M. SC. BOTANY SYLLABUS AS PER CREDIT SYSTEM

The credit system pattern syllabus in affiliated colleges of University of Pune will be implemented from the academic year 2013-2014. M. Sc. Botany will be of four semester two year course. The students for this course will be admitted those who have successfully completed B. Sc. Botany.

The pattern of examination (Internal and External), structure of the course, subject wise detailed syllabus, University terms, recommended books etc. will be as below:

A. EXAMINATION PATTERN:

1. Total marks of examination/course

- Internal Examination: 40 marks
- External Examination: 60 marks

2. Internal Examination: 40 marks

- Two tests should be taken (each of 20 marks) and one home assignment of 20 marks is compulsory. In which two best from this (2 tests and I home assignment) will be selected and on this basis internal marks out of 40 will be given.
- Home assignments include 4 questions each of 5 marks having 100 % optional for each question. Home assignment should be based on all credits from the course.

3. External Examination: 60 marks

- Total 5 questions and all are compulsory.
- Each question 12 marks
- **First question:** Objective type questions baseed on all credits from the course and each question for 2 marks.
- It should be brief answer type that is, Definitions, concept, principle, explanation, enlisting and distinguishing etc.)

- **Question no 2, 3 and 4:** Short answer and short note type (each of 6 marks).
- In these questions 100 % optional questions should be given.
- **Question no 5:** It should be long answer type based on any one credit which is not covered in question 2, 3, and 4.
- In this question 100 % optional will be given.

4. Passing system for each course

- Internal and External examination passing should be independent.
- Internal Examination: Out of 40 marks minimum 16 marks required for passing.
- External Examination: Out of 60 marks minimum 24 marks required for passing.

B. STRUCTURE OF THE COURSE:

- M. Sc. Botany is four semester course.
- In each semester there will be four theory and two practical courses.
- Each theory course will be of four credits and each credit of 15 lectures.
- Each practical course will be of five credits and each credit contains five practicals minimum.
- Semester I and II have compulsory courses.
- Semester III three compulsory and one optional course as special paper.
- Semester IV have three theory compulsory courses and one practical course based on (BO 4.1 and BO 4.2) theory papers.
- Semester IV BO 4.5 course contains two credits of one practical course based on BO 4.3, review of literature and its presentation which is based on some advanced aspects in Botany (1.5 credit) and one summer training report submission not less than one month duration (1.5 credit).
- Semester IV should have compulsory project for 100 marks (5 credits) based on optional paper selected.
- Exhaustive list of recommended books for each course is given followed by syllabus of respective course.
- Structure of semester wise M. Sc. Botany courses is as below:

SEMESTER I

BO 1.1 Cryptogamic Botany I (60 L)
Bryophytes (2 cr)
Pteridophytes (2 cr)

BO 1.2 Biochemistry and Plant Physiology (60 L)
Biochemistry (2 cr)
Physiology (2 cr)

BO 1.3 Genetics and Plant Breeding (60 L)
Genetics (3 cr)
Plant Breeding (1 cr)

BO 1.4 Botanical Techniques (60 L)

BO 1.5 Practical based on BO 1.1 and BO 1.4

BO 1.6 Practical based on BO 1.2 and BO 1.3

SEMESTER II

BO 2.1 Cryptogamic Botany II (60 L)
Algae (1.75 cr)
Fungi (2.25 cr)

BO 2.2 Cell Biology and Evolution (60 L)
Cell Biology (3 cr)
Evolution (1 cr)

BO 2.3 Molecular Biology and Genetic Engineering (60 L)
Molecular Biology (2 cr)
Genetic Engineering (2 cr)

BO 2.4 Plant ecology and Phytogeography (60 L)
Plant ecology (3 cr)
Phytogeography (1 cr)

BO 2.5 Practical based on BO 2.1 and BO 2.2

BO 2.6 Practical based on BO 2.3 and BO 2.4

SEMESTER III

BO 3.1 Spermatophytic Botany (60 L)
Gymnosperm (2 cr)
Angiosperm (2 cr)

BO 3.2 Developmental Botany and Palynology (60 L)
Developmental Botany (3 cr)
Palynology (1 cr)

BO 3.3 Industrial Botany I (60 L)
Biofertilizer technology – Algal, Fungal, Synthetic fertilizer (1 cr)
Sea weed technology (0.5 cr)
Mushroom Technology (0.5 cr)
Fermentation technology (0.5 cr)
Biopesticide Technology (0.5 cr)
Entrepreneurship and management and Project report preparation (1 cr)

Bo 3.4 Special Paper I (Any One Special Paper) (60 L)
A. Advanced Mycology
B. Advanced Angiosperm
C. Advanced Physiology
D. Advanced Genetics and Molecular Biology

E. Advanced Biotechnology
F. Advanced Medicinal Botany
G. Advanced Environmental Botany
H. Advanced Seed technology and Plant Breeding
I. Advanced Horticulture and Floriculture

BO 3.5 Practicals Based on Bo 3.1, 3.2 and 3.3

BO 3.6 Practicals based on special paper

SEMESTER IV

BO 4.1 Computational Botany (60 L)
Biomathematics (1 cr)
Biostatistics (1 cr)
General Computer (1 cr)
Bioinformatics (1 cr)

BO 4.2 Plant Pathology and Plant Protection (60 L)
Plant Pathology (3 cr)
Plant Protection (1 cr)

BO 4.3 Industrial Botany II (60 L)
Pharmacognosy (0.5 cr)
Forest Botany (0.5 cr)
Tissue Culture (1 cr)
Horticulture (1 cr)
Floriculture (0.5 cr)
Nursery Management (0.5 cr)

BO 4.4 Practicals Based on 4.1 and 4.2

BO 4.5 A. Practicals based on BO 4.3 (2 cr)

B. Review of literature and its presentation (Other than special paper on some advanced techniques in Botany) (1.5 cr)

C. Summer training report submission (Institute and Industries) (1.5 cr)

BO 4.6 Project Report submission based on special paper selected in Semester III (5 cr)

C. GRADING SYSTEM:

Grade	Points	Description of performance
A	10	Outstanding
A(-)	9	Excellent
B	8	Very Good
B (-)	7	Good
C	6	Average
C (-)	5	Below average
D	4	Marginal
E	2	Poor
F	0	Very poor
I		Incomplete

M. Sc. Botany syllabus is of 100 credits and each semester minimum 20 to 30 credits as per semester pattern have been given. The core course of botany is around 70 % and other 30 % syllabus has been prepared as per industry requirement, some management based, pharmacy based. The examination pattern for compulsory and optional special papers has continuous assessment. The internal and external marking system and passing system for the same has been specifically mentioned. The qualification for the teachers involved in PG Botany teaching should be M. Sc. Ph. D./ SET/ NET. The maximum efforts have been taken to train the students in basic and applied botany in addition to industrial requirement.

BO 1.1 CRYPTOGAMIC BOTANY PART –I (4 Credit)

(60 Lectures)

Credit 1 = (15 Lectures)

1. Bryophytes **-** Affinities with Thallophytes and Pteridophytes, Classification of Bryophyta upto Family level accrding to G.M. Smith , Contributions of any three Bryologists from India……. **3L**
2. Fossil Bryophytes, Origin of Bryophyta - Pteridophytean and algal hypothesis, Biological Importance of Bryophytes, Evolution of sporophyte, Theory of sterilization and Reduction Theory……. **6L**
3. Ecology and Physiology of Bryophytes, Bryophytes as indicators of water pollution and air pollution, Vegetative reproduction in Bryophytes, Economic Importance of Bryophytes ……. **4L**
4. Cytology of Bryophytes, Morphogenesis and culture of Bryophytes, Apogamy and apospory in Bryophytes…….. **2L**

Credit 2 = (15 Lectures)

1. Hepaticopsida– Distribution, Distinguishing Characters, Morphology and anatomy of gametophyte and sporophytes of liverworts, Takakiales, Calobryales, Jungermanniales, Metzeriales Marchantiales, Sphaerocarpales, Monocleales……. **7L**
2. Anthocerotopsida – Distributron, Distinguishing Characters, Morphology and anatomy of gametophyte and sporophyte in Anthocerotales, Biological importance of *Anthoceros* sporophyte.. **3L**
3. Bryopsida / Musci- Distribution, Distinguishing Characters, Morphology and anatomy of gametophyte and sporophyte of Sphagnales, Funariales, Polytrichales, Buxbaumiales, Andreaeales, Eubryales ……. **5L**

Credit 3 = (15 Lectures)

1. Pteridophytes – Distinguishing Characters, Origin of Pteridophytes – Algal origin, Bryophyte Origin; Apospory, Apogamy, Parthenogenesis, Telome Theory, Stelar Evolution ……. **5L**
2. Classification of Pteridophytes as per Sporne System (1975), Economic importance of Pteridophytes, Indian Pteridology, Heterospory and seed habit…….. **3L**
3. *Fossil Pteridophytes* – Psilopsida -: *Rhynia*, *Lycopsida* -: *Lepidodendron, Lepidophyllum, Stigmaria, Lepidostrobus, Lepidocarpon, Sigillaria, Sphenopsida*:- *Calamites, Annularia, Calamostachys, Cheirostrobus* … **7L**

Credit 4 = (15 Lectures)

1. Psilopsida:- Distribution, Distinguishing Characters, Morphology and anatomy of sporophyte and gametophyte of *Psilotum* and *Tmesipteris*……. **1L**
2. *Lycopsida* :- Distribution, Distinguishing Characters, Affinities, Morphology and anatomy of sporophyte and gametophyte of Lycopodiales, Selaginellales, Isoetales, Life cycle pattern…….. **4L**
3. Sphenopsida :- Distribution, Distinguishing Characters, Morphology and anatomy of Sporophyte and gametophyte, Life cycle Pattern of Equisetales ……. **2L**
4. Pteropsida / *Filicophyta* :- Distribution, Distinguishing Characters,Morphology and anatomy of sporophyte and gametophyte of order Ophioglossales (1L), Marattiales (2L), Osmundales (1L), Filicales (2L) Marsileales (1L), Salviniales (1L) **8L**

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BO 1.2 PLANT PHYSIOLOGY AND BIOCHEMISTRY (4 CREDITS)

(60 Lectures)

Credit 1 = (15 Lectures)

1. Introduction, present status of plant physiology in India and abroad **1L**

2. Plant Water Relation: - **3L**

Regulation of water supply, Aquaporins and facilitated water transport, Soil plant atmosphere continuum (SPAC), Theories on stomatal physiology, Signal transdution in guard cell.

3. Oveview of Solute Transport: - **2L**

Diffusion, Nerst equation, Uniport, Symport, Antiport channels, ATP driven active transport (Phloem loading and unloading)

4. Photosynthesis: - **7L**

Photosynthetic pigments, absorption and transformation of radiant energy, Light harvesting complexes, Kok curve, Kautsky curve, ETS, photo inhibition O_2 and H_2 evolution, Regulation of Calvin cycle, RUBISCO activity, Photorespiration, CAM, C_4 Pathway and its type

5. Sensory Photobiology:- **2L**

Structure, Function and mechanism of action of phytochromes, cryptochromes, phototropins, photoperiodism and biological clock

Credit 2 = (15 Lectures)

1. Stress Physiology: - **2L**

Response of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses. Mechanism of resistance to biotic stress and tolerance to abiotic stress

2. Respiration: - **4L**

EMP pathway, TCA cycle, PPP, Mitochondrial ETS, Cyanide resistance pathway, Gluconeogenesis, High energy compounds: Synthesis and utilization, ATP synthesis.

3. Plant growth regulators: - **3L**

Biosynthesis and action mechanism of : Auxins Gibberellins, (GA), Cytokinins, Ethylene, Abscicsic Acid, Introduction to brassinosteroids and other hormones.

4. Seed Germination, Flowering and Fruit ripening: - **4L**

Metabolic changes during seed germination, flowering initiation, maturity and fruiting, fruit ripening.

5. Agri-Electronic equipments usefull for plant physiological studies **2L**

Principle, working and application of-

a.Grain moisture meter (Capacitance meter)

b.Turbidity meter (PAR meter)
c.Chlorophyll flurometer
d.Lux meter
e.Infrared Pyrometer
f. Infrared Gas Analyzer (IRGA)
g.Leaf Area Meter
h. Portable Pigment Analyzer

BIOCHEMISTRY (30 Lectures, 2 Credits)

Credit 3 = (15 Lectures)

1. Energy Dynamics: - 3L

Structure of atoms, molecules and chemical bonds, Principles of thermodynamics, free energy, Redox potentials, Dissociation and associations constants, Activation energy, Binding energy.

2. Enzymology: - 4L

General classification of Allosteric mechanism, Isozymes, Factors affecting enzyme activity, Enzyme Kinetics, Michaelis – Menton equation, Competitive, uncompetitive and non competitive inhibition.

3. Carbohydrates: - 3L

General classification, Synthesis and breakdown of carbohydrates (starch, glycogen, pectin, Glucose)

4. Amino acids and proteins: - 5L

General classification of amino acids and proteins, Structure, synthesis and properties of amino acids, protein structure (Primary, secondary, tertiary and quaternary), Ramchandran plot.

Credit 4 = (15 Lectures)

1. Nitrogen metabolism: - 3L

Nitrate and ammonium assimilation, Nitrogen uptake, NOD factor, root nodulation and nitrogen fixation.

2. Nucleic Acid and their metabolism:- 3L

DNA, RNA, Purines, Pyrimidines, their biosynthesis and metabolism

3. Secondary metabolites: - 5L

General classification of Major pathways, Phenolics (Lignins, tannins) Flavonoids, terpenoids (steroids), Alkaloids, pigments (Carotenoids, Anthocynins)

4. Lipid metabolism: - 4L

General classification of Phospho, Spingo, Glyco Lipid biosynthesis and oxidation.

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BO 1.3 GENETICS AND PLANT BREEDING (4 Credits)

(60 Lectures)

Credit 1 = GENETIC INHERITANCE : (15 Lectures)

1. **Principles of Mendelian inheritance and Interaction of genes:- 6L**
   - Introduction to genetics
   - Early concepts of inheritance
   - Mendel's Laws - Dominance, Segregation, Independent assortment, Discussion on Mendel's paper, Chi Square test, Probability
   - Interaction of genes- Complementary, epitasis, inhibitory, polymeric and additive
   - Chromosomal theory of inheritance

2. Cytoplasmic inheritance:- 3L
   - Mitochondrial and chloroplast genomes
   - Inheritance of chloroplast genes (*Mirabilis jalapa* and *Zea mays*)
   - Inheritance of mitochondria genes (Petit yeasts and cytoplasmic male sterility in plants)
   - Interaction between nuclear and cytoplasmic genes
   - Maternal effect in inheritance (*Limnaea peregra*)

3. Quantitative inheritance and Inheritance of complex traits:- 4L
   - Quantitative traits, Continuous variation
   - Inheritance of quantitative traits, (Polygenic traits) in - corolla length in *Nicotiana*, cob length in *Zea mays*
   - Introduction to complex traits
   - Heritability and its measurement
   - Marker assisted selection

4. Population Genetics 2L
   - Hardy Weinbergs Law, Factors affecting gene and gene frequencies

Credit 2 = ALLELE, RECOMBINATION AND LINKAGE : (15 Lectures)

1. Concept of gene, allele, multiple allele, pseudo allele- complimentation tests 2L

2. Recombination, Linkage and mapping of eukaryotes :- 9L
   - Linkage and crossing over
   - Recombination: homologous and non-homologous, Inducing transposition site specific recombination
   - Genetic markers
   - Linkage maps, lod score for linkage testing, mapping by 3 point test cross
   - Mapping by tetrad analysis in Yeast (unordered) and *Neurospora* (ordered)
   -

3. Mutation: - **4L**

- Mutation- causes and detection
- Types of Mutation- lethal, conditional, biochemical, Loss of function, gain of function
- Germinal vs somatic mutants
- Insertional mutagenesis
- Point mutagenesis

Credit 3 = MICROBIAL GENETICS AND CYTOGENETICS: (15 Lectures)

1. Microbial Genetics:- **3L**

- Methods of genetic transfers- transformation, conjugation and transduction in bacteria and genetic recombination
- Mapping of bacterial genome by interrupted mating
- Mutant phenotypes

2. Phage genetics:- **3L**

- Lytic and lysogenic cycles in phages
- Genetic recombination, specialized transduction, site specific recombination in phage
- Mapping the bacteriophage genome
- Fine structure analysis of rII gene in T4 bacteriophage
- Phage mutants

3. Karyotype:- **2L**

- Structure and Organization of chromosome, Concept of karyotope
- Chromosome banding
- Preparation of chromosome for karyotype
- Karyotype evolution
- Role of karyotype in plant species identification

4. Numerical alterations of chromosomes:- **4L**

- Classification of polyoploids: cytological and genetical method of identification of autopolyploids and allopolyploids
- Classification, method of production, identification and meiotic behavior of aneuploids (Monosomics, Nullisomics and trisomics)

5. Structural alterations of chromosomes:- **3L**

- Deletion, duplication, inversion, translocation, complex translocation heterozygotes
- Robert sonian
- BA translocations

Credit 4 = PLANT BREEDING: (15 Lectures)

1. Plant Breeding: - **1L**

- Pre and post Mendelian development,
- Objectives of plant breeding,
- Plant breeding in India.
- Patterns of evolution in cultivated crop species

2. Plant Genetic resources: - **2L**

- Centers of origin, distribution and areas of diversity
- Importance of genetic diversity in crop improvement and its erosion
- Importance of genetic diversity in conservation and regulation.

3. Reproductive systems, population structure and breeding strategies: - **2L**

- Sexual reproduction (Cross and self pollination)
- Asexual reproduction
- Pollination control mechanisms and implications of reproductive system on population structures
- Genetic structure of populations

4. Selection methods:- **5L**

- Selection methods in self pollinated crops
- Selection methods in cross pollinated crops
- Selection methods in asexually propagated crops

5. Hybridization: - **3L**

- Hybridization and its role
- Inter-varietal and wide/distant crosses
- Principles of combination breeding and its application

6. Induced mutations in crop plants: - **2L**

- Physical and chemical mutagens used for induction of mutations
- General method of induction of mutations in crop plant
- Role of induced mutations
- Induction of polyploidy in crop plants
- Role of polyploidy in plant breeding

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BO 1.4 BOTANICAL TECHNIQUES (4 CREDITS)

(60 Lectures)

Credit 1 = (15 Lectures)

Microscopy

A. Image formation (properties of light), Lens- refraction, dispersion of light, objects, images, image quality, magnification concept, resolution **1L**

B. Light microscopy, Confocal microscopy, Phase Contrast microscopy, Fluorescence microscopy, Electron microscopy (SEM and TEM), Flow cytometery **6L**

C. Dissection, maceration, squash, peeling and whole mount- pretreatment and procedures **1L**

D. Microtomy- serial sectioning, double or multiple staining, Lesser assisted Microtomy **3L**

E. Histochemical and cytochemical techniques- Localization of specific Compounds/ reactions/ activities in tissues and cells **3L**

F. Micrometry and camera lucida **1L**

Credit 2 = (15 Lectures)

A. Chromatography techniques:-

Introduction, concept of partition coefficient, Paper, TLC, Column, Gel filtration, Affinity, Ion exchange, HPLC, Gas chromatography (Principle, method and applications of each) **8L**

B. Elctrophoretic techniques:-

History, Principles, Agarose gel electrophoresis, Pulsed Field Gel Electrophoresis, Polyacrylamide Gel Electrophoresis (PAGE/ Native), Sodium Dodecyl Sulphate polyacrylamide gel electrophoresis (SDS-PAGE/ Denaturing), Isoelctric focusing, 2 Dimensional Gel Electrophoresis (2-D method) **7L**

Credit 3 = (15 Lectures)

A. Spectroscopic techniques:-

General principles, Beer and Lambert's Law, Molar extinction coefficient, Spectrophotometer (working and application), UV-Visible spectroscopy, Nuclear Magnetic Resonance (NMR) spectroscopy, X-ray crystallography, Spectoflurometry, AAS, MS, IR Spectroscopy **10L**

B. Radioactive techniques:-

Radioisotopes used in biology and their properties, Units of radioactivity, Interaction of radioactivity with matter, Detection and measurement of radioactivity, Autoradiography, Safe handling of radio isotopes, Non-Radio labeled techniques, Green Fluorescent Proteins **5L**

Credit 4 = (15 Lectures)

A. Centrifugation techniques:-
Principles, Rotors, Factors affecting centrifugation, Ultra-centrifugation, Density Gradient Centrifugation, High speed centrifuges, **3L**

B. Electrochemical techniques:-
Electrical conductivity, pH meter, Oxygen electrode **3L**

C. Immunological techniques:-
Principles, Antigen–antibody interaction, Immuno diffusion, Immuno precipitation, Radio-immuno assay, Rocket immumo-electrophoresis, ELISA **4L**

D. Molecular biology techniques:-
DNA sequencing techniques- Sanger's method, Maxam- Gilbert's mehod, Automated DNA sequences, Pyrosequencing, Sequencing of proteins, PCR, DNA-microarray **5L**

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BO- 1.5 PRACTICALS BASED ON BO 1.1 AND BO 1.4 (5 Credits)

(Any 24 practicals)

Practicals based on BO 1.1 Bryophytes and Pteridophytes

A. Morphological, anatomical and reproductive studies of Bryophytes:

1.Hepaticopsida: *Astrella, Plagiochasma, Marchantia, Targionia*, *Cyathodium*, *Fossombronia, Pallavicinia, Riccardia* and *Metzeria*, *Porella* and *Fruillania* (Any six forms) **3P**

2. Anthocerotopsida: *Anthoceros* and *Notothylus*. **2P**

3. Musci: *Sphagnum, Funaria, Polytrichum, Pogonatum, Bryum* (Any four forms) **2P**

B. Morphological, anatomical and reproductive studies of Pteridophytes:

1. Psilopsida: *Psilotum* and *Tmesipteris (*Figure of *Tmesipteris* must be shown*)* **1P**

2. Lycoposida and Sphenopsida: *Lycopodium, Selaginella, Equisetum, Isoetes* **2P**

3.Pteropsida: *Ophioglossum, Angiopteris*, *Osmunda*, *Salvia*, *Azolla, Marsilea, Lygodium, Pteris, Adiantum, Gleichenia, Cheilanthus, Blechnum, Acrostichum* **4P**

4. Fossil Pteridophytes: Any eight forms (At least one from each group) **2P**

Note: Collection and submission of any eight Pteridophytes and excursion report on studies of Bryophytes and Pteridophyta from Western Ghat is compulsory. Submission of any five photographs of Bryophytes and Pteridophytes form each

Practicals based on BO 1.4 Botanical Techniques (Any 12 practicals)

1. Study of microscopes **1P**
2. Use of flurochromes to visualize specific cell components **1P**
3. Micrometry **2P**
4. Maceration technique **1P**
5. Electrical conductivity and pH measurements **1P**
6. Absorption spectra of BSA/DNA and determination of absorption maxima **2P**
7. Gel filtration **1P**
8. Ouchterlony immunodiffusion technique for testing of antigens and antibodies **1P**
9. Rocket immunoelectrophoresis **1P**
10. Separation of leaf pigments by paper chromatography and TLC **2P**
11. Separation of isozymes by native polyacrylamide gel electrophoresis **2P**
12. Microtomy- Processing, double staining, sectioning **2P**
13. Cytochemical analysis- Nucleus, Golgi bodies, Mitochondria **2P**

BO 1.6 PRACTICAL ON BO 1.2 AND BO 1.3 (5 Credits)

(Any 24 Practicals)

Practicals based on BO 1.2 Biochemistry and Physiology (Any 12 Practicals)

1. Preparation of solution of different concentrations, Buffers, Conductivity and pH measurements 1P
2. Enzyme assays – extraction and estimation of enzyme activity- Catalase/ amylase/lipase/peroxidase (Any one) 1P
3. Purification of enzyme by ammonium sulphate precipitation / gel filtration 1P
4. Effect of pH and enzyme concentrations on enzyme activity 1P
5. Effect of substrate concentration on rate of enzyme action and calculation of Km by Michalie's Menten Curve 2P
6. Estimation of soluble proteins in germinating and non-germinating seed by Lowry and Bradford's method 2P
7. Estimation of total amino acid in germinating and non germinating seed 1P
8. Isolation and estimation of chlorophylls and carotenoids. Separation of pigment using column Chromatography. Determination of absorption spectra of each pigment 2P
9. Estimation of ascorbic acid in ripe and unripe fruits 1P
10. Assaying IAA oxidase activity in green and senescent leaves 1P
11. Studies on induction of amylase activity by GA 3 in germinating cereal grains 1P
12. Estimation of reducing sugars 1P
13. To determine the chlorophyll-a and chlorophyll-b ratio in C3 and C4 plants 1P
14. Effect of salt stress on proline accumulation and its estimation 1P

Practicals based on BO 1.3 Genetics and Plant Breeding (Any 12 practicals)

1. Preparation of stains, Fixatives, Preservatives and pretreatments to plant material 1P
2. Karyotype analysis, preparation of somatic C- metaphase chromosomes of appropriate material Using camera lucida drawing and Karyotype analysis in Allium / Aloe. 2P
3. Study of meiotic configuration in maize/ Allium, Rhoe/ Aloe, Tradescantia (prophase I, Chiasma analysis). 3P
4. Induction of mutation in plant material using sutaible mutagen 1P

5. Study of Polygenic inheritance. 1P
6. Problems of Mendelian inheritance and estimation of gene frequencies and heterozygotic Frequencies, population genetics and Linkage. 1P
7. Neurospora tetrad analysis. 1P
8. Study of Drosophilla sexual dimorphism and mutants 1P
9. Linear differentiation of chromosomes through banding techniques such as C-Banding, Banding and Q-Banding. 2P
10. Penetrance and expressivity of PTC testing ability in humans and tounge rollers/non Rollers 1P
11. Floral Biology, Study of Pollen Viability, germination in vitro and staining (any two major crops) 1P
12. Study of monohybrid and dihybrid crosses and interactions. 1P
13. Use of Colchicine for induction of polyploidy in appropriate plant material. 2P

BO 2.1 CRYPTOGAMIC BOTANY PART – II (4 Credit)

(60 Lectures)

Credit -1 (15 Lectures):-

1. Systematics and Taxonomy –Concept, Structural, Biochemical and Molecular systematic, Principles and procedures of plant systematics, Sources of data for plant systematics, Position of algae and fungi in Five Kingdom System, Economic importance of algae … (3L)
2. Classification of algae up to order level- Fritsch system, Bold and Wyne's System ……. (1L)
3. Recent algological studies - Abroad and in India, Algal habitats, , Pigment constitution in algae, Reserve food, Modes of perennation in algae,Origin and evolution of sex and thallus in the algae, Fossil algae ……. (4L)
4. Cyanophyta – Distinguishing characters, Thallus organization, Cell structure, Heterocyst and its significance, Structure and reproduction in Chrococcales, Nostocales, Stigonematales….. (3L)
5. Chlorophyta- Distinguishing characters, Origin of green algae, Thallus structure, Reproduction – asexual and sexual, Life cycle pattern in unicellular, filamentous and Multicellular green algae, morphogenesis in *Acetabularia*…… (4L)

Credit - 2 (15 Lectures):-

1. Charophyta and Euglenophyta – Distinguishing characters, Thallus structure, Reproduction and Life cycle pattern ……. (2L)
2. Xanthophyta, Bacillariophyta and Chrysophyta - Distinguishing characters, Thallus structure, reproduction and Life cycle pattern ……... (3L)
3. Phaeophyta and Rhodophyta – Distinguishing characters, Thallus morphology, anatomical peculiarities, reproduction and life cycle patterns (5L)
4. Lichens – History of Lichenology, Types and Classification of lichens, Nature of association, Morphology and anatomy of lichen thallus, reproduction, Economical and Ecological importance……. (3L)
5. Mycorrhizae – Definition, Classification, Types and Importance in agriculture…… (2L)

Credit - 3 (15 Lectures):-

1. Fungi- Classification of fungi as per- Alexopoulos Mims and Blackwell system (1999), and Ainsworth et al system (1973),Recent studies of fungi- abroad and in India. (2L)
2. Fungi – Distinguishing characters, Thallus- unicellular and multicellular filamentous, Nutrition, Cell structure, Hyphal modifications in Fungi, Phylogeny of Fungi, Economic importance……. (4L)
3. Myxomycotina - Distinguishing characters, structure of thallus and reproductive bodies, life cycle pattern….. (3L)
4. Mastigomycotina - Distinguishing characters, Evolution of thallus structure and reproduction (Asexual and sexual), Life cycle pattern in Chytridiomycetes and Oomycetes …… (3L)
5. Zygomycotina - Distinguishing characters, Thallus structure, Heterothallism and sexual reproduction, Evolution of Asexual reproduction, Life cycle pattern (3L)

Credit - 4 (15 Lectures):-

6. Ascomycotina - Distinguishing characters, Thallus structure, Evolution of sexuality, Concept of Hamathecium and centrum, Fructifications, Life cycle pattern in Hemiascomycetes and Euascomycetes . ……. (5L)
7. Basidiomycotina – Distinguishing characters, Thallus structure, Types and Structure of Basidia and basidiocarps, life cycle pattern in Teliomycetes, Hymenomycetes and Gasteromycetes……. (5L)
8. Deuteromycotina – Distinguishing characters, Thallus structure, fructifications, Types of conidia, Conidial ontogeny, Life cycle patterns …….. (3L)
9. Fungi – Parasexual cycle, Sex hormones in fungi, Mycotoxins, Fossil fungi……. (2L)

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14. **Sharma O.P. Algae**
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23. **Dube H.C.** (2004). An Introduction to fungi. Vikas Publishers.
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BO 2.2 CELL BIOLOGY AND EVOLUTION (4 Credits)

(60 Lectures)

Credit 1 = (15 Lectures)

1. Introduction to cell biology- Cell theory and cell structure **1L**
2. Cell Wall- Biogenesis, Ultra Structure and function, Growth- primary and secondary wall. **2L**
3. Cell membranes: molecular organization, Fluid mosaic model, Membrane protein diffusion, Electrical properties of membranes, Transport across membranes- Facilitated diffusion, Carrier and channel proteins, Transporters, Active transport, Transport of ions and solutes. **4L**
4. Molecular organization and biogenesis of chloroplast and mitochondrial membrane **3L**
5. Vacuoles- biogenesis, transporters, Mechanism of sorting and regulation of intra-cellular transport, Role as storage organelle, Transport across vacuolar membrane **2L**
6. Endoplasmic reticulum- Ultra structure of ER, Role in synthesis and transport of secretary proteins **1L**
7. Golgi complex- Ultra structure of golgi complex, Role in sorting, storage and secretion **1L**
8. Lysosomes- Ultra structure of lysosomes, Membrane integrity and role **1L**
9. Glyoxysomes and Peroxisomes- Structure and functions **1L**

Credit 2 = (15 Lectures)

1. Nucleus- Structure, Organization and regulation of nuclear pore complex, Transport across nuclear membrane **2L**
2. Ribosomes- Structure, Assembly and dissociation of subunits, function **1L**
3. Cytoskeleton- Composition and organization of microtubules, microfilaments, signaling and intracellular traffic, Role in motility, flagella- Structure and organization, Intermediate filaments **3L**
4. Plasmodesmata- Structure and role in movement of molecules, virus transport **1L**
5. Signal transduction: Types of receptors, G-proteins and G-protein coupled receptors **2L**

6. Phospholipid signaling, Ca^{2+}, Calmodulin cascade, Diversity in protein kinases and phosphatases, secondary messengers, regulation of signaling pathways **2L**
7. Specific signaling mechanisms with suitable examples- Biotic and abiotic stress, ABA induced stomatal closure, Stomatal guard cell signaling **2L**
8. Nuclear- organelle signaling during plastid development **1L**
9. Receptor Serine/ Threonine kinase, Ethylene mediated two component system **1L**

Credit 3 = (15 Lectures)

1. Cell cycle- Phases of cell cycle, functional importance of each phase, Molecular events during cell cycle, Regulation of cell cycle, Cyclins and protein kinase, MPF (Maturaton promoting factor), Method of study cell cycle- labeled mitotic curve, flow cytometry, use of mutants **8L**
2. Cell aging and cell senescence, programmed cell death-moleular aspects, regulation of cell death, PCD in response to stress, Apoptosis- Role of different genes, cell organelles during apoptosis, genetic control of apoptosis **7L**

Credit 4: Evolution = (15 Lectures)

1. Emergence of evolutionary thought: Steps and preview of evolution, Lamarkism, Darwinism- Concepts of variation, adaption, struggle for fitness and natural selection; Nerdarwinism, Spontaneity of mutations, The evolutionary synthesis, Fossils- Formation, Nature, Types, Geological time scale **3L**
2. Origin of cells and unicellular evolution: Origin of basic biological molecules, abiotic synthesis of organic monomers and polymers, Concepts of Opairn and Halden, Experiment of Miller (1953), The first cell, evolution of prokaryote, origin of eukaryotic cells, evolution of unicellular eukaryotes, anaerobic metabolism, photosynthesis and aerobic metabolism, RNA world theory **4L**
3. Molecular Evolution: Concepts of natural evolution, molecular clocks, molecular tools in phylogeny, classification and identification, protein and nucleotide sequence analysis, origin of new genes and proteins, gene duplication and divergence **4L**
4. The mechanism of evolution: Population genetics- populations gene pool, gene frequency, Hardy-Weinberg law, Concepts and rate of change in gene frequency

through natural selection, migration and random genetic drift, adaptive radiation and modification, isolation mechanism, speciation, allopatric and sympatricality, parapetric, convergent evolution, sexual selection, co-evolution **4L**

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BO 2.3 – MOLECULAR BIOLOGY AND GENETIC ENGINEERING (4 Credits)

(60 Lectures)

Credit 1 = (15 Lectures)

1. Structure and Properties of Nucleic acids: - 8L

- Structure, Chemical, Physical, Spectroscopic and thermal properties of nucleic acids. (e.g. Buoyant density, Melting temperature, Effect of acid and alkali, UV absorption, hypo and hyperchromicity)
- Packaging of genome in viruses, bacteria, organelle and nuclei structure of chromatin, nucleosome.
- Dissociation and reassociation kinetics of DNA, C-value paradox, Cot curves, Cot ½ values and its significance. Unique, moderately repetitive and highly repetitive DNA, forms of DNA. (A, B, C, Z) RNA as a genetic material.

2. DNA Replication: - 4L

- Mechanism of prokaryotic and eukaryotic DNA replication, replication apparatus.
- Origins of replication, priming and DNA polymerases.
- Rolling circle and theta (Ø) models.
- Fidility of replication, Extrachromosomal replications.

3. DNA damage and repair: - 3L

- Types of DNA damage,
- Enzymes involving in repairing of DNA,
- Type of DNA repair, Photoactivation, excision repair, recombination repair and mismatch repair systems, SOS.

Credit 2 = (15 Lectures)

1. Gene Structure: - 3L

- Organization and Structure of prokaryotic and eukaryotic genes;
- Structure and role of promoters, exons, introns, terminators and enhancers.

2. Transcription: - 5L

- RNA polymerases and their role,
- Transcription apparatus,

- Transcription in prokaryotes and eukaryotes- Initiation, elongation and termination,
- RNA processing- RNA editing Caping, Methylation, polyadenation and splicing
- Ribonucleoproteins
- Structure of mRNA- RNA transcript

3. Protein synthesis: - 4L

- Structure of rRNA, tRNA and Ribosomal assembly.
- Mechanism of protein synthesis in prokaryotes and eukaryotes: initiation, elongation and termination.
- Translational and post translational control.
- Targeting of organelle proteins.
- Protein folding and processing. Chaperones.

4. Regulation of Transcription in prokaryotes and eukaryotes: - 3L

- Operon concept (Lac, Tryptophan, Arabinose)
- Positive and negative regulation of prokaryotic genes,
- Eukaryotic transcription factors.

Credit 3 = (15 Lectures)

1. Introduction to recombinant DNA technology 2L

- Steps involved in construction of recombinant DNA molecule

2. Enzyme used in genetic engineering 5L

- Restriction endonucleases,
- Other endonucleases
- Exonucleases
- Ligases,
- Polymerases,
- Kinase and
- Phosphatase,
- DNA methylases,
- Topoisomerases

- Reverse transcriptase

3. Use of vector in cloning **5L**

- Plasmids,
- Phages,
- Cosmids,
- Phagemids,
- BACs and
- YACs
- Vector for marker-free selection
- Shuttle vectors,
- Expression vectors

4. Screening and selection of recombinants (Plasmids and phages) **3L**

Credit 4 = (15 Lectures)

1. Isolation of gene and gene libraries **3L**

- Techniques of DNA isolation and purification
- Genomic DNA library
- Preparation of cDNA
- cDNA libraries

2. Plant Genetic Engineering: - **6L**

Gene Transfer Methods- direct and indirect gene transfer in plants.

Factor affecting transformation,

Screening for transformants

Handling transformants in subsequent generation

3. Blotting Methods **2L**

Southern, Northern, Western, and Dot Blot method

4. Application of Genetic Engineering: - **4L**

- Transgenic plants for insect, fungal, bacteria disease resistance
- Lignin, modification,
- Abiotic stress tolerance,

- Production of useful products.

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BO 2.4 PLANT ECOLOGY AND PHYTOGEOGRAPHY (4 Credits)

(60 Lectures)

Credit 1 = (15 Lectures)

Plant relation with the environment **15L**

1. Plant relation with the climatic factors: water, precipitation, temperature, light and radiation **4L**
2. Plant relation with the edaphic factors: types of soil, soil moisture and water holding capacity of the soil, soil nutrients, soil microbes **4L**
3. Plant distribution with respect to topographic and climatic factors, centres of origin, migration **4L**
4. Environmental pollution and its impact – Air, water, soil and noise **3L**

Credit 2 = (15 Lectures)

Population Ecology **15L**

1. Ecological limits and the size of population, factors affecting population size, demes **3L**
2. Life history strategies, r and k selection, C-S-R triangle **3L**
3. Concept of metapopulation, extinction events, population viability analysis **3L**
4. Community structure and species diversity **3L**
5. Diversity types and levels (alpha, beta, gamma), ecotone and edge effect **3L**

Credit 3 = (15 Lectures)

Ecosystems **15L**

1. Ecosystem: Components and organization **1L**
2. Energy flow and mineral cycling, carbon sequestration **2L**
3. Ecosystem types **4L**
   Terrestrial: Forests, grasslands and deserts
   Aquatic: Fresh water and marine
   Artificial: Agricultural
4. Eco-physiology: Adaptive responses of plants to variation in: **4L**
   Light: Photoinhibition, protection against light-induced damage
   Temperature: Winter hardness, vernalization, adaptation to high temperature
   Water availability: Adaptation to light drought and flooding
   Plant succession: Autogenic and allogenic, mechanism and phases

5. Cerial communities and climax communities: Hydroseres, lithoseres, xeroseres, haloseres **4L**

Credit 4 = (15 Lectures)

Phytogeography **15L**

1. Introduction, major plant communities of world, phytogeographic regions of world (vegetation of belts), soil, climate, flora and vegetation of India, floristic (Botanical) regions of India **7L**
2. Biomes: Classification and components **2L**
3. Habitat ecology: Fresh water, Marine water, Estuarine ecology, Terrestrial ecology, Dessert ecology **3L**
4. Endemism and EIA **3L**

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BO 2.5 PRACTICAL BASED ON BO 2.1 AND BO 2.2 (5 Credits)

(Any 24 Practicals)

Practicals based on BO 2.1 (Any 12 practicals)

Algae

1. Morphological observations, documentation (description and illustrations) and classification according to Fritsch with reasons of taxa belonging to (At least one example from each order):

a. Chlorophyta- Any eight forms, Charophyta - Any two forms **3P**
b. Phaeophyta - Any five forms **1P**
c. Rhodophyta - Any five forms **1P**
d. Cyanophyta- Any five forms **1P**
e. Minor Groups - Any three forms **1P**

Note: Collection tour to any marine/oceanic habitat to collect algae is compulsory

Fungi

1. Preparation of cotton blue, Lactophenol and culture medium - PDA **1P**
2. Study of Lichens -Any three forms **1P**
3. Study of representative genera belonging to following subdivisions of fungi with respect to vegetative, reproductive structures and classification with reasons according to Ainsworth et al. (1973) (At least one example from each class):

a. Myxomycotina -Any three forms **1P**
b. Mastigomycotina - Any five forms **1P**
c. Zygomycotina - Any three forms **1P**
d. Ascomycotina - Any five forms **1P**
e. Basidiomycotina- Any five forms **1P**
f. Deuteromycotina - Any five forms **1P**

Note: Collection tour to any forest to observe, collect fungi and lichens and submission of ten specimens and excursions report is compulsory

Practicals based on BO 2.2 Cell Biology and Evolution (Any 12 Practicals)

1. Differential centrifugation for isolation of cell fractions- Nuclear fraction **1P**
2. Isolation of Chloroplasts to study: **2P**
    a. Hill reaction to measure intactness,
    b. Chlorophyll estimation
3. Isolation of mitochondria for: **2P**
    a. Estimation of succinic dehydrogenase activity

b. Microscopic observations using MitoTracker Green FM/ MitoTracker Red 580/ Janus green B

4. Isolation of Lysosomal fraction and estimation of acid phosphatase activity **1P**
5. Study of Electron Micrographs of cell organelles **1P**
6. Study of cell cycle using BrdU (demonstration) **1P**
7. Isolation of protoplasts and viability staining to determine % viability **1P**
8. Study of metaphase nucleus: Localization of Euchromatin and heterochromatin **1P**
9. Cytochemical / Histochemical studies of special cell types: guard cells, senescent cells, bundle sheath cells, meristematic cells, laticiferous cells, glandular cells, pollen grains **2P**
10. Study of induced cell senescence in leaf discs **1P**
11. Study of programmed cell death in plants **1P**
12. Study of different plant fossils with respect to evolution- **1P**
    - Impression
    - Compression
    - Petrefication
    - Coal ball
13. Geological Time Scale **1P**

BO 2.6 Practicals based on BO 2.3 and BO 2.4 (5 Credits)

(Any 24 Practicals)

Practicals based on BO 2.3 Molecular Biology and Genetic engineering

1. Isolation of Plasmid DNA and quantification **2P**
2. Electrophoretic separation of plasmid isoforms. **1P**
3. Restriction digestion of plasmid DNA, electrophoresis and molecular weight determination of DNA fragments. **2P**
4. Isolation of plant genomic DNA and quantification. **2P**
5. Effect of temperature and alkali on absorption of DNA: hyperchromicity **1P**
6. Separation of seed storage proteins from leguminous seeds and quantitation of each fraction **2P**
7. SDS-PAGE separation of seed storage proteins from legumes. Determination of molecular size of the globulin subunits. **3P**
8. Isolation of RNA and its quantification by UV-spectrophotometer **2P**

Practicals based on BO 2.4 Plant Ecology and Phytogeography

1. Study of morphological and anatomical characteristics of plants under stress **2P**
2. Allelopathic analysis of the plants **2P**
3. To find the minimum size of sampling unit for studying plant communities. **2P**
4. Determination of frequency, density, abundance, dominance, IVI and richness of the species among the plant communities **2P**
5. Studying siuccession at field level, hydroseric and xeroseric **2P**
6. Interpretation of satellite imageries and aerial photographs with respective major vegetation/ landforms/ land use patterns etc. **1P**
7. Physicochemical analysis of soil (Colour, Texture, Water holding capacity, N, P, K, Mg, Ca, Organic carbon) and water (pH, Turbidity, EC, TDS, Total solids, Hardness, Cl) **3P**
8. Biological analysis of water samples (clean and polluted): Phytoplankton, DO, CO_2, BOD and COD **2P**
9. Comparison of stomata index, chlorophyll contents and pollution fertility of the plants from polluted and non-polluted area **2P**