B.SC BOTANY & BIOTECHNOLOGY

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DEFINITIONS

'Semester' means a term consisting of a minimum of **450** contact hours distributed over **90** working days, inclusive of examination days, within **18** five-day academic weeks.

'Academic Week' is a unit of five working days in which distribution of work is organized from Monday to Friday, with five contact hours of one hour duration on each day.

'Programme' means a three year programme of study and examinations spread over six semesters, according to the regulations of the respective programme, the successful completion of which would lead to the award of a degree.

'Course' means a complete unit of learning which will be taught and evaluated within a semester.

'Common Course I' means a course that comes under the category of courses for English and ***'Common Course II'*** means additional language, a selection of both is compulsory for all students undergoing undergraduate programmes.

'Core course' means a course in the subject of specialization within a degree programme.

'Complementary Course' means a course which would enrich the study of core courses.

'Open course' means a course outside the field of his/her specialization, which can be opted by a student.

'Credit' is the numerical value assigned to a course according to the relative importance of the content of the syllabus of the programme**.**

'***Parent Department'*** means the department which offers core courses within a degree programme.

'Grade' means a letter symbol (A, B, C, etc.), which indicates the broad level of performance of a student in a course/ semester/programme.

'Grade point' (GP) is the numerical indicator of the percentage of marks awarded to a student in a course.

Words and expressions used and not defined in this regulation shall have the same meaning assigned to them in the Act and Statutes.

COURSE STRUCTURE OF BSc ZOOLOGY PROGRAMME

The U.G.programme in Zoology includes

(a) Common Courses
(b) Core Courses
(c) Complementary Courses
(d) Open Course
(e) Investigatory Project

No course shall carry more than 4 credits.
Student shall have the option to choose Open courses offered by any other Department.

Programme Duration	6 Semesters
Total Credits required for successful completion of the programme	120
Minimum credits required from common courses	38
Minimum credits required from Core courses + Complementary + Project	79
Minimum credits required from Open course	3
Minimum attendance required	75%

EXAMINATIONS

The evaluation of each course shall contain two parts:

(i) In-Semester Assessment (ISA)
(ii) End-Semester Assessment (ESA)

The in-semester to end-semester assessment ratio shall be 1:4, for both courses with or without practical. There shall be a maximum of **80** marks for end-semester evaluation and maximum of **20** marks for in-semester evaluation. For all courses (theory & practical), grades are given on a 07-point scale based on the total percentage of marks. ***(ISA+ESA)*** as given below

Percentage of Marks	**Grade**	**Grade Point**
90 and above	A+ - Outstanding	10
80-89	A - Excellent	9
70-79	B - Very Good	8
60-69	C - Good	7
50-59	D - Satisfactory	6
40-49	E - Adequate	5
Below 40	F - Failure	4

Note: Decimal are to be rounded to the next whole number

CREDIT POINT AND CREDIT POINT AVERAGE

Credit Point (CP) of a course is calculated using the formula

CP = C x GP, where C = Credit; GP = Grade point

Credit Point Average (CPA) of a Semester/Programme is calculated using the formula

CPA = TCP/TC, where TCP = Total Credit Point; TC = Total Credit

Grades for the different semesters and overall programme are given based on the corresponding CPA as shown below:

CPA	Grade
Above 9	A+ - Outstanding
Above 8, but below or equal to 9	A - Excellent
Above 7, but below or equal to 8	B -Very Good
Above 6, but below or equal to 7	C – Good
Above 5, but below or equal to 6	D – Satisfactory
Above 4, but below or equal to 5	E – Adequate
4 or below	F – Failure

Note: A separate minimum of 30% marks each for in-semester and end-semester (for both theory and practical) and aggregate minimum of 40% are required for a pass for a course. For a pass in a programme, a separate minimum of Grade **E** is required for all the individual courses. If a candidate secures **F** Grade for any one of the courses offered in a Semester/Programme only **F** grade will be awarded for that Semester/Programme until he/she improves this to **E** grade or above within the permitted period. Candidate who secures **E** grade and above will be eligible for higher studies.

MARKS DISTRIBUTION FOR END-SEMESTER EXAMINATION AND IN-SEMESTER EVALUATION

The end-semester examination of all semesters shall be conducted by the College at the end of each semester. In-semester evaluation is to be done by continuous assessment. Marks distribution for end-semester and in-semester assessments and the components for in-semester evaluation with their marks are shown below:

Components of the in-semester evaluation and their marks are as below.

1) For all courses without practical

a) Marks of end-semester Examination: 80
b) Marks of in-semester evaluation: 20

All the three components of the in-semester assessment are mandatory.

Components of In- semester Evaluation	***Marks***
Attendance	5
Assignment /Seminar/Viva	5
Test paper(s) (1 or 2) (1x10=10; 2x5=10)	10
Total	**20**

2) For all courses with practical

a) Marks of theory –End-semester Examination: 60

b) Marks of theory –In-semester Evaluation: 10

Components of Theory: In-semester Evaluation	**Marks**
Attendance	3
Assignment/Seminar/Viva	2
Test paper(s) (1 or 2)	5
Total	**10**

a) Marks of Practical: End-semester Examination: 20

b) Marks of Practical: In-semester Evaluation: 10

Components of Practical: In-semester evaluation	**Marks**
Attendance	2
Record	5
Lab involvement	3
Total	**10**

PROJECT EVALUATION

Components of Project Evaluation	**Max. Marks**
In-semester Evaluation	20
Dissertation (End-semester)	50
Viva-Voce (End-semester)	30
Total	**100**

ASSIGNMENTS

Assignments are to be done from 1st to 4th Semesters. At least one assignment should be done in each semester.

SEMINAR/VIVA

A student shall present seminar for each course in the 5th semester.
Student shall appear for a Viva-voce examination for each course in the 6th semester.

ATTENDANCE EVALUATION

1) For all courses without practical

Percentage of attendance	Marks
90 and above	5
85 – 89	4
80-84	3
76-79	2
75	1

(Decimals are to be rounded to the next higher whole number)

2) For all courses with practical

% of Attendance	Marks for theory
90 and above	3
80--89	2
75--79	1

% of Attendance	Marks for practical
90 and above	4
85--89	3
80--84	2
75--79	1

(Decimals are to be rounded to the next higher whole number)

IN-SEMESTER ASSESSMENT - TEST PAPERS

At least one in-semester test-paper is to be attended in each semester for each course. The evaluations of all components are to be published and are to be acknowledged by the candidates. All documents of in-semester assessments are to be kept in the college for two years. The responsibility of evaluating the in-semester assessment is vested on the teacher(s), who teach the course.

PATTERN OF QUESTIONS

Questions shall be set to assess knowledge acquired, standard application of knowledge, application of knowledge in new situations, critical evaluation of knowledge and the ability to synthesize knowledge. The question setter shall ensure that questions covering all skills are set. He/She shall also submit a detailed scheme of evaluation along with the question paper.

A question paper shall be a judicious mix of objective type, short answer type, short essay type /problem solving type and long essay type questions.

Pattern of questions for end-semester examination for theory paper without practical

	Total no. of questions	Number of questions to be answered	Marks of each question	Total marks
	10	10	1	10
	12	8	2	16
	9	6	4	24
	4	2	15	30
TOTAL	**35**	**26**	x	**80**

Pattern of questions for end-semester examination for theory papers with practical

	Total no. of questions	Number of questions to be answered	Marks of each question	Total marks
	8	8	1	8
	10	6	2	12
	6	4	4	16
	4	2	12	24
TOTAL	**28**	**20**	x	**60**

Semester 1

Course Code	Course Title	Hrs./ Week	Hrs/ Sem.	Credit
CEN101	English foundation course I	5	90	4
BBO101	General Botanic And Scientific Skills	2	36	2
BBO1P01	BBO101-Practical	2	36	1
BBT101	Biological evolution and plant classification	2	36	2
BBT1P02	BBT101-Practical	2	36	1
BBT102	Cytology	2	36	2
BBT1P03	BBT102 –Practical	1	36	1
DBB101	Complimentary Biochemistry	2	36	2
DBB1P01	DBB101 –Practical	2	36	1
DZO101	Complimentary Zoology	4	72	4

Semester 2

Course Code	Course Title	Hrs./ Week	Hrs/ Sem.	Credit
CEN202	English foundation course II	5	90	4
BBT203	Microbiology and mycology	2	36	2
BBT2P04	BBT203- Practicals	2	36	1
BBT204	Phycology bryology	2	36	2
BBT2P05	BBT204- Practicals	2	36	1
BBT205	Genetics	2	36	2
BBT2P06	BBT205Practical	2	36	1
DBB202	Complimentary Biochemistry	2	36	2
DBB2P02	DBB202-Practical	2	36	1
DZO202	Complimentary Zoology	4	72	4

Semester 3

Course Code	Course Title	Hrs./ Week	Hrs/ Sem.	Credit
BBT306	Plant Physiology and plant pathology	3	54	3
BBT3P07	BBT306- Practicals	2	36	1
BBT307	Pteridology, Gymnosperms	3	54	3
BBT3P08	BBT307-Practical	2	36	1
BBT308	Moleccular Biology	3	54	3
BBT3P09	BBT307- Practicals	2	36	1
DBB303	Complimentary Biochemistry	3	54	3
DBB3P03	DBB303-Practical	2	36	1
DZO303	Complimentary Zoology	5	90	4

Semester 4

Course Code	Course Title	Hrs./ Week	Hrs/ Sem.	Credit
BBT409	Angiosperm Morphology anatomy and Ebryology	3	54	3
BBT4P10	BBT409- Practicals	2	36	1
BBT410	plant ecology phytogeography and Environmental Studies	3	54	3
BBT4P11	BBT410- Practicals	2	36	1
BBT411	Immunology	3	54	3
BBT4P12	BBT411- Practicals	2	36	1
DBB404	Complimentary Biochemistry	3	54	3
DBB4P04	DBB404-Practicals	2	36	1
DZO404	Complimentary Zoology	5	90	4

Semester 5

Course Code	Course Title	Hrs./ Week	Hrs/ Sem.	Credit
BBT512	angiosperm taxonomy and economic botany	3	54	3
BBT5P13	BBT512-Practicals	2	36	1
BBT513	Agri-Horticulture Plant Breding and pecision farming	3	54	3
BBT5P14	BBT513- Practical	2	36	1
BBT514	BIOPHYSICS	3	54	3
BBT5P15	BBT514-Practical	2	36	1
BBT515	Plant Cell, Tissue and Organ Culture	2	36	2
BBT5P16	BBT515-Practical	4	72	2
	Open Course: Beginners Botany	4	72	4

Semester 6

Course Code	Course Title	Hrs./ Week	Hrs/ Sem.	Credit
BBT616	genetic engineering	3	54	3
BBT6P17	BBT616-Practical	3	54	1.5
BBT617	genomics, bioinformatics	3	54	3
BBT6P18	BBT617- practical	3	54	1.5
BBT618	Industrial and environmental biotecnology	3	54	3
BBT6P19	BBT618-Practical	2	36	1
BBT619	Core Choice :Animal bioechnology & Nanobiotechnology	3	54	3
BBT6P20	Taught And Directed Research Paper	3	54	3
	laboratory/field /librarywork	2	36	1

Semester – 1
GENERAL BOTANICAL AND SCIENTIFIC SKILLS

Theory :- (36 hours)

Module 1 – Microscopy(8 hours)

Introduction to microscopy, basic principle of light, phase contrast, fluorescent, TEM and SEM, confocal microscope and their specific uses, setting up using and caring compound and dissection microscope, preparing specimens for light microscopy, fixing, important fixatives-FAA, Carnoys fluid, whole mounts ,squashes, smears, hand sections, and serial sections, maceration, staining plant tissues: Safranin, Haematoxylin, Acetocarmine, Fast Green, Crystal Violet, double staining, mounting, important mountants-Glycerine, DPX, temporary, semi-permanent and permanent preparations, labeling microscopic preparations, analyzing microscopic image-micrometry, photomicrography, cell counting, plane of sectioning- TS, LS, TLS,RLS , Epidermal.

Module 2–Logic of Science (9 hours)

Logic: Deductive, Inductive, definition of science, goals of science, basic tenets of science, reflection on the value of learning science, method of science– hypothetico-deductive, empiricism, experimentation, variables, controls, , scientific process and skills. Classic experiments in biological science –Edward Jenner, Robert Koch Loius Pasteur

Module 3–Information technology and online bibliographic resources (8 hours)

MS word; word processor toolbars, and their uses in making a document, working with word templates.MS Excel; spreadsheet toolbars, and their uses in making worksheets, performing calculations with formulas and functions, raw data, transformation of raw data into informational data , working with charts, MS PowerPoint; tools of PowerPoint, creating a .ppt presentation.

Module 4–Descriptive statistics(7 hours)

Data collection, data; grouped, ungrouped.Mean, median, mode,range, variance; standard deviation, coefficient of variation, standard error. Graphical representation of data.Data interpretation.

Module 5–Laboratory etiquettes (4 hours)

Basic rules of laboratory and field work, biosafety regulations and biosafety levels, biological containment.

GENERAL BOTANICAL AND SCIENTIFIC SKILLS
PRACTICAL:- (36 HOURS)

1. whole mount of an alga
2. Macerationof anther.
3. Squashes of root tip
4. Making a stainedTS, LS TLS,RLSsectionsof plants and observe the anatomical details.
5. Make microphotograph of the above preparations
6. Epidermal peel of onion scale leaves and observes the details of cells.
7. Measuring microscopic objects with micrometer
8. Counting the number of yeast cells using a haemocytometer
9. Reasoning with venn diagrams
10. Making serial dilutions
11. Making up stock solutions and dispensing aliquots
12. Making a raw database of the quantitative feature of a plant in the campus, analyse, Interpret and present the data graphically along with a written report of the work in 250 words and make a power point presentation.

SEMESTER 1
BIOLOGICAL EVOLUTION AND PLANT CLASSIFICATION
THEORY :- (36 HOURS)

Module 1 – Concept of Evolution (2 hours)
Nature's war -the evolution of the concept of evolution from de Candollee, Malthus Darwin and Wallace, Hooker

Module 2 – Evidence of Evolution (5 hours)
Evidence for evolution, fossils , fossils types, dating of fossils, radiometry, molecular clocks, plant fossils, - paleogeoraphy, discontinuous distribution of flora and fauna, Paleo flora of India, Contributions of Birbal Sahni, History of life on earth, geological time scale

Module 3 – Theories of Evolution (3 hours)
Theories of evolution Lamarck, Wallace, Charles Darwin, Hugo De Vries

Module 4 – Origin of life on earth (3 hours)
Origin of life on earth, Operins hypothesis and Miller's exp. from molecules to life; origin of cells and the first organisms

Module 5 – Forces of Evolution (2 hours)
Mutation,migration, selection and genetic drift; Evolution of species, populations reproductive and geographic isolation and mechanisms

Module 6 – Human Evolution (3 hours)
Human evolution, evolution & society

Plant Classification
Module 1 – Introduction (3 hours)
Classification;purpose and significance,two kingdoms, five kingdoms, three domains.
naming; polynomial to binomial
Module 2 – Systems of Plant Classification (5 hours)
Approaches in plant classification; artificial, natural, phyletic, cladstic, evolutionary
History of plant Classification.
Module 3 – Introduction to Plant diversity (10 hours)
Salient features of plants, diagnostic features and basic life cycle pattern of algae, fungi, bryophyte, pteridophyta, gymnosperms, and angiosperms. Adaption in land plants against that of an aquatic plant. Plant distribution; endemism and cosmopolitan.

BIOLOGICAL EVOLUTION AND PLANT CLASSIFICATION
PRACTICAL:- (36 HOURS)

1. Identify the different types of fossils
2. Draw to scale the geological history of earth and place on the time line the appearance of algae and angiosperms
3. Explore the industrial Melanism of ***Biston betularia from*** population data
4. Compare the adaptations in land plants, against that of an aquatic plant
5. Study the diagnostic features of algae, fungi, bryophyte, Pteridophyta, gymnosperms and angiosperms
6. Chart the life cycle patterns in and algae, fungi, bryophyte pteridophyta, gymnosperms, angiosperms,
7. Investigate leaf adaptations in stinging nettles, mimosa, Utricularia, Casurina
8. Conduct a field trip of minimum 2 days in Kerala to study the diversity, distribution, endangered, endemic plants of Kerala and write an illustrated report of the work in 750 words

SEMESTER – 1
CYTOLOGY
THEORY :- (36 HOURS)

Module 1- Cell architecture and membrane structure (3hours)
Cell Architecture: prokaryotic and eukaryotic cells. Biomembrane structure : The Phospholipid Bilayer: Composition and structural Organization.Membrane Proteins: Structure and Functions, Phospholipids, Sphingolipids, and Cholesterol: Structure and function

Module 2 - Cell structure (3hours)
The detailed structure of plant cell. Sturcture and function of the following organelles-nucleus, endoplasmic reticulum, plastids, mitochondria, ribosomes, dictyosome, microbodies, lysosomes, vacuole, nucleolus. Differences between animal cell and plant cell

Module 3 – Cytoskeleton (6 hours)
Functions of cytoskeleton; Structure, assembly, disassembly and regulation of filaments involved , actinfilaments (microfilaments), microtubules, and intermediate filaments . Molecular motors; kinesins, dyneins, myosins

Module 4 – Chromosomes (6 hours)
Morphology - fine structure, Nucleosome model , karyotype and idiogram; Special type of chromosomes - salivary gland, Lamp brush and B chromosome ; Change in number of chromosomes -Aneuploidy and Euploidy, Down's, Klinefelter's and Turner's syndromes, Change in the structure of chromosomes , deletion, duplication, inversions and translocations and their meiotic behavior

Module 5 - Transmembrane Transport of Ions and Small Molecules(6 hours)
Overview of Transmembrane Transport , Facilitated Transport of Glucose and Water , ATP-Powered Pumps and the Intracellular Ionic Environment, Nongated Ion Channels and the Resting Membrane Potential, Cotransport by Symporters and Antiporters; Transcellular Transport

Module 6 – Cell Cycle and Cell Division (6 hours)
Overview of the Cell Cycle and its Control, Surveillance Mechanisms in Cell Cycle Regulation, Model Organisms and Methods to Study the Cell Cycle, Details of mitosis and meiosis, cell senescence andcell death,programmed cell death; the events of apoptosis, caspases

Module 7 - Cell Signaling(6 hours)
Signaling molecules and their receptors, modes of cell – cell signaling, steroid hormones and their nuclear receptor super family, nitric oxide, carbon monoxide, neurotransmitters, cell surface receptors ; G-protein coupled receptors, Intracellular signal transduction pathway; the cAMP pathway, itegrins and signal transduction

CYTOLOGY
PRACTICAL:- (36 HOURS)

1. Study of plant cell structure using Onion epidermal peel
2. Isolation of chloroplast
3.Isolation of mitochondira and staining using Janus Green B
4. Barr body analysis in cheek epithelium.
5. Study of the different stages of mitosis using onion root tip squash
6. Study of the different stages of meiosis using permanent slides
7. Study of normal human karyotype and differentiating it with the karyotypes of Down's, Klinefelter's and Turner's syndromes

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2. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P., (2002),
3. Molecular Biology of the Cell (4th Ed.), Garland Science, New York.
4. Becker, W. M. and Klein smith, L. J., (2005), World of the Cell (6th Ed.), Benjamin Cummings.
5. Gupta, P. K. (2003), Cell and Molecular Biology (2nd Ed.), Rastogi Publication, Meerut17
6. Harvey, L., Arnold, B., Lawrence, S., Zipursky, Paul, M., David, B., and James, D(2000), Molecular Cell Biology (4th Ed.), W. H. Freeman, New York
7. Lodish et al.2004. Molecular Cell Biology " (Scientific American Book)
8. Stern, K.R. (2002), Introduction to plant Biology (8th Ed.), Mc Graw Hill, Boston

SEMESTER – 2
MICROBIOLOGY AND MYCOLOGY
THEORY :- (36 HOURS)

MICROBIOLOGY (18 hours)

Module - 1 General introduction (4 Hours)

Introduction, History of microbiology, Germ theory, Koch's postulates. Brief classification and general characters of microbes:- bacteria, archaea, protozoa, viruses . introduction to Bergey's manuel, examples and characteristics (brief account) of gram negative bacteria, gram positive bacteria, bacteria with unusual properties, gram positive filamentous bacteria with complex morphology.

Module - 2 Structure of bacterial cell (4 Hours)

Structures external to cell wall: Cell wall: composition, structure, function, cell wall and Gram staining mechanism, Flagella: structure of flagella, different types of arrangements of flagella, Fimbriae and pili. Structures internal to cell wall: Plasma membrane, composition, structure and function Spheroplast, cytoplasm, ribosome, nucleoid, plasmid, inclusions, endospores.

Module - 3 Genetic material in bacteria (4 Hours)

Genetic materials in bacteria.Bacterial chromosome. Extrachromosomal genetic elements, plasmid, mechanism of genetic recombination – transformation, transduction and conjugation. Reproduction by binary fission

Module - 4 Virology (6 Hours)

Characteristics of viruses, size range, host range. classification of viruses, Structure of viruses: general morphology, nucleic acids, capsid and envelope , Sub viral particles - prions, viroids, virusoid, Ultra structure of TMV, Structure and multiplication of T_4 bacteriophage. Methods to culture bacteriophages in the laboratory, culturing animal viruses: in living animals, in embryonated eggs, in cell cultures.Viral multiplication: Multiplication of bacteriophages; lytic cycle, lysogenic cycle, multiplication of animal viruses, differences in the multiplication strategies of DNA and RNA viruses.

MYCOLOGY (18 hours)

Module - 1 General introduction (3 Hours)

Introduction to fungi , structure, basic life cycle patterns, evolutionary trends, Classification based on Ainsworth (1973). Economic importance of Fungi –useful and harmful aspects, Fungi of Agricultural importance – mycoherbicides, myconematicides , mycoparasites , Mycorrhiza – diversity , function and significance.

Module - 2 Detailed type study (13 Hours)

Distinguishing characters of different classes of fungi with special reference to reproductive structures and life history of the following genera

A. Myxomycotina – General Characters
   Mastigomycotina – *Albugo*
   Zygomycotina - *Rhizopus*
B. Ascomycotina
   Hemiascomycetes - *Saccharomyces*

Plectomycetes - *Pencillium*
Pyrenomycetes – *Xylaria*
Discomycetes - *Peziza*

C. Basidiomycotina
Teliomycetes - *Puccinia*
Hymenomycetes -*Agaricus*

D. Deuteromycotina – *Cercospora*

Module - 3 Lichenology (2 Hours) 1. Lichenology- General account , crustose, foliose and fruticose lichens, economic and ecological importance of lichen , thallus structure, reproduction and life cycle of *Parmelia*

MICROBIOLOGY AND MYCOLOGY
PRACTICALS:- (36 HOURS)

Microbiology (18 hours)

1. Gram staining technique
2. Acid fast staining technique
3. Endospore staining technique
4. Flagella staining technique
5. Bacteriological analysis of water samples
6. Identification of bacteria using biochemical tests

Fungi (18hours)

1. Detailed study of the thallus anatomy and morphology of reproductive structures of the fungal and lichen genera mentioned in the syllabus
2. Staining of VAM
3. Observation of fungal succession on cow dung
4. Isolation and identification of fungus from dung, air , fruits ,vegetables.
5. Familiarizing the slide culture technique of fungus.

References :

1. Ahamadjian Vernon and Hale M.E (eds) 1973. *The Lichens* , Academic press, New Delhi.
2. Ainsworth G.C ., Sparrow K.F & Sussman A.S (eds) 1973. *The Fungi an advanced Treatise* ,Vol. 4 a & 4b, a Taxonomic review with keys , academic press New York.
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SEMESTER – 2
PHYCOLOGY AND BRYOLOGY
THEORY:- (36 hours)

PHYCOLOGY(36 HOURS)

Module 1 - Introduction (7 hours)
General characters – habitat, habit, pigmentation, reproduction and life cycles of algae.Classification by Fritsch F. E, 1935; 1945.

Module 2 - Detailed Type study (20 hours)
General characters of the following major classes with special reference to the systematic position, habitat, thallus structure, reserve food, reproduction (excluding developmental stages) and life cycle of the following types:-
Cyanophyceae: *Nostoc*; *Oscillatoria*, Chlorophyceae: *Chlamydomonas*, *Chlorella*, *Volvox*, *Oedogonium*, *Cladophora*, *Coleochaete*, *Chara*; Xanthophyceae: *Vaucheria* Bacillariophyceae: *Pinnularia*; Phaeophyceae: *Sargassum;* Rhodophyceae: *Polysiphonia*

Module 3-Economical and ecological significance (6 hours)
Algae as pollution indicator and in waste water treatment; Algae as primary producers – Oxygen liberators; Algae in soil fertility, cyanobacteria and nitrogen fixation, soil algae; Toxic algae – Algal blooms and red tides; Role of algae in aquaculture; Commercial products: Agar, Alginates, Carrageenin, Diatomaceous earth; Algae as a source of fuel - Hydrogen.

Module 4 - Experimental Phycology (3 hours)
Recent trends in Algal research; Diatoms and Nanotechnology; Cyanobacteria as a source of restriction endonuclease; Algal culture: scope and methods; Indian contribution to algal research.

BRYOLOGY (18 HOURS)
Module 1 - Introduction (5 hours)
General characters – habitat, habit, reproduction, and life cycle of Bryophytes; alternation of generation.Classification; Kasyap and Smith and evolution of sporophyte and gametophyte in Bryophytes.

Module 2 –Detailed Type study (10 hours)
General characters of the following major groups with special reference to the systematic position, occurrence, structure (morphology and anatomy), reproduction -vegetative, asexual, and sexual (excluding developmental stages) and life cycle of the following types: Hepaticopsida:*Riccia*, *Marchantia*; Anthocerotopsida: *Anthoceros*; Bryopsida: *Funaria*.

Module 3 - Ecological and economical importance: (3 hours)
Bryophytes as ecological indicators, role in plant succession,prevention of soil erosion, water retention, Economic importance of Bryophytes: Antibiotics, Horticultural importance.

PHYCOLOGY AND BRYOLOGY
PRACTICAL:-36 HOURS

PHYCOLOGY (24 HOURS)

1. Detailed study of the thallus anatomy of the algal genera mentioned in the syllabus
2. Detailed study of the morphology and anatomy of reproductive structures of the algal genera mentioned in the syllabus
3. Collect and submit any five genera of algae mentioned in the syllabus
4. Familiarize with algal culture

BRYOLOGY(12 HOURS)

1. Detailed study of the thallus morphology and anatomy of the genera mentioned in the syllabus.
2. Detailed study of the Reproductive structures of the genera mentioned in the syllabus.

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5. Vasishta B R, Sinha A.K, Singh V.P. 2004. *Botany for Degree Students- Algae*, S. chand& Co. Ltd. New Delhi.
6. Chopra R.N and Kumar P. K. 1988. *Biology of Bryophytes*, Wiley Eastern Ltd, New Delhi.
7. Mamatha Rao, 2009, *Microbes and Non flowering plants- impact and application.* Ane Boopks Pvt Ltd.
8. Rasheed A. 2000. *An Introduction to Bryophyta*. Vikas Publishing House, New Delhi.
9. Singh, Pande Jain. 2007, *Diversity of Microbes and Cryptogam*, Rastogi Publications.
10. Vashista B. R .1993. *Bryophyta*. S Chand & Co., New Delhi.
11. Smith GM Cryptogamic botany vol.1
12. Smith GM Cryptogamic botany vol.2

SEMESTER – 2
GENETICS
THEORY :- (36 HOURS)

Module 1 - Mendelism and its extension (18 hours)
Experiment of Mendel with *Pisum sativum*, recessive and dominant traits, alleles, principles of inheritance, incomplete dominance and codominance; Incomplete dominance-flower color in Mirabilis: Interaction of genes- comb pattern in poultry (9:3:3:1): Epistasis- recessive- coat color in mice (9:3:4); dominant epistasis- fruit color in summer squash (12:3:1): complementary genes- flower color in Lathyrus (9:7) ; Multiple alleles- general account: ABO blood group in man; co dominance, inheritance of Rh factor, psuedoalleles ; pleotropism, Quantitative characters: polygenic inheritance, continuous variation- kernel color in wheat/ear size in maize. Pedigree analysis, Chromosome theory of inheritance.

Module 2 – Linkage (3 hours)
Linkage, crossing overand chromosome mapping, Linkage and crossing over-Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Construction of linkage map, Sex Linkage, eye color in Drosophila, Haemophilia in man

Module 3 - Extrachromosomal Inheritance (5 hours)
Extrachromosomal Inheritance**,** Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast; Maternal effects -shell coiling in snail; Infective heredity-Kappa particles in Paramecium.

Module 4 – Sex Determination (3 hours)
Sex determination- sex chromosomes and autosomes- chromosomal basis of sex determination; XX-XY, XX-XO mechanism; sex determination in higher plants (*Melandrium album*)

Module 5 – Mutation (4 hours)
Mutations, definition, importance of mutation, types of mutations, gene mutations, types of gene mutations, causes of mutations

Module 6 – **Population Genetics**(3 hours)
Gene pool, Gene frequencies, Genotype frequencies; Hardy Weinberg principle,Evolutionary agents – Selection, Migration, Mutation and Genetic drift

GENETICS
PRACTICAL:- (36 HOURS)

1. Work out problems in:
   a. Monohybrid , dihybrid and back crosses.
   b. All types of modified Mendelian ratios mentioned in the syllabus.
   c. Multiple alleles and their inheritance
   c. Sex linked inheritance
   d. Population genetics (Mendelian traits with typical dominant and recessive relations only)

2. Raise a population of Drosophila and List the contrasting features among the individuals in the Drosophila population

References:

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- Daniel, H. & Jones, E.W. (1998) Genetics, Principles and Analysis (4th Ed.). Jones & Barlett Publication.
- Griffiths, A. J. F., Miller, J. H., Suzuki, D. T., Lewontin, R. C. &Gelbart, W. M.(2000) An Introduction to Genetic Analysis (7th Ed.), Freeman, New York
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- Sturtevant, A. H. (1965), History of Genetics, Harper & Row, New York

SEMESTER – 3
PLANT PHYSIOLOGY AND PLANT PATHOLOGY
THEORY :- 54 HRS

PLANT PHYSIOLOGY (36 HOURS)

Module 1- Water relation of plants (5 hours)

Physical aspects of absorption-Diffusion, imbibition, osmosis, OP, DPD, TP, WP, Concept of Water potential, Permeability and its importance. Absorption of water-active and passive, pathway of water movement, symplast, apoplast, transmembrane pathways Ascent of sap-cohesion adhesion theory, Transpiration- types, mechanism, theories- (starch-sugar, H^+-K^+ion exchange), significance, anti-transpirants, guttation.

Module 2 - Mineral Nutrition and absorption (3 hours)

Essential and non essential elements- macro& microelements, biological role- deficiency symptoms. Absorption of minerals – passive -ion exchange, active - carrier concept.

Module 3 - Photosynthesis and Photorespiration (9 hours)

Structure of chloroplast - Photosynthetic pigments, antenna complexes and reaction centre, details of electromagnetic spectrum, photo excitation and energy transfer, Fluorescence, Phosphorescence - absorption and action spectra, red drop and Emerson effect, concept of two photosystems, Cyclic & Non Cyclic photophosphorylation (Z- scheme), Carbon assimilation pathways-C_3, C_4, CAM. Photorespiration, significance, factors affecting photosynthesis.

Module 4 - Translocation of organic solutes (2 hours)

Direction of translocation, mechanism of translocation - pressure flow and protoplasmic streaming theory, role of p proteins, phloem loading and unloading.

Module 5 - Respiration (6 hours)

Structure of mitochondria, aerobic respiration- Glycolysis, Krebs cycle, Electron transport system & Oxidative phosphorylation, ATPases - chemi osmotic theory, anaerobic respiration- Fermentation, RQ and its significance, respiratory inhibitors, factors affecting respiration.

Module 6-Nitrogen metabolism (2 hours)

Assimilation of nitrate by plants, biological nitrogen fixation (brief study only), ammonification, nitrification and denitrification.

Module 7: Physiology of growth and development (4 hours)

Phases and measurement of growth, physiological effects and practical application of Plant growth substances and hormones:Auxins, gibberellins, cytokinins, abscisic acid, ethylene. Seed dormancy and germination: Seed dormancy, causes of seed dormancy, dormancy breaking methods, Seed germination- types, factors affecting seed germination.

Module 8: Physiology of flowering and plant movements (3 hours)

Phytochrome mediated flowering, photoperiodism, vernalisation. Plant movements- classification, movements of curvature and movements of variation (paratonic and nasticmovements)

Module 9 - Stress physiology and plant responses to environment(2 hours)
Abiotic- plant responses to water, temperature and salt stresses. Biotic- pathogens and insects, Allelochemicals and herbivory

PLANT PATHOLOGY(18 HOURS)
Module - 1 General introduction (4 Hours)
History of plant pathology, Classification of plant diseases on the basis of causative organism and symptoms , Host parasite interaction , Defense mechanism in host ,Mechanism of infection, transmission and dissemination of diseases.
Module - 2 Control of plant diseases (4 Hours)
Quarantine measures, seed certification,prophylaxis, therapeutic, physical therapy , chemotherapy, classes of fungicides and bactericides, method of application, different types of sprayers and their working,biological control. Bordeaux mixture, Tobacco decoction, preparation.

Module - 3 Detailed study of plant diseases (10 Hours)
Study of following diseases with emphasis on symptoms, etiology and controlBunchy top of Banana, leaf mosaic of tapioca, . root wilt of Coconut, abnormal leaf fall of Rubber, red rot of sugar cane

PLANT PHYSIOLOGY AND PLANT PATHOLOGY
PRACTICAL :- (36 HOURS)
PLANT PHYSIOLOGY (27 HOURS)
Core Experiments
1. Determination of osmotic pressure of plant cell sap by plasmolytic method.
2. Measurement of transpiration rate using Ganong's potometer/ Farmer's potometer.
3. Separation of leaf pigments by thin layer chromatography/paper chromatography.
4. Measure the effect of environmental conditions on photosynthetic rate using Willmott's bubbler or any suitable method.
5. Estimation of plant pigments by colorimeter.

Demonstration only experiments.
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 R.Q.
7. Fermentation- Kuhne's tube

PLANT PATHOLOGY(9 HOURS)
1. Identify the diseases mentioned in the syllabus with respect to causal organisms and symptoms
2. Submit herbarium preparations of all the diseases mentioned in the syllabus
3. Preparation of Bordeaux mixture, Tobacco decoction
4. Familiarize with the various kinds of sprayers

References

1. Datta, S.C.1989. *Plant Physiology*, Central Book Depot, Allahabad.
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20. Gupta V .K & Paul T.S 2004, *Fungi & Plant deseases*. Kalyani publishers , New Delhi
21. Malhotra & Aggarwal Ashok 2003 *Plant Pathology*, Tata Mc Graw Hill

SEMESTER – 3
PTERIDOPHYTES AND GYMNOSPERMS
THEORY :- 54HRS

PTERIDOPHYTES(27 HOURS)

Module 1 - General characters of Pteridophytes (4 Hours)
General characters of Pteridophytes, basic life cycle patterns in pteridophytes ; life cycles of homosporous and heterosporuspteridophytes , vascular tissues in Pteridophytes, stelar types and their evolution , Classification of Pteridophytes by Smith

Module 2 – Detailed type study (19 hours)
Structural organization of sporophyte and gametophyte (development of sex organs not necessary) of *Psilotum ,Lycopodium , Selaginella , Equisetum , Pteris , Marsilea*

Module 3 – General topics (4 hours)
Telome theory, Heterospory and seed habit, Economic importance of Pteridophytes , ecological importance of Pteridophytes,

GYMNOSPERMS (27 HOURS)

Module 1 - General characters of Gymnosperms (4 Hours)
General characters ,Classification (Sporne's system)

Module 2 – Detailed type study (19 hours)
Study of morphology, anatomy and reproductive features of,*Cycas,Pinus* and*Gnetum.*

Module 3 – General topics (4 Hours)
Evolutionary tendencies among Gymnosperms ,Affinities of Gymnosperms, Economic importance of Gymnosperms

PTERIDOPHYTES AND GYMNOSPERMS
PRACTICAL:- 36 HOURS

PTERIDOPHYTES–(18 HOURS)
Study of the morphology, anatomy and reproductive structures of the types mentioned.

GYMNOSPERMS– (18 HOURS)
Study of the morphology, anatomy and reproductive structures of the types mentioned

Reference

1. Bhatnagar S P &Moitra A., 2003, *Gymnosperm*s, New Age International (P)Ltd., New Delhi.
2. Coutler J.M & Chamberlain C. J ,1958. *Morphology of Gymnosperm*s. Central Book Depot Allahabad.
3. Dutta S.C, 1991, *An Introduction To Gymnosperms*, Kalyan Publishing Co. New Delhi.
4. Pandey S.N.et al, 2006, A text book of Botany, Vikas Publishing House, New Delhi.
5. Rasheed A. 1999, *An Introduction to Pteridophyta,*Vikas Publishing House, New Delhi.
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7. Vashista B. R, 1993. *Pteridophyta*, S Chand & Co., New Delhi
8. Smith GM Cryptogamic botany vol.1
9. Sporne KR morphology of Gymnoperm

SEMESTER – 3
MOLECULAR BIOLOGY
THEORY :- (54HOURS)

Module 1- Genetic material (6 hours)
Introduction to heredity and the genetic material, characteristics of genetic material, Early studies on DNA [works of F.Miescher, Albert Kossel, Phoebus Levene, Erwin Chargaff], The discovery of transforming principle [Griffith's experiment], Identification of the transforming principle[Avery, MacLeod and McCarty's experiment]; [Hershey and Chase experiment], Watson and Crick's discovery of the structure of DNA, discovery of RNA as the genetic material in some organisms [Heinz Fraenkal-Conrat's experiment].

Module 2- Structure of DNA (8 hours)
The structure of DNA, Primary structure; structure of ribose and deoxyribose sugars, Structure of N bases, structure of nucleosides and nucleotides, phosphodiester bond and structure of a polynucleotides, Secondary Structure; structure of DNA double helix, different secondary structures [A,B and Z] , circular DNA

Module 3- DNA replication and DNA repair (8 hours)
Suspected forms of DNA replication, conservative, dispersive and semi-conservative, Meselson and Stahl's experiment, Requirements for replication; template, raw materials, enzymes and other proteins,direction of replication, mechanism of replication, Bacterial DNA replications, eukaryotic DNA replication. DNA repair, mismatch repair, direct repair, base-excision repair, nucleotide excision repair, photoreactivation, SOS response, DNA replicationinhibitors

Module 4- Transcription (8 hours)
Transcription, concept of gene, types of RNAs and their function, mRNA, tRNA, rRNA, snRNA, snoRNA, miRNA, requirements for transcription, the template and nontemplate strands of DNA, experiments by Julius Marmur, Promoters; bacterial and eukaryotic, RNA polymerase; bacterial and eukaryotic, the process of bacterial transcription, the process of eukaryotic transcription, RNA processing; addition of 5' cap and 3'polyA tail, split genes, exons, introns, RNA splicing , transcription inhibitors

Module 5 - Translation (6 hours)

Structure of tRNA, clover leaf and 'inverted L' models of tRNA, the genetic code, characteristics of the code, process of translation, polyribosomes, mRNA survilience; non-sense mediated mRNA decay, non-stop mRNA decay, stalled ribosome, translation inhibitors

Module 6–Gene Regulation (9 hours)
Levels of gene regulation, gene regulation in bacterial cells; operon concept, negative and positive control, inducible and repressible operons, *lac* operon of *E.coli*, *trp* operon of *E.coli*, Gene regulations in eukaryotes; chromatin remodelling, histone acetylaltion, DNA methylation, alternative splicing of mRNA, RNA silencing, Transcriptional Control by hormones, Regulation mediated through transcription factors, Regulation of enhancer activity.

Module 7–Molecular biology of cancer (3 hours)
What is cancer? Is cancer contagious? Tumor viruses,genes that cause cancer, regulation of cell growth,genes that prevent cancer: tumor suppressors, the cell cycle, pRb and p53

Module 7 – Epigenetics(6 hours)
History and development of ideas, mechanism of epigenetics, chromatin remodelling, histone acetylaltion, DNA methylation, inheritance of epigenetic traits

MOLECULAR BIOLOGY
PRACTICAL :- (36 HOURS)

1. Work out problems based on DNA structure , replication, transcription and translation
2 . Isolation of DNA from plant tissue
3. Agarose Gel Electrophoresis of DNA
4. Spectrophotometric quantification of DNA

References:-

1. Cooper GM and Hausman (2013), The Cell, a molecular approach , 6th Edition,Sinauer Associates, Sunderland
2. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P., (2002),
3. Molecular Biology of the Cell (4th Ed.), Garland Science, New York.
4. Becker, W. M. and Klein smith, L. J., (2005), World of the Cell (6th Ed.), Benjamin Cummings.
5. Gupta, P. K. (2003), Cell and Molecular Biology (2nd Ed.), Rastogi Publication, Meerut17
6. Harvey, L., Arnold, B., Lawrence, S., Zipursky, Paul, M., David, B., and James, D(2000),
7. Molecular Cell Biology (4th Ed.), W. H. Freeman, New York
8. Lodish et al.2004. Molecular Cell Biology " (Scientific American Book)
9. Weinberg, Robert A. The Biology of Cancer. New York: Garland Science, 2007

SEMESTER –4
ANGIOSPERM MORPHOLOGY, ANATOMY AND EMBRYOLOGY
THEORY :- 36 HRS

ANGIOSPERM MORPHOLOGY (12 HOURS)

Module 1 - Plant habit and morphology of vegetative parts (3 hours)
Diverse Plant habits ; herbs, shrubs, trees, twiners, climbers, lianas Morphology of vegetative parts ; Leaf - compound and simple, phyllotaxy, leaf modifications,; stem modifications, root modifications

Module 2 – Structure of flower(3 hours)
Floral parts, symmetry of flower ,union of floral parts, types of flowers based on ovary position, types of aestivation, floral diagram, floral formula

Module 3 – Inflorescences (3 hours)
Racemose types-simple raceme, corymb, umbel, spike, catkin,spadix;Cymose types-simple cyme, monochasial cyme -scorpoid and helicoid, dichasialcyme, Special type- cyathium, hypanthodium, head, coenanthium, Panicle.

Module 4 – Fruits (3 hours)
Different types of fruits belonging to Simple, fleshy, dry dehiscent, indehiscent, aggregate,multiple categories with examples

ANGIOSPERM ANATOMY(12 HOURS)

Module 1 – Plant cell and tissues (5 hours)
The plant cell wall,gross structure , primary and secondary cell walls, channels of intercellular transport;pits ,plasmodesmataTissues- simple , complex,composition of xylem and phloem, meristematic tissue,types. Tissue Systems; Epidermal tissue -epidermis, cuticle, trichome, stomata,hydathodes,bulliform cells, cork and silica cells. Ground Tissue - cortex, endodermis, pericycle, pith and pith rays. Vascular Tissue - different types of vascular bundles and their arrangement in root and stem.

Module 2 – Structure and Organisation of Root and Shoot Apices(1 hour)
Histogen theory, Tunica-Corpus theory and Korper- Kappe theory

Module 3 – Secondary growth (4 hours)
Cambium; Development, structure and function, Normal secondary growth in dicot stem and root ;stelar and extrastelar, periderm, bark, polyderm, rhytidome and lenticels. Anomalous secondary growth inBougainvillea stem, Bignonia stem and Dracaena stem.

Module 3 – Wood anatomy(2 hours)
Wood; basic structure, heart wood, sap wood, hard wood, soft wood, tyloses, growth rings and dendrochronology, porous and non porous wood, ring porous and diffuse porous wood, wood

rays;structure and cell types, uniseriate and multiseriate rays; heterocellular and homocellular rays. Wood anatomy in wood identification

ANGIOSPERM REPRODUCTIVE BOTANY (12 HOURS)

Module 1 – Microsporogenesis(3 hours)
Anther; structure, different types, pollinium, development, dehiscence. Development of male gametophyte, pollen germination and viability.

Module 2 – Megasporogenesis(3 hours)
Structure and development of ovule, placentaion types, Structure of mature embryo sac.- monosporic (polygonum type), bisporic (Allium type) and tetrasporic (Peperomia type)
.

Module 3 – Pollination and fertilization (3 hours)
Pollination,mechanisms and agencies, natural Mechanisms to prevent self-pollination-hercogamy, heterostyly, protrandry and protogyny, Special typ of pollination mechanism, Fertilisation; syngamy, triple fusion.

Module 4 – Embryo development (3 hours)
Development of endosperm,cellular, nuclear and helobialendosperms . Structure of embryo in dicots and monocots, variancein embryo developmentpolyembryony and apomixes ,apogamy, apospory, parthenocarpy. Development and general structure of fruits(dry and fleshy) and seed (pea and paddy)

ANGIOSPERM MORPHOLOGY, ANATOMY AND EMBRYOLOGY PRACTICAL (72 HRS) –

Identifications

1. Cell types and tissues
2. Non living inclusions – starch grains, cystolith, raphides, aleurone grains.
3. Anther (Monothecous and Dithecous), embryo sac , embryo and PlacentationTypes
4. Following inflorescence and fruits:-
   (a) Different Inflorescence types mentioned in the syllabus
   (b)Different Fruit types mentioned in the syllabus

Micropreparations

5. Primary structure of stem, root and leaf-Dicots and Monocots.
6. Stomatal types: - anomocytic, anisocytic, paracytic, diacytic and grass type.
7. Secondary structure of dicot stem and root.
8. Anomalous secondary structure of *Bougainvillea* stem, *Bignonia* stem and *Dracaena* stem.

Experimentation and Field work

9. Preparation of floral formula and floral diagram from floral description and flower dissection
10. Pollen germination study
11. Field work for a minimum of 3 days under the guidance of a teacher

References

1. Ashok Bendra and Ashok Kumar, 1980. *Economic Botany*. Rastogi Publication, Meerut.
2. Cornquist A. 1968. *The Evolution and Classification of Flowering plants*.
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17. Maheswari P. and Umaro Singh, 1965. *Dictionary of Economic Plants in India*, ICAR, New Delhi.
18. Shivanna K.R. and B.M. Joshi 1985. *The Angiosperm Pollen Structure & Function*. Wiley Eastern Ltd., New Delhi.

SEMESTER –4
PLANT ECOLOGY, PHYTOGEOGRAPHY AND ENVIRONMENTAL SCIENCE
THEORY :- (54 HOURS)

Module - 1 General introduction (2 Hours)
Relevance and scope of ecology,Ecology and Environmental Science, Interdisciplinary nature of environmental science, Types of resources-Renewable and non-renewable, Sustainable development and ecological footprints

Module - 2 Ecosystems: Structure and function (10 Hours)
Ecosystem components- abiotic and biotic**,** Energy flow: Ecological energetics, trophic levels, food chain and food web and ecological pyramids, Productivity – primary, secondary and net productivity, Lebig's law of minimum, Nutrient cycles: Biogeochemical cycles of C, N and S. Habitat, ecological niche and microclimate

Module - 3 Population and Community ecology(10 Hours)

Population characteristics, population growth, Metapopulations, Ecotypes and Ecads, Community characteristics: Quantitative (eg. frequency, density and abundance), Qualitative (eg. physiognomy and phenology), Synthetic (eg. dominance), ecotone and edge effect, Ecological succession: types of succession, process of succession. Hydrosere and xerosere.

Module - 4 Plants and environment (10 Hours)
Ecological complexes and factors affecting plants growth and response: Climatic factors: temperature and pressure, water - precipitation, humidity, soil water holding capacity, light - global radiation,Topographic factors: altitude and aspects, Edaphic factors – Soil profile and physical and chemical properties of soil, soil formation, Biotic factors: interactions – positive and negative, Adaptation of plants to environment: Xerophytes, Hydrophytes, epiphytes and halophytes, Climate, vegetation and botanical zones of India. Western Ghats – a brief study

Module - 5 Global environmental problems and management (12 Hours)
Definition and general introduction, Air pollution, Water pollution, Land pollution, Noise pollution, Thermal pollution, Radioactive pollution, Solid waste management , Phytoremediation, ecological indicators, EIA: Environmental Impact Assessment in polluted areas, Global warming, Acid rain, Ozone layer depletion, Impacts of climate change on agricultural production, human health and global distribution of ecosystems.

Module - 6 Biodiversity and Conservation of resources (10 Hours)
Biodiversity general introduction, Endemism: Definition, types, Hotspots in India, IUCN-threat categories, Red data book, Biodiversity loss: Causes and rate of biodiversity loss, extinction causes; habitat destruction, invasive species, over exploitation and pollution, Conservation efforts: In situ and ex situ conservation methods, National parks and wild life sanctuaries of Kerala. Joint Forest Management (JFM). Ecotourism

PLANT ECOLOGY, PHYTOGEOGRAPHY AND ENVIRONMENTAL SCIENCE
PRACTICAL :- (54 HOURS)

1. Estimation of CO_2, Dissolved O_2 and total alkalinity of water samples (Titremetry)
2. Determination of pH of soil and water
3. Assessment of diversity, abundance, and frequency of plant species by quadrate 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, Quadrate)
6. Visit to any forests types including grasslands and preparation of the list of Rare and threatened (R&T) plants (no collection of specimens) OR Visit to any ecotourism center in Kerala and prepare a report on the project.
7. Collection, identification and preparation of the list of exotic species in the locality.
8. Study of anatomical, morphological, physiological adaptation of plants to the environment (Xerophytic, Hydrophytic, Epiphytic and Halophytic)
10. Collection and recording of rain data by using simple rain gauge.
11. Western ghats conservation; issues and approaches, Comparison of Kasthuri Rangan report and Gadgil report

REFERENCES:

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6. Smith T. M. and Smith R. L. 2012 Elements of ecology ,Pearson publication, New Delhi
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8. Trivedi R.K. and Goel P.K. chemical and biological methods for water pollution studies

SEMESTER – 4
IMMUNOLOGY
THEORY :- (54HOURS)

Module 1-Introduction(6 hours)
Introduction to immunology, Types of immunity. Innate and acquired, passive, active , Mechanisms of innate immunity (eg. Barriers, phagocytosis, inflammation), Types of infections.

Module 2-Cells of the immune system(7 hours)
Leucocytes, lymphocytes and differentiation of lymphocytes, T&B cells , Macrophages, Primary and Secondary lymphoid organs , Complement system and biological effect of complements

Module 3 - Antigens and Antibodies (7 hours)
Antigens and Antibodies, Antigenicity and immunogenicity, Types of antigens, haptens ,antigenic determinants, antigen presentation, Basic structure of immunoglobulins, Different classes of immunoglobuins and functions

Module 4-Antigen Antibody reactions (8 hours)
Antigen Antibody reactions, Agglutination test , Precipitation test, Clinical applications of antigen antibody reaction, Complement fixation test, Coombs test, Radioimmuno assay, HIV test, direct ELISA, indirect ELISA, competitive ELISA, sandwich ELISA , Immunodiffusion, Immunoflourescence, immunoelectrophoresis.

Module 5 -Humoral and cell mediated immune response (9 hours)
Humoral and cell mediated immune response, Receptors on T and B cells , MHC, Antibody production, Monoclonal antibodies, Hybridoma technology

Module 6 -Immune Disorders (5 hrs)
Immune Disorders, Hypersenstivity, Autoimmunity, Immunodeficiency and AIDS

Module 7 -Vaccines (5 hrs)
Vaccines- Major types of vaccines (BCG, DPT, Polio vaccine and TAB Vaccines). Recent trends in vaccine preparation

Module 8 (7 hours**)**
Immunology of Organ and tissue transplantation , Immunology of malignancy, immunotherapy of cancer, ABO and Rh blood group system, immunology of blood transfusion.

IMMUNOLOGY
PRACTICALS:- (36 HOURS)

1. Immunodiffusion in gel
2. Haemagglutination test and identification of blood groups A,B,AB and O, Rh factor
3. Preparation of human blood smear and identification of leucocytes
4. Widal
5. VDRL
6. Rocket immunoelectrophoresis

References:-

- Text book of Microbiology – R. Ananthanarayanan and C K Jayaram Panicker. Orient Longman
- Coleman: Fundamentals of Immunology
- Michael J. Pelczar ECS, Chan & Noel .R.Kreig, Microbiology , Tata McGraw Hill 5th ed .1996
- Park, K., Parks Text Book of Preventive and Social Medicine, 2002, 17th Ed.
- Banarasidass Bhenot Publications
- Panicker, S.Francis g., and Abraham G.K. 2008, Microbiology and Immunology, Study Material Series published by Zoological Society of Kerala
- Ivan Roitt, 2002, *Essential Immunology* ELBS
- Sobha & Sharma (2008) Essentials of Modern Biology Ones Student edition PP 463-468

SEMESTER –5
ANGIOSPERM TAXONOMY AND ECONOMIC BOTANY
THEORY – 54 HRS

TAXONOMY (45 HOURS)

Module 1 – Different taxonomic approaches(6 hours)
Objectives of taxonomy, research scope and opportunities in taxonomy , .Types of Classification- Linnean sexual system(Brief account),Bentham and Hooker(Detailed account), APG system(Brief account), Binomial Nomenclature, Interdiciplinary approach in Taxonomy; Cytotaxonomy, Chemotaxonomy, Molecular taxonomy, Numerical taxonomy.

Module 2 – Herbarium (3 hours)
Herbarium technique- Preparation of herbarium, preservation , ICBN, Botanical, gardens and BSI (Brief account)

Module 3 – Detailed Study of Angiosperm Families (36 hours)
Study of the following families of Bentham and Hooker's System with special reference to their morphological and floral characters. Special attention should be given to common and economically important plants within the families.
Annonaceae, Nymphaeaceae,Capparidaceae, Malvaceae, Sterculiaceae, Rutaceae, Meliaceae, Anacardiaceae, Leguminosae (Mimosaceae, Caesalpiniaceae and Fabaceae), Combretaceae, Myrtaceae, Cucurbitaceae, Apiaceae, Rubiaceae, Compositae (Asteraceae), Sapotaceae,Apocynaceae, Asclepiadaceae, Solanaceae, Convolvulaceae, Scrophulariaceae, Acanthaceae, Verbenaceae, Lamiaceae (Labiatae), Amaranthaceae, Euphorbiaceae, Orchidaceae, Liliaceae, Arecaceae, Graminae (Poaceae)

ECONOMIC BOTANY (9 HOURS)

Module 1 – Economic Botany (6 hours)
Study of the following groups of plants based on their uses with special reference to the botanical name, family and morphology of the useful part ,

Cereals- Rice, Wheat, Maize
Millets- Ragi
Pulses- Green gram, Bengal gram, Black gram
Fruits:- Apple, Pineapple, Grape, Mango and Banana
Vegetables:- Bittergourd,Snake gourd, Ash gourd, Ladies finger, Carrot and Cabbage.
Sugar: - Sugar cane, Sugar beet
Timber yielding plants:- Teak wood and Jack wood, Rose wood
Beverages- Tea, Coffee
Oil yielding plants- Ground nut, Gingelly
Rubber yielding plants- Para rubber
Gums and Resins- White damer, Gum Arabic, Asafoetida
Spices – Cardamom, cloves , ginger, star anise, nutmeg , pepper
Insecticide yielding Plants- Tobacco and Neem

Module 2 – Ethanobotany (3 hours)

Ethnobotany and it's significance. Methodology of ethnobotanical studies, Study of the following plants used in daily life by tribals and village folks for Food, Shelter and Medicine

Food :-*Artocarpus, Corypha*

Shelter - *Bamboosa, Ochlandra and Calamus*

Medicine –*Scoparia dulcis, Aegle marmalose, Saraca ashoka, Coleus umbonicus*

ANGIOSPERM TAXONOMY AND ECONOMIC BOTANY
PRACTICAL:- (36 HOURS)

1. Preparation of floral formula from floral description.
2. Identify the member plants belonging to the families mentioned in the syllabus
3. Students must describe the floral parts, draw the L.S., floral diagram and write the floral formula of at least one flower from each family.
4. Study the finished products of plants mentioned in the syllabus of economic botany with special reference to the morphology, botanical name and family.
5. Prepare herbarium of 25 plants with field notes.
6. Conduct field work for a minimum of 5 days under the guidance of a teacher

References

1. Ashok Bendra and Ashok Kumar ,1980. *Economic botany*.:Rastogi publications, Meerut.
2. CornquistA. ,1968. *The evolution and Classification of FloweringPlants*.
3. Davis P.H and Heywood V.H. 1967 *Principles of Angiosperm Taxonomy*. Edinburgh: Oliver and Boyl.
4. Henry and Chandra Bose 2001 *An Aid to the International Code of Botanical Nomenclature*. Botanical Survey of India. Coimbatore.
5. Heywood V.H. 1967. *Plant Taxonomy*. London: Edward Arnold.
6. Hill A.F. 1982. *Economic Botany*.:McGraw Hill ,New York.
7. Jain S K 2004, *A Manual Of Ethnobotany*, Scientific Publishers, India
8. Jain S. K. 1981. *Glimpses of Indian Ethnobotany*.:Oxford and IBH. New Delhi
9. Jain S. K. 1987. A Manual of Ethnobotany. Jodhpur Scientific Publishers.
10. Jain S.K. and Rao R.R. 1976. A hand book of field and herbarium technique. Today and Tomorrow's Publishers, New Delhi.
11. Jeffery C. (1968) *An Introduction to Plant Taxonomy*, J and A Churchill. London.
12. Maheshwari P. and Umaro Singh. (1965) *Dictionary of Economic Plants in India*, ICAR. New Delhi.
13. Naik V.N. (1984) *Taxonomy of angiosperms*. Tata McGraw- Hill Publishing Company, New Delhi.
14. Pandey&Misra 2008 *Taxonomy of Angiosperms*. Ane Book Pvt. Ltd.
15. Pandey B.P. 2000 *Economic Botany* S. Chand& Company Ltd. New Delhi.
16. Rendle A.B. (1979) *Classification of flowering plants*. Vikas Publishing House, U.P. Vols. I & II.
17. Singh V. and Jain D. K. (1989)*Taxonomy of Angiosperms*. Meerut :Rastogi Publication.
18. Sivarajan V.V. (1982) *Introduction to Principles of Taxonomy*, Oxford and IBH Publication. New Delhi
19. Sivarajan V.V. 1991, *Introduction to the Principles of Plant taxonomy*. Oxford IBH Publishing Co. Pvt. Ltd., New Delhi.
20. Sreemali J.L. (1979) *Economic Botany*. Allahabad :KitabMAhal.
21. Swain T. (1963) *Chemical Plant Taxonomy*. New York: Academic Press.
22. Verma .V. *Text book of Economic Botany* ,Ane Book Pvt. Ltd.

SEMESTER – 5
AGRI-HORTICULTURE AND PLANT BREEDING
THEORY :- (54 HOURS)

PLANT BREEDING (27 hours)

Module1- History and objectives (2 hour)
History and objectives of plant breeding. Centers of origin of cultivated plants.

Module1- Plant Introduction (2 hour)
Plant introduction- procedure, quarantine regulations, acclimatization.Agencies of plant introduction in India.Achievements.

Module3 – Selection (6 hours)
Selection- mass, pureline, clonal, achievements.

Module4 – Hybridization (10 hours)
Hybridization: procedure- intergeneric, interspecific and intervarietal hybridization with examples.Composite and synthetic varieties.Heterosis in plant breeding, inbreeding depression; Single cross: pedigree method, bulk population method, multiple cross, back cross, polyploidy breeding, male sterility in plant breeding.Use of apomixis in plant breeding.

Module 5 – Mutation breeding (5 hour)
Mutation breeding: Mutagens- physical and chemical, spontaneous and induced mutations, effect of mutation, methods of mutation breeding.Gamma gardens and its working. Breeding for Biotic(disease)and abiotic (drought) stress resistance

Module 6 – Modern trends (2 hour)
Modern trends in plant breeding; Somaclonal variations in crop improvement ,genetically modified crops

HORTICULTURE (27 hours)
Module 1 – Basics of Horticulture (4 hours)
Scope and importance, Divisionsof horticulture, Global scenario of horticultural crops, export and import, HorticultureZones of India and Kerala, Horticultural developmental agencies in India

Module 2 – Soil and climate (4 hours)
Soil; physical and chemical properties, climatic factors; light,temperature, photoperiod, relative humidity, rainfall, micro climate, influence of biotic and abiotic stresses on crop production

Module 3 – Plant Propagation (7 hours)
Propagation of horticultural plants- by seeds- Seed viability, seed dormancy, seed testing and certification, seed bed preparation, seedling transplanting, hardening of seedling; advantages and disadvantages of seedpropagation.

Vegetative propagation- organs used in propagation- natural and artificial vegetative propagation; methods- cutting, layering, grafting and budding; stock scion union, advantages and disadvantages of vegetative propagation,

Module 4 – Gardening (6 hours)
Garden tools and implements, Irrigation methods- surface, sub, drip and spray irrigations, mist chambers- advantages and disadvantages. Ornamental gardens, indoor gardens, kitchen gardens- terrestrial and aquatic gardens.Garden designing- garden components- lawns, shrubs and trees, borders, hedges, edges, walks, drives.

Landscape architecture- home landscape design, parks. Physical control of plant growth- training and pruning;selection of plant for bonsai, bonsai containers and method of bonsai formation

Module 5 – Precision Farming (6 hours)
Need for precision agriculture, technologies for precision farming, fertigation, methods of irrigation, crop scouting,plant growing structures; hot beds, cold frames, cloth houses, glass houses, green houses , hydroponics , Israel model

AGRI-HORTICULTURE AND PLANT BREEDING PRACTICAL(36 HOURS)

Emasculation and bagging
Tongue grafting, budding ('T' and patch), air layering
Identification of different garden tools and their uses
List out the garden components in the photograph of the garden given
Preparation of potting mixture in the given proportion
Establishing a crop museum

Reference:

1. Adams C.R., Early M.P. 2004. *Principles of Horticulture*. Elsevier, N. Delhi.
2. Barton West R. 1999. *Practical Gardening in India*. Discovery Pub. House, New Delhi.
3. Edmond J.B., Senn T.L., Andrews F.S., Halfacre P.G. 1975. *Fundamentals of Horticulture*. 4th Edn.TMHN.Delhi .
4. John Weathers. 1993, *Encyclopaedia of Horticulture*. Discovery Pub. House. New Delhi.
5. Jules Janick. 1979. *Horticultural Science*. Surjeet publications, Delhi.
6. Kumar N., 1994. *Introduction to Horticulture*. Rajalakshmi Pub. Nagarcoil.
7. ManibhushanRao K. 2005. *Text Book of Horticulture*. Macmillan India Ltd.
8. Randhawa G.S., Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publishers Pvt. Ltd. Ahamedabad.
9. Sadhu M.K. 1996. *Plant propagation*. New age international publishers, N. Delhi.
10. Schilletter J.C., Richey H.W. 1999. *Text Book of General Horticulture. Biotech Books*, New Delhi.
11. Shukla R.S., Chandel P.S. 2004. *Cytogenetics Evolution and Plant breeding*. S. Chand&Co.Ltd New Delhi.
12.

SEMESTER – 5
BIOPHYSICS AND INSTRUMENTATION
THEORY :- (54 HOURS)

Module 1- Atomic & Molecular structure(6 hours)
Structure of atom, Schrödinger's theory , Quantum numbers, Pauli's exclusion principle , Hunds rule, Concept of bonding; valence of carbon; hybridizations of carbon; hybridizations of nitrogen & oxygen; polar & non polar molecules; Secondary bonding: weak interactions, hydrogen bonding; dipole-dipole & dipole-induced dipole interactions; Bonds within molecules- Ionic, covalent, Hydrogen, Electrostatic, Disulphide & peptide bonds, Vander Waals forces , Bond lengths & Bond energies , Bond angles.

Module 2- Biophysics of Water(6 hours)
Molecular structure, association of water through H-bonding, nature of hydrophobic interactions, physicochemical properties of water, state of water in biostructures & its significance, water as a liquid and solvent , Aqueous Environment of the cell, protein hydration, the hydration shell, specific roles of water in protein structure and function, involvement of bound water in catalytic action, water and nucleic acids.

Module 3 - Thermodynamics and Bioenergetics(6 hours)
Laws of thermodynamics , concept of free energy, unavailable energy , entropy, Energy generation and energy transfer processes in biochemical reactions. high energy compounds in biological system, ATP and phosphoryl group transfers, Redox potential in biological system, oxidation-reduction reactions: FAD and NAD+ .

Module 4 - Membrane potential (6 hours)
Nature & magnitude of cell surface charge, electric properties of membranes: electric double layer, Poisson-Boltzmann theory of electric double layer, Gouy-Chapman model of electric double layer, free energy of electric double layer, influence of size and distribution of electrical charge of a membrane on ransport of electrified molecules through a membrane, bonds and adhesion of electrified molecules on the surface of a membrane, Relation between membrane potential & cell characteristics, transmembranes potential & it's measurement by microelectrodes.

Module 5 - Transport across the membrane(6 hours)
Electrostatic interaction between membrane surfaces: influence of components of solvents on the interaction between membranes, influence of electrical properties of molecules in solvents on the interaction between membranes, adhesion of membranes, passive transport; diffusion, Fick's law. diffusion in two compartment & multi compartment systems, mechanisms of simple diffusion & facilitated diffusion, osmosis, osmotic pressure, osmotic equilibrium, molecular basis of aqueous channels. Active transport; Nature, Selective permeability of biomembrane, ion channel structure and gating function, Ion channel types and characterization, Role of carriers in ion transport, Transporting ATPase-Na-K ATPase

Module 6 – Spectroscopy (6 hours)
Basic principles, nature of electromagnetic radiation, interaction of light with matter, absorption and emission of radiation; atomic and molecular energy levels, atomic and molecular spectra, principle, instrument Design and applications of UV–Visible spectroscopy, IR and Raman spectroscopy, fluorescence spectroscopy, atomic absorption spectroscopy, inductively coupled plasma atomic emission spectrophotomerty , NMR spectroscopy, ESR spectroscopy, mass spectroscopy

Module 7 – Hydrodynamic Techniques (6 hours)
Centrifugation and ultracentrifugation, basic principles, forces involved, RCF, centrifugation, principles, types and applications, ultracentrifugation, instrument design, applications of preparative[Differential, Density Gradient] and analytical [sedimentation velocity, sedimentation equilibrium] ultracentrifugation. viscometry; general features of fluid flow (streamlined and turbulent) nature of viscous drag for streamlined motion, definition of viscosity coefficient, determination of viscosity coefficient of liquids, viscometric measurement, surface tension ; definition, determination of surface tension.

Module 8 - Physicochemical Fractionation & Electro-analytical Techniques (6 hours)
Chromatography-basic concepts of adsorption and partition chromatography, principle , methodology and applications of paper, thin layer, column (gel filtration, ion exchange, affinity), gas (GC,GLC) and HPLC chromatography, electrophoresis - principle, instrument design, methodology and applications of AGE , Pulsed-field AGE, PAGE, SDS-PAGE, capillary electrophoresis, isoelectric focusing, 2D electrophoresis

Module 9 - Optical & Diffraction Techniques (6 hours)
Principle, instrument design and applications of polarimetry, refractometry, atomic force microscopy, circular dichroism(CD) and optical rotatory dispersion(ORD), relation between CD and ORD, application of ORD in conformation and interactions of biomolecules, crystallography, secondary and tertiary structures of crystals, X ray diffraction by crystals, Bragg's Law & Bragg's diffraction equation, application in biomolecular structural studies

BIOPHYSICS AND INSTRUMENTATION
PRACTICAL:- (36 HOURS)

1. Spectral properties (Colorimetric or UV/Visible Spectral analysis of colouring pigments- Beta cyanin, Anthocyanin, Xanthine, Lycopene, Curcumin, capsicin)
2. Separation Techniques: Chromatography (PC, TLC and Column), GC & HPLC , HPTLC (Demonstration only)
3. Electrophoretic separation of protein.

References

1. Perspective of Modern Physics-Arthur Beisen(Mc Graw Hill)
2. Nuclear Physics:an introduction:SB Patel(New Age International)
3. Introduction to Atomic Spectra: HE White(Mc Graw Hill)
4. Text Book of optics and atomic physics:PP Khandelwal(Himalaya publications)
5. Molecular Cell Biology:Lodish,Berk,Matsudora,Kaiser,Kriegen(WH Freeman and Co.)
6. Biophysics:Cotrell(Eastern Economy Edition).
7. Clinical Biophysics:Principles and Techniques:P Narayanan (BhalaniPubl.,Mumbai).
8. Biophysics:Pattabhi and Gautham

SEMESTER – 5
PLANT CELL, TISSUE AND ORGAN CULTURE
THEORY:- (36 HOURS)

Module 1 – History and basic concepts (3 hours)
Experiments of Gottlieb Haberlandt, P R White, Gautheret, Nobecourt, Skoog and Steward, Cellular totipotency, *in vitro* differentiation–de differentiation and re-differentiation

Module 2 – Tissue culture Media(6 hours)
Basic components of tissue culture media, inorganic nutrients, carbon source, vitamins, organic supplements, chelating agents, plant hormones, gelling agents, adsorbents, pH of medium, general methodology of medium preparation with special reference to MS medium

Module 3 – Sterilization techniques (6 hours)
Sterilization of equipments, glasswares, medium end explant. sterilizationusing hot air, steam, filter, UV, alcohol and chemicals . Working of hot air oven, autoclave and laminar air flow chamber , layout of a tissue culture lab

Module 4 – Micropropagation (9 hours)
Micropropagation- different methods – axillary bud proliferation, meristem and shoot tip culture, direct and indirect organogenesis, somatic embryogenesis, hardening, transplantation and field evaluation, advantages and disadvantages of micropropagation, somaclonal variation, production of haploids through tissue culture; androgenic methods, gynogenic methods, uses of haploids, cryopreservation of plant cells

Module 5 – Cell suspension culture and secondary metabolite production(6 hours)
Types of suspension cultures; batch culture, continuous culture, measurement of cell growth, synchronization of cells in suspension culture, single cell culture, Bergmann cell plating technique, production of secondary metabolites, medium composition for secondary metabolite production, cell immobilization, biotransformation

Module 6 – Protoplast isolation and fusion(6 hours)
Methods ; mechanical, enzymatic, use of osmoticum, protoplast purification, protoplast viability testing, protoplast culture techniques and medium, somatic hybridization, spontaneous fusion, induced fusion, selection of hybrids, cybrids, applications of protoplast fusion

PLANT CELL, TISSUE AND ORGAN CULTURE
PRACTICALS:- (72 HOURS)

1. Preparation of nutrient medium – Murashige and Skoog medium
2. Establishing shoot tip, axillary bud cultures
3. Establishing single cell culture of any one plant and preparing a growth curve
4. Immobilization of whole cells or tissues in sodium alginate.
5. Determination of appropriate flower bud containing uninucleate pollen for anther culture using cytological techniques
6. Establishment of the axenic culture of any one crop plant
7. Micropropagation of an orchid variety from immature seeds
8. Production of somatic embryos from one plant
9. Visit a well equipped biotechnology lab and submit a report along with the practical record.

SEMESTER – 5
BEGINNERS BOTANY (OPEN COURSE)
THEORY:- 72 HRS

Module 1- Basic architecture of plants (12 hours)
Plant groups (general features only), Algae, Fungi, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms; Dicots and Monocots; Parts of an angiosperm plant Root, Stem, Leaf. Functions of the different parts. Plant part modifications: Stem modifications, tuber, rhizome, bulb, corm, sucker, Root modifications, tuber, aerial roots , Leaf , function, phyllotaxy, simple and compound leaves

Module 2 – Plant growth and reproduction(12hours)
Growth in length, growth in girth, meristem, cambium, increase in girth, buds. Flower, parts, inflorescences, racemose and cymose, pollination, pollination agents, development of fruits and seeds, seed dispersal, parts of a seed,

Module 3- Plant propagation (12 hours)
Propagation through seeds, seed germination, vegetative propagation; stem, root and leaf cuttings, layering, grafting and budding

Module 4 – Plant Nutrition (12 hours)
Major nutrients, minor nutrients, sources of nutrients in soil, types of fertilizers; organic and inorganic fertilizers, green manure, biofertilizer, methods of applying fertilizers; base dressing, top dressing, liquid feeding, foliar feeding

Module 5 – **Medicinal plants and their identification**(12 hours)
Study of the common name , binomial and important medicinal uses of the following common medicinal plants of Kerala: *Eclipta alba, Vernonia cineraria, Emelia sonchifolia, Ocimum sanctum, Leucas aspera, Adhathoda vasica, Boerhavia diffusa, Scoparia dulcis, Aegle marmalose, Saraca ashoka, Coleus umbonicus, Eupatorium ayapana, Rauwolfia serpentine, Alpinia galanga, Achorus calamus, Kaempheria galanga, Andrographis paniculata, Terminalia catapa, Terminalia tibula, Phyllanthus niruri* .

Module 6 – Applied botany (12 hours)
Totipotency of plant cells, *in vitro* plant propagation through tissue culture, advantages, requirements, aseptic techniques, basic composition of tissue culture medium, direct and indirect organogenesis, somatic embryo genesis, cell suspension culture, hardening of tissue culture plants. Somaclonal variation.
Edible and poisonous mushrooms, Mushroom cultivation, requirements and basic steps, detailed cultivation practices of Oyster mushroom

SEMESTER – 6
METHODS IN MOLECULAR BIOLOGY AND GENETIC ENGINEERING
THEORY :- (54HOURS)

Module 1- Methods in molecular biology (24 hours)

- Nucleic acid isolation, chemistry and procedure
- Agarose gel electrophoresis and visualization of the nucleic acid bands
- Blotting techniques; Southern, Northern and Western blotting and hybridization,
- Probe preparation via nick translation, random priming, end labeling, radioactive and non radioactive probes.
- DNA sequencing; Sanger's dideoxy method, working of automated DNA sequencer, pyrosequencing
- Polymerase chain reaction; An Overview ,Components and Conditions for PCR Optimization, Primer Design, Symmetric PCR , Asymmetric PCR ,Inverse PCR, Anchored PCR, Quantitative real time PCR, SYBR Green and TaqMan chemistries, Applications of PCR,
- RAPD, RFLP, AFLP, DNA finger printing
- DNA foot printing

Module 2 - Enzymes used in genetic engineering(6 hours)
Restriction enzymes ,types, properties, nomenclature; DNA methylation systems in *E.coli* (dam, dcm, M *EcoKI*); Phosphatase, polynucleotide kinase, single strand specific nucleases; DNA polymerases (DNA Polymerase I,Klenow fragment, T4DNA Polymerase, T7 DNA Polymerase); RNAPolymerases(T3, T7, SP6); Reverse Transcriptase (AMV, MoMLV), Ligases (T4 DNA ligase,E.coli DNA ligase), TOPO cloning (Vaccinia topoisomerase I), Taq polymerase

Module 3 - Cloning vectors (18 hours)

- Cloning vectors for *E.coli*

Biology of plasmids (conjugative, nonconjugative, relaxed and stringentcontrol of copy number) Plasmid based vectors, pBR 321, pUC series, Biology of Lambda phage (lytic and lysogenic cycle), λ bacteriophage basedvectors (insertional and replacement),in vitro packaging; Biology of M13 bacteriophage,M13 phage based vectors, phagemids, High capacity vectors: cosmids, P1 phage based vectors, bacterial artificial chromosomes. Advantages of each vector. Bacmids

- Cloning vectors for *eukaryotes*

Agrobacterium tumefaciens and the biology of crown gall formation, Agrobacterium Ti plasmid based vectors,yeast artificial chromosomes,PACs, pcDNA

Module 4 - Covalent linkage of DNA fragments to vector molecules(1 hour)
linkers, adapters, homopolymer tailing,

Module 5 - Generation of genomic and cDNA libraries(2 hour)
Genomic library, definition and procedure of construction, cDNA library, definition, advantages and procedure of construction, different methods of first strand and second strand of cDNA synthesis

Module 6 - Selection and screening of recombinant clones(3 hour)
Insertional inactivation, alpha complementation and blue white selection, colony and plaque hybridization, immunological screening

METHODS IN MOLECULAR BIOLOGY AND GENETIC ENGINEERING PRACTICAL :- (54 HOURS)

1. Isolation of chromosomal and plasmid DNA from bacterium
2. Restriction digestion of DNA and assigning restriction sites
3. Isolation of plant genomic DNA
4. Designing a primer for a well characterized *E.coli* gene
5. PCR amplification of the gene from *E.coli* DNA using the designed primer
6. RAPD analysis of three closely related bacterial strains

SEMESTER – 6
GENOMICS AND BIOINFORMATICS
THEORY :- (54 HOURS)

GENOMICS

Module 1 –Genomics introduction (1 hour)

Genomics - Definition, Functional genomics ,Structural genomics, Applications of genomic studies

Module 2 –genome Sequencing(3 hours)

Overview: Genomes of Bacteria, Archaea, and Eucarya; Chromatin, supercoiling and packaging; Genome sequencing approaches, Major findings of the following genome projects a)Human b) *Arabidopsis thaliana c)Drosophila melanogaster d)Caenorhabditis elegans e) Mus musculus*

BIOINFORMATICS

Module 1 –Bioinformatics introduction(1 hour)

An Introduction to bioinformatics. Scope and relevance of bioinformatics. Elementary commands and Protocols, ftp, telnet, http . Formats: FASTA format,ASN.1 format, PDB flat file format,mmCIF format, Data mining. Use of PERL in bioinformatics. Application of Bio Edit.

Module 2: Biological Data bases (20 hours)

Online databases and search tools, data organization, NCBI .Biological data bases, structural data bases, DNA and RNA sequence data bases.

Nucleic acid sequence databases : GenBank ,EMBL, DDBJ
Protein sequence databases: SWISS-PROT
Protein structure database : Protein Data Bank
Bibliographic databases (Finding Scientific Articles) : PubMed
Miscellaneous : Gene expression Omnibus, OMIM, KEGG, , SCOP, CATH. REBASE

Module 3: Alignment (15 hours)

Sequence comparison, Pair wise sequence alignment, Global alignment: Use of ALIGN, Local alignment: Use of BLAST, FASTA .Amino acid substitution matrices PAM and BLOSUM, Multiple sequence alignment : Use of ClustalW, Phylogenetic analysis : Use of PHYLIP, MEGA

Module 4: Molecular Visualization Tools (14 hours)

Molecular structure viewers : RasMol, SWISS-PDBViewer. Predicting protein structure and function from sequence. Protein modeling, Docking and drug discovery

GENOMICS AND BIOINFORMATICS
PRACTICAL:- (54 HOURS)

1. Analysis of Nucleotide sequence using GENBANK
2. Analysis of Protein sequence using PIR database, SWISSPROT
3. Analysis of structural features of proteins using protein data bank and RASMOL
4. BLAST,FASTA – Similar DNA sequences search
5. Multiple sequence alignment and phylogenetic trees

References

1. Bioinformatics : A Machine Learning Approach. P Baldi and S Brunak. MIT Press
2. David W Mount, Bioinformatics: sequence and genome analysis, CBS Publishers
3. Developing Bioinformatics Computer Skills. Cynthia Gibas and Per Jambeck. O'Reilly Genomes . TA Brown. Wiley-Liss.
4. Genomics: The Science and Technology Behind the Human Genome Project. CR Cantor and CL Smith. John Wiley and Sons.
5. Bioinformatics ,databases, tools and algorithms, Orpita Bosu, Simminder Kaurthukral.

SEMESTER – 6
INDUSTRIAL AND ENVIRONMENTAL BIOTECHNOLOGY
THEORY :- (54 HOURS)

INDUSTRIAL BIOTECHNOLOGY

Module 1 – Introduction (4 hours)

Introduction, scope and historical developments, importance of microbes in industry; microbial biomass, microbial enzymes, microbial metabolites and microbial recombinant products. Isolation, screening and genetic improvement of industrially important organisms.

Module 2 – Fermentation (15 hours)

Fermentation, Definition, Submerged fermentation and solid state fermentation. Media for industrial fermentation, major components, water, carbon sources, nitrogen sources, minerals, chelators, oxygen requirement, rheology, foaming and antifoaming agents. Medium optimization : Plackett-Burman design .

Fermenter, functions of a fermenter, Design of a fermenter, body constructon, types of fermenters: Waldhof type, tower type, air lift type, packed tower type , sterilization of the fermenter, aeration, porous sparger, orifice spurger, nozzle sparger, probes.

Recovery of fermentation products, foam separation, precipitation, filtration, centrifugation

Module 3 – (5 hours)

Primary metabolism products, production of amino acids as a case study; Secondary metabolites, bacterial antibiotics production. Metabolic pathway engineering of microbes for production of novel product for industry.

Module 4 – (2 hours)

Microbial enzymes, amylase, proteases, cellulases, role of enzymes in various industrial processes, Bioaugmentation with production of vitamin C as a case study.

ENVIRONMENTAL BIOTECHNOLOGY

Module 1 – Introduction(6 hours)

Introduction to Environmental pollution. Air pollution and control. Water pollution and sewage. Bacteriological analysis of drinking water, Presumptive, completed, and confirmed test.

Module 2 –Microbiology and biochemistry of waste water treatment (10 hours)

Treatment strategies primary , Secondary and tertiary treatment. Waste water treatment. Sludge and solid wastes treatment and disposal. Bioreactors for wastewater treatment**.**

Module 3 – Bioremediation and Biodegradation (12 hours)

Biological monitoring of environmental pollution. Biodegradation of Hydrocarbons, cellulose, lignin, pesticides . Role of immobilized cells/enzymes in treatment of toxic compounds. Bioremediation. Production of eco-friendly agricultural chemicals, biopesticides, bio-fertilizers, biodegradable plastics, bio-fuels, compost and composting methods, biogas production

INDUSTRIAL AND ENVIRONMENTAL BIOTECHNOLOGY
PRACTICAL :- (36 HOURS)

1. Isolation of bacteria through serial dilution and plating technique
2. Isolation of Nitrogen Fixing Bacteria from root nodule of Leguminous plants.
3. Standard plate count of Sewage water sample.
4. MPN analysis of water samples
5. Estimation of dissolved oxygen
6. IMViC test
7. Production of wine and recovery of alcohol
8. Production of one enzyme through solid state fermentation
9. Production of an enzyme through submerged fermentation
10. Immobilization of enzymes using sodium alginate
11. Immobilization of yeast cells using sodium alginate

References

1. Michael J Pelczar et al. 2000. TATA McGraw Hill
2. Stanbury, P.F.A. Whitaker and S.J. Hall (1995). Principles of fermentation technology. Pregamon Press.
3. Cruger and Annilesse cruger (1990). A text book of industrial microbiology,sinaser associates. Inc.
4. Environmental Biotechnology by A.K. Chatterjee
5. Environmental Biotechnology by Prof. Jogdand, Himalayan publication
6. Industrial and Environmental Biotechnology - Nuzhat Ahmed, Fouad M. Qureshi and Obaid Y. Khan, 2006. Horizon Press.

SEMESTER – 6
ANIMAL BIOTECHNOLOGY AND NANOBIOTECHNOLOGY
THEORY:- (54 HOURS)

ANIMAL BIOTECHNOLOGY (36 HOURS)

Module 1 – Animal cell culture basics (8 hours)
Structure of animal cell, History of animal cell culture, Cell culture media and reagents, different type of cell culture media, growth supplements, culture of different tissues and its application, Hayflick's limit.
Infrastructure requirements, CO_2 incubator, Biosafety cabinet, conditions required for culturing animal cells, Behaviour of cells in culture conditions, division, their growth pattern, estimation of cell number.
Culture of mammalian cells, tissues and organs, primary, culture, secondary culture, continuous cell lines, suspension cultures , Development of cell lines, characterization and maintenance of cell lines, stem cells, cryopreservation, common cell culture contaminants.

Module 2 – Applications of animal cell culture (7 hours)
Application of animal cell culture for in vitro testing of drugs, testing of toxicity of environmental pollutants in cell culture, application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.

Module 3 – In vitro fertilization and animal cloning (7 hours)
Structure of sperms and ovum, cryopreservation of sperms and ova of livestock, artificial insemination, super ovulation, *in vitro* fertilization, culture of embryos, cryopreservation of embryos, embryo transfer, embryo-splitting
Animal cloning basic concept, cloning from embryonic cells and adult cells, cloning of different animals, cloning for conservation of endangered species, Ethical, social and moral issues related to cloning

Module 4 – Transgenic animals (7 hours)
Transgenic manipulation of animal embryos, animal viral vectors, different applications of transgenic animal technology, Transgenic animal production and application in expression of therapeutic proteins, biopharming , Gene knock out technology and animal models for human genetic disorders, Ethical, social and moral issues related to the production of transgenic animals

Module 5 – Gene therapy (7 hours)
Gene therapy, somatic cell therapy, germline therapy, gene augmentation therapy, gene replacement therapy, Candidate diseases for gene therapy, Methods of gene transfer, vectors used ,Initial trials and observations ,Current status of gene therapy

NANOBIOTECHNOLOGY (18 HOURS)

Module 1 - Basic concepts and Fundamentals of Nanotechnology (4 hours)
Historical Aspects of Nanotechnology, Modern Aspects of Nanotechnology, Biomimetics, Nanomaterials, Types of various Nanostructures materials, Properties of Nanostructures materials, Quantum wire – Quantum well – Quantum dot – Dendrimers, Nano-robots, Carbon Nanotubes and applications – Graphene and applications, Properties and technological advantages of Nanomaterials.

Module 2 – Introduction to Biomacromolecules(4 hours)
Modern concepts to describe the conformation and dynamics of biological macromolecules, Scattering techniques, Micromanipulation techniques, Cellular engineering - signal transduction in biological systems, effect of physical, chemical and electrical stimuli on cell function and gene regulation

Module 3 – Biomaterials (4 hours)
Chemical, Physical and biological properties of biomaterials and bioresponse, Biosynthesis and properties of natural materials (Proteins, DNA and polysaccharides), Polymeric materials - synthetic polymers and structural proteins, Statistical mechanics in biological systems

Module 4 – Synthesis of nanoparticles (6 hours)
Top-down and Bottom-Up approaches, Physical, Chemical and Biological fabrication of nanoparticles - Characterization of nanomaterials. *Applications* – Nanoparticular carrier system, Nanofluidics, Nanofabrication, Biosensors, Nano-imaging, Gene therapy, Nano-manipulation and Nanolithography, Nano-computation, Nanotechnology in Agriculture/Food, Nanotechnology in Electronics, Nanotechnology in Textile, Nanotechnology in Energy, Nanotechnology in Medicine & Pharmaceuticals, Nanotechnology in Environment, and Nanotoxicology

Suggested reading

1. Mick Wilson, Kamali Kannangara, Michells Simmons and Burkhard Raguse, "Nano Technology – Basic Science and Emerging Technologies", 1st edition, Overseas Press,New Delhi,2005.
2. Nalwa H.S. 2005. Handbook of Nanostructured biomaterials and their applications in Nanobiotechnology. American Scientific publications
3. Niemeyer CM and Mirkin CA. 2005. Nanobiotechnology. Wiley

SEMESTER – 6
TAUGHT AND DIRECTED RESEARCH PAPER
THEORY:- (54 HOURS)

1. Search and research,
2. Characteristics of research
    a. Sufficient and necessary conditions
    b. Systematic and rigorous
    c. Logic and validity,
    d. Controls
    e. Empirical observations, public scrutiny, openness to criticism,reproducibility ,
3. Kinds: Descriptive, Explanatory Co Relational Exploratory
4. Function: Pure, Applied Practical
5. Epistemology : Intuitive, Serendipity , Authoritative,, Empirical, Logical, Hypothetico-Experimental-Deductive,
6. Ontology :Positivism, Logical Positivism, Subjective
7. Research process
    a. Raising questions one or many
    b. Defining problem- articulate the problem in a sentence
    c. Literature review:1- to establish necessary sufficient and conditions –do they say there are gaps
    d. Guessing the tentative solutions
    e. Literature review:2- to establish the theoretical bonds between the problem and hypothesis/es –the research proposal
    f. Designing method and controls to capture data - in time
    g. Collecting data
    h. Analyzing data for hypothetico- experimental-deductive conclusions
    i. Writing the thesis
8. Key skills.
    a. Inferential statistics to test hypothesis
    b. Literature review with online bibliographic packages
    c. Writing the research proposal
    d. Writing a research paper
    e. Writing the thesis in specified format

INBOT 399 – TAUGHT AND DIRECTED RESEARCH PAPER
PRACTICAL:- (36 HOURS)

1. Develop your research proposal with the guidance of a faculty and submit it before the undergrad research committee for evaluation, recommendations and clearance to undertake the research work
2. Undertake the research work in the college with the guidance of a faculty
3. Conduct a capstone seminar on the topic of your research
4. Submit the thesis in the specified format before a pre announced deadline and defend your thesis before the undergrad viva vice committee for evaluation