

# Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.



Curriculum under Credit Based Grading System

## M.Sc. Botany

### Semester-I & II

Run at college level from the Academic Year 2015-2016

### Course Structure

Sr. No.	Course No.	Title of the Course	Hrs	Credits Allotted	Theory				Practical	
					internal	External	(Maximum)	Minimum	Maximum	Minimum
<b>Semester I</b>										
01.	<b>BOT 401</b>	Cell Biology	08	4T + 2 P	20	80	100	40	50	20
02.	<b>BOT 402</b>	Molecular Biology	08	4T + 2 P	20	80	100	40	50	20
03.	<b>BOT 403</b>	Biology and diversity of Virus, Phytoplasma, Bacteria, algae and fungi	08	4T + 2 P	20	80	100	40	50	20
04.	<b>BOT 404</b>	Taxonomy of Angiosperms	08	4T + 2 P	20	80	100	40	50	20
05		Seminars and Tutorial	03	3T	--	--	--	--	--	--
<b>Total</b>					<b>27 Credits</b>					
<b>Semester II</b>										
06.	<b>BOT 405</b>	Cytology and Genetics	08	4T + 2 P	20	80	100	40	50	20
07.	<b>BOT 406</b>	Plant development and reproduction	08	4T + 2 P	20	80	100	40	50	20
08.	<b>BOT 407</b>	Biotechnology	08	4T + 2 P	20	80	100	40	50	20
09.	<b>BOT 408</b>	Plant Physiology and Metabolism	08	4T + 2 P	20	80	100	40	50	20
10		Seminars and Tutorial	03	3T	--	--	--	--	--	--
<b>Total</b>				<b>27 Credits</b>						

## **Semester I**

### **BOT 401: Cell Biology**

**Unit I.** Prokaryotic and eukaryotic Cell: The ultra-structural details and comparative assessment.

**Unit II** i. Plasma membrane: Molecular organization, current models and functions. Cell wall architecture, biosynthesis, assembly, growth and cell expansion.

ii Plasmodesmata: Structure and role in movement of molecules and macromolecules.

**Unit III.** i. Cytoskeleton: Organization and role of microtubules and microfilaments. Implications in flagellate and other movements.

ii. Plant vacuole: Tonoplast membrane, ATPases, transporters, as storage organelle.

**Unit IV.** Chloroplast and Mitochondria: Ultrastructure, function and biogenesis. The organization of genome and patterns of gene expression.

**Unit V.** Nucleus: Microscopic and submicroscopic organization. Structure and function of nuclear Envelope. The ultrastructure of nucleolus and its role in rRNA biosynthesis.

**Unit VI.** Ribosomes: Structure and site of protein synthesis. Mechanism of translation, details of initiation, elongation and termination. The structure and role of RNA.

### **Practical's based on Bot-401**

1. To determine mitotic Index in different plant materials.
2. Karyomorphological studies from slide/photograph.
3. Induction of mitotic abnormalities through chemical treatment.
4. Determination of chiasma Frequency in plants.
5. Fluorescence staining with FDA for cell viability and cell wall staining with calcoflour.
6. Demonstration of-SEM and TEM organelles.
7. Demonstration of acid phosphataes and succinic dehydrogenase activity in plants. 8.
8. Localization of nuclear DNA by using Feulgen as a DNA specific stain.

## **BOT-402**

### **Molecular Biology**

**Unit I. Cell signaling:** Signal transduction, signaling pathways, second messengers, cAMP, genetic disorders ; due to the G protein defect. Lipid derived second messengers. Receptor tyrosine kinase and signaling pathway. Molecular biology of signaling.

**Unit II. Other cellular organelles:** Structure and functions of micro bodies, Golgi apparatus, Lysosomes and Endoplasmic reticulum.

**Unit III. Protein sorting:** Targeting of proteins to organelles. Translocation of secretory proteins across the ER membrane. The post translational modifications in RER.

**Unit IV. Cell Cycle and its molecular aspects:** Control mechanism, the role of cyclin and cyclin dependent kinases, Retinoblastoma and E<sub>2</sub>F proteins. Cytokinesis and cell plate formation. Mechanism of programmed cell death (Apoptosis) and Senescens.

#### **Unit V. Molecular Cytogenetics**

- **Nuclear DNA Content:** The C-value paradox, the COT value curve & its significance
- **Restriction mapping:** Concept and techniques, multigene families and their evolution.
- Computer assisted chromosome analysis, chromosome micro-dissection and micro cloning.

**Unit VI. Laboratory Techniques:** Microscopy, SEM & TEM, Ultracentrifugation, fractionation, Electrophoresis, PCR, GISH, FISH and Immunochemical techniques. The flow cytometry and confocal microscopy in karyotype analysis.

#### **Practicals based on BOT-402**

1. Demonstration of native and SDS PAGE profiles of seed proteins.
2. Isolation of plant DNA and its quantitation by spectrophotometric method.
3. Isolation of DNA and preparation of Cot curve.
4. Restriction digestion of plant DNA, its separation by agarose gel electrophoresis and visualization by ethidium bromide staining.
5. Isolation of RNA and its quantitation by spectrophotometric method.
6. Separation of plant RNA by agarose gel electrophoresis and visualization by ethidium bromide staining,
7. Demonstration of Western blotting.
8. Estimation of seed proteins by Lowry's method.

## **BOT 403 (Biology and Diversity of Algae, Fungi and microbes)**

### **UNIT- I. Algae:**

- Introduction of phycology with special reference to Indian work.
- Algae in diversified habitats (Terrestrial, fresh water, marine)
- Criteria used in classification of algae, pigments, reserve food and flagella; and important systems of classification of algae.
- A general account of thallus organization, reproduction and life history of algae.
- Study of important groups of algae with reference to General account, cell structure and method of reproduction in
  1. Cyanophyta - *Nostoc and Oscillatoria*.
  2. Chlorophyta- salient features of Volvocales, Oedogonials and zygnematales (Desmids)
  3. Xanthophyta - *Botrydium, vaucheria*.
  4. Bacillariopyta - *Diatoms*.
  5. Phaeophyta - *Ectocarpus*.
  6. Rhodophyta - *Batrachospermum*. - Algal blooms, Role of Algae in human welfare, bio fertilizer.

### **UNIT- II. Fungi:**

- General Characters, Classification.
- Economic importance of fungi in medicine, Agriculture (Biopesticide and biofertilizer), food (SCP. Mushrooms)
- Fungi as plant pathogen
- General account of different groups and type study of fungi as pathogen.
  1. Mastigomycotina - *Phytophthora, albugo*,
  2. Zygomycotina – *Rhizopus*,
  3. Ascomycotina – *Claviceps, Erysiphae*,
  4. Basidiomycotina – *Puccinia, Ustilago*,
  5. Deuteromycotina – *Alternaria, Fusarium, Cercospora, Helminthosporium*.

### **UNIT- III. Bacteria:**

General characters, ultrastructure, classification, Koch's postulates, archaeobacteria and eubacteria.

- Role of agrobacterium in GM crops.

- Citrus canker.
- Angular leaf spot of cotton.

#### **UNIT- IV. Phytoplasma:**

General Account, ultrastructure and economic importance of Grassy shoot of sugarcane. of Little leaf of brinjal.

**UNIT- V. Viruses:** General account, ultrastructure and economic importance of viruses.

- TMV - Papaya leaf curl.

### **Practicals: Based On BOT 403**

#### **(Biology and Diversity of Algae, Fungi and microbes)**

##### **Algae:**

01. Collection and study of algae from different localities, Identification up to generic level.
02. Morphological study of algal forms: *Microcystis*, *Oscillatoria*, *Lyngbya*, *Nostoc*, *Anabaena*, *Scytonema*, *Tolypothrix*, *Rivularia*, *Gloeotrichia*, *Cathrix*, *Chlamydomonas*, *Pandorina*, *Eudorina*, *Volvox*, *Hydrodictyon*, *Scenedesmus*, *Pedestrium*, *Ulothrix*, *Ulva*, *Odeogonium*, *Cladophora*, *Pithophora*, *Draparnaldia*, *Draparnidiopsis*, *Coleochaete*, *Cosmarium*, *Closterium*, *Caulerpa*, *Acetabularia*, *Chara*, *Nitella*, *Botrydium*, *Vaucheria*, *Pinnularia*, *Navicula*, *Fragillaria*, *Ectocarpus*, *Dicliyota*, *Fucus*, *Batrachospermum*, *Polysiphonia*, *Corallina*.

##### **Fungi and microbes:**

01. Principle and working of instruments.
02. Preparation of Media, strains and Isolation of Bacteria and Fungi from soil and infected plant tissues and pure culture.
03. Gram staining of bacteria.
04. Morphology and Taxonomy of following fungi - *Albugo*, *Phytophthora*, *Mucor*, *Rhizopus*, *Plasmopara*, *Sclerospora*, *Taphrina*, *Phyllochora*, *Claviceps*, *Chaetomium*, *Puccinia*, *Ustilago*, *Sphacelotheca*, *Agaricus*, *Potyporus*, *Volveriella*, *Cyathus*, *Lycoperdon*, *Geaster*, *Alternaria*, *Aspergillus*, *Penicillium*, *Helminthosporium*, *Cercospora*, *Curvularia*, *Fusarium*, *Rhizoctonia*,

*Coltetrachutn, Phoma.*

05. Growth of Fungi on liquid and solid media — *Fusarium* and *Helminthosporium*.
06. Study of bacterial plant diseases - Citrus canker, Angular leaf spot of cotton, soft rot of fruits.
07. Study of Phytoplasma diseases - Little leaf of brinjal, Sesamumphylloidy, Grassy shoot of sugarcane.
08. Study of viral plant diseases - Papaya mosaic, Tomato leaf curl, Yellow vein mosaic of Bhindi.
09. Collection and submission of fungal, viral, phytoplasma and bacterial diseases of plants.

**BOT 404**  
**(Taxonomy of Angiosperms)**

**UNIT- I: Angiosperms:**

Definition, its characteristic features and probable causes of their evolutionary success.

**Taxonomy:** Definition, scope, principles, aims and objectives of taxonomy. History of Botanical Explorations in Maharashtra with special reference to Marathwada.

**UNIT- II: Phylogeny of Angiosperms:**

A general account of origin of Angiosperms with reference to time and place and possible ancestors: euanthial theory (Bennettitales, Caytoniales, Cycadales) and pseudanthial theory (Pentoxylales, Glossopteridae).

**UNIT- III: Criteria used for classification;** phases of plant classification and brief history on account of artificial, natural, phylogenetic systems of classifications with special reference to Bentham and Hooker, Cronquist's system, Takhtajan's system and Broad outline of APG III (2009) system of classification and its merits and demerits.

**UNIT-IV: Botanical Nomenclature:**

Concept of nomenclature, Binomial nomenclature and its advantages, formation of code, Melbourne Code 2011, Principles of International Code of Nomenclature of Algae, Fungi and Plants (ICN), ending of taxa names, Typification. Taxonomic literature: Flora, manuals, monographs, periodicals, dictionaries, indices, journals, pictorial encyclopedias and books.

**UNIT-V: Taxonomic evidences:**

Morphology, anatomy, embryology, palynology, cytology, phyto- chemistry and numerical taxonomy.

Taxonomic tools: Serological and molecular techniques, GIS, GPS, Use of computers in angiosperms taxonomy (Use of computer and data bases for identification of plants with the help of website).

Herbarium Techniques, Major herbaria of the World and India. Contributions of Herbarium BAMU.

**UNIT-VI:** Causes of variations in population; Speciation, Species Concepts; Taxonomic Hierarchy.

**UNIT-VII: Angiosperm Families:** Nymphaeaceae, Hydatellaceae, Magnoliaceae, Papaveraceae, Malvaceae, Sapotaceae, Apiaceae, Asteraceae, Arecaceae and Poaceae.

## **Practicals Based on BOT-404**

### **TAXONOMY OF ANGIOSPERMS**

1. Morphology: Terminologies related to Habit and life span, root, stem, leaves, inflorescence, Flower, fruits.
2. Phytography: preparation of scientific botanical description of a plant specimen.
3. Study of at least 20 locally available families of flowering plants.
4. Identification of genus and species of locally available wild plants.
5. Preparation of botanical keys at generic level by locating key characters.
6. Knowledge of at least 10 medicinal plant species.
7. Demonstration of the utility for secondary metabolites in the taxonomy of some appropriate genera.
8. Field trips within and around the University Campus, compilation of field notes and preparation of herbarium sheets of plants.
9. Botanical excursion of about one week duration to any botanically rich location preferable outside the State.

## **Semester – II**

### **BOT 405 Cytology and Genetics**

#### **Unit I. Chromatin organization:**

- i. Chromosome structure and packaging of DNA.
- ii. Nucleosome organization, DNA Structure (A, B and Z forms)
- iii. Organization of centromere and telomere.
- iv. Karyotype analysis and the banding patterns.
- v. Special types of chromosomes- Polytene, Lampbrush, B-chromosome and sex chromosomes.
- vi. Molecular basis of chromosome pairing.

#### **Unit II. Structural and Numerical alterations in chromosomes:**

- i. The origin, meiosis and breeding behaviour of duplication, deficiency, inversion, translocation heterozygotes, haploids, aneuploids and autopolyploids. \
- ii. The allopolyploids and evolution of major crop plants.

#### **Unit III. Mutation:**

- i. Spontaneous and induced mutations.
- ii. Physical and chemical mutagens.
- iii. Molecular basis of gene mutations.
- iv. Transposable elements and mutation induced by transposons.
- v. Site directed mutagenesis.

#### **Unit IV. DNA damage and repair mechanism.**

- i. DNA damage and repair mechanism.
- ii. Initiation of cancer at cellular level.
- iii. Proto-oncogenes and oncogenes.

#### **Unit V. Cytogenetics of aneuploids and structural heterozygotes:**

- i. Effect of aneuploids on plant phenotypes.
- ii. The use of monosomics and trisomics in chromosome mapping of diploid and polyploid species. The breeding behavior and genetics of structural heterozygotes.
- iii. The complex translocation heterozygotes.
- iv. Robertsonian translocation. vi. B-A translocation.

#### **Unit VI. Genetics of prokaryotic and eukaryotic organelles:**

- i. Phage and Bacterial Genetics —mapping of the bacteriophage genome, genetic recombination in phage, transformation, transduction and conjugation in bacteria
- ii. Genetics of mitochondria and chloroplast, cytoplasmic male sterility.
- iii. Gene fine structure.
- iv. Cis-trans test, introns and their significance, RNA splicing.
- v. Regulation of gene expression in prokaryotes and eukaryotes.

## Practical Based on 405

1. Induction of polyploidy in plants using colchicine. Different methods of application of colchicine.
2. Isolation of biochemical mutants following physical and chemical mutagenic
3. Isolation of chlorophyll mutants following physical and chemical mutagenic treatments.
4. Isolation of morphological mutants following physical and chemical mutagenic treatments.
5. Karyotype analysis in any two plant species.
6. Meiosis of complex translocation heterozygotes.
7. Meiotic behaviour of monosomy in plants & its effect.
8. Meiotic behaviour of trisomy in plants and its effect.
9. Mitotic/ meiotic chromosomal behaviour in mutagen treated materials.
10. Orcein and Feulgen staining of the polytene chromosomes of Chironomus.
11. Study of chromosome pairing and disjunction in translocation heterozygote.
12. Utilization of banding technique for identification of chromosomes in karyotype.

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# **BOT 406 Plant Development & Reproduction**

## **Plant Development**

### **Unit I.**

- i. **Meristems:** Organization of shoot and root apical meristem, various theories, Cytological and Molecular analysis of SAM, control of tissue differentiation especially Xylem and Phloem.
- ii. **Tissue systems:** Differentiation and functions of different tissue systems such as epidermis, parenchyma, chlorenchyma, sclerenchyma, laticifers and glands.

### **Unit II.**

**Vascular tissues:** Origin, structure and functions Xylem and Phloem elements and their taxonomic significance, Wood development in relation to Environment.

### **Unit III.**

- i. **Leaf:** Growth and differentiation, differentiation of epidermis (with special reference to stomata and trichomes) and mesophyll.
- ii. **Root:** Initiation and development; lateral roots, root hair, root microbe Interaction.

## **Plant Reproduction**

### **Unit IV.**

- i. **Flower:** Structure and development
- ii. **Pollination:** Types of pollination, attractions and rewards of pollination, pollination mechanism and vectors, breeding systems, structure of pistil, pollen interaction and fertilization.

### **Unit V.**

- i. **Male gametophyte:** Structure of anthers, micro-sporogenesis, role of tapetum, male sterility, pollen germination, pollen tube growth and development, pollen storage, pollen allergy, pollen embryos.
- ii. **Female gametophyte;** Ovule development, megasporogenesis, organization of the embryo sac. Structure of the embryo sac.

### **Unit VI.**

- i. **Seed development and fruit growth:** Double fertilization, Endosperm development, Embryogenesis, Ultra-structure and nuclear cytology; Development of dicot and monocot embryos, poly-embryony, apomixes, embryo culture.

### **Practicals Based on BOT-406**

1. Dermatology - trichomes and stomata and leaf anatomy of Nerium, Terminalia etc.
2. Mechanical tissues (Collenchyma, Sclerenchyma, Stone cells and Xylem) , Secretary tissues (Mucilage Canals, Resin canals, Nectaries, and oil glands), laticifers (Latex cells and Vessels).
3. Vascular tissues and its constituents by sections and maceration, wood anatomy, TS, TLS and RLS
4. Abnormal secondary growth in Dracaena, Bignonia, Aristolochia, Achyranthus, Nyctanthus, Salvadora, Beta, Mirabilis, Tinospora.
5. Study of microsporogenesis and gametogenesis in sections of anthers.
6. Examination of modes of anther dehiscence and collection of pollen grains for
7. Microscopic examination (maize, grasses, Croton, Tradescantia, Brassica, Petunia, Solanum etc.)
8. Test for pollen viability using stains and in vitro pollen germination using hanging drop and sitting drop cultures, suspension culture and surface culture.
9. Estimation of percentage and average pollen tube length in vitro
10. Pollen storage, pollen pistil interaction, in vitro pollination.
11. Study of ovules and embryo sacs.
12. Field study of types of flowers and pollination mechanism. .
13. Study of nuclear and cellular endosperms.

## **BOT 407 Biotechnology**

**Unit I. Biotechnology:** Basic concept, Historical, principles of tissue culture, Cellular totipotency, Discoveries of Plant Growth hormones in brief review, Contribution of Sir Gottlieb Haberlandt, Development of Tissue culture as a technique, Scope and Importance.

**Unit II. Introduction to tissue culture:** Tissue culture laboratory, Equipment's in Tissue culture laboratory, Preparation of Media, Media composition, Plant Growth Regulators and their Role, selection of media for specified applications, Selection of explant, Sterilization, Sterilizing agents, initiation of tissue culture

**Unit III. Cellular totipotency:** Media for initiation of callus, dynamics of callus growth, measurement of growth, organogenesis and factors controlling it, genome instability in reaction to morphogenesis, somaclonal variation and its applications.

**Unit IV. Cell and organ culture:** Plant organ culture; shoot tip, shoot apical meristem, root, leaf, flower and ovary culture, embryo rescue, factors influencing embryogenesis, suspension culture in stationary and stirred tank reactors, isolation of single cells and their culture, measurement of growth,

**Unit V. Practical approaches of single cell culture:** Somatic embryogenesis, protoplast isolation, regeneration of protoplasts and protoplasts fusion, Synthetic seeds, generation of cybrid and hybrids, cryopreservation of plant cells.

**Unit VI. Applications of tissue culture:** Applications in agriculture and Horticulture, Application in Forestry, Application of Tissue culture in pharmaceutical industry. In situ and ex-situ conservation. In vitro mutagenesis and its application. Production of transgenic plants

**Unit. VII. Recombinant DNA technology:** Gene cloning, Vectors, Role of Agrobacterium, Gene cloning techniques - Gene gun, Electroporation, Microinjection, Liposome mediated gene transfer, Ultra sonication and Pollen Mediated gene transfer.

## **Practicals based on 407**

1. Equipment's required in Tissue culture Lab
2. Media preparation
3. Sterilization of media
4. Sterilization of explant.
5. Explant Culture.
6. Anther culture
7. Pollen culture,
8. Micropropagation.
9. Embryo rescue technique.
10. Somaclonal variation.
11. In vitro mutation.
12. Isolation of plant protoplasts and viability testing.
13. Protoplast fusion by PEG.
14. Tissue culture of Horticultural plant Banana.
15. Tissue culture of Medicinal plant.

## **BOT 408 Plant Physiology and Metabolism**

**Unit I. Plant water relations:** Water Potential, Absorption and Transpiration, Stomatal Physiology, Active and passive transport of solutes, Phloem loading and unloading, sourcesink relationship, Physiology of plants under water stress.

**Unit II. Enzyme:** Nomenclature, Properties and classification of enzymes, Mechanism of Enzyme action, regulation of enzyme action, isoenzymes.

**Unit III. Photosynthesis:** Light and dark reactions, pigments and mechanism of light absorption, Photosystem I and II, Emerson enhancement effect, C<sub>3</sub>, C<sub>4</sub> and CAM pathways, significance of C<sub>4</sub> and CAM pathways, photorespiration, Photo synthetic productivity.

**Unit IV. Respiration:** Glycolysis, TCA cycle and its role in synthesis of bio-molecules Mitochondrial electron transport, oxidative phosphorylation, Pentose phosphate pathway, cyanide resistance, Bioenergetics principles.

**Unit V. Nitrogen Metabolism:** Nitrification and denitrification, Nitrate assimilation, Biological nitrogen fixation, Biosynthesis of amino acids - reductive amination and trans amination, Protein synthesis, classification of amino acids and proteins, amphoteric nature and zwitter ions, structure of proteins, protein denaturation, Isolation and purification of proteins.

**Unit VI. Lipid Metabolism:** Fatty acids, lipids, triglycerides, Saponification, oxidation of Fatty acids- alpha and beta oxidation.

**Unit VII. Plant Growth:** Growth curve, growth analysis, plant growth regulating substance (PGRS), Gibberellins, Cytokines, Abscisic acid, Ethylene, role of PGRs in agriculture.

**Unit VIII. Plant Development:** Physiology of flowering, Phytochrome, flowers induction, Seed germination and dormancy, senescence and aging, stress physiology, vernalization and abscission.

### **Practicals Based On BOT- 408**

1. Separation of chlorophyll pigments by paper and thin layer chromatography,
2. Spectrophotometry - Absorption spectrum for chlorophyll pigments extracted from green leaves.
3. Estimation of total chlorophyll, chlorophyll 'a' and chlorophyll b
4. Estimation of reducing sugars using Fehling's solution A and B.
5. Isolation of starch from potato.
6. Isolation of pectin from fruit rinds.
7. Hydrolysis of starch by acid and crude enzyme extract from germinating seeds.
7. Effect of temperature on permeability.
8. Difference between C3 and C4 plants- chlorophyll content and leaf anatomy.
9. Estimation of Ascorbic acid from fruit juice and germinating seeds.
10. Estimation of proline in normal plant and that under stress.
11. Separation of amino acids by paper and thin layer chromatography.
12. Chemical tests for protein.
13. Estimation of protein by Lawry's method.
14. Estimation of protein by Biuret method.
15. Isoelectric point of casein.
16. Immobilization of enzymes using sodium alginate.
17. Preparation of leaf protein concentrate (LPC) by heat coagulation method. 18. Iodine number of fat.
19. Saponification number of fat.
20. Growth analysis - RGR, NAR and LAI.
21. Biostatistics: mode, median, mean, range, mean deviation, standard deviation, coefficient of variation (C.V.) in simple or classified data (frequency distribution).

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