



PGK Mandal's

**Haribhai V. Desai College of Arts Science and
Commerce, Pune-02**

(Autonomous)

Undergraduate Degree Program in Botany (B.Sc. Botany)

(Faculty of Science & Technology)

Revised Syllabi as per National Education Policy (2020) for

S.Y.B.Sc. Botany (Semester-I and II)

To be implemented from

Academic Year 2025-2026

Framed by

BOARD OF STUDIES IN BOTANY

Haribhai V. Desai College,

596 Badhwar Peth Pune -411002

AIMS AND OBJECTIVES

- To develop employability oriented diversified course content.
- To introduce skill oriented specialized education by introducing in-depth learning concepts.
- To expose students to the process of systematic academic inquiry and exhibiting courtesy to the vast universe of basic and applied knowledge of plants.

PROGRAM OUTCOMES (POS)

According to NEP-2020 criteria, the Undergraduate degree in Botany (S.Y.B.Sc. Botany) program at Haribhai V. Desai College, Pune's associated colleges, is structured to provide students with advanced field-related knowledge and essential fundamentals. Through a unique combination of required major core courses with in-depth exposure to multidisciplinary minor, elective, and vocational skill courses, among other courses, students will be trained and acquire the fundamental and advanced knowledge essential to the plant sciences industries.

With the knowledge gained in the field of plant sciences, this upgraded curriculum will develop educated, outcome-oriented candidates who are nurtured through discovery and learning, equipped with practice and skills to deal with practical problems, and competent with recent pedagogical trends in education, including E-learning, flipped class, hybrid learning, and experiential learning. These candidates will become responsible citizens, transforming the nation to lead the world in the future.

After successful completion of the Undergraduate (UG) Degree program, the students would be able to:

PO1: Attain thoughtful proficiency in the field of plant sciences.

PO2: Acquire the ability to perform in multidisciplinary domains.

PO3: Attain the ability to exercise intelligence of scientific knowledge for investigation and innovation and nourishment of the world.

PO4: Learn value based ethical practices and principles committed to professional ethics.

PO5: Incorporate 21st century skill oriented self-directed and life-long learning.

PO6: Obtain ability to inculcate the knowledge of plant science in diverse contexts with global perspective.

PO7: Attain maturity to harness the destiny and responds to one's calling.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Recall the diversity, classification, evolution and developmental changes among the plants with reference to lower and higher plant groups and create a knowledge base

in understanding the basis of plant diversity, economic values and taxonomy of plants.

PSO2: Understand the advanced concepts of Genetics, Cell biology and Plant Biotechnology of plants and its implementation for the improvement of crop productivity.

PSO3: Acquire and utilize the skills of post-harvest, flower design, fruit processing and dehydration techniques, organic farming and various plant processing technologies for developing the economy to the growing world.

PSO4: Know about the importance of Medicinal plants and its useful parts, economically important plants in our daily life and about the traditional medicines and herbs, and its relevance in modern times.

PSO5: Inculcate the methodology followed in plant breeding, pharmacognosy, herbal drug technology, plant protection, propagation and improvement.

PSO6: Adapt methods of scientific research in plant improvement program and create entrepreneurships, employment to the society.

PSO7: Analyze the impact of scientific and technological advances on the environment and society and understand the importance of biodiversity conservation, green cover development, carbon sequestration and utilize the knowledge for sustainable development.

PSO8: Explore the knowledge of biotic and abiotic stress tolerance, plant microbe interaction and Integrate pest management for making the revolution in the agriculture.

PSO9: Enrich the ability of critical thinking, development of scientific attitude, handling of problems and generating solutions, improve practical skills, and enhance communication skill.

PSO10: Apply the fruitful knowledge of plant sciences and plant resources for the sustainable development, betterment of society and environment by recognizing the ethical values.

PSO11: Become competent enough in various analytical and 21st century technical skills related to plant sciences for their exploration.

PSO12: Exhibit the potential to effectively accomplish tasks independently and as a member or leader in diverse teams, and in multidisciplinary settings.

PSO13: Employ critical thinking-based problem solving and practical skills pertaining to botanical techniques and computational knowledge and apply strategies for environmental conservation.

PSO14: Demonstrate knowledge and scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyze and interpret

data and provide solutions. Exhibit organizational skills and the ability to manage time and resources.

CREDIT FRAMEWORK FOR S.Y.B.Sc. BOTANY, SEMESTER – I and II (Level 4.5 / 100)

SEMESTER I			
COURSE DETAILS	COURSE CODE	COURSE TITLE	CREDITS
Subject 1 – (1T + 1P) x 2 C = 4 C	BOT-201-TH	Taxonomy of Angiosperms and Plant Physiology	2 C
	BOT-202-PR	Practical Based on BOT-201-TH	2 C
Subject 2 – (1T + 1P) x 2 C = 4 C	Subject 2 -T	-----	2 C
	Subject 2 -P	-----	2 C
Open Elective (1T = 2 C)	OE-1	Horticulture	2 C
SEMESTER – II			
Subject 1 – (1T + 1P) x 2 C = 4 C	BOT-251-TH	Plant Anatomy and Plant Biotechnology	2 C
	BOT-252-PR	Practical Based on BOT-251-TH	2 C
Subject 2 – (1T + 1P) x 2 C = 4 C	Subject 2 -T	-----	2 C
	Subject 2 -P	-----	2 C
Skill Enhancement Courses (SEC) – (1T / 1P = 2C) (Anyone from basket)	SEC-251-BOT-PR	Plant Tissue Culture	2 C
Open Elective (1T = 2 C)	OE-2	Horticultural Practices	2 C

S.Y. B. Sc. Botany
Semester – I

S. Y. B. Sc. Botany [Semester - I]
Course Code - BOT-201-TH

Course Title: Taxonomy of Angiosperms and Plant Physiology
[No. of Credits: 2 C] [No. of Lectures: 30 L]

OBJECTIVES:

1. Equip students with the practical skills needed to apply theoretical knowledge in plant sciences to real-world scenarios, such as agriculture, horticulture, and environmental management.
2. Familiarize students with modern techniques and technologies used in plant science research and applications, including genetic engineering, biotechnology, and molecular biology.
3. Educate students about sustainable practices in plant production and resource management, emphasizing the importance of environmental conservation and sustainable agriculture.
4. Enhance students' ability to analyse and solve complex problems in plant sciences, including issues related to crop productivity, pest management, and environmental sustainability.
5. Foster a culture of innovation and creativity among students, encouraging them to

explore new ideas and approaches to address challenges in plant sciences and agriculture.

OUTCOMES:

Credit I

1. CO1 (Remember & Understand):
Define Taxonomy and Angiosperms and describe its scope and applications in understanding flowering plants.
2. CO2 (Understand & Apply):
To know classification systems and apply it in studying Angiosperms.
3. CO3 (Understand & Analyze):
To know distinguishing characters of Angiosperms and causes of their success and analyse various plant groups as per Geological time scale.
4. CO4 (Understand & Evaluate):
Mention various floras and their importance.
5. CO5 (Apply & Analyze):
Explain various plant families with suitable examples and make a chart w.r.t. morphological characters.

Credit II: Plant Physiology

6. CO1 (Remember & Understand):
Define plant physiology and describe its scope and applications in understanding plant life processes.
7. CO2 (Understand & Apply):
Explain the fundamental principles of plant-water relations, including diffusion, osmosis, plasmolysis, and imbibition, and illustrate their physiological significance in plants.
8. CO3 (Understand & Analyze):
Discuss the sources and types of soil water and analyze the mechanisms of water absorption in plants through active and passive pathways.
9. CO4 (Understand & Evaluate):
Explain the concept of ascent of sap and evaluate the transpiration pull theory by assessing its evidences, objections, and influencing factors.
10. CO5 (Apply & Analyze):
Describe different types of transpiration and analyze the mechanism of stomatal movement using Steward's hypothesis and the potassium ion transport theory

S. Y. B. Sc. Botany [Semester - I]**Course Code - BOT-201-TH****Course Title: Taxonomy of Angiosperms and Plant Physiology****[No. of Credits: 2 C]****[No. of Lectures: 30 L]**

S.Y.B.Sc. Botany (Semester III) BOT -Taxonomy of Angiosperms (01 Credit)		
	CREDIT – I	15 L
1	Introduction to Plant Taxonomy 1.1 Definition, scope and importance 1.2 Objectives- Identification, classification, nomenclature	01 L
2	Contribution of Taxonomists Indian- H. Santapau, S.R. Yadav Foreign- Armen Takhtajan, Arthur Cronquist. Taxonomic literature: Flora: Flora of Purandar fort	02 L
3.	Systems of classification Broad outline of systems of classification: i. Artificial system of classification by Carl Linnaeus ii. Natural system of classification by Bentham and Hooker iii. Phylogenetic System of classification by Engler and Prantl's	03 L
4.	Angiosperms: Geological time scale Distinguishing characters of Angiosperms Causes of phenomenal success of Angiosperms	03 L
5	International Code of Nomenclature (ICN) and Plant nomenclature • ICN- Introduction and Principles • Binomial nomenclature- Definition and concept • Concept of Taxonomic Ranks- Kingdom, Division, Class, Series, Order, Family, Genus and Species	02 L
6	Study of Plant Families Study of following families concerning systematic position (as per Bentham & Hooker), General morphological characters (vegetative and reproductive), Distinguishing features, floral formula, floral diagram, and economic importance of Caesalpinaceae, Solanaceae, Euphorbiaceae and Amaryllidaceae.	04 L
	Credit II : Plant Physiology	15 L
1	Introduction to Plant Physiology Definition, Scope and applications of plant physiology	(1 L)
2	Plant- Water relations Membrane Permeability, Types of Membrane. Diffusion- Definition, factors affecting diffusion, importance of diffusion in plants. Osmosis- Definition, Mechanism, Types of osmosis – endosmosis and exosmosis, Solution – solute and solvent; types of solutions- Hypotonic, hypertonic and isotonic. Concept of osmotic pressure (OP), turgor pressure (TP), wall pressure (WP), Diffusion pressure deficit (DPD), Relation between OP, TP and DPD, Role of osmosis in plants. Plasmolysis- Definition, mechanism, Deplasmolysis, Significance of plasmolysis. Imbibition- Concept, Mechanism, Imbibition Pressure (IP), Significance of imbibition.	(5 L)

3	Water Absorption and Ascent of Sap Water Absorption: Role of water in plants, Sources of water- Soil water, gravitational, hygroscopic and capillary, Types of soil - sand, clay and loam; Water holding capacity of soil, Mechanisms of water absorption: Active absorption - osmotic and non-osmotic absorption of water; Passive absorption – transpiration pull. Ascent of Sap: Definition, Path for ascent of sap, Transpiration Pull or cohesion-tension theory, Evidences and objections, Factors affecting ascent of sap	(5L)
4	Transpiration Definition, Types of transpiration- Cuticular, Lenticular and Stomatal, Stomata- Structure, number and distribution, Mechanism of opening and closing of stomata- Steward's hypothesis, Active K ⁺ transport mechanism, Significance of transpiration, Factors affecting transpiration.	(4L)

References:

Credit I: Taxonomy of Angiosperms

Chopra G.L. 2000- Angiosperms

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3. Datta S.C.- A Hand Book of Systematic Botany

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20. V. V. Shivrajan 1991-Introduction to Principles plant taxonomy

21. Yadav S.R. and Sardesai M.R.- Flora of Kolhapur District.

Credit II: Plant Physiology:

1. Bidwell, R.G.S. 1974. Plant Physiology. Macmillan Pub. Co., N.Y.

2. Taiz, L. and Zeiger, E. 2006. Plant Physiology. 4th Edition. Sinauer Associates, Sunderland, Massachusetts, USA
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6. Dennis, D.T., Turpin, D.H., Lefebvre, D.D. and Layzell, D.B. 1997. Plant Metabolism. 2nd Edition. Longman Group, U.K.
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12. Moore, T.C. 1979. Biochemistry and Physiology of Plant Hormones. Springer-Verlag. Berlin.
13. Raman, K. 1997. Transport Phenomena in Plants. Narosa Publishing House. New Delhi.
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16. Verma, V. 2000: Text Book of Plant Physiology, Ane Books India, New Delhi.
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F. Y. B. Sc. Botany [Semester - I]**Course Code – BOT-102-PR****Course Title: Practical Based on BOT-101-TH****[No. of Credits: 2 C]****[No. of Lectures: 60 L]****OBJECTIVES:**

1. To equip students with hands-on experience in using essential laboratory instruments and equipment.
2. To provide students with a thorough understanding of the genetic engineering processes.
3. To train students soil health analysis and interpret the results in the context of soil health and sustainable agriculture.
4. To teach students the process of composting organic waste to produce biofertilizer and to evaluate its effectiveness in enhancing soil fertility and plant growth.
5. To demonstrate and practice post-harvest techniques.
6. To organize visits to nurseries and plant-based industries and train students for preparing visit reports to link theory with real-world applications.

OUTCOMES:

1. CO1 (Understand & Apply):
Know and understand basic terminology of Taxonomy and apply it in Study of plant families.
2. CO2 (Apply & Analyse):
Learn classification system and apply it in studying plant families and prepare comparative account of plant families
3. CO3 (Apply & Analyse):
Conduct experiments to study tools of taxonomy and apply the knowledge during field excursions.
4. CO4 (Apply & Evaluate):
Learn methods of studying taxonomic literature like flora and identify the wild flowering plants.
5. CO5 (Understand & Apply):
Know the skill of sectioning and apply it during practicals.
6. CO6 (Understand & Analyse):
Observe the distinguishing characters of plants, classify the plants upto family level.

Plant Physiology:

1. CO1 (Understand & Apply):
Prepare and calculate solutions using different units of concentration (w/v, v/v, molar, normal, molal), and apply these in physiological experiments.
2. CO2 (Apply & Analyse):
Measure and interpret soil properties such as pH and water holding capacity (WHC) to assess their impact on plant water availability.
3. CO3 (Apply & Analyse):
Conduct experiments to study plasmolysis and DPD using plant tissues and Analyse their physiological relevance in plant-water relations.
4. CO4 (Apply & Evaluate):
Determine and compare the rate of transpiration in different environmental conditions (sunlight, wind, shade) and evaluate the impact of external factors.
5. CO5 (Understand & Apply):

Demonstrate the effect of plant growth regulators like auxins and gibberellins on specific plant functions such as root induction and seed germination.

6. CO6 (Understand & Analyse):

Observe and explain the working principles of classical demonstration experiments like the Arc Auxanometer, Curling experiment, Imbibition, and Ringing, and Analyse their significance in plant physiology.

S. Y. B. Sc. Botany [Semester - I]**Course Code – BOT-102-PR****Course Title: Practical Based on BOT-101-TH****[No. of Credits: 2 C]****[No. of Lectures: 60 L]**

Sr.No	Title of the Practical	No. Of Practical
1.	Description of flowering plant in botanical terms	1P
2.	Study of tools of taxonomy	1P
3.	Study of Families:	4P
	Caesalpinaceae,	
	Solanaceae,	
	Euphorbiaceae and	
	Amaryllidaceae.	
4.	Prepare the video of any 05 plant species with detailed morphology. Preparation of 05 digital Herbarium (photographs) sheets.	1P
5.	Botanical Excursion and Writing (Preparation of checklist) and submission of Botanical excursion report.	1P
	Plant Physiology:	
6.	Preparation of solution: Percent (w/v, v/v), Normal, Molar, Molal.	1P
7.	Determine water holding capacity (WHC) and pH of soil.	1P
8.	Study of plasmolysis in suitable plant material.	1P
9.	Determine Diffusion Pressure Deficit (DPD) by using potato tubers.	1P
10.	Determine rate of transpiration under different conditions of shade, wind and sunlight.	1P
11.	Effect of plant growth regulators on plant growth: auxins - root induction; Gibberellic acid – seed germination.	1P
12.	Demonstration Experiments.	1P
	Arc Auxanometer	
	Curling experiment	
	Imbibition in seeds	
	Ringing experiment	

S. Y. B. Sc. Botany [Semester - I]**Course Code – OE-1****Course Title: Horticulture****[No. of Credits: 2 C]****[No. of Lectures: 30 L]****Course Outcomes**

1. CO:1 Remember
Provides theoretical base for horticultural practices and plant propagation practices
2. CO:2 Understand
Attain the knowledge of Landscape design and different Garden types
3. CO:3 Apply
Know the special horticultural techniques like- cutting, budding, layering, grafting, training and pruning
4. CO : 4 Apply
Get competencies in the cultivation of flowers, fruits and vegetable and post-harvest management involved.

S. Y. B. Sc. Botany [Semester - I]**Course Code – OE-1****Course Title: Horticulture****[No. of Credits: 2 C]****[No. of Lectures: 30 L]**

Sr. No	Topics	Lectures
1.	Introduction to Horticulture	(2L)
2.	Introduction and Definition, Branches of Horticulture – Fruits (Pomology), Vegetables (Olericulture), Flowers (Floriculture), Nursery Management, Landscaping, Plantation crops, Spices (Culinary Herbs), Medicinal Plants. Importance and scope of horticulture.	
3.	Morphology of plant parts used and their importance	(3L)
4.	Morphology and importance of horticultural plant with respect to their parts used: root – carrot; bulb - onion; rhizome – turmeric; stem tuber - potato; leaf - Cabbage; flower - Rose; flower bud – clove; fruit - mango; seed - cashew nut.	
5.	Propagation of horticultural plants	(5L)
6.	Introduction and definition of propagation; Methods - Cutting – Stem cutting; Layering – Air-layering; Grafting: Cleft and approach grafting; Budding – T- budding. Role of plant growth regulators in horticulture Introduction to plant propagation facilities and their applications – Mist chamber, Humidifiers, Greenhouse; Phytotrons, Cold frames, and Hot beds.	
7.	Special horticultural Practices	(5L)
8.	Introduction, concept and importance of following horticultural practices – training, pruning, girdling, notching, bending, earthing up, staking, blanching and Bahar treatment.	
9.	CREDIT II Commercial cultivation of horticultural crops: Introduction; Cultivation practices of <i>Gerbera</i> , Pomogranate and Tomato with reference to soil, climate, varieties, cultivation techniques, irrigation and fertigation practices, weed management, disease and pest control, harvesting, grading and packaging.	(6L)
10.	Value-added products of horticultural crops Introduction, processing, and importance of Rose – Gulkand, Rose water; Grapes – Wine, Raisins; Tomato – Sauce, Ketchup.	(3L)
11.	Landscape gardening Introduction to landscape gardening Landscape gardening components: Lawns, hedges, pergolas, Pathways, Fountains and topiary. Ornamental plant display techniques- Moss stick, hanging baskets, Wall planters, bonsai, and terrarium.	(4L)
12.	Role of government agencies in horticulture development National Horticulture Board (NHB), Mission for Integrated Development of Horticulture (MIDH), National Horticulture Mission (NHM).	(2L)

References-

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- 2 Plant Propagation, Principles and Practices: Hartmann and Koster
- 3 Principles of Horticulture and Fruit Growing: Y. N Kunte, M.P Kawathalkar and K.S
- 4 Yawalkar (Agri- Horticultural Publication House, Nagpur)
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- 6 Advances in Horticulture Vol. IV Malhotra Publications : Chadha K. L & Pareek O. P
- 7 Post Harvest Technology of Horticultural Crops New Delhi Publications : Sudheer K. P and Indira V.
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- 12 Bose TK, Maiti RG, Dhua RS and Das P. 1999. :Floriculture and Landscaping,, Naya Prokash.
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- 14 Ornamental Horticulture" – S. C. Dey (Pointer Publishers)
- 15 Horticulture – Principles and Practices – George Acquaah (Pearson)
- 16 Plant Propagation: Principles and Practices – Hartmann & Kester (Prentice Hall)
- 17 Propagation of Horticultural Crops – S. K. Sadhu (New Age International)
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- 19 Fruit Science (Fundamentals and Practices)" – V. K. Chattopadhyay (Kalyani Publishers)
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- 24 Post-Harvest Technology of Horticultural Crops" – K. P. Sudhakar Rao (Agrotech Publishing)
- 25 Protected Cultivation of Horticultural Crops" – S. Prabhakar Rao (Kalyani Publishers)
- 26 Handbook of Horticulture" – (ICAR Publication)- K. L. Chadha
- 27 Fundamentals of Horticulture. – Jitendra Singh (Kalyani Publishers)

S. Y. B. Sc. Botany [Semester - II]**Course Code – BOT-251-TH****Course Title: Plant Anatomy and Plant Biotechnology****[No. of Credits: 2 C]****[No. of Lectures: 30 L]**

Course Outcomes (COs):**Plant Anatomy:**

1. CO1: Learn the internal structure of plant organs with respect to their origin, position, structure and functions. Able to observe and identify the different plant groups based on anatomical features
2. CO2: Learn the importance of various tissues systems like epidermal, vascular, mechanical and apply the gained knowledge in day today life. Understand different embryological structures and the process of evolution in the nature amongst flowering plants.
3. CO3: Use plant anatomy as tool to identify the plants in absence of reproductive organs. Apply the knowledge in pharmacognostic analysis, and classification of plants.
4. CO4: Distinguish the internal structures of vascular plants & its functional significance in the development of plant.

Plant Biotechnology:

1. CO1: Develop a conceptual understanding of plant biotechnology and tissue culture, including cellular totipotency, sterilization techniques, nutrient media formulation, micropropagation stages, and their applications.
2. CO2: Demonstrate knowledge of enzyme technology, including enzyme properties, classification, industrial applications, methods of immobilization, and commercial production of key enzymes such as amylases, proteases, and lipases.
3. CO3: Explain the principles and applications of fermentation technology, including types of culture systems, solid and liquid state fermentation, types of bioreactors, process scale-up, and downstream processing.

S. Y. B. Sc. Botany [Semester - II]**Course Code – BOT-251-TH****Course Title: Plant Anatomy and Plant Biotechnology****[No. of Credits: 2 C]****[No. of Lectures: 30 L]**

Sr. No.	Topic Details	No. of Lectures
	Credit: I - Plant Anatomy	(15L)
	Introduction to Plant Anatomy 1.1 Introduction, Definition, Scope and application.	1 L
	Plant Tissues: 2.1 Ground tissues - structure and functions of parenchyma, chlorenchyma, collenchyma, and sclerenchyma. 2.2 Vascular tissues: structure and function of xylem and phloem; types of vascular bundles.	3 L
	Primary internal structure of Dicot and Monocot root, stem and leaf Comparative account	3L
	Mechanical tissue system 4.1 Principles involved in distribution of mechanical tissues – Inflexibility, Incompressibility, Inextensibility and Shearing stress. 4.2 Tissues providing mechanical support, their distribution in leaf, stem and root of dicots and monocots.	3 L
	Normal secondary growth 5.1 Introduction and definition. 5.2 Normal secondary growth in annual (Sunflower) and perennial stem (<i>Annona</i>). 5.3 Structure and function of periderm, bark, tyloses, growth rings and lenticels.	3 L
	Credit II	15
1	Introduction to Plant Biotechnology 1.1. Introduction and Definition. 1.2. Scope and importance of plant biotechnology.	02
2	Plant Tissue Culture Technology 2.1. Introduction, definition, concept of cellular totipotency, differentiation, dedifferentiation, and re-differentiation. 2.2. Sterilization – definition, methods of sterilization. 2.3. Nutrient medium – definition and concept of medium; composition of Murashige and Skoog (MS) medium. 2.4. Micropropagation – definition and concept; stages of micropropagation - Stage I: Mother plant selection; Stage II: Initiation / establishment; Stage III: Multiplication; Stage IV: Rooting; Stage V: Hardening and acclimatization. 2.5. Applications of plant tissue culture.	04
3	Enzyme Technology 4.1. Introduction and definition; properties and classification of enzymes. 4.3. Industrial applications of enzymes. 4.4. Importance and commercial production of amylases, proteases and lipases w.r.t source organism, substrate, growth conditions and purification of enzyme. 4.5. Enzyme immobilization –definition and concept.	05

	4.6. Immobilization methods – a) Chemical – Adsorption; covalent bonding – support and cross-linking; b) Physical – Entrapment and Encapsulation.	
4	Fermentation Technology 6.1. Introduction, definition, and concept of fermentation. 6.2. Types of culture: a) Batch culture – phases of microbial growth in batch culture b) Continuous culture 6.3. Solid and liquid state fermentation 6.4. Bioreactor (Fermenters) – definition; Types of Bioreactors – Tubular Tower, Stirred Tank, Digestive Tank bioreactor. 6.5. Concept of scaling up. 6.6. Downstream processing.	04

References :

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2. B.D. Singh (4th Edn 2012) Biotechnology-expanding horizons, Kalyani Publishers.
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4. Brown, T. A. – Gene Cloning and DNA Analysis: An Introduction (Wiley-Blackwell)
5. Chaplin, M. F., & Bucke, C. – Enzyme Technology (Cambridge University Press)
6. Chawla, H. S. – Introduction to Plant Biotechnology (Science Publishers)
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8. Demirbas, A. – Biofuels: Securing the Planet's Future Energy Needs (Springer)
9. Dubey, R. C. – A Textbook of Biotechnology (S. Chand Publishing)
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S. Y. B. Sc. Botany [Semester - II]**Course Code – BOT-252-TH****Course Title: Practical Based on Plant Anatomy and Plant
Biotechnology BOT-251-TH****[No. of Credits: 2 C]****[No. of Lectures: 60 L]****Course Outcomes (COs):****Plant Anatomy**

1. CO1 (Remember & Understand):
Identify and describe various plant tissue systems, mechanical tissues, and explain their structural adaptations and functional significance.
2. CO2 (Remember & Understand):
Identify and describe Dicot and Monocot stomata and explain their functional significance.
3. CO3 (Understand & Apply):
Demonstrate the process of normal secondary growth through double-stained temporary slides, and interpret differences between dicot patterns using examples such as Annona, Moringa, Helianthus.
4. CO4 (Understand & Apply):
Demonstrate the process of anomalous secondary growth through double-stained temporary slides, and interpret differences between monocot patterns using examples such as Bignonia, and Dracaena.

Plant Biotechnology:

1. CO5 (Understand & Apply):
Explain the principles and demonstrate the working of key instruments used in plant tissue culture like the autoclave, hot air oven, laminar airflow, and pH meter.
2. CO6 (Apply & Analyze):
Perform aseptic preparation of Murashige and Skoog (MS) medium and carry out micropropagation through inoculation of explants like nodal segments or embryos, followed by analysis of growth stages.
3. CO7 (Apply & Analyze):
Execute microbial fermentation using *Aspergillus niger* for citric acid production and estimate the output using the titration method to analyze productivity.
4. CO8 (Apply & Evaluate):
Investigate catalase enzyme activity from plant extracts and evaluate the enzyme's effectiveness under different conditions using observable changes (e.g., oxygen release).
5. CO9 (Apply & Create):
Design and perform enzyme immobilization protocols for amylase or yeast invertase using sodium alginate and calcium chloride, and discuss its advantages in industrial enzyme use.
6. CO10 (Evaluate & Create):
Critically analyze operations and applications observed during industry visits (tissue culture, fermentation, or effluent treatment) and compose a well-structured report based on practical observations.

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Sr. No.	Title of the Practical	No. of Practical
1	Study of epidermal tissue system – Epidermis and epidermal outgrowths.	1 P
2	Study of Dicot and Monocot stomata with suitable examples.	1 P
3	Study of the distribution of mechanical tissues in Dicot root, stem and leaf; and principles involved in it.	1 P
4	Study of the distribution of mechanical tissues in Monocot root, stem and leaf; and principles involved in it.	1 P
5	Study of normal secondary growth in dicot stem – <i>Annona</i> and <i>Moringa</i> (Double stained temporary preparation).	1 P
6	Study of anomalous secondary growth in <i>Bignonia</i> and <i>Dracaena</i> stem. (Double stained temporary preparation).	1 P
7	Instrument / equipment used in plant tissue culture – principle and working of autoclave, hot air oven, laminar air flow, pH meter.	1 P
8	Cultivation of Yeast and study of its commercial product (Demonstration).	1 P
9	Preparation of MS medium and inoculation of nodal sector / apical meristem / embryo.	2 P
10	Production of citric acid by <i>Aspergillus niger</i> and estimation of citric acid by titration method.	1 P
11	To study the activity of catalase enzyme extracted from suitable plant material.	1 P
12	To immobilize the enzyme amylase (or yeast invertase) using sodium alginate and calcium chloride.	1P
13	Visit to tissue culture / biotechnology industry / fermentation industry / effluent treatment plant and submission of visit report.	1 P

S. Y. B. Sc. Botany [Semester - II]**Course Category – Skill Enhancement Course – Practical (SECP)****Course Code – SEC-103-BOT-PR****Course Title: Plant Tissue Culture****[No. of Credits: 2 C]****[No. of Lectures: 60 L]****Objectives:**

1. Gain an understanding of algal biology, including the diversity of algae species, their classification, and their ecological roles.
2. Learn various techniques for cultivating algae, including open pond systems, closed photo-bioreactors, and hybrid systems, to maximize biomass production.
3. Acquire skills in harvesting algae biomass and processing it into valuable products, such as biofuels, biofertilizers, and nutraceuticals.
4. Understand the potential of algae in bioremediation, including their ability to remove pollutants from water and air, and develop skills in applying algal technology for environmental remediation.
5. Develop skills in the development of value-added products from algae, such as cosmetics, pharmaceuticals, and food additives, to explore the commercial potential of algal technology.

Course Outcomes (COs)

1. CO1 (Understand & Apply):
Demonstrate an understanding of laboratory layout and apply aseptic techniques essential for establishing and maintaining a functional plant tissue culture lab.
2. CO2 (Understand & Apply):
Explain the principles, uses, and safe handling procedures of key instruments and glassware used in plant tissue culture practices.
3. CO3 (Apply):
Prepare and sterilize plant tissue culture media and stock solutions of plant growth regulators for use in various in vitro protocols.
4. CO4 (Apply & Analyze):
Perform critical tissue culture steps including explant sterilization, inoculation, callus induction, shoot/root proliferation, and micropropagation, and analyze outcomes with respect to plant development.
5. CO5 (Apply, Analyze & Evaluate):
Conduct sub-culturing, in vitro rooting, and hardening of plantlets, and evaluate the acclimatization process; compile findings and observations into a well-documented technical report based on laboratory or industrial visits.

S. Y. B. Sc. Botany [Semester - II]**Course Category – Skill Enhancement Course – Practical (SECP)****Course Code – SEC-203-BOT-PR****Course Title: Plant Tissue Culture****[No. of Credits: 2 C]****[No. of Lectures: 60 L]**

Sr. No.	Title of the Practical	No. of Practical
1	To study the basic layout of a typical Plant Tissue Culture Laboratory and various sterilization methods used in PTC using ICT tools.	1 P
2	To study the principle, working and applications of instruments / equipment / glassware used in PTC laboratory: Autoclave, Hot Air Oven, pH Meter, One pan Digital Balance, Hot plate Magnetic stirrer, Laminar Air Flow, Refrigerator, Micropipettes, Air Conditioner, Culture Racks, Digital Temperature controlled rotary shaker.	1 P
3	Basics of laboratory mathematics, calculations for solution preparation.	1 P
4	To perform the procedure of stocks solution preparation for various components of MS basal media and plant growth regulators (PGRs).	1 P
5	Preparation and sterilization of MS media supplemented with plant growth regulators (Auxins and cytokinin) for organogenesis (shoot and root formation) and callogenesis (callus production).	2 P
6	Surface sterilization and inoculation of leaf / apical meristem / nodal sector for organogenesis and callogenesis.	2 P
7	To study the steps involved in sub culturing of proliferated shoots and roots on freshly prepared nutrient media.	1P
8	To study the procedure involved in hardening of rooted plantlets and its acclimatization.	1 P
9	Micropropagation of commercially important plants	3 P
10	Initiation of cell suspension culture and its growth measurement.	1 P
11	Visit to the plant tissue culture laboratory and preparation of visit report.	1 P

S. Y. B. Sc. Botany [Semester - I]**Course Code – OE- 2****Course Title: Horticultural Practices****[No. of Credits: 2 C]****[No. of Lectures: 60 L]****Course Outcomes**

1. CO:1 Remember
Provides Practical base for horticultural practices and plant propagation practices
2. CO:2 Understand
Attain the knowledge of Landscape design and different Garden types and its practical applications
3. CO:3 Apply
Know the special horticultural techniques like- cutting, budding, layering, grafting, training and pruning and skills to use.
4. CO:4 Apply
Get practical competencies in the cultivation of flowers, fruits and vegetable and post-harvest management involved.

S. Y. B. Sc. Botany [Semester - I]**Course Code – OE-2****Course Title: Horticultural Practices****[No. of Credits: 2 C]****[No. of Lectures: 60 L]**

Sr. No	Title of the Practical	No. of Practical
1.	Study of morphology of root – carrot; bulb - onion; rhizome – turmeric; stem tuber - potato; leaf - Cabbage; flower - Rose; flower bud – clove; fruit - mango; seed - cashew nut.	1P
2.	Study of horticultural tools.	1P
3.	Demonstration of special horticultural practices - training, pruning, girdling, notching, bending, earthing up, staking, blanching.	1P
4.	Study of plant propagation by Cutting (stem and leaf) and Layering (air and soil).	1P
5.	Study of plant propagation by grafting (simple approach and stone) and Budding (I, T and patch).	2P
6.	Preparation of gulkand and rose water.	1P
7.	Demonstration on laboratory preparation of grape wine.	1P
8.	Preparation of tomato sauce and ketchup.	2P
9.	Preparation of moss-stick, hanging baskets, potted plants and wall planters.	1P
10.	Demonstration on bonsai and terrarium.	1P
11.	Preparation and application of plant growth regulator solutions for vegetative propagation.	1P
12.	Submission of potted plant / Moss stick / Hanging Basket / Wall planters / Bonsai.	1P
13.	Visit to Nursery / orchard / floriculture industry / floricultural market and report writing.	1P