UNIVERSITY OF MUMBAI

Syllabus for Semester III and IV

Program: M.Sc.

Course: BOTANY

(Credit Based Semester and Grading System with effect from The academic year 2017–2018)

M.Sc Botany Semester III

Outline of the Course: PSBO301 and PSBO302 are common papers for all specialisations

PSBO301: Techniques and Instrumentation

PSBO302: Cell and Molecular Biology

PSBO303 and PSBO304 are Optional Papers in any one of the following specialisations.

1. Mycology and Plant Pathology (MPP)
2. Plant Physiology and Biochemistry (PPB)
3. Angiosperms and Phytochemistry (ANP)
4. Molecular Biology, Cytogenetics and Biotechnology (MCB)
5. Environmental Botany (EB)

Theory	**PSBO301**	**:**	**4 Credits**
	PSBO302	**:**	**4 Credits**
	PSBO303	**:**	**4 Credits**
	PSBO304	**:**	**4 Credits**
Practicals (based on all 4 courses) PSBOP303 & Project		**: PSBOP301, PSBOP302,**	**16 Credits**

SEMESTER III
Common Papers

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
PSBO301	Title of the Paper: TECHNIQUES AND INSTRUMENTATION			
	I	Biostatistics	4	1
	II	Bioinformatics		1
	III	pH and buffers and Electrophoresis		1
	IV	Colorimeter, UV-visible spectrophotometer		1
PSBO302	Title of the Paper: Molecular Biology			
	I	DNA replication	4	1
	II	Transcription		1
	III	RNA processing		1
	IV	Translation		1

PSBOP301	**Techniques and Instrumentation**	**2**	**4**
PSBOP302	**Molecular Biology**	**2**	**4**

Specialization : Mycology and Plant Pathology (MPP)

PSBOMPP303	**Title of the Paper: General Mycology**	**4**
	I History of Mycology	**1**
	II Taxonomy and Life Histories	**1**
	III Fungal Physiology	**1**
	IV Fungal Cytology & Ecology	**1**
PSBOMPP304	**Title of the Paper: Applied Mycology& Plant Pathology**	**4**
	I Pathogenesis and Crop Pathology	**1**
	II Seed Pathology & Seed Mycoflora	**1**
	III Culture Studies and Food Borne Fungi	**1**
	IV Industrial Mycology	**1**

PSBOMPPP303	**Mycology and Plant Pathology**	**2**	**4**
PSBOMPPP304	**Research project proposal and review of literature**	**2**	**4**

Specialization : Plant Physiology and Biochemistry

PSBOPPB303	**Title of the Paper: Plant Biochemistry**	**4**
	I Enzymes	**1**

	II Vitamins as Coenzymes	**1**
	III Plant proteins	**1**
	IV Nucleotide metabolism	**1**
PSBOPPB304	**Title of the Paper: Plant Physiology**	**4**
	I Solute transport & photo assimilate translocation	**1**
	II Post-harvest technology	**1**
	III Stress Physiology: Drought	**1**
	IV Stress Physiology: Salinity	**1**

PSBOPPBP303	**Plant Biochemistry**	**2**	**4**
PSBOPPBP304	**Research project proposal and review of literature**	**2**	**4**

Specialization : Angiosperms and Phytochemistry (ANP)

PSBOANP303	**Title of the Paper: Angiosperms and Phytochemistry I**			
	I	**Approaches to Angiosperm Taxonomy**	**4**	**1**
	II	**Anatomy**		**1**
	III	**Tools of Angiosperm Taxonomy**		**1**
	IV	**Methods in Evaluating Crude Drugs**		**1**
PSBOANP304	**Title of the Paper: Angiosperms and Phytochemistry II**			
	I	**Evolution**	**4**	**1**
	II	**Cladistics**		**1**
	III	**Nomenclature**		**1**

	IV	Embryology and Palynology		1

PSBOANPP303	Angiosperms -I	2	4
PSBOANPP304	PROJECT	2	4

Specialization : Molecular Biology, Cytogenetics and Biotechnology (MCB)

PSBOMCB303	Title of the Paper: Plant Biotechnology			
	I	Plant Tissue Culture I	4	1
	II	Plant Tissue Culture II		1
	III	Biotransformation		1
	IV	Commercial aspects		1
PSBOMCB304	Title of the Paper: Molecular Biology and Cytogenetics			
	I	Cytology	4	1
	II	Cancer Biology		1
	III	Immune System		1
	IV	Genetic Diseases		1

PSBOMCBP303	Plant Biotechnology	2	4
PSBOMCBP304	PROJECT	2	4

Specialization : Environmental Botany (EB)

PSBOEB303	Title of the Paper: Ecology and Environmental Botany	4
	I Basic Ecological Concept	1

	II Ecosystem	**1**
	III Bio-Geochemical Cycle	**1**
	IV Natural Resources	**1**
PSBOEB304	**Title of the Paper: Recent Trends & Applied Environmental Botany**	**4**
	I Conservation Ecology –I	**1**
	II Conservation Ecology II	**1**
	III Biodiversity Studies	**1**
	IV Renewable and Non-Renewable Sources of Energy	**1**

PSBOEBP303	**Ecology and Environmental Botany**	**2**	**4**
PSBOEBP304	**Research project proposal and review of literature**	**2**	**4**

SEMESTER IV

Common Papers

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
PSBO401	**Title of the Paper: TECHNIQUES AND INSTRUMENTATION**			
	I	**Centrifugation**	**4**	**1**
	II	**Chromatography**		**1**
	III	**Tracer Technique & PCR**		**1**
	IV	**Nanotechnology & IPR**		**1**

PSBO402	**Title of the Paper: Molecular Biology**			
	I	**Gene Regulation I**	**4**	**1**
	II	**Gene Regulation II**		**1**
	III	**Gene Regulation III**		**1**
	IV	**Cell signaling**		**1**

PSBOP401	**Techniques and instrumentation**	**2**	**4**
PSBOP402	**Molecular Biology**	**2**	**4**

Specialization : Mycology and Plant Pathology (MPP)

PSBOMPP403	**Title of the Paper: General Mycology**	**4**
	I History of Mycology	**1**
	II Taxonomy and Life Histories	**1**
	III Fungal Physiology	**1**
	IV Fungal Genetics & Ecology	**1**
PSBOMPP404	**Title of the Paper: Applied Mycology& Plant Pathology**	**4**
	I Pathogenesis and Crop Pathology	**1**
	II Seed Pathology & Seed Mycoflora	**1**
	III Culture Studies and Food Borne Fungi	**1**
	IV Industrial Mycology	**1**

PSBOMPPP403	**Mycology and Plant Pathology**	**2**	**4**
PSBOMPPP404	**Research project report and presentation**	**2**	**4**

Specialization : Plant Physiology and Biochemistry

PSBOPPB403	**Title of the Paper: Plant Biochemistry**	**4**
	I Lipid Metabolism	**1**
	II Amino Acid Metabolism	**1**
	III Cytosolic Carbon & Mitochondrial Metabolism	**1**
	IV Senescence	**1**
PSBOPPB404	**Title of the Paper: Plant Physiology**	**4**
	I PGR	**1**
	II Phytoremediation	**1**
	III Sensory photobiology	**1**
	IV Secondary Metabolism	**1**

PSBOPPBP403	**Plant Physiology**	**2**	**4**
PSBOPPBP404	**Research project submission and presentation**	**2**	**4**

Specialization : Angiosperms and Phytochemistry (ANP)

PSBOANP403	**Title of the Paper: Angiosperms and Phytochemistry III**			
	I	**Approaches to Angiosperm Taxonomy**	**4**	**1**
	II	**Anatomy**		**1**
	III	**Medicinal plant biotechnology**		**1**
	IV	**Methods in Evaluating Crude Drugs**		**1**
PSBOANP404	**Title of the Paper: Angiosperms and Phytochemistry IV**			
	I	**Progressive taxonomy**	**4**	**1**
	II	**Tools of taxonomy**		**1**
	III	**Applied taxonomy**		**1**
	IV	**Evolution of Reproductive elements**		**1**

PSBOANP P403	**Angiosperms and Phytochemistry -I**	**2**	**4**
PSBOANP P404	**PROJECT**	**2**	**4**

Specialization : Molecular Biology, Cytogenetics and Biotechnology (MCB)

PSBOMCB403	**Title of the Paper: Plant Biotechnology**			
	I	**Environmental Biotechnology**	**4**	**1**
	II	**Traditional Knowledge & IPR**		**1**
	III	**Nanotechnology**		**1**
	IV	**Food Biotechnology**		**1**
PSBOMCB404	**Title of the Paper: Molecular Biology and Cytogenetics**			
	I	**Plant Breeding I**	**4**	**1**

II	**Plant Breeding II**		**1**
III	**Molecular plant Breeding**		**1**
IV	**Plant Genetic Engineering**		**1**

PSBOMCBP303	**Plant Biotechnology**	**2**	**4**
PSBOMCBP304	**PROJECT**	**2**	**4**

Specialization : Environmental Botany (EB)

PSBOEB403	**Title of the Paper: Ecology And Environment Botany**			
	I	**Pollution**	**4**	**1**
	II	**Climatic Change**		**1**
	III	**Plant Population Dynamics**		**1**
	IV	**Coastal Zone Management In India**		**1**

PSBOEB404	**Title of the Paper: Recent Trends & Applied Environmental Botany**			
	I	**Restoration Of Ecosystems I**	**4**	**1**
	II	**Restoration Of Ecosystems II**		**1**
	III	**Restoration of Land**		**1**
	IV	**Water Shed management**		**1**

PSBOEBP P403	**Ecology and Environmental Botany**	**2**	**4**
PSBOEBP P404	**PROJECT**	**2**	**4**

Detailed Syllabus

SEMESTER III General Papers

Course Code	Topic	Credits
PSBO301	**TECHNIQUES AND INSTRUMENTATION**	**4**
UNIT I: Biostatistics • Hypothesis testing: Theory of errors – Type I and Type II errors, Null Hypothesis, z-test, Test of significance. • Introduction to ANOVA, One-way & two way ANOVA, Dunett's test. • Randomized Block Design and Latin Square. (5 problems to be solved in each category)		**1**
Unit II: Bioinformatics • Organization of biological data, databases (raw and processed), Queering in data bases. • Gene finding, motif finding and multiple sequence alignment. • Protein sequence analysis (theory and algorithms). • Exploration of databases, retrieval of desired data, BLAST etc		**1**
Unit III: pH and Buffers; Electrophoresis • pH and buffer solutions, acids and bases, hydrogen ion concentration, dissociation of acids and bases, measurement of pH, titration curves. Physiological Buffers. • Electrophoresis: Theory and application, • PAGE (Native & SDS) and AGE • 2D Electrophoresis		**1**
Unit IV: Microscopy & Spectroscopy • Principles, instrumentation, working and applications of o Fluorescence microscope, TEM, SEM, Biological sample preparation for electron microscopy o IR, AAS , Plasma Emission spectroscopy, NMR, MS		**1**

Course Code	Topic	Credits
PSBO302	**Molecular Biology**	**4**
<u>UNIT I:</u> DNA Replication • Molecular details of DNA replication in prokaryotes and eukaryotes. • Assembly of raw DNA into nucleosomes. • DNA recombination, holliday model for recombination.		**1**
<u>Unit II:</u> Transcription • Transcription, RNA synthesis, classes of RNA and the genes that code for them. • Transcription of protein coding genes, prokaryotes and eukaryotes, mRNA molecule. • Transcription of other genes, ribosomal RNA, and ribosomes, tRNA.		**1**
<u>Unit III:</u> RNA processing • Capping, polyadenylation, splicing, introns and exons. • snRNA, Types of snRNA, snRNA in spliceosome, significance of snRNA • Non coding RNAs, ribozyme, riboswitches, RNA localization.		**1**
<u>Unit IV:</u> Translation • Protein structure, nature of genetic code, translation of genetic message. • Post translational modifications, localization, chaperons.		**1**

PBSOP301	TECHNIQUES AND INSTRUMENTATION	2	4
• Hypothesis testing, Normal deviate test. • ANOVA- one way & two way. • Randomized block Design and Latin square • Multiple alignments • Phylogenetic tree. • BLAST • Motif finding • Preparation of buffers (phosphate and acetate) • Determination of pKa			

PBSOP302	Molecular Biology	2	4
• Aseptic techniques, safe handling of microorganisms. • Establishing pure cultures, streak plate method (T-streak and pentagon method), Pour plate, spread plate. • Maintenance of cultures - Paraffin embedding, Lyophilisation. • Preparation of culture medium, stock solutions • Determination of cell number, viable count method (using pour plate and serial dilution technique). • Separation of seed proteins using PAGE. • Analysis of proteins by one and two dimensional gel electrophoresis. • Genomic DNA isolation and quantification.			

Special Papers

Specialization: Mycology and Plant Pathology (MPP)

Course Code	Topic	Credits
PSBOMPP303	**General Mycology**	**4**
UNIT I: History of Mycology and Plant Pathology in India & Soil Mycology • History of Mycology and Plant Pathology in India and contribution of Mycologists and Plant Pathologists: o C J. Alexopoulos o E. A. Bessey o K. S. Bilgrami o E. A. Butler o K. S. Thind o M. N. Kamat o R. N. Tandon • Soil Mycology: o Various techniques to determine the fungal population in soil. o Various interactions amongst the soil fungi and other organisms. o Keratinophillic fungi		**1**

Unit II: Fungal Taxonomy & Life history and Systematic position of fungi • Fungal Taxonomy: A comparative account of outline systems of classification of fungi proposed by Bessey and Ainsworth. • Polyphasic taxonomy- morphology, enzymatic and molecular characteristics of class Ascomycetes and Basidiomycetes. • Life cycle and Systematic position of the following fungi: Myxomycetes: *Physarum polycephalum,* Ascomycetes:*Claviceps purpurea* Basidiomycetes: *Ganoderma*	**1**
Unit III: Fungal Physiology • Mode of nutrition-Saprophytic, parasitic, mutualistic, hyperparasitic, predaceous. • Nutrition in fungi with reference to: i) Carbon ii) Sulphur iii) Potassium iv) Magnesium v) Nicotinic acid vi) Riboflavin, vi)Nitrogen, vii) Phosphorus, viii) Thiamine ix) Folic acid x) Pantothenic acid xi) Iron • Melvonate pathway, Shikimic acid pathway	**1**
Unit IV: Fungal Cytology, and Ecology • Fungal Cytology: Microscopic structure of fungal cell, Chemical composition and functional attributes of fungal septa and cell wall. • Fungal Ecology: A) Physical Environmental factors influencing fungal growth: i) Light ii) Hydrostatic pressure iii) Radiations	**1**

Course Code	Topic	Credits
PSBOMPP304	**Applied Mycology and Plant Pathology**	**4**
UNIT I: Pathogenesis and Crop Pathology • Prepenetration, Penetration and entry of pathogen into host tissue – mechanical, physiological, enzymatic and through natural openings • Host-parasite interaction • enzymes and toxins in pathogenesis • Significance of phyllosphere and rhizosphere fungi • Crop Pathology: Causal organism, Symptoms, Disease Cycle and Control measures of the following diseases i) Wart of potato ii) Downy mildew of grapes iii) Bunt of rice iv) Citrus canker		**1**

<u>UNIT II:</u> Seed Mycoflora & Seed Pathology • Seed Mycoflora: Fungi on seeds- a) Field Fungi b) Storage Fungi – i) Characteristics of major storage fungi ii) Effect of storage fungi iii) Control of storage fungi • Seed Pathology: Pathological Effects of Seed borne diseases- i) Seed abortion ii) Shrunken seeds & Reduced seed size iii) Seed rot iii) Sclerotisation & Stromatisation iv) Seed discolouration v) Reduced or complete loss of germinability	**1**
<u>Unit III:</u> Cultural Studies and Food borne Fungi • Cultural Studies in Fungi: Culture Media and their types based on i) Empirical use ii) Physical states iii) Chemical composition • Food borne fungi: Common contaminants of i) Fresh food, ii) Processed food iii) Stored food • Use of chemical preservatives to protect the food against contamination	**1**
<u>Unit IV:</u> Industrial Mycology • Fungal enzymes, extraction and purification • Industrial application of fungal enzymes – i) Protease ii) Cellulase iii) Invertase iv) Phosphatase • Uses of immobilization technique in fermentation by fungi • Fermenters- design and construction, types of fermenters, aseptic operation and use of computer in fermenters, maintenance, types of fermentation process - batch fermentation, fed-batch fermentation, continuous fermentation, scale up of fermentations, industrial processes- upstream and down-stream processes, strain improvement of microbes • Organic Acid Industry - Sources and methods of production of vinegar, and citric acid	**1**

PSBOMPPP303	**Mycology and Plant Pathology**	2	4
• Isolation of soil fungi from different locations (garden loam, agricultural soil, salt marsh, rhizoshpere) by Warcup method and identification of fungi • Study of the following fungal types with reference to their systematic position thallus and reproductive structures: *Physarum, Arcyria, Taphrina, Chaetomium, Phyllachora* • Preparation of artificial key based on appropriate characters • Measurement of fungal growth by linear determination (days) • Study of effect of incubation temperatures on fungal growth (15˚C 30˚C & 60˚C)			

• Immobilization of fungi and biodegradation of azo dye using fungal alginate beads • Isolation of fungal pathogens from infected leaves / wood/ phylloplane • Study of the following diseases: i) Wart of potato ii) Downy mildew of grapes iii) Bunt of rice iv) Citrus canker • Isolation and detection of organic acid from fungal culture • Minimum inhibition concentration of salt/ sodium benzoate on fungal growth • Quantitative estimation of cellulose by DNSA method Note: 1. Compulsory visit to Western Ghats for collection and observation of fungi (at least for three days). 2. Visit to any one Mycology Institute/ Laboratory			
PSBOMPPP304	Projects will be allotted in third semester and students will submit project work having introduction, review of literature, well defined material and methods, expected results and references	2	4

Specialization: Plant Physiology and Biochemistry (PPB)

Course Code	Topic	Credits
PSBOPPB303	**Plant Biochemistry**	**4**
<u>UNIT I:</u> Enzymes • Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, Isozymes.		**1**
<u>Unit II:</u> Vitamins and Coenzymes • Structure, occurrence of all water soluble and fat soluble vitamins and coenzyme activity		**1**
<u>Unit III:</u> Plant Proteins • Lectins and storage proteins in plants, transamination, oxidative deamination and urea cycle.		**1**
<u>Unit IV:</u> Nucleotide Metabolism		**1**

• Purine and pyrimidine biosynthesis and regulation. • Recycling of Purine and Pyrimidine nucleotides by salvage pathways.	

Course Code	Topic	Credits
PSBOPPB304	**Plant Physiology**	**4**
<u>UNIT I:</u> Solute transport and photo assimilate translocation • The concept of water potential; Uptake, transport and translocation of water, ions, solutes and macromolecules across membranes, transpiration; mechanisms of loading and unloading of photoassimilates		**1**
<u>Unit II:</u> Post Harvest Technology • Physiological changes during ripening, fruit preservation, role of ethylene in post-harvest technology.		**1**
<u>Unit III:</u> Stress Physiology: Drought • Morphological and cellular adaptations, mechanism of drought tolerance, role of Proline, Glycine Betaines, Mannitol, Pinitol and Osmotin in stress resistance.		**1**
<u>Unit IV:</u> Stress Physiology: Salinity • Generic Pathway for Plant Response to Stress Effect of salt on metabolic processes, Mechanism of Salt resistance- salt avoidance (exclusion, extrusion & dilution) and tolerance (Regulation of ion homeostasis by SOS pathway), Role of Glycine Betaine and Proline in Salinity Stress, DEAD-Box Helicases in Salinity Stress Tolerance		**1**

PSBOPPBP303	**Plant Physiology**	2	4
• Enzyme kinetics: Effect of substrate variation on the activity of enzyme. • Isolation and estimation of DNA. • Estimation of RNA by Orcinol method. • Extraction and estimation of pectin, sugars, polyphenols and vitamin C from ripe & unripe fruits. • Proline and Na content estimation in garden and salt stressed plants.			

PSBOPPBP304	Projects will be allotted in third semester and students will submit project work having introduction, review of literature, well defined material and methods, expected results and references	2	4

Specialization: Angiosperm and Phytochemistry (ANP)

Course Code	Topic	Credits
PSBOANP303	**Angiosperms & Phytochemistry –I**	**4**
UNIT I: Approaches to Angiosperm Taxonomy • Study the following families with reference to its systematic position, distribution, salient features, floral formula, floral diagram, morphological peculiarities, economic importance, present status, affinities, phylogeny and interrelationships: Ranunculaceae, Annonaceae, Nympheaceae, Pedaliaceae, Onagraceae, Scrophulariaceae, Vitaceae, Acanthaceae, Nyctaginaceae, Orchidaceae		**1**
Unit II: Anatomy • Study of cambium with reference to its origin, position, structure, distribution, behavior and its importance in vascular plants. • Study of Leaf Architecture Patterns in dicotyledonous plants and its significance. • A study on basic features on Node-petiole and Nodal anatomy. • Ontogeny of stomatal development. • Study of abscission zone in Plants. • Floral anatomy in hypogynous, perigynous and epigynous flowers and its significance.		**1**
Unit III: Tools for classification • Morphological characters with respect to study of Root, Stem, fruit, seed and seed germination • Screening of plant extracts – Fingerprinting. • Types of keys o Single access and multi access keys, preparation of keys for Taxon based on exomorphic characters		**1**

Unit IV: Methods in Evaluating Crude Drugs
• Organoleptic
• Microscopic
  o Leaf constants: palisade ratio and vein islet number.
  o Trichomes and Trichome density
  o Stomata structure and types, stomatal frequency & stomatal index.
  o Cell inclusions
  o Sclereids
  o Wood elements: structure and organization
• Physico-chemical:
  o Ash content
  o Extractive values
  o Qualitative chemical analysis
• Quantitative chemical analysis
• Biological
  o Hepatoprotective
  o Anti-fertility
  o Anti-inflammatory
  o Anti-ulcer
  o Neuro-pharmacological
• Evaluation of powdered drugs
	1

Course Code	Topic	Credits
PSBOANP304	**Angiosperms &Phytochemistry –II**	**4**

UNIT I: Evolution
• The effects of evolutionary theory on systematic, monographic and floristic development
  o Primitive versus advanced
  o Homology and Analogy
  o Parallelism and Convergence.
  o Phylogeny, phylogenetic and phynetic ontogeny
  o Monophyly and Polyphyly
• Character weighing
		1

UNIT II: Cladistics • **Numerical Taxonomy: Principles,** OTU, Taxonomic characters, coding of characters		**1**

• Use of cladistics in classification • Phylogenetic classification systems-Takhtajan, Cronquist, APGI, II, III • Patterns of variation and phylogenetic trees, cluster analysis; Building Trees-Rooting technique, Distance methods, Maximum likely hood methods, Bootstrapping using trees. Phyllocode	
Unit III: Nomenclature • International code of Botanical Nomenclature 1830 – Paris Code to 2017 – China Code. • Major adaptations considered in these International Botanical Congress • Nomenclatural terminology- o Important Rules of ICBN, Principles, articles, recommendations, rules and exercises on plant nomenclature (problems to be asked in theory). o Type method (typification) - holotype, isotype, syntype, lectotype, paratype, neotype; Effective and Valid publication; Priority; Scientific names-Correct name, Autonym, Basionym, Homonym, Synonym, Tautonym; alternative, ambiguous, illegitimate, naked, rejected and superfluous names.	**1**
Unit IV: Embryology and Palynology • Types, Technique, factors affecting somatic embryogenesis and importance of embryogenesis. • Embryology in relation to taxonomy. • Role of embryology in plant breeding. • Evolution of pollen aperture types in angiosperms • Palynology in relation to taxonomy	**1**

PSBOANPP303	**Angiosperms &Phytochemistry –I**	2	4
• Study of Angiosperm families mentioned for theory with reference to morphological peculiarities, floral diagrams and economic importance of its members with the help of locally available plants. • Study of exomorphic characters to describe a plant in technical terms by study of root, stem, leaves, inflorescence, flower, fruit and seed of families prescribed. • Study of Cambium primary, secondary and cork cambia. • Study of leaf architecture. Prepare permanent leaflet of Tamarind leaf architecture (submission).			

• Study of Node petiole anatomy. • Use of keys for identification of family, genus and species • Writing of species description using taxonomic keys • Macroscopic & Microscopic evaluation, Physico-chemical & Phytochemical analysis of the following crude drugs [TLC to be performed]: *Mimosa pudica* entire plant; *Boerhaavia diffusa* entire plant, *Saraca asoka* bark, Asparagus roots, *Glycyrrhiza glabra* rhizome **Note:** 1. Compulsory visit to Western Ghats for observation of plants (at least for three days). 2. Compulsory excursion for observation of plants (local, atleast 2 in each term) 3. Same Field diary to be continued from Sem I and II & maintained for all four semesters.			
PSBOANPP304	Projects will be allotted in third semester and students will submit project work having introduction, review of literature, well defined material and methods, expected results and references	2	4

Specialization: Molecular Biology, Cytogenetics and Biotechnology (MCB)

Course Code	Topic	Credits
PSBOMCB304	**Plant Biotechnology**	**4**
UNIT I: Plant Tissue Culture I • Micropropagation of floricultural and medicinal plants using organogenesis and embryogenesis. • Factors responsible for *in vitro* and *ex vitro* hardening. • Plant improvement through somaclonal variations.		**1**

<u>Unit II:</u> Plant Tissue Culture II • Plant cell cultures as chemical factories: Cell suspension, enhancement of product formation using biotic and abiotic elicitors, immobilization, permeabilization and product recovery. • Problems in plant tissue culture: contamination, phenolics and recalcitrants. • In vitro storage of germplasm, Cryopreservation	**1**
<u>Unit III:</u> Biotransformation • Biotransformation using: Freely suspended plant cells and Immobilized plant cells, • Biotransformation for Vanillin production from Capsicum cell cultures. • In vitro storage of germplasm, cryopreservation. • Studies on *Agrobacterium* mediated transformed root cultures.	**1**
<u>Unit IV:</u> Commercial aspects • The quest for commercial production from plant cell: scaling up of cell cultures, • Bioreactors: factors for bioreactor design, pneumatically agitated bioreactors, comparison of bioreactors, operating mode, batch, fed-batch, semicontinuous, two stage operation, continuous cultivation. • Factors for growth in Bioreactors. • Shikonin production by *Lithospemum erythrorhizon* cell cultures.	**1**

Course Code	Topic	Credits
PSBOMCB304	**Molecular Biology and Cytogenetics**	**4**
<u>UNIT I:</u> Cytology • Cell membrane and permeability: Molecular models of cell membrane, cell permeability. Differentiation of cell membrane, intercellular communications and gap junctions. Cell coat and cell recognition, cell surface. • Cell Cycle and Apoptosis: Mechanism of Cell division; Regulation, Roles of Cyclins and Cyclin dependent kinases, Cell Plate formation, PCD. • Organization and function of mitochondrial and chloroplast genomes.		**1**

<u>Unit II:</u> Cancer Biology • Cancer cells: Characteristics, division, spread, treatment. Course of cancer cell formation, Carcinogens: radiations, chemicals, oncogenic virus. • Cancer and mutations, reproductive properties of transformed animal cell in culture, oncogenes, protoncogenes and their conversion. Oncogenes and growth factors.	**1**
<u>Unit III:</u> Immune System • Phylogeny of immune system, innate and acquired immunity, nature and biology of antigens, major histocompatibility complex cells of immune system, regulation of immune responses. Production of antibodies by plant cells and organs. • Immunity in Health and Disease: Immunodeficiency and AIDS	**1**
<u>Unit IV:</u> Genetic Diseases • Genetic disorders, genetic counseling and gene therapy • Biochemical disorders, sex linked disorders, cardiovascular disorders.	**1**

PSBOMCBP303	**Plant Biotechnology**	2	4
• Preparation of stock solutions and MS medium. • Callus induction and regeneration. • Isolation of bioactive compounds from callus and plant source using TLC. • Types of Bioreactors.			
PSBOMCBP304	Projects will be allotted in third semester and students will submit project work having introduction, review of literature, well defined material and methods, expected results and references	2	4

Specialization: Environmental Botany (EB)

Course Code	Topic	Credits
PSBOEB303	**Ecology and Environmental Botany**	**4**
<u>UNIT I:</u> Basic Ecological Concept • Ecosytem: Definition, Components of Ecosystems, Trophic Levels, Food Chains, Food Webs, Ecological Pyramids, Ecosystem Energetics, Laws of Thermodymadics, Energy Flow Models in Terrestrial Ecosystem • Concept of Productivity , Principles of Limiting Factor, Liebigs Law, Shelford Law of Tolerance, Basic Concepts in Ecology • Branches of Ecology: Autecology; Aims, Aspects: General Account of Seed, Seed Output, Seed Dispersal, Seed Viability, Seed Dormancy, Reproductive Capacity, Growth Regulators and Seed Germination • Synecology: Plant Community, Ecological Amplitude, Population Characteristics: Associaiton, Consociation Fasciation Society		**1**
<u>Unit II:</u> Ecosystem • Succession; Causes, Types, Steps, Migration , Ecesis, Aggregation, Competition, Invasion, Hydrosere, Xerosere, Climax , Disclimax, Sub Climax • Plant and Plant Communities as Indicators: Forests as Indicators Grassland, Soil types Salinity, Grazing, Indicators of Forests. • Types of Habitat: Marine, Freshwater, Estuarine • Seaweeds: their uses maintenance and control		**1**
<u>Unit III:</u> Bio-Geochemical Cycle • **Gaseous Cycle:** o Nitrogen Cycle: Role of Nitrogen in Plant Metabolism and Biosphere. Nitrogen Cycle change due to human activity – Agricultural Nitrogen Fixation, Industrial Emissions, Transportations. Impact in terms of Eutrophication of Environment and Health. o Carbon Cycle: Forms and places of occurrence of Carbon. Photosynthetic Sequestration of Carbon. Role of Carbon in Forest Ecosystems. Cycling of Carbon in Biosphere. Role of carbon in Global Warming Problem and its possible implication. • **Sedimentary Cycle:** o Sulphur Cycle: Forms of Sulphur in biosphere and geosphere, in fossil fuels and its release with industrialization, Sulphur cycling in Soil Bacterial Metabolism. o Phosphorus Cycle: Ecological Function, Biological Function and		**1**

Process of the Cycle.	
<u>Unit IV:</u> Natural Resources • Forest Resources: Use And Over-Exploitation • Biome types of India • Biocitation of Tropical, Temperate, Alpine And Desert Biomes • Gap Dynamics in Tropical Forests and Parameters Of Gap Dynamics, Importance of gap dynamics	**1**

Course Code	Topic	Credits
PSBOEB304	**Recent Trends & Applied Environmental Botany**	**4**
<u>UNIT I:</u> Conservation Ecology –I • Role of National and International Organisations in Conservation and Some relevant terms UNDP, WWF, World Bank, BNHS, MoEF, DST,DBT, CSIR, CPCB, Municipal Corporation Agenda 21, NGOS, IBGP, TRIPS. • Legislation Aiming at Conservation (Objectives and penalties).,Environment Protection act 1986, Forest Conservation Act 1980, Wildlife protection Act 1972 • Conventions: Earth summit, Vienna Convention, Ramsar Convention, Protocol: Montreal protocol, Cartagena protocol • Case studies: Tuvalu -A sinking nation, Basmati patent issue, Chernobyl disaster		**1**
<u>Unit II:</u> Conservation Ecology II • EIA- Environmental Impact Assessment-Types, Benefits, Process Monitoring and Evaluation, Risk Management. Role or Contribution of Botanist in EIA And EMP • Environmental Impact Assessment for Physical, Chemical, Biological and Socio-Economic Factors; Legislative Implications of EIA, Environmental Impacts Assessment and Environmental Auditing. • Watershed Management: Economics Assessment of Watershed Development Vis-A-Vis Ecological and Environmental Protection. • Soil Conservation - Definition, Causes For Erosion; Types - Wind And Water Erosion; Conservation And Management Of Eroded Soils/Areas, Wind Breaks, Shelter Belts; Sand Dunes; Reclamation Of Saline And Alkaline Soils, Water Logged And Other Waste Lands		**1**
<u>Unit III:</u> Biodiversity Studies		**1**

• Biodiversity: Concepts and Levels, National & Global Status, Role of Biodiversity in Ecosystem Function And Stability, Speciation And Extinction, IUCN Categories Of Threats, Distribution And Global Pattern • Biodiversity Hotspots, Inventory. Types Of Resources., Conservation, In-Situ.,Ex-Situ; Biosphere reserves, National Parks, Sanctuaries, Forest Conservation Chipko Movement • Biodiversity Management Approaches**:** Measures of Maintaining Biodiversity, Need For Preservation of Biodiversity With Special Reference to Tropical Forest Biodiversity Centers of Origin of Crops, Species Concept; Significance of Biodiversity; Plant Genetic Resources, Exploration and Collection; Crop Domestication, Plant Introductions; Migration and Utilization; IUCN Clauses and Concept of Threatened and Endangered species • Endemism, Endemic and Exotic Plants Of India, PAN	
<u>Unit IV:</u> Renewable and Non-Renewable Sources of Energy • Concept and Demand of Energy, Growing Energy Needs, Renewable and Non-Renewable Sources, use of Alternate Energy Sources, Wind Energy, Solar Energy. • Water as Source of Energy. • Biofuels Production, Use and Sustainability, Use and Over Exploitation of Energy Sources and Associated Problems. • Nuclear and geothermal energy	**1**

PSBOEBP303	**Ecology and Environmental Botany**	2	4
• Comparison of Primary Productivity by I) Chlorophyll Method, II) Harvest Method And III) Light And Dark Bottle Method in Polluted and Unpolluted Regions. • Determination of pH, Electrical Conductivity and Water Holding Capacity of Different Types of Soil. • Determination of Total Organic Carbon of the Soil • To Study the Quantitative Characters of Plant Community by Quadrat Method. (Density Frequency Abundance) • To Determine Diversity Indices in Plant Communities. • Identification of Some Medicinal Plants Of India, o Rhizome: *Acorus, Curcuma, Zingiber* o Root: Ashwgandha,*Glycyrrhiza*, Asperagus o Fruit: Amla, *Aegle, Datura* o Stem : *Santalum, Saraca, Tinospora* o Leaves : , *Aloe, Ocimum, Bacopa* • To Determine Viability Of Seeds Under Salinity Stress (TTC method)			

• EIA Report Preparation-(Field Exercise-Report To Be Submitted along with Journal).			
PSBOEBP304	Projects will be allotted in third semester and students will submit project work having introduction, review of literature, well defined material and methods, expected results and references	2	4

M.Sc Botany Semester IV

Outline of the Course: PSBO401 and PSBO402 are common papers for all specialisations

PSBO401: Techniques and Instrumentation

PSBO402: Cell and Molecular Biology

PSBO403 and PSBO404 are Optional Papers in any one of the following specialisations.

1. Mycology and Plant Pathology (MPP)
2. Plant Physiology and Biochemistry (PPB)
3. Angiosperms and Phytochemistry (ANP)
4. Molecular Biology, Cytogenetics and Biotechnology (MCB)
5. Environmental Botany (EB)

Theory	**PSBO401 :**	**4 Credits**
	PSBO402 :	**4 Credits**
	PSBO403 :	**4 Credits**
	PSBO404 :	**4 Credits**
Practicals (based on all 4 courses) : **PSBOP401, PSBOP402, PSBOP403 & Project**		**16 Credits**

Detailed Syllabus

SEMESTER IV

General Papers

Course Code	Topic	Credits
PSBO401	**TECHNIQUES AND INSTRUMENTATION**	**4**
UNIT I: Centrifugation • Basics principle of Sedimentation		**1**

• Types of rotors • Differential & density gradient centrifugation • Preparative centrifugation & Applications; Analytical centrifugation & applications	
Unit II: Chromatography • General Principle of chromatography. • Techniques and applications of Ion exchange, Affinity Chromatography& HPLC • Application of HPTLC & HPLC in validation of herbal drugs	**1**
Unit III: Tracer techniques & PCR • Pattern and rate of radioactive decay, Units of radioactivity, Stable Isotopes • Principle, instrumentation & technique: Geiger-Muller counter, Liquid scintillation counters & Autoradiography • Applications of isotopes in biology: Tracer techniques & Autoradiogrpahy • PCR and its applications	**1**
Unit IV: Nanotechnology & IPR • Synthesis of nanoparticles using biological samples. • Characterization of nanoparticles (FTIR, SEM, TEM, STEM, Scanning Tunneling Microscope, Atomic Force Microscope, UV-Vis,). • IPR: Objectives, process & scope	**1**

Course Code	Topic	Credits
PSBO402	**Molecular Biology**	**4**
UNIT I: Gene Regulation I • Regulations of gene expression in bacteria – trp operon, ara operon, histidine operon. • Regulation of gene expression in bacteriophage λ.		**1**
Unit II: Gene Regulation II • Control of gene expression in eukaryotes, Transcriptional control, RNA processing control, mRNA translocation control, mRNA degradation control, protein degradation control		**1**

Unit III: Gene Regulation III • Genetic regulation of development in *Drosophila* Developmental stages in *Drosophila* – embryonic development, imaginal discs, homeotic genes	**1**
Unit IV: Cell signaling • Hormones and their receptors, cell surface receptor, , intracellular receptor, signaling through G-protein coupled receptors, signal relay pathways-signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component systems, light signaling in plants, bacterial chemotaxis and quorum sensing. • Forms of signalling (paracrine, synaptic, autocrine, endocrine, cell to cell contact)	**1**

PBSOP401	**TECHNIQUES AND INSTRUMENTATION**	2	4
• Separation of proteins by Ion exchange chromatography • Separation of amino acids by two dimensional chromatography. • Viscosity studies of proteins: standard BSA and varying concentrations of urea • Synthesis of nanoparticles • Characterization of nanoparticles by UV spectroscopy. • Filing a patent • Industrial visit and report submission.			

PBSOP402	**Molecular Biology**	2	4
• Isolation of plasmid DNA • Quantification of plasmid DNA • Agarose gel electrophoresis separation of plasmid DNA • Restriction enzyme digestion and separation of fragments			

• Southern blot transfer technique • Transformation of *E. coli* cell by plasmid DNA • β-galactosidase expression and assay	

Special Papers

Specialization: Mycology and Plant Pathology (MPP)

Course Code	Topic	Credits
PSBOMPP403	**General Mycology**	**4**
<u>UNIT I:</u> History of Mycology and Plant Pathology in India & Soil Mycology • History of Mycology and Plant Pathology in India and contribution of Mycologists and Plant Pathologists:i) S. D. Garrett ii) K. C. Mehta iii) B. B. Mundkur iv) C. V. Subramanium v) T. S. Sadashivan vi) M. J. Thirumalachar vii) John Webster • Soil Mycology: Distribution of Mycoflora with relation to the soil factors - i) Texture ii) Moisture iii) Temperature iv) Aeration v) pH vi) Organic matter, Phosphate solubilizing fungi, Organic matter decomposition and humus formation, its importance in agriculture		**1**
<u>Unit II:</u> Fungal Taxonomy & Life history and Systematic position of fungi • Fungal Taxonomy: A comparative account of systems of classification of fungi proposed by i) Smith ii) Martin • Phyllogenetic system, ICBN, Basic Principles , major rules, effective and valid publications, Nomenclature of fungi • Life cycle and Systematic position of the following fungi: Phycomycetes: *Saprolegnia* Basidiomycetes: *Cyathus* Deuteromycetes: *Helminthosporium*		**1**
<u>Unit III:</u> Fungal Physiology • Fungal Metabolites: Acetate and Nitrogenous metabolites • Aromatic terpenes • Pigments in Fungi • Organic Acids from fungi • Fungi in Nanotechnology		**1**
<u>Unit IV:</u> Fungal Genetics and Ecology		**1**

• Fungal Genetics: Study of fungal genetics with reference to – Nuclear behavior during cell division . i) Neurospora ii) Saccharomyces iii) Puccinia graminis iv) Ustilago • Parasexual cycle, Heterokaryosis • Fungal Diversity: i) Fresh water fungi ii) Marine fungi iii) Coprophilous fungi iv) Aero-fungi Environmental factors influencing fungal growth: i) Humidity ii) Temperature • Fungal Diversity: Anamorphic fungi- i) Nematophagous fungi ii) Aquatic hyphomycetous fungi iii) Aero-aquatic fungi • Colonization strategies in fungi	

Course Code	Topic	Credits
PSBOMPP404	**Applied Mycology and Plant Pathology**	**4**
<u>UNIT I:</u> Pathogenesis and Crop Pathogeny Symptomology • Study of various symptoms of plant diseases caused by fungi. • Defense mechanism in plants-Pre-existing structural and biochemical defense mechanisms, lack of essential nutrients. Induced structural and biochemical defense mechanisms, inactivation of pathogen enzymes and toxins, altered biosynthetic pathways. • Plant disease management : Physical: Exclusion, eradication and protection. Chemical disease control:– common fungicides, antibiotics and nematicides. Biological disease control: Phytoalexins • Crop Pathology: Causal organism, Symptoms, Disease Cycle and Control measures of the following diseases; i) Club root of cabbage ii) Coffee Rust iii) Brown spot of rice iv) Papaya mosaic		**1**
<u>Unit II:</u> Seed Mycoflora & Seed Pathology • Seed Mycoflora: Detection of Seed borne pathogens by- i) Washing test ii) Incubation method: a) Blotter method b) Agar plate method • Seed Pathology: Management of Seed borne diseases - i) Chemicals ii) Antibiotics iii) Biological control agents iv) Host – Resistance in disease management		**1**
<u>Unit III:</u> Cultural Studies and Fungal Toxins • Cultural Studies in Fungi: Preservation techniques of fungal cultures – i) Sub-culturing ii) Storage under mineral oil iii) Storage in distilled water iv) Storage by drying v) Storage by freezing		**1**

• Fungal Toxins: Mycotoxins- historical background, detection, estimation, effect on human /animal health. • Mycotoxins and their types i) Alternaria Toxins ii) Citrinin iii) Ochratoxins iv) Patolin v) Penicillic Acid vii) Sterigmatocystin viii) Zearalenone	
<u>Unit IV:</u> Industrial Mycology • Fungal bio-conversions of Lignocellulose materials i) Lignocellulose ii) Potential bio-products and their applications • Fungal bioremediation • Food Industry- SCP single cell protien- advantages and disadvantages, production of yeast biomass, production of mycoproteins, traditional fungal foods (Shoyu, Miso, Sake, Tempeh)	**1**

PSBOMPPP403	**Mycology and Plant Pathology**	2	4
• Study of the following fungal types with reference to theirsystematic position, thallus and reproductive structures: i) *Achlya* *ii) Allomyces iii) Cyathus iii) Uromyces iv)Curvularia* • Problems in Nomenclature • To study effect of different nitrogen sources on fungal growth in term of biomass • Light as physical factor influencing fungal growth & sporulation • Isolation of fresh water fungi by baiting technique. • Study of effect of relative humidity on fungal growth ($CaSO_4.5H_2O$ - 98%, KCl-85% & $CaNO_3.4H_2O$ -52%) • Study of different symptoms of plant diseases: i) Wilting ii) Leaf spot iii) Canker iv) Leaf mosaic • Study of Seed Surface Mycoflora by Dry Seed Agar Plate technique .& Micrometry: Measurement of spores of fungal pathogens • Detection of Mycotoxins by Paper Chromatographic method • Preparation of slants by Sub-culturing of fungal culture from pour plate culture /slide culture • Percent infection and spore count of AMF from rhizosphere soils. • Study of wood rotting fungi: i) *Pleurotus ii) Schyzophyllum iii) Auricularia* iv) *Hexagonia* • Collection of fungal specimens, tour report, submissions of the fungal specimens			

PSBOMPPP404	Research methodology will be discussed and well defined material and methods, discussion, results and conclusions, references and its presentation based on some advanced techniques in Botany	2	4

Specialization: Plant Physiology and Biochemistry (PPB)

Course Code	Topic	Credits
PSBOPPB403	**Plant Biochemistry**	**4**
UNIT I: Lipid metabolism • Synthesis and Function of membrane, structural & storage lipids, Omega fatty acids, beta oxidation of odd and even carbon containing fatty acids		**1**
Unit II: Amino acid metabolism • Biosynthesis of Amino Acids (Proline, Glycine, Aspergine, Tryptophan, Phenylalanine), Regulation of amino acid biosynthesis.		**1**
Unit III: Cytosolic carbon and Mitochondrial metabolism • Synthesis and breakdown of Sucrose and starch, regulation of Glycolysis and Gluconeogenesis. Catabolic role of the TCA cycle, Anabolic role of the TCA cycle intermediates, anapleurotic CO_2 fixation, provision of acetyl CoA for biosynthesis, Regulation of TCA.		**1**
Unit IV: Senescence • Pigment Metabolism, protein metabolism and oxidative metabolism during senescence. Programmed cell death (PCD) an overview.		**1**

Course Code	Topic	Credits
PSBOPPB404	**Plant Physiology**	**4**
UNIT I: PGR's • Modulation of plant genomes by natural PGRs- Auxins, GA,		**1**

Cytokinins, Ethylene & ABA.	
<u>UNIT II:</u> Phytoremediation • Types of Phytoremediation- Advantages & limitations, Remedial measures- Rhizosphere based & Plant based, Hyper accumulators • Role of genetic engineering & various enzymes in phytoremediation	**1**
<u>UNITIII:</u> Sensory Photobiology • Structure, function and mechanism of phytochromes cryptochromes and phototropins, phytochrome induced whole plant response, Molecular basis of flower organization: MADS box genes and their expression. Problems based on ABC model for flower organization	**1**
<u>UNIT IV: Secondary Metabolism</u> • General biosynthetic pathways in the formation of secondary metabolites Biosynthesis and role of Phenols, Phenylpropanes, Coumarinns, lignins, flavonoids, alkaloids, tannins, and terpenes.	**1**

PSBOPPBP403	**Plant Biochemistry**	2	4
• Estimation of Saponification & Iodine Value of Fats and Oil • Measurement and Characterization of Chlorophylls and Carotenoids by Spectroscopy at different stages of Senescence. • Estimation of Tryptophan. • Study of enzymes SDH and effect of inhibitors on its activity. • Estimation of polyphenols. • Extraction & separation of Glucosinolates from Mustard • Extraction & separation of Piperine from *Piper* • Extraction & separation of lycopene from *Lycopersicum*			
PSBOPPBP404	Research methodology will be discussed and well defined material and methods, discussion, results and conclusions, references and its presentation based on some advanced techniques in Botany	2	4

Specialization: Angiosperm and Phytochemistry (ANP)

Course Code	Topic	Credits
PSBOANP403	**Angiosperms &Phytochemistry –III**	**4**
UNIT I: Approaches to Angiosperm Taxonomy • Study the following families with reference to its systematic position, distribution, salient features, floral formula, floral diagram, morphological peculiarities, economic importance, present status, affinities, phylogeny and interrelationships: Anacardiaceae, Oleaceae , Plumbaginaceae, Sapotaceae, Bignonaceae, Caryophyllaceae , Loranthaceae, Urticaceae, Casuarinaceae and Araceae		**1**
Unit II: Anatomy • Fruit and seed anatomy. • Evolution of Tracheary elements • Types of stomata (Follow Dilcher's Classification)		**1**
Unit III: Medicinal plant biotechnology • **Genetics as applied to medicinal herbs**: Mutation; polyploidy, chemodemes; artificial mutation; hybridization; genetic engineering and recombinant DNA technology • **Plant tissue culture as source of biomedicinals**: types of cultures; culture mediums; surface sterilizationof explants; establishment of cultures; phytopharmaceuticals in plant tissue culture; bioproduction of useful metabolites in hairy root and multiple shoot cultures • **Introduction to biogenesis of phytopharmaceuticals**: biosynthesis of alkaloids; isoprenoid compounds & triglycerides.		**1**
Unit IV: Methods in Evaluating Crude Drugs • History, origin, characteristics, uses, present status and varieties of Ginger, Chilly, and Eucalyptus. • Psychoactive drugs: Narcotics, Hypnotics and Hallucinogens: Introduction to Narcotics, Hypnotics and Hallucinogens; biological source, chemical constituents and uses, effects; cultivation, collection, processing of *Erythroxylum coca*, Opium & *Cannabis* • Fumitories and Masticatories: Introduction to Fumitories & masticatories, biological source, chemical constituents and uses & effects; cultivation, collection, processing of tobacco; Betel leaves & areca nut		**1**

• Mild stimulants: tea, coffee, cocoa • Detection of adulterants and quality testing of crude drugs	

Course Code	Topic	Credits
PSBOANP404	**Angiosperms &Phytochemistry –IV**	**4**

UNIT I: Progressive Taxonomy
• Internet
  o Taxonomic databases
• Present status and future scope of Taxonomy in India
  o Vegetation survey
  o Floristics
  o Revisionary and monographic studies
  o Ethnobiological studies
  o Development and establishment of new herbaria
• Global Positioning System in vegetation studies
		1

Unit II: Tools of Taxonomy
• **Library**
  o Literture:definition,origin,History and Evolution of Literature of Taxonomy in India.
  o Classification of Taxonomic Literature: Checklist, Catalogue, Floras, Monographs, Revisions, Encyclopedias, Indices, Dictionaries, Journals.
• **Museum(Herbarium)**
  o Definition, Steps involved in development of a herbarium, Maintenance of Herbarium, General account of Herbaria in India. Role of B.S.I in Herbaria, Private herbaria, Herbarium of KEW, Utility and importance of Herbaria in Taxonomy.
• **Garden**
  o Origin, History and Development of gardens in India
  o Types of Gardens
  o Role of gardens in taxonomic studies
  o Preservation of germ-plasm techniques and its importance in taxonomy.
		1

Unit III: Applied Taxonomy • **Remote Sensing** o History, Principles and types of Remote sensing		**1**

o Advantages and limitations of remote sensing o Applications of Remote Sensing in Vegetation Classification and Forest resource Management. o Remote sensing of soil and water • **Plant quarantine** o Purpose o Historical account o Plant protection organization o Exclusive quarantine o Regular quarantine o Domestic quarantine o Certification of plant materials • **Green -belt planning** o Concept and recommendations o Utility of GBP o List of plants (ornamental, Flowering, shade loving) o Importance of Green Belt in the current environmental conditions in India • **Relevance of taxonomy** o Taxonomy and conservation of bioresources o Taxonomy and sustainable utilization of bioresources o Taxonomy and ecosystem research	
Unit IV: Evolution of Reproductive elements • Stamens and evolution of stamens. • Carpel and evolution of carpels based on position and placentation • Placentation and its types, evolution of placentation • Evolution of fruits in angiosperms	**1**

PSBOANPP403	**Angiosperms &Phytochemistry –III**	2	4
• Study of Angiosperm families mentioned for theory with reference to morphological peculiarities, floral diagrams and economic importance of its members with the help of locally available plants. • Study of fruit anatomy o Study of dehiscent fruit: Lady finger, *Alstonia*, *Linum*, *Phaseolus* o Study of indehiscent fruit: Lotus, *Physalis*, Maize, wheat o Study of fleshy fruit: *Citrus* o Study of Pome: Apple • Study of seed coat structure in Cotton, *Ludvigia*, *Bauhinia*, Castor, Pumpkin,			

Canna. • Detection of adulterants in the following samples on the basis of organoleptic, microscopic and physico-chemical evaluation. o Tobacco leaves (adulterant *Diospyros* leaf) o Pepper fruits (adulterant lantana fruits/papaya seeds) o *Terminalia arjuna* bark (*Terminalia tomentosa*) • Extraction and detection of alkaloids from Tobacco using TLC. • Extraction and detection of tannins from Areca nut using TLC. • Extraction and detection of Volatile oils from Betel leaves using TLC. **Note:** 1. Compulsory visit to Western Ghats for observation of plants (at least for three days). 2. Compulsory excursion for observation of plants (local, atleast 2 in each term) Same Field diary to be continued from Sem I, II, III.			
PSBOANPP404	Research methodology will be discussed and well defined material and methods, discussion, results and conclusions, references and its presentation based on some advanced techniques in Botany	2	4

Specialization: Molecular Biology, Cytogenetics and Biotechnology (MCB)

Course Code	Topic	Credits
PSBOMCB403	**Plant Biotechnology**	**4**
UNIT I: Environmental Biotechnology • Biosorption: use of fungi, algae and biological components • Biomass for energy:Sources of biomass, advantages &disadvantages, uses of biomass • Biogas production from food processing waste: vegetable canning waste,,flour,mollases etc • Ethanol from biomass and Lignocellulosic residue • Risks of GMO		**1**

<u>Unit II:</u> Traditional Knowledge & IPR • Different property rights & IPR in India • TRIPS &Patent laws: Introduction & standards for patent protection • WTO& Indian Patent Laws • Protection of traditional knowledge– objective, concept of traditional knowledge, holders, issue concerning, bio-prospecting and biopiracy; Advantages of IPR , some case studies • International Depository authority ,Gene patenting, plant variety protection ,trade secrets & plant breeders right	**1**
<u>Unit III:</u> Nanotechnology • Introduction, properties of nano-materials. • Green synthesis of nano-materials, biological methods, use of microbial system & plant extracts, use of proteins & templates like DNA • Application of nano-materials in food, cosmetics, agriculture, environment management and medicine • Risk of Nanomaterial to human health and Environment	**1**
<u>Unit IV:</u> Food Biotechnology • Factors affecting spoilage • Quality control of food • Enzyme immunoassays (ELISA) • Radioimmunoassay (RIA), Monoclonal antibodies and DNA probes.	**1**

Course Code	Topic	Credits
PSBOMCB404	**Molecular Biology and Cytogenetics**	**4**
<u>UNIT I:</u> Plant Breeding I • Aims and objectives, plant introductions and acclimatization. • Selection – mass, pure line and clonal. • Hybridization techniques, hybridization in self pollinated and cross pollinated plants. • Genetic control and manipulation of breeding systems including male sterility and apomixes		**1**

<u>Unit II:</u> Plant Breeding II • Distant hybridization: In nature (plant breeding) – Barriers to the production of distant hybrids; Unreduced gametes in distant hybridization; Sterility in distant hybrids; Consequences of segregation in distant hybrids; 2.Applications and Achievements of distant hybridization in crop improvement; Limitations of distant hybrids.	**1**
<u>Unit III:</u> Molecular plant Breeding (Transgenic Crops) • Natural method of gene transfer (*Agrobacterium* and virus), selectable markers • Artificial methods of gene transfer: Direct DNA uptake by protoplast, electroporation, liposome mediated and particle gun transformation • Production of Transgenic plants :virus resistant & Herbicide –resistant, plants, Bt Cotton, Golden rice	**1**
<u>Unit IV:</u> Plant Genetic Engineering • Production of bio pharmaceuticals in transgenic plants. • Edible vaccines & Plantibodies • DNA-based molecular marker aided breeding: RAPD, RFLP, AFLP, STS, ISSR, Microsatellites	**1**

PSBOMCBP403	**Plant Biotechnology**	2	4
• Identification of mutant genotype in Drosophila and Arabidopsis stocks maintained by the department. • Field exploration for detection of male sterile plants and estimation of their pollen fertility in locally grown plants (Tomato, Brassica, Linum). • Study of mitotic index. • Culturing of Drosophila and study of genetic traits. • Blood group testing. • Identification of genetic diseases by chemical tests. • Karyotypes of genetic disorders.			
PSBOMCBP404	Research methodology will be discussed and well defined material and methods, discussion, results and conclusions, references and its presentation based on some advanced techniques in Botany	2	4

Specialization : Environmental Botany (EB)

Course Code	Topic	Credits
PSBOEB403	**Recent Trends & Applied Environmental Botany**	**4**
<u>UNIT I:</u> Pollution • **Environmental Polllution:** o Photochemical smog-Concept, London type smog, inhibition, adverse effect of photochemical smog. Types of particulate matter, removal of particulate matter from air. o Radiation- Manmade and natural, biological effects of radiation. Maximum permissible doses. Abnormal exposures in emergencies and accidents. Nuclear fission and radiation hazards Radioactive waste management. o Fossil fuels automobile emmissions from vehicles. Alternate fuels-CNG, Propane and methanol. o Environmental impact of petroleum products-Impact of crude oil on marine life		**1**
<u>Unit II:</u> Climatic Change • Global Climate Change: Concept, Green House Gases, Their Major Sources, Ozone Layer • Consequences Of Climate Change (CO_2 Level, Global Warming, UV Radiation). • Kyoto Protocol: Major Recommendations, • Concept Of Carbon Footprint, Carbon Credits, Importance Of Carbon Foot Printing.		**1**
<u>Unit III:</u> Plant Population Dynamics • Population - Characteristics And Measurement; Communities - Habitats, Niches, Population Dynamics, Species And Individual in the Ecosystem. • **Allelopathy:** Concept, Allelochemicals, Leachates, Root Exudates, Weed – Crop Interactions, Weed Control, Herbicides From Natural Compunds, Methods For Determining Allopathy, Petriplate Experiments,Allelochemicals As Nematicides(Narwals Work) • **Stress ecology:** Stress and plant life stress due to temperature, radiation, water, salt and anthropogenic activity, • Bioidicators of stress.		**1**
<u>Unit IV:</u> Coastal Zone Management In India • Coastal Zone Management In India- Coastal Environment India, Coastal Issues,		**1**

Land Use and Changes • Coastal Zone Management, initiatives In India, Prohibited and Regulated activities in Coastal Areas, State Coastal Zone Management Authorities. • Mangrove: Habitat And Characteristics, Mangrove, Plantation-Establishment and Rehabilitation of degraded mangrove formations; silvicultural systems. • Mangrove protection of habitats against natural disasters.	

Course Code	Topic	Credits
PSBOEB404	**Recent Trends & Applied Environmental Botany**	**4**
<u>UNIT I:</u> Restoration Of Ecosystems I • Urban Forests. Role of Urban Forests. Study of Urban Health Through Surveys Of Urban Trees • Holistic approach to study- Industrial Areas, Population and their Habitats, water and Waste Disposal. • Transportation, Infrastructure, Education, Health, Sport And Entertainment. Amenities And Cultural Issues- And Relationship of all these With Plants. • Urban Issues: Urban Challenges, Urban Transport System, Energy Demand • Case Study: Mumbai and Kolkata, with reference to: o Air Pollution, Noise Pollution Water Pollution. o Restoration efforts Gardens, design of Waste Management, waste storage Transportation, reclamation. o Urban forestry and ecotourism		**1**
<u>Unit II:</u> Restoration Of Ecosystems II • Restoration Of Mangrove Ecosystem- Mangroves of coastal Maharashtra, Selection and Treatment Of Coastal Area with Reference to Tidal situation and Physical Properties. • Restoration of Mangroves: Choice of Species, Collection of Seeds and Seedling Material, Storage and Plantation. • Problems of Seed Dormancy, Tidal Forces, Predation Nutrient Supply and restoration methods. • Disaster management: Natural calamities and their impact, PEER – Program for enhancement of Emergency response and LCA –Life cycle assessment.		**1**
<u>Unit III:</u> Restoration of Land • Solid waste management: Classification of waste, waste generation, separation and processing, waste treatment and disposal , Factors governing the choice of technology		**1**

• Municipal solid waste management and handling rules 2013, Responsibilities of Municipal authorities, state and Central control Boards, Management of municipal soild waste (MSW act 2013). • Biological treatment of waste water from food processing Industry • Biopesticides and integrated pest management • Microbial transformation of heavy metals	
<u>Unit IV:</u> Water Shed management • Concepts of watershed; role of mini-forests and forest trees in overall resource management, forest hydrology • Watershed development in respect of torrent control, river channel stabilization, avalanche and landslide controls, rehabilitation of degraded areas; hilly and mountain areas • Watershed management and environmental functions of forests; • Water-harvesting and conservation; ground water recharge and watershed management; role of integrating forest trees, horticultural crops, field crops, grass and fodders	**1**

PSBOEBP403	**Ecology and Environmental Botany**	2	4
• Comparative study of Foliar Dust Capturing Capacity from Different Plant Species (minimum five) collected from polluted and unpolluted sites. • Comparative study of Water Turbitdity of Sea Water, Pond Water, Polluted Water • Comparative study of Biological Oxygen Demand Value For Industrial Waste effluent collected from any two sites. • Comparative study of Chemical Oxygen Demand Value For Industrial Waste effluent collected from any two sites. • Measurement of sound using decibel meter in different areas, at different time. • Identification of Mangroves • Determination of Water, Ascorbic Acid content and pH of Leaf collected from polluted and unpolluted sites. • Study of mangrove: Field report			
PSBOEBP404	Research methodology will be discussed and well defined material and methods, discussion, results and conclusions, references and its presentation based on some advanced techniques in Botany	2	4