# Proposed Syllabus for M.Sc. in Botany

[Two Years M.Sc course based on Choice Based Credit System (CBCS)]

Four semesters will cover all 25 units of the whole syllabus. One project work or one review paper will be prepared by the students in final semester. Each semester with five units of 50 marks each.

Two years PG course of Botany will be conducted for 1000 marks with 100 credit points. Semester I & II (BOT /ThGL/101-105 & BOT/ThGL/201-205) is totally based on Core subject.

**Semester I : Full marks = 250 with 5 units (25 credit points).**

| Unit | Topic | Periods per week | Internal Assessment * | Theory | Practical | Full Marks | Credit points (Int.Assmt.+ Th + Pr) |
|---|---|---|---|---|---|---|---|
| BOT/ThGL/101 | Microbiology | 5 | 10 | 25 | 15 | 50 | 5 (1+2.5+1.5) |
| BOT/ThGL/102 | Phycology | 5 | 10 | 25 | 15 | 50 | 5 (1+2.5+1.5) |
| BOT/ThGL/103 | Mycology | 5 | 10 | 25 | 15 | 50 | 5 (1+2.5+1.5) |
| BOT/ThGL/104 | Bryophytes and Pteridophytes | 5 | 10 | 25 | 15 | 50 | 5 (1+2.5+1.5) |
| BOT/ThGL/105 | Gymnosperm, Paleobotany, & Palynology | 5 | 10 | 25 | 15 | 50 | 5 (1+2.5+1.5) |
| | Five units | 25 periods | Marks 50 | Marks 125 | Marks 75 | Total Marks 250 | Total credit 25 |

Internal assessment (10 marks* for each unit) will be evaluated on the basis of attendance, performance in theory and practical classes, submission of practical note book, unit tests, performance in remedial classes etc.

**Semester II : Full marks = 250 with 5 units (25 credit points).**

| Unit | Topic | Periods per week | Internal Assessment * | Theory | Practical | Full Marks | Credit points (Int.Assmt.+ Th+Pr) |
|---|---|---|---|---|---|---|---|
| BOT /ThGL/201 | Cell Biology | 5 | 10 | 25 | 15 | 50 | 5 (1+2.5+1.5) |
| BOT /ThGL/202 | Genetics | 5 | 10 | 25 | 15 | 50 | 5 (1+2.5+1.5) |
| BOT /ThGL/203 | Molecular biology | 5 | 10 | 25 | 15 | 50 | 5 (1+2.5+1.5) |
| BOT /ThGL/204 | Plant Physiology | 5 | 10 | 25 | 15 | 50 | 5 (1+2.5+1.5) |
| BOT /ThGL/205 | Biochemistry | 5 | 10 | 25 | 15 | 50 | 5 (1+2.5+1.5) |
| | Five units | Total 25 | Marks 50 | Marks 125 | Marks 75 | Total Marks 250 | Total credit 25 |

ThGL: Theory (general) + Laboratory

**FIRST SEMESTER**
**UNIT: BOT/ThGL/101:**
**Microbiology**
**(Theory 25 marks + Internal Asst.)**

1. **History of Microbiology:** Leeuwenhoek's Animalcules, Cell theory, Spontaneous Generation, Germ theory of Disease, Koch's Postulates.
2. **Microbial taxonomy:** Basis of bacterial classification: polyphasic approaches to bacterial taxonomy. Salient features of major bacterial groups according to Bergey's Manual of Systematic Bacteriology.
3. **Microbial growth, nutrition and control:**

Microscopy, Staining, Culturing Microorganisms: Obtaining a pure Culture, Preservation of microorganisms. Doubling time and growth rate, Phases of growth, Measurement of microbial growth, Continuous cultures of microorganisms, Different types of culture media, Factors affecting microbial growth, Nutritional types of microorganisms. Physical and chemical methods of controlling growth of microorganisms. Antibiotic resistance

4. **Concept on prokaryotic cells:** Structure and chemical composition of Gram + and Gram – bacterial cell wall, Passage of Molecules across microbial cell membrane; Archae: Characteristics, types and differences with eubacteria. Structure and functional characteristics of Actinomycetes and Mycoplasma.
5. **Nutrition and metabolisms of microorganisms**: Heterotrophy, chemoorganotrophy, chemolithotrophy, mixotrophy, and photoautotrophy.
6. **Virology:** Classification of viruses, Replication of viral nucleic acids; one step growth curve; lytic and lysogenic cycle.
7. **Enviromental Microbiology:** a) Soil Microbiology: Rhizosphere & Microbial flora, nitrogen cycle, biological nitrogen fixation-symbiotic and nonsymbiotic; Role of Phosphorus and Sulfur stabilizing bacteria, b)Air Microbiology: Microbial flora of air; c)Water Microbiology: Microbial flora of water, treatment of waste water

8. **Applied and Industrial Microbiology and Clinical Microbiology:**

a) Microbial fermentation and production of small and macro molecules.
b) Microbial diseases: Animal diseases; cholera, AIDS, hepatitis, giardiasis. Plant diseases; tungro virus of rice, potato scab by Streptomyces, Black leg of Potato by bacteria, Downy mildew of Grape.

## Practical: (15 marks)

1. Basic microbiological techniques: Light-Microscopy; use of oil-immersion objective, Preparation of media, sterilization, slant and stab preparation.

2. Cultivation of Microorganisms : on agar-slant/agar-plate;
a) Streak culture: Bacteria (Bacillus subtilis, Staphylococcus aureus, Escherichia coli);
b) Pure-culture: by streak-plate/pour plate methods.

3. Characterization of selected pure culture isolates by Gram staining, simple and negative staining, endospore staining and physio-biochemical features (extracellular enzymes, antibiotic sensitivity).

4. Determination of bacterial growth and growth kinetics by turbidometric and cell count method.

5. A) Microbiological examination of water: i) a) Presumptive test b) Confirmatory test c) Completed test: for coliform; ii) IMViC reactions.

B) Microbiological examination of milk by methylene-blue dye reduction test.

6. Isolation of antibiotic producing organism from soil and their sensitivity assay against standard laboratory strains of bacteria.

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**FIRST SEMESTER**
**UNIT: BOT/ThGL/102 :**
**Phycology**
**(Theory 25 marks + Internal Asst.)**

## 1. Introduction, Classification, Phylogeny and Evolution:

a. Range in thallus organization; Ultra-structure of algal cells; Reproduction and Phylogeny.

b. Parameters for classifying algae: Salient features of Cyanophyta (Cyanobacteria: classification, Heterocyst-ultra structure and biochemistry, nif gene);

Chlorophyta (Cell division pattern, ultra structure of flagella; classification and phylogeny); Heterokontophyta [Xanthophyceae, Bacillariophyceae : Ultra structure and developmental patterns of diatom frustules, Role of Frustule protein; Phaeophyceae] and Rhodophyta.

c. Glaucophyta : Characteristics features and phylogenetic significance

d. Dinoflagellates: Cell structure.

e. Concept of Streptophyta and algal origin of land plants.

g. Phylogeny & Evolution: Endosymbiotic origin of Chloroplasts; evolution of chloroplast in different algal groups; molecular markers for phylogenetic study.

## 2. Algal ecology and Economic importance :

a. Algae in diversified habitats-examples with different geographical locations; Eutrophication, Algal Blooms, Red-tides; Algal toxins.

b. Pheromone in algae and ecological implication

c. Mass production for industrial use: nutraceuticals, pharmaceuticals, biofuel, biofertilizer, Phycocolloids - agar-agar, alginic acid, carageenan; Diatomaceous earth; Single cell protein.

d. *Chlamydomonas reinhardtii* as a model system for molecular biology and genetics.

## Practical: (15 marks)

(i) Study on algal diversity: Staining, micrometry, microphotography, Identification of the representative specimen from Cyanophyta (Cyanobacteria), Chlorophyta, Phaeophyta and Rhoodophyta.

(ii) Field survey of Phytoplankton in different habitat and seaweed. Each candidate will submit 5 algal specimen with identification.

(iii) Identification with anatomical features of seaweeds.

(iv) Qualitative and Quantitative estimation of phytoplankton of different habitats.

(vi) Algal culture using defined media.

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**FIRST SEMESTER**

**UNIT: BOT/ThGL/103:**
**Mycology**
**(Theory 25 marks + Internal Asst.)**

**1. Fungi in living world:**

a. Introduction **:** Diversity of fungi and fungus-like organisms; evolution and phylogeny including systematics.
b. Physiology of Fungi : Growth - Factors affecting growth (Physical and Nutritional); Growth kinetics.
c. Reproduction of Fungi : Spore forms, molecular and biochemical changes accompanying sporulation, spore liberation, spore dispersal, spore dormancy and germination. Sex hormones in fungi; Patterns of life cycle.
d. Genetics of Fungi : Structure and organization of fungal genome, Mitosis and meiosis in fungi. Genetic control of asexual and sexual reproduction; extra-chromosomal inheritance in fungi.
e. Ecology of Fungi : Fungi in different ecosystems : saprophytes, parasites, predators and symbionts – Lichens and Mycorrhizae (A brief over-view)

**2. Fungi of Medical Interest** :

a. Mycoses ; Allergies of man and animal caused by fungi.

b. Mycotoxins and Mycotoxicoses, with special reference to Aflatoxins and Ergot alkaloids.

**3. Applied Mycology :**

a. Industrial application : Single cell protein, alcohol production, antibiotic production (penicillin), organic acids, enzymes and alkaloids (general account).

b. Application of Mycorrhizae : Mycorrhizal networking in plant community benefitting agriculture and forestry.

c. Mushrooms and Mushroom Cultivation : Edible and medicinal mushrooms; biological value of mushrooms, bioconversion of lingo-cellulosic wastes; Cultivation practices – pure culture, spawn production, compost and their preparation, techniques of cultivation of oyster and button mushrooms.

## MYCOLOGY

### Practical: (15 Marks)

1. Sterilization techniques and sterilizers.

2. Preparation of fungal culture medium , slant, stab and pouring of plates

3. Monosporous, Polysporous and fungal tissue culture; subculturing

4. Isolation of fungi from air, water and soil by culture plate technique.

5. Study of different type of spores.

6. Study on the effect of temperature and pH on spore germination and mycelia growth.

7. Studies on the morphological and reproductive structures of macro- and micro fungi : *Plasmodiophora, Albugo, Saccharomyces, Xylaria, Daldenia, Agaricus, Pleurotus, Volvariella, Clavaria, Puccinia, Auricularia, Fusarium, Alternaria, Colletotrichum, Cercospora, Curvularia, Cladosporium*

8. Study of fungal flora during field trip / Visit to Mushroom Cultivation Centre.

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**FIRST SEMESTER**
**UNIT: BOT/ThGL/104 :**
**Bryophytes & Pteridophytes**
**(Theory 25 marks + Internal Asst.)**

**BRYOPHYTES (Marks 10)**

**1.** General habit, habitat, global distribution, biogeography, growth forms, life forms and colonization.

**2. Outline of recent classification** (Goffinet & Shaw 2009) of bryophytes into three coordinate Phyla: Marchantiophyta (liverworts), Anthocerophyta (hornworts) and Bryophyta (mosses). Origin, evolution and fossil history of bryophytes.

**3.** Characteristics, affinities and systematic position of Calobryales, Takakiales and Sphagnales. Comparative study of the gametophyte and sporophyte of major groups with special reference to Indian bryodiversity.

**4. Role of bryophytes in ecology& ecosystem dynamics :**
Poikilohydry, desiccation tolerant, succession dynamicity, as pollution indicator and for biomonitoring; as phytoremediator.

5. Metabolic chemistry of bryophytes.

**PTERIDOPHYTES (Marks 15)**

**1. Origin of land plants, Classification & Evolution :** Adaptive features of pteridophytes for early colonization on land habit; Outline of systematic treatment of pteridophytes; molecular systematic and chemosystematic approach; Distribution of extant groups in time and space; evolutionary significance of the members: a) Rhyniopsida, b) Zosterophyllopsida, c) Trimerophytopsida and d) Early Lycopsids and Sphenopsids.

**2. Major Fern groups:** Distribution; Structure (study of shoot apex, leaf initiation and early leaf ontogeny in ferns, stomatal types and development; evolution of stele); Reproduction (origin and evolution of sporangium); Diversity of ferns in an ecological domain.

Characteristics and affinity of the members from the following orders:
a) Ophioglossales b) Marattiales c) Osmundales d) Filicales (generilsed form of Simplices, b) Gradatae and Mixtae types) e) Polypodiales; f) Gleichaniales.

**3. Ecological Perspective :** Diversity of ferns in an ecological domain; Heterospory and seed habit; Soral evolution in ferns, Salviniaceae; insect, microorganism interaction with pteridophyte; Endangered and Endemic pteridophytes and their conservation.

**4. Phytochemistry, Cytogenetic of Pteridophytes :** Biochemical aspects of gametophyte differentiation; antheridogens-chemical nature and mode of action; Determination of femaleness in free sporing; Heterosporous plants; Polyploidy, Apospory, Apogamy, Apomixis and genetic variability in fern population-genetic load.

## Practical: (15 Marks)

## BRYOPHYTE (Marks 5)

1. Workout on comparative morphology and anatomy of the gametophytes and sporophytes of different groups of Bryophytes: Marchantiales, Jungermanniales, Anthocerotales, Isobryales, Hypnobryales, Funariales, Pottiacles, Bryales & Dicranales (depending on availability of the specimen).

2. Workout on different types of peristome structure (Nematodonteae and Arthrodonteae) for classification of mosses.

## PTERIDOPHYTE (Marks 10)

1. Study of external and internal morphology of vegetative and reproductive structures (spore types, soral anatomy etc.) of the following species (depending on availability of species):

*Lycopodium, Selaginella, Equisetum, Drynaria, Lygodium, Diplopterygium, Dicranopteris, Phymatosorus, Oleandra, Nephrolepis, Asplenium, Blechnum, Adiantum, Pteris, Glychaenia, Cyathea/Alsophila/Hemitelia, Christella, Microsorum, Phymatosorus, Ophioglossum* and *Salvinia.*

2. External morphological features of the following taxa:

*Psilotum/Tmesipteris, Isoetes coromandelina, Ophioglossum, Schizaea, Marattia, Cibotium, Ceratopteris, Acrostichum, Dryopteris, Cheilanthes, Woodwardia* and *Onychium.*

**Field trip to different ecological terrain for submission of 4 specimen only (keeping in mind the importance of Biodiversity & Conservation of different species) from Bryophytes and Pteridophytes.**

**FIRST SEMESTER**

**UNIT: BOT/ThGL/105:**
**Gymnosperm, Palaeobotany and Palynology**
**(Theory 25 marks + Internal Asst.)**

**A. GYMNOSPERMS:** (**Marks 10**)

Classification and economic importance. General account on the morphology, anatomy and reproduction of the following groups:

i) **Glossopteridales**- with special reference to Indian members; concept of angiosperm ancestor,

ii) **Cycadales**- with special reference to distribution of extant members; origin and evolution of leaves and megasporangiate fructification, Molecular phylogeny.

iii) **Coniferales** with special reference to Indian distribution; origin and evolution of seed-cone complex.

v) **Gnetales**. with special reference to distinction among the groups and molecular phylogeny.

**B. PALEOBOTANY (Marks 8)**

**a. Geologic time scale, Fossils and fossilization process:** Types, nomenclature, Techniques for studying fossil plants (ground thin section, peel technique, transfer technique and microfossil analysis), Importance and significance.

**b. Radiometric dating:** Principle and application of Relative and Absolute dating ($C^{14}$, Argon and Uranium dating).

**c. Continental drift hypothesis and Plate Tectonics**- concept, evidences, mechanism.

**d. Indian Gondwana system**- 3-fold division, megafloristic assemblages.

**C. PALYNOLOGY:** (**Marks 7**)

a. **Concept :** Symmetry; Polarity; Shape, classes; Sporoderm stratification, sporoderm ornamentation, Extraexinous wall material; NPC classification, LO analysis; Sporopollenin: physical and chemical nature, function; Pollen wall proteins, chemical markers of exine and intine.

b. **Application** : Palynology in oil exploration, Honey analysis and in detection and diagnosis of pollen/spore allergy.

## Practical : (15 Marks)

1. Study of Vegetative and reproductive structure of representative member of Cycadales, Coniferales and Gnetales and others depending on availability: (For eg. *Cycas, Zamia, Pinus, Cedrus, Cupressus, Cryptomeria, Thuja, Araucaria, Cephalotaxus, Encephalartos, Tsuga, Taxodium, Ginkgo, Cunninghamia, Callitris, Cedrus, Podocarpus, Juniperus, Cryptomeria, Gnetum, Ephedra* and *Welwitschia).*

2. Study of gymnosperm fossils (slide and megafossils).

3. Pollen morphological study of different plant taxa.

4. Pollen slide preparation (temporary and permanent).

5. Study of Pollen in honey sample.

6. Analysis of peat samples.

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## Proposed Syllabus for M.Sc in Botany

## Semester II :

## Full marks = 250 with 5 units (25 credit points including Practical).

| Unit | Topic | Periods per week | Internal Assessment * | Theory | Practical | Full Marks | Credit points (Int.Assmt.+ Th + Pr) |
|---|---|---|---|---|---|---|---|
| **BOT/ThGL/201.** | **Cell Biology** | 5 = 2 (Th) + 3 (Pr) | 10 | 25 | 15 ( 3pds) | 50 | 5 (1+2.5+1.5) |
| **BOT/ThGL/202.** | **Genetics** | 5 = 2 (Th) + 3 (Pr) | 10 | 25 | 15 ( 3pds) | 50 | 5 (1+2.5+1.5) |
| **BOT/ThGL/203.** | **Molecular Biology** | 5 = 2 (Th) + 3 (Pr) | 10 | 25 | 15 ( 3pds) | 50 | 5 (1+2.5+1.5) |
| **BOT/ThGL/204.** | **Plant Physiology** | 5 = 2 (Th) + 3 (Pr) | 10 | 25 | 15 ( 3pds) | 50 | 5 (1+2.5+1.5) |
| **BOT/ThGL/205.** | **Biochemistry** | 5 = 2 (Th) + 3 (Pr) | 10 | 25 | 15 ( 3pds) | 50 | 5 (1+2.5+1.5) |
| | **5 units** | Total 25 10 (Th) + 15 (Pr) | Marks 50 | Marks 125 | Marks 75 | Total Marks 250 | Total credit 25 |

*** One practical period = 3 hrs duration in each day. Therefore, 3 practical classes one for each of 201, 202, 203, 204 & 205. Total 5x3=15 Practical Classes per Week.**

**SECOND SEMESTER**
**UNIT: BOT/ThGL/201**
**CELL BIOLOGY**
**(Theory 25 marks + Internal Asst. 10 = Total 35 marks + 15 for Practical, Total=50marks)**

**1. Prokaryotic cell & Eukaryotic cell and their compartmentalization**.

**2. Cell Structure and Function:**
Extracellular matrix: biochemical composition and function (cell-matrix interaction); The Plasma membrane: biochemical composition, molecular organization (Phospholipid & Glycolipid composition, Fluid mosaic model) and function (ion uptake) and mobility
Cytoskeleton: microtubule structure, assembly and function (chromosome movement), The Nucleus: The nuclear envelope and nuclear pore complex — ultrastructure and function (traffic between the nucleus and the cytoplasm),
Nucleolus: ultrastructure and function (ribosome biogenesis),
Chromosomes: biochemical composition, molecular organization (nucleosomes and higher-order structures) and its regulation (role of histone modification); Centromere — types, kinetochore, molecular organization and function; Telomere — molecular organization and function,
Mitochondria: ultrastructure, genome, protein import and function (oxidative phosphorylation);
Chloroplasts: ultrastructure, genome, protein import and function (photophosphorylation), Endoplasmic reticulum: ultrastructure and function (protein folding and processing), Lysosomes: ultrastructure and function (phagocytosis) and other intracellular organalles.

**3. Cell cycle & Regulation:**
Overview on eukaryotic cell cycle-phases, Control mechanisms: role of cyclins and cyclin-dependent kinases; checkpoints and role of MPF; Apoptosis and programmed cell death: events and role of caspases; Cancer cell — properties and causes (oncogenes).

**4. The Origin and Evolution of Cells:**
The First cell; Origin of eukaryotes; Development of multicellular organisms;
Theories of organic evolution- Mutation theory, Synthetic theory; Evolution at molecular level- Rates of Molecular Evolution; Molecular Clock, Genome Evolution, Evolution of proteins, Evolution of nucleotide sequences; Speciation- Biological Species Concept, Reproductive Isolating Mechanisms, Modes of Speciation, Genetic Differentiation Associated with Speciation.

**SECOND SEMESTER**
**UNIT: BOT/ThGL/202**
**GENETICS**
**(Theory 25 marks + Internal Asst. 10 = Total 35 marks + 15 for Practical, Total=50marks)**

**1. Extension of Mendelism and Gene Interaction:**

Allelism; Gene-environment interactions; Penetrance and Expressivity; Epistasis; Pleiotropy; Continuous and Discontinuous Variations; Complementation test for alleles, Sex Determination and Sex-Linked Characteristics; Sex chromosomes.

**2. Linkage, crossing over and gene mapping:**

Linkage, crossing over; Molecular mechanism of recombination; chromosome mapping; three-point test cross, construction of genetic and physical map; Haploid mapping (tetrad analysis), LOD score, QTL mapping.

**3.Transposable elements:** Different types, importance. Ac-Ds, IS elements, P-elements and their significance.

**4. Mutation:** Basic concept & types; spontaneous and induced mutations; Luria Delbruk fluctuation test; physical and chemical mutagens; Chromosome Mutation: Numerical changes, Rearrangement of chromosome structure; Gene Mutation: Molecular basis of gene mutation, Ames test; Transposon mutagenesis, site-directed mutagenesis, environmental mutagenesis, *in vitro* mutagenesis, DNA damage and repair mechanism.

**5. Population Genetics-** Definition of populations, Allele frequency in a population, Genetic equilibrium, Hardy-Weinberg principle, barriers to gene flow and mechanism of speciation; Using highly polymorphic DNA sequences in DNA typing, Inbreeding and genetic consequences of self-pollination in plants.

**SECOND SEMESTER**
**UNIT: BOT/ThGL/203**
**Molecular Biology**
**(Theory 25 marks + Internal Asst. 10 = Total 35 marks + 15 for Practical, Total=50marks)**

1. **Structure of nucleic acids:** Details of chemistry of DNA molecule, Double helical structure, Conformation & Stability; Sugar puckering; Coiling & Packaging; Non-Watson pairing; Different forms of DNA: A,B,Z; their physical properties; Denaturation kinetics of DNA; Cot curves and their significance. Detailed 2D & 3D structure of RNA; Different types of RNA; RNA as genetic material.

2. **Perpetuation of genome:** The central dogma of molecular biology: Overview of replication, transcription, translation and reverse transcription. Structure and organization of genome: prokaryotic and eukaryotic. Organization and function of cpDNA and mtDNA, Role of genomic DNA, mitochondrial genome and chloroplastidal genome in Bar coding for Biodiversity study & Evolution; Mitochondrial DNA and male sterility.

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3. **Replication:** Brief account of DNA replication in prokaryotes. Semi conservative mode of replication, Differences in prokaryotic & eukaryotic replication. 6. Enzymes involved in DNA replication. DNA polymerase in prokaryotes (I, II, III) & eukaryotic DNA polymerases (α, € and $), Ligases. Primosome and Replisome.

4. **Transcription and regulation of gene expression**: Classical and modern concept of the gene. General features of transcription in Prokaryotes & Eukaryotes. Promoters and Transcription factors. Brief study of regulation of gene expression in prokaryotes (Lac-operon, Arabinose operon) and eukaryotes (promoters, transcription factors and enhancers); RNA processing in Eukaryotes (splicing, capping and polyadenylation). Regulation of transcription by noncoding RNA.

5. **Genetic code and Translation:** Salient features of Genetic Code. Codon assignment. Genetic code of mitochondria. Structure and role of tRNA as translational adapter. Structure of ribosome. Translation and factors involved in translation.

6. **DNA repair and Recombination:** Physical and chemical agents causing DNA damage and DNA methylation; Survival curve as evidence of repair. Reversal of UV damage in prokaryotes: photoreactivation, base excision and nucleotide excision repair, post replication repair, mismatch repair, SOS response. Homologous recombination (Holiday structure : RecBCD system); gene conversion; site specific recombination (lambda).

**SECOND SEMESTER**
**UNIT: BOT/ThGL/204**
**PLANT PHYSIOLOGY**
**(Theory 25 marks + Internal Asst. 10 = Total 35 marks + 15 for Practical, Total=50marks)**

1. **Phytosynthesis:** Light harvesting complexes; Bioenergetics of light reaction; mechanisms of electron transport; photoprotective mechanisms; $CO_2$ fixation-$C_3$, $C_4$ and CAM pathways.

2. **Respiration:** Glycolysis and Acetyl COA synthesis & control; Citric acid cycle and its regulation; plant mitochondrial electron transport, oxidative phosphorylation, Proton gradient and ATP synthesis; structure of ATP synthase in mitochondria; alternate oxidase; photorespiratory pathway; Gluconeogenesis; Glyoxylate cycle.

3. **Phyto-hormones:** Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action of Auxin, Gibberellins, Cytokinins, Ethylene and ABA, Brassinosteroid and Jasmonates.

4. **Developmental physiology :**
   i. **Sensory photobiology:** Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks.
   ii. **Physiology of Senescence & Aging**: Senescence promoter, Whole plant & organ senescence; Environmental control on senescence.
   iii. **Dormancy & Germination:** Types of dormancy; seed viability; dormancy enforcement and termination, biochemical and molecular basis of dormancy, hormonal regulation of dormancy and germination, circadian clock and germination control.

5. **Solute transport and photoassimilate translocation**: Uptake, transport and translocation of water, ions, solutes and macromolecules from soil; Ion transporter-types, structure and function, through cells, across membranes, through xylem and phloem; transpiration; mechanisms of loading and unloading of photoassimilates.

6. **Stress physiology:** Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses. LOX system for biotic and abiotic stress; Reactive oxygen species: formation, role and scavenging.

7. **Cell signaling:** Hormones receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, and regulation of signaling pathways, light signaling in plants.

**SECOND SEMESTER**
**UNIT: BOT/ThGL/205**
**BIOCHEMISTRY**
**(Theory 25 marks + Internal Asst. 10 = Total 35 marks + 15 for Practical, Total=50marks)**

**1. Macromolecules:**

i. **Carbohydrates:** Simple and conjugated sugars, nomenclature; structure; stereochemistry – Fischer projection, Haworth perspective, boat and chair conformation; mutarotation; glycoside formation; Derivative sugar; glycoproteins and proteoglycans.
ii. **Protein :** Hierarchy of protein structure, motifs and domains, torsion angle and Ramachandran plot, Forces stabilizing protein structure, fibrous proteins (keratins and collagen), globular protein; Protein folding: Leventhal paradox; Different models of Protein folding and concept of chaperones;
iii. **Lipid:** simple and conjugated lipid, different neutral & polar classes of membrane lipid, nomenclature of different fatty acids.

**2. Enzymology and metabolism:**
Enzyme activity and specificity, Constitutive and Induced enzymes; Active site, Activation energy, Reaction rate, Mechanism of action, Enzyme Kinetics; Derivation of Michaelis Menten equation; Lineweaver Burke plot; Multiple substrate reaction mode Enzyme inhibition: Reversible, irreversible with one example in each case.

3. **Nitrogen metabolism:** Structure and function of nitrogenase, Mechanism of nodule formation; Nitrate and ammonium assimilation; amino acid biosynthesis (all families).

4. **Lipid metabolism:** Biosynthesis and oxidation of fatty acids, regulation of FAS, Phospholipid synthesis and sterol synthesis.

5. **Protein synthesis:** Ribosomes; Mechanism of translation.

6. **Functional Genomics, Proteomics & Metabolomics :**
Preliminary concepts: BLAST, EST, SAGE; Sequencing, alignment and reconstruction for phylogenetic study; analysis of differential expression of gene, NIST library for structural identity of molecules etc.; Lipidomics concept.

## Combined experiments of unit BOT/ThGL/ 201, 202 & 203

**(Cell Biology, Genetics & Molecular Biology)**
**PRACTICAL EXPERIMENTS : FULL MARKS 45 (15+15+15)**
**[Experiment demonstration 30 + viva 15] = 45 (Credit 4.5);**
**[9 periods per wk].**

**1. Different types of Microscopes and application in Cell Biology: (Demonstration in laboratory and through internet; Questions for viva)**

Light microscopy: Fluorescence, Dark field and Phase-contrast microscopy; Electron microscopy: scanning, transmission; Atomic Force and Confocal microscope.

**2. Plant Chromosome study: (from two plant sources)**

i. Pre-treatment, Fixation, Preparation of stains

ii. Mitotic chromosomes preparation and staining, observation on different stages under light microscope; Calculation of Mitotic Index of the given sample and karyotyping.

iii. Meiotic chromosomes preparation and observation of different stages under light microscope.

iii. Treatment of chromosome with toxic chemicals and observation on abnormalities.

**3. Nucleolus staining with hematoxylin and study under light microscope.**

**4. Study on Nucleic acid:**

i. Isolation of Plasmid DNA (from plasmid-bearing strains of *E.coli*).

ii. Isolation of genomic DNA from plant (from young leaves).

iii. Spectrophotometric determination of concentration and purity of DNA.

iv. Comparative analysis on electrophoretic separation of plasmid DNA and plant Genomic DNA,

v. Estimation of DNA content (from synthetic/plant sample) through DPA method.

vi. Estimation of RNA content (from synthetic/plant sample) through Orcinol method.

vii. Denaturation profiling of DNA and Determination of tm value.

## Combined experiments of unit BOT/ThGL/204 & 205.

**(Plant physiology & Biochemistry)**
**PRACTICAL EXPERIMENTS: FULL MARKS 30**
**[Experiment demonstration 20 + viva 10] = 30 (Credit 3.0);**
**[6 periods per wk].**

**A. Studies on Photosynthesis & Respiration:**

1. Extraction of Chlorophyll content by solvent system and spectrophotometric quantification from Leaf tissues of two different plants.

2. Demonstration of Hill Reaction.

3. Application of promoters and inhibitors on the rate of aerobic respiration.

**B. Study of enzymes from plant systems:**

1. Enzyme kinetics: Determination of Vmax, Km values on Urease activity (from synthetic Urease) and its expression by Lineweaver-Burk plot by double reciprocal transformation.

2. Assay and effect of promoter and inhibitor on Urease activity.

3. Assay for nitrate reductase in leaf tissues.

**C. Analysis on Macromolecules:**

1. Protein Analysis:

i. Separation of amino acids from a synthetic mixture by TLC and staining by Ninhydrin.

i. Extraction of Protein from plant leaves by precipitation method.

i. Preparation of Standard curve by Bradford's reagent with BSA.

ii. Estimation of extractable protein from leaves by the method of Bradford.

iii. Separation of proteins by polyacrylamide gel electrophoresis and determination of approximate MW.

2. Lipid analysis:

i. Extraction of lipid from mustard oil seeds.

ii. Chromatographic separation by TLC, iodine treatment and calculation of Rf.

**D. Study on Hormone:**

i. Colorimetric estimation of IAA by Salkowaski reagent