

Shree Warana Vibhag Shikshan Mandal's

**WARANA UNIVERSITY,
WARANANAGAR**

(A State Public University established under Section 3 (6) of MPUA, 2016)

॥ विद्या सर्वस्य भूषणम् ॥



Warana University

Established: 2025

**Structure & Syllabus For
Bachelor of Science (B. Sc.) in Botany**

UNDER

Faculty of Science & Technology

B. Sc. Part - II (Semester - III and IV)

(As Per National Education Policy – 2020)

With Effect from Academic Year 2026-27 Onwards

Sr. No.	CONTENT	Page No
1.	PREAMBLE	4
2.	GENERAL OBJECTIVES	4
3.	PROGRAMME OUTCOMES (POS)	5
4.	PROGRAMME SPECIFIC OUTCOMES (PSOS)	5
5.	ELIGIBILITY	6
6.	DURATION	6
7.	MEDIUM OF INSTRUCTION	6
8.	MEME INSTRUCTIONS	7
9.	SCHEME OF TEACHING AND EXAMINATION	8 - 9
10.	COURSE STRUCTURE B.Sc.-II	10
11.	COURSE STRUCTURE SUBJECT SPECIFIC	11 - 12
12.	NOTE ON OE COURSE	13
13.	STRUCTURE OF PROGRAMME	-
14.	SYLLABUS	14 – 51
15.	SCHEME OF EXAMINATION	52 - 56

Abbreviations:

POs	Program Outcomes
PSOs	Program Specific Outcomes
COs	Course Outcomes
DSC	Discipline Specific Core
DSE	Discipline Specific Elective
GE	Generic Elective
OE	Open Elective
VSC	Vocational Skill Course
SEC	Skill Enhancement Course
IKS	Indian Knowledge System
AEC	Ability Enhancement Course
VEC	Value Education Course
OJT	On Job Training (Internship)
FP	Field project
CEP	Community engagement project
CC	Co-curricular Courses
RM	Research Methodology
RP	Research Project
MJ	Major Course
MN	Minor Course

PREAMBLE

Botany, as a core branch of life sciences, plays a vital role in understanding plant diversity, ecology, agriculture, biotechnology, and environmental sustainability. The B.Sc. Botany programme under NEP-2020 is designed to provide broad-based knowledge of plant sciences while fostering scientific temper, critical thinking, and problem-solving skills.

The curriculum emphasizes conceptual learning, laboratory and field-based training, skill development, and exposure to traditional as well as modern scientific approaches. It aims to equip students with competencies required for higher education, research, employment, and entrepreneurship in diverse sectors such as education, agriculture, forestry, pharmaceuticals, and environmental management.

This programme aspires to nurture responsible graduates who are not only academically competent but also committed to biodiversity conservation, sustainable development, and societal well-being.

GENERAL OBJECTIVES OF THE COURSE

- To provide a strong foundation in plant sciences covering diversity, structure, function, physiology, genetics, ecology, and applied aspects of Botany.
- To develop scientific temper and critical thinking by encouraging observation, experimentation, and logical interpretation of biological phenomena.
- To impart practical skills in laboratory techniques, fieldwork, plant identification, herbarium preparation, data analysis, and use of modern tools in Botany.
- To integrate traditional knowledge with modern science, highlighting the importance of ethnobotany, medicinal plants, and sustainable use of biodiversity.
- To cultivate awareness of environmental issues and the role of plants in climate regulation, ecosystem services, conservation, and sustainable development.
- To prepare students for higher education and research in plant sciences, biotechnology, agriculture, forestry, and allied disciplines.
- To enhance employability and entrepreneurship skills through exposure to applied aspects of Botany such as horticulture, nursery management, mushroom cultivation, biofertilizers, and herbal industries.
- To foster values of responsibility and ethics towards nature, biodiversity, and society, preparing students as informed citizens and contributors to national development.
- To encourage teamwork, communication, and digital literacy as essential skills for 21st-century scientific and professional careers.
- To nurture lifelong learning habits and inspire curiosity about the natural world, enabling students to adapt to evolving global challenges in science and environment.

PROGRAMME OUTCOMES (POs) – B.Sc.

- PO1. Knowledge and Understanding: Acquire comprehensive knowledge of plant diversity, structure, physiology, genetics, ecology, and applied aspects of Botany.
- PO2. Scientific Temper and Inquiry: Develop the ability to observe, analyse, and interpret biological phenomena using scientific reasoning and evidence-based approaches.
- PO3. Practical and Field Skills: Demonstrate competence in laboratory techniques, field methods, plant identification, herbarium preparation, and use of modern tools in plant sciences.
- PO4. Environment and Sustainability Awareness: Recognize the importance of plants in ecosystems and human welfare and apply principles of conservation and sustainable resource use.
- PO5. Problem-Solving and Critical Thinking: Apply botanical knowledge and analytical skills to address issues in agriculture, environment, biotechnology, and related fields.
- PO6. Communication and Teamwork: Communicate scientific ideas effectively in oral and written forms, and work collaboratively in laboratory, field, and community settings.
- PO7. Employability and Entrepreneurship: Gain skills relevant for careers in teaching, agriculture, forestry, pharmaceuticals, environmental consultancy, horticulture, and plant-based industries.
- PO8. Ethics and Lifelong Learning: Cultivate ethical responsibility towards nature and society, while nurturing curiosity and the ability to engage in lifelong learning in the biological sciences.

PROGRAMME SPECIFIC OUTCOMES (PSOs) – B.Sc. BOTANY

After successful completion of the B.Sc. Botany course, the students will

- PSO 1. Understanding Plant Diversity and Systematics: Gain in-depth knowledge of plant diversity, taxonomy, and evolutionary relationships among algae, fungi, bryophytes, pteridophytes, gymnosperms, and angiosperms.
- PSO 2. Plant Structure and Function: Comprehend the organization, physiology, metabolism, and development of plants at cellular, tissue, organ, and whole-plant levels.
- PSO 3. Genetics, Molecular Biology, and Biotechnology: Apply principles of genetics, molecular biology, and modern biotechnological tools to understand heredity, variation, crop improvement, and plant-based innovations.
- PSO 4. Ecology and Environment: Analyse plant–environment interactions, ecological adaptations, ecosystem dynamics, and strategies for biodiversity conservation and climate resilience.
- PSO 5. Applied Botany: Acquire practical knowledge of applied aspects such as horticulture, nursery techniques, mushroom cultivation, biofertilizers, plant pathology, and herbal industries.
- PSO 6. Research and Analytical Skills: Develop the ability to design experiments, collect and analyse data, prepare herbarium specimens, and use ICT/digital tools in plant science research.

- PSO 7. Traditional and Indigenous Knowledge: Appreciate the role of ethnobotany, medicinal plants, and traditional practices in healthcare and sustainable livelihoods, integrating them with modern science.
- PSO 8. Contribution to Sustainable Development: Apply botanical knowledge to address agricultural, environmental, and industrial challenges while promoting conservation, sustainability, and societal well-being.

ELIGIBILITY FOR ADMISSION

As per guidelines obtained from Warana University, Warananagar by following rules and regarding reservations by Govt. of Maharashtra

DURATION

The course shall be a fulltime course. One Year, Semester III and IV.

MEDIUM OF INSTRUCTION

The medium of instruction shall be English

MEME Instructions: In alignment with the National Education Policy (NEP) 2020, the Bachelor of Science (B.Sc.) program adopts the Multiple Entry and Multiple Exit (ME-ME) framework. This flexible structure is designed to provide students with academic mobility, skill development, and lifelong learning opportunities. Through ME-ME framework, the program enables students to enter and exit at different stages with appropriate certifications. Information regarding different entry and exit options available to students and respective mandatory number of credits to be earned by the students are provided in the table below.

Year	Stage of exit	Type of Award	Mandatory Credits to be earned	Minimum credits to be earned
1	After successful completion of One Year	Undergraduate Certificate in Science	44	40
2	After successful completion of Two Year	Undergraduate Diploma in Science	88	80
3	After successful completion of Three Year	Bachelor of Science Degree	132	120

Re-entry provision: Students leaving after a undergraduate certificate or undergraduate diploma may re-enter the program within 5 years by earning required credits through Academic Bank of Credits.

SCHEME OF TEACHING AND EXAMINATION: [The scheme of teaching and examination should be given as applicable to the course/paper concerned.]

B.Sc.Program Structure for Level 5 of B.Sc.-II Semester III														
Teaching Scheme						Examination Scheme								
Sr. No.	Theory (TH) & Practical (P)					Semester-end Examination (SEE)			Internal Assessment (IA)			Practical		
	Course Type	No. of Lectures	Pract-ical	Hours	Credits	Paper Hours	Max	Min	Internal	Max	Min	Paper Hours	Max	Min
1.	Major V	4		4	2	1	30	12	Assignment	20	8	-	-	-
2.	Major VI	4		4	2	1	30	12		20	8	-	-	-
3.	Major PIII		1	4	2	-	-	-		-	-	2	50	20
4.	Minor V	4		4	2	1	30	12		20	8	-	-	-
5.	Minor VI	4		4	2	1	30	12		20	8	-	-	-
6.	Minor PIII		1	4	2	-	-	-		-	-	2	50	20
7.	OE III	-	1	4	2	-	-	-		-	-	2	50	20
8.	VSC I	-	1	4	2	-	-	-		-	-	2	50	20
9.	SEC I	-	1	4	2	-	-	-		-	-	2	50	20
10.	AEC I	4	-	4	2	1	30	12		20	8	-	-	-
11.	CC-I	-	-	-	2	-	-	-		-	-	2	50	20
Total					22	Major, Minor, AEC 30 X 5 Total SEE = 150			Major, Minor, AEC 20 X 5 Total SEE = 100			Practical. = 50X6 Total Practical. = 300		
						Total Semester –III = 550								

B.Sc.Program Structure for Level 5 of B.Sc.-II Semester IV														
Teaching Scheme						Examination Scheme								
Sr. No.	Theory (TH) & Practical (P)					Semester-end Examination (SEE)			Internal Assessment (IA)			Practical		
	Course Type	No. of Lectures	Pract-ical	Hours	Credits	Paper Hours	Max	Min	Internal	Max	Min	Paper Hours	Max	Min
1.	Major VII	4		4	2	1	30	12	Assignment	20	8	-	-	-
2.	Major VIII	4		4	2	1	30	12		20	8	-	-	-
3.	Major PIV		1	4	2	-	-	-		-	-	2	50	20
4.	Minor VII	4		4	2	1	30	12		20	8	-	-	-
5.	Minor VIII	4		4	2	1	30	12		20	8	-	-	-
6.	Minor PIV		1	4	2	-	-	-		-	-	2	50	20
7.	OE IV	-	1	4	2	-	-	-		-	-	2	50	20
8.	SEC II	-	1	4	2	-	-	-		-	-	2	50	20
9.	VEC II	-	1	4	2	-	-	-		-	-	2	50	20
10.	AEC II	4	-	4	2	1	30	12		20	8	-	-	-
11.	CEP-I	-	-	-	2	-	-	-		-	-	2	50	20
Total					22	Major, Minor, AEC 30 X 5 Total SEE = 150			Major, Minor, AEC 20 X 5 Total SEE = 100			Practical. = 50X6 Total Practical. = 300		
						Total Semester –III = 550								

General Guidelines for the selection of subjects

1. In first year, student has to choose three DSC subjects from the basket for faculty of Science.
(The DSC Basket for faculty of Science includes Mathematics, Physics, Chemistry, Botany, Zoology, Biochemistry, Industrial Microbiology and Computer Science)
2. At the start of second year, out of these 3 DSC subjects, he/she must opt one subject as Major subject and one as Minor subject. The remaining DSC subject will be dropped.
3. Student cannot select a subject as major or minor other than the subjects taken in first year.
4. OE is to be chosen compulsorily from faculty other than that of the major. (B.Sc. students needs to select OE from faculty of Arts or Faculty of Commerce)
5. VSC is to be selected from the basket of Skill courses approved by the university.
6. IKS (Generic) will be provided by the university separately.

Credit Distribution Structure for B.Sc.-II in Botany with Multiple Entry and Multiple Exit Options:

COURSE CATEGORY	ABBREVIATION (Only 2 Letters)	DESCRIPTION	Sem.-III Credit	Sem.-IV Credit
MAJOR	Major (MJ)	Discipline Specific Course	2x3=6	2x3=6
MINOR	Minor (MN)	Discipline Specific Course	2x3=6	2x3=6
OE	OE(OE)	Open Elective	2x1=02	2x1=02
SEC	SEC (SE)	Skill Enhancement Course	2x1=02	2x1=02
AEC/IKS/VEC	AEC(AE)	Ability Enhancement Course	2x1=02	2x1=02
	VSC (VS)	Vocational Skill Course	2x1=02	-
	VEC(VE)	Value Education Course	-	2x1=02
CC/CEP	CC (CC)	Co-curricular Course	2x1=02	-
	CEP(CE)	Community Engagement Project	-	2x1=02
			22	22
			Total 44	

Bachelor of Science in BOTANY
Credit Framework
Second Year (B. Sc. II- BOTANY)

	WARANA UNIVERSITY, WARANANAGAR NEP-2020: Credit Framework for UG (B. Sc.) Programme under Faculty of Science and Technology							
SEM (Level)	COURSES		OE	VSC/ SEC	AEC /VEC / IKS	OJT/ FP/ CEP / CC/ RP	Total Credits	Degree / Cum. Cr
	MAJOR	MINOR						
SEM III (5.0)	Major V (2) Major VI (2) Major PIII (2)	Minor V (2) Minor VI (2) Minor PIII (2)	OE-3(2) (T/P)	VSC I (2) (P) (Major specific) SEC I (2) (T/P)	AEC I (2) (English)	CC-I (2)	22	UG Diploma 88
SEM IV (5.0)	Major VII (2) Major VIII (2) Major P IV (2)	Minor VII (2) Minor VIII (2) Minor P IV (2)	OE-4(2) (T/P)	SEC-II (2) (T/P)	AEC-II (2) (English) VEC-II (2) (Environmental studies)	CEP-I (2)	22	
Credits	8(T)+4(P) = 12	8(T)+4(P) =12	2+2=4 (T/ P)	4(T/P) +2(P) = 6	2+4=6	2+2=4	44	Exit Option:4 credits NSQF/ Internship/ Skill courses

Course Code Table**B.Sc.-II: SEMESTER-III (TOTALCREDITS-22):** (Note: Put '—' wherever 'Not Applicable')

COURSE CATEGORY		COURSE NAME	COURSE CODE	CREDITS
MAJOR	MJ-V	Plant Morphology And Anatomy	2602USBOMJ301	2
MAJOR	MJ-VI	Genetics And Molecular Biology	2602USBOMJ302	2
MAJOR	MJ-PIII	Major Practical-Iii	2602USBOMJ303	2
MINOR	MN-V	Horticulture	2602USBOMN301	2
MINOR	MN-VI	Plant Physiology And Biochemistry	2602USBOMN302	2
MINOR	MN-PIII	Minor Practical – Iii	2602USBOMN303	2
OE	OE-III	Organic Farming And Biopesticides (सॅमिय शेती आमि जैव कीटकनाशके)	2602USBOOE301	2
SEC	SE-I	Floriculture	2602USBOSE301	2
VSC	VS-I	Nursery Development And Management	2602USBOVS301	2
AEC	AE-I	English	-	2
CC	CC	Cocurricular Course	-	2
CREDITS FOR B.Sc.-II, SEM-III				22

B.Sc.-II: SEMESTER-IV (TOTALCREDITS-22): (Note: Put '—' wherever 'Not Applicable')

COURSE CATEGORY		COURSE NAME	COURSE CODE	CREDITS
MAJOR	MJ-VII	Plant Physiology and Ecology	2602USBOMJ401	2
MAJOR	MJ-VIII	Plant Systematics and Economic Botany	2602USBOMJ402	2
MAJOR	MJ-PIV	Major Practical -IV	2602USBOMJ403	2
MINOR	MN-VII	Biological Techniques	2602USBOMN401	2
MINOR	MN-VIII	Plant Genetics and Plant Utilization	2602USBOMN402	2
MINOR	MN-PIV	Minor Practical – Iv	2602USBOMN403	2
OE	OE-IV	Fruit Processing and Management (फल प्रक्रिया आणि व्यवस्थापन)	2602USBOOE401	2
SEC	SE-II	Ethnobotany	2602USBOSE401	2
VEC	VE-I	Environmental Studies		2
AEC	AE-I	English	-	2
CEP	CE	Community Engagement Program	-	2
CREDITS FOR B.Sc.-II, SEM-IV				22

NOTE REGARDING OPEN ELECTIVE:

The OE courses offered by the Department of Botany are available for the second-year students of the faculty of Arts and Humanities or faculty of Commerce and Management. The students of science should select the open elective subject from the OE basket provided by the faculty of Arts and Humanities or the faculty of Commerce and Management. The details of OE courses available are provided in the prospectus and posted on Institutional Website.

SEMESTER - III

Semester- III**Botany MAJOR PAPER V: PLANT MORPHOLOGY AND ANATOMY (2602USBOMJ301)****CREDITS: 2, LECTURE HOURS: 2 PER WEEK, MARKS: 50****Course Outcomes:**

After successful completion of this course, the students will be able to:

CO1	Describe the fundamental morphological structures of vegetative and reproductive plant parts, including roots, stems, leaves, flowers, and fruits.
CO2	Classify various plant modifications and types of inflorescences, flowers, and fruits based on their structural characteristics and functional adaptations.
CO3	Demonstrate the technical skills to construct floral formulas and floral diagrams for representing the floral symmetry and arrangement of different plant families.
CO4	Compare and Contrast the internal organization (anatomy) of monocot and dicot vegetative organs, identifying key differences in tissue arrangement.
CO5	Explain and Appraise the processes of normal and abnormal secondary growth in stems and roots, assessing how these processes contribute to the plant's structural complexity.
CO6	Integrate knowledge of shoot and root apex organization (Apical Cell Theory and Quiescent Centre concept) to predict the development patterns of the primary plant body.

Syllabus

MODULE	SUB MODULE	TOPIC	LECTURE PERIOD
1	PLANT MORPHOLOGY		13
	1a. Morphology of Root, Stem and Leaf	i. Root: Definition, Types and Modifications of roots (Conical, Fusiform, Napiform, Prop, Pneumatophore) ii. Stem: Definition and Modifications Stem- (Phylloclade, Rhizome, Corm, Tuber) iii. Leaf: Definition, Structure of typical leaf, Types of leaves-Simple and compound; Kinds of stipules; Leaf modifications-Phyllode and Leaf Tendril	
	1b. Morphology of Inflorescence, Flower and Fruit	i. Inflorescence: Definition and Types-Racemose, Cymose and Special Types. ii. Flower: a) Definition, Typical flower-Hypogynous, Epigynous and perigynous, forms of corolla; Aestivation b) Androecium- Definition, Study of typical stamen; Adhesion and Cohesion of stamens c) Gynoecium- Definition, Study of typical carpel; Placentation d) Concept of floral formula and floral diagram iii. Fruits: Definition, Classification of fruits- Simple, Aggregate and Multiple	

PLANT ANATOMY			
2	2a. Structure and development of plant body	i. Plant Anatomy: Introduction to internal organization of plant body ii. Organization of shoot apex: Apical cell theory iii. Organization of root apex: Quiescent centre concept iv. Types of tissues: a. Meristematic tissue types based on position (Apical, Intercalary and Lateral) b. Permanent tissue types [Simple tissue: Parenchyma, Collenchyma, Sclerenchyma and Complex tissue: Xylem, Phloem]	17
	2b. Secondary structure of the Plant Body	i. Primary Structure of Monocotyledonous (Maize) and Dicotyledonous (Sunflower) Root, Stem and Leaf ii. Normal secondary growth in Dicotyledonous (Sunflower) stem and root; Periderm and Lenticel iii. Abnormal secondary growth in dicot stem (<i>Bignonia</i>), monocot stem (<i>Dracaena</i>)	
	2c. AI in botany	i. Introduction to AI (Artificial Intelligence): terminologies, analytical vs generative AI, and ChatGPT ii. Prompt Engineering for botany iii. Limitations of AI and Ethics	

References:

1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. E. John Jothi Prakash (2006) Plant Anatomy. Emkay Publication
3. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
4. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.
5. Evert, R.F. (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc.
6. Pandey, S.N. and Chadha, Ajantha (2015). A Textbook of Botany Vol. II (Plant Anatomy and Economic Botany). Vikas Publishing House Pvt. Ltd. Noida (U.P.), India.
7. Pandey, B. P. (2012). Plant Anatomy. S Chand Publishing, New Delhi.

Botany MAJOR PAPER VI: GENETICS AND MOLECULAR BIOLOGY (2602USBOMJ302)**CREDITS: 2,****LECTURE HOURS: 2 PER WEEK,****MARKS: 50****Course Outcomes:**

After successful completion of this course, the students will be able to:

CO1	Define and recall core genetic terminology and the fundamental laws of Mendelian inheritance, including monohybrid and dihybrid ratios.
CO2	Explain the mechanisms of linkage, crossing over, and extra-chromosomal inheritance, highlighting their significance in genetic variation.
CO3	Apply knowledge of chromosomal structure to identify and differentiate between numerical (euploidy/aneuploidy) and structural aberrations (deletions/translocations).
CO4	Analyze the experimental evidence (Griffith's experiment) that established DNA as the genetic material and examine the solenoid model of DNA packaging.
CO5	Appraise the precision of semi-conservative DNA replication and the regulatory efficiency of the Lac Operon model in prokaryotic systems.
CO6	Synthesize the concepts of the Central Dogma to illustrate the step-by-step flow of genetic information through transcription and translation using the genetic code.

MODULE	SUB MODULE	TOPIC	LECTURE PERIOD
1	GENETICS		
	1a. Mendelian Genetics	1.1 Introduction and Terminology – Allele, Dominant, Recessive, Genotype, Phenotype, Homozygous, Heterozygous etc. 1.2 Mendel's laws of Inheritance, Monohybrid cross, Dihybrid cross, Back cross, Test cross. 1.3 Linkage: Definition, Types, and significance. 1.4 Crossing over: Definition, Mechanism of crossing over, and significance. 1.5 Extra chromosomal inheritance: chloroplast inheritance in 4 o'clock plant	15
	1b. Chromosomal aberrations	1.6 Chromosomes: Structure and Polytene chromosome 1.7 Numerical chromosomal aberrations: Euploidy and Aneuploidy 1.8 Structural chromosomal aberrations: Deletions, Duplications, Inversions and Translocations	
2	MOLECULAR BIOLOGY		
	2a. Genetic information	2.1 Carriers of genetic information- DNA as a carrier of genetic information (Griffith's experiment) 2.2 Genome Organization- Nuclear DNA (gDNA), Packaging of DNA helix (Solenoid model). 2.3 DNA Replication – Semi-conservative DNA replication in prokaryote and eukaryotes– Introduction, mechanism, significance	15

	2b. Expression of genetic information	2.4 Concept of Central Dogma- Introduction, definition, Significance 2.5 Transcription (Eukaryotes)-Mechanism in brief 2.6 Translation (Eukaryotes)-Mechanism in brief 2.7. Lac Operon Concept 2.7 Concept of Genetic code- Introduction and general features	
--	--	--	--

References:

1. Ahluwalia K. B. (2009). Genetics, New Age International Publishers, India, 2nd Edition
2. Alberts, Bruce, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. Molecular Biology of the Cell. New York: Garland Science, 2002.
3. Cooper, Geoffrey M, and Robert E. Hausman. The Cell: A Molecular Approach. Sunderland, MA: Sinauer Associates, 2013.
4. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.
5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
6. Gupta P. K. (2017). Molecular Biology, Rastogi Publication, Meerut.
7. Gupta P. K. (2018) Genetics, Rastogi Publications, Meerut, 5th Edition.
8. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9th edition.
9. Krebs, Jocelyn E, Benjamin Lewin, Stephen T. Kilpatrick, and Elliott S. Goldstein. Lewin's Genes XI. Burlington, Mass: Jones & Bartlett Learning, 2014.
10. Kumar, H. D. (2001). Molecular Biology. Vikas Publishing House.
11. Lewin, B. (2000) Gene VII. Oxford University Press
12. Lodish, Harvey F, Arnold Berk, Chris Kaiser, Monty Krieger, Anthony Bretscher, Hidde L. Ploegh, Angelika Amon, and Kelsey C. Martin. Molecular Cell Biology. , 2016.
13. Maniatis, Tom, Edward F. Fritsch, and Joseph Sambrook. Molecular Cloning: A Laboratory Manual. Cold Spring Harbor: Cold Spring Harbor Laboratory, 1982.
14. Russell, P. J. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
15. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
16. Varma, P. S. and Agrawal, V. K. (2020). Molecular Biology. S. Chand Publications.

SEMESTER – III
Major Practical-III (2602USBOMJ303)
based on Major Paper III and IV
CREDIT: 2. PRACTICAL HOURS:60 MARKS: 50

Course Outcomes:

After successful completion of this course, the students will be able to:

CO1	Identify and classify various plant specimens based on their morphological modifications (roots, stems, leaves) and reproductive structures (inflorescence, flowers, fruits).
CO2	Execute the technical procedure of double-staining and micro-preparation to study the internal organization and secondary growth in plant tissues.
CO3	Examine and interpret floral symmetry and structural details to accurately represent plant diversity through floral formulas and diagrams.
CO4	Critically evaluate cytological preparations to identify meiotic abnormalities and analyze karyotypic variations in different plant species using photomicrographs.
CO5	Solve numerical problems related to Mendelian genetics, linkage, and crossing over to predict inheritance patterns in plant populations.
CO6	Perform the isolation of genomic DNA from plant material and illustrate the molecular organization of DNA using experimental models and photographs.

Practical

1. Study of modifications of Roots (Napiform, Stilt root, Conical), Stem (Rhizome, Bulb, Tuber) and Leaf (Phyllode and Tendril)
2. Study of types of inflorescence.
3. Study of Flower: Types of flowers (hypogynous, Perigynous and epigynous) and Aestivation.
4. Study of Flower: Types of Adhesion, Cohesion and Placentation.
5. Study of concept of floral formula and floral diagram.
6. Study of types of fruits.
7. Study of organization of shoot and root apex.
8. Study of normal secondary growth in dicot stem and root (*Parthenium*/Sunflower/*Tinospora*) by double-stained permanent micro-preparation technique.
9. Study of abnormal secondary growth in dicot stem (*Bignonia*) and monocot stem (*Dracaena*).
10. Study of Mendel's Laws through suitable phenotypic trait in plant material.
11. Genetic problems on Linkage and Crossing over.
12. Analysis of Mendelian inheritance and linkage using AI simulation.
13. Meiotic abnormalities in *Tradescantia* sp.
14. Karyotypic study in plants using photomicrograph (any two plant materials e.g. *Allium cepa* and *Aloe vera*).
15. Analysis of karyotype using AI simulation
16. Study of 'DNA' as genetic material (Griffith's experiment) and study of DNA packaging into chromosome by using suitable photographs (Solenoid model)
17. Isolation of plant genomic DNA.Skill

Reference Books:

1. Practical Manual for B.Sc.-II Botany Sem-III and VI

GENERAL SAFETY RULES FOR LABORATORY WORK

1) List of equipment needed for Laboratory Safety: -

1. Fire extinguisher
2. First Aid Kit
3. Good earthing and insulated wirings for electrical supply.
4. Emergency exit
5. Apron and goggles wherever necessary
6. Fuming Chambers
7. Masks flows and shoes while handling hazardous chemicals & gases (Good valves, manometers and regulators for gas supply)
8. Operational manuals for instruments (handling to be made as suggested.)
9. Rules of animals and blanks ethics.
10. Leakage of gases to be avoided.
11. Cylinders or flow pipes to handle Acids.
12. No weighing for NaOH and hygroscopic substances.
13. Stabilized supply in the laboratory.

There is No Substitute for Safety:

1. Any injury no matter how small, it must be reported to teacher immediately.
2. a) In case any chemical enters your eyes go immediately to eye- wash facility and flush your eyes and face with large amount of water.
b) For acid or phenol spill, do not use water instead put some bicarbonate.
3. In case of fire, immediately switch off all gas connections in the laboratory and pour sand on the source of fire or cover it with asbestos or cement sheet.
4. While leaving laboratory, make sure that gas, water taps and electricity are switched off.
5. Remove your lab coat. Gloves and clean your hands before leaving laboratory.
6. Make your workplace clean before leaving the laboratory.
7. Keep your hands away from your face, while working in laboratory.
8. Each laboratory must have a first aid box.
9. Know what to do in case of emergency - e.g.
a) Know the place of fire extinguisher and first aid box.
10. Don't use cell phones in the laboratory.
b) Remember important phone numbers

DO's

1. Always wear lab coat, shoes in the laboratory. Every student must have their weight box, a napkin etc.
2. Maintain separate record book for each subject.
3. Keep your belongings at the place allotted for the same.
4. Maintain silence, order, cleanliness and discipline in the laboratory.
5. Work at the place allotted to you or specially used for certain operations.
6. Keep the working table clean.
7. Handle the laboratory equipment's, glassware and chemical with great care.
8. Use only required quantities of material and apparatus of essential size.
9. Perform the test in their proper order.
10. Know the location of eye wash fountain and water shower.
11. Minimize your exposure to organic solvents.
12. The Metal like sodium should be kept under kerosene or liquid paraffin layer in a vessel with a cork stopper.
13. Sodium metal should be cut on dry filter paper. The cut off pieces of sodium should be immediately collected in a vessel containing kerosene or liquid paraffin.
14. Always pour acid into water when diluting and stir slightly.
15. All operations involving poisonous flammable gases and vapours should be carried out in the

- flame chamber (with exhaust facility)
16. Ladies should avoid wearing saree. If it is there, apron is essential.

DON'T

1. Don't work alone in the laboratory
2. Don't leave the glass wares unwashed.
3. Don't take apparatus, chemicals out of lab.
4. Don't leave any substance in a vessel or bottle without label.
5. Don't weigh the reagent directly on the balance pan.
6. Don't throw the cut off pieces of sodium metal in sink or water. Transfer it immediately in its container.
7. Don't take sodium metal with hands. Use forceps.
8. Don't panic and run in case of fire. Use the fire extinguishers or sand buckets.
9. Don't breathe the vapours of organic solvents.
10. Don't pour any unused reagent back in its stock bottle.
11. Don't eat or drink any food in laboratory.
12. Don't use inflammable solvents like benzene, ether, chloroform, acetone and alcohol around flame.
13. Don't distil to dryness.
14. Don't exchange stoppers of flasks and bottles containing different reagents.
15. Don't leave reagent bottle lying on the table.
16. Don't disturb the order of reagent bottles in which they are placed.
17. Don't bring reagent on your working table from the general shelf.
18. Don't throw burning matchstick into dustbin.
19. Don't leave the laboratory without permission.

LABORATORY / FIELD WORK CARE AND SAFTY FOR BOTANY STUDENTS

1. Unnecessary wastage of plant material during practical's should be avoided.
2. During study tour / personal collection, more emphasis be given on study of plants in nature and collection of wild plants should not be carried out.
3. If at all the collection of the plant material is needed, it should be carried out under supervision of concerned teacher. Collection of poisonous plants / poisonous mushrooms should be avoided.
4. Oral intake of unknown plant material, out of curiosity, during practical or collection tour is strictly prohibited.
5. If there is any allergic reaction while handling the plants / plant parts / pollen grains / fungal specimens it should be immediately brought to the notice of the concerned teacher and reported to the registered medical purloiner.
6. Wearing of hand gloves (and mask) is essential while handling poisonous plants / herbarium sheets / toxic and hazardous chemicals / reagents / strong acids / strong alkalis during the experiment should be made with vacuum pipette / auto pipette / burette under the supervision of concerned teacher / lab assistant.
7. Highly inflammable organic solvents (alcohol, acetone etc.) should not be kept in vicinity of spirit lamp.
8. The laboratory safety measures adopted for handling of hazardous chemicals in chemistry practical should be followed for conducting practical in plant biochemistry / microbiology.
9. Operational manuals for equipment such as centrifuge, autoclave, spectrophotometer should be followed.
10. In case of minor injuries, preliminary treatment should be undertaken with the help of first aid kit available in the laboratory. In case of serious injury, concerned teacher should be immediately contacted for consultation to the physician.
11. The instruction report for breeding; experimentation will be submitted in a week period.

Botany MINOR PAPER V: HORTICULTURE (2602USBOMN301)**CREDITS: 2, LECTURE HOURS: 2 PER WEEK, MARKS: 50****Course Outcomes:**

After successful completion of this course, the students will be able to:

CO1	Define and recall basic horticultural terminology including Pomology, Olericulture, and Floriculture, and identify their scope in the industry.
CO2	Explain the principles of both sexual and asexual plant propagation, outlining the merits and demerits of each method.
CO3	Demonstrate proficiency in artificial propagation techniques such as stem cutting, air layering, whip grafting, and budding.
CO4	Compare different landscape gardening styles and indoor gardening setups like terrariums and hanging gardens.
CO5	Appraise the design and management of aesthetic gardens in India, such as Lalbagh and Lead Botanical Garden, for their botanical and cultural significance.
CO6	Design a nursery development plan, including the preparation of nursery beds and strategies for seedling raising.

SYLLABUS

MODULE	SUB MODULE	TOPIC	LECTURE PERIOD
1		INTRODUCTION TO HORTICULTURE AND PROPAGATION OF HORTICULTURAL PLANTS	
	1a. Introduction to Horticulture	1.1 Introduction, definition, importance and scope of horticulture 1.2 Terminology used in horticulture – Pomology, Olericulture, Floriculture, Arboriculture, Silviculture Landscape horticulture, Home Gardening.	

	1b. Propagation of horticultural plants	1.3 Introduction and definition of propagation 1.4 Methods of plant propagation–Sexual and asexual methods 1.5 Sexual methods (seed propagation): Introduction, definition, merits and demerits, criterion for selection of seeds. 1.6 Asexual (Vegetative) propagation: Definition, types Natural and artificial. 1.6.1 Natural methods of vegetative propagation: Introduction and definition, Merits and demerits; bulbs, tubers, rhizomes, bulbils. 1.6.2 Propagation by Artificial Methods: i) Cutting: Stem cutting. ii) Layering: Air layering/Gootee (Marcottage). iii) Grafting: whip. iv) Budding: T and patch budding.	15
2	2a Landscape Gardening	2.1 Definition, scope and objectives of landscape gardening. 2.2 Indoor Garden - Terrarium, Hanging garden. 2.3 Outdoor Garden – Preparation and importance of lawn and Terrace Garden. 2.4 Important aesthetic Gardens of India: i) Lalbagh garden, Bangalore i) Lead Botanical Garden (Shivaji University, Kolhapur)	15
	2b Nursery Development	2.5 Objective and scope of nursery. 2.6 Types of nursery beds and preparation of nursery beds. 2.7. Techniques of seedling raising.	

References:

1. Chadha, K. L. *Handbook of Horticulture*. 2nd ed., Indian Council of Agricultural Research (ICAR), 2023.
2. Kumar, N. *Introduction to Horticulture*. 8th ed., Rajalakshmi Publications, 2021.
3. Sharma, R. R., and Manish Srivastav. *Plant Propagation and Nursery Management*. 2nd ed., Rama Publishing House, 2022.
4. Singh, Jitendra. *Basic Horticulture*. 6th ed., Kalyani Publishers, 2024.
5. Bose, T. K., et al. *Propagation of Tropical and Subtropical Horticultural Crops*. 3rd ed., Naya Udyog, 2021.
6. Randhawa, G. S., and Amitabha Mukhopadhyay. *Floriculture in India*. 2nd ed., Allied Publishers, 2023.
7. Kausal, R. T., et al. *A Textbook on Landscape Gardening and Design*. 1st ed., Astral, 2022.
8. Peter, K. V. *Plantation Crops*. 2nd ed., National Book Trust, India, 2021.
9. Prasad, S., and U. Kumar. *Commercial Floriculture*. 2nd ed., Agrobios (India), 2023.
10. Bhattacharjee, S. K. *Advanced Commercial Floriculture*. 4th ed., Aavishkar Publishers, 2021.

Botany MINOR PAPER VI: PLANT PHYSIOLOGY AND BIOCHEMISTRY
(2602USBOMN302)

CREDITS: 2, LECTURE HOURS: 2 PER WEEK, MARKS: 50

Course Outcomes:

After successful completion of this course, the students will be able to:

CO1	Describe the phases of plant growth and the physiological basis of photoperiodism, distinguishing between short-day, long-day, and day-neutral plants.
CO2	Analyze the mechanisms of seed dormancy and the biochemical changes that occur during epigeal, hypogeal, and viviparous germination.
CO3	Identify the structure and biological functions of primary metabolites, specifically organic acids (Citric/Malic) and vitamins.
CO4	Assess the ecological and physiological roles of secondary metabolites, including alkaloids (Nicotine/Caffeine) and terpenoids.
CO5	Explain enzyme nomenclature and the "Lock and Key" hypothesis regarding the mechanism of enzyme action.
CO6	Examine how external factors such as temperature and \$pH\$ influence enzyme kinetics and overall plant metabolic activity.

SYLLABUS

MODULE	SUB MODULE	TOPIC	LECTURE PERIOD
1	PLANT PHYSIOLOGY		15
	1a. Plant growth	1. Plant growth –Introduction and definition, Phases of growth, Growth curve. 2. Flowering Physiology: Photoperiodism –Introduction and definition, Classification of plants based on photoperiodism-Short Day Plants, Long Day Plants and Day Neutral Plants, flowering hormone- Florigen.	
	1b. Seed Dormancy and Seed germination:	1.3. Introduction and definition of Seed, Typical structure of monocot and dicot seed. 1.4. Seed dormancy: Introduction and definition, causes and methods of breaking of seed dormancy- Mechanical scarification and Chemical Scarification. 1.5. Seed germination – Introduction and types of seed germination-Epigeal, Hypogeal and Viviparous. 1.6. Biochemical changes during seed germination.	
	Plant Biochemistry		

2	2a. Plant Biochemistry	1. Plant Biochemistry 1.1 Introduction to Plant Biochemistry Definition and importance of plant biochemistry 2 Primary Metabolites: introduction, structure and functions Organic acids: e. g. Citric acid, Malic acid Vitamins: e.g. Vitamin C, B complex Role of primary metabolites in plants 3 Secondary Metabolites: introduction, structure and functions: Alkaloids: Nicotine and Caffeine Terpenoids: Limonene, Carotenoids Role of secondary metabolites in plants	15
	2b. Enzymes	2.4. Introduction, definition and Classification 2.5. Nomenclature of enzyme. 2.6 Mechanism of enzyme action: Lock and Key hypothesis. 2.7. Factors affecting enzyme activity- temperature and PH.	

Reference Books

1. Bajracharya, Dayananda. *Experiments in Plant Physiology: A Laboratory Manual*. 2nd ed., Narosa Publishing House, 2023.
2. Jain, V. K. *Fundamentals of Plant Physiology*. 21st ed., S. Chand Publishing, 2024.
3. Kochhar, S. L., and Sukhbir Kaur Gujral. *Plant Physiology: Theory and Applications*. 2nd ed., Cambridge University Press (South Asia Edition), 2021.
4. Kumar, Arvind, and S. S. Purohit. *Plant Physiology: Fundamentals and Applications*. 2nd ed., Agrobios (India), 2022.
5. Pandey, S. N., and B. K. Sinha. *Plant Physiology*. 5th ed., Vikas Publishing House, 2023.
6. Sadasivam, S., and A. Manickam. *Biochemical Methods*. 4th ed., New Age International Publishers, 2023.
7. Srivastava, H. S. *Plant Physiology and Biochemistry*. 3rd ed., Rastogi Publications, 2022.
8. Taiz, Lincoln, et al. *Plant Physiology and Development*. 7th ed. (Indian Edition), Sinauer Associates/Oxford University Press, 2023.
9. Verma, S. K., and Mohit Verma. *A Textbook of Plant Physiology, Biochemistry and Biotechnology*. 7th ed., S. Chand Publishing, 2021.
10. Wattal, S. K. *Principles of Plant Biochemistry*. 1st ed., Crescent Publishing Corporation, 2022.

Botany Minor Practical – III (2602USBOMN303)

(Based on Minor Paper V and VI)

CREDIT: 2. PRACTICAL HOURS:60 MARKS: 50

Course Outcomes:

After successful completion of this course, the students will be able to:

CO1	Perform specialized horticultural tasks including air layering, grafting, budding, and the construction of terrariums or bottle gardens.
CO2	Investigate the effect of environmental variables (pH and temperature) on the catalytic activity of enzymes like catalase and malate dehydrogenase.
CO3	Execute various methods of breaking seed dormancy (mechanical and chemical scarification) and record different types of seed germination.
CO4	Determine the concentration of Citric Acid and Vitamin C in plant samples using quantitative titration methods.
CO5	Conduct qualitative biochemical tests (Dragendorff's and Salkowski tests) to detect the presence of alkaloids and terpenoids in plant extracts.
CO6	Document vegetative growth parameters and synthesize observations from field visits to nurseries or botanical gardens into formal technical reports.

PRACTICALS

1. Study of propagules from suitable materials-Tubers, Bulbs, Rhizome, Corms,
2. Propagation of horticultural plants by stem cutting and air layering.
3. Propagation of horticultural plants by whip grafting.
4. Propagation of horticultural plants by 'T' and Patch budding.
5. Demonstration of Bottle Garden/Terrarium/Hanging Baskets.
6. Preparation of nursery beds.
7. Analysis of vegetative growth by measuring seedling height
8. Study of effect of P^H on enzyme activity of catalase.
09. Study of effect of temperature on enzyme activity of malate dehydrogenase
10. Breaking of seed dormancy by Chemical and Mechanical Scarification.
12. Study of different types of Seed germination as per theory.
13. Estimation of Citric Acid from Lemon by Titration
14. Estimation of Vitamin C by Titration Method
15. Qualitative test for Alkaloid – (Dragendorff's Reagent)
16. Qualitative Test for Terpenoids (Salkowski Test)
17. Visit to nursery/ Aesthetic Garden/Exhibition/Places of botanical interest (Separate report to be submitted by students).

References:

Practical Handbook for Minor Botany Practical III, Phadake Prakashan, Kolhapur

SEMESTER –III
OPEN ELECTIVE - III: ORGANIC FARMING AND BIOPESTICIDES (2602USBOOE301)
CREDIT: 2 PRACTICAL HOURS:60 MARKS: 50

Course Outcomes:

After successful completion of this course, the students will be able to:

CO1	Identify and describe the essential components of organic fertilizers like Jeevamrut and Panchagavya and biopesticides like Neem and Garlic-Chili sprays.
CO2	Explain the role of soil testing parameters (pH, moisture, nutrients) and mulching techniques in maintaining sustainable soil health.
CO3	Demonstrate the practical preparation of organic compost, natural growth promoters (banana peel spray), and fermented buttermilk for disease control.
CO4	Compare and contrast the efficacy of different botanical extracts (Tobacco, Neem, Garlic) in controlling specific pests like aphids and caterpillars.
CO5	Appraise the benefits of Azolla and algae cultivation as eco-friendly alternatives to chemical fertilizers and animal feed.
CO6	Develop and execute a comprehensive organic plant protection schedule for a specific crop based on local farm observations and natural pesticide preparation.

Practical

1. Soil Testing: Collection of soil samples and test for pH, moisture, and nutrient levels.
2. Compost Making: Preparation of compost using kitchen waste, dry leaves, and manure.
3. Mulching: Application of organic mulch (straw, leaves) to conserve moisture and suppress weeds.
4. Seed Treatment: Treatment of seeds using neem extract or cow urine.
5. Natural Pesticides: Preparation of pest resistant seeds using neem oil spray, garlic spray, or cow dung-based pesticides.
6. Cow Dung and Urine Fertilizer: Preparation of Jeevamrut or Panchagavya as natural fertilizers.
7. Broad spectrum Botanical pesticide: Preparation of pesticide using Neem Spray (General Pest Repellent)
8. Insect and Fungal Control: Preparation of Garlic-Chili Spray
9. Algae Cultivation: Grow algae or Azolla in water trays to use as a biofertilizer or animal feed.
10. Natural Growth Promoters: Prepare a banana peel spray by soaking banana peels in water for 24 hours and applying it to plants as a potassium-rich solution.
11. Aphid and Caterpillar Control: Preparation of Tobacco Extract.
12. General Pest Control and Growth Promoter: Preparation of Cow Urine Biopesticide.
13. Fungal Disease Control: Preparation of fermented Buttermilk Spray.
14. Field Visit to any farm.

Suggested Readings:

1. S.P. Palaniappan & K. Annadurai, (2019) Organic Farming: Theory and Practice, Scientific Publishers
2. P.K. Gupta, (2019) Principles of Organic Farming, Scientific Publishers, 2019.
3. Arun K. Sharma (2019) Fundamentals of Organic Farming and Sustainable Agriculture, Scientific Publishers.
4. Opendar Koul & G.S. Dhaliwal (2001) Biopesticides: A Bio-rational Approach to Pest Management, CRC Press.
5. L.P. Awasthi (2015) Biopesticides Handbook, CRC Press
6. S.S. Bhooshan & A.K. Pandey (2017) Recent Advances in Biopesticides, Springer

सेमिस्टर- ३
ओपन एलेक्टिव- ३ : सेंद्रिय शेती आणि जैव कीटकनाशके (2602USBOOE301)
क्रेडिट २ **६० तास** **मार्क्स : ५०**

१. माती परीक्षण : मातीचे नमुने गोळा करणे आणि पीएच, आर्द्रता आणि पोषक तत्वांची पातळी तपासणे.
२. कंपोस्ट बनविणे: स्वयंपाक घरातील कचरा, सुकी पाने आणि खत वापरून कंपोस्ट तयार करणे.
३. आच्छादन: ओलावा टिकवून ठेवण्यासाठी आणि टन दाबण्यासाठी सेंद्रिय आच्छादन (पेंढा, पाने) वापरणे.
४. बियाणे प्रक्रिया: कडूलिंबाचा अर्क किंवा गोमूत्र वापरून बियाण्यावर प्रक्रिया करणे
५. नैसर्गिक कीटकनाशके: कडूलिंबाचे तेल स्प्रे, लसून स्प्रे, किंवा शेण आधारित कीटकनाशके वापरून कीटक प्रतिरोधक बियाणे तयार करणे.
६. गायीचे शेण आणि मुत्र खत: नैसर्गिक खते म्हणून जीवामृत किंवा पंचगव्य तयार करणे.
७. ब्रॉड स्पेक्ट्रम वनस्पती कीटकनाशक: कडूलिंब स्प्रे (सामान्य कीटक नाशक) वापरून कीटक नाशक तयार करणे
८. कीटक आणि बुरशी नियंत्रण: लसून मिरची स्प्रे तयार करणे.
९. शैवाल लागवड: जैवखत किंवा पशुखाद्य म्हणून वापरण्यासाठी पाण्याच्या ट्रे मध्ये शैवाल किंवा अझोला वाढवणे.
१०. नैसर्गिक वाढ प्रवर्धक: पोट्याशियम द्रावण युक्त केळीच्या सालीपासून नैसर्गिक वाढ प्रवर्धक स्प्रे बनविणे.
११. मावा आणि सुरवंट नियंत्रण: तंबाखूच्या अर्काची तयारी.
१२. सामान्य कीटक नियंत्रण आणि वाढ प्रवर्धक: गोमूत्र, जैव कीटक नाशक तयार करणे.
१३. बुरशीजन्य रोग नियंत्रण: आंबलेल्या ताकाचा स्प्रे तयारी.
१४. शेताला भेट देऊन कीटकनाशक, बुरशी नाशक आणि वाढ प्रवर्धक यांचा अभ्यास करणे.

Suggested Readings:

1. S.P. Palaniappan & K. Annadurai, (2019) Organic Farming: Theory and Practice, Scientific Publishers
2. P.K. Gupta, (2019) Principles of Organic Farming, Scientific Publishers, 2019.
3. Arun K. Sharma (2019) Fundamentals of Organic Farming and Sustainable Agriculture, Scientific Publishers.
4. Opender Koul & G.S. Dhaliwal (2001) Biopesticides: A Bio-rational Approach to Pest Management, CRC Press.
5. L.P. Awasthi (2015) Biopesticides Handbook, CRC Press
6. S.S. Bhooshan & A.K. Pandey (2017) Recent Advances in Biopesticides, Springer

SEMESTER –III
SKILL ENHANCEMENT COURSE - I: FLORICULTURE (2602USBOSE301)
CREDIT: 2 PRACTICAL HOURS; 60 MARKS: 50

Course Outcomes:

After successful completion of this course, the students will be able to:

CO1	Identify and categorize commercially important floricultural crops into annuals, biennials, perennials, and bulbous flowering plants.
CO2	Perform specialized plant maintenance tasks such as pruning and training of roses and the application of growth regulators to ornamental plants.
CO3	Explain various propagation techniques, differentiating between natural vegetative structures (runners, suckers, bulbs) and artificial methods.
CO4	Examine post-harvest technologies, including methods for drying, preserving, and prolonging the vase life of various commercial flowers.
CO5	Design and assemble aesthetic floral arrangements, including bouquets, button-holes, garlands, and traditional items like Veni and Gajara.
CO6	Critically analyze flower market trends and polyhouse management strategies through field surveys to evaluate the commercial viability of floriculture.

List of Practical

1. Preparation of different types of nursery beds (Flat beds, raised beds, ridges and furrows, basin etc.) and pots.
2. Identification of commercially important floricultural crops: Annuals, Biennials, Perennials and Bulbous flowering plants.
3. Study of methods of propagation a) Natural Asexual or Vegetative Propagation: Runner, Sucker, Bulb, Tubers, Offset, Corms, Rhizome, Bulbs, Stolo
4. Study of methods of propagation b) Artificial Asexual or Vegetative Propagation: Stem Cutting, T-Budding, Whip Grafting and Air Layering.
5. Study of Planting and Transplanting Technique.
6. Study of pruning and training of rose.
7. Study of different plant growth regulators used for growth of ornamental flowering plants.
8. Study of methods of drying and preservation of flowers.
9. Study of methods of Packaging and Marketing of flowers.
10. Study the method of prolonging Vase life of flowers.
11. Study of methods of Techniques in Flower arrangement and floral decoration.
12. Practices in preparation of bouquets, button-holes, flower baskets, Corsages, Floral Wreaths, Garlands, Veni and Gajara. with fresh flowers.
13. Study of Common Diseases and pests of ornamental flowering plants and application of 'Plantify AI' for identification and care of horticulture plants.
14. Landscaping and Architecture of garden using AI (like DALL-E / openart AI)
15. Report on Flower market survey/visit to flower polyhouse

Suggested Readings

1. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

2. Nag. K. 2019. Principles and Practices of Floriculture, Jaya Publishers.
3. Prasad S, Kumar U 2013, A Handbook of Floriculture Agrobios (India)
4. S. K. Bhattacharjee, Lakshman Chandra De 2003. Advanced commercial floriculture. Vol. 1 Aavishkar Publications, Jaipur, India.
5. S. K. Bhattacharjee, Lakshman Chandra De 2003. Advanced commercial floriculture. Vol. 2 Aavishkar Publications, Jaipur, India.

SEMESTER –III

VSC-1: NURSERY DEVELOPMENT AND MANAGEMENT (2602USBOVS301)

CREDIT: 2

PRACTICAL HOURS:60

MARKS: 50

Course Outcomes:

After successful completion of this course, the students will be able to:

CO1	Explain the fundamental requirements of a nursery, including tool selection, irrigation methods, and the critical role of the mother plant.
CO2	Execute the preparation of various nursery beds and soil mixtures tailored for pots and specific plant types.
CO3	Distinguish between different propagation methods (cuttings, layering, budding, grafting) and select the most appropriate technique for given ornamental plants.
CO4	Demonstrate technical skills in plantlet hardening, potting, and repotting to ensure maximum survival rates in a commercial nursery.
CO5	Assess and manage common nursery plant diseases using appropriate fertilizers and growth regulators for seed germination.
CO6	Design a professional nursery layout drawing that optimizes space, irrigation efficiency, and workflow for ornamental and indoor plant production.

List of Practical

1. Designing nursery layout and drawing.
2. Study of tools and implements used in nurseries.
3. Study of irrigation methods in nursery.
4. Preparation of soil mixture for nursery beds and pots.
5. Preparation of different types of nursery beds.
6. Study of importance of Mother plant in nursery, its selection criteria and maintenance.
7. Preparation of plant material for potting and repotting.
8. Study of plantlet hardening methods in the nursery.
9. Study of different types of plants propagated in nursery: Ornamental, Indoor, Outdoor, Edge and Hedge plants.
10. Study of different type of propagation methods: Cuttings and Layering.
11. Study of different type of propagation methods: Buddings and Grafting.
12. Study of different plant growth regulators used for seed germination and vegetative

propagation.

13. Study of different types of fertilizers used in nursery.
14. Study of Common nursery plant diseases and their management.
15. Visit to a plant nursery.

Suggested Reading:

1. Krishnan, P. R., Kalia, R. K., Tewari, J. C., & Roy, M. M. (2014). *Plant nursery management: principles and practices*. Central Arid Zone Research Institute, Jodhpur, 40.
2. Ray, P.K. (2012). *Plant Nursery Management: How to Start and Operate a Plant Nursery*. Scientific Publishers.
3. Hartmann, H.T., Kester D.E., Davis, F.T and R.L Geneve (2010) *Plant Propagation: Principles and practices* (8th Edition)
4. Mason, J. (2004). Nursery management. Landlinks Press. 5. Sharma, R.R and Srivastav M (2004): *Plant propagation and nursery management* (First Edition) International Book Distributing Co.
6. Bose, T.K. Sanyal, D and Sandhu, M.L. (1998) *Propagation of Horticultural crops*. Naya Prakash Publishers, Kolkatta .
7. K. K. Nanda and V.K. Kochhar (1985). *Vegetative propagation of plants*. Kalyani Publisher- New Delhi-Ludhiana.

SEMESTER –IV

SEMESTER –IV
Botany MAJOR PAPER VII: PLANT PHYSIOLOGY AND ECOLOGY (2602USBOMJ401)

CREDITS: 2, LECTURE HOURS: 2 PER WEEK, MARKS: 50

Course Outcomes:

After successful completion of this course, the students will be able to:

CO1	Explain the fundamental mechanisms of photosynthesis, including light reactions, photophosphorylation, and the biochemical pathways of C ₃ , C ₄ , and CAM plants.
CO2	Compare and contrast the stages of aerobic respiration (Glycolysis, Krebs Cycle, and ETS), highlighting the energy yield and metabolic significance of each.
CO3	Identify and classify the biotic and abiotic components of ecosystems, illustrating the flow of energy through food chains, webs, and ecological pyramids.
CO4	Examine the dynamics of biogeochemical cycles (Nitrogen and Phosphorus) and the stages of plant succession in Hydrosere and Xerosere environments.
CO5	Assess the phytogeographical regions of India and the distribution patterns of flora as proposed by D. Chatterjee.
CO6	Appraise the concept of endemism and the conservation status of specific endemic plants found in the Sahyadri Ranges.

SYLLABUS

MODU LE	SUB MODULE	TOPIC	LECTU RE PERI OD
1	PLANT PHYSIOLOGY		15
	1a. Photosynthesis	1.1 Introduction to Plant Physiology 1.2 Photosynthesis-Introduction and significance 1.3 Photosynthetic pigments (Chlorophyll a, b, xanthophylls, carotene) and Photosystems 1.4 Mechanism of Photosynthesis- a) Light reaction: (Photolysis of water, cyclic and non-cyclic Photophosphorylation) b) Dark Reaction: C ₃ , C ₄ and CAM pathways	

	1b. Respiration	1.5 Respiration: Introduction and significance 1.6 Types of Respiration: Aerobic and Anaerobic 1.7 Mechanism of Aerobic respiration a) Glycolysis b) Formation of Acetyl- CoA c) TCA / Krebs cycle d) Electron transport system	
2	PLANT ECOLOGY		
	2a. Plant Ecology	2.1 Introduction: Basic concepts; Levels of organization in ecology, Ecosystems: Structure-biotic and abiotic components, Trophic organization, Food chains and Food web; Ecological pyramids. 2.2 Energy flow in Ecosystem: Box and pipe model 2.3 Biogeochemical cycles; Gaseous and sedimentary cycles- Nitrogen and Phosphorus 2.4 Succession – Hydrosere and Xerosere	15
	2b. Phytogeography	2.5 Phytogeographical regions of India. (D. Chatterjee, 1962) 2.6 Endemism: Concept and Endemic plants in Sahyadri Ranges	
	2c. AI tools for Botany	2.7 Application of ChatGPT and GeminiAI 2.8 Introduction to Pl@ntNet, Midjourney, openart.ai (or DALL-E)	

References

1. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2018). Plant Physiology and Development (6th ed.). Sinauer Associates, Sunderland, MA.
2. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & Molecular Biology of Plants (2nd ed.). Wiley-Blackwell, Hoboken, NJ.
3. Heldt, H.-W., & Piechulla, B. (2021). Plant Biochemistry (5th ed.). Academic Press, London.
4. Hall, D. O., & Rao, K. K. (1999). Photosynthesis (6th ed.). Cambridge University Press, Cambridge.
5. Govindjee, & Raghavendra, A. S. (2006). Photosynthesis: A Comprehensive Treatise. Cambridge University Press, Cambridge.
6. Odum, E. P., & Barrett, G. W. (2004). Fundamentals of Ecology (5th ed.). Brooks Cole, Belmont, CA.
7. Smith, T. M., & Smith, R. L. (2020). Elements of Ecology (10th ed.). Pearson, Boston.
8. Lomolino, M. V., Riddle, B. R., & Brown, J. H. (2017). Biogeography (5th ed.). Oxford

University Press, Oxford.

9. Cain, S. A. (1944). Foundations of Plant Geography. Harper & Brothers, New York.
10. Good, R. (1974). The Geography of Flowering Plants (4th ed.). Longman, London.
11. Cox, C. B., & Moore, P. D. (2010). Biogeography: An Ecological and Evolutionary Approach (8th ed.). Wiley-Blackwell, Hoboken, NJ.

**Botany MAJOR PAPER VIII: PLANT SYSTEMATICS AND ECONOMIC BOTANY
(2602USBOMJ402)**

CREDITS: 2, LECTURE HOURS: 2 PER WEEK, MARKS: 50

Course Outcomes

After successful completion of this course, the students will be able to:

CO1	Describe the principles of the International Code of Nomenclature (ICN) and the taxonomic hierarchy from species to family level.
CO2	Critically evaluate the Bentham and Hooker system of classification, discussing its merits and demerits in the context of plant identification.
CO3	Demonstrate the use of diagnostic vegetative and floral characters to identify plants belonging to families such as Malvaceae, Solanaceae, Nyctaginaceae, and Liliaceae.
CO4	Analyze the functions of herbaria and botanical gardens, utilizing digital resources like Plants of the World Online (POWO) for virtual specimen searching.
CO5	Explain the origin of cultivated plants with reference to Vavilov's centers of origin and their global distribution.
CO6	Identify and document the botanical description, source, and economic importance of key cereals, legumes, spices, fibers, and sugar-yielding plants.

Syllabus

MODULE	SUB MODULE	TOPIC	LECTURE PERIOD
1	PLANT SYSTEMATICS		
	1a. Plant Systematics	1.1 Introduction to systematics, Functions of taxonomy- Plant identification, Classification, Nomenclature 1.2 Principles and rules of ICN 1.3 Bentham and Hookers system of classification (up to order), Merits and Demerits 1.4 Study of diagnostic characters (vegetative and floral characters), classification, inter-relationship and economic importance of the following families: Polypetalae: Malvaceae Gamopetalae: Solanaceae Apetalae: Nyctaginaceae Monocot: Liliaceae	
	1b. Taxonomic hierarchy	1.5 Concept of taxa (family, genus, Taxonomical and biological concept of species), Categories and taxonomic hierarchy.	

	1c. Herbaria and Botanical Gardens	1.6 Herbarium: Concept and functions, Virtual herbarium (POWO: Plants of the World Online) 1.7 Botanical gardens: Introduction and functions, Royal Botanical Garden, Kew; Acharya Jagdish Chandra Bose Indian Botanical Garden, Kolkata; Lead Botanical Garden, Shivaji University, Kolhapur.	15
2	ECONOMIC BOTANY		
	2a. Origin of Cultivated Plants	2.1 Centers of Origin of cultivated plants with reference to Vavilov's work.	15
	2b. Cereals, Legumes, Fatty Oils and vegetable fats	2.2 Origin, Botanical description, Sources and Economic importance of a. Cereal: Wheat b. Millet: Finger millet. c. Legumes: Chick pea d. Fatty Oils: Groundnut e. Vegetable fats: Soybean	
	2c. Spices Beverages and fiber	2.3 Botanical description, Sources and Economic importance of a. Spices: Clove b. Beverages: Lemon c. Fiber yielding plants: Cotton	
	2d. Sources of sugars and starches	2.4 Sugarcane: products-Sugar, Jaggary; by-products- molasses, alcohol, bagasse. Products of potato.	

References:

1. Plant Systematics (2nd edition). Jones, S.B. Jr. and Luchsinger, A.E. 1986. McGraw-Hill Book Co., New York.
2. Plant Systematics: Theory and practice. G. Singh, 1999. Oxford & IBH Pvt., Ltd. New Delhi.
3. An Introduction to Plant Taxonomy. C. Jeffrey, 1982. Cambridge University Press, Cambridge London.
4. Plant Taxonomy and Biosystematics. C.A. Stace, 1989. 2nd ed. Edward Arnold, London. Contemporary Plant Systematics. D.E. Woodland. 1991. Prentice Hall, New Jersey.
5. Plant Systematics for 21st Century. B. Nordenstam, El-Gazaly, G. and Kassas. M. 2000, Portland Press Ltd., London.
6. Current Concepts in Plant Taxonomy. V.H. Heywood and D.M. Moore 1984. Academic Press, London.
7. A Textbook of Modern Economic Botany. 1st edition, CAS publishers and Distributors Pvt. Ltd.
8. Economic Botany. 1st edition, Aahyayan Publishers and Distributors.

SEMESTER – IV
Major Practical -IV (2602USBOMJ403)
(Based on Major Paper VII and VIII)

CREDIT: 2.

PRACTICAL HOURS:60

MARKS: 50

Course Outcomes:

After successful completion of this course students will be able to :

CO1	Execute laboratory experiments to demonstrate the evolution of oxygen during photosynthesis and separate plant pigments using thin-layer chromatography.
CO2	Investigate the rate of respiration in germinating seeds using Ganong's respirometer and interpret the resulting ecological data.
CO3	Prepare and preserve herbarium specimens following standard protocols and navigate virtual herbaria for botanical research.
CO4	Deconstruct the floral and vegetative morphology of assigned plant families to create detailed technical descriptions and identification keys.
CO5	Assess the economic value and biological sources of local agricultural products, including oils, fibers, and legumes, through macroscopic and microscopic study.
CO6	Synthesize observations from field and industrial visits into comprehensive reports regarding local biodiversity, endemism, and plant-based industries.

Practical:

1. To study evolution of oxygen during photosynthesis.
2. Separation of Photosynthetic pigments by thin layer chromatography.
3. Study of respiration in germinating seeds by using Ganong's respirometer.
4. Study of ecological pyramids from the given data without and with application of AI.
5. Study of Phytogeographical regions of India.
6. Study of any five endemic plants in Sahyadri Ranges.
7. to 10. Study of vegetative and floral characters of the following families:
Polypetalae: Malvaceae
Gamopetalae: Solanaceae
Apetalae: Nyctaginaceae
Monocot: Liliaceae
11. Preparation of herbarium specimens and searching of digital or e-herbarium specimen with virtual herbarium (POWO) and Pl@ntnet AI.
12. and 13 Study of source and economic importance in cereals and legumes (as per theory)
14. and 15 Study of source and economic importance in Oil crops and fiber yielding crops (as per theory).
16. Field / Industrial visit

References:

Practical handbook for B.Sc.-II Sem-IV botany.

Botany MINOR PAPER VII: BIOLOGICAL TECHNIQUES (2602USBOMN401)**CREDITS: 2, LECTURE HOURS: 2 PER WEEK, MARKS: 50****Course Outcomes:**

After successful completion of this course students will be able to :

CO1	Identify and describe the components and working principles of light and stereo microscopy, micrometry, and camera lucida.
CO2	Explain the principles of paper and thin-layer chromatography, including the factors affecting the separation of biological molecules.
CO3	Demonstrate the correct procedures for preparing and sterilizing natural, semi-synthetic, and synthetic culture media using autoclaves and hot air ovens.
CO4	Compare and differentiate between various pure culture techniques, specifically the pour plate and streak plate methods, for microbial isolation.
CO5	Select and justify the use of specific biological stains (e.g., Acetocarmine, Janus Green) and mounting media for temporary versus permanent slide preparation.
CO6	Develop standardized protocols for herbarium techniques and micrometric measurements to ensure precision in botanical documentation and research.

Syllabus

MODULE	SUB MODULE	TOPIC	LECTURE PERIOD
1	BIOLOGICAL TECHNIQUES		15
	1.a Principles and applications Microscopy and micro-technique	1.1 Light microscopy 1.2 Stereo microscopy 1.3 Hand refractometer 1.4 Micrometry 1.5 Camera lucida 1.6 Herbarium Technique.	
	1.b. Principles and applications Chromatography	1.7 Paper Chromatography- Ascending. 1.8 Thin layer Chromatography.	
2	2. a Culture media technique.	2.1 Definition, types and preparation of culture media- Natural- Coconut milk, Semisynthetic-PDA, Synthetic- NA 2.2 Sterilization technique-Autoclave and Hot air Oven. 2.3 Pure culture Techniques-pour plate method and streak plate method.	

	2.b. Biological stains	2.4 Introduction 2.5 Types of biological stains- 2.6 Preparation of common laboratory stains- Saffranine, light green, cotton blue, Acetocarmine and Janus green. 2.8 Mounting media and its Applications -Temporary (- Water, Glycerin, lactophenol) and Permanent-(DPX and Canda balsam)	15
--	------------------------	---	----

References:

1. Barker, Kathy. *At the Bench: A Laboratory Navigator*. Updated ed., Cold Spring Harbor Laboratory Press, 2024.
2. Chandra, Suneel, and S. V. S. Chauhan. *Botanical Microtechnique and Cytochemistry*. 2nd ed., Ratan Prakashan Mandir, 2023.
3. Hofmann, Andreas, and Samuel Clokie, editors. *Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology*. 8th ed., Cambridge University Press, 2018.
4. Johansen, Donald Alexander. *Plant Microtechnique*. Reprint ed., McGraw-Hill Book Company, 2022.
5. Jones, Allan, et al. *Practical Skills in Biology*. 7th ed., Pearson, 2021.
6. Marimuthu, R. *Microscopy and Microtechnique*. 2nd ed., MJP Publishers, 2019.
7. Patra, Akhil Kumar. *Techniques in Microbiology: A Student Handbook*. 1st ed., Astral, 2023.
8. Prasad, S. N. *Laboratory Manual of Biostatistics, Cytogenetics and Plant Breeding*. 1st ed., Ik Onkar Publications, 2022.
9. Ruzin, Steven E. *Plant Microtechnique and Microscopy*. Oxford University Press, 2021.
10. Sadasivam, S., and A. Manickam. *Biochemical Methods*. 4th ed., New Age International Publishers, 2023.

**Botany MINOR PAPER VIII: PLANT GENETICS AND PLANT UTILIZATION
(2602USBOMN402)**

CREDITS: 2, LECTURE HOURS: 2 PER WEEK, MARKS: 50

Course Outcomes:

After successful completion of this course students will be able to :

CO1	Recall and define Mendelian terminologies and the seven pairs of contrasting traits in <i>Pisum sativum</i> studied by Gregor Mendel.
CO2	Explain the principles of Dominance, Segregation, and Independent Assortment, along with the Chromosomal Theory of Inheritance.
CO3	Solve genetic problems involving monohybrid, dihybrid, back cross, and test cross to predict genotypic and phenotypic ratios.
CO4	Distinguish between nuclear inheritance and cytoplasmic (extra-chromosomal) inheritance using the example of <i>Mirabilis jalapa</i> .
CO5	Appraise the economic importance and biological sources of various plant groups, including underutilized fruits, medicinal plants, and timber.
CO6	Document and categorize the botanical names, morphology, and industrial applications of major aromatic, fiber, and green manure crops.

Syllabus

MODULE	SUB MODULE	TOPIC	LECTURE PERIOD
1	PLANT GENETICS	1.1 Concept of Genetics, Biography of Mendel and his experiments: Mendel's terminologies, Mendel's seven traits. 1.2 Mendel's Laws of Dominance, Segregation and independent assortment. 1.3 Monohybrid cross, Dihybrid cross, Back cross and Test cross. 1.4 Chromosomal theory of inheritance. 1.5 Extrachromosomal (Cytoplasmic) inheritance in <i>Mirabilis jalapa</i> .	15

2	PLANT UTILIZATION	2.1. Study the following plants with reference to Botanical name, Morphology, biological source and economic importance of: 2.2. Underutilized fruits - <i>Carrisa</i> 2.3 Edible Oils - Soyabean 2.4 Spices - Ginger 2.5 Medicinal - <i>Adhatoda</i> 2.6 Aromatic plants – Eucalyptus 2.7 Fodder - Elephant grass 2.8 Fiber Crops – Cotton 2.9 Timber – Teak 2.10. Green Manure – <i>Crotalaria</i>	15
---	------------------------------	---	----

References:

1. Brooker, Robert J. *Genetics: Analysis and Principles*. 8th ed., McGraw Hill, 2024.
2. Gardner, Eldon J., et al. *Principles of Genetics*. 8th ed., Wiley India, 2022.
3. Klug, William S., et al. *Concepts of Genetics*. 12th ed., Pearson, 2021.
4. Kochhar, S. L. *Economic Botany: A Comprehensive Study*. 6th ed., Cambridge University Press, 2023.
5. Pandey, B. P. *Economic Botany*. 1st ed., S. Chand Publishing, 2022.
6. Pierce, Benjamin A. *Genetics: A Conceptual Approach*. 8th ed., W. H. Freeman, 2024.
7. Prasad, S. *A Text Book of Economic Botany*. 2nd ed., Campus Books International, 2023.
8. Singh, B. D. *Plant Breeding: Principles and Methods*. 13th ed., Kalyani Publishers, 2022.
9. Snustad, D. Peter, and Michael J. Simmons. *Principles of Genetics*. 7th ed., Wiley, 2019.
10. Wickens, G. E. *Economic Botany: Principles and Practices*. Reprint ed., Springer Nature, 2024.

Minor Botany Practical – IV (2602USBOMN403)
(Based on Minor Paper VII and VIII)

CREDIT: 2.

PRACTICAL HOURS:60

MARKS: 50

Course Outcomes:

After successful completion of this course students will be able to :

CO1	Demonstrate proficiency in using specialized laboratory instruments, including the stereo microscope for observation and the hand refractometer for measuring sugar percentage.
CO2	Execute and interpret micrometry techniques and thin-layer chromatography (TLC) to quantify biological dimensions and separate amino acids.
CO3	Perform the standardized procedures for herbarium preparation and culture media formulation to support botanical documentation and microbial studies.
CO4	Appraise Mendelian inheritance patterns by analyzing phenotypic traits in pea plants and solving complex monohybrid and dihybrid genetic problems.
CO5	Identify and describe the morphology, biological source, and economic significance of diverse plant groups, including medicinal, aromatic, fodder, and fiber crops.
CO6	Synthesize theoretical knowledge into practical applications by conducting field visits to study wild plant resources and preparing professional technical reports.

Practical

1. Study of Stereo microscope.
2. Study of micrometry technique by using any suitable material
3. Study of Herbarium technique
4. Measurement of sugar percentage by Hand refractometer
5. Separation of amino acids by thin layer chromatography technique
6. Preparation of culture media as per theory.
7. Study of different types of stains used in biology.
8. Study of Mendelian traits of pea plants (Photographs)
9. Genetic Problems on Monohybrid cross and Dihybrid cross.
10. Study the morphology, biological source and importance of underutilized fruit plant-*Carissa* and oil yielding plant - Soyabean
11. Study the morphology, biological source and importance of Spices - Ginger and Medicinal plant *Adhatoda*
12. Study the morphology and importance of Aromatic plant – *Eucalyptus*
13. Study the morphology and importance of Fodder crop - Elephant grass and Green Manure plant – *Crotalaria*
14. Study the morphology and importance of Fibre crop – Cotton and Timber plant - Teak
15. Report on field visit to study wild plant resources.

References: Practical Handbook for Minor Botany IV, Phadake Publication, Kolhapur

SEMESTER –IV
OPEN ELECTIVE - IV:

FRUIT PROCESSING AND MANAGEMENT (2602USBOOE401)

CREDIT: 2

PRACTICAL HOURS: 60

MARKS: 50

Course Outcomes

After completing this course, students will be able to:

1. Identify and understand the working principles of common fruit processing equipment such as pulpers, sealers, juice extractors, autoclaves, and corking machines.
2. Analyze different packaging methods and preservation techniques as well as cold storage methods.
3. Evaluate different drying methods, including sun drying, cabinet drying, and solar drying, for fruit preservation.
4. Examine the effect of growth regulators on fruit ripening in banana, mango, and grapes.
5. Prepare fruit juices with and without the addition of preservatives.
6. Demonstrate the processing of tomatoes into various products such as juice, puree, ketchup, sauces, soup, and chutney.
7. Prepare different types of pickles, jam, jelly, and marmalades using locally available fruits.

Practical

1. Study of common fruit processing equipment's (Pulper, sealers, juice extracting machines, autoclaves, corking machines).
2. Study of methods of packaging, packaging materials and packaging technology for export of fruits.
3. Study of fruit preservation methods (Natural agent: sugar, salt and chemical agents: sodium benzoate, calcium propionate, Cold storage)
4. Study of preservation of coconut shreds using humectants.
5. Study of various methods of drying: sun drying, cabinet drying and solar drying.
6. Study of effect of growth regulators in fruit ripening in banana/mango/grapes.
7. Study of preparation of fruit juices with/without addition of preservatives.
8. Study of Tomato processing: juices, puree, ketchups, sauces, soup, chutney etc.
9. Preparation of different types of pickles from locally available fruits.
10. Preparation of jam, jelly and Marmalades from locally available fruits.
11. Preparation of Amla juice, Amla pickle and Amla candy.

12. Study of food safety standards (GMP, FSSAI, ISO22000, HACCP).

13. Visit to fruit processing industry.

Suggested Readings:

1. Giridhari, Lal, Siddapa, G.S. and Tandon, G. L. (1998) Preservation of fruit and vegetables, Publication and information division, ICAR.
2. Srivastava, R. P., Sanjeev Kumar, (2006) Fruits and vegetable preservation, International book distributing Co. Lucknow.
3. Chanda, K. L. and Pareek, O. P. (1996) Advances in Horticulture, Vol. IV. Malhotra Publ. House, Kirti Nagar, Delhi.
4. Prasad and Kumar, (2024) Principles of Horticulture 2nd Edn. Agrobios (India).
5. Neeraj Pratap Singh, (2005) Basic concept of fruit science, 1st Eds. IBDC Publishers.
6. Salunkhe, D. K. and Kadam, S. S., (2013) A Handbook of Fruit Science and Technology, CRC Press.
7. Prasad, S. and Kumar, U. (2010) A Handbook of Fruit Production, Agrobios (India).

ओपन इलेक्टिव अभ्यासक्रमाचे अपेक्षित परिणाम

विद्यार्थ्यांनी ओपन इलेक्टिव अभ्यासक्रम यशस्वीरीत्या पूर्ण केल्यानंतर त्यांना खालील गोष्टींचा फायदा होईल.

- पल्पर, सिलर्स, रस काढणारी मशीन, ओटोक्लेव, कोर्किंग मशीन यासारख्या सामान्य फळ प्रणिया उपकरणांच्या कार्याची ओळख आणि महत्व समजून घेणे.
- वेगवेगळ्या पॅकेजिंग पद्धती आणि जतन तंत्राचा तसेच कोल्ड स्टोरेज पद्धतींचे विश्लेषण करणे.
- फळांच्या जतनासाठी वापरल्या जाणाऱ्या वेगवेगळ्या पद्धतींचे मुल्यांकन करणे.
- केळी, आंबा आणि द्राक्ष फळ पिकविण्याच्या वाढीच्या नियमकांचा परिणाम तपासणे.
- प्रीझर्वेटीवज सोबत / शिवाय फळांचा रस तयार करणे.
- रस, प्युरी, केचअप, सॉस, सूप, व चटणी अशी उत्पादने तयार करणे.
- स्थानिक उपलब्ध फळांपासून लोणचे, जाम, जेली आणि मुरांबा तयार करणे.

प्रात्याक्षिके

- सामान्य फळ प्रक्रिया उपकरणांचा अभ्यास करणे (पल्पर, सिलर्स, रस काढणारी मशीन, ओटोक्लेव, कोर्किंग मशीन)
- फळ निर्यातीसाठी पॅकेजिंग पद्धती, पॅकेजिंग साहित्य आणि तंत्रज्ञान याचा अभ्यास करणे
- फळ संरक्षण पद्धतींचा अभ्यास करणे (नैसर्गिक घटक: साखर, मीठ, आणि रासायनिक घटक: सोडियम बेन्झोएट, केलशीयम प्रोपियोनेट, कोल्ड स्टोरेज)
- ह्यूमेक्टॅन्स वापरून नारळाच्या तुकड्यांच्या जतनाचा अभ्यास करणे.
- कोरडे करण्याच्या विविध पद्धतींचा अभ्यास: सूर्य प्रकाशात वाळवणे, केबिनेट आणि सौर पद्धतीने कोरडे करणे
- केळी/ आंबा / द्राक्षे फळांमध्ये पिकविण्यासाठी कारणीभूत वाढ नियंत्रकाच्या प्रभावाचा अभ्यास करणे.
- प्रीझर्वेटीवज सोबत / शिवाय फळांचा रस तयार करण्याचा अभ्यास करणे
- टोमेटो प्रक्रियांचा अभ्यास: रस, प्युरी, केचअप, सॉस, सूप, व चटणी
- स्थानिक उपलब्ध फळांपासून विविध प्रकारचे लोणचे तयार करणे
- स्थानिक उपलब्ध फळांपासून जाम, जेली आणि मुरांबा तयार करणे.
- आवळा रस, आवळा लोणचे आणि आवळा कैन्डी तयार करणे.
- अन्न सुरक्षा मानकांचा (GMP, FSSAI, ISO22000, HACCP) अभ्यास करणे.
- फळ प्रक्रिया उद्योगाला अभ्यास भेट देऊन अहवाल तयार करणे

सुचवलेले वाचन:

- Giridhari, Lal, Siddapa, G.S. and Tandon, G. L. (1998) Preservation of fruit and vegetables, Publication and information division, ICAR.
- Srivastava, R. P., Sanjeev Kumar, (2006) Fruits and vegetable preservation, International book distributing Co. Lucknow.
- Chanda, K. L. and Pareek, O. P. (1996) Advances in Horticulture, Vol. IV. Malhotra Publ. House, Kriti Nagar, Delhi.

4. Prasad and Kumar, (2024) Principles of Horticulture 2nd Edn. Agrobios (India).
5. Neeraj Pratap Singh, (2005) Basic concept of fruit science, 1st Eds. IBDC Publishers.
6. Salunkhe, D. K. and Kadam, S. S., (2013) A Handbook of Fruit Science and Technology, CRC Press.
7. Prasad, S. and Kumar, U. (2010) A Handbook of Fruit Production, Agrobios (India).

SKILL ENHANCEMENT COURSE - II: ETHNOBOTANY
CREDIT: 2 PRACTICAL HOURS:60 MARKS: 50
Course Code: 2602USBOSE401

Course Outcomes:

After successful completion of the course the student will be able to:

CO1	Identify and recall the botanical names, families, and primary uses of key food plants, beverage sources, and oil-yielding crops.
CO2	Explain the therapeutic properties of various plant parts (roots, stems, leaves, flowers) used in traditional medicine, such as Ashwagandha, Gulvel, and Aloe vera.
CO3	Demonstrate the technical procedures for preparing herbal products, including Churn (Triphala), Kadha (Adulsa), hair oils, and herbal cosmetics.
CO4	Execute and interpret biochemical tests to detect adulteration in common spices and drugs like Haldi, Hing, Camphor, and Saffron.
CO5	Critically appraise the phytochemical profile (alkaloids, tannins, saponins) and organoleptic characteristics of significant ethnomedicinal plants.
CO6	Synthesize ethnobotanical data through field visits to tribal communities and herbal industries to document endangered plant resources and traditional knowledge.

SYLLABUS

List of Practical

- 1) Study of Food plants: Morphology and uses of Rice [*Oryza sativa* L.] and Jowar [*Sorghum bicolor* (L.) Moench].
- 2) Study of Beverages: Morphology and uses of Kokam [*Garcinia indica* (Thou.) Sharbat, Vala [*Vetiveria zizanioides* (L.) Nash.] Sharbat.
- 3) Study of Oil yielding plants: Morphology and uses of Coconut [*Cocos nucifera* L.], Groundnut [*Arachis hypogea* L.].
- 4) Study of drugs obtained from root and stem. Root: - Ashwagandha [*Withania somnifera* L. Dunal], Stem- Gulvel [*Tinospora cordifolia* (Willd.) Miers.]
- 5) Study of drugs obtained from leaf and flower. Leaf- Korphad [*Aloe vera* (L.) Burm.f.], Flower- Clove [*Syzygium aromaticum* (L.) Merr. & Perry]
- 6) Study of herbal cosmetics: Hair dye-Mehandi [*Lawsonia inermis* L.], Facemask-Chandan [*Santalum album* L.], Bath oil- Deshi-Gulab [*Rosa cymosa* Tratt. and Perfume-[*Jasminum sambac* (L.) Sol.]
- 7) Study of herbal preparation of Churn: Triphalachurna- Awala [*Emblica officinalis* Gaertn.],

- Hirada [*Terminalia chebula* Retz.], and Behada [*Terminalia bellirica* (Gaertn.) Roxb.] and Kadha/Decoction- Adulsa [*Justicia adhatoda* L.]
- 8) Study of herbal preparation of Hair oil-Maka [*Eclipta prostrata* (L.) L. and Shampoo-Ritha [*Sapindus trifoliatu*s Vahl.] and Shikakai- [*Acacia concinna* (Willd.) DC]
 - 9) Study of Biochemical tests for drug adulteration of Haldi [*Curcuma longa* L.] and Hing [*Ferula asafoetida* (Falc.) H. Karst.], Camphor [*Cinnamomum camphora* (L.) J. Presl] and Saffron [*Crocus sativus* L.]
 - 10) Study of preliminary phytochemical tests for Alkaloids, Tannins, Saponins and Terpenoids.
 - 11) Organoleptic study of Tulsi [*Ocimum tenuiflorum* L.], Ginger [*Zingiber officinale* Roscoe], Methi [*Trigonella foenum-graecum* L.] and Avala [*Phyllanthus emblica* L.]
 - 12) Study of Endangered Ethnomedicinal plants.
 - 13) Study of distribution of tribal/ethnic communities of India
 - 14) Visit to herbal industry/villages for collection of ethnobotanical knowledge

References:

1. Jain, S.K. (1991). Dictionary of Indian Folk Medicine and Ethnobotany. Deep Publications, New Delhi.
2. Jain, S.K. and Mudgal, V. (1999). A Handbook of Ethnobotany. Bishen Singh Mahendra Pal Singh, Dehradun.
3. Rastogi, P.R. and Mehrotra, B.N. (1993). Compendium of Indian Medicinal Plants. CDRI, Lucknow.
4. Jain, S.K. (2010). Ethnobotany in India: A Status Report. Deep Publications, New Delhi.
5. Martin, G. J. (2004). Ethnobotany: A Methods Manual, Earthscan, London.
6. Balick, M. J. and Cox, P. A. (1996). Plants, People, and Culture: The Science of Ethnobotany, Scientific American Library, New York.

SCHEME OF EXAMINATION:

- The examination shall be conducted at the end of each term for semester pattern.
- The theory paper shall carry 30 marks.
- The evaluation of the performance of the students in theory papers shall be on the basis of Semester Examination of 30 marks.
- The internal evaluation for each paper shall carry 10 marks. (Semester I and II: Home assignment, class assignment, unit test a and midterm test)
- Question paper will be set in the view of the /in accordance with the entire syllabus and preferably covering each unit of syllabi.

STANDARD OF PASSING: As prescribed under rules and regulation for each degree.

SPECIAL INSTRUCTIONS, IF ANY**Determination of CZPA, Grading and Declaration of result**

University has adopted 10-point Grading System as follows: **In each semester, marks obtained in each course (Paper) are converted to grade points:** If the total marks of course are 100 and passing criteria is 40%, then use the following Table for the conversion.

Gradation Chart:**Table**

Marks Obtained	Numerical Grade (Grade Point)		CGPA	Letter Grade
Absent	0 (zero)		-	Ab: Absent
0–39	0 to 4		0.0– 4.99	F: Fail
40– 49	5		5.00–5.49	C: Average
50– 54	6		5.50–6.49	B: Above Average
55– 64	7		6.50–7.49	B+: Good
65– 74	8		7.50–8.49	A: VeryGood
75– 84	9		8.50–9.49	A+: Excellent
85– 100	10		9.50–10.0	O: Outstanding

Note:

1. Marks obtained ≥ 0.5 shall be rounded off to next higher digit.
2. The SGPA & CGPA shall be rounded off to 2 decimal points.
3. Marks obtained in 50 marks or 200 marks paper shall be converted to 100 marks.

Calculation of SGPA & CGPA

1. Semester Grade Point Average (**SGPA**)

$$\text{SGPA} = \frac{\sum (\text{Course credits} \times \text{Grade points obtained}) \text{ of a semester}}{\sum (\text{Course credits}) \text{ of respective semester}}$$

2. Cumulative Grade Point Average (**CGPA**)

$$\text{CGPA} = \frac{\sum (\text{Total credits of a semester} \times \text{SGPA of respective semester}) \text{ of all semesters}}{\sum (\text{Total course credits}) \text{ of all semesters}}$$

NATURE OF THEORY QUESTION PAPER AND SCHEME OF MARKING:

Duration of question paper: As per University rule:

- | | | | |
|------|---------------------------------------|-----------|---------|
| i. | Duration of Examination for | 60 marks- | 2 Hours |
| ii. | Duration of Examination for | 30 marks- | 1 Hours |
| iii. | Duration of Practical Examination for | 50 marks- | 2 Hours |

Assessment pattern

For 4 Credits 60:40 (SSE : CIE)

For 2 Credits 30:20 (SSE : CIE)

ESE Question paper pattern for theory

(Botany Major and Minor)

Duration: 1 Hr

Total Marks: 30

Q. 1. Multiple choices questions (6-questions)

6 Marks

(It may include Wh que., match the pairs, true/false, multiple correct options MCQ etc.)

i)

ii)

iii)

iv)

v)

vi)

Q. 2. Attempt any two of the following

12 Marks

A. or B.

C. or D.

Q. 3. Short answer questions (any three) (out of five).

12 Marks

(It may include short notes, label the diagram, compare between, distinguish between etc.)

a.

b.

c.

d.

e.

SSE Question paper pattern for Practical
(Botany Practical Major, Minor and SEC)

Duration: 2 Hr

Total Marks: 30

Q. 1. Specimen A -	5 Marks
Q. 2. Specimen B -	5 Marks
Q. 3. Specimen C -	5 Marks
Q. 4. Specimen D -	5 Marks
Q. 5. Identification	10 Marks
a.	
b.	
c.	
d.	
e.	

Internal Evaluation

(20)

Journal	5
Practical Note Book	5
Oral based on practical	5
Tour report / Project/ Model etc.	5

SSE Question paper pattern for Practical
(Botany Open Elective – III and IV)

Duration: 3 Hr

Total Marks: 50

Q. 1. Long answer que -	10 Marks
Q. 2. Long answer que -	10 Marks
Q. 3. Long answer que -	10 Marks
Q. 4. Short answer que –	
a.	05 Marks
b.	05 Marks
Q. 5. Submission	
a. Journal	05 Marks
b. Field visit/ work Report	05 Marks