CURRICULUM AND SYLLABUS

M.Sc in Botany syllabus (Semester I,II,III And IV)
COURSE STRUCTURE OF M. Sc. Botany Syllabus  
(Semester I,II,III,IV)

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BO 1.1 - Taxonomy (Algae, Fungi, Bryophytes) 4C

Credits-1.5: Algae

1. Plant Systematics: Taxonomy Vs Systematics, Principles and Methods of Taxonomy: Concept of species and hierarchical taxa, Biological nomenclature (International code of Botanical Nomenclature), Classical and quantitative methods of taxonomy. 2L
3. Cyanophyta: Ultrastructure; strategy of cell division; thallus organization, heterocyst. 2L
4. Brief introduction, structural and reproductive features of Chrysophyta, Xanthophyta, Bacillariophyta, Dinophyta. 4L
5. Chlorophyta – structure and evolution of thallus, unicellular eukaryotes (endosymbiotic theory), morphogenesis in Acetabularia, reproduction and life histories with reference to orders of green algae. 5L
6. Charophyta and Euglenophyta: structure and reproduction and interrelationship 2L
7. Phaeophyta: general account of morphology, anatomy, reproduction and life histories. 3L
8. Rhodophyta: classification, thallus structure, reproduction, reproductive strategies and life histories. 3L

Credits - 1.5: Fungi

1. Taxonomy of fungi: Characters of fungi used of classification, various systems of classification of fungi. 2L
2. Chromista – Its present status in classification; general characters, classification up to orders. Lichen: types, morphology and reproduction. 4L
3. Fossil fungi: Occurrence and their significance. 1L
4. An outline of latest classification system proposed by Ainsworth or Alexopoulos. 3L
5. Myxomycotina: structure, life cycle patterns of major classes. 1L
6. Mastigomycotina: structure, life cycle patterns of major classes. 2L
7. Zygomycotina: structure, thallus organization, evolution of sexual reproductive structures. 2L
8. Ascomycotina: thallus organization, centrum development, different types of ascocarps 3L
9. Basidiomycotina: tissue differentiation, development of basidia and basidiospore 2L
10. Deuteromycotina: types of conidial ontogeny and fruit body organization 2L

Credit -1:  Bryophytes

1. Introduction, characteristic features and diversity of Bryophytes, Medicinal, Ecological and economic importance of Bryophytes. 2L
2. Systems of classification of Bryophytes. 1L
3. Distribution, morphological, anatomical, reproductive studies along with comparative account of sporophyte and gametophyte, interrelationships and evolutionary trends of the following orders: (development of sex organs is not included).
   (a) Sphaerocarpales 1L
   (b) Calobryales, Takkakiales 1L
   (c) Marchantiales 1L
   (d) Jungermanniales 2L
(e) Anthocerotales
(f) Sphagnales
(g) Andraeales
(h) Polytrichales
(i) Buxbaumiales
(j) Funariales
4. Fossil bryophytes

References- Algae:

References – Fungi:

Reference- Bryophytes:
BO 1.2 Plant Ecology (3C)

Credit 1
A. Concept and scope of Ecology
1. Inter disciplinary nature of ecology and relevance to mankind
2. Autecology and synecology
3. Taxonomy as base for ecology

B. Population ecology
1. Characteristics of population: Distribution and size, factors affecting population size
2. Ecological limits and size of the population
3. Life history strategies, r and K selection, CSR triangle
4. Concept of metapopulation, types and dynamics in metapopulation
5. Extinction events, population viability analysis

Credit 2
A. Community Ecology
1. Community structure and species diversity: alpha, beta and gamma diversity
2. Ecotone and edge effect
3. Niche, evolution and coevolution
4. Control processes: homeostasis and homeorhesis

B. Community interactions
1. Plant-plant interaction, Concept of allelopathy, parasitism, dimorphism
2. Species interaction: Mutualism, commensalism, competition, predation, herbivory
3. Community analysis methods

Credit 3
A. Ecosystem ecology
1. Development of ecosystem: Succession
2. Organization of ecosystem: Biotic and abiotic components
3. Ecosystem types: Natural and artificial
4. Perturbation in ecosystems: Natural and anthropogenic
5. Resistance and resilience in ecosystem

B. Applied Ecology
1. Sources of pollution (air, water and soil)
2. Pollution monitoring: Physicochemical and biological analysis
3. Environmental impact assessment (EIA) methodology
4. Carbon test plants and carbon sequestration
References
BO 1.3 Genetics and Plant Breeding: 3C

Credit- 1
1. Extensions of Mendelian principles: Codominance, Incomplete dominance, pleiotropy, genomic imprinting, penetrance, expressivity and phenocopy, sex linkage, sex limited and sex influenced characters 3L
2. Inheritance of complex traits - introduction to complex traits, Polygenic inheritance, Heritability & its measurement 3L
3. Karyotype analysis: Method, karyotype evolution, applications 1L
4. Structural alterations of chromosomes: Inversion, translocation, complex translocation heterozygotes, Robertsonian translocations and their genetic implications 3L
5. Population genetics: Allele frequencies and genotype frequencies, random mating and Hardy-Weinberg principle, Implications of Hardy-Weinberg principle, rate of change in gene frequency through natural selection, mutation, migration and random genetic drift. 5L

Credit- 2
1. Microbial genetics: mutant phenotypes, Methods of genetic transfers in bacteria: transformation, conjugation and transduction, mapping of bacterial genome by interrupted mating. 3L
2. Phage genetics: Phage mutants, Lytic and lysogenic cycles in phages, genetic recombination in phages, mapping the bacteriophage genome, Fine structure analysis of rII gene in T4 bacteriophage. 4L
3. Linkage and mapping in eukaryotes: Linkage and crossing over, Recombination: homologous and non-homologous, Linkage maps, lod score for linkage testing, mapping by 3 point test cross, mapping by tetrad analysis in Yeast and Neurospora. 8L

Credit- 3
1. Breeding objectives, Plant Genetic resources: Centers of origin, Importance of genetic diversity in crop improvement and its erosion. 2L
3. Cross pollinated crops: Mass selection, Progeny selection, Recurrent selection 3L
4. Clonally propagated crops: Clonal selection, Hybridization 2L
5. Breeding for heterosis 1L
6. Mutation breeding: Types, Mutagens: Physical and chemical mutagens, Mutant types, Role of mutation in breeding. 2L
7. Role of polyploidy in plant breeding 2L

References:
8. David Freifelder, Microbial Genetics
BO 1.4 - (Practicals based on BO 1)  
Practicals on Algae: (Any 8 practicals)  
1. Handling of compound microscope and methods to study algae (Use computational facility attached with microscope for observations)  
2. Morphological observations, documentation (description and illustrations) and classification with reasons of taxa belonging to:
   a. Chlorophyta  
   b. Charophyta  
   c. Phaeophyta  
   d. Rhodophyta  
   e. Cyanophyta  
   f. Minor groups  
3. Use of monographs  

Practicals on Fungi: (Any 8 practicals)  
1. Study of the representative genera belonging to Myxomycotina, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina with respect to observations made based on tissue differentiation, accessory organs, asexual and sexual structures, and fruiting body: Ascocarp/Basidiocarp.  
   Subdivision Myxomycotina: Any five forms  
   Subdivision Mastigomycotina: Any five forms  
   Subdivision Zygomycotina: Any two forms  
   Subdivision Ascomycotina: Any ten forms  
   Subdivision Basidiomycotina: Any ten forms  
   Subdivision Deuteromycotina: Any four forms  
   Lichen: Any three forms  

Preparation of PDA medium and isolation and culture of plant pathogenic fungi  
Study the antimicrobial activity against of Trichoderma against fungi.  

Practicals on Bryophytes: any 4 practicals  
Morphological, anatomical, and reproductive studies of the following members:  
2. Metzereineae: Fossmbronlia, Pallavicinia  
3. Metzereineae: Riccardia and Metzaria  
4. Jungermanniae: Porella, Frullania  
5. Anthocerotales: Folioceros, Phaeoceros, Notothylus  
6. Musci: Sphagnum, Polytrichum, Pogonatum, Bryum, Fissidens (any three)
BO 1.5 Practicals based on BO 2 (2C)

Any 8 practicals
1. Finding minimum size of sampling unit for studying specific plant community 1P
2. Determination of frequency, density, abundance and IVI of the plant community 1P
3. Determination of species richness, similarity and diversity indices in different plant communities 1P
4. Estimation of DO and free CO₂ 2P
5. Determination of Palmer’s algal index 1P
6. Study of morphological and anatomical characteristics of plants under pollution stress 2P
7. Allelopathic analysis of the plants 2P
BO 1.6 Practicals based on BO 3 (3C) 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. Study of chromosomal aberrations in irradiated plant material 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. Handling of Drosophila for study of mono, dihybrid, and sex linked inheritance 1P
9. Linear differentiation of chromosomes through banding techniques such as C-Banding, GBand and Q-Banding. 2P
10. Penetrance and expressivity of PTC testing ability in humans and tongue rollers/non rollers 1P
11. Floral Biology, study of Pollen Viability, germination in vitro and staining of any two major crops. 1P
12. Study of monohybrid and dihybrid crosses and interactions. 1P
13. Study of quality traits in rice, cotton/wheat/soybean/Brassica. 1P
14. Use of Colchicine for induction of polyploidy in appropriate plant material. 1P
BO 2.1 Systematics II (Pteridophytes, Gymnosperms)  Credit-3

Credit 1: Pteridophytes

1. Introduction, diversity and importance of pteridophytes  
2. Recent systems of classification  
3. Telome concept, Soral evolution in Filicales  
4. Gametophyte evolution, Heterospory and seed habit, Stellar evolution  
5. Study of Fossil groups-  
6. Psilopsida sailent features of Psilophytes  
7. External and internal morphology of Rhynia and Lycopsida sailent features of Lepidodendrales.  
8. External and internal morphology of Calamites, Annularia, Calamostactys.  
9. Pteridosperms sailent features of pteridosperms Lyginopteris, Oldhamia, Lagenostoma  
10. Comparative account of distribution, morphology, anatomy, gametophyte, sporophyte and interrelationship of following orders–  
11. Psilotales, Lycopodiales, Isoetales, Equisetales, Ophioglossales, Maratiales, Osmundales  

Credit 2: Pteridophytes and Gymnosperms

1. Alternation of generations of Pteridophytes, Apogamy, Apospory  
2. Comparative account of distribution, morphology, anatomy, gametophyte, sporophyte and interrelationship of following orders–Filicales, Marsileaales, Salviniales  
3. Fossil history, geographical distribution, characteristic features, affinities and distinct features with Pteridophytes and Angiosperms  
4. Classification systems, economic importance of Gymnosperms  
5. Affinities and distinct features of progymnosperms, Pteridospermsles, Cycadeoidales, Cycadales, Caytoniales, Glossopteridales, Pentoxylales, Ginkgoales  
6. Comparative account of morphology, anatomy, sporogenesis, gametogenesis, embryology, and interrelationship Cycadales and Ginkgoales  

Credit 3

1. Introduction to Gymnosperms- Characters, diversity, importance and affinity with Angiosperms and Pteridophytes  
2. Comparative account of morphology, anatomy, sporogenesis, gametogenesis, embryology, and interrelationship of Cordiatales and Voltziales  
3. Coniferales  
4. Taxales  
5. Gnetales, Ephedrales and Welwitschiales  
6. Seed development in Gymnosperms  
7. Economic importance of Gymnosperms
References:
BO 2.2 Cell Biology (3C)

Credit 1 Cell organelles–functional aspects 15L
3. Plasmodesmata – Structure and role in movement of molecules, virus transport
4. Vacuoles – Tonoplast membrane biogenesis, transporters, role as storage organelle, transport across vacuolar membrane
5. Endoplasmic reticulum- Role in synthesis and transport of Secretory proteins
6. Golgi complex – Role in sorting, storage and secretion,
7. Lysosomes , Glyoxysomes and Peroxisomes- structure and functions
8. Cytoskeleton – Composition and organization of microtubules, microfilaments. Treadmilling, role in cell division, signalling and intracellular traffic.
10. Ribosomes – Structure, assembly and dissociation of subunits, function.
11. Biogenesis of chloroplasts and mitochondria

Credit 3 Signal transduction 15L
1. Signal transduction: Types of receptors, G-proteins and G-protein coupled receptors
2. Phospholipid signalling, Ca^{2+}-calmodulin cascade, diversity in protein kinases and phosphatases, secondary messengers, regulation of signalling pathways
3. Specific signalling mechanisms with suitable examples – biotic and abiotic stress, ABA induced stomatal closure
4. Nuclear-organelle signaling during plastid development

Credit 4 Cell cycle, aging and cell death 15L
1. Cell Cycle – Phases of Cell Cycle, functional importance of each phase, Molecular events during cell cycle, Check points, Cyclins and protein kinases, MPF (Maturation Promoting Factor), Regulation of cell cycle. Methods to study cell cycle – labelled mitotic curve, flow cytometry, use of mutants.
2. Senescence, programmed cell death- molecular aspects, regulation of cell death, PCD inresponse to stress
3. Apoptosis- Role of different genes, cell organelles during apoptosis, genetic control of apoptosis.
Reference Books:
4. De Robertis and De Robertis, 1988, Cell and Molecular Biology, 8th edn, Info-Med, Hongkong
BO 2.3 - Molecular Biology

Credit – 1 DNA
1. DNA structure – types of base pairing, unusual structures, topology
2. Melting and reassociation of DNA, Cot curves and kinetic complexity of DNA. Organization of genomes (from whole genome sequences), repetitive and unique sequences, C value paradox, gene duplication and divergence. Number of genes, exons. Rot curves and gene expression
4. Initiation, elongation and termination of DNA replication, molecular machinery of DNA replication in prokaryotes and eukaryotes.
5. DNA damage and repair.
6. Molecular mechanism of recombination and transposition

Credit – 2 RNA
1. RNA structure – modified bases, pairing, secondary structure
2. Transcription units, RNA polymerases, initiation, elongation and termination of transcription in prokaryotes and eukaryotes, proof reading
3. RNA processing – Processing of tRNA, rRNA and mRNA. mRNA localisation
4. Non-coding RNAs, ribozymes and riboswitches

Credit – 3 Proteins
5. Seed-storage proteins and their genes in cereals and legumes.

Credit – 4 Regulation of gene expression
1. Regulation of transcription - Operons, repressors and inducers, positive and negative control, regulation of lytic and lysogenic cycles in phages.
3. Regulation of gene expression at higher levels of genome organization, chromatin remodeling, locus control regions, enhancers and insulators
4. Regulation of protein synthesis, post-translational regulation, regulation of protein function
Reference books:
1. Genes IX– Benjamin Lewin, Jones and Bartlett, 2008
2. Genes X– Benjamin Lewin, Jones and Bartlett, 2011
BO 2.4 Plant Physiology & Biochemistry (3C)

**Credit 1**
- 1. Structure and properties of water: Biological significance. Ionization of water, pH, buffers 1L
- 2. Bioenergetics: Free energy, changes in free energy during chemical reactions, entropy and enthalpy, high energy compounds, synthesis of ATP, activation energy 1L
- 3. Enzymology: Classification and properties of enzymes, Isoenzymes, coenzymes and cofactors, coupled reactions, units of enzyme activity. Enzymekinetics–substrate concentration and rate; Competitive and noncompetitive inhibitors. Covalent and allosteric regulation 3L
- 4. Building blocks of biological macromolecules: Biosynthesis and metabolism of amino acids, carbohydrates, fatty acids and lipids, purine and pyrimidine bases 3L
- 5. Mineral nutrition of plants: Cation-anion exchange capacity of soil, types of ion transporters, passive and active transport, primary and secondary active transport, Role of membrane potential in ion transport, high and low affinity transporters. 4L
- 6. Nitrogen: Uptake, assimilation and remobilization of nitrogen in plants, Biological nitrogen fixation by free living and symbiotic organisms, mechanism of nitrogen fixation. 4L
- 7. Phloem structure and function: Source and sink relationship, translocation of photoassimilates through phloem, phloem loading and unloading, composition of phloem sap. 4L

**Credit 2**
- 1. Water uptake, transport and transpiration, Stomatal physiology, mechanism and regulation of guard cell 2L
- 2. Photosynthesis– Photosynthetic pigments, organization of photosynthetic electron transport system in thylakoid membranes. Charge separation and electron transport, fluorescence and photochemistry, oxygen evolution, NADP reduction, photophosphorylation. 4L
- 3. Reduction of carbon dioxide - RuBPcase and Calvin cycle, photorespiration. CO₂ 4L
- 4. Respiration – Glycolysis, citric acid cycle, pentose phosphate pathway. Organization of mitochondrial electron transport system, ATP synthesis. Respiratory control, Anaerobic respiration 5L

**Credit 3**
- 1. Plant growth hormones – Structure, biosynthesis and metabolism of auxins, cytokinins, gibberellins, abscisic acid and ethylene. Physiological role of hormones 8L
- 2. Photoperiodism and vernalization. Tropic and nastic movements in plants 3L
Reference books:
BO 2.5 (Practical’s on BO2.1): 2C

Pteridophytes-(Any 4P)

Morphological and/or anatomical and/or reproductive studies of the following members with the help of live material/or herbarium specimens and/or museum specimens and/or permanent slides of the following orders: (any 8 order 4P)

1. Psilotales: *Psilotum, Tmesipteris*
2. Lycopodiales: *Lycopodium*
3. Selaginellales: *Selaginella*
4. Isoetales: *Isoetes*
5. Equisetales: *Equisetum*
6. Ophioglosales: *Ophioglossum, Botychium, Helminhostachys, Marattiales, Angiopteris*
7. Osmundales: *Osmunda*
9. Salviniales: *Salvinia, Azolla*
10. Marsileales: *Marsilea*

   Study of available fossil of Pteridophytes
   Field visit for the study of Pteridophytes biology. (1P)

Gymnosperm-(Any 4P)

1. Double staining technique and permanent slide preparation (1P)
2. Study of available fossils- At least 10 specimen (1P)
3. Morphological and/or anatomical and/or reproductive studies of the following members with the help of live material/or herbarium specimens and/or museum specimens and/or permanent slides of the following orders: (any 4 order 4P)
   i) Cycadales- *Cycas, Zamia, Ceratozamia, Encephalertos*
   ii) Coniferales
   iii) Taxales
   iv) Ginkgoales
   v) Gnetales
4. Field visit for the study of Gymnosperms biology. (1P)
5. Methods of turpentine and oleo resin extraction from the pine tree (Demonstration with the help of samples) (1P)
BO 2.6 practicals based on BO 2.2 & BO 2.3  

**Cell Biology (Any8P)**

1. Differential centrifugation for isolation of cell fractions – Nuclear fraction  
2. Isolation of chloroplasts to study:  
   a. Hill reaction to measure intactness,  
   b. Measurement of size of chloroplasts using micrometry and chlorophyll estimation  
3. Isolation of mitochondria and  
   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  
5. Study of electron micrographs of cell organelles  
6. Study of cell cycle using BrdU (demonstration)  
7. Isolation of protoplasts and viability staining to determine % viability.  
8. Study of metaphase nucleus: Localization of euchromatin and heterochromatin  
9. Cytochemical studies of special cell types- guard cells, senescent cells, bundle sheath cells, meristematic cells, laticiferous cells, glandular cells, pollen grains  
10. Study of induced cell senescence in leaf discs  
11. Study of programmed cell death in plants  
12. Ouchterlony immunodiffusion technique for testing specificity of antigens and antibodies  
13. To study plasmodesmatal connections in plant cells  
14. Determination of permeability of living cells to acids and bases

**Molecular Biology (Any 8P)**

1. Isolation of plasmid DNA and quantification  
2. Electrophoretic separation of plasmid isoforms  
3. Restriction digestion of plasmid DNA, electrophoresis and molecular weight determination of DNA fragments.  
4. Isolation of plant genomic DNA and quantification  
5. Effect of temperature and alkali on absorbance of DNA – hyperchromicity  
6. Separation of seed-storage proteins from leguminous seed and quantitation of each fraction  
7. SDS-PAGE separation of seed storage proteins from legumes. Determination of molecular sizes of the globulin subunits.
BO 3.1 - Taxonomy of Angiosperms

Credit -1 15L
1. Aims, principles and practices in taxonomy. Botanical Nomenclature: Brief history, Scientific names, ICN, Principles, typification, Principle of priority, effective and valid publication, rank of taxa. 4L
2. Tools of taxonomy: Floras, monographs, revisions, websites. Herbarium and botanical gardens, their role in teaching, research and conservation, important herbaria and botanic gardens of the World. Botanical Survey of India. 3L
3. Floristics: Need and significance. History of botanical exploration in India and recent works with special emphasis on Maharashtra. Botanical Survey of India. 3L
4. Morphological features used in identification. Artificial dichotomous keys 3L
5. Biodiversity, types, importance and methods of conservation 2L

Credit -2 15L
1. Importance and need for classification, hierarchical classification. Criteria used for classification; phases of plant classification. Overview on pre- and post-Darwinian systems of classification. 2L
2. Artificial systems of classification - Herbalists, Theophrastus, Linnaeus 2L
3. Natural system of classification - Bentham and Hooker 2L
4. Phylogenetic systems of classification - Cronquist, Takhtajan 4L
5. APG system of classification, contributors, APweb 5L


3. Crop plants and their wild relatives: Cereal grains, legumes, starch plants, fruits, vegetables, fibers, cordage, medicinal plants, poisonous plants.

1. Major clades in APG-IV: characteristic features, interrelationships, classification (APG-IV) and economic importance of families of angiosperms in following clades: ANA grade: Amborellaceae, Nymphaeaceae, Hydatellaceae; MAGNOLIIDS: Magnoliaceae; MONOCOTS: Araceae; COMMELINOIDS: Arecaceae; PROBABLE SISTER OF EUDICOTS: Ceratophyllaceae; EUDICOTS: Ranunculaceae; CORE EUDICOTS: Amaranthaceae; EUROSIDS-I: Leguminosae; EUROSID-II: Malvaceae; ASTERIDS: Santalaceae; EUASTERIDS-I: Apocynaceae, EUASTERID-II: Asteraceae.
Practicals on BO 3.1 – Taxonomy of Angiosperms  

1. Studies on the following Classes as per Bentham and Hooker’s system of classification using any 3 typespecimens and preparation of artificial keys for identification of any two unknowns specimen:  

**Dicotyledonae**  
- a. Polypetalae: Thalamiflorae, Disciflorae, Calyciflorae  
- b. Gamopetalae: Inferae, Heteromerae, bicornellatae  
- c. Monochlamydae: Curvembryae, Multiovulateaquaticae, Multiovulateterrestris, Microembryae, Daphniales, Achlamydosporae, Unisexualae, Ordinesanomali.  

**Monocotyledonae**  
- a. Microspermae  
- b. Epigynae  
- c. Coronariae  
- d. Calycinae  
- e. Nudiflorae  
- f. Apocarrae  
- g. Glumaceae  

2. Comparative study of morphological and structural adaptations of hydrophytes, mesophytes, xerophytes, halophytes  

3. Ex-situ conservation methods of biodiversity – through seed, vegetative and micro-propagation methods. ( any one plant species per technique)  

**Reference Books:**  

BO 3.2 – Plant Development (3C)

Credit 1 – Vegetative development
1. Processes basic to plant development
   a. Competence, determination, commitment, specification, induction, differentiation, dedifferentiation and redifferentiation.
   b. Morphogenetic gradients, cell fate and cell lineages.
   c. Polarity and symmetry.
   d. Juvenility and transition to adult phase.
2. Vegetative development –
   b. Leaf development, plastochochron, phyllotaxy, development of trichomes and stomata.
   e. Secretory tissues – Nectaries, laticifers, resin ducts.
   f. Molecular genetics of root, shoot and leaf development.
   g. Transition from vegetative to reproductive phase – induction, morphological and histochemical changes in shoot apex, floral meristems.

Credit 2 – Reproductive development
1. Transition to flowering and flower development: Molecular Basis-ABC & ABCE Model.
2. Development of stamen, anther, sporogenous tissue, tapetum, microsporogenesis, types of pollen tetrads, pollen and male gametophyte.
3. Development of carpel, placenta, ovule, integuments, sporogenous tissue, megaspore, female gametophyte.
4. Molecular basis of male and female gametophyte development.
5. Interaction between pollen & pistil, pollen tube guidance, self-incompatibility, double fertilization and triple fusion, role of synergids, endosperm development and imprinting.
6. Fruit development, structure of seed, germination, and germination mutants.
7. Stages of embryogenesis, structure and organization of embryo, suspensor, Embryogenesis mutants, establishment of body plan.

Credit 3 - Intrinsic and extrinsic factors regulating plant development
1. Light mediated regulation
   a. Photoreceptors- phytochromes, crytochromes, phototropins.
   b. Signal transduction leading to photomorphogenesis and photoperiodic responses.
   c. Circadian rhythms
2. Hormonal regulation
   a. Perception, signaling and regulation of gene expression by hormones – Hormone receptors, mutants in hormone signaling, transcription factors involved in hormone signalling.
   b. Role of hormones in germination, growth and flowering. Cross-talk between hormone signaling pathways
   3. Regulation of development by metabolites (sugars, nitrogen status)
References:
1. The Arabidopsis Book. (www.arabidopsisbook.org)
BO 3.3: Tools and Techniques in Botany (3C)

Credit 1 (15L)
1. Microtomy: Principle of tissue fixation for microtomy, types of microtome, serial sectioning and staining.
3. Electrochemical techniques: Construction and working of equipments for measurement of electrical conductivity, pH meter.
5. Gas exchange measurements: Types, Construction and working of Infra-red gas analyzer, O₂ electrode.

Credit 2 (8L)
1. Spectroscopic techniques: UV-visible and IR spectrophotometry, spectrofluorimetry, NMR and ESR spectroscopy, circular dichroism, atomic absorption and mass spectrometry, MALDI-TOF.
2. Microscopy and microscopic techniques: Light, phase contrast, fluorescence, electron, confocal microscopy, micrometry.

Credit 3 (5L)
1. Chromatographic techniques: Paper, thin layer and column chromatography, gel filtration, ion exchange and affinity chromatography, high pressure liquid chromatography, gas chromatography.
2. Immunological techniques: Immune response. Antibodies and their specificity, antigen-antibody interactions, immunodiffusion and immunoelectrophoresis techniques, immunoassays, Western blotting.
3. Electrophoretic techniques: Supports, electroendoosmosis, electrophoresis under native and denaturing conditions, 2-D electrophoresis, staining, activity staining.

References:
Practicals on BO 1 Plant Development

1. Isolation of vegetative and reproductive apical meristems.
2. Tracing the course of stomatal development and observations on stomatal types.
3. Anatomical studies on secondary growth (wood).
4. Origin and development of epidermal structures (trichomes, glands and lenticels) and study of secretory structures (nectaries and laticifers).
5. Histochemical comparison between vegetative SA and reproductively induced SA.
6. Observations on:
   a. Microsporogenesis and development of male gametophyte (pollen).
   b. Megasporogenesis and development of female gametophyte.
7. Observations on types of endosperm, dissection and isolation of endosperm.
8. Observations on stages of embryo development, dissection and isolation of developing embryo (3 stages).
9. In vitro germination of spore/pollen. Correlation between fertility (stainability), viability (TTC and FDA staining) and germinability (in vitro) of pollen.
Bo 3.7: Practicals Based on BO 2

1. Principle and working of Conductivity meter and pH meter. Conductivity measurement of different solutions. Determination of pKa and buffering capacity of acetate buffer. 3P

2. Absorption spectra of BSA / DNA and determination of absorption maxima, molar extinction coefficient. 2P

3. Separation of Plant Pigments by Thin Layer Chromatography / Column Chromatography. 3P

4. Native PAGE and activity staining. 3P

5. Ouchterlony immunodiffusion technique for testing specificity of antigens and antibodies. 2P

6. Separation of protein Gel filtration/ affinity / ion exchange chromatography 2P

7. Microtomy – fixation, dehydration, serial sectioning and staining of plant tissues 3P

8. Demonstration of Spectrofluorimetry 1P

9. Demonstration of HPLC and GC-MS techniques and quantification. 2P
BO 4.1 Biostatistics and bioinformatics 2C

**Credit 1 - Statistics 1** 15L
1. Descriptive statistics - Populations and samples, graphical presentation of data frequency distribution, central tendency and dispersion - mean, median, variance standard deviation 1L
2. Sampling distributions, standard error of mean 1L
3. Normal distribution, standardised normal distribution (z), attributes of normal distributions, Student's t distribution Estimation, Confidence interval 1L
4. Hypothesis testing, type I and type II errors 2L
5. Binomial and Poisson distribution 2L
6. Non-parametric tests 2L
7. Experimental designs- completely randomised, randomised block and factorial experimental designs, Analysis of variance. 3L
8. Correlation and regression, linear and non-linear regression, 2L
9. Chi-square test for goodness of fit and independence 1L

**Credit 2 – Basic Bioinformatics** 15L
1. Introduction to databases and retrieving information from databases: Databases 1L
2. Molecular tools in protein and nucleotide sequence analysis; origin of new genes and Proteins, 1L
3. Sequence similarities. Pairwise comparison of DNA and protein sequences, dynamic programming algorithms, FASTA and BLAST. 2L
4. Multiple sequence alignments, progressive methods, iterative methods, localized alignments 1L
5. Determining phylogenetic relationships using DNA and protein sequences 3L
6. Protein structures, Ramachandran plot, protein folding. 2L
7. Structure function relationship, conformational energy calculations, 2L
8. Protein structure predictions, secondary and tertiary, 2L
9. Protein structure classification- SCOP, CATH, 1L
References:
References:

8. David Freifelder, Microbial Genetics
2003

Relevant review articles from journals
Biostatistics - Any 4
1. Data, graphical presentation of data – frequency distribution, Sample means and standard deviations, confidence intervals 1P
2. Hypothesis testing-comparison of means 1P
3. Analysis of variance 1P
4. Correlation and regression 1P
5. Binomial distribution 1P
6. Non-parametric test 1P

Bioinformatics - Any 4
1. Databases and database searching 1P
2. Pairwise comparison of DNA and protein sequences - BLAST 1P
3. Multiple sequence alignments, progressive methods, CLUSTAL 1P
4. Determining phylogenetic relationships using DNA and protein sequences 1P
5. Visualizing protein 3D structure 1P
6. Prediction of 3D structure of proteins using homology modeling 1P
7. Assessment of homology modeled protein structure

BO 4.5: Project 1P