Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous),

Shivajinagar, Pune 5

(An Autonomous College Affiliated to Savitribai Phule Pune University)

Framework and Syllabus For

T.Y.B.Sc. (Botany)

(Based on NEP 2020 framework)

(To be implemented from the Academic Year 2025-26)

TYBSc Semester V								
Course Type	**Course Code**	**Course**	**Course / Paper Title**	**Hours / Week**	**Credit**	**CIA**	**ESE**	**Total**
Major Mandatory (4 + 4 + 2)	23ScBotU5101	Major Core Paper 9 (Theory) Section 1	Palaeobotany and Plant Systematics	2	4	40	60	100
		Major Core Paper 9 (Theory) Section 2		2				
	23ScBotU5102	Major Paper 10 (Theory) Section 1: Genetics	Genetics and Plant Breeding	2	4	40	60	100
		Major Paper 10 (Theory) Section 2: Genetics and Plant Breeding		2				
	23ScBotU5103	Major Paper 11 (Practical)	Practical Course IV Based On Minor	4	2	20	30	50
Major Electives	23ScBotU5201	Elective I (Theory)	Ecology and Conservation	2	4	40	60	100
	23ScBotU5202	Elective I (Practical)	Practical Course I Based On Elective Paper	4				
	23ScBotU5203	Elective II (Theory)	Landscaping and Gardening	2	4	40	60	100
	23ScBotU5204	Elective II (Practical)	Practical Course I Based On Elective Paper	4				
Minor (4)	23ScBotU5301	Minor Paper IV (Theory) Section 1	Plant Physiology and Biochemistry	2	4	40	60	100
		Minor Paper IV (Practical) Section 2	Practical Course IV Based On Minor	4				
OE (2)		--	--	--	--	--	--	--
VSC (2)	23ScBotU5501	Major Specific Practical IV	Phytochemical Techniques	4	2	20	30	50
SEC (2)		--	--	--	--	--	--	--

AEC(2),		--	--	--	--	--	--	--
VEC (2)		--	--	--	--	--	--	--
IKS (2)		--	--	--	--	--	--	--
FP / CEP(2)	23ScBotU5002	FP –II	Field Project II	4	2	20	30	50
Total				**38**	**22**	**220**	**330**	**550**

TYBSc Semester VI								
Course Type	**Course Code**	**Course**	**Course / Paper Title**	**Hours / Week**	**Credit**	**CIA**	**ESE**	**Total**
Major Mandatory (4 + 4 + 2)	23ScBotU6101	Major Core Paper 12 (Theory) Section 1: Molecular Biology	Molecular Biology and Plant Biotechnology	2	4	40	60	100
		Major Core Paper 12 (Theory) Section 2: Plant Biotechnology		2				
	23ScBotU6102	Major Paper 13 (Theory) Section 1: Plant Physiology	Plant Physiology and Metabolism	2	4	40	60	100
		Major Paper 13 (Theory) Section 2: Metabolism		2				
	23ScBotU6103	Major Paper 14 (Practical)	Practical Course VI Based On Major	4	2	20	30	50
Major Electives	23ScBotU6201	Elective III (Theory)	Plant Analytical Techniques and Biostatistics	2	4	40	60	100
	23ScBotU6202	Elective III (Practical)	Practical Course II Based On Elective Paper	4				
	23ScBotU6203	Elective IV (Theory)	Industrial and Environmental Microbiology	2	4	40	60	100
	23ScBotU6204	Elective IV (Practical)	Practical Course II Based On Elective Paper	4				
Minor (4)	23ScBotU6301	Minor Paper V (Theory) Section 1	Plant Biotechnology	2	4	40	60	100
		Minor Paper V (Practical) Section 2	Practical Course V Based On Minor	4				
OE (2)		--	--	--	--	--	--	--

VSC (2)		--	--	--	--	--	--	--
SEC (2)		--	--	--	--	--	--	--
AEC(2),		--	--	--	--	--	--	--
VEC (2)		--	--	--	--	--	--	--
IKS (2)		--	--	--	--	--	--	--
FP / CEP(2)		--	--	--	--	--	--	--
OJT(4)	23ScBotU6004	OJT	On Job Training	8	4	40	60	100
Total				**38**	**22**	**220**	**330**	**550**

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Third Year of B.Sc. Botany

(2023 Course under NEP 2020)

Course Code: 23ScBotU5101 **Course Name: Palaeobotany and Plant Systematics**

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**

Examination Scheme: CIE: 40 Marks **End-Sem: 60 Marks**

Pre-requisite: A basic understanding of plant biology, including plant morphology, anatomy, and evolution, is essential. Familiarity with geological time scales and fossilization processes will be beneficial. Additionally, prior knowledge of plant classification systems and botanical nomenclature is recommended to grasp the advanced concepts covered in this course.

Course Objectives:

- To introduce students to the fundamental concepts of palaeobotany, including fossil formation, fossil types, and major fossil localities in India.
- To develop an understanding of different fossil plant groups, their morphological features, and their evolutionary significance.
- To explore the origin and evolution of angiosperms with reference to geological time scales, theories of angiosperm origin, speciation, and endemism.
- To familiarize students with the principles of plant taxonomy and systematics, including the historical development of plant classification systems.
- To impart knowledge about the rules and principles of botanical nomenclature, including the International Code of Nomenclature (ICN) and its applications.
- To enable students to use taxonomic tools such as herbaria, botanic gardens, and taxonomic literature for plant identification and classification.

Course Outcomes:

On completion of this course, students will be able to:

- Explain the concepts of paleobotany and identify different types of plant fossils and their significance in plant evolution.
- Gain knowledge about the characteristics and classification of major fossil plant groups, including Psilopsida, Lycopsida, Sphenopsida, Pteridosperms, Pentoxylae, and Bennettitales.
- Understand the theories of angiosperm origin, speciation, and endemism, and apply this knowledge to evolutionary studies.
- Differentiate between various classification systems, including artificial, natural, and phylogenetic systems, and critically analyze their merits and limitations.
- Demonstrate proficiency in botanical nomenclature by applying ICN rules for proper naming and classification of plant species.
- Identify and classify plant species using diagnostic characters, floral formulae, floral diagrams, and systematic positions of major plant families.

Course Contents:

Unit 1	**Introduction**	5 Lectures
	1.1. Definition and concept 1.2. Paleobotanical studies and fossil localities in India 1.3. Fossil formation and Form genera concept 1.4. Types of fossils	
Unit 2	**Fossil groups of plants**	12 Lectures
	2.1. Psilopsida- Salient features of order Psilophytales, external and internal morphology of Rhynia. 2.2. Lycopsida- Salient features of order Lepidodendrales, external and internal morphology of Lepidodendron, 2.3. Sphenopsida- Salient features of Calamitales, external and internal morphology of Calamites 2.4. Pteridosperms- External and internal morphology of Lyginopteris oldhamia. 2.5. Pentoxylae- Salient feature, external and internal morphology of stem [Pentoxylon], Leaf [Nipaniophyllum]. 2.6. Bennettitales – Salient features, external morphology of Cycadeoidea, Williamsonia and Williamsoniella	
Unit 3	**Origin of Angiosperms**	11 Lectures
	3.1. Geological time scale and evolution of major plant groups 3.2. Origin of Angiosperms – Theories 3.3. Speciation 3.4. Endemism	
Unit 4	**Applications of palaeobotany**	2 Lectures
Unit 5	**Introduction to Plant Systematics**	2 Lectures
	5.1. Concept of Plant Taxonomy and Systematics 5.2. Aspects of Plant Taxonomy 5.3. Phases of Plant Taxonomy	
Unit 6	**Classification systems for plants**	5 Lectures

	6.1. Types of classification systems 6.2. Linnaeus's artificial system (basis, outline, merits and limitations) 6.3. Bentham and Hooker's natural system (basis, outline, merits and limitations) 6.4. Engler and Prantl's phylogenetic system (basis, outline, merits and limitations) 6.5. APG 4.0 system of classification	
Unit 7	**Botanical nomenclature**	7 Lectures
	7.1 Introduction and Objectives 7.2 ICN: Rules, recommendations; Principles 7.3 Important rules of nomenclature (Priority of publication, Nomina conservanda, Author's citation, Rank and ending of taxa names and valid and effective publication) 7.4 Typification and its types	
Unit 8	**Tools of Taxonomy**	4 Lectures
	8.1 Introduction 8.2 Herbaria and Museums 8.3 Botanic Gardens 8.4 Taxonomic literature	
Unit 9	**Study of plant families**	
	(Diagnostic characters, floral formula, floral diagrams, systematic position and economically important plants from each family) 9.1 Magnoliaceae 9.2 Meliaceae 9.3 Fabaceae 9.4 Rubiaceae 9.5 Apocynaceae 9.6 Solanaceae 9.7 Lamiaceae 9.8 Euphorbiaceae 9.9 Amaryllidaceae 9.10 Poaceae	

Suggested readings:

Datta, S. C. (1988). Systematic botany (4th ed.). New Age International Publishers.

Judd, W. S., Campbell, C. S., Kellogg, E. A., Stevens, P. F., & Donoghue, M. J. (2016). Plant systematics: A phylogenetic approach (4th ed.). Sinauer Associates.

Maheshwari, J. K. (2000). Taxonomy of Indian plants (1st ed.). International Scientific

Publishing Academy.
Naik, V. N. (1984). Taxonomy of angiosperms (1st ed.). Tata McGraw-Hill Education.
Pandey, B. P., & Trivedi, P. C. (2008). A textbook of botany: Angiosperms (1st ed.). S. Chand Publishing.
Raven, P. H., Evert, R. F., & Eichhorn, S. E. (2013). Biology of plants (8th ed.). W.H. Freeman and Company.
Sharma, O. P. (2009). Plant taxonomy (2nd ed.). Tata McGraw-Hill Education.
Shukla, P., & Misra, S. P. (2014). Plant systematics and evolution (1st ed.). Rastogi Publications.
Singh, G. (2012). Plant systematics: An integrated approach (3rd ed.). Science Publishers.
Spicer, R. A., & Collinson, M. E. (2014). Introduction to plant fossils. Cambridge University Press.
Stewart, W. N., & Rothwell, G. W. (1993). Paleobotany and the evolution of plants (2nd ed.). Cambridge University Press.
Taylor, T. N., Taylor, E. L., & Krings, M. (2009). Paleobotany: The biology and evolution of fossil plants (2nd ed.). Academic Press.
Vasishta, P. C., Sinha, A. K., & Singh, V. P. (2010). Botany for degree students: Part III—Plant taxonomy (1st ed.). S. Chand Publishing.

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Third Year of B.Sc. Botany
(2023 Course under NEP 2020)

Course Code: 23ScBotU5102 **Course Name: Genetics and Plant Breeding**

Teaching Scheme: PR: 4 Hours/Week **Credit: 04**

Examination Scheme: CIE: 40 Marks **End-Sem: 60 Marks**

Pre-requisite: A foundational understanding of cell biology, basic genetics, and plant biology is essential. Students should be familiar with cell division (mitosis and meiosis), DNA structure, basic laboratory skills, such as microscopy and sample handling, will also be beneficial for successfully engaging in genetic analysis and plant breeding practices.

Course Objectives:

- To introduce students to the basic concepts of heredity, variation, and Mendelian genetics.
- To explore the principles of gene interactions, including dominance, complementary, and lethal genes.
- To understand multiple alleles and their roles in inheritance patterns, using blood groups and self-incompatibility as examples.
- To study quantitative inheritance and cytoplasmic inheritance mechanisms with real-life plant examples.
- To examine sex-linked inheritance and the significance of linkage, crossing over, and chromosome mapping in genetic analysis.
- To provide foundational knowledge of plant breeding, including its history, objectives, and methods for crop improvement.

Course Outcomes:

On completion of this course, students will be able to:

- Describe fundamental genetic concepts, including Mendelian principles and the significance of heredity and variation.
- Demonstrate an understanding of various gene interactions and apply these principles to predict genetic outcomes.
- Identify examples of multiple alleles and explain their inheritance patterns in organisms.
- Analyse the genetic and cytoplasmic inheritance patterns in plants, differentiating between qualitative and quantitative traits.
- Apply knowledge of linkage, mapping, and genetic recombination processes in bacteria and haploid organisms to practical genetic analysis.
- Gain practical insight into plant breeding techniques and the genetic foundations of crop improvement strategies, fostering skills for future research or agricultural applications.

Course Contents:

Unit 1	Introduction to Genetics and Mendelism	3 L
	1.1 Definition, concept of heredity and variations 1.2 Mendel's contribution 1.3 Monohybrid cross and principle of dominance 1.4 Law of segregation/law of purity of gametes 1.5 Dihybrid cross 1.6 Law of independent assortment 1.7 Back cross and test cross	
Unit 2	Interactions of genes	4 L
	2.1 Incomplete dominance (1:2:1) 2.2 Complementary genes (9:7) 2.3 Duplicate genes (15:1) 2.4 Masking genes (12:3:1) 2.5 Supplementary genes (9:3:4) 2.6 Inhibitory genes (13:3) 2.7 Lethal genes in mice (2:1)	
Unit 3	Multiple alleles	3 L
	3.1 Definition 3.2 Characters of multiple alleles 3.3 Examples of multiple alleles – inheritance of blood group in human, self-incompatibility in *Nicotiana*	
Unit 4	Quantitative and Cytoplasmic Inheritance	4L
	4.1 Concept of quantitative inheritance 4.2 Difference between qualitative and quantitative traits 4.3 Inheritance of quantitative trait in maize 4.4 Cytoplasmic inheritance - definition and concept 4.5 Cytoplasmic inheritance in plants - variegation in four O'clock plants	
Unit 5	Sex linked inheritance	3 L
	5.1 Concept of sex chromosomes and autosomes 5.2 Inheritance of X- linked genes – eye colour in *Drosophila* and colour blindness in humans,	
Unit 6	Linkage and chromosome mapping	14 L
	6.1 Definition and types of linkage 6.2 Definition and types of crossing over 6.3 Construction of a linkage map by two-point test cross	

	and three-point test cross 6.4 Mapping in haploid organisms: Mapping genes in *Chlamydomonas* and *Neurospora*, gene to centromere mapping, ordered and unordered tetrad analysis, linkage and mapping	
Unit 7	Genetic analysis and mapping in bacteria and bacteriophage	14 L
	7.1 Conjugation leading to genetic recombination in bacteria: F^+ and F^- bacteria, Hfr bacteria and chromosome mapping, recombination in matings, F-state and merozygotes 7.2 Transformation and genetic recombination in bacteria: process of transformation, transformation and linked genes 7.3 Transduction - virus-mediated bacterial DNA transfer: Phage T4: Structure and life cycle, plaque assay lysogeny, Lederberg-Zinder experiment, nature of transduction, transduction and mapping	
Unit 8	Introduction to Plant Breeding	2 L
	8.1 History and objectives of plant breeding: Importance of plant breeding in crop improvement 8.2 Basic Concepts: Genetic basis of plant breeding (genotype, phenotype, variation)	
Unit 9	Modes of reproduction in crop plants	3 L
	9.1 Asexual and sexual reproduction: Self-pollination and cross-pollination 9.2 Genetic consequences: Homogeneity in self-pollinated crops, heterogeneity in cross-pollinated crops 9.3 Mechanisms to promote cross-pollination: Dichogamy, herkogamy, self-incompatibility	
Unit 10	Methods of Plant Breeding	10 L
	10.1 Selection: Mass selection and pure-line selection, clonal selection, advantages and limitations 10.2 Hybridization: Procedure and types of hybridization (inter-varietal, inter-specific, inter-generic), Production of hybrids and their significance in crop improvement	

	10.3	Heterosis (Hybrid Vigor): Concept and significance in agriculture	
	10.4	Backcross breeding: Use of backcrossing in transferring traits	
	10.5	Mutation breeding: Use of induced mutations for crop improvement	

Suggested readings:

Annadurai, B. (2007). A Textbook of Biostatistics. New Age International (P) Limited.

Bhatia, K. N. (2014). Principles of Genetics. Atlantic Publishers & Distributors.

Gardner, E. J., Simmons, M. J., & Snustad, D. P. (2006). Principles of Genetics. John Wiley & Sons.

Gupta, P. K. (2010). Genetics. Rastogi Publications.

Jain, H. K., & Kharkwal, M. C. (2004). Plant Breeding: Principles and Methods. Narosa Publishing House.

Lewin, B. (2008). Genes IX. Jones & Bartlett Learning.

Miglani, G. S. (2009). Advanced Genetics. Narosa Publishing House.

Pierce, B. A. (2008). Genetics: A Conceptual Approach. W. H. Freeman and Company.

Purohit, S. S. (2009). Plant Breeding and Biotechnology: Concepts and Perspectives. Agrobios (India).

Rastogi, V. B. (2008). A Textbook of Genetics and Evolutionary Biology. Kedar Nath Ram Nath.

Singh, B. D. (2012). Genetics. Kalyani Publishers.

Singh, B. D. (2014). Plant Breeding: Principles and Methods. Kalyani Publishers.

Snustad, D. P., & Simmons, M. J. (2012). Principles of Genetics. John Wiley & Sons.

Strickberger, M. W. (2008). Genetics. Pearson Education India.

Swaminathan, M. S., & Singh, S. (2010). Cytogenetics and Plant Breeding. Narosa Publishing House.

Tamarin, R. H. (2004). Principles of Genetics. Tata McGraw-Hill Education.

Verma, P. S., & Agarwal, V. K. (2012). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand & Company Ltd.

Weiling, F. (2013). History of Human Genetics: Aspects of Its Development and Global Perspectives. Springer India.

Wilson, E. (2010). Genetic Analysis: An Integrated Approach. Pearson Education India.

Wolfe, S. L. (2009). Molecular and Cell Biology. Wadsworth Publishing Company.

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Third Year of B.Sc. Botany
(2024 Course under NEP 2020)

Course Code: 23ScBotU5103 Course Name: Lab on 23ScBotU5101 and 23ScBotU5102

Teaching Scheme: TH: 4 Hours/Week **Credit: 02**
Examination Scheme: CIA: 20 Marks **End-Sem: 30 Marks**

Pre-requisite: Students should have a foundational understanding of cell biology, including chromosome structure, genetic mutations, and basic lab skills such as microscopy and sample staining. Familiarity with genetic concepts like polyploidy and gene mapping will aid in understanding complex genetic analyses.

Course objectives:

- To develop student skills in analyzing chromosomal structures and abnormalities in plants and model organisms.
- To introduce methods for inducing and observing genetic mutations and polyploidy.
- To provide hands-on experience in genetic mapping and data analysis techniques, including three-point test crosses.

Course outcomes:

On completion of this course, students will be able to:

- Demonstrate proficiency in identifying structural chromosomal variations, including translocations and polyploid cells.
- Gain skills in experimental techniques for inducing genetic mutations and polyploidy in plants.
- Conduct genetic mapping using test cross data, interpreting chromosomal arrangements and gene linkage patterns.

Course content – (Any fifteen practicals)

1. Study of Types of fossils 1P
2. Study of fossil Group of plants (Psilopsida, Lycopsida, Sphenopsida, Pteridosperms and Pentoxylae) 1P
3. Study of family Magnoliaceae and Meliaceae 1P
4. Study of Fabaceae 1P
5. Study of family Solanaceae and Euphorbiaceae 1P
6. Study of family Amaryllidaceae 1P
7. Identification of plants with regional flora 1P
8. Study of structural heterozygotes (multiple translocations) in *Rhoeo* 1P
9. Induction of tetraploidy in the roots of suitable plant and observation of tetraploid cells 1P
10. Preparation of salivary gland chromosomes in *Chironomous* larvae 1P

11. Analysis of three-point test cross data and mapping of genes	1P
12. Demonstration of plant hybridisation technique	1P
13. Induction of mutations in a suitable plant.	1P
14. Induction of tetraploidy in a suitable plant.	1P
15. Karyotype analysis in a suitable plant	1P
16. Excursion tour	1P

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Third Year of B.Sc. Botany

(2023 Course under NEP 2020)

Course Code: 23ScBotU5201 **Course Name: Ecology and Conservation**

Teaching Scheme: TH: 2 Hours/Week **Credit: 02**

Examination Scheme: CIE: 20 Marks **End-Sem: 30 Marks**

Prerequisite: A basic understanding of biology, particularly concepts related to organisms and their environments, is required. Familiarity with ecological principles such as species interactions, energy flow, and ecosystem dynamics will be helpful. Additionally, knowledge of environmental issues and conservation practices is recommended to fully engage with the course content.

Course Objectives:

- Develop an understanding of the differences in the structure and function of different types of ecosystems.
- Become familiar with the variety of ways organisms interact with both the physical and the biological environment.
- Obtain knowledge of ecological principles
- Get the knowledge of various environments in which plants grow
- Acquire information about the biodiversity of organisms
- Understand the conservation methods

Course Outcomes:

On completion of the course, students will be able to–

- Learn various ecological concepts and principles
- Gain knowledge of habitat of organisms, interactions within and across trophic levels, flow of energy and the movement and recycling of matter in communities and ecosystems.
- Understand the changes in the vegetation occurring due to various environmental factors and the methods of conservation of the environment
- Develop realization towards the conservation of Biodiversity
- Learn about the consequences of the relationship between organisms and the environment
- Gain the international strategies for conservation of biodiversity and organizations involved in it

Course Contents:

Unit 1	**Introduction to Ecology**	3 Lecture
	1.1. Concept and Definition 1.2. Biotic and Abiotic Environment 1.3. Interactions-Interspecific competition, herbivory, carnivory, pollination, symbiosis. 1.4. Concept of habitat and niche, types of niche	

Unit 2	**Ecosystem**	5 Lectures
	2.1. Structure and function of ecosystems: terrestrial (forest, grassland) and aquatic (freshwater, marine, and estuarine) 2.2. Energy flow in ecosystems 2.3. Food chains and food webs 2.4. Ecological pyramids 2.5. Biogeochemical cycles 2.6. Productivity in ecosystems	
Unit 3	**Adaptation**	3 Lectures
	3.1. Concept 3.2. Ecological grouping of plants: Hydrophytes, Mesophytes, Xerophytes and Halophyes	
Unit 4	**Ecological Succession**	4 Lectures
	4.1. Types and mechanisms 4.2. Changes involved in succession 4.3. Concept of climax community	
Unit 5	**Soil and water Conservation**	3 Lectures
	5.1. Soil erosion 5.2. Soil conservation methods 5.3. Control of floods 5.4. Water quality monitoring	
Unit 6	**Conservation of Biodiversity**	7 Lectures
	6.1. Extinction of species 6.2. Susceptibility to extinction 6.3. Causes of extinction 6.4. The IUCN red list categories 6.5. Institutes involved in conservation of biodiversity in India 6.6. International efforts for conservation of biodiversity	

Suggested readings:

Arihant Experts. (n.d.). Environment and Ecology. Arihant Publications.

Bharucha, E. (n.d.). Textbook of Environmental Studies for Undergraduate Courses. University

Grants Commission.

Joseph, B. (n.d.). Environmental Studies. Tata McGraw Hill Education.

Odum, E. P. (n.d.). Fundamentals of Ecology. Cengage Learning.

Pratiyogita Darpan. (2012). CSAT Environmental Ecology, Biodiversity & Climate Change. Upkar Prakashan.

Rajagopalan, R. (n.d.). Environmental Studies: From Crisis to Cure. Oxford University Press.

Sharma, P. D. (n.d.). Ecology and Environment. Rastogi Publications.

Singh, B. B. (n.d.). Objective Environmental Sciences. McGraw Hill Education.

Singh, J. S., Singh, S. P., & Gupta, S. R. (2014). Ecology, Environmental Science & Conservation. S. Chand Publishing.

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Third Year of B.Sc. Botany
(2023 Course under NEP 2020)

Course Code: 23ScBotU5201 **Course Name: Lab Course on Ecology and Conservation**

Teaching Scheme: PR: 4 Hours/Week **Credit: 02**
Examination Scheme: CIE: 20 Marks **End-Sem: 30 Marks**

Prerequisite: Basic understanding of ecology and environmental science is required. Familiarity with laboratory instruments and techniques for water and soil analysis is recommended. Prior knowledge of plant adaptations and ecosystem dynamics will be beneficial..

Course Objectives:

- To familiarise students with the variety of ways that organisms interact with both the physical and the biological environment
- To learn various methods used to study ecological parameters
- Grasp the knowledge of aquatic flora
- Make the student familiar with the instruments used for various ecological studies
- Create awareness about the identification of polluted and disturbed ecosystems
- Gain knowledge about adaptations plants acquire while living in various habitats

Course Outcomes:

On completion of the course, students will be able to–

- Analyse ecological data
- Draw inferences about the relationship between organisms and the environment
- Comment on the status of the ecosystem
- Derive conclusions about the type of vegetation
- Find remedial measures for the restoration of Ecosystem
- Learn the biodiversity of organisms

Course Contents

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, hair hygrometer, Lux meter 1P
2. Study of hydrophytes and xerophytes 2P
3. Determination of BOD from given sample 2P
4. Determination of pH, carbonate and bicarbonate, chlorides and phosphates from the given sample 2P

5. Study of the plankton communities in a fresh-water ecosystem. 1P
6. Determination of COD from given sample 1P
7. Estimation of the productivity of a pond ecosystem 1P
8. Determination of minimal quadrat size for the study of herbaceous vegetation by Species area curve method. (Species to be listed) 1P
9. Determination of density, abundance and frequency by list count quadrat method 1P
10. Demonstration of methods in assessment of Biodiversity 1P
11. Visit to a forest/ river/ wetland ecosystem. 2P

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Third Year of B.Sc. Botany
(2023 Course under NEP 2020)

Course Code: 23ScBotU5202 **Course Name: Landscaping and Gardening**

Teaching Scheme: TH: 2 Hours/Week **Credit: 02**
Examination Scheme: CIE: 20 Marks **End-Sem: 30 Marks**

Prerequisite: A basic understanding of plant biology, horticulture, and environmental aesthetics is recommended. Familiarity with gardening techniques, plant care, and landscape design concepts will be beneficial. Additionally, an interest in art, design, and cultural aspects of gardening will enhance learning..

Course Objectives:

- Introduce students to the history, importance, and scope of gardening and landscaping.
- To develop an understanding of bioesthetic planning and its application in urban and rural settings.
- To explore various garden styles, designs, and their cultural significance.
- To provide knowledge about different types of gardens, their components, and maintenance.
- To familiarize students with popular gardens in India and their unique features.
- To teach the art of flower arrangement, terrarium creation, and bonsai cultivation.

Course Outcomes:

On completion of the course, students will be able to–

- Explain the historical background, principles, and components of gardening and landscaping.
- Demonstrate the ability to plan and design bioesthetic landscapes for various settings, including urban and rural areas.
- Identify and differentiate between formal and informal garden styles and their design elements.
- Gain practical skills in creating and maintaining lawns, rock gardens, vertical gardens, and other specialized garden types.
- Analyze and appreciate the design and cultural significance of popular gardens in India.
- Develop proficiency in flower arrangement, terrarium making, and bonsai cultivation techniques.

Course Contents:

Unit 1	**Introduction**	2 Lectures
	1.1. History, importance and scope of gardening 1.2. Landscaping – definition, historical background	

	1.3. Design, basic principle and components of gardens and landscapes	
Unit 2	**Bioesthetic planning**	8 Lectures
	2.1. Definition, need, round country planning 2.2. Concept of urban landscaping 2.3. Planning and planting avenues for schools, villages, beautifying railway stations, dam sites, hydroelectric stations, colonies, and river banks 2.4. Planting material for playgrounds	
Unit 3	**Gardens**	11 Lectures
	3.1. Concept, garden components and their importance 3.2. Styles of the garden: Formal and Informal 3.3. Concept and design of lawns 3.4. Types of lawns and planting materials 3.5. Care of lawns 3.6. Types of gardens – Persian gardens, Mughal gardens, English gardens, French gardens, Spanish gardens, Japanese gardens	
Unit 4	**Popular gardens in India**	6 Lectures
	4.1. Design and components of: Temple Garden, water garden, Vertical gardens, roof gardens, terrace gardens, Rock Gardens (methods of designing rockery, layout of rockery), Clock Gardens, miniature gardens, Table gardens, window gardens, indoor gardens, 4.2. Parks and public gardens	
Unit 6	**Flower arrangements and Bonsai**	3 Lectures
	5.1 Concept, designs and materials for flower arrangement 5.2 Terrarium 5.3 Bonsai- Concept, styles and methods	

Suggested readings:

Arora, J. S. (1998). Introductory Ornamental Horticulture. Kalyani Publishers.

Bose, T. K., Maiti, R. G., Dhua, R. S., & Das, P. (2003). Floriculture and Landscaping. Naya Prakash.

Bose, T. K., & Yadav, L. P. (Eds.). (1988). Commercial Flowers. Naya Prokash.

Randhawa, G. S. (1986). Floriculture in India. Allied Publishers.

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Third Year of B.Sc. Botany

(2023 Course under NEP 2020)

Course Code: 23ScBotU5202 **Course Name: Lab Course on 23ScBotU5202**

Teaching Scheme: TH: 4 Hours/Week **Credit: 02**

Examination Scheme: CIE: 20 Marks **End-Sem: 30 Marks**

Prerequisite: A basic understanding of plant biology, horticulture, and landscape design principles is required. Familiarity with garden tools, plant identification, and propagation techniques will be beneficial. Additionally, an interest in practical gardening and design aesthetics is recommended.

Course Objectives:

- To develop skills in identifying physical elements of landscapes (hardscape) and various ornamental plants.
- To familiarize students with garden tools, implements, and their uses in landscaping.
- To teach the principles and techniques of designing residential and public gardens, water gardens, and rock gardens.
- To provide hands-on experience in preparing Bill of Quantities (BOQ) for garden designs.
- To introduce students to tray landscapes, terrarium designing, and propagation methods for ornamental plants.
- To enhance practical knowledge through visits to botanical gardens and real-world applications of landscaping.

Course Outcomes:

On completion of the course, students will be able to–

- Identify and classify physical elements of landscapes and various ornamental plants.
- Demonstrate proficiency in using garden tools and implements for landscaping purposes.
- Design residential and public gardens, water gardens, and rock gardens using appropriate techniques.
- Prepare accurate Bill of Quantities (BOQ) for given garden designs.
- Create tray landscapes and terrariums, and apply propagation methods for ornamental plants.
- Gain practical insights into landscaping through visits to botanical gardens and real-world applications.

Course Contents:

1. Identification of Physical Elements in Landscape (Hardscape) 1P
2. Identification of plants- ground cover plants and bulbous plants, hedge and edge, pergolas, arches, Palms, foliage and flowering Shrubs, foliage and flowering, climbers and ramblers, Lawn grasses and Plantation of lawn. 2P
3. Identification of Garden tools and implements. 1P
4. Landscape designing of Residential area and Public Garden 2P

5. Designing of Water garden and Rock Garden 2P
6. Estimation of given garden design- BOQ preparation 1P
7. Designing of Tray Landscape. 1P
8. Study of Terrarium Designing. 2P
9. Study of propagation methods of ornamental plants. 2P
10. Visit to botanical garden. 1P

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Third Year of B.Sc. Botany
(2023 Course under NEP 2020)

Course Code: 23ScBotU5301 **Course Name: Plant Physiology and Biochemistry (Theory)**

Teaching Scheme: TH: 2 Hours/Week **Credit: 02**

Examination Scheme: CIE: 20 Marks **End-Sem: 30 Marks**

Prerequisite: A foundational understanding of plant biology, including basic concepts of cell structure and function, is essential. Familiarity with chemical processes such as diffusion, osmosis, and water relations in plants will be beneficial. Additionally, basic knowledge of biochemistry, including carbohydrates, proteins, and lipids, is recommended to grasp advanced topics in plant physiology.

Course Objectives:

- To acquaint students with preliminary knowledge of Plant Physiology
- Comprehend the importance of the role of water in plant life and its uptake and absorption
- To learn the mechanism of water and solute uptake in plants
- To impart the concept of the transpiration process
- To deliver the basic concept of primary metabolites in Plants
- To Illustrate the role of lipids in plants

Course Outcomes:

On completion of the course, students will be able to

- Gain preliminary knowledge of plant physiology and metabolism
- Understand the importance of the role of water in plant life
- Learn mechanisms of water and solute uptake in plants
- Explain the mechanism of transpiration
- Understand the importance of primary metabolites in metabolism
- Understand the importance of lipids in plants

Course Contents:

Unit 1	**Introduction to Plant Physiology**	1 Lecture
	1.1. Definition and concept 1.2. Scope and importance 1.3. History of Plant Physiology	
Unit 2	**Plant Water Relations**	5 Lectures

	2.1. Concept, structure and properties of water 2.2. Structure of Plasma membrane 2.3. Types of membranes based on permeability 2.4. Aquaporins 2.5. Diffusion - Definition, concept, Graham's law of diffusion, significance of diffusion in plants 2.6. Solution - Definition and types 2.7. Osmosis - Definition, concept, types, concept of osmotic pressure, U-tube experiment, significance of osmosis in plants, turgor pressure, wall pressure 2.8. Diffusion Pressure Deficit (DPD), relationship between Osmotic Pressure (O.P), Turgor pressure (T.P.) and DPD 2.9. Plasmolysis - Definition, mechanism, significance in plants 2.10. Imbibition - Definition, concept of imbibition and imbibition	
Unit 3	**Transpiration**	5 Lectures
	3.1. Definition, concept, types of transpiration 3.2. Structure of stomata, pathway of stomatal transpiration, mechanism of closing and opening of stomata 3.3. Steward's hypothesis, active potassium transport 3.4. Factors affecting transpiration, significance of transpiration 3.5. Antitranspirants 3.6. Guttation and Exudation	
Unit 4	**Ascent of sap**	3 Lectures
	4.1. Definition, concept, path of ascent of sap 4.2. Transpiration pull theory 4.3. Factors affecting ascent of sap	
Unit 5	**Absorption of water**	3 Lectures
	5.1. Role of water in plants 5.2. Concept of water potential and capillary water 5.3. Structure of xylem	

	5.4. Mechanism of water absorption - active absorption, passive absorption, factors affecting rate of water transport	
Unit 6	**Introduction to Biochemistry**	1 Lecture
	6.1. Definition and concept 6.2. Scope and importance	
Unit 7	**Carbohydrates**	4 Lectures
	7.1. Definition and classification 7.2. Properties and functions 7.3. Biosynthesis and breakdown of starch	
Unit 8	**Amino acids and proteins**	4 Lectures
	8.1. Definition and classification of amino acids 8.2. Synthesis and functions of amino acids 8.3. Structure and functions of proteins	
Unit 9	**Lipids**	4 Lectures
	9.1 Definition and classification 9.2 Properties and functions 9.3 Biosynthesis of lipids 9.4 Beta oxidation	

Suggested readings:

Bidwell, R. G. S. (1979). Plant Physiology (Revised ed.). Macmillan Publishing Co.

Buchanan, B. B., Gruissem, W., & Jones, R. L. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists.

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www.plantphysiology.org

www.nature.com

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Third Year of B.Sc. Botany
(2023 Course under NEP 2020)

Course Code: 23ScBotU5301 **Course Name: Plant Physiology and Biochemistry (Practical)**

Teaching Scheme: TH: 2 Hours/Week **Credit: 02**

Examination Scheme: CIE: 20 Marks **End-Sem: 30 Marks**

Prerequisite: A basic understanding of plant physiology, including concepts like diffusion, osmosis, transpiration, and water relations, is essential. Familiarity with laboratory instruments such as pH meters, spectrophotometers, and conductivity meters is recommended. Additionally, prior knowledge of biochemical techniques like chromatography and qualitative/quantitative analysis will be beneficial for conducting experiments effectively..

Course Objectives:

- Understand how the physiological phenomenon occurs
- To learn various metabolic, developmental and biochemical processes occurring in plants
- Understand the basics behind physiological processess
- Acquire the knowledge of the principles of various physiology instruments
- Analyse the various metabolites
- Learn the qualitative and quantitative methods for understanding the metabolites

Course Outcomes:

On completion of the course, students will be able to understand:

- Plant physiological processes
- Basics concepts
- Mechanisms of various physiological processes
- Identification of metabolites in the given sample
- The principles behind biochemistry experiments
- Methods used for quantification of metabolites

Course contents:

1. Determination of Diffusion Pressure Deficit (DPD) using potato tubers. 1P
2. Determination of rate of transpiration under different conditions. 1P
3. Study of plasmolysis. 1P
4. Determination of Water Holding Capacity (WHC) and pH of soil. 1P
5. Plant physiology demonstration experiments - Conductivity meter, pH meter, transpiration pull, leaf area meter, spectrophotometer
6. To study suction due to transpiration 1P

7. To study permeability of seed coat 1P
8. To determine the stomatal frequency 1P
9. Imbibition by different types of seeds 1P
10. Effect of salt on growth of the seedlings 1P
11. Effect of pH on stomatal opening and closing 1P
12. Estimation of sugars 1P
13. Estimation of proteins by Bradford's method 1P
14. Qualitative tests for secondary metabolites/primary metabolites 1P
15. Separation of amino acids by paper chromatography 1P

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Third Year of B.Sc. Botany

(2023 Course under NEP 2020)

Course Code: 23ScBotU5501 Course Name: Lab on Phytochemical Techniques

Teaching Scheme: PR: 4 Hours/Week Credit: 02

Examination Scheme: CIE: 20 Marks End-Sem: 30 Marks

Prerequisite: Students should have basic knowledge of plant biology, particularly in plant biochemistry and cellular structure, along with essential lab skills in sample handling, microscopy, and solvent usage.

Course Objectives:

- To introduce students to methods of plant sample collection and preparation for phytochemical analysis.
- To familiarize students with extraction techniques like Soxhlet extraction, maceration, and percolation for isolating plant phytochemicals.
- To enable students to identify and quantify specific plant compounds, such as phenolics, flavonoids, and alkaloids.
- To provide training in chromatographic techniques, including TLC, column chromatography, and paper chromatography for compound separation.
- To teach students to assess the bioactivities of plant extracts, such as antioxidant and antimicrobial properties, using standardized assays.
- To equip students with skills in using UV-VIS spectrophotometry and SDS-PAGE for the quantitative analysis of phytochemicals and plant proteins.

Course Outcomes:

Upon completion of the course, students will be able to:

- Demonstrate competency in collecting and preparing plant samples for phytochemical investigations.
- Conduct preliminary phytochemical screening and isolate compounds like alkaloids, tannins, and essential oils from plant materials.
- Effectively use chromatographic techniques (TLC, column chromatography, and paper chromatography) for compound separation and analysis.
- Gain proficiency in quantifying plant phytochemicals, including total phenolics and flavonoids, using appropriate analytical techniques.
- Evaluate antioxidant and antimicrobial activities of plant extracts, gaining insights into their bioactive properties.
- Demonstrate skills in protein separation using SDS-PAGE, understanding its applications in phytochemical and protein analysis.

Course Contents:

1.	Plant sample collection and preparation	1P
2.	Demonstration of Soxhlet extraction, maceration, and percolation to extract phytochemicals.	1P
3.	Preliminary phytochemical screening of plant extracts	1P
4.	TLC separation of alkaloids from suitable plant material	1P
5.	Demonstration of column chromatography for separation of mixture of phytochemicals	1P
6.	Demonstration of UV-VIS spectrophotometry for quantification of phytochemicals	1P
7.	Evaluation of antioxidant activity of plant extracts using DPPH assay and FRAP assay	2P
8.	Demonstration of antimicrobial assay by using the agar well diffusion method	1P
9.	Quantification of total phenolic content	1P
10.	Quantification of total flavonoid content	1P
11.	Extraction of essential oils from suitable plant material	1P
12.	Isolation of alkaloids from suitable plant material	1P
13.	Isolation of tannins from suitable plant material	1P
14.	Paper chromatographic separation of plant pigments other than chlorophyll	1P

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Third Year of B.Sc. Botany
(2023 Course under NEP 2020)

Course Code: 23ScBotU6101 **Course Name: Molecular Biology and Plant Biotechnology**

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**

Examination Scheme: CIE: 40 Marks **End-Sem: 60 Marks**

Prerequisite: Students should have a basic understanding of cell biology, genetics, and biochemistry, including the structure and function of biomolecules, cellular processes, and Mendelian inheritance. Familiarity with fundamental laboratory techniques such as DNA extraction and electrophoresis is also recommended.

Course Objectives:

- To provide a comprehensive understanding of the molecular basis of life, including the structure, function, and replication of genetic material.
- To explore the mechanisms of gene expression, regulation, and protein synthesis in prokaryotes and eukaryotes.
- To introduce the principles and applications of recombinant DNA technology and its role in plant biotechnology.
- To familiarize students with omics technologies and their applications in understanding plant systems and crop improvement.
- To discuss the role of plant-microbe interactions, phytoremediation, and bioremediation in sustainable agriculture.
- To address biosafety, regulatory frameworks, and ethical issues related to genetically modified crops and emerging biotechnologies.

Course outcomes: On completion of the course, students will be able to–

- Explain the structure and function of nucleic acids and the central dogma of molecular biology.
- Describe the mechanisms of DNA replication, transcription, and translation in prokaryotes and eukaryotes.
- Apply the principles of recombinant DNA technology to design experiments for gene cloning and transfer in plants.
- Analyze the role of omics technologies in advancing plant biotechnology and crop improvement.
- Evaluate the significance of plant-microbe interactions and phytoremediation in sustainable agriculture and environmental management.
- Discuss the biosafety, regulatory, and ethical challenges associated with genetically modified organisms and emerging biotechnologies.

Course Contents:

Section I: Molecular Biology		
Unit 1	**Introduction to Molecular Biology**	**6 L**
	6.1 Essential features of genetic material and central dogma of molecular biology 6.2 Evidences favoring DNA as genetic material: Frederick Griffiths' contribution, transformation: Avery, MacLeod and McCarty's experiments, Hershey–Chase experiment 6.3 RNA as genetic material and its types (mRNA, rRNA and tRNA) 6.4 Structure of DNA: Base-composition studies, X-ray diffraction analysis, Watson–Crick model, alternative forms of DNA	
Unit 2	**Physical properties of nucleic acids**	**4 L**
	7.1 Absorption of ultraviolet light 7.2 Sedimentation behavior 7.3 Denaturation and renaturation of nucleic acids 7.4 Reassociation kinetics and repetitive DNA	
Unit 3	**DNA replication**	**5 L**
	3.1 The Meselson–Stahl Experiment 3.2 Origins, forks, and units of replication 3.3 Replication in prokaryotes: DNA Polymerases, unwinding the DNA helix, initiation of DNA synthesis, continuous and discontinuous DNA synthesis of antiparallel strands, concurrent synthesis on the leading and lagging strands, integrated proofreading and error correction 3.4 Summary DNA replication in eukaryotes	
Unit 4	**Organization of gene**	**4 L**
	4.1 Promoter-structure and function in prokaryotes and eukaryotes 4.2 Terminators 4.3 Units of gene 4.4 Enhancers, linear genes and split genes	
Unit 5	**Transcription**	**5 L**
	5.1 Mechanism of prokaryotic transcription: Enzymatic	

	synthesis of RNA, prokaryotic RNA polymerases, initiation, elongation and termination of transcription in prokaryotes 5.2 Overview of eukaryotic transcription and post transcriptional modifications	
Unit 6	**Translation**	**4 L**
	6.1 Concept of genetic code and its characteristics 6.2 Mechanism of protein synthesis: Amino acylation of t-RNA 6.3 Mechanism of protein synthesis in prokaryotes and eukaryotes 6.4 Introduction to post translational modifications	
Unit 7	**Regulation of gene expression in Prokaryotes**	**2 L**
	7.1 Concept of operon 7.2 Mechanism of lac operon, its positive and negative control	
Section II: Plant Biotechnology		
Unit 1	**Introduction to Plant Biotechnology**	1 L
	1.1 Concept and Definition 1.2 Scope and Importance	
Unit 2	**Recombinant DNA Technology**	5 L
	2.1 Introduction and scope of RDT 2.2 Restriction enzymes 2.3 Restriction digestion of DNA 2.4 DNA electrophoresis 2.5 Southern hybridization 2.6 Ligation of DNA fragments	
Unit 3	**Cloning Vectors**	4 L
	3.1 Concept of vector, and cloning 3.2 Types of vectors used for gene cloning- their properties and advantage	
Unit 4	**Methods of gene transfer in plants**	3 L
	4.1 Direct gene transfer methods- Electroporation, Biolistic gene transfer, liposome-mediated transfer, microinjection 4.2 Vector-mediated gene transfer- *Agrobacterium* mediated gene transfer in plants	

	4.3 Ti and Ri plasmids: structure and functions 4.4 Confirmation of transgenes	
Unit 5	**Plant Biotechnology and crop improvement**	3 L
	5.1 Introduction 5.2 Use of r-DNA technology for; Insect pest resistance, abiotic stress tolerance, herbicide resistance, storage protein quality	
Unit 6	**Introduction to Omics Technologies**	2 L
	6.1 Concept of genomics, transcriptomics, proteomics, and metabolomics 6.2 Applications of omics technologies in plant biotechnology 6.3 Role of omics in understanding plant systems and crop improvement	
Unit 7	**Plant-Microbe Interactions**	3 L
	7.1 Introduction to plant-microbe interactions 7.2 Role of beneficial microbes in plant growth and stress tolerance 7.3 Applications of microbial biotechnology in agriculture	
Unit 8	**Biotechnology and Environment**	4 L
	8.1 Introduction to Environmental Biotechnology 8.2 Concept of phytoremediation and bioremediation 8.3 Role of plants and microbes in environmental cleanup 8.4 Applications of phytoremediation in sustainable agriculture	
Unit 9	**Biosafety and Regulatory Issues in Plant Biotechnology**	2 L
	9.1 Biosafety concerns in genetically modified crops 9.2 Regulatory frameworks for GM crops 9.3 Ethical and social implications of plant biotechnology	
Unit 10	**Recent Trends in Plant Biotechnology**	3 L
	10.1 Emerging technologies in plant biotechnology (e.g., artificial intelligence, precision breeding) 10.2 Role of plant biotechnology in addressing global challenges (climate change, food security) 10.3 Case studies of innovative biotechnological solutions	

Suggested Readings

Baltimore, D., Berk, A., Lodish, B., Darnell, J. E., Matsudaira, P., Lodish, H. F., Zipursky, S. L. (2000). Molecular Cell Biology. United Kingdom: W.H. Freeman.

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Third Year of B.Sc. Botany

(2023 Course under NEP 2020)

Course Code: 23ScBotU6102 **Course Name: Plant Physiology and Metabolism**

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**

Examination Scheme: CIE: 40 Marks **End-Sem: 60 Marks**

Pre-requisite: A foundational understanding of plant biology, including cell structure, basic biochemistry, and physiological processes, is essential. Familiarity with concepts like photosynthesis, respiration, and mineral nutrition will be beneficial. Additionally, basic knowledge of plant growth regulators and secondary metabolites is recommended to grasp advanced topics in plant physiology and metabolism.

Course Objectives:

- To gain knowledge of various physiological and metabolic processes occurring in plants
- Illustrate the role of minerals in plant nutrition and their deficiency symptoms
- To impart basic knowledge of different movements in plants, plant growth regulators and stress physiology
- To develop an understanding in the role of light and temperature on flowering
- Critically understand the light reactions and carbon assimilation processes responsible for the synthesis of food in plants
- To impart the basic concept of secondary metabolites in plants

Course Outcomes:

On completion of the course, students will be able to:

- Gain preliminary knowledge of plant physiology and metabolism
- Acquire critical knowledge on nutrient uptake and utilisation
- Understand different types of plant movements and plant growth regulators and stress physiology
- Explain the mechanism and factors affecting flowering in plants
- Orient into developing an understanding of the principles of photosynthesis and respiration
- Understand the importance and applications of secondary metabolites in plants

Course Contents:

	SECTION I- PLANT PHYSIOLOGY	
Unit 1	**Introduction to Plant Physiology**	**1 L**
	1.1 Definition and concept 1.2 Scope and importance	
Unit 2	**Mineral Nutrition**	**6 L**
	2.1 Soil types and elements 2.2 Hydroponics	

	2.3 Mechanism of salt uptake 2.4 Mineral deficiencies in plants	
Unit 3	**Plant movements**	**5 L**
	3.1 Movements of locomotion 3.2 Movement of curvature 3.3 Curvature stimulus, response and irritability 3.4 Hygroscopic movement 3.5 Tactic, tropic and nastic movements 3.6 Autonomic movement	
Unit 4	**Photomorphogenesis**	**6 L**
	4.1 Photoperiodism: Definition and concept 4.2 Long-day, short-day and day-neutral plants 4.3 Photoperiodic induction 4.4 Phytochromes 4.5 Importance of Photoperiodism 4.6 Vernalization: Definition and concept 4.7 Perception of stimulus 4.8 Mechanism of vernalization 4.9 Significance	
Unit 5	**Plant Water Relations**	**6 L**
	5.1 Role of water in plants 5.2 Concept of water potential and capillary water 5.3 Structure of xylem 5.4 Mechanism of water absorption - active absorption, passive absorption, factors affecting rate of water transport	
Unit 6	**Plant growth regulators**	**6 L**
	6.1 Types and role of plant growth regulators 6.2 Discovery, structure, chemical nature, transport, physiological effect and practical applications of auxins, cytokinins, gibberellins, ethylene and abscisic acid, BRs, strigolactones, polyamines, jasmonates and karrikins, 6.3 Growth retardants	
	SECTION II - METABOLISM	
Unit 1	**Photosynthesis**	**10L**
	1.1 Structure of chloroplast 1.2 Photosynthetic pigments and their role 1.3 Photosystems 1.4 Light reaction 1.5 Electron transport chain	

	1.6 Cyclic and Noncyclic photophosphorylation, 1.7 Path of carbon in photosynthesis - Calvin cycle 1.8 Salient features of C_4 plants 1.9 HSK pathway 1.10 CAM pathway 1.11 Photo-respiration 1.12 Introduction to artificial photosynthesis 1.13 Significance of photosynthesis	
Unit 2	**Respiration**	**10 L**
	2.1 Structure of mitochondrion 2.2 Respiratory substrates 2.3 Types of respiration 2.4 Mechanism of aerobic respiration – Glycolysis, TCA cycle,Pentose Phosphate Pathway, Electron transport system 2.5 Chemi-osmotic hypothesis of ATP synthesis Balance sheet of ATP generation in respiration and 2.6 Significanceof respiration	
Unit 3	**Secondary metabolites**	**10 L**
	3.1 Introduction 3.2 Classification 3.3 Mechanism of action of any five metabolites 3.4 Practical applications of secondary metabolites	

Suggested readings:

Bidwell, R. G. S. (1979). Plant Physiology (Revised ed.). Macmillan Publishing Co.

Buchanan, B. B., Gruissem, W., & Jones, R. L. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists.

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Third Year of B.Sc. Botany
(2023 Course under NEP 2020)

Course Code: 23ScBotU6103 **Course Name: Lab Course on 23ScBotU6101 and 23ScBotU6102**

Teaching Scheme: PR: 4 Hours/Week **Credit: 02**

Examination Scheme: CIE: 20 Marks **End-Sem: 30 Marks**

Prerequisite: Basic knowledge of biochemistry, microbiology, and plant physiology is required. Familiarity with laboratory techniques such as centrifugation, electrophoresis, and spectrophotometry is recommended.

Course Objectives:

- To provide hands-on experience in isolating and analyzing DNA, proteins, and plasmids from plant and microbial sources.
- To study the effects of environmental factors (temperature, alkali, heavy metals) on biomolecules and plant physiology.
- To develop skills in biochemical assays (enzyme activity, chlorophyll estimation, nitrate reductase assay).
- To demonstrate key physiological processes in plants (transpiration, solute translocation, CAM metabolism).
- To introduce microbiological techniques for isolating and identifying plant growth-promoting rhizobacteria (PGPR).
- To familiarize students with electrophoresis (SDS-PAGE) and restriction digestion techniques for molecular analysis.

Course Outcomes:

On completion of this course, students will be able to:

- Perform DNA, protein, and plasmid isolation from biological samples and estimate their concentration.
- Analyze the impact of external factors (temperature, alkali, heavy metals) on DNA stability and plant physiology.
- Conduct biochemical assays to determine enzyme activity (SDH, nitrate reductase) and photosynthetic pigments.
- Demonstrate physiological processes (transpiration, DPD, CAM metabolism) through experiments.
- Isolate and identify PGPR and assess their role in plant growth promotion.
- Apply molecular techniques (SDS-PAGE, restriction digestion) to separate and analyze biomolecules.

Course Content:

1. Isolation of DNA from a suitable plant material 1P

2. Estimation of DNA with suitable method 1P
3. Effect of temperature and alkali on DNA 1P
4. Isolation of seed storage proteins and separation by SDS-PAGE 2P
5. Isolation of plasmid DNA 1P
6. Demonstration of restriction digestion of plasmid DNA and separation of fragments. 1P
7. Isolation and identification of Plant Growth-Promoting Rhizobacteria (PGPR) 1P
8. Determination of phytoremediation potential of plants for heavy metal uptake 1P
9. Determination of Diffusion Pressure Deficit (DPD) using potato tubers. 1P
10. Determination of stomatal frequency and rate of transpiration 1P
11. Determination of TAN in CAM succulents 1P
12. Estimation of chlorophyll pigments by Arnon's method 1P
13. Determination of succinate dehydrogenase activity 1P
14. Determination of nitrate reductase activity 1P
15. Demonstrations 1P
    a. Ringing experiment for path of solute translocation.
    b. Demonstration of catalase activity
    c. Demonstration of Hill reaction
    d. Effect of PGRs on plant growth

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Third Year of B.Sc. Botany
(2023 Course under NEP 2020)

Course Code: 23ScBotU6201 **Course Name: Plant Analytical Techniques and Biostatistics (Theory)**

Teaching Scheme: TH: 2 Hours/Week **Credit: 02**

Examination Scheme: CIE: 20 Marks **End-Sem: 30 Marks**

Prerequisite: Students should have a basic understanding of cell biology, analytical techniques, and introductory mathematics. Familiarity with laboratory protocols, such as using lab equipment, and basic statistical concepts will support students in mastering advanced analytical and statistical methods covered in this course.

Course Objectives:

- To introduce students to centrifugation techniques, including various types and applications of centrifuges.
- To provide knowledge on the principles and applications of spectroscopic techniques, such as UV-Vis and infrared spectroscopy.
- To explore the fundamentals of chromatography, including paper, column, and affinity chromatography, and their practical applications.
- To explain electrophoretic techniques, such as PAGE and AGE, focusing on their principles and applications in molecular analysis.
- To familiarize students with biostatistical concepts, such as descriptive and inferential statistics, and data sampling methods.

Course outcomes: On completion of the course, students will be able to–

- Understand and apply centrifugation techniques for isolating and analyzing cellular components.
- Demonstrate competency in using spectroscopic techniques to quantify and analyze chemical substances in biological samples.
- Perform chromatography techniques to separate and identify biomolecules.
- Use electrophoretic methods to analyze nucleic acids and proteins.
- Develop skills in biostatistical analysis, including data collection, sampling, and summarizing data distributions and descriptive and inferential statistics

Course Contents:

Unit 1	**Centrifugation and Spectroscopy**	**7 L**
	1.1 Definition and concept of sedimentation 1.2 Types of centrifuge - Desktop centrifuges, high speed centrifuges and the ultracentrifuge 1.3 Types of rotors 1.4 Centrifuge: care and maintenance 1.5 Applications of Centrifugation 1.6 Definition of spectroscopy and Beer Lambert's Law 1.7 Instrumentation, working and applications of UV-Vis (single beam and double beam), and infrared spectrophotometers	
Unit 2	**Chromatography**	**4 L**
	2.1 Definition, concept and the partition principle 2.2 Principal and technique of paper chromatography and thin layer chromatography 2.3 Column chromatography and its types 2.4 Applications of chromatography	
Unit 3	**Electrophoresis**	**4 L**
	3.1 Definition, migration of an ion in an electric field 3.2 Factors affecting electrophoretic mobility 3.3 Polyacrylamide Gel Electrophoresis (PAGE) and Agarose Gel Electrophoresis (AGE): Procedures and Applications	
Unit 4	**Introduction to Biostatistics**	**4 L**
	4.1 Definitions of statistics and biostatistics 4.2 Types of statistics: Descriptive and inferential 4.3 Population verses sample 4.4 Basic terms: Element or member, variable, observation or measurement, data set, parameter and statistic, statistical error, linear and non-linear functions of statistics, frequency, and its distribution 4.5 Types of variables: Quantitative and qualitative or categorical variables 4.6 Scope, applications and uses of biostatistics	
Unit 5	**Sample and sampling**	**4 L**
	5.1 Definition 5.2 Sampling unit, sample and population 5.3 Types of sampling 5.4 Random sampling – with replacement, without replacement, systematic sampling, stratified sampling	

	5.5 Non-random sampling- Purpose, quota sampling 5.6 Importance of randomness and how to achieve it: Lottery method, use of random number table 5.7 Merits and limitations of sampling	
Unit 6	**Measures of central tendency of grouped and ungrouped data**	**4 L**
	6.1 Simple arithmetic mean, its merits and limitations 6.2 Averages of position: Median and mode, their merits and limitations	
Unit 7	**Measures of dispersion**	**3 L**
	7.1 Meaning of dispersion 7.2 Range: Computation in individual, discrete and continuous series, coefficient of range, merits and limitations 7.3 Variance: Definition, coefficient of variance 7.4 Mean deviation and standard deviation: computation, merits and limitations	

Suggested readings:

Annadurai, B. (2007). A Textbook Of Biostatistics. India: New Age International (P) Limited.

Banerjee, P. K. (2007). Introduction to Biostatistics (A Textbook of Biometry). India: S. Chand Limited.

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Huber, W., Holmes, S. (2018). Modern Statistics for Modern Biology. United States: Cambridge University Press.

McCleery, R. H., Watt, T. A., Hart, T. (2007). Introduction to Statistics for Biology. United Kingdom: CRC Press.

Prasad, S. (2012). Elements of Biostatistics: For Undergraduate Students. India: Rastogi Publications.

Satyanarayana, L., Indrayan, A. (2006). Biostatistics for Medical, Nursing and Pharmacy Students. India: Prentice-Hall of India.

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Upadhyay, A., Upadhyay, K., & Nath, N. (2009). *Biophysical Chemistry: Principles and Techniques*. India: Himalaya Publishing House.

Harvey, D. (2000). *Modern Analytical Chemistry*. New York, NY: McGraw-Hill Education.

Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2013). *Fundamentals of Analytical*

Chemistry. Boston, MA: Cengage Learning.

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Segel, I. H. (1976). *Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry*. New York, NY: John Wiley & Sons.

Narayanan, P. (2000). *Essentials of Biophysics*. New Delhi, India: New Age International.

Skoog, D. A., & Holler, F. J. (2006). *Principles of Instrumental Analysis*. Boston, MA: Cengage Learning.

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Third Year of B.Sc. Botany
(2023 Course under NEP 2020)

Course Code: 23ScBotU6201 **Course Name: Plant Analytical Techniques and Biostatistics (Practical)**

Teaching Scheme: PR: 4 Hours/Week **Credit: 02**

Examination Scheme: CIE: 20 Marks **End-Sem: 30 Marks**

Prerequisite: Students should have a foundational understanding of basic chemistry and introductory biostatistics concepts. Familiarity with fundamental biological and biochemical laboratory techniques will also be beneficial for grasping the methods involved in this course.

Course Objectives:

- Understand the principles and applications of centrifugation, chromatography, electrophoresis, and photometry techniques.
- Develop practical skills in isolating and separating biomolecules such as pigments and proteins.
- Gain competency in statistical analysis methods, including mean, mode, median, variance, standard deviation, and graphical data representation.
- Learn how to execute and interpret statistical tests like the Student's t-test, chi-square test, correlation, and regression.
- Recognize the significance of isoenzyme analysis and storage protein profiling in various biological contexts.
- Integrate laboratory techniques and statistical analysis to interpret biochemical data accurately.

Course Outcomes:

On completion of the course, students will be able to-

- Determine relative centrifugal force (RCF) and understand its application in different rotor systems.
- Proficiently separate chlorophyll pigments using paper chromatography and demonstrate knowledge of adsorption chromatography.
- Demonstrate competence in protein separation techniques for isoenzyme analysis.
- Conduct flame photometry, analyze the data obtained, and understand its relevance in quantitative analysis.
- Gain proficiency in statistical calculations, including measures of central tendency and variability, and present data effectively.
- Apply statistical tests to biological data, interpret the results accurately, and draw meaningful conclusions from correlation and regression analyses.

Course Contents:

1. Determination of Relative Centrifugal force (RCF) in different rotors 1P
2. Separation of chlorophyll pigments by paper chromatography 1P
3. Demonstration of Flame Photometry 1P
4. Electrophoretic separation of DNA 1P
5. Separation of isoenzymes by native PAGE 2P
6. Demonstration of adsorption column chromatography 1P
7. Computation of mean, mode, median, variance, standard deviation, and standard error from the given data 3P
8. Representation of data by various graphical methods 1P
9. Statistical problem-solving based on student's 't' test and χ^2 test 2P
10. Statistical problem-solving based on data for correlation and regression 2P

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Third Year of B.Sc. Botany
(2023 Course under NEP 2020)

Course Code: 23ScBotU6202 **Course Name: Industrial and Environmental Microbiology (Theory)**

Teaching Scheme: TH: 2 Hours/Week **Credit: 02**
Examination Scheme: CIE: 20 Marks **End-Sem: 30 Marks**

Pre-requisite: Basic knowledge of microbiology, biochemistry, and environmental science is required.

Course Objectives:

- To understand the role of microorganisms in industrial and environmental processes.
- To explore the applications of microbiology in biotechnology, agriculture, and waste management.
- To develop practical skills in isolating, culturing, and analysing microorganisms.
- Explain the principles of industrial microbiology and its applications in production systems.
- Analyse the role of microorganisms in environmental sustainability and biodegradation.
- Apply microbiological techniques in solving industrial and environmental challenges.

Course Outcomes:

On completion of this course, students will be able to:

- Recall microbial processes in industries like brewing, enzyme production, and pharmaceuticals.
- Explain the ecological roles of microbes in nutrient cycling and bioremediation.
- Design experiments to isolate and utilize microbes for industrial purposes.
- Compare microbial bioprocesses and their environmental impact.
- Assess the efficiency of microbial systems in waste treatment and resource recovery.
- Develop sustainable strategies using microbial technologies for industrial and environmental applications.

Unit 1	**Introduction to Industrial Microbiology**	**8 Lectures**
	1.1. Scope and history of industrial microbiology. 1.2. Types of fermentation processes (batch, fed-batch, continuous). 1.3. Bioreactors: Types, design, and operation. 1.4. Downstream processing: Recovery and purification of products.	

Unit 2	**Microbial Products of Industrial Use**	**8 Lectures**
	2.1. Primary metabolites: Alcohols, organic acids. 2.2. Secondary metabolites: Antibiotics, vitamins, and enzymes. 2.3. Microbial production of bioplastics and biofuels. 2.4. Quality control in microbial industries.	
Unit 3	**Environmental Microbiology and Bioremediation**	**7 Lectures**
	3.1. Role of microbes in the biogeochemical cycles (carbon, nitrogen, sulfur, phosphorus). 3.2. Microbial bioremediation: Types, mechanisms, and case studies. 3.3. Wastewater treatment: Microbial processes in primary, secondary, and tertiary treatment. 3.4. Phytoremediation and microbial interactions in the rhizosphere.	
Unit 4	**Applied Microbial Ecology**	**7 Lectures**
	4.1. Microbial communities in extreme environments (halophiles, thermophiles). 4.2. Microbes in agriculture: Biofertilizers, biopesticides, and plant growth-promoting rhizobacteria (PGPR). 4.3. Industrial pollution and biodegradation of xenobiotics. 4.4. Emerging trends: Metagenomics, synthetic biology in environmental microbiology.	

Suggested readings

Pelczar, M.J., Chan, E.C.S., & Krieg, N.R. (1993). *Microbiology: Concepts and Applications*. McGraw-Hill.

Prescott, L.M., Harley, J.P., & Klein, D.A. (2008). *Microbiology*. McGraw-Hill.

Atlas, R.M., & Bartha, R. (1998). *Microbial Ecology: Fundamentals and Applications*. Addison Wesley Longman.

Casida, L.E. (1968). *Industrial Microbiology*. Wiley Eastern Limited.

Stanbury, P.F., Whitaker, A., & Hall, S.J. (1995). *Principles of Fermentation Technology*. Pergamon Press.

Subba Rao, N.S. (1995). *Soil Microorganisms and Plant Growth*. Oxford & IBH Publishing.

Singh, D.P., & Singh, H.B. (2013). *Microbial Bioremediation*. Springer.

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Third Year of B.Sc. Botany
(2023 Course under NEP 2020)

Course Code: 23ScBotU6202 **Course Name: Industrial and Environmental Microbiology (Practical)**

Teaching Scheme: TH: 4 Hours/Week **Credit: 02**

Examination Scheme: CIE: 20 Marks **End-Sem: 30 Marks**

Prerequisite: Students should have a basic understanding of microbiology and biochemistry, including microbial structure, function, and metabolism. Prior experience with aseptic techniques, microbial culturing, and basic laboratory skills is recommended. Familiarity with industrial and environmental microbiology concepts will be beneficial for performing the experiments effectively.

Course Objectives:

- To provide students with a fundamental understanding of industrial and environmental microbiology concepts.
- To develop skills in culturing, isolating, and analysing microorganisms for their industrial and environmental applications.
- To equip students with knowledge of microbial processes for production, bioremediation, and enzymatic applications.
- To foster the ability to apply microbiological techniques for addressing environmental and industrial challenges.

Course Outcomes:

On completion of this course, students will be able to:

- Recall sterilization techniques and microbial media preparation while identifying biochemical tests for microbial identification.
- Understand microbial growth patterns and the ecological roles of rhizobium and soil microbes.
- Apply microbiological techniques to perform alcohol fermentation, enzyme assays, and microorganism isolation.
- Analyze antibiotic sensitivity patterns and investigate wastewater microbiology for coliform contamination.
- Evaluate microbial diversity using advanced methods and compare enzymatic activities of different microbial isolates.
- Create case studies on microbial applications in bioremediation and design experiments to screen industrial microbes for enzyme production.

Course Contents

1. Sterilization techniques and preparation of culture media. 2P
2. Isolation and maintenance of industrially important microorganisms. 2P
3. Study of microbial growth pattern. 1P
4. Alcohol fermentation and estimation. 2P
5. Screening of microbes for the production of amylase. 1P
6. Antibiotic sensitivity testing of microbial isolates. 1P
7. Biochemical tests for microbial identification (Catalase, Oxidase). 1P
8. Microbial production of citric acid. 2P
9. Isolation of *Rhizobium* from root nodules. 1P
10. Isolation of microorganisms from soil (serial dilution and plating). 2P
11. Study of wastewater microbiology: Isolation of coliforms. 1P
12. Biofilm formation and its analysis. 1P
13. Analysis of microbial diversity using culture-independent methods. 1P
14. Enzyme activity assays: Protease and lipase. 2P
15. Case study presentation: Application of microbial technology in bioremediation. 1P

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Third Year of B.Sc. Botany
(2023 Course under NEP 2020)

Course Code: 23ScBotU6301 **Course Name: Plant Biotechnology (Theory)**
Teaching Scheme: TH: 2 Hours/Week **Credit: 02**
Examination Scheme: CIE: 20 Marks **End-Sem: 30 Marks**

Pre-requisite: Students should have a foundational knowledge of plant biology, microbiology, and biochemistry, including cell structure, metabolism, and microbial interactions. Familiarity with biotechnological techniques like tissue culture and fermentation is recommended. Basic understanding of agricultural practices and environmental science will help in grasping the applications of biotechnology in agriculture and industry.

Course Objectives:

- Understand the fundamental principles, definitions, and scope of plant biotechnology,
- Explore the significance and diverse applications of plant biotechnology, emphasizing its role in addressing global challenges
- Examine the production process, nutritional aspects, and technological implications of Single Cell Proteins (SCP)
- Analyze the principles, types, and modes of action of biocontrol agents, focusing on their applications in sustainable agriculture
- Investigate the wide-ranging applications of algae in biotechnology
- Investigate the wide-ranging applications of fungi in biotechnology

Course Outcomes:

On completion of this course, students will be able to:

- Demonstrate a comprehensive understanding of the principles, definitions, and historical development of plant biotechnology.
- Evaluate the significance and potential impact of plant biotechnology on addressing global challenges
- Acquire knowledge of SCP production, enabling them to assess the feasibility and applicability of SCP technology in different contexts.

- Develop proficiency in identifying and analyzing biocontrol agents
- Gain practical skills in algae cultivation, harvesting, and the production and application of biofertilizers
- Understand anaerobic digestion processes, fungal fermentation techniques, and product isolation methods, enhancing their ability to apply fungal biotechnology in industrial settings and bioprocess engineering.

Unit 1	**Introduction to Plant Biotechnology**	**2 Lectures**
	1.5. Definition and scope of plant biotechnology 1.6. Historical development and milestones 1.7. Importance and applications in agriculture, industry, and medicine	
Unit 2	**Single Cell Proteins (SCP)**	**5 Lectures**
	6.1. Introduction 6.2. Need for microbial production of SCP 6.3. Sources of microorganisms and the selection criteria 6.4. Nutritional aspects of SCP 6.5. SCP production process 6.6. Technological advantages and side effects of SCP	
Unit 3	**Biocontrol**	**3 Lectures**
	7.1. Principles of biocontrol: use of natural enemies to manage pests and diseases 7.2. Types and modes of action of biopesticides: microbial, botanical, and biochemical agents 7.3. Applications in integrated pest management and sustainable agriculture practices	
Unit 4	**Algal Biotechnology**	**6 Lectures**
	8.1. Applications of algae in biofuels, food, pharmaceuticals, and wastewater treatment 8.2. Techniques for algae cultivation and harvesting 8.3. Biofertilizers: nitrogen-fixing bacteria and algae, phosphate solubilizers 8.4. Production methods and application strategies of biofertilizers	

	8.5. Advantages and limitations of biofertilizers	
Unit 5	**Fungal Biotechnology**	**6 Lectures**
	9.1. Mycorrhizal biofertilizers 9.2. Anaerobic digestion process for biogas generation from organic waste 9.3. Types of biogas digesters: batch, continuous, and plug-flow systems 9.4. Industrial applications of fungi in fermentation 9.5. Techniques for fungal fermentation and product isolation – Citric acid fermentation	
Unit 6	**Plant Tissue Culture**	**8 Lectures**
	3.1. Introduction to plant tissue culture: historical perspective and applications 3.2. Plant tissue culture techniques: sterilisation, culture media and culture conditions 3.3. Micropropagation techniques: shoot proliferation, rooting, and acclimatisation 3.4. Callus and suspension culture: induction, maintenance, and regeneration, applications in genetic transformation and secondary metabolite production 3.5. Protoplast isolation techniques: enzymatic digestion and mechanical methods 3.6. Protoplast fusion: principles and applications in somatic hybridization and cybrids	

Suggested readings:

Arora, R. (2015). Textbook of fungal biotechnology (2nd ed.). CBS Publishers & Distributors.

Bhojwani, S. S., & Dantu, P. K. (2013). Plant tissue culture: An introductory text. Springer.

Das, H. K. (2018). Textbook of biotechnology (5th ed.). S. Chand Publishing.

Dubey, R. C. (2016). A textbook of biotechnology (4th ed.). S. Chand Publishing.

Gupta, P. K. (2018). Biotechnology and genomics. Rastogi Publications.

Ignacimuthu, S. (2015). Plant biotechnology: Principles and applications. Narosa Publishing House.

Jogdand, S. N. (2017). Industrial biotechnology (2nd ed.). Himalaya Publishing House.

Kumar, A., & Roy, S. (2015). Plant tissue culture and biotechnology. Kalyani Publishers.

Kumar, H. D. (2014). Modern concepts of biotechnology. Vikas Publishing House.

Kumar, U. (2018). Biotechnology and its applications in agriculture (2nd ed.). Medtech Publishers.

Pandey, B. P. (2016). Plant pathology (3rd ed.). S. Chand Publishing.

Razdan, M. K. (2017). Introduction to plant tissue culture (3rd ed.). Oxford & IBH Publishing.

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Singh, B. D. (2020). Biotechnology: Expanding horizons (4th ed.). Kalyani Publishers.

Thatoi, H., & Dash, S. (2018). Biotechnology of microbial enzymes: Production, biocatalysis, and industrial applications. Academic Press.

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Third Year of B.Sc. Botany
(2023 Course under NEP 2020)

Course Code: 23ScBotU6301 **Course Name: Plant Biotechnology (Practical)**
Teaching Scheme: TH: 4 Hours/Week **Credit: 02**
Examination Scheme: CIE: 20 Marks **End-Sem: 30 Marks**

Pre-requisite: Students should have a basic understanding of microbiology, biochemistry, and plant biology, including microbial cultivation, fermentation, and plant tissue culture techniques. Familiarity with laboratory skills such as sterilization, media preparation, and molecular techniques (e.g., DNA isolation and electrophoresis) is essential. Knowledge of biotechnological applications in agriculture and environmental science will be beneficial for performing the experiments effectively.

Course Objectives:

- To provide students with theoretical and practical knowledge of the cultivation techniques for microorganisms
- To introduce students to the production processes of biofertilizers and mushrooms
- To facilitate understanding of the citric acid fermentation process
- To explore the principles and methods of biodiesel production
- To investigate the effects of Effective Microorganisms (EM) solution on plant growth
- To familiarize students with the basic techniques of plant tissue culture

Course Outcomes:

On completion of this course, students will be able to:

- Demonstrate proficiency in the cultivation techniques of *Spirulina* and *Trichoderma*
- Design and implement production processes for biofertilizers
- Gain practical skills in the cultivation of *Pleurotus* mushrooms
- Acquire knowledge of citric acid fermentation principles and techniques
- Develop proficiency in biodiesel production methods
- Understand basic practical skills in PTC and handling of plant genomic DNA

Course Contents: (Any fifteen practical)

1. Cultivation of *Spirulina* 1P
2. Cultivation of *Trichoderma* on suitable substrate 1P
3. Production of biofertilizers 1P
4. Preparation of compost from suitable biomass 1P
5. Demonstration of *Pleurotus* cultivation 1P
6. Citric acid fermentation and assay 2P
7. Biodiesel production from suitable sources 1P
8. Effect of Effective Microbes (EM) solution on plant growth 1P
9. Preparation of plant tissue culture media and sterilization 2P
10. Demonstration of embryo culture 1P
11. Demonstration of callus and suspension culture 2P
12. Isolation of protoplast 1P
13. Demonstration of isolation of plant genomic DNA 1P
14. Demonstration of electrophoresis 1P
15. Field Visit 1P

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