; Biopesticides - Neem, Tobacco; Ornamental plants - Rose, Orchids, Anthurium.

Unit 2

Medicinal plants (8hrs)

Study of the following medicinal plants with special reference to their binomial, family, morphology of useful parts and uses: *Adhatoda, Aloe*, *Bacopa*, *Catharanthus*, *Eclipta*, Neem, *Ocimum*, *Phyllanthus amarus*, *Rauvolfia*, *Sida.*

PRACTICAL (36hrs; 1 Credit)

1. Students should be trained to identify the different types of inflorescence and fruits of typical plants belonging to the families prescribed in the syllabus.
2. Students should be trained to identify typical local plants belonging to the families prescribed in the syllabus.
3. Students should be trained to describe the floral parts in technical terms and draw the L.S. of flower, construct the floral diagrams and write the floral formula of at least one flower from each family.
4. Study of the groups of plants mentioned in the economic botany syllabus with special reference to their botanical name, family, morphology of useful part, economic products and uses.
5. Students should study the botanical name, family, morphology of the useful part and the uses of the medicinal plants listed in the syllabus.

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SEMESTER IV

Complementary Course 4; Code: BO4CMT04

ANATOMY AND APPLIED BOTANY

(Theory 54 hrs; 3 Credits)

Aim To help the students understand theinternal structure of different plant organs with reference to their functions and applied aspects

Objectives:

- Understand different types of plant tissues.
- Understand the process of normal and anomalous secondary thickening in plants. .
- Know the morphological and anatomical adaptations of plants growing in different habitats.
- Understand how botanical knowledge could be applied for crop improvement.

Module 1

Plant Anatomy (27hrs)

Unit 1

Cells and tissues (9 hrs)

Gross structure of primary and secondary cell walls; structure and function of plasmodesmata; non-living inclusions - cystolith, raphides; Tissues –meristematic and permanent types of meristems; simple and complex tissues, secretory tissues (nectaries, hydathodes, mucilage ducts and lactiferous tissue).

Unit 2

Anatomy of plant organs (12 hrs)

Primary structure of stem and root in dicots and monocots; anatomy of monocot and dicot leaf. Secondary thickening in dicot

Stem and dicot root, heart wood and sap wood; tyloses; hard wood and softwood; growth rings, dendrochronology. Anomalous secondary thickening in *Bignonia*.

Unit 3

Ecological Anatomy (6 hrs)

Study of the morphological and anatomical adaptations of the following groups: Hydrophytes – *Nymphaea,* Hydrilla; Xerophytes – *Nerium;* Epiphytes - *Vanda*.

Module 2

Unit 1

Plantbreeding (12 hrs)

Objectives of plant breeding, methods of plant improvement –plant introduction, acclimatization, plant quarantine; selection – mass selection, pure line selection and clonal selection; hybridization - intervarietal, interspecific and intergeneric; procedure of hybridization.

Unit 2

Artificialvegetativepropagationmethods (5 hrs)

Propagation of plants through cutting, layering – air layering; budding T and patch budding; grafting - tongue and splice grafting. Role of cambium in budding and grafting.

Module 3

Plant Tissue culture (10 hrs)

Principles of tissue culture, micropropagation – different steps – selection of explants, culture media – general composition and preparation; sterilization of media and explants; callus. Regeneration of plants: organogenesis, somatic embryogenesis; artificial seeds. Applications of plant tissue culture.

PRACTICAL (36hrs; 1 Credit)

1. Primary structure of stem and root of dicots and monocots;Dicot stem - Centella; Monocot stem – Bamboo, grass, asparagus; Dicot root - Tinospora; Monocot root - Colocasia, Musa.
2. Structure of dicot stem and dicot root after secondary thickening; Stem- Vernonia, Eupatorium; Root - Tinospora, Papaya.
3. Anomalous secondary thickening in *Bignonia*.
4. Anatomical adaptations of Hydrophytes – *Nymphaea* petiole, *Hydrilla* stem; Xerophytes - *Nerium* Leaf; Epiphytes - Velamen root of *Vanda*.
5. Emasculation of pea or *Caesalpinia* flower.
6. Demonstrate T and patch budding.
7. Demonstration of tissue culture techniques: culture media, surface sterilization and inoculation of explants.
8. Identification of non living inclusions - cystolith, raphides.

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