

As Per NEP 2020

University of Mumbai



Title of the program

- A-P.G. Diploma in Botany (One year) } 2023-24
B-M.Sc. (Botany) (Two year) }
C-M.Sc (Botany) (One year) - 2027-28

Syllabus for

Semester – Sem I & II

Ref: GR dated 16th May, 2023 for Credit Structure of PG

Preamble

The National Education Policy 2020 emphasizes to provide students with quality education in the context of sustainable development and inculcate in them self-learning aptitude, scientific temper, moral values and social responsibilities. The MSc Part 1 syllabus has been designed as per the objectives and guidelines of National Education Policy 2020. The present syllabus is concerned with imparting knowledge related to Plant Sciences, Current trends and advanced developments in the field of Plant Sciences and its interdisciplinary branches.

In current situation of climate change and environment degradation, sustainable development in proper direction is the need of the hour. The syllabus includes topics of social concerns so that the students can be responsive citizens with their small contributions in day-to-day life.

The course is based on experiential learning as well as self-study initiatives. The course includes topics that will enhance the creative and critical thinking aptitude of the students and develop their research skills.

It also has professional skill-based components which are practical based. Electives like Food processing, Dietetics and Biotechnology fulfill the growing demands of industry concerns. The courses also have self-employment potential itself.

Thus, the course is a unique amalgamation of core and elective papers with a holistic approach to develop the students academically, socially and in terms of research and employability.

**PROGRAMME SPECIFIC OUTCOMES
FOR M.Sc. (BOTANY)
AT THE END OF SEMESTER I AND II**

THE STUDENTS WOULD HAVE ACQUIRED THE FOLLOWING SKILLS:

1. Students will be able to identify the major groups of organisms amongst plants and be able to classify them within a phylogenetic framework. Students will be able to compare and contrast the characteristics of Cryptogams and Phanerogams that differentiate them from each other and from other forms of life.
2. Students will be able to explain how organisms function at the level of the gene, genome, cell, tissue, organ and organ-system. Drawing upon this knowledge, they will be able to give specific examples of the physiological adaptations, development, reproduction and behaviour of different forms of life.
3. Students will be able to explicate the ecological interconnectedness of life on earth by studying ecological principles and nutrient flow through the environment. They will be able to relate the physical features of the environment to the structure of populations, communities, and ecosystems.
4. Students will be able to use the evidence of comparative biology to explain how the theory of evolution offers the only scientific explanation for the unity and diversity of life on earth. They will be able to use specific examples to explicate how descent with modification has shaped plant morphology, physiology, and life history.
5. Students will be able to carry out a thorough study of the active constituents of medicinal plants with an emphasis on the use of plant based food as medicine.
6. Students will be able to demonstrate proficiency in the experimental techniques and methods of analysis appropriate for understanding the above.

**Credit Distribution Structure for Two Years/ One Year PG
M. Sc. (Botany)**

Year	Level	Sem	Major		RM	OJ T/ FP	RP	Cum. Cr.	Degree	
			Mandatory	Electives						
1	6.0	Sem I	4+4+ 2 +2+2 =14		2+2	4	-	22	PG Diploma (after 3 Years Degree)	
			Course: I Plant Diversity-I I. Algae II. Fungi III. Gymnosperms IV. Angiosperms	T H	4	Course: V Industrial Application of Botany I Algae & Fungi II: Lichens, Gymnosperms & Angiosperms Practicals based on Course V (OR) Biotechnology I Genetic Engineering & Tissue culture II: Nanotechnology & Biosafety and Bioethics Practicals based on Course V				Research Methodology
			Course: II Plant Physiology and Cytogenetics I. Photosynthesis II. Proteins III. Cytogenetics I IV. Cytogenetics II	T H	4					
			Course: III Molecular Biology and Recombinant DNA technology I. Molecular Biology II. Recombinant DNA technology	T H	2					
			Course:IV Practicals based on Course I, II, III I,Practical I II.Practical II	P R	2 + 2					
Cum. Cr. For PG Diploma			14	4	4		22			
Exit Option: PG Diploma (44 credits) after Three Year UG Degree										

Year	Level	Sem	Major		RM	OJT/FP	RP	Cum. Cr.	Degree	
			Mandatory	Electives						
1	6.0	Sem. II	4+4+ 2 +2+2 =14		2+2	4	OJT	-	22	PG Diploma (after 3 Years Degree)
			Course I Plant DiversityII I. Bryophyta II. Pteridophyta III. Anatomy IV. Developmental Botany & Palynology	TH	4	Course V Dietitics and Food Technology I. Dietitics II. Food Technology Practicals based on Course V (OR) Environmental Studies I. Natural Resources & Coastal Zone Management in India II. Ecotoxicology & Public Participation for Environmental Protection Practicals based on Course V				
			Course II Plant Physiology and Environmental Botany I Seed Physiology II. Stess Physiology III. Environment, Biogeography & Population Ecology IV. Climate Change	TH	4					
			Course III Medicinal Botany I. Medicinal Botany I II. Medicinal Botany II	TH	2					
			Course IV Practical based on Practical based on Course I, II, III I, Practical I II. Practical II	PR	2+2					
Cum. Cr. For PG Diploma			14	4		4		22		
Exit Option: PG Diploma (44 credits) after Three Year UG Degree										



Sign of Chairperson _____
 Name of the Chairperson: **Dr. Smita Jadhav**
 Name of the Department: Botany



Sign of Dean _____
 Name of the Dean **Dr. Shivram Garje**
 Name of the Faculty _____

SEM. - I

COURSE OUT COMES

COURSE CODE	TITLE AND LEARNING OUTCOMES
PSBO501	<p>Plant Diversity I The students will be able to:</p> <ul style="list-style-type: none"> ● Classify algae into various groups, understand the importance in various fields and will be able to collect and identify them. ● Classify fungi into various groups, understand the role of fungi in various fields and will be able to collect and identify fungi, fungal pathogens and culture them. ● Differentiate between gymnosperms and angiosperms, study their origin and nomenclature, understand evolutionary theories for origin of Angiosperms, understand characteristics of selected Angiosperm families and learn the rules governing the code of botanical nomenclature, also learn the recent developments as in molecular systematics.
PSBO502	<p>Plant Physiology and Cytogenetics</p> <ul style="list-style-type: none"> ● Students should be able to understand how to apply the basic concepts of Plant Physiology in other fields and also to know and discuss the concept of physiological processes of plants. ● Students will be able to understand the control points in a cell cycle.
PSBO503	<p>Molecular Biology and Recombinant DNA Technology</p> <ul style="list-style-type: none"> ● Students will be able to understand and apply principles of microbial genetics, ● Understand Recombinant DNA technology and study applications of the same for the improvement of crops.
PSBO601	<p>Plant Diversity- II The student will be able to:</p> <ul style="list-style-type: none"> ● Classify Bryophytes into various groups, study their importance. ● Classify Pteridophytes into various groups, study their importance and multiplication of important ferns. ● Understand the development of pollen, spore, fertilization and to apply palynological information to plant systematics.
PSBO602	<p>Plant Physiology and Environmental Botany The students should be able to:</p> <ul style="list-style-type: none"> ● Distinguish key physiological processes underlying the seed germination. ● Identify the physiological factors that regulate growth and developmental processes of plants. ● Demonstrate clear understanding of crop-environment interaction and its implication on crop growth and yield. ● Integrate and apply their knowledge of crop physiology for analytical thinking and solving practical problems experienced in agricultural systems. ● To understand and apply ecological principles and understand legislation and measures to solve environmental problems.
PSBO603	<p>Medicinal Botany Students will be able to</p> <ul style="list-style-type: none"> ● Identify medicinal plants and understand the effects of plant chemical constituents on humans.

M.Sc. (Botany) Syllabus
Choice Based Credit System
To be implemented from the Academic year 2023--2024

SEMESTER I

Course Code PSBO501	Title of the Paper- Plant Diversity- I		Course No. 1	
	I	Algae	4	1
	II	Fungi		1
	III	Gymnosperm		1
	IV	Angiosperm		1

SEMESTER I

Course outcomes

The students will be able to:

CO1: Classify algae into various groups, understand the importance in various fields and will be able to collect and identify them.

CO2: Classify fungi into various groups, understand the role of fungi in various fields and will be able to collect and identify fungi, fungal pathogens and culture them.

CO3: Differentiate between gymnosperms and angiosperms, study their origin and nomenclature, understand evolutionary theories for origin of Angiosperms.

CO4: Understand characteristics of selected Angiosperm families and learn the rules governing the code of botanical nomenclature, also learn the recent developments as in molecular systematics.

Course Code	Topic	Credits: 4
PSBO501	Plant Diversity- I	
UNIT 1	<p><u>Algae:</u></p> <ul style="list-style-type: none"> ● Life cycle of <i>Scytonema</i>, <i>Nitella</i>, <i>Padina</i> and <i>Dictyota</i>. ● Diversity and distribution of marine algae in Maharashtra. ● Contributions of Eminent Algologists in India: M. O.P. Iyengar and T. V. Desikachary. 	1
UNIT 2	<p><u>Fungi:</u></p> <ul style="list-style-type: none"> ● Life cycle of <i>Saprolegnia</i>, <i>Daedalea</i>, and <i>Trichoderma</i>. ● Study of the following diseases with reference to occurrence, symptoms, causal organism, disease cycle, predisposing factors and control measures of the following diseases: a. Red rot of Sugarcane (<i>Colletotrichum falcatum</i>) 	1

	b. Blast of Rice (<i>Pyricularia oryzae</i>) c. Wilt of Arhar/ Tur (<i>Fusarium oxysporum</i>) d. Green ear of Bajra (<i>Sclerospora graminicola</i>) Mycorrhiza: type, distribution and significance with reference to agriculture and forestry.	
UNIT 3	<u>Gymnosperm:</u> <ul style="list-style-type: none"> • Classification of Gymnosperms up to orders according to the system proposed by C. J. Chamberlain. • General characters; affinities and interrelationships of Cycadofilicales, Bennettitales, Cordaitales and Ginkgoales. • Life cycle of <i>Cupressus</i> and <i>Araucaria</i> 	1
UNIT 4	<u>Angiosperms:</u> Study of following families with reference to its systematic position, distribution, floral formula, floral diagram, affinities, morphological peculiarities, economically important plants and their uses: Brassicaceae, Portulacaceae, Sterculiaceae, Rutaceae, Celastraceae, Lythraceae, Chenopodiaceae, Acanthaceae.	1

Course Code PSBO502	Title of the Paper- Plant Physiology and Cytogenetics Course No. II			
	I	Photosynthesis	4	1
	II	Proteins		1
	III	Cytogenetics I		1
	IV	Cytogenetics II		1

Course outcomes

Students should be able to understand

CO1: How to apply the basic concepts of Plant Physiology in other fields and also to know and discuss the concept of physiological processes of plants.

CO2: The control points in a cell cycle, Study and apply principles of microbial genetics, understand recombinant DNA technology and study applications of the same for the improvement of crops.

Course Code	Title	Credits
PSBO502	Plant Physiology and Cytogenetics	4
Unit 1	<p><u>Photosynthesis (Eukaryotes)</u></p> <ul style="list-style-type: none"> ● ATP synthesis in chloroplasts (chemiosmotic hypothesis) ● Regulation of C3, C4 and CAM pathways of photosynthesis: <ul style="list-style-type: none"> ○ C3 plants: Role of light, regulation of RUBISCO ○ C4 plants: Role of light, regulation of PEPcase, transport of metabolites, carbonic anhydrase, NADP-MDH and PPDK ○ Regulation of CAM through transport of metabolites. ● Pentose Phosphate Pathway and its importance, effect of glucose-6-phosphate dehydrogenase deficiency. 	1
Unit 2:	<p>Proteins</p> <ul style="list-style-type: none"> ● Primary, secondary, tertiary and quaternary structural features and their analysis – Theoretical and experimental. ● Protein folding – biophysical and cellular aspects, ● Role of chaperons in protein folding. 	1
Unit 3:	<p>Cytogenetics I</p> <ul style="list-style-type: none"> ● Check points during cell cycle-G1 to S, progression of S phase, G2to M phase. Anaphase check points and components involved as regulators of check points. ● Role of cyclins and CDKs, synthesis and degradation of cyclins, structural features of CDKs and cyclins, activation and inactivation of CDKs; role of E2Fs, and DP proteins, P53, different types of Cyclin dependent CDKs, CDC25, CAKs, Wee1 proteins, nim-proteins, SCFs. ● Anaphase Promoting Complexes APC (cyclosomes), replication origin and replication initiation complexes. 	1
Unit : 4	<p>Cytogenetics II</p> <ul style="list-style-type: none"> ● Centrosome activation- structure, duplication of centrosomes. ● Role of nucleophosmins, organization of mitotic apparatus, binding of tractile fibers to kinetochore complexes, molecular motors involved in movement of chromosomes to equatorial plate and in anaphase movement. ● Cytokinesis by cleavage and phragmoplast formation- different gene products and structures involved and the mechanisms of cytokinesis. 	1

Course Code PSBO503	Title of the Paper- Molecular Biology and Recombinant DNA Technology		Course No. III
	I	Molecular Biology	1
	II	Recombinant DNA Technology	1

Course Outcomes:

CO1: Students will be able to understand and apply principles of microbial genetics,

CO2: Understand recombinant DNA technology

CO3: Study applications of the same for the improvement of crops.

Course Code	Title	Credits
PSBO503	Molecular Biology and Recombinant DNA Technology	2
Unit I	Molecular Biology <ol style="list-style-type: none"> 1. Microbial Genetics: Molecular basis of transformation, Transduction, Conjugation; 2. Fine structure of the gene, T4 Phage, complementation analysis, deletion mapping, cis-trans tests. 3. Tetrad analysis in Neurospora: Linkage detection (2 genes and centromere) 	1
Unit 2	Recombinant DNA Technology <ol style="list-style-type: none"> 1. Strategies to create Transgenic plants with herbicide resistance: Following strategies to be studied in detail with reference to herbicide Glyphosate resistance: <ol style="list-style-type: none"> a) Overexpression of the target protein by using a strong promoter. b) Improved plant detoxification resulting in a more and faster conversion of toxic herbicide to non-toxic or less toxic compounds. c) Detoxification of herbicide by using a foreign gene. d) Mutation of target protein 2. Improvement of nutritional content and Quality: <ol style="list-style-type: none"> a) Increase in sweetness and flavor in fruits and vegetables for e.g., Monellin b) Gene from African plant (<i>Dioscoreophylum cumminsii</i>)- introduction in tomato and lettuce c) Increase and change in the quality oils in <i>Brassica</i> species (increase in medium chain fatty acids and converting unsaturated fatty acid to saturated fatty acids). d) Increase in starch content (potato). 	1

Course Code PSBO505A	Title of the Paper- Industrial Application of Botany		Course No. V	
	I	Algae & Fungi	2	1
	II	Economic Botany		1

Course Outcomes:

CO1: At the end of the course the students will be able to understand industrial applications of Botany

CO2: Practice the knowledge of Industrial applications of Botany.

CO3: Apply the acquired knowledge of Industrial applications of Botany.

Course Code	Title: Industrial Application of Botany	Course No. V	Credits
PSBO505A			2
Unit I	<p>Algae</p> <ul style="list-style-type: none"> ● Introduction to Industrial Applications of Algae ● Overview of algae as a valuable resource for various industries ● Industrial uses of algae in food, pharmaceuticals, biofuels, and bioremediation <p>Algal Bioremediation</p> <ul style="list-style-type: none"> ● Role of algae in wastewater treatment and nutrient removal ● Algae as a tool for carbon dioxide capture and utilization ● Algae-based bioremediation of pollutants and heavy metals <p>Fungi</p> <p>Fungal Biotechnology and Enzyme Production</p> <ul style="list-style-type: none"> ● Industrial applications of fungi in enzyme production: amylases, cellulases, proteases, and lipases ● Fungal fermentation processes for enzyme production ● Downstream processing and purification of fungal enzymes <p>Fungi in Food and Beverage Industries</p> <ul style="list-style-type: none"> ● Role of fungi in food fermentation: bread, cheese, beer, and wine production ● Fungal cultures and starter cultures in food processing ● Flavor and aroma compounds produced by fungi 		1
Unit 2	<p>Lichens</p> <p>Lichens as Bioindicators and Environmental Monitors</p> <ul style="list-style-type: none"> ● Lichens as indicators of air pollution, heavy metal contamination, and climate change ● Monitoring lichen biodiversity and ecological health ● Use of lichens in biomonitoring programs and environmental assessments <p>Lichens in Dye Production and Textile Industry</p> <ul style="list-style-type: none"> ● Natural dyes and pigments obtained from lichens ● Traditional dyeing techniques and modern applications in the textile industry ● Sustainability aspects of using lichen dyes <p>Industrial Uses of Gymnosperms and Angiosperms</p>		1

	<p>Timber and wood products from gymnosperms: construction, furniture, and paper industries</p> <ul style="list-style-type: none"> ● Industrial crops and their applications: fibers, oils, resins, and rubber ● Ornamental plants and landscaping industry <p>Plant-based Natural Products and Cosmetics Plant-derived ingredients in cosmetics, skincare, and personal care products</p> <ul style="list-style-type: none"> ● Extraction methods and formulation techniques for plant-based cosmetics ● Market trends and consumer demand for natural and botanical products 	
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Course Outcomes:

On completion of the course students should be able to:

CO1: Understand the concept and applications of Genetic engineering.

CO2: Develop skills and gain knowledge of Tissue culture techniques.

CO3: Demonstrate clear understanding of Green synthesis of Nano technology.

CO4: Comprehend Biosafety and Bioethics in Biotechnology.

(Elective)		
Course Code: PSBO505B	Title: Biotechnology	Course V
Course Code: PSBO505B	Title: Biotechnology	Credit: 2
Unit I	Genetic engineering and its applications: <ul style="list-style-type: none">● Methods of modifying the Diazotrophs (N₂ fixing bacteria) by Gene alterations in <i>Rhizobium sp.</i>● Transgenic plants with insect resistance from microbes Tissue culture <ul style="list-style-type: none">● Impact of Cell and Tissue Culture on commercial applications and importance in Plant Science with special reference to Agriculture, Forestry, Horticulture, floriculture, production of ornamental plants, virus free plants;● Global market; Commercial opportunities in plant tissue culture with special reference to plant tissue culture industries in India.	1
Unit II	Nanotechnology <ul style="list-style-type: none">● Introduction, properties of nano-materials & Green synthesis of nano-materials,● Application of nano-materials in food, , agriculture, environment management and medicine. Biosafety and Bioethics <ul style="list-style-type: none">● Biosafety guidelines in India; International biosafety guidelines: OECD, FAO, WHO.● Introduction to bioethics; social and ethical issues in biotechnology: bioethics in genetic engineering.	1

Semester I

Course Outcomes:

The students will be able to,

CO1: Understand the concept of research and its types.

CO2: Develop skills of data collection and scientific documentation.

CO3: Comprehend the importance of ethics involved in research.

CO4: Familiarize the methods of scientific writing and reporting.

Course Code	Title	Credits
PSBO 506	Research Methodology	4
UNIT I	<p>Introduction to Research Methodology-</p> <ul style="list-style-type: none"> ● Introduction: Research Experimental design principles, Classification of Research- pure research, applied research; descriptive, experimental, historical, etc, Design of Survey, statistical methods, interpretation of results. ● Problem Identification & Formulation – Research area – Investigation – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null & Alternative Hypothesis. Hypothesis Testing – Logic & Importance, parametric and non-parametric. ● Review of literature: ● Library: Concepts of a scientific library, journals, books, E books, websites and Digital library and Data bases, NCBI-Pub Med. 	1
Unit II	<p>Referencing and Research</p> <ul style="list-style-type: none"> ● Qualitative and Quantitative Research: Concept of measurement, causality, generalization, replication. Merging the two approaches. ● Journals: Indexing journals, H-index, I -10, ISSN, ISBN, abstracting journals, research journals, review journals, e-journals, Impact factor of journals, UGC Care Journals. ● Reprints, Open access initiative, INFLIBNET, INSDOC, Shodh Ganga, etc. ● Google Scholar, Research Gate, LinkedIn, Orcid id, Scopus (Q1 to Q4), Web of Science, Boolean words. ● Preparation of index cards: Author index and subject index; Open source, bibliography management system. 	1

<p>Unit III</p>	<p>Research Scientific writing and Communication</p> <ul style="list-style-type: none"> ● Measurement: Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability, Consultation in Herberia and Library, authentication of plant material. Levels of measurement – Nominal, Ordinal, Interval, Ratio. ● Introduction to scientific writing: Meaning of Scientific and non-scientific writing; Scientific Vocabulary and grammar. Synopsis, Dissertations, Thesis, Posters. ● Correspondence: Formal letters and permissions (Forest department, State Biodiversity board, International authorities, Quarantine process, etc.), cover letters, drafting emails, replying to reviewers. ● Writing a Research article/ paper: Title, Abstract, Introduction, Review of literature, Methodology, Observations, Results, Discussions, Summary, Conclusion, and Bibliography (Referencing and citation styles), IMRAD format. Research ethic: Ethical issues related to publishing, Plagiarism and Self-Plagiarism. 	<p>1</p>
<p>Unit IV</p>	<p>Research Data Analysis, Tools and Project Proposal</p> <ul style="list-style-type: none"> ● Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism. ● Writing for Research Proposal Grant: Funding agencies, guidelines, structure of research proposals – Setting a budget (Manpower, Consumables, Equipment, Travel, Contingencies, Overheads) with justifications, Expected outcomes, Cost benefit analysis, Work plan, and Time schedule of activities. ● Presentations: Presenting numerical data - Graphical, Tabular, Animations, Slides, etc. ● Data analysis –SPSS, R (statistical software) and MS Excel. 	<p>1</p>

	SEMESTER I (Practical I)	Credits
	External	2
PSBOP501	Plant Diversity I	
1	Study of following type of algae with reference to their systematic position, thallus and reproductive structures: <i>Scytonema, Volvox, Scenedesmus, Ulothrix, Enteromorpha, Closterium, Padina, Gracilaria and Dictyota.</i>	
2	Extraction of algal pigments and their separation by Paper Chromatography.	
3	Study of the following types of fungi with reference to their systematic position, thallus and reproductive structures: <i>Saprolegnia, Penicillium, Daedalea, Fusarium and Trichoderma.</i>	
4	Study of the following diseases with reference to occurrence, symptoms, causal organism, disease cycle, predisposing factors and control measures of the following fungal diseases: <ul style="list-style-type: none"> • Red rot of Sugarcane (<i>Colletotrichum falcatum</i>) • Green ear of Bajra (<i>Sclerospora graminicola</i>) 	
5	Study of Gymnosperms and fossil specimens <ul style="list-style-type: none"> • <i>Cycadeoidea</i> (Fossil) • <i>Cupressus</i> 	
7	A study of the angiosperm families mentioned in theory with reference to their morphological peculiarities and economic importance of its members.	
	Internal	
1	Culturing of Spirulina algae	
2	Culturing of Penicillium by Streak method	
3	Study of the following disease with reference to occurrence, symptoms, causal organism, disease cycle, predisposing factors and control measures of the following fungal disease: <ul style="list-style-type: none"> • Blast of Rice (<i>Pyricularia oryzae</i>) 	
4	Study of Gymnosperms and fossil specimens <ul style="list-style-type: none"> • <i>Williamsonia</i> (Fossil) • <i>Araucaria</i> 	
5	Identification of genus and species of Angiosperm families using flora (In addition to the above-mentioned families, all families studied in undergraduate classes are included)	

SEMESTER I (Practical II)		
External		
PSBOP502	Plant Physiology and Cytogenetics, Molecular Biology	Credits 2
1	Quantitative study of diurnal fluctuation in Titratable Acid Number (TAN) in a CAM plant.	
2	Determine the Chl a / Chl b ratio in C 3& C 4 plants.	
3	A study of the enzyme polyphenol oxidase from potato peels.	
4	Solvent extraction of Chlorophyll a/b, Xanthophylls and study of absorption pattern.	
5	Immobilisation of yeast cells and study of invertase activity.	
6	Squash preparation from pre-treated root tips (Colchicine/ Paradichlorobenzene/ Aesculin).	
7	Problems based on: <ul style="list-style-type: none"> • Restriction map analysis and construction of restriction maps. • Tetrad analysis in <i>Neurospora</i> – two genes and centromere. • Deletion mapping in Bacteriophage. 	
Internal		
1	Determination of Km and Vmax of the enzyme amylase (purified amylase)	
2	Extraction and estimation of GOT and GPT from suitable plant material.	
3	Preparation of cytological stains, fixatives and pre-treatment agents.	
4	Smear preparation from any suitable plant material	

	SEMESTER II Elective (Practical)	
	External	Credits 2
PSBOP505A	Industrial Application of Botany	
1	Study of algae used in industries.	
2	Detection of mycotoxins by paper chromatography method.	
3	Estimation of total protein content from mushroom by Lowry's method/Biuret method.	
4	Economic importance of Lichens.	
5	Analyse wood density (Angiosperms and Gymnosperms) by Buoyancy method	
6	Medicinal and Industrial uses of Angiosperms and Gymnosperms	
	Internal	
1	Demonstration of algal cultivation using Bioreactor.	
2	Study of antibacterial effect of <i>Parmelia</i>	
3	Preparation of any personal care product using natural ingredients	

	SEMESTER II Elective (Practical)	
PSBOP505B	External	Credits 2
	Biotechnology	
1	Encapsulation of Axillary Bud.	
2	Inoculation of Explant.	
3	Green Synthesis of Silver nano particles using plant extract.	
4	Identification of Biosafety Symbols.	
	Internal	
1	Techniques of preparing Petri plate, Slant and Butt	
2	Fermentation of Sugarcane juice/fruit juice using Yeast (Kuhne's tube)	
3	Isolation and quantification of plant genomic DNA.	

M.Sc. Semester II Botany Syllabus
Choice Based Credit System
To be implemented from the Academic year 2023--2024

SEMESTER II

Course Code PSBO601	Title of the Paper- Plant Diversity- II		Course No. 1	
	I	Bryophyta	4	1
	II	Pteridophyta		1
	III	Anatomy		1
	IV	Developmental Botany & Palynology		1

Course Outcomes:

Upon successful completion of this course, the student will be able to:

CO1: Classify Bryophytes into various groups, study their importance

CO2: Classify Pteridophytes into various groups, study their importance and multiplication of important ferns.

CO3: The development of pollen, spore, fertilization and to apply palynological information to plant systematics.

Course Code	Title	Credits
PSBO601	Plant Diversity- II	4
Unit I: Bryophyta <ul style="list-style-type: none"> • Classification of Bryophyta, up to orders, according to the system proposed by G. M. Smith ,Diversity and distribution of Indian Bryophytes • Life cycle and Alternation of generations in <i>Pogonatum</i> . • Bryophytes: Applied aspects: Agriculture, medicine, Food technology and environmental aspects. • Contribution of Shiv Ram Kashyap and S. C. Srivastava in Bryology. 		1

<p>Unit II: Pteridophyta</p> <ul style="list-style-type: none"> • Classification of Pteridophyta, up to orders, according to the system proposed by G.M.Smith., Heterospory and seed habit • Life cycle of Pteris and Azolla • Cultivation and maintenance of ornamental ferns, Ethnomedicinal uses of Pteridophytes • A study of fossil Pteridophytes: <i>Horneophyton, Cladoxylon, Coenopteris</i>) 	<p>1</p>
<p><u>Unit III: Anatomy</u></p> <ul style="list-style-type: none"> • Meristems: Definition type of meristems, apical cell theory, histogen theory and Tunica corpus theory. • Morphogenesis and organogenesis in plants: phyllotaxy; transition of flowering, floral meristems and floral development. • Study of Secretory Tissue System: Introduction, Glands, Digestive glands, Nectaries, Resin ducts and oils ducts, Laticiferous ducts. • Wood Anatomy: Coniferous and Angiosperm wood Parenchyma: Storied and non-storied wood parenchyma, Distribution of axial parenchyma, Distribution of vessels, Structure of rays. 	<p>1</p>
<p><u>Unit : IV Developmental Botany</u></p> <ul style="list-style-type: none"> • Embryology: Male gametophyte: Pollen development and gene expression male sterility sperm dimorphism and hybrid seed production; pollen tube growth and guidance. Female gametophyte; Types of embryo sacs; structure of embryo sac cells. Endosperm- Types and importance. • Pollination: Evolutionary history of flowers and animals, introduction to pollinator syndrome; Floral attractants-: Olfactory, Floral scent biology. Ultrastructural and histochemical details of style and stigma, self and interspecific incompatibility, significance of pollen-pistil interaction, role of pollen wall proteins and stigma surface proteins, barriers to fertilization, in-vitro pollination. • Fertilization: heterospermy, syngamy and triple fusion, post-fertilization metabolic & structural changes in embryo-sac. • Palynology <ol style="list-style-type: none"> 1. Pollen Chemistry: Introduction, Chemical constituents of pollen-Major metabolites (Carbohydrates, Mineral content, Callose, Organic acids, Amino acids, Pigments, Vitamin. s, Hormones and steroids), Chemistry of pollen wall, 2. Utilization of pollen: Pollen as health food, Pollen as medicine, Pollen allergens for diagnosis and therapy. 	<p>1</p>

Course Code PSBO602	Title of the Paper- Plant Physiology and Environmental Botany		Course No. 2	
	I	Seed Physiology	4	1
	II	Stress Physiology		1
	III	Environment, Biogeography and Population Ecology		1
	IV	Climate Change		1

Course outcomes:

On completion of the course students should be able to

CO1: Distinguish key physiological processes underlying the seed germination.

CO2: Identify the physiological factors that regulate growth and developmental processes of plants.

CO3: Demonstrate clear understanding of crop-environment interaction and its implication on crop growth and yield.

CO4: Integrate and apply their knowledge of crop physiology for analytical thinking and solving practical problems experienced in agricultural systems.

CO5: To understand and apply ecological principles and understand legislation and measures to solve environmental problems.

Course Code	Title	Credits
PSBO602	Plant Physiology and Environmental Botany	4
UNIT I: Seed physiology: <ul style="list-style-type: none"> • Physiology and Biochemistry of seed germination, • Mobilization of food reserves, Germination and growth factors. • Seed dormancy, Control and release of seed dormancy. • Factors in control for the long-term storage of seeds, seed proteins. 		1
UNIT II: Stress Physiology: <ul style="list-style-type: none"> • Biotic and abiotic stress, Response of plants to Biotic (pathogenic and insects) stress • Adaptations to eliminate and tolerate the infection, Hypersensitive reaction. • Response of plants to abiotic stress - Drought stress, Heat stress - Heat shock proteins, Chilling, and freezing, Salinity stress • Signaling pathways activated during stress. 		1
UNIT III: The Environment, Biogeography and Population Ecology: <ul style="list-style-type: none"> • Environment: Components, Major components of physical environment, biotic and abiotic interactions • Biogeography: Major terrestrial biomes, Theory of island bio-geography • Bio-geographical zones of India. • Population Ecology: Characteristics of a population; population growth curves; population regulation. 		1

UNIT IV

1

Climate Change:

- Global warming, carbon credits, Kyoto mechanism.
- Factors responsible for climate change, Climate change in relation to the changes in patterns of temperature, precipitation and sea level rise, Impacts of Climate Change on various sectors – Agriculture, Forestry and Ecosystem.
- The Montreal Protocol, Paris Agreement, UNFCCC, IPCC.
- Adaptation Strategy/ Mitigation Measures, Blue carbon initiative.

Course outcomes:

Students will be able to

CO1: Identify medicinal plants.

CO2: Understand the effects of plant chemical constituents on human.

Course Code	Title- Medicinal Botany	Credits
PSBO603		2
	<ul style="list-style-type: none"> • Medicinal Botany I Monograph of drugs with respect to Biological source, Geographical distribution, macro and microscopic characters, chemical constituents and therapeutic uses of the following drugs: <ul style="list-style-type: none"> • Root:<i>Withania somnifera</i> (Ashwagandha) • Rhizome:..<i>Zingiber officinale</i>(Ginger) • Stem bark: <i>Holarrhena antidysenterica</i> (Kurchi) • Leaf:<i>Azadirachta indica</i> (Neem) • Fruit:<i>Foeniculum vulgare</i> (Fennel) • Seed:<i>Plantago ovata</i> (<i>Isabgol</i>) 	1
	<p>Medicinal Botany II</p> <ul style="list-style-type: none"> • Introduction to Pharmacopoeia: Indian pharmacopoeia and Ayurvedic pharmacopoeia. <p>Quality control of crude drugs:</p> <ul style="list-style-type: none"> ○ Morphological examination – Exomorphic characters and importance ○ Microscopical evaluation – Anatomical characters and importance ○ Preliminary phytochemical tests: Introduction and importance • Standardization parameters: Introduction, importance – Moisture content, Ash values, Solvent extraction value, bitterness value, foaming index, swelling index. 	1

Course outcomes:

At the end of the course the students will be able to:

CO1: Comprehend the nutraceutical value of food and human nutrition.

CO2: Understand the concept of food technology and processing.

CO3: Gain knowledge of food adulterants and their types.

(Elective)		Credits
PSBO605A Dietetics and Food Technology		2
UNIT I – Dietetics		1
1	Nutraceutical: Definition and Introduction, classification (Dietary supplements, functional foods, Medicinal food, Pharmaceuticals)	
2	Plant Food as medicine: Phytonutrients its types, food source and its benefits	
3	Concept of Antioxidants, their significance, Plants as a source of antioxidants	
4	Plant food in the treatment of diseases – hormones, arthritis, constipation, diarrhea diabetes, hypertension, cancer, jaundice, memory and piles	
UNIT II – Food Technology		1
1	Food Processing technology: Principle of Food processing, Processing of beverages, fruit beverage, tea, coffee, cocoa etc.	
2	Food preservation: - introduction and objective, preservation by fermentation	
3	Food additives and Adulteration: Food additives, colouring & flavoring substance	
4	Food packaging technology: introduction, packaging material, aseptic and biodegradable methods. Advantage and disadvantage of packaging materials like metal, aluminium and plastic	

Course outcomes:

At the end of the course the students will be able to,

CO1: Understand the concept of different natural resources and their utilization.

CO2: Evaluate the management strategies of different natural resources.

CO3: Critically analyze the coastal zone management.

CO4: Reflect upon the role of society in environmental protection and its conservation.

(Elective)		Credits
Course V	Course Code: PSBO605B	2
Title: Environmental Botany		
Natural Resources and Coastal Zone Management in India		1
1	Definition, types and concept of Natural Resources. EIA, GIS, Green audit.	
2	Waste management - National and international efforts in resource management and conservation.	
3	Coastal Zone Management, initiatives in India, Prohibited and Regulated activities in Coastal Areas, State Coastal Zone Management Authorities.	
4	Mangrove: Habitat and Characteristics, Mangrove, Plantation - Establishment and Rehabilitation of degraded mangrove formations; silvicultural systems.	
UNIT II Ecotoxicology, Public Participation for Environmental Protection		1
1	Introduction to Toxicology Definitions, Classification, General Nature of Toxicants in Environment, concepts; Toxic chemicals in the environment - air, water & their effects.	
2	Toxic Mechanisms, Bioaccumulation and Biomagnification of toxic materials in food chain, detoxification, bioconcentration	
3	Environmental movement and people's participation with special references to Gandhamardan, Chilika and Narmada Bachao Andolan, Chipko and Silent valley Movement.	
4	WTO and Environment, Corporate Social Responsibility, Environmental awareness and Education., Environmental Ethics.	

	SEMESTER II (Practical)	
PSBOP601	Plant Diversity II	Credits
1	Bryophyta Study of vegetative and reproductive structures in <i>Plagiochasma</i> , <i>Fimbraria</i> , and <i>Pogonatum</i> .	2
2	Pteridophyta Study of vegetative and reproductive structures in: <i>Ophioglossum</i> , <i>Pteris</i> , <i>Lygodium</i> and <i>Azolla</i> .	
3	Anatomy Study of the following leaves with respect to leaf surface characters (wax, cuticle, epidermis, stomata, epidermal outgrowth): <i>Pistia</i> , <i>Ficus</i> , <i>Avicennia</i> .	
4	Mounting of Glands- Salt glands of halophytes- <i>Avicennia</i> , Nectaries- <i>Euphorbiaceae</i> , Resin ducts- <i>Pinus</i> , Oils ducts- <i>Citrus</i> , <i>Murraya</i> , Laticiferous ducts <i>Asclepiadaceae</i> . Digestive glands- From permanent slides/photomicrograph.	
5	Developmental Botany Microtomy- Processing of material, Block making & staining (2 slides for submission).	
6	A study of types of embryo sacs with the help of permanent slides/photomicrographs.	
7	Palynology In vitro germination of pollen grains, effect of temperature on pollen viability and short-term storage.	
PSBOP602	Plant Physiology, Environmental Botany and Medicinal Botany	Credits 2
1	Assessing seed viability by TTC method.	
2	Comparison of two populations of a species collected from two areas.	
3	Determination of primary production of an area by chlorophyll method.	
4	Effect of water and salinity stress on chlorophyll content of leaves.	
5	Effect of water and salinity stress on Proline content of leaves.	

6	Determination of Stomatal Index of leaves.	
7	Determination of LAI of different types of trees.	
8	<p>Medicinal Botany Monograph of drugs with respect to Biological source, Geographical distribution, macro and microscopic characters, chemical constituents and therapeutic uses of the following drugs:</p> <ul style="list-style-type: none"> ● Root:<i>Withania somnifera</i> (Ashwagandha) ● Rhizome:.....<i>Zingiber officinale</i>(Ginger) ● Stem bark: <i>Cinnamom zeylanicum</i> (Cinnamon) / <i>Holarrhena antidysenterica</i> (Kurchi) ● Leaf:<i>Azadirachta indica</i> (Neem) ● Fruit:<i>Foeniculum vulgare</i> (Fennel) ● Seed:<i>Plantago ovata</i> (<i>Isabgol</i>) 	
9	Determination of Moisture content, Ash values of the given sample.	
10	Determination of foaming index and swelling index of the given sample.	

	SEMESTER II Elective (Practical)	
PSBOP605A	Dietetics and Food Technology	
1	Estimation of Crude fibres	
2	Estimation of Pectin content of fruits.	
3	Monitor changes in pH and taste during yogurt fermentation.	
4	Analyze the phytochemical contents of Herbal tea.	
5	Measure pH and titratable acidity of fruit juice.	
6	Test food samples for common additives (Eg. Artificial colours,etc.) and adulterants (Eg. Starch etc.) using appropriate chemical test.	
7	Detect the presence of synthetic colours in fruit flavored drinks.	
8	Identify and state uses of plant food in the treatment of diseases (Studied in theory)	

	SEMESTER II Elective (Practical)	
PSBOP605B	Environmental Botany	Credits 2
1	Determination of mineral matter from soil by ignition method.	
2	Identification of mangroves plants in India and plotting their distribution on map of India	
3	Calculate the carbon foot print of different activities using available data. Compare carbon foot prints of modes of transportation.	
4	Identify potential environmental impact and propose mitigation measures	
5	Determination of LD-50 values for Pollutants (Cu, Pesticides, Phenols etc.) using duckweed culture.	
6	Report writing of Green Audit	

Note:

- A minimum of **Two** field excursions (with at least one beyond the limits of Mumbai / Local Area) for habitat studies are compulsory.
- Field work of not less than **eight hours** duration is equivalent to one period per week for a batch of fifteen students.
- Industrial visit / Institutional visit at least **One** per Semester are compulsory.

Evaluation Pattern:

External assessment: 50%

Internal assessment: 50%

Internal Assessment- 50%

Sr. No.	Evaluation type	Total Marks
1	One Assignments/Case study	20
2	Seminar	20
3	Group Discussion / Quiz / Test	10

External examination- 50%

a) Semester End Theory Assessment- 50%

50 Marks

- Duration – These examinations shall be of two hours duration for each paper.

1. Theory Question Paper Pattern:

- There shall be five questions each of 10 marks.
- One question from each unit.
- Question No. 5 will be based on all 4 Units.
- All questions shall be compulsory with internal choice within the questions. Each question will be of 15 to 20 marks with options.
- Question may be subdivided into sub-questions a, b, c... and the allocation of marks depend on the weightage of the topic.

b) Practicals : Two Practical

(50 marks + 50 marks)

University of Mumbai
M.Sc. (BOTANY)
Semester I / Semester II EXAMINATION
Course PSBO

Maximum Marks: 50

Duration: 2.00 Hours

- Question 1: Based on Unit I
- Question 2: Based on Unit II
- Question 3: Based on Unit III
- Question 4: Based on Unit IV
- Question 5: Based on Unit I to IV (Mixed Questions)

Instructions:

1. All questions are compulsory.
 2. All questions carry equal marks.
 3. Draw neat and labelled diagrams wherever necessary.
-
1. Answer any one questions from the following. (Based on Unit 1) (10 Marks)
 - A)
 - B)
 - C)
 2. Answer any one questions from the following. (Based on Unit2). (10 Marks)
 - A)
 - B)
 - C)
 3. Answer any one questions from the following. (Based on Unit 3). (10 Marks)
 - A)
 - B)
 - C)
 4. Answer any one questions from the following. (Based on Unit 4). (10 Marks)
 - A)
 - B)
 - C)
 5. Answer any Two questions from the following. (Based on all 4 units). (10 Marks)
 - A)
 - B)
 - C)
 - D)

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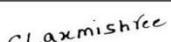
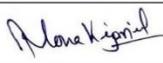
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Letter Grades and Grade Points:

Semester GPA / Programme CGPA Semester/ Programme	% of Marks	Alpha-Sign/ Letter Grade Result
9.00 - 10.00	90.0 - 100	O (Outstanding)
8.00 - < 9.00	80.0 - < 90.0	A+ (Excellent)
7.00 - < 8.00	70.0 - < 80.0	A (Very Good)
6.00 - < 7.00	60.0 - < 70.0	B+ (Good)
5.50 - < 6.00	55.0 - < 60.0	B (Above Average)
5.00 - < 5.50	50.0 - < 55.0	C (Average)
4.00 - < 5.00	40.0 - < 50.0	P (Pass)
Below 4.00	Below 40.0	F (Fail)
Ab (Absent)	-	Absent

Syllabus
A -P.G. Diploma in Botany
B- M.Sc. (Botany)
(Semester I & II)

Team for Creation of Syllabus

Name	College Name	Sign
Dr. Smita Jadhav	Kirti M. Doongursee College of Arts, Science and Commerce, Dadar West.	
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Acknowledgement: We are thankful to Dr. Vasant Mali, Principal, J. Watumull Sadhubella Girls College of Commerce, Ulhasnagar for his constant support and motivation throughout the process of this syllabus designing.

Sign of Chairperson 
Name of the **Chairperson: Dr. Smita Jadhav**
Name of the Department: Botany

Sign of Dean _____
Name of the Dean **Dr. Shivram Garje**
Name of the Faculty _____

Justification for (M.Sc. Botany)

1.	Necessity for starting the course:	NEP Implementation
2.	Whether the UGC has recommended the course:	Yes
3.	Whether all the courses have commenced from the academic year 2023-24	Yes
4.	The courses started by the University are self-financed, whether adequate number of eligible permanent faculties are available?:	NA
5.	To give details regarding the duration of the Course and is it possible to compress the course?:	2 Years Not Possible to Compress
6.	The intake capacity of each course and no. of admissions given in the current academic year:	NA
7.	Opportunities of Employability / Employment available after undertaking these courses:	Employability, Research Fellow on Projects, Analytical and Environmental Projects, Pharma Industries, Self-Employment



Sign of Chairperson _____

Name of the **Chairperson: Dr. Smita Jadhav**

Name of the Department: Botany



Sign of Dean _____

Name of the Dean **Dr. Shivram Garje**

Name of the Faculty _____