SIES College of Arts, Science & Commerce (Autonomous)

RISE WITH EDUCATION

NAAC REACCREDITED - 'A' GRADE

DEPARTMENT OF BOTANY

Faculty: Science

Program Name: MSc

Class: MSc - I

Subject: Botany

Course: MSc - I Botany

Credit Based Semester System Syllabus Under NEP, 2020

Approved By Board of Studies in Botany for the

Academic Year 2023 – 24

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SION (WEST) MUMBAI: 400022

DEPARTMENT OF BOTANY

MSc - I BOTANY NEP SYLLABUS 2023 – 24

MAJOR MANDATORY: BOTANY MSC (BOTANY) SEMESTER – I (Credits: 6)				
Theory: Paper I – Diversity of Plant Life I				
Paper Code	**Unit No.**	**Unit Name**	**Credits**	**Lectures/week**
	1	Algae and Applied Phycology	04	01
	2	Fungi & Plant Pathology		01
	3	Spermatophyta I		01
	4	Spermatophyta II		01
Practical I – Diversity of Plant Life I				
	Based on theory (Diversity of Plant Life I)		02	04

MAJOR MANDATORY: BOTANY MSC (BOTANY) SEMESTER – I (Credits: 6)				
Theory: Paper II – Life Processes and Functional Botany I				
Paper Code	**Unit No.**	**Unit Name**	**Credits**	**Lectures/week**
	1	Photosynthesis	04	01
	2	Proteins & PGRs		01
	3	Cytogenetics: Cell Division and Cell Cycle		01
	4	Molecular Biology		01
Practical II – Life Processes and Functional Botany I				
	Based on theory (Life Processes and Functional Botany I)		02	04

MAJOR MANDATORY: BOTANY MSC (BOTANY) SEMESTER – I (Credits: 2)				
Theory: Paper III – Recombinant DNA Technology				
Paper Code	**Unit No.**	**Unit Name**	**Credits**	**Lectures/week**
	1	Recombinant DNA Technology: Concept and Techniques	02	01
	2	Recombinant DNA Technology: Applications		01

MAJOR ELECTIVE: BOTANY MSC (BOTANY) SEMESTER – I (Credits: 4)				
Theory: ELECTIVE I – Ecology and Environmental Botany I				
Paper Code	**Unit No.**	**Unit Name**	**Credits**	**Lectures/week**

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	1	Concepts in Ecology	01	01
	2	Ecosystems and Natural Resources	01	01
	3	Biogeochemical Cycles	01	01
Practical Elective I – Ecology and Environmental Botany I				
	Based on theory (Ecology and Environmental Botany I)		01	02

MAJOR ELECTIVE: BOTANY MSC (BOTANY) SEMESTER – I (Credits: 4)				
Theory: ELECTIVE II – Plant Biotechnology I				
Paper Code	**Unit No.**	**Unit Name**	**Credits**	**Lectures/week**
	1	Plant Tissue Culture I	01	01
	2	Plant Tissue Culture II	01	01
	3	Biotransformation and its Commercial Aspects	01	01
Practical Elective II – Plant Biotechnology I				
	Based on theory (Plant Biotechnology I)		01	02

RESEARCH METHODOLOGY: BOTANY MSC (BOTANY) SEMESTER – I (Credits: 4)				
Theory: Research Methodology in Botany				
Paper Code	**Unit No.**	**Unit Name**	**Credits**	**Lectures/week**
	1	Research Methodology – I	01	01
	2	Research Methodology – II	01	01
	3	Research Methodology – III	01	01
Practical Research Methodology – Research Methodology in Botany				
	Based on theory (Research Methodology in Botany)		01	02

MAJOR MANDATORY: BOTANY MSC (BOTANY) SEMESTER – II (Credits: 6)				
Theory: Paper I – Diversity of Plant Life II				
Paper Code	**Unit No.**	**Unit Name**	**Credits**	**Lectures/week**
	1	Bryophyta	04	01

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	2	Pteridophyta		01
	3	Plant Anatomy		01
	4	Embryology and Palynology		01
Practical I – Diversity of Plant Life II				
	Based on theory (Diversity of Plant Life II)		02	04

MAJOR MANDATORY: BOTANY MSC (BOTANY) SEMESTER – II (Credits: 6)				
Theory: Paper II – Life Processes and Functional Botany II				
Paper Code	**Unit No.**	**Unit Name**	**Credits**	**Lectures/week**
	1	Seed & Stress physiology	04	01
	2	Environment, Biogeography and Population Ecology		01
	3	Medicinal Botany I		01
	4	Medicinal Botany II		01
Practical II – Life Processes and Functional Botany II				
	Based on theory (Life Processes and Functional Botany II)		02	04

MAJOR MANDATORY: BOTANY MSC (BOTANY) SEMESTER – II (Credits: 2)				
Theory: Paper III – Dietetics				
Paper Code	**Unit No.**	**Unit Name**	**Credits**	**Lectures/week**
	1	Dietetics I	02	01
	2	Dietetics II		01

MAJOR ELECTIVE: BOTANY MSC (BOTANY) SEMESTER – II (Credits: 4)				
Theory: ELECTIVE I – Ecology and Environmental Botany II				
Paper Code	**Unit No.**	**Unit Name**	**Credits**	**Lectures/week**
	1	Pollution and Climate Change	01	01
	2	Plant Population Dynamics and Allelopathy	01	01
	3	Coastal Zone Management in India	01	01
Practical Elective I – Ecology and Environmental Botany II				

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	Based on theory (Ecology and Environmental Botany II)	01	02

MAJOR ELECTIVE: BOTANY MSC (BOTANY) SEMESTER – II (Credits: 4)				
Theory: ELECTIVE II – Plant Biotechnology II				
Paper Code	**Unit No.**	**Unit Name**	**Credits**	**Lectures/week**
	1	Traditional Knowledge & IPR	01	01
	2	Nanotechnology	01	01
	3	Food Biotechnology	01	01
Practical Elective II – Plant Biotechnology II				
	Based on theory (Plant Biotechnology II)		01	02

On Job Training	**Credits**
	04

SEMESTER I PAPER I (MAJOR MANDATORY) THEORY			
Course Code	**Course Title**	**Hr**	**Cr**
	Diversity of Plant Life I	**60**	**04**

Learning Objectives:

The mandatory course 'Diversity of Plant Life I' in semester I includes the theory based units on Algae & Applied Phycology, Fungi & Plant Pathology, Spermatophyta I and Spermatophyta II. The course aims to expose the students to the classification of algae, fungi and gymnosperms up to order as per the system proposed by G. M. Smith (1950), Alexopoulos & Mims (1979) and C. J. Chamberlain (1934) respectively. The course will teach systematics, general characteristics, and life cycles of some algae, fungi and gymnosperms. The course will provide insight on economic importance of algae, algal culturing, cultivation, and preservation. It aims to make students aware about the plant diseases and its management. The course will impart knowledge about various theories of origin and APG systems of classification of angiosperms. Students will acquire information about the principles and rules of the International Code of Nomenclature (ICN) for algae, fungi and other plants. It would develop insight for diagnostic characteristics and economic importance of some angiospermic families.

Course Outcomes:

After completion of the course, the learners would be able to:

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CO1: Classify algae, fungi and gymnosperms up to orders according to the system of classification proposed by G. M. Smith (1950), Alexopoulos & Mims (1979) and C. J. Chamberlain (1934) respectively.
CO2: Classify and describe the morphology, structure, life cycle of some algae, fungi and gymnosperms.
CO3: Explain techniques of algal culturing, cultivation, and preservation.
CO4: Exemplify algae of economic importance.
CO5: Identify common plant diseases and devise the suitable control measures.
CO6: Describe theories related to origin of angiosperms.
CO7: Memorize angiosperm families with respect to their systematics, affinities, peculiarities, and economic importance.
CO8: Tell the principles, rules, and significance of the International Code of Nomenclature (ICN) for algae, fungi and other plants.
CO9: Recall APG system of plant classification and advanced branches of taxonomy like numerical taxonomy and molecular systematics.

UNIT I – Algae and Applied Phycology		**15**	**01**
1	Classification of Algae up to orders, according to the system proposed by G.M. Smith (1950).		
2	Life cycle of *Scytonema, Chara* and *Padina.*		
3	Culturing and preservation of algae.		
4	Economic importance and environmental applications of algae with reference to: Food and Nutraceuticals, Agriculture - Fodder, Biofertilizers; Industry: Agar agar, Medicine, Sewage disposal, Water pollution, Energy production, Biofuel.		
UNIT II – Fungi and Plant Pathology		**15**	**01**
1	Classification of fungi up to orders, according to the system proposed by Alexopoulos and Mims (1979).		
2	Types of Septa, Hyphal modifications in various groups of fungi		
3	Life cycle of *Stemonitis*, *Peziza*		
4	Study of the following diseases with reference to occurrence, symptoms, causal organism, disease cycle, predisposing factors and control measures of the following diseases: ● Red rot of Sugarcane (*Colletotrichum falcatum*) ● Wilt of Arhar/ Tur (*Fusarium oxysporum*) ● Green ear of Bajra (*Sclerospora graminicola*) ● Angular leaf spot of Cotton (*Xanthomonas* sp.)		

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UNIT III – Spermatophyta - I		**15**	**01**
1	Classification of Gymnosperms upto orders according to the system proposed by C. J. Chamberlain (1934).		
2	Life cycle of *Araucaria* and *Podocarpus*		
3	Theories of origin of angiosperms - • Isoetes monocotyledon theory • Coniferales amentiferae theory • Bennettitalean theory • Caytonialean theory • Pentoxylales theory		
4	Taxonomy as a synthetic branch - Numerical taxonomy, Molecular systematics. Introduction to APG system.		
5	International Code of Nomenclature for Algae, Fungi and Plants (I.C.N.) Principles and Rules and recommendation.		
UNIT IV – Spermatophyta - II		**15**	**01**
1	Study of following families with reference to its systematic position, distribution, floral formula, floral diagram, affinities, morphological peculiarities, economic important plants and their uses: Nymphaeaceae, Sterculiaceae, Meliaceae, Rhamnaceae, Lythraceae, Passifloraceae, Sapotaceae, Boraginaceae, Polygonaceae, Orchidaceae, Scitamineae – Musaceae, Zingiberaceae and Cannaceae.		

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SEMESTER I PAPER I (MAJOR MANDATORY) PRACTICAL			
Course Code	**Course Title**	**Hr**	**Cr**
	Diversity of Plant Life I	**04**	**02**

Learning Objectives:

1. The practical course will enable students to study systematic position, thallus, and reproductive structures in some algae and fungi.
2. The course will help to learn culturing methods for cultivation of algae and fungi.
3. It will demonstrate extraction of algal pigments and their separation by paper chromatography.
4. The course will aid in investigating plant diseases with respect to symptoms, causal organism, and control measures.
5. The course will help to study the life cycle of some gymnosperms and fossil gymnosperms.
6. It will assist in study of morphological peculiarities and economic importance of few angiospermic families.
7. It will aid in identification of genus and species with the help of flora.

Course Outcomes:

After completion of the course, the learners would be able to:

CO1: Understand systematics, thallus structure and reproductive structures of different algae and fungi with the help of specimen and permanent slides.

CO2: Learn and apply the technique of culturing algae.

CO3: Get hands-on experience of fungal culturing by streak method.

CO4: Analyze various plant diseases based on symptoms, causal organisms and disease cycle and recommend effective control measures.

CO5: Observe and study different plant fossil specimens.

CO6: Perform morphological and anatomical studies on some gymnospermic plants.

CO7: Learn the technique of identification of plant genus and species using Cookes' flora.

CO8: Gain knowledge about angiosperm families with respect to their systematics, diagnostic characters, and economic importance, thereby assign plants to respective angiosperm families.

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1.	Study of the following types with reference to their systematic position, thallus and reproductive structures: *Scytonema*, *Anabaena*, *Scenedesmus*, *Ulothrix*, *Pithophora*, *Chara*, *Padina* and *Gracilaria*.
2.	Cultivation of algae with special reference to *Chlorella* and *Spirulina.*
3.	Culturing of *Fusarium* by three-point inoculation.
4.	Study of the following types with reference to their systematic position, thallus and reproductive structures: *Stemonitis*, *Saprolegnia*, *Peziza*, *Daedalea*, *Fusarium* and *Trichoderma*.
5.	Study of the disease mentioned in the syllabus (theory) with reference to the symptoms, causal organisms, disease cycle and control measures.
6.	A study of the following types: *Cycadeoidea* (Fossil), *Williamsonia* (Fossil), *Araucaria* and *Podocarpus*.
7.	A study of the angiosperm families mentioned in theory with reference to their morphological peculiarities and economic importance of its members.
8.	Identification of genus and species with the help of flora (In addition to the abovementioned families, all families studied in undergraduate classes are included)

SEMESTER I PAPER II (MAJOR MANDATORY) THEORY			
Course Code	**Course Title**	**Hr**	**Cr**
	Life Processes and Functional Botany I	**60**	**04**

Learning Objectives:

The mandatory course 'Life Processes and Functional Botany I' in semester I includes the units on Photosynthesis, Proteins & Plant Growth Regulators, Cytogenetics: Cell Division & Cell Cycle and Molecular Biology. The course will help students to learn the phenomenon of photosynthesis in prokaryotes and eukaryotes. It will enable them to understand structural features of proteins and their experimental analysis, role of chaperones in folding of proteins also. The course will make students comprehend biosynthesis, storage, breakdown, transport and physiological responses PGRs. The course will teach students about microbial Genetics with respect to transformation, transduction, Conjugation & fine structure of the gene. Students will study eukaryotic and prokaryotic transposable elements. It will give them the opportunity to understand the steps involved in cell cycle and its control.

Course Outcomes:

After completion of the course, the learners would be able to:

CO1: Describe the process of photosynthesis in eukaryotes.

CO2: Compare between regulation of C3 pathway, C4 pathway, CAM pathway and Pentose Phosphate Pathway.

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CO3: Classify photosynthetic bacteria and gain insight about photosynthesis, pigment systems, structure, and mechanism of light harvesting complex in prokaryotes.
CO4: Explain structural features of proteins and role of chaperons in protein folding.
CO5: Decipher structural features of proteins experimentally.
CO6: Describe biosynthesis, storage, breakdown, transport and physiological responses PGRs.
CO7: Interpret functions of different proteins in the regulation of the cell cycle.
CO8: Explain the process of transformation, transduction & Conjugation and fine structure of the gene.
CO9: Solve problems based on recombination and genetic mapping.
CO10: Explain transposable elements in prokaryotes and eukaryotes along with their significance.

UNIT I – Photosynthesis		**15**	**01**
1	**Photosynthesis in eukaryotes:** Regulation of C 3 , C 4 and CAM pathways of photosynthesis C 3 plants: Role of light, regulation of RUBISCO. C 4 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		
2	**Photosynthesis in prokaryotes:** Pigment System, structure and mechanism of light harvesting system in photosynthetic bacteria. Reductive TCA Cycle		
UNIT II – Proteins and PGRs		**15**	**01**
1	Primary, secondary, tertiary and quaternary structural features of proteins; Protein folding.		
2	Experimental analysis of protein structures		
3	Biosynthesis, storage, breakdown, transport and physiological effects of Auxins, Gibberellins, Cytokinins, Ethylene, Abscisic acid.		
UNIT III – Cytogenetics: Cell Division and Cell Cycle		**15**	**01**
1	Checkpoints during cell cycle: G 1 to S, progression of S phase, G 2 to M phase, Anaphase check points and components involved as regulators of checkpoints.		
2	Cyclins and CDKs: Role of cyclins and CDKs, synthesis and degradation of cyclins, structural features of CDKs and cyclins, activation, and inactivation of cyclin dependent kinases		

3	Role of proteins in cell cycle: E2Fs and DP proteins, P53, CDC25, CAKs, Wee1 proteins, nim-proteins, SCFs, Anaphase Promoting Complexes APC (cyclosomes), licensing factors (replication origin and replication initiation complexes).		
4	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 the equatorial plate and in anaphase movement.		
5	Cytokinesis: by cleavage and phragmoplast formation		
Unit IV – Molecular Biology		**15**	**01**
1	Microbial Genetics: Molecular basis of transformation, transduction, conjugation; fine structure of the gene, T4 Phage; complementation analysis; deletion mapping; cis-trans tests.		
2	Tetrad analysis in *Neurospora*: Linkage detection (2 genes and centromere).		
3	Transposable elements.		

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SEMESTER I PAPER II (MAJOR MANDATORY) PRACTICAL			
Course Code	**Course Title**	**Hr**	**Cr**
	Life Processes and Functional Botany	**04**	**02**

Learning Objectives:

1. The practical course will enable students to understand principle and learn methods to extract & study activity of fungal cellulase enzyme; estimate diurnal fluctuation in TAN of a CAM plant; estimate GOT and GPT from plant material; study enzyme polyphenol oxidase; study polyphenol oxidase; determine Chl a/Chl b ratio in C3 & C4 plants. Students will acquire skills of immobilizing enzymes and study their activity.
2. Students will learn methods of preparation of cytological stains, fixatives, and pre-treatment agents.
3. The practical course will aid in understanding the technique of squash preparation from pre-treated root tips and smear preparation of anthers to study chromosomal aberrations and stages of meiosis respectively.
4. Students will learn theory and steps to solve problems based on restriction mapping, deletion mapping and tetrad analysis.

Course Outcomes:

After completion of the course, the learners would be able to:

CO1: Extract the enzyme fungal cellulase and evaluate its activity.

CO2: Immobilize and explore industrial applications of enzymes.

CO3: Demonstrate diurnal fluctuation in TAN in Crassulaceae members resulting from CAM pathway.

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CO4: Extract and estimate GOT and GPT activity. **CO5:** Evaluate the activity of enzyme polyphenol oxidase. **CO6:** Determine the values for Chlorophyll a: Chlorophyll b ratio in C3 and C4 plants. **CO7:** Prepare stains, fixatives, and pretreatment agents. **CO8:** Process plant material to observe chromosomes under microscope. **CO9:** Identify and describe the normal stages of mitosis in plants and the aberrations caused in the same due to mutagen activity. **CO10:** Plan research protocols for designing the experiments demonstrating mutagenic potential of some chemicals. **CO11:** Identify and describe the stages of meiosis in plant specimens. **CO12:** Apply the knowledge of genetic and physical mapping for linkage detection and for the construction of restriction and deletion map.	
1.	Extraction of cellulase from a suitable fungal culture and study of enzyme activity by DNSA method.
2.	Immobilisation of yeast cells and study of invertase activity.
3.	Quantitative study of diurnal fluctuation in Titratable Acid Number (TAN) in a CAM plant.
4.	Extraction and estimation of GOT and GPT from suitable plant material.
5.	A study of activity of enzyme polyphenol oxidase, from potato peels.
6.	Determine the Chl a/Chl b ratio in C3 & C4 plants.
7.	Preparation of cytological stains, fixatives, and pre-treatment agents.
8.	Squash preparation from mutagen treated root tips for study of aberrations (Colchicine/ Paradichlorobenzene/ Aesculin/ Hydroxyquinoline).
9.	Smear preparation from any suitable plant material.
10.	Problems based on: a. Restriction map analysis and construction of restriction maps, b. Tetrad analysis in *Neurospora* – two genes and centromere, c. Deletion mapping in Bacteriophage.

SEMESTER I PAPER III (MAJOR MANDATORY) THEORY			
Course Code	**Title**	**Hr**	**Cr**
	Recombinant DNA Technology	**30**	**02**
Learning Objectives: The mandatory course 'Recombinant DNA Technology' in semester I includes two units viz., rDNA Technology: Concept & Techniques and rDNA Technology: Applications. The course will make students understand the basics of recombinant DNA technology. Students will study vectors and some of the techniques involved in rDNA technology. The course will make students aware of			

bioethics, biopiracy and bioprospecting in genetic engineering. The course will make them explore applications of rDNA technology for plant improvement.			
Course Outcomes: After completion of the course, the learners would be able to: **CO1:** Describe basic procedure of rDNA technology. **CO2:** Summarize and exemplify enzymes involved in rDNA technology. **CO3:** Explain various vectors used in recombinant DNA technology. **CO4:** Comment on methods of modifying the Diazotrophs by gene alterations in *Rhizobium*. **CO5:** Explain principle, working of techniques viz. CRISPR/Cas system, FISH, blotting techniques, DNA microarray and flow cytometry. **CO6:** Discuss Bioethics, biopiracy and bioprospecting in genetic engineering. **CO7:** Apply rDNA technology in the production of plants with enhanced characters like disease resistance, improved shelf life, improved nutrient quality, ability of phytoremediation, etc.			
Unit I – Recombinant DNA Technology: Concept and Techniques		**15**	**01**
1	Introduction; Enzymes involved in rDNA technology; basic procedure of rDNA technology; methods for creating rDNA molecules.		
2	General information on SV-40, Vaccinia, Baculovirus & retroviral vectors. Use of YAC or YEp of yeast (*Saccharomyces cerevisiae*) as effective cloning vectors because of their high copy numbers in production of HBsAg vaccine. Use of BAC and its advantages.		
3	CRISPR/Cas system; FISH; blotting techniques; DNA microarray; flow cytometry		
4	Methods of modifying the Diazotrophs (N2 fixing bacteria) by Gene alterations in *Rhizobium* sp.		
5	Bioethics, biopiracy and bioprospecting of genetic engineering		
Unit II – Recombinant DNA Technology: Applications		**15**	**01**
1	**Resistance to biotic stress:** Transgenic plants with insect resistance: Resistance genes from microbes: Gene from *Bacillus thuringiensis*, Cholesterol oxidase of *Streptomyces* culture filtrate, Isopentenyl transferase gene from *Agrobacterium tumefaciens*; Resistance genes from higher plants: Genes for Proteinase inhibitors: e.g., Cowpea trypsin inhibitor gene (CpTi), Genes for alpha amylase inhibitors.		
2	**Improvement of nutritional content and Quality:** a) Increase in sweetness and flavour in fruits and vegetables for e.g.		

	− Monellin gene from African plant (*Dioscorephyllum cumminsii*) - introduction in tomato and lettuce − Brazzein gene from West African fruit Oubli (*Pentadiplandra brazzeana* Baillon) b) Increase and change in the quality oils in *Brassica* species (increase in medium chain fatty acids and converting unsaturated fatty acid to saturated fatty acids). c) Transgenics for delayed fruit ripening and extended shelf life: Tomato d) Transgenic plants: Biopolymers and vitamins.		
3	Transgenic plants in floriculture: Increase in the shelf life of cut flowers - (Carnation flowers), Genetic engineering of Orchids, Genetic manipulation of flower pigmentation.		
4	Genetic engineering for inducing Male Sterility in plants.		
5	Transgenic plants for enhancing phytoremediation.		

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SEMESTER I PAPER I (MAJOR ELECTIVE) THEORY			
Course Code	**Title**	**Hr**	**Cr**
	Ecology and Environmental Botany I	**45**	**03**

Learning Objective:

The elective course 'Ecology and Environmental Botany I' in semester I comprises of the units on Basic Ecological Concepts, Ecosystem, Biogeochemical Cycles and Natural Resources. The course aims to provide deeper insight into basic ecological concepts & types of ecosystems including plant succession. The course will throw light on the various Bio-geochemical cycles operating in nature & their impact on environment and health. The course will help to explore natural resources w. r. t. use and over-exploitation.

Course Outcomes:

After completion of the course, the learners would be able to:

CO1: Learn in detail about the basic concepts of ecology and its branches, including productivity with various laws governing different ecosystems and communities.

CO2: Explore the process of plant succession in nature by understanding its various types and steps.

CO3: Delve into detailed aspects of plants and plant communities as indicators.

CO4: Gain insight into different types of aquatic habitats in detail.

CO5: Explore the process of gaseous & sedimentary cycles operating in nature along with their regulation & significance.

CO6: Recognize issues related to over exploitation of forest resources with eco-geographical aspects and biodiversity of the world.

CO7: Get acquainted with the different ways of forest management and their aspects.

CO8: Learn about the concept of gap dynamics and their importance.

UNIT I – Concepts in Ecology		**15**	**01**
1	**Ecosystem**: Definition, Components of Ecosystems, Trophic Levels, Food Chains, Food Webs, Ecological Pyramids, Ecosystem Energetics, Laws of Thermodynamics, Energy Flow Models in Terrestrial Ecosystem.		
2	**Ecological Concepts**: Productivity, Principles of Limiting Factor, Liebig's Law, Shelford's Law of Tolerance.		
3	**Autecology:** Aims, Aspects: General Account of Seed, Seed Output, Seed Dispersal, Seed Viability, Seed Dormancy, Reproductive Capacity, Growth Regulators and Seed Germination.		

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4	**Synecology:** Plant Community, Ecological Amplitude, Population Characteristics: Association, Consociation Fasciation Society.		
UNIT II – Ecosystems and Natural Resources		**15**	**01**
1	**Ecological Succession**: Concept, Causes, Types, Steps of Succession, Dis-climax and Sub-climax.		
2	**Plants and Plant communities as indicators**: Concept and Characteristics, Forests as indicators, Grasslands as indicators, Indicators of soil type, Salinity indicators, Grazing indicators.		
3	**Study of aquatic habitats**: Characteristics, distribution and biodiversity of marine, estuarine and freshwater habitats.		
4	**Forest Resources and its Management**: Uses and Over-Exploitation of forest resources. Afforestation, Joint Forest Management, Agroforestry, Social forestry, Reserved forests.		
5	**Gap Dynamics** in Tropical Forests and Parameters of Gap Dynamics, Importance of gap dynamics.		
UNIT III – Biogeochemical Cycles		**15**	**01**
1	**Gaseous Cycles**: **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. **Carbon Cycle**: Forms and places of occurrence of Carbon. Photosynthetic Sequestration of Carbon. Role of Carbon in Forest Ecosystems. Cycling of Carbon in the Biosphere. Role of carbon in Global Warming Problem and its possible implication.		
2	**Sedimentary Cycles**: **Sulphur Cycle**: Forms of Sulphur in biosphere and geosphere, in fossil fuels and its release with industrialization, Sulphur cycling in Soil Bacterial Metabolism. **Phosphorus Cycle**: Ecological Function, Biological Function and process of cycle.		

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SEMESTER I PAPER I (MAJOR ELECTIVE) PRACTICAL			
Course Code	**Title**	**Hr**	**Cr**
	Ecology and Environmental Botany I	**02**	**01**

Learning Objective:

1. The course aims to help students perform the technique for estimation of primary productivity of terrestrial and aquatic ecosystems.
2. It will assist them to discover the difference in productivity of ecosystems in polluted and unpolluted conditions.
3. The course demonstrates analysis of soil for its various physico-chemical properties using different ecological instruments.

4. It also provides insight into the technique for studying plant communities. 5. It enables them to discern the biodiversity of an aquatic community by calculating various diversity indices.	
Course Outcomes: After completion of the course, the learners would be able to: **CO1:** Learn the various techniques involved in productivity studies. **CO2:** Determine various characteristics of soil analytically. **CO3:** Estimate the diversity indices of different aquatic plant communities. **CO4:** Determine the plankton diversity of an aquatic community using established indices.	
1.	Comparison of Primary Productivity by Chlorophyll Method in Polluted and Unpolluted Regions.
2.	Comparison of Primary Productivity by Harvest Method in Polluted and Unpolluted Regions.
3.	Comparison of Primary Productivity by Light and Dark Bottle Method in Polluted and Unpolluted Regions.
4.	Determination of pH of soil samples.
5.	Determination of Electrical Conductivity of soil samples.
6.	Comparison of Water Holding Capacity of Different Soil types using Gooch crucible.
7.	Determination of Total Organic Carbon of given soil samples.
8.	Study of phytoplankton diversity from freshwater samples using Nygaard's index.
9.	Determination of diversity indices of aquatic habitats.

SEMESTER I PAPER II (MAJOR ELECTIVE) THEORY			
Course Code	**Course Title**	**Hr**	**Cr**
	Plant Biotechnology I	**45**	**03**
Learning Objectives: The elective course 'Plant Biotechnology I' in Semester I includes units on plant tissue culture I, plant tissue culture II, and biotransformation & its commercial aspects. The course aims to expose the students to somaclonal variations & plant cell cultures as chemical factories. It will also elaborate upon mechanism of *Agrobacterium* mediated transformed root cultures. It will further elucidate the method of biotransformation & protein synthesis & quest for commercial production.			
Course Outcomes: After completion of the course, the learners would be able to: **CO1:** Comment on importance of micropropagation in floriculture and medical industry			

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CO2: Explain factors responsible for hardening and somaclonal variations.
CO3: Acquire specific skills regarding enhanced production, extraction and purification of secondary metabolites. Also, overcoming the problems associated with plant tissue culture.
CO4: Delve deep into the process of biotransformation with special reference to Vanillin production from *Capsicum* cell cultures, and *Agrobacterium* mediated transformation of root cultures.
CO5: Apply the fundamental principles & methods of commercial production using effective bioreactor design for large scale production of metabolites.

UNIT I – Plant Tissue Culture I		**15**	**01**
1	Micropropagation of floricultural and medicinal plants using organogenesis and embryogenesis.		
2	Factors responsible for *in vitro* and *ex vitro* hardening.		
3	Plant improvement through somaclonal variations.		
UNIT II – Plant Tissue Culture II		**15**	**01**
1	Plant cell cultures as chemical factories: Cell suspension, enhancement of product formation using biotic and abiotic elicitors, immobilization, permeabilization and product recovery.		
2	Problems in plant tissue culture: contamination, phenolics and recalcitrants.		
3	In vitro storage of germplasm, Cryopreservation.		
UNIT III – Biotransformation and its Commercial Aspects		**15**	**01**
1	Biotransformation using: Freely suspended plant cells and Immobilized plant cells, Biotransformation for Vanillin production from Capsicum cell cultures. Studies on *Agrobacterium* mediated transformed root cultures.		
2	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.		
3	Factors for growth in Bioreactors. Shikonin production by *Lithospermum erythrorhizon* cell cultures.		

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SEMESTER I PAPER II (MAJOR ELECTIVE) PRACTICAL			
Course Code	**Course Title**	**Hr**	**Cr**
	Plant Biotechnology I	**02**	**01**

Learning Objectives:

1. The course will help students to prepare stock solution and MS media for plant tissue culture techniques.
2. It will also develop students' skills regarding callus induction, isolation & culturing of protoplast and regeneration of plants.
3. The course will aid students to conduct preliminary phytochemical analysis by isolation of active compounds from callus and other plant sources.
4. It will explore types of bioreactors and helps students get an insight into scaling up of plant metabolites.

Course Outcomes:

After completion of the course, the learners would be able to:

CO1: Prepare stock solutions and MS (basal & defined) media for plant tissue culture.

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CO2: Inoculate explant for callus induction and regeneration of plants. **CO3:** Carry out phytochemical analysis by isolation of active compounds from callus. **CO5:** Isolate protoplast from given plant material and culture the same. **CO4:** Identify and describe bioreactors used for scaling up of plant metabolites.	
1.	Preparation of stock solutions and MS medium.
2.	Callus induction and regeneration.
3.	Isolation of bioactive compounds from callus and plant source using TLC.
4.	Isolation of protoplast.
5.	Culturing of protoplast.
6.	Types of Bioreactors.

SEMESTER I RESEARCH METHODOLOGY THEORY			
Course Code	**Course Title**	**Hr**	**Cr**
	Research Methodology in Botany	**45**	**03**

Learning Outcomes:

The mandatory course 'Research Methodology' in Botany in Semester I includes units Research Methodology I, Research Methodology II and Research Methodology III. The course aims to provide an overview of research methodology and inculcate skills to conduct research. Students will get acquainted with basic concepts of research, types of research, research design and research ethics. It will enable students to have the right approach towards data collection, its measurement and analysis. Students will learn the art of writing a research proposal and research paper; citation, references and bibliography and presenting a research work. Students will learn about the use of libraries, encyclopaedias and academic search engines for data retrieval. The course will introduce several ICTs and AI tools used in research.

Course Outcomes:

After completion of the course, the students would be able to:

CO1: Define research, summarise objectives and significance of research, criteria of good research.

CO2: Define a research problem, design hypotheses and experiments, test hypotheses as well.

CO3: Value and explain research ethics.

CO4: Explain the details of sampling designs, different methods of data collections.

CO5: Perform statistical data analysis.

CO6: Write research proposal and research paper.

CO7: Understand and apply the use of libraries, publications and academic search engines in information retrieval.

CO8: Use ICTs and AI for data analysis and interpretation, reference management software, and software for detection of plagiarism.

CO9: Apply different formats and styles of writing references.

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CO10: Prepare posters and presentations to present research work effectively.			
Unit I – Research Methodology I		**15**	**01**
1	**Introduction to Research:** Meaning, Objectives, Motivation, Types of Research, Significance of Research; Research process and Criteria of good research.		
2	**Basic concepts of Research:** Defining a research problem: Selection and necessity of defining the problem; Technique involved in defining a problem; Literature review; Hypothesis: Qualities of a good Hypothesis Null Hypothesis and Alternative Hypothesis; Hypothesis Testing: Logic and Importance.		
3	**Research Design**: Meaning, concepts and features of a good research design; Types of research designs; Basic principles of experimental designs: concept of Independent & Dependent variables.		
4	**Qualitative and Quantitative Research**: Qualitative research and Quantitative research: Concept of measurement, causality, generalisation, replication. Merging the two approaches.		
5	**Research Ethics**		
Unit II – Research Methodology II		**15**	**01**
1	**Data Collection**: Sampling Design: Steps in sampling design; Characteristics and types of sample designs; Selection of a random sample.		
2	**Measurement**: Concept of measurement: What is measured? Problems in measurement in research: Validity and Reliability; Levels of measurement: Nominal, Ordinal, Interval, Ratio.		
3	**Data Analysis**: Observations and Errors in research; Descriptive and Inferential statistics; Common statistical tests.		
4	**Research Proposal Writing**: General considerations while designing a research proposal; proposal outline; Some major funding agencies.		
5	**Research Paper Writing**: Research Paper, research journal, Impact factor, indexing, Ethical issues related to publishing, Plagiarism and Self-Plagiarism.		
Unit III – Research Methodology III		**15**	**01**
1	**Publications and Libraries**: Role of Libraries in Information retrieval; Use of Encyclopedias, Research Guides, Handbook etc.; Types of publications; Digital libraries.		
2	**Academic Databases**: Bibliographic databases; Academic search engines; Citation indexes; Online searching methods.		

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3	**Use of ICTs and AI in Research**: Popular statistical packages: SPSS, MS Excel – Analysis ToolPak, PSPP (Open-source software); Use of SPSS for Data Analysis and Interpretation; AI tools used in research; Tabulation and Graphical Representation of Data: tables, illustrations and photographs, Microsoft Power-BI		
4	**Citation, References and Bibliography**: Reference Management Software like Zotero / Mendeley; Formats and Styles (APA, Chicago, MLA, ASA); Software for paper formatting like LaTeX / MS Office, Software for detection of Plagiarism; Quoting, Paraphrasing, and Avoiding Plagiarism.		
5	**Conferences, Presentations and Posters**.		

References:

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SEMESTER I RESEARCH METHODOLOGY PRACTICAL			
Course Code	**Course Title**	**Hr**	**Cr**
	Research Methodology in Botany	**02**	**01**

Learning Outcomes:

1. Students will be able to get mastery over basic laboratory practices.
2. They will also learn systematic management and presentation of research data using appropriate tools and softwares, different styles of citation and references, and the use of photography in research.
3. They will also develop skills of writing research reports with a scientific flair.

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Course Outcomes: After completion of the course, the learners would be able to: **CO1:** Prepare solutions of desired concentrations and safely handle toxic chemicals. **CO2:** Systematically present research data from simple tabulation to graphical ways using the latest tools and softwares. **CO3:** Develop the process of reviewing literature and acknowledge other researches with appropriate styles of citation, references and bibliography. **CO4:** Apply the technique of paraphrasing in research report writing. **CO5:** Avoid and detect plagiarism using suitable softwares. **CO6:** Explore the technique and role of various methods of photography in research. **CO7:** Apply the knowledge of technique of writing a research report.	
1	**Basic laboratory practices** • Preparation of molar, normal and ppm solutions • Preparation of serial dilutions • Common toxic chemicals and safety measures in their handling
2	**Data management and presentation** • Documentation and maintenance of lab records • Tabulation of research data and generation of graphs using MS Excel • Use of SPSS / PSPP / MS Excel – Analysis ToolPak for data analysis and interpretation • Use of Power BI for infographic data presentation • Use of AI tools in research
3	**Citations, References and Bibliography** • Review of literature and its consolidation • Use of Zotero and arrangement of references in different formatting styles: APA, Chicago and MLA • Use of paraphrasing to avoid plagiarism • Use of free plagiarism detection softwares
4	**Photography in research** Photomicrography, Art of field photography and Application of Scale Bar
5	**Research report writing**

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SEMESTER II PAPER I (MAJOR MANDATORY) THEORY			
Course Code	**Course Title**	**Hr**	**Cr**
	Diversity of Plant Life II	**60**	**04**

Learning Objectives:

The mandatory course 'Diversity of Plant Life II' in semester II includes the units: Bryophyta, Pteridophyta, Plant Anatomy and Embryology & Palynology. The course will help students to understand origin, evolution, classification, general characteristics and life cycles of some bryophytes. It will also educate the students about the classification and life cycles of some pteridophytes. Students will study different fossil pteridophytes and ethnomedicinal uses of pteridophytes. The course aims to illustrate plant anatomy with respect to meristems, sensory tissue system and wood anatomy. The course will enable the students to learn about morphogenesis and organogenesis in plants, embryology of angiosperm, evolutionary trends among pollen grains and utilization of pollen.

Course Outcomes:

After completion of the course, the learners would be able to:

CO1: Classify bryophytes and pteridophytes up to orders according to the system of classification proposed by G.M. Smith (1955).

CO2: Elaborate on the systematics, morphology, structure, life cycle, alternation of generations of various bryophytes and pteridophytes.

CO3: Comprehend the nature of bryophytes with respect to its origin, evolution, physiology and fossils.

CO4: Describe abnormalities in life cycle of some pteridophytes, concepts of heterospory and seed habit.

CO5: Gain adequate knowledge about applied aspects of pteridophytes like evolution and ethnomedicinal uses.

CO6: Explain the concept of root stem transition in angiosperms; types and theories of meristems; sensory systems in plants.

CO7: Analyze floral development in *Arabidopsis.*

CO8: Get an insight of morphogenesis and organogenesis in plants; wood structure, hardwoods, softwoods, and overall wood anatomy as per the parameters set by IAWA.

CO9: Describe various aspects of Developmental Botany such as male and female gametophyte, pollination, fertilization, seed development and fruit growth.

CO10: Summarize evolutionary trends among pollen grains and utilization of pollen allergens for diagnosis and therapy.

UNIT I – Bryophyta		**15**	**01**
1	Classification of Bryophyta, up to orders, according to the system proposed by G. M. Smith (1955).		
2	Origin and evolution of Bryophyta with reference to habitat and form		
3	Study of life-cycles of *Targionia, Pellia* and *Sphagnum*		

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4	Physiology of bryophytes.		
5	Fossil Bryophytes		
UNIT II – Pteridophyta		**15**	**01**
1	Classification of Pteridophyta, upto orders, according to the system proposed by G.M.Smith (1955).		
2	Life cycle of *Pteris* and *Salvinia*		
3	Heterospory and seed habit.		
4	Abnormalities in the life cycle - Apogamy and Apospory		
5	Ethnomedicinal uses of Pteridophytes		
6	A study of fossil Pteridophytes *Horneophyton, Cladoxylon, Sphenophyllum* and *Etapteris.*		
UNIT III – Plant Anatomy		**15**	**01**
1	**Root stem transition**		
2	**Meristems**: Definition, Types, Theories of meristem – Apical cell theory, Histogen theory and Tunica corpus theory.		
3	**Morphogenesis and Organogenesis in Plants**: Shoot and root development; Development of the leaf in plants; Phyllotaxy, genetic spiral and its types.		
4	**Floral development in *Arabidopsis*.**		
5	**Study of tissue systems in plants**: **Sensory tissue system** – Tactile sense organs, Gravitational sense organs, Optical sense organs.		
6	**Wood Anatomy:** Growth rings in wood and their significance; Characters used in identification of softwood and hardwood according to IAWA (1989); Ray parenchyma in wood – structure and composition; Axial parenchyma in wood – distribution and types; Structure and distribution of vessels in wood; Applications of wood science.		
UNIT IV – Embryology & Palynology		**15**	**01**
1	Male gametophyte: Pollen development; sperm dimorphism; male germ unit		
2	Female gametophyte: Structure of mature embryo sac		
3	**Pollination**: 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, methods to overcome incompatibilities, intra-ovarian pollination; in-vitro pollination.		
4	**Fertilization**: heterospermy, differential behavior of male gametes, discharge and movement of sperms; syngamy and triple fusion, post-fertilization metabolic & structural changes in embryo-sac.		

5	**Seed development and fruit growth**; endosperm development during Early Maturation and Desiccation stages; embryogenesis, ultrastructure and nucellar cytology; cell lineage during late embryo development; storage proteins of endosperm and embryo; apomixis; embryo culture; dynamics of fruit growth; biochemistry and molecular biology of fruit maturation; fruit ripening.		
6	Utilization of pollen: Pollen allergens for diagnosis and therapy.		
7	Evolutionary trends among pollen grains based on palynotaxonomical work.		

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SEMESTER II PAPER I (MAJOR MANDATORY) PRACTICAL			
Course Code	**Course Title**	**Hr**	**Cr**
	Diversity of Plant Life II	**04**	**02**

Learning Objectives:

1. The course will help to study vegetative and reproductive structures in some bryophytes and pteridophytes.
2. It will throw light upon selected fossil pteridophyte.
3. The course will help students to explore leaf surface characters.

4. The course will help to study wood anatomy in details and study of wood elements using the maceration technique.
5. It will also illustrate sketching of camera lucida diagrams of plant tissues.
6. It will demonstrate effect of temperature on pollen viability.
7. The course will aid in detection of pollen pigments and biomolecules and will also help to study of pollen morphology.

Course Outcomes:

After completion of the course, the learners would be able to:

CO1: Understand the systematics, thallus structure and reproductive structures of different bryophytes and pteridophytes.

CO2: Broaden their perspective about fossilized pteridophytes and their evolutionary relationships.

CO3: Compare between the wood anatomy of angiosperms and gymnosperms.

CO4: Gain an idea of the structural variations in wood parenchyma useful in species identification and authentication.

CO5: Expertise in mounting of peculiar anatomical structures of plants for their detailed study.

CO6: Utilize camera lucida for sketching microscopic structure.

CO7: Evaluate the effect of temperature on pollen viability.

CO8: Study pollen morphology using Chitale's method.

CO9: Acquire the skills to perform TLC of pollen pigments and biomolecules such as amino-acids and sugars.

1.	Study of vegetative and reproductive structures in *Targionia*, *Pellia, Fimbraria* and *Sphagnum*.
2.	Study of vegetative and reproductive structures in: *Isoetes*, *Ophioglossum*, *Pteris*, *Lygodium* and *Salvinia*
3.	Study of fossil pteridophyte: *Sphenophyllum*
4.	Study of wood elements in *Sterculia* and *Araucaria* using the maceration technique.
5.	Study of the following leaves with respect to leaf surface characters (wax, cuticle, epidermis, stomata, epidermal outgrowth): *Pistia*, *Ficus*, *Avicennia* and *Peperomia*.
6.	Study of Axial Parenchyma – Apotracheal: Terminal, Diffuse, Banded, Reticulate; Paratracheal: Vasicentric, Aliform, Confluent, Abaxial Study of Ray Parenchyma & Rays: Homogenous & Heterogenous
7.	Use of Camera lucida for microscopic sketching
8.	Study of the morphology of the pollen using Chitale's method from the families studied in previous semesters.
9.	Effect of temperature on pollen viability.
10.	Detection of amino-acids, sugars and pigments by paper/ Thin layer chromatography from pollen grains

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SEMESTER II PAPER II (MAJOR MANDATORY) THEORY			
Course Code	**Course Title**	**Hr**	**Cr**
	Life Processes and Functional Botany II	**60**	**04**

Learning Objectives:

The mandatory course 'Life Processes and Functional Botany II' in semester II includes the units: Seed Physiology & Stress Physiology, Environment, Biogeography & Population Ecology, Medicinal Botany I and Medicinal Botany II. The course aims at teaching the students about aspects of seed and stress physiology of plants. It will help them to explore various concepts related to environment, biogeography and population ecology. It also aims to teach students about the characteristics, active constituents, and effective utilization of the herbal medicines & crude drugs.

Course Outcomes:

After completion of the course, the learners would be able to:

CO1: Elucidate upon various biochemical changes occurring during seed germination.

CO2: Describe factors responsible for and the methods to break the seed dormancy.

CO3: Appreciate the various physiological mechanisms protecting the plant from environmental stresses.

CO4: Explore the various signalling pathways activated during stress.

CO5: Learn the concepts of components of ecosystem and their biodiversity.

CO6: Explore major terrestrial biomes and get an insight of Theory of island biogeography.

CO7: Explain the concepts of population ecology with special reference to growth curves, population regulation and life history strategies.

CO8: Carry out monographic studies of herbal drugs with respect to their biological source, geographical distribution, macro and microscopy, chemical constituents, and therapeutic use.

CO9: Get an insight of Indian pharmacopeia, Ayurvedic pharmacopeia used for evaluation and quality control of crude drugs.

CO10: Explore various standardization parameters used in Quality control of crude drugs.

	UNIT I – Seed & Stress Physiology	**15**	**01**
1	Physiology and Biochemistry of seed germination, Mobilization of food reserves, Germination and growth factors.		
2	Seed dormancy, Control, and release of seed dormancy; seed proteins.		
3	Biotic and abiotic stress, Response of plants to Biotic (pathogenic and insects) stress, Adaptations to eliminate and tolerate the infection, Hypersensitive reaction.		
4	Response of plants to abiotic stress - Drought stress, Heat stress - Heat shock proteins, Chilling, and freezing, Salinity stress.		
5	Signalling pathways activated during stress.		

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UNIT II – Environment, Biogeography and Population Ecology		**15**	**01**
1	**Environment:** Components, Major components of physical environment, biotic and abiotic interactions.		
2	**Biogeography:** Major terrestrial biomes and biocitation; Theory of island biogeography.		
3	**Population Ecology:** Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection).		
UNIT III – Medicinal Botany I		**15**	**01**
1	**Introduction to Pharmacopoeia:** Indian pharmacopoeia and Ayurvedic pharmacopoeia.		
2	**Quality control of crude drugs:** • Morphological examination – Exomorphic characters • Microscopical evaluation – Anatomical characters • Preliminary phytochemical tests. • Development of standardization parameters – Moisture content, Ash values, Solvent extraction value, bitterness value, foaming index, swelling index and heavy metals.		
UNIT IV – Medicinal Botany II		**15**	**01**
1	Monograph of drugs with respect to Biological source, Geographical distribution, macro and microscopic characters, chemical constituents, and therapeutic uses of the following drugs: • Root: *Withania somnifera* (Ashwagandha) • Rhizome: *Zingiber officinale* (Ginger) • Stem bark: *Cinnamomum zeylanicum* (Cinnamom) and *Holarrhena antidysenterica* (Kurchi) • Leaf: *Azadirachta indica* (Neem) • *Fruit: Foeniculum vulgare* (Fennel) • Seed: *Plantago ovata* (Isabgol*)* • Preliminary phytochemical tests.		

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SEMESTER II PAPER II (MAJOR MANDATORY) PRACTICAL			
Course Code	**Course Title**	**Hr**	**Cr**
	Life processes and Functional Botany II	**04**	**02**

Learning Objectives:

1. The course will enable students to learn methods to break seed dormancy, evaluate the effect of water and salinity stress on chlorophyll and proline content of leaves.
2. The course will assist students in determination of stomatal index and dust load on leaves, also to assess pollution in ambient air based on injured leaf area.
3. The course will help to study the macroscopic and microscopic characters and identification of active ingredients of herbal drugs.
4. Students will memorize the methods to determine moisture content, ash values, solvent extraction values, foaming index, swelling index of herbal drug samples.

Course Outcomes:

After completion of the course, the learners would be able to:

CO1: Apply the physical and chemical methods for breaking of seed dormancy.

CO2: Evaluate the effects of water and salinity stress on chlorophyll and proline content of leaves.

CO3: Compare two populations of a species collected from two areas for determining the effects of air pollution on plants.

CO4: Determine the dust load on leaves of roadside plants to throw light on the status of air pollution.

CO5: Assess the level of pollution in ambient air based on injured leaf area.

CO6: Determine the stomatal index of leaf.

CO7: Carry out macroscopic, microscopic analysis; identify active phytoconstituents and uses of medicinal plants.

CO8: Predict physicochemical properties of crude drugs by finding out their ash values, extractive values, moisture content, swelling index, foaming index, etc.

1.	Breaking of seed dormancy.
2.	Effect of water and salinity stress on chlorophyll content of leaves.

3.	Effect of water and salinity stress on Proline content of leaves.
4.	Comparison of two populations of a species collected from polluted and unpolluted sites.
5.	Determination of dust load on leaves of roadside plants.
6.	Assessment of pollution in ambient air, on the basis of injured leaf area.
7.	Determination of Stomatal Index of leaves.
8.	A study of the macroscopic and microscopic characters and identification of active ingredients of drugs mentioned in the syllabus for theory by means of chemical tests. Root: *Withania somnifera* (Ashwagandha) Rhizome: *Zingiber officinale* (Ginger) Stem bark: *Cinnamomum zeylanicum* (Cinnamom) and *Holarrhena antidysenterica* (Kurchi) Leaf: *Azadirachta indica* (Neem) Fruit: *Foeniculum vulgare* (Fennel) Seed: *Plantago ovata* (Isabgol)
9.	Determination of Moisture content, Ash values and Solvent extraction value of the given sample.
10.	Determination of foaming index of the given sample.
11.	Determination of swelling index of the given sample.

SEMESTER II PAPER III (MAJOR MANDATORY) THEORY			
Course Code	**Course Title**	**Hr**	**Cr**
	Dietetics	**30**	**02**

Learning Objectives:

The mandatory course 'Dietetics' in semester II includes the units on Dietetics I and Dietetics II. The course will enable students explore the classes of nutraceuticals, their health benefits. Students will understand how nutraceuticals interact with other drugs. It will throw light on some health foods used as a source of antioxidants and also for treating some diseases. The course will create awareness about nutrigenomics.

Course Outcomes:

After completion of the course, the learners would be able to:

CO1: Classify nutraceuticals and summarize the role of plant nutraceuticals.

CO2: Describe the source and health benefits of some nutraceuticals namely lycopene, glucans, rutin, β-carotene, allicin, ascorbic acid, quercetin, kaempferol, limonene, α-tocopherol, zeaxanthin and caffeine.

CO3: Explore the plant remedies for treatment of human ailments.

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CO4: Select and include plant nutraceuticals in diet based on various factors such as type of ailment, ongoing medication.
CO5: Explain the concept, sources, and uses of antioxidants.
CO6: Discuss about nutrigenomics and its applications for disease prevention and better health.

Unit I – Dietetics I		**15**	**01**
1	Nutraceuticals: Definition and Introduction, classification (Dietary supplements, functional foods, Medicinal food, Farmaceuticals)		
2	Role of plant nutraceuticals in health benefits (onion, garlic, tomato, carrot, beet, turmeric).		
3	Sources and health benefits of nutraceuticals: Lycopene, glucans, rutin, β-carotene, allicin, ascorbic acid, quercetin, kaempferol, limonene, α-tocopherol, zeaxanthin, caffeine. Algae as nutraceuticals Probiotics, Prebiotics, Synbiotics		
4	Safety, adverse effects and interactions of nutraceuticals		
Unit II – Dietetics II		**15**	**01**
1	Plant food in the treatment of diseases: constipation, diarrhoea, jaundice, anorexia.		
2	Nutraceuticals in management of lifestyle diseases: Obesity, Cardiovascular diseases, Diabetes, Cancer.		
3	Concept of Antioxidants, their significance, Plants as a source of antioxidants.		
4	Nutrigenomics and its applications for disease prevention and better health.		

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SEMESTER II PAPER I (MAJOR ELECTIVE) THEORY			
Course Code	**Course Title**	**Hr**	**Cr**
	Ecology and Environmental Botany II	**45**	**03**

Learning Objectives:

The elective course 'Ecology and Environment Botany II' in semester II comprises of units on Pollution, Climatic change, Plant Population dynamics and Coastal Zone Management in India. The course will be elaborate upon various types of environmental pollution. It will throw light upon the global ongoing issues of Climatic Change w. r. t. their impact on ecosystem and productivity. The course aims to explore characteristics & measurements of Plant Population Dynamics including allelopathy and stress ecology. It will further discuss issues related to Coastal Zone Management in India including mangrove ecosystems in the coastal areas.

Course Outcomes:

After completion of the course, the learners would be able to:

CO1: Enhance their knowledge about the adverse impacts of air pollution, radiation, and automobile emissions as well as oil spills on the environment and mankind.

CO2: Gain insight into the global challenge of climatic change; its consequences and impacts in India and the world with recent case studies.

CO3: Understand the phenomena of El Nino and La Nina and its impact on the climate of some countries.

CO4: Learn the concept of Carbon footprint and its relevance & importance in daily life for reducing the emissions at individual level.

CO5: Obtain insight into the concepts of Plant Population Dynamics, Allelopathy and Stress Ecology.

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CO6: Acknowledge the issues associated with Coastal Zone management activities in India and the authorities related to the same. **CO7:** Highlight the importance of mangrove ecosystem in coastal areas against natural disasters and its conservation.			
UNIT I – Pollution and Climatic change		**15**	**01**
1	**Environmental Pollution:** Air Pollution - Sources and Classification of air pollutants, Acid rain, Air Quality Standards, Vehicular emission norms. Photochemical smog - Concept, London type smog, inhibition, adverse effect of photochemical smog. Types of particulate matter, removal of particulate matter from air. Radiation pollution - Manmade and natural, biological effects of radiation. Maximum permissible doses. Abnormal exposures in emergencies and accidents. Nuclear fission and radiation hazards, Radioactive waste management. Environmental impact of petroleum products - Impact of crude oil on marine life.		
2	**Climatic Change:** Greenhouse Effect: Concept, Greenhouse gases and their major sources, Ozone layer. Consequences of climate change: Ozone depletion, Global warming. Climate change Impacts on India. El Nino and La Nina. Carbon Footprinting & its significance.		
UNIT II – Plant Population Dynamics and Allelopathy		**15**	**01**
1	**Population** - Characteristics and Measurement.		
2	**Communities** - Habitats, Niches, Population Dynamics, Species and Individual in the Ecosystem.		
3	**Features of plant communities - Qualitative:** Physiognomy, Phenology, Stratification, Sociability, Vitality, Growth form, Life form. **Quantitative:** Frequency, Density, Basal area or Cover, Abundance, IVI. **Quantitative studies of plant community -** quadrats, transects, bisects.		
4	**Allelopathy**: Introduction, Types of allelopathy, allelochemicals. Crop and weed allelopathy. Allelochemicals and Photosynthesis. Allelopathy and abiotic stress. Allelopathy and biotic stress.		

5	**Stress ecology**: Stress and plant life stress due to temperature, radiation, water, salt and anthropogenic activity; Bioindicators of stress.		
UNIT III – Coastal Zone Management in India		**15**	**01**
1	Coastal Zone Management in India - Coastal Environment India, Coastal Issues.		
2	Coastal Zone Management, initiatives in India, Prohibited and Regulated activities in Coastal Areas, State Coastal Zone Management Authorities.		
3	Mangrove: Habitat and Characteristics, Mangrove, Plantation - Establishment and Rehabilitation of degraded mangrove formations; silvicultural systems.		
4	Mangrove protection of habitats against natural disasters.		

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SEMESTER II PAPER I (MAJOR ELECTIVE) PRACTICAL			
Course Code	**Course Title**	**Hr**	**Cr**
	Ecology and Environmental Botany II	**02**	**01**

Learning Objective:

1. The course will aid students to estimate the characters of plant community quantitatively, which can be used on a larger scale for project work.
2. It will assist students to observe and study a plant community by preparing life form spectrum and its comparison with the normal biological spectrum.
3. It will make them realize the significance of species in a community in terms of its Importance Value Index (IVI).
4. It will create awareness about the common mangrove species in India as well as around the city through field studies and map plotting.
5. It will enable them to determine the amount of oil and grease content in polluted water bodies which can be replicated in larger scales in future for researches based on pollution analysis.
6. It will help them to visualize the effect of allelochemicals on seed germination of various plants.
7. It will highlight the contribution of individuals to climate change by enabling the use of carbon footprint calculator so as to bring about realistic solutions to the global climatic issues and increase awareness about the same.

Course Outcomes:

After completion of the course, the learners would be able to:

CO1: Carry out quantitative studies on plant communities.
CO2: Determine the Importance Value Index (IVI).
CO3: Identify mangrove & some important plants along with their locations & their significance.
CO4: Use carbon footprint calculator.
CO5: Determine the oil and grease content in polluted water bodies.

SIES COLLEGE OF ARTS, SCIENCE AND COMMERCE

(AUTONOMOUS)

SION (WEST) MUMBAI: 400022

DEPARTMENT OF BOTANY

MSc - I BOTANY NEP SYLLABUS 2023 – 24

CO6: Understand allelopathic effect of one plant over another.	
1.	To Study the Quantitative Characters of Plant Community by Quadrat Method. (Density, Frequency, Abundance)
2.	Comparison of Life-form classification of a given plant community with the Normal Biological Spectrum by Raunkiaer.
3.	Determination of IVI of a given plant community.
4.	Estimation of oil and grease content in polluted waters.
5.	Effect of Allelochemicals on seed germination.
6.	Identification of mangrove plant species in India and plotting their distribution on a map of India.
7.	Preparation of report on findings of survey using carbon footprint calculator.

SEMESTER II PAPER II (MAJOR ELECTIVE) THEORY			
Course Code	**Course Title**	**Hr**	**Cr**
	Plant Biotechnology II	**45**	**03**
Learning Objectives: The elective course 'Plant Biotechnology II' in semester II includes units on Traditional Knowledge & IPR, Nanotechnology and Food Biotechnology. The course will help students to understand biosynthesis, properties of nanomaterials and their applications in different fields. Students will understand the concept of traditional knowledge and IPR. It will help students to acknowledge objectives of IPR. Students will learn about factors responsible for food spoilage along with techniques used for its detection, hurdle technology, quality control of food and different plant based products used in food industry.			
Course Outcomes: After completion of the course, the learners would be able to: **CO1:** Explain properties, methods of biosynthesis of nanomaterials. **CO2:** Discuss applications of nanomaterials; along with its risks to human health and environment. **CO3:** Acquire insight into the concept of Traditional Knowledge and IPR **CO4:** Summarize factors affecting food spoilage and food quality control. **CO5:** Explore and make use of biotechnology techniques to monitor food spoilage in order to reduce losses during production. **CO6:** Enlist and describe plant based products such as preservatives and sweeteners used in food industry.			
UNIT I – Traditional Knowledge & IPR		**15**	**01**
1	Different property rights & IPR in India		

2	TRIPS & Patent laws: Introduction & standards for patent protection		
3	WTO & Indian Patent Laws		
4	Protection of traditional knowledge – objective, concept of traditional knowledge, holders, issue concerning, Advantages of IPR, case studies on traditional knowledge.		
5	International Depository Authority, Gene patenting, plant variety protection, trade secrets & plant breeders' right.		
UNIT II – Nanotechnology		**15**	**01**
1	Introduction, properties of nano-materials.		
2	Green synthesis of nano-materials, biological methods, use of microbial system & plant extracts, use of proteins & templates like DNA.		
3	Application of nano-materials in food, cosmetics, agriculture, environment management and medicine.		
4	Risk of Nanomaterial to human health and Environment.		
UNIT III – Food biotechnology		**15**	**01**
1	**Food spoilage:** Types of food spoilage: Microbial, physical and chemical; Factors affecting spoilage; Detection of microbial food spoilage: Enzyme immunoassays (ELISA); Radioimmunoassay (RIA); Monoclonal antibodies; DNA probes.		
2	Principles and applications of Hurdle technology.		
3	Quality control of food: Principles; Intrinsic attributes and extrinsic attributes.		
4	Plant based food additives: Colour, flavours, thickening and gelling agents, emulsifiers, antibrowning and anticaking agents, stabilizers, preservatives, sweeteners.		

References:

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2. Patten, C. L., Glick, B. R. (2017). *Molecular Biotechnology: Principles and Applications of Recombinant DNA.* India: Wiley.
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4. Shukla, A. K., Iravani S. Green Synthesis, *Characterization and Applications of Nanoparticles.* (2018). Netherlands: Elsevier Science.
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6. Sharon Maheshwar, Sharon Madhuri; (2007), Nano forms of Carbon & its Applications, Manad Nanotech Pvt. Ltd.
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10. Cornier, J., Keck, C. M., & Van de Voorde, M. (Eds.). (2019). *Nanocosmetics: from ideas to products*. Springer.
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18. Innovation in Agri-Food Systems. (2005). Germany: Wageningen Academic Publishers.
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23. McClements, D. J., Grossmann, L. (2022). Next-Generation Plant-based Foods: Design, Production, and Properties. Switzerland: Springer International Publishing.

SEMESTER II PAPER II (MAJOR ELECTIVE) PRACTICAL			
Course Code	**Course Title**	**Hr**	**Cr**
	Plant Biotechnology II	**02**	**01**

Learning Objectives:

1. The course will help students to understand the principle and method of nanoparticles biosynthesis.
2. It will assist students to evaluate antioxidant and antimicrobial activity of nanoparticles.
3. The course will help students to understand the principle & methodology of ELISA and enable them to perform ELISA technique.

4. Students will learn the techniques used to count the number of microorganisms in a food sample.
5. The course will provide hands on training to extract pigments and essential oils from plant material.

Course Outcomes:

After completion of the course, the learners would be able to:

CO1: Synthesize nanoparticles using plant extracts.
CO2: Assess antioxidant and antimicrobial activity of nanoparticles
CO3: Perform ELISA technique and interpret results.
CO4: Evaluate the type and number of microbes in spoilt food using different techniques.
CO5: Extract pigments and essential oils from plant material.

1.	Synthesis of nanoparticles using plant extract
2.	Study of antioxidant activity of nanoparticles.
3.	Study of antimicrobial activity of nanoparticles.
4.	Study of ELISA technique.
5.	Enumeration of microbes from spoilt food by spread plate and pour plate method.
6.	Extraction of plant-based pigments and essential oils.

On Job Training (OJT)	**Credits**
	04

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