

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI



THREE /FOUR YEAR DEGREE OF BACHELOR OF SCIENCE

Bachelor of Science

SUBJECT: BOTANY

FACULTY: SCIENCE AND TECHNOLOGY

**(Courses effective from Academic Year 2026-2027)
Under Uniform NEP 2020**

SYLLABUS

**Semester I and II
Semester III and IV
Semester V and VI**

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THREE YEAR UNDERGRADUATE PROGRAMME

B.Sc. BOTANY

FACULTY: SCIENCE AND TECHNOLOGY

Sant Gadge Baba Amravati University

FACULTY: Science and Technology

(Three Years- Six Semesters Bachelor's Degree Programme)

Preamble:

Welcome to the Undergraduate Program in Botany, an immersive and comprehensive journey into the world of plant sciences. At the heart of this program lies a commitment to nurturing a deep understanding and appreciation of the plant kingdom, from the molecular to the ecosystem level. This curriculum is thoughtfully designed to blend rigorous scientific inquiry with practical applications, ensuring our students emerge as well-rounded, skilled, and knowledgeable botanists.

This program offers a rich tapestry of courses that cover a wide spectrum of botanical sciences. From exploring the theoretical foundations in plant science and delving into the diversity of microbial life to hands-on experimentation in plant pathology and advanced studies in genomics, proteomics, and metabolomics, the program provides an all-encompassing educational experience. These major courses are complemented by specialized vocational skill courses and skill enhancement courses, meticulously structured to bridge the gap between academic learning and vocational expertise. Students engage in in-depth studies of medicinal plant cultivation and processing, seed development technology, and nursery and garden management, seamlessly connecting these skills to practical vocational applications like commercialization, supply chain management, and entrepreneurship.

In addition to the core and vocational curricula, this program offers elective courses in critical areas like plant systematics, physiology, molecular biology, and fungal systematics, further broadening our students' scientific horizons. A unique feature of this program is the course on "Sacred Plant Heritage of Maharashtra", which integrates the rich botanical heritage of the region with the broader Indian Knowledge System, offering students a unique perspective on the cultural and historical significance of plants.

The graduates are not just academically proficient; they are also equipped with practical skills, an ethical mindset, and the capability to innovate and adapt in the dynamic field of botany. They emerge as individuals who are ready to contribute to scientific research, industry, environmental conservation, and academia. This program is an invitation to embark on a journey of discovery, learning, and growth in the fascinating world of plants, preparing students to become leaders and innovators who will shape the future of botanical sciences and contribute positively to society and the environment.

Core Competencies:

Based on the guidelines provided by the University Grants Commission under the National Education Policy 2020, the Graduate Attributes for the Discipline of Botany for the Undergraduate Program at Sant Gadge Baba Amravati University can be defined as follows:

Plant Identification and Comparison: Ability to recognize and differentiate between major plant groups, such as Algae, Fungi, Angiosperms, and Gymnosperms.

Understanding Plant Evolution and Diversity: Comprehend the evolutionary process and genetic diversity, analyzing plant functions and metabolism at various biological levels.

Adaptation, Development, and Behavior Analysis: Insight into the adaptation, development, and behavioral aspects of different life forms.

Ecosystem Understanding: Grasping the interconnectedness of life, tracing energy and nutrient flow, and understanding ecological relationships.

Analytical and Problem-Solving Skills

Research and Practical Problem Addressing: Utilization of scientific methods for hypothesis formulation, data collection, and critical analysis.

Critical Thinking: Enhanced understanding of fundamental concepts and their application in scientific principles, fostering problem-solving capabilities.

Digital Proficiency

Integration of Digital Tools: Acquiring digital skills and amalgamating fundamental concepts with modern technological tools.

Ethical and Psychological Development

Ethical and Moral Values: Strengthening ethical and moral principles, coupled with psychological resilience.

Teamwork

Collaboration Skills: Developing abilities to work efficiently in teams for institutional, industrial, and societal contributions.

Independent Learning

Self-directed Learning: Acquiring knowledge and skills for higher studies, competitive examinations, and employment readiness.

Additional Learning Outcomes

Critical Evaluation: Ability to critically assess plant information, understanding their classification and phylogenetic position.

Creative Problem Solving: Independently formulating solutions through interdisciplinary experiences.

Taxonomical Interpretation: Skill in using taxonomical information for plant classification.

Scientific Method Application: Proficiency in applying scientific methods to botanical questions.

Communication Skills: Effective presentation of scientific hypotheses and data, both orally and in written formats.

Literature Review: Ability to access and evaluate primary literature in Botany.

Application of Mathematical and Physical Principles: Using mathematical tools and physical principles in biological contexts.

Ecological Interconnectedness: Explaining ecological relationships and energy and nutrient flow in the environment.

Experimental Proficiency: Demonstrating expertise in experimental techniques and methods within Botany.

Curriculum Framework

Multidisciplinary and Holistic Education: Offering a comprehensive, in-depth, and focused curriculum that is student-centric and outcome-based.

Innovation and Curiosity: Promoting experiential learning, hands-on training, field studies, and internships to foster innovation and curiosity.

Adaptation to Modern Technology: Keeping abreast with the latest developments in plant sciences and technology.

Career Readiness: Equipping students with knowledge, competencies, and professional skills for the job market.

These attributes are designed to create well-rounded, skilled, and knowledgeable graduates who are ready to contribute effectively in their chosen careers and as responsible citizens.

Graduate Attributes

Graduate Attributes for a Botany program encapsulates the essential qualities, skills, and understandings that a student is expected to acquire throughout their academic journey. These attributes are meticulously designed to prepare graduates for diverse roles in scientific research, industry, environmental conservation, and academia. They reflect a blend of theoretical knowledge, practical skills, technological proficiency, and ethical understanding. Importantly, these attributes also foster a mindset of lifelong learning, adaptability, and innovation. Graduates are expected to not only excel in their scientific endeavors but also contribute positively to societal and environmental challenges. By integrating knowledge from various sub-disciplines of Botany and related fields, students are equipped to approach complex problems holistically and innovatively, making them valuable assets in any professional setting they choose to pursue.

Graduate Attributes specifically with the Major Courses, Vocational Skill Courses, Skill Enhancement Courses, and Elective Courses you've listed. This will provide a comprehensive picture of the attributes expected from students graduating from this Botany program.

1. **Advanced Scientific Understanding:** Develop an in-depth understanding of plant science, including theoretical foundations, microbial diversity, plant pathology, cryptogams and phanerogams, economic Botany, and advanced fields like genomics, proteomics, and metabolomics.
2. **Practical and Laboratory Skills:** Gain hands-on experience in practical techniques in microbial studies, plant pathology, cell biology, cytogenetics, and various experimental approaches, preparing students for real-world scientific challenges.
3. **Technological and Analytical Proficiency:** Achieve expertise in using modern technologies in plant science. This includes proficiency in bioinformatics, genetic engineering, molecular biology, and data analysis techniques, crucial for research and industry applications.
4. **Entrepreneurial and Business Skills:** Develop skills in commercialization, medicinal plant cultivation and processing, supply chain management, seed development technology, entrepreneurship, and nursery and garden management, preparing students for business ventures in Botany.
5. **Environmental Stewardship and Ethical Considerations:** Cultivate an understanding of the ecological and ethical implications of plant sciences, especially in areas like genetic engineering, conservation, and sustainable use of plant resources.
6. **Interdisciplinary Integration and Innovation:** Ability to integrate knowledge from plant systematics, physiology, molecular biology, and fungal systematics, and apply innovative solutions to challenges in the field of Botany.
7. **Communication and Collaboration Skills:** Develop strong communication skills for conveying complex botanical concepts clearly and collaborating effectively in interdisciplinary teams.
8. **Global Perspective and Societal Impact:** Awareness of the global and societal impact of plant sciences, including the role of plants in addressing issues like food security, medicine, and climate change.
9. **Critical Thinking and Problem Solving:** Foster critical thinking and problem-solving skills, essential for tackling complex scientific questions and challenges in Botany.
10. **Research and Inquiry:** Encourage a strong foundation in research methodology and inquiry, essential for contributing to the growing body of knowledge in plant science and related fields.

The course "Sacred Plant Heritage of Maharashtra," deeply rooted in the Indian Knowledge System, offers an enriching study of the traditional and sacred botanical heritage specific to the Maharashtra region of India. This course delves into the rich tapestry of cultural, spiritual, and medicinal significance of plants that are integral to the local traditions and practices. Students will explore the historical context, religious importance, and the ethnomedicinal uses of these plants, gaining insights into how they have been revered and utilized over centuries. Through field visits, interaction with local communities, and studying ancient texts, students will learn how these plants are not only

a part of the state's ecological biodiversity but also a vital component of its cultural identity and traditional wisdom. This course, therefore, bridges the gap between conventional botanical studies and the rich, often unexplored, indigenous knowledge systems of India.

These attributes ensure that graduates are not just academically proficient but also equipped with practical skills, an ethical mindset, and the ability to adapt and innovate in the dynamic field of Botany.

The structure of the Vocational Skill Courses and Skill Enhancement Courses in this Botany program is strategically designed to provide students with a comprehensive skill set that aligns directly with viable vocational pathways. For instance, the course on "Medicinal Plant Cultivation and Processing" lays the foundational skills necessary for understanding the nuances of cultivating and processing medicinal plants. This knowledge is then extended and applied in the course "Commercialization of Medicinal Plant and Products," enabling students to grasp the business aspects of the medicinal plant industry, including market analysis, product development, and sales strategies.

Similarly, the course on "Seed Development Technology" equips students with the technical know-how in seed science and technology. This knowledge is complemented by the "Supply Chain Management in Seed Products" course, which teaches students the logistics and management skills required to effectively distribute seed products in the market. This integrated approach ensures that students not only learn the scientific and technical aspects of Botany but also gain expertise in the business and management side of the industry.

In the realm of horticulture, the course "Skilling Botanists for Nursery and Garden Management" provides practical skills in nursery operations and garden management. This is synergistically linked with the vocational course "Nursery and Garden Management," focusing on the entrepreneurial aspects of running a nursery or garden business, including financial management, marketing, and customer relations.

Moreover, specialized courses like "Entrepreneurship for Botanists" and "ECO Friendly Plant Products" open further avenues for career opportunities. "Entrepreneurship for Botanists" encourages an entrepreneurial mindset, preparing students to start their ventures or innovate within existing organizations in the botanical field. "ECO Friendly Plant Products" course focuses on sustainable and environmentally friendly practices in product development, aligning with the growing global trend towards green solutions.

This cohesive and integrated educational approach ensures that students are not only well-versed in theoretical and practical aspects of Botany but also equipped with the necessary skills to turn their knowledge into successful vocational pursuits. This alignment of skills with vocational outcomes is key to providing students with a clear and achievable career path post-graduation.

Program Outcomes

Program Outcomes for an Undergraduate Botany Program, especially one with a comprehensive curriculum like the one, involves articulating the specific knowledge, skills, and attitudes students are expected to possess upon graduation. Following are the Program Outcomes:

1. **Scientific Knowledge and Understanding:** Graduates will demonstrate a thorough understanding of plant biology, including the study of microbial diversity, plant pathology, botany (Cryptogamic, Phanerogamic), and advanced topics like genomics, proteomics, and metabolomics.
2. **Practical and Experimental Skills:** Graduates will acquire hands-on skills in various laboratory techniques and experimental approaches in plant science, enabling them to conduct scientific investigations effectively.
3. **Technological Proficiency:** Graduates will be adept in using modern technologies and tools relevant to botany and plant sciences, including bioinformatics, genetic engineering, and analytical software.
4. **Environmental Awareness and Sustainability:** Graduates will understand the ecological and environmental impact of plants and plant-based industries and will be knowledgeable about sustainable practices in botany.
5. **Entrepreneurial and Business Acumen:** Graduates will possess skills in entrepreneurship and business management, particularly in areas such as medicinal plant commercialization, seed product management, and nursery and garden management.
6. **Interdisciplinary Integration:** Graduates will be able to integrate knowledge across various sub-disciplines of botany, applying them to solve complex problems in plant science and related fields.
7. **Communication Skills:** Graduates will develop strong communication skills, capable of effectively conveying botanical concepts and findings to diverse audiences, both in academic and industry settings.
8. **Ethical and Societal Understanding:** Graduates will have a deep appreciation of the ethical implications and societal importance of plant sciences, particularly in areas like genetic engineering and conservation.
9. **Research Competence:** Graduates will be proficient in scientific research methodologies, enabling them to contribute to the expansion of knowledge in plant sciences.
10. **Global Perspective and Societal Contribution:** Graduates will recognize the global challenges and opportunities in botany and will be prepared to contribute to societal needs and environmental conservation efforts.
11. **Career Readiness and Adaptability:** Graduates will be ready for a variety of career paths in botany and related fields, equipped with the adaptability and lifelong learning skills necessary to navigate a dynamic professional landscape.
12. **Innovation and Problem-Solving Skills:** Graduates will have the ability to apply creative and critical thinking to innovate and solve problems in the field of botany.

These Program Outcomes ensure that graduates from the Botany program are not only academically proficient but also ready to apply their knowledge and skills in practical, research, and entrepreneurial settings, contributing positively to the field of plant sciences and the broader community.

THREE YEAR UNDERGRADUATE PROGRAMME

B.Sc. BOTANY under **FACULTY: SCIENCE AND TECHNOLOGY**

Board of Studies in Botany (Including Environmental Science and Seed Technology)

1. Agnihotri Dr. Adarsh Kumar, Principal Scientific Officer, Bio-processing & Herbal Division, Mahatma Gandhi Institute for Rural Industrialization, Maganwadi, Wardha	7. Hande Dr. Dilip Vinayakrao Shri Pundlik Maharaj Mahavidyalaya, Nandura Rly
2. Dagwal Dr M. J. Radhabai Sarada Mahavidyalaya, Anjangaon Surji	8. Kadu Dr. Suruchi R., Brijlal Biyani Science College, Amravati.
3. Deosthale Dr. S. M. B. B. Arts & N.B. Commerce & B.P. Science College, Digras	9. Khedkar Dr. Dinesh Shri Shivaji Science College, Amravati
4. Dongarwar, Dr. Nitin M. Department of Botany, Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur	10. Khodke Dr. Suchita Pravin Vinayak Vidnyan Mahavidyalaya, Nandgaon Kh.
5. Dr. Dipak K. Koche, Shri. Shivaji College of Arts, Commerce & Science, Akola	11. Maggirwar Dr. Rekha Shri Shivaji Science College, Amravati
6. Gawande Dr. P. A. Dept. of Botany, Sant Gadge Baba Amravati University, Amravati	12. Mangale Dr. Vijay Art, Commerce and Science College, Chikhaldara
	13. Nathar Dr. Sou. V. N. Dept. of Botany, Sant Gadge Baba Amravati University, Amravati
	14. Shahejad Dr. M. A. SPM Gilani Arts Commerce College, Ghatanji, District -Yavatmal
	15. Wankhede Dr. Tushar Bhimrao J. D. Patil Sangaludkar Mahavidyalaya, Daryapur

THREE YEAR UNDERGRADUATE PROGRAMME

B.Sc. BOTANY under **FACULTY: SCIENCE AND TECHNOLOGY**

Committees Constituted by BoS (Botany Including Environmental Science and Seed Technology) for Curriculum Development in Botany for Semester I and II

FOUNDATIONS OF PLANT SCIENCE AND CAREER DEVELOPMENT Dr. D. D. Khedkar (C) Dr. P. A. Pawade Dr. S. J. Ishwarkar Dr. D.M. Ratnparkhi Dr. Mangesh Bobade Dr. P. D. Deshmukh Mr. Ankit Kale Mr. Avinash Darsimbe Advisory Members; Dr. N. H. Sahare Dr. P. G. Bansod	HANDS-ON EXPLORATION OF CRYPTOGRAMS, PHANEROGAMS AND PALEOBOTANY Dr. S. M. Deosthale Dr. D.V. Hande
MICROBIAL DIVERSITY Dr. D. K. Koche (C) Dr. R. P. Sirsat Dr. V. S. Patil (Dandge) Dr. V. N. Badgujar Dr. Anjali Thakare Dr. Ananat Morey Dr. Kishor Theng Dr. Anand Oke Dr. Suvarna Dakhore Advisory Members: Dr. Manik Dhore Dr. A. V. Padghan	FUNDAMENTAL LIFE PROCESSES IN PLANTS Dr. Pendam S. T. (C) Dr. Thorat S. B. Dr. S. K. Lande Dr. Nilesh Kakade Dr. Khandare N. A. Advisory Members: Dr. Suryakant Kanherkar
TECHNIQUES IN MICROBIAL STUDIES AND PLANT DISEASES Dr. D. D. Khedkar Dr. D. K. Koche	PLANT HEALTH CARE Dr. T. B. Wankhade (C) Dr. N. H. Shahare Dr. Ravi Dhande Dr. S. M. Patole Dr. Y. P. Patil (Malkapur) Mr. Gokul Bajaj Dr. Nutanvarsha Deshmukh Mr. Himanshu Jaiswal Dr. Vivek Narkhedkar Advisory Members: Dr. G. C. Kamble
CRYPTOGAMIC BOTANY Dr. S. M. Deosthale (C) Dr. K. S. Sontake Dr. P.Y. Anasane Dr. Parvin A. Theng Dr. Mohammed Nafees Iqbal Dr. Ashay Muneshwar Dr. N. S. Gopkar Dr. Swati Tathod Dr. K. P. Suradkar Advisory Members: Dr. S. I. Kamble	KITCHEN GARDENING Dr. S. R. Kadu (C) Dr. Ajay Rajurkar Dr. K. M. Thorat Dr. Simeet Rokade Dr. S. P. Kalbende Dr. Umesh More Mr. G. S. Bajaj Dr. Jayashri More Advisory Members: Dr. V. U. Pochhi
PHANEROGAMIC BOTANY Dr. D. V. Hande (C) Dr. A.V. Padghan Dr. V. P. Deshmukh Dr. Sanjay Satpute Dr. Kakode K. U. Dr. Pankaj Kashte Dr. Suchita Dighe Dr. Shrikant Patil Advisory Member Dr. G. B. Hedawoo	FLORICULTURE AND VALUE ADDITIONS Dr. R. C. Maggirwar (C) Dr. G. B. Hedawoo Dr. A. T. More Dr. Bhade D. L. Dr. Shaikh Farah Tahesin Dr. S. P. Patil Dr. K. S. Sontakke Dr. S. P. Patharkar Dr. S. V. Pundkar Dr. Pranjali Deshmukh Dr. Sumit Chaudhari Advisory Members: Dr. D. S. Talwankar

AYUSH Dr. S. P. Khodke (C) Dr. R. B. Kalbande Dr. Minal Keche Dr. Ravindra Dhore Dr. S. S. Mhasal Dr. Mahendra Bhise Dr. D. S. Pawar Mr. Shilanand Hiwrale Dr. Sneha Ingale Dr. Amrapali Bhagat Advisory Members: Dr. U. R. Kokate	MEDICINAL PLANT CULTIVATION AND PROCESSING Dr. Mangesh Dagwal (C) Dr. G. D. Wadankar Dr. Pramod Khadse Dr. Umesh Kanherkar Dr. Yugandhara Gulhane Dr. Manoj Kakpure Dr. M. U. Ghurde Dr. P. G. Khapecar Advisory Member: Dr. S. V. Satpute
COMMERCIALIZATION OF MEDICINAL PLANT AND PRODUCTS Dr. Santosh Suradkar (C) Dr. Mangesh Dagwal Dr. K. M. Ranjalkar Dr. Mahendra Salve Dr. Shidas Aher Dr. Umesh Kanherkar Dr. Yugandhara Gulhane Dr. Manoj Kakpure Dr. M. U. Ghurde Advisory Member: Dr. S. S. Ingale	SUPPLY CHAIN MANAGEMENT IN SEED PRODUCTS Dr. Mukund M. Dhore (C) Dr. Sujata Shende Dr. P. D. Wanjare Dr. V. D. Samarth Dr. Suchita Dighe Advisory Member: Dr. A. N. Deore
	SEED DEVELOPMENT TECHNOLOGY Dr. M. A. Shahezad (C) Dr. N. S. Dharkar Dr. Pankaj Kahate Dr. Vijay Watile Dr. Vinod Chavhan Dr. Ravindra Mate Dr. Pravin R. Sardar Advisory Member: Dr. Mukund M. Dhore

Credit Distribution

Three/Four-year UG Degree Programme (Level 4.5 to 5.5)

Vertical	Vertical Type	I	II		III	IV	V	VI	Total Credits	Grand Total
	(i) Three-year UG Degree Programme (Level 4.5.to 5.5)									
A	Major DSC (60–64) (Minimum 50% of Total Credits)	4	4	Major	6	8	8	8	38	48
				IKS	2				2	
		0	0	Elective	0	0	4	4	8	
B	Minor (from same faculty of DSC) (18–24)	4	4		4	4	4	4	24	24
C	Generic/Open Elective (OE) (Faculty-wise basket other than Major/Minor faculty) (10–12)	4	4		2	2	0	0	12	12
D(i)	Vocational Skill Courses (VSEC) corresponding to Major/Minor (8–10)	0	2		2	2	2	2	10	16
D(ii)	Skill Enhancement Courses (SEC)	2	2		0	0	2	0	6	
E(i)	Ability Enhancement Courses (AEC) (English + Modern Indian Language)	1+ 1	1+ 1		1+ 1	1+ 1	0	0	8	14
E(ii)	Indian Knowledge System (IKS) 2 Generic	2	0		0	0	0	0	2	
E(iii)	Value Education Courses (VEC) (Understanding India, EVS, Digital & Technological Solution) 4	2	2		0	0	0	0	4	
F(i)	Internship / Apprenticeship corresponding to Major 8 (OJT)	0	0		0	0	0	4	4	18
F(ii)	Field Projects / Community Engagement & Service (CEP) corresponding to Major 4-6	0	0		2	2	2	0	6	
F(iii)	Co-curricular Courses (CC) (health & wellness, yoga education, sports, fitness, cultural activities, NSS/ NCC & Fine/ Applied/ Visual/ Performing Arts 8	2	2		2	2	0	0	8	
	Total Credits per Semester	22	22		22	22	22	22	132	132

(ii) Four-year UG Degree programme (Level 6.0) Honors Degree in Major or Minor						
A. Honors Degree in Major or Minor						
	Vertical Type			Semester VII	Semester VIII	
	Major (Offered at Three-year	Mandatory		12-14(2*4+2*2 or 3*4+2)	12-14(2*4+2*2 or 3*4+2)	28
	UG Programme)	Elective		4	4	8
	Research Methodology (RM)			4	0	8
	On the Job Training (OJT)			0	4	4
	Total			22	22	44
	Cumulative			(132+44) 176		
(ii) Four-year UG Degree Programme (Level 6.0)						
B. Honors with Research Degree in Major or Minor						
	Major (Offered			Semester VII	Semester VIII	
	at Three-year	Mandatory		8-10 (24+2 or 24)	8-10 (24+2 or 24)	20
	UG Programme)					
		Elective		4	4	8
	Research Methodology (RM)			4	0	4
	Research Project (RP)			4	8	12
	Total			22	22	44
	Cumulative			(132+44) 176		

Teaching and Learning Scheme: for the Degree of Bachelor of Botany as Major

Sant Gadge Baba Amravati University, Amravati

FACULTY: SCIENCE AND TECHNOLOGY

Teaching and Learning Scheme: for the Degree of Bachelor of Botany as Major and as Minor

TLE Scheme for FIRST YEAR: SEMESTER – I (Level 4.5)

Mode of Teaching	Vertical No.	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical Workload (Hrs/Week)
Classroom Teaching / Lab Work (Practical)/ Outdoor / Field	a.	Major / Minor	Theory1	107201	Foundations of Plant Science and Career Development	2	2	6
			Lab/Practical-1	107202	Foundations and Prospects of Plant Science	2	4	
	b.	Minor / Major	Theory1	-	-	2	2	6
			Lab/Practical-1	-	-	2	4	
	c.	Generic/Open Elective	Theory1	107203	Plant Health Care	2	2	4
			Theory2	107204	Kitchen Gardening	2	2	
	d.	VSC	-	-	-	-	-	4
		SEC	Lab/Practical-2	107205	Medicinal Plant Cultivation and Processing	2	4	
	e.	AEC - English	Theory		Refer University basket	1	1	6
		AEC –MIL	Theory		Refer University basket	1	1	
		IKS-Generic	Theory		Refer University basket	2	2	
		VEC	Theory		Refer University basket	2	2	
	f.	CC	Outdoor		Separate SOP will be released	2	4	4
		TOTAL				22	30	30

Minor Subject opted by the Student

TLE Scheme for FIRST YEAR: SEMESTER – II (Level 4.5)

Mode of Teaching	Ver. No	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/Week)	Vertical Workload (Hrs/Week)
Classroom Teaching / Lab Work (Practical)/ Outdoor / Field	a.	Major / Minor	Theory2	107206	Fundamental Life Processes in Plants	2	2	6
			Lab/Practical-3	107207	Hands on Exploration of Life Processes	2	4	
	b.	Major / Minor	Theory2		-	2	2	6
			Lab/Practical-5		-	2	4	
	c.	Generic/ Open Elective	Theory3	107208	Floriculture and Value Additions	2	2	4
			Theory4	107209	AYUSH	2	2	
	d.	VSC	Lab/Practical-6	107210	Commercialization of Medicinal Plant and Products	2	4	8
		SEC	Lab/Practical-7	107211	Seed Development Technology	2	4	
	e.	AEC - English	Theory		Refer University basket	1	1	4
		AEC –MIL	Theory		Refer University basket	1	1	
		VEC	Theory		Refer University basket	2	2	
	f.	CC	Outdoor		Separate SOP will be released	2	4	4
		TOTAL				22	32	32

Minor Subject opted by the Student

*** Important:**

- VSC Should be Complementary to Major/Minor
- SEC has to be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor

TLE Scheme for SECOND YEAR: SEMESTER – III (Level 5.0)

Subject	The Vertical	Course Code	Course Title	Credits	Workload	Theory/Practical				Theory/Pract (Total)	
						External		Internal			
						Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks
Botany	Major-T	107212	Microbial Diversity	2	2	30	9	20	6	50	20
Botany	Major-T	107213	Cryptogams and Gymnosperms	2	2	30	9	20	6	50	20
Botany	Major-P	107214	Techniques in Microbial Studies, Plant Diseases and Cryptogams and Gymnosperms	2	2	30	9	20	6	50	20
Botany	IKS-T	107215	Sacred Plant Heritage of Maharashtra	2	2	30	9	20	6	50	20
Botany	Minor-T	107216	Plant Diversity, Conservation and Forensic Botany	2	2	30	9	20	6	50	20
Botany	Minor-P	107217	Practical Approach towards Plant Diversity, Conservation and Forensic Botany	2	4	25	10	25	10	50	20
Botany	GOEC-T	107218	Traditional Health Care	2	2	30	9	20	6	50	20
Botany	VSC-P	107219	Supply Chain Management in Seed Products	2	4	-	-	50	20	50	20
Botany	FP/CES	10720	Botany Lab 9 (FP/ CEP in Botany - I)	2	4	-	-	50	20	50	20
Botany	CC		Separate SOP shall be consulted from University website	2	4	-	-	50	20	50	20

Important: * VSC Should be Complementary to Major

** SEC has to be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor

TLE Scheme for SECOND YEAR: SEMESTER – IV (Level 5.0)

Subject	The Vertical	Course Code	Course Title	Credits	Workload	Theory/Practical				Theory/Pract (Total)	
						External		Internal		Max. Marks	Min. Marks
						Max. Marks	Min. Marks	Max. Marks	Min. Marks		
Botany	Major-T	107221	Botanical Wealth – Economic Botany, Ethnomedicine and Phytochemistry	2	2	30	9	20	6	50	20
Botany	Major-T	107222	Cellular Frontiers in Botany - Cell Biology, Cytogenetics and Molecular Biology	2	2	30	9	20	6	50	20
Botany	Major-T	107230	Angiosperm Taxonomy	2	2	30	9	20	6	50	20
Botany	Major-P	107223	Experimental Botany in Economic, Medicinal, Cellular, Molecular, Morphological and Taxonomic Studies	2	4	25	10	25	10	50	20
Botany	Minor-T	107224	Plant Propagation and Growth	2	2	30	9	20	6	50	20
Botany	Minor-P	107225	Investigations of Plant Life Sketch	2	4	25	10	25	10	50	20
Botany	GOEC-T	107226	Wonders of Plant World	2	2	30	9	20	6	50	20
Botany	VSC-P	107227	Nursery and Garden Management	2	4	-	-	50	20	50	20
Botany	SEC	107228	Skilling Botanists for Nursery and Garden Management (Discontinued from 2026-27)	2	4	-	-	50	20	50	20
Botany	FP/CES	107229	Botany Lab 14 (FP/ CEP in Botany - II)	2	4	-	-	50	20	50	20
Botany	CC		Separate SOP shall be consulted from University website	2	4	-	-	50	20	50	20

Important:

- VSC Should be Complementary to Major
- SEC has to be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor

TLE Scheme for THIRD YEAR: SEMESTER – V (Level 5.5)

Level	The Vertical	Course Code	Course Title	Credits	Workload	Theory/Practical Marks				Theory/Pract (Total) Marks	
						External		Internal			
						Max.	Min.	Max.	Min.	Max.	Min.
5.5	Major-T	107231	Theoretical Foundations in Anatomy, Embryology, and Pharmacognosy	2	2	30	9	20	6	50	20
5.5	Major-T	107232	Innovative technologies of Genetics, Plant Breeding, Green Revolution and Biotechnology	2	2	30	9	20	6	50	20
5.5	Major-T	107234	Biochemistry and Plant Physiology	2	2	30	9	20	6	50	20
5.5	Major-P	107235	Practical Based on Major Theory Papers of Semester V	2	4	25	10	25	10	50	20
5.5	Major-Elective T1	107236	Plant Systematics - 1	2	2	30	9	20	6	50	20
5.5	Major-Elective P1	107237	Lab-Based Learning of Plant Systematics - 1	2	4	25	10	25	10	50	20
OR											
5.5	Major-Elective T2	107238	Molecular Biology and Genetic Engineering - 1	2	2	30	9	20	6	50	20
5.5	Major-Elective P2	107239	Lab-Based Learning of Mole.Bio. and Genetic Eng. - 1	2	4	25	10	25	10	50	20
OR											
5.5	Major-Elective T3	107240	Advance Plant Physiology - 1	2	2	30	9	20	6	50	20
5.5	Major-Elective P3	107241	Lab-Based Learning of Advance Plant Physiology - 1	2	4	25	10	25	10	50	20
OR											
5.5	Major-Elective T4	107242	Basic and Applied Mycology and Plant Pathology- 1	2	2	30	9	20	6	50	20
5.5	Major-Elective P4	107243	Lab-Based Learning of Basic and Applied Mycology and Plant Pathology- 1	2	4	25	10	25	10	50	20
5.5	Minor-T	107244	Biochemistry, Plant Physiology and Ecology	2	2	30	9	20	6	50	20
5.5	Minor-P	107245	Lab Techniques in Biochemi, Plant Physio. and Ecology	2	4	25	10	25	10	50	20
5.5	VSC-P	107246	Eco-Friendly Plant Products	2	4	-	-	50	20	50	20
5.5	SEC-P1	107247	Skilling Botanists for Nursery and Garden Management (from session 2027-2028 onwards)	2	4	-	-	50	20	50	20

OR											
5.5	SEC-P2	107248	Mushroom Culture Technology & Production (from 26-27)	2	4	-	-	50	20	50	20
OR											
5.5	SEC-P3	107249	Biofertilizer Technology (2026-27 Onwards)	2	4	-	-	50	20	50	20
OR											
	SEC-P4	107250	Herbs and Herbal Products	2	4	-	-	50	20	50	20
5.5	FP/CEP	107251	Botany Lab (Field Project / Community Engagement Program)	2	4	-	-	50	20	50	20
5.5	Non Credit		Foundation of Artificial Intelligence	NC	2			30+20	9+6	50	20

Important:

- **VSC Should be Complementary to Major**
- **SEC must be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor**
- As per Sant Gadge Baba Amravati University, Amravati Extra-Ordinary Notification No. No. 241/2025 Dated 24/12/2025 “Foundation of Artificial Intelligence” is the Mandatory **Non Credit Course** compulsory course for all the UG students in fifth semester of all undergraduate programs of all faculties in Sant Gadge Baba Amravati University, Amravati to earn their degree
- NC is Non Credit Course
- Students must select **Any One** of the Major-Elective Courses (T1 to T4) with respective Practical Course in Semester V and **same shall be continued** for Semester VI
- Students must select **Any One** of the SEC-P (P1 to P4) Course in Semester V and Semester VI

TLE Scheme for THIRD YEAR: SEMESTER – VI (Level 5.5)

Level	The Vertical	Course Code	Course Title	Credits	Workload	Theory/Practical Marks				Theory/Pract (Total) Marks	
						External		Internal			
						Max.	Min.	Max.	Min.	Max.	Min.
5.5	Major-T	107252	Genomics, Proteomics and Metabolomics	2	2	30	9	20	6	50	20
5.5	Major-T	107253	Plant Ecology & Conservation Biology	2	2	30	9	20	6	50	20
5.5	Major-T	107254	Modern Tools and Techniques in Plant Sciences	2	2	30	9	20	6	50	20
5.5	Major-P	107255	Hands on Omics, Ecology & Modern Techniques	2	4	25	10	25	10	50	20
5.5	Major-Elective T1	107256	Plant Systematics - 2	2	2	30	9	20	6	50	20
5.5	Major-Elective P1	107257	Lab-Based Learning of Plant Systematics -2	2	4	25	10	25	10	50	20
OR											
5.5	Major-Elective T2	107258	Molecular Biology and Genetic Engineering - 2	2	2	30	9	20	6	50	20
5.5	Major-Elective P2	107259	Lab-Based Learning of Mole.Bio. and Genetic Eng. -2	2	4	25	10	25	10	50	20
OR											
5.5	Major-Elective T3	107260	Advance Plant Physiology - 2	2	2	30	9	20	6	50	20
5.5	Major-Elective P3	107261	Lab-Based Learning of Advance Plant Physiology - 2	2	4	25	10	25	10	50	20
OR											
5.5	Major-Elective T4	107262	Basic and Applied Mycology and Plant Pathology-2	2	2	30	9	20	6	50	20
5.5	Major-Elective P4	107263	Lab-Based Learning of Basic and Applied Mycology and Plant Pathology-2	2	4	25	10	25	10	50	20
5.5	Minor-T	107264	Molecular Biology, Genetic Engineering and Biotechnology	2	2	30	9	20	6	50	20
5.5	Minor-P	107265	Experimental Mole. Bio, Genetic Engi. & Biotech.	2	2	30	9	20	6	50	20
5.5	VSC-P	107266	Entrepreneurship for Botanists	2	4	-	-	50	20	50	20
5.5	Intern/Apprenticeship	107267	Botany Lab (Internship / Apprenticeship)	4	8	-	-	50	20	50	20

Important: VSC Should be Complementary to Major and SEC has to be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor

SWAYAM/NPTEL Courses under NEP 2020

Sr. No.	Semester	Course Title	Course Code*	Credits**	Institution	Agency	Enrollment Ends	Link to Enroll
1	I	Indian Traditional Medicinal and Aromatic Plants	AIC23_GE18	2	Govt. College of Pharmacy, Amravati	AICTE	Open	https://onlinecourses.swayam2.ac.in/e-learning/preview/aic23_ge18
2	II	Introduction to Cell Biology	noc26_bt102	3	IISER Pune	NPTEL	17 Aug 2026	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_bt102
3	III	Post Harvest Operations and Processing of Fruits, Vegetables, Spices and Plantation Crop Products	NOC26_AG31	3	IIT Kharagpur	NPTEL	27 Jul 2026	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ag20
4	IV	Cell and Molecular Biology	NOC26_BT44*	4	IIT Guwahati	NPTEL	27 Jul 2026	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_bt91
5	IV	Awareness on Biosafety Aspects of Genetically Engineered Plants	AIC20_GE07	1–2	Biosafety Capacity Building Project	AICTE	Open	https://onlinecourses.swayam2.ac.in/e-learning/preview/aic20_ge07
6	V	Genetic Engineering: Theory and Application	NOC26_BT43*	3	IIT Guwahati	NPTEL	27 Jul 2026	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_bt93
7	VI	Plant Cell Bioprocessing	NOC26_BT51*	2	IIT Madras	NPTEL	27 Jul 2026	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_bt67

* Course codes may vary according to the year and session of enrollment

** Credits will be awarded as per provisions of the SWAYAM/NPTEL at the time of actual enrollment.

Instructions for Enrollment in SWAYAM/NPTEL Courses under NEP 2020

All students of B.Sc. with Botany as Major or Minor of all semesters are encouraged to enroll in suitable SWAYAM/NPTEL online courses to enhance their academic knowledge, practical skills, and employability.

General Instructions

1. Students may choose any course of their interest listed in table above.
2. Before enrollment, students must ensure that they have an active Academic Bank of Credits (ABC) ID. The same ABC ID should be used while registering for the selected SWAYAM/NPTEL course so that earned credits can be deposited in the Academic Bank of Credits.
3. Students should carefully read the course details including duration, eligibility, syllabus, examination schedule, and credit structure before enrolling.
4. Merely enrolling in a course does not make a student eligible for academic credits. Students must:
Complete the course requirements, Appear for the proctored examination, and Successfully pass the examination as per the norms prescribed by SWAYAM/NPTEL.
5. Credits will be awarded only after successful completion and certification of the course by the concerned agency.
6. Every student must submit the details of the enrolled course to the Department of Botany immediately after registration.
7. Submission of enrollment details to the Department is mandatory to facilitate record maintenance and compliance with University requirements regarding credit transfer and academic documentation.
8. Students are advised to preserve all course-related documents, including Enrollment confirmation, Course progress records, Examination registration receipt, Score card, Final certificate.
9. Students shall be responsible for timely registration for the examination, payment of examination fees (if applicable), and completion of all course requirements within the stipulated period.
10. The Department of Botany shall not be responsible for missed deadlines, incomplete registrations, examination non-appearance, or failure to satisfy the certification requirements of the concerned SWAYAM/NPTEL course.
11. After successful completion of the course, students must submit a copy of the course certificate and score card to the Department of Botany for further processing and reporting to the University.

Notes:

- a. The strength of the batch of the Practical for UG Classes shall be 16 with an addition of 10% with the permission of Hon'ble Vice Chancellor. The number of the students required to constitute a batch or calculate the workload shall be in accordance with the relevant Government Resolution in force at the time, applicable to specific time, region, course type, mode of instruction, and other pertinent factors.
- b. 1 Credit shall mean 1 Hour Teaching per Week per Semester (Total 15 Hrs/ Semester), the duration of 1 Teaching Period will be 60 Minutes. For Practical 1 Credit shall mean 2 Hour Teaching per Week per Semester (Total 30 Hrs/ Semester).
- c. For Examination and Evaluation of Theory Courses, 40 % Marks shall be assigned to Internal Examination and 60% Marks shall be assigned to end-semester external university examination.
- d. **Co-curricular Courses:** Health and wellness, Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC, Fine/Applied/Visual/Performing Arts During Semester I, II, III, IV, V and VI. These courses may be taught by Physical Education Director or may be assigned to Language Teacher by the Principal of HEI based on the expertise of the concerned.
- e. **Value Education Courses** to be selected from the Basket of Courses provided by the University. These courses may be assigned to the Language Teacher by the Principal of HEI based on the expertise of the concerned.
- f. **Generic / Open Elective Courses (GE/OE):** Courses to be selected from the Basket of Courses provided by the University
- g. **Abbreviations:** Department Specific Core: DSC, Department Specific Elective: DSE, FSC: Faculty Specific Core, FSE: Faculty Specific Elective, Indian Knowledge System: IKS, Inter Faculty Specific Core: IFSC, Inter Faculty Specific Elective: IFSE, Theory: Th, Practical/Practicum: Pr, Environment Studies: ES, Pre-requisite Course mandatory if applicable: Prq, Laboratory: Lab (Practical), Generic/ Open Electives: OE; Vocational Skill and Skill Enhancement Courses: VSEC; Vocational Skill Courses: VSC; Skill Enhancement Courses: SEC; Ability Enhancement Courses: AEC; Value Education Courses: VEC; OJT: On Job Training: Internship/ Apprenticeship; Field projects: FP; Community Engagement and Service: CES; Co-curricular Courses: CC; RM: Research Methodology; Research Project: RP; MIL: Modern Indian Language

Examination and Assessment Process:

- i. The basic principle of the Credit framework is that Credits are a function of the successful completion of a program of study/ vocational education/ training and assessment. No Credit can be earned by the student unless the student is assessed for the achievement of the desired competencies and outcome of a program.
- ii. Exit options are provided with Certificate, Diploma and Basic Bachelor’s degrees to the students at the end of the second, fourth and sixth semesters of a Four Years Multidisciplinary Degree Programme. Students will receive a Bachelor’s degree with Honors/ Research on successfully completing of all eight semesters of the UG Program either at a stretch or with opted exits and re-entries.
- iii. For the smooth success of four-year degree programme with multiple entry and exit systems, the examination mode should be based on the combination of innovative trends in formative (informal and formal tests administered during the learning process) and summative (evaluation of students learning at the end of an instructional unit) examination modes in line with the UGC Report on ‘Evaluation Reforms in Higher Educational Institutions (2019).

Examination, Evaluation and Assessment Scheme

The total marks for each Course shall be based on Continuous Assessment and Semester End Examination. Each theory course of Major, Minor, GE/OE, AEC, IKS, VEC as mentioned in **Teaching Learning Scheme** prepared by the Board of Studies shall be evaluated as per the scheme as mentioned in the following table

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Table: Examination, Evaluation and Assessment Scheme

Vertical No.	The Vertical	Mode of Examination, Evaluation & Assessment	Theory				Theory (Total)		Practical				Practical (Total)	
			External		Internal		Max. Marks	Min. Marks	External		Internal		Max. Marks	Min. Marks
			Max. Marks	Min. Marks	Max. Marks	Min. Marks			Max. Marks	Min. Marks	Max. Marks	Min. Marks		
a	Major	External & Internal	30	9	20	6	50	20	25	10	25	10	50	20
b	Minor		30	9	20	6	50	20	25	10	25	10	50	20
c	Generic/ Open Elective		30	9	20	6	50	20	--	--	--	--	--	--
d	VSC	Internal	--	--	--	--	--	--	--	--	50	20	50	20
	SEC	Internal	--	--	--	--	--	--	--	--	50	20	50	20
e	AEC (Eng. & One MIL Composite)	External & Internal	30	9	20	6	50	20	--	--	--	--	--	--
	IKS (Generic)	External & Internal	30	9	20	6	50	20	--	--	--	--	--	--
	VEC	External & Internal	30	9	20	6	50	20	--	--	--	--	--	--
f	Internship/ Apprenticeship	Internal	Assessment of these verticals shall be based on various activities/practices. It shall be evaluated by giving maximum marks of 50 per 2 Credit Course with separate activity weightages/levels. A detailed SOP for this assessment process shall be prescribed separately.											
	FP/CEP													
	CC													

Continuous Assessment Tests (CAT)

For internal assessment, the Continuous Assessment Tests (CAT) shall be conducted as under-

- i. Three CAT each of 8 / 10 Marks (Theory) as applicable and 10 Marks (Practical).
 - First on completion of 25% Syllabus of the course or on completion of 25 teaching days,
 - Second on completion of 50% Syllabus of the course or on completion of 50 teaching days,
 - Third on completion of 75% Syllabus of the course or on completion of 75 teaching days.
- ii. Each concurrent assessment (CAT-I, II & III) will be mapped to relevant Course Learning Outcome.
- iii. Total Performance in CAT (i.e. 40 %) shall be based on the **best two out of three** in CAT examinations
- iv. Internal assessment shall be carried out by the respective course teacher by choosing variety of assessment tools/methods such as class test, record book, seminar, case study, field work, mini project work, quiz or any innovative method, which may be deemed to be appropriate for assessing the relevant course outcome.

Conduction of the Examination:

As per the scheme of teaching, learning, examination and evaluation, theory/practical examinations of Semester-I, II, III, IV, V, VI, VII and VIII shall be conducted by the University (except for Internal Examinations as applicable) at the end of each semester.

The theory/practical examinations of all the Semesters shall be held as per the following Schedule –

Sr. No.	Name of the Examination	End Sem Examination	Supplementary Examination*
1	Semester-I, III, V and VII	Winter	Summer
2	Semester-II, IV, VI and VIII	Summer	Winter

* The University may evolve mechanism for conducting repeat end semester examination. Such repeat examinations shall have to be conducted within one month of the regular even semester examination and on demand examination.

1. The practical examination of all semesters shall be conducted by the University at the end of each semester. The HEI shall conduct the Practical examination of odd semesters as per the schedule announced by the University. **However, the appointment of the External and Internal Examiners shall be done by the Head or Principal of respective HEI to conduct external examination of the odd semester and the same should be communicated to the University before commencement of the practical examination.** The University shall conduct the external practical examination of all even semester by appointing external and internal examiners.
2. The examinations specified above shall be held twice in a year at such places and on such dates as may be prescribed by the University.
3. An applicant to an examination specified above, shall pursue a regular course of study in courses prescribed for the examination concerned for not less than one semester in a particular semester in a College/Institute/University department.
4. Provided that the student shall be eligible to appear for examination if -
 - a. He/she complies with the provisions of the Ordinance pertaining to the Examination in general from time to time.
 - b. He/she has prosecuted a regular course of study in a university department/college affiliated to the University.
 - c. He/she has in the opinion of the Principles shown satisfactory progress in his/her studies.
5. The provisions of Ordinance No. 6 and Ordinance No. 9 shall be *mutatis-mutandis* applicable to every collegiate/non-collegiate student.
6. The fees for each theory examination and practical examination conducted by the university shall be as prescribed by the University, from time to time.

THREE YEAR UNDERGRADUATE PROGRAMME

B.Sc. BOTANY

FACULTY: SCIENCE AND TECHNOLOGY

SEMESTER – I

The Vertical	Type of Course	Course Code	Course Name
Major / Minor	Theory1	107201	Foundations of Plant Science and Career Development
	Lab/Practical-1	107202	Foundations and Prospects of Plant Science
Minor / Major	Theory1	-	-
	Lab/Practical-1	-	-
Generic/Open Elective	Theory1	107203	Plant Health Care
	Theory2	107204	Kitchen Gardening
VSC	-	-	-
SEC	Lab/Practical-2	107205	Medicinal Plant Cultivation and Processing
AEC - English	Theory		Refer University basket
AEC –MIL	Theory		Refer University basket
IKS-Generic	Theory		Refer University basket
VEC	Theory		Refer University basket
CC	Outdoor		Separate SOP will be released

Major/Minor Theory- Foundations of Plant Science and Career Development

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	I	107201	Foundations of Plant Science and Career Development	2	30	2 Hrs	30 (Ext)+20 (Int)

Course Objectives: 1. To Provide a Comprehensive Understanding of Plant Biology and Botany 2. To Develop Practical Skills in Plant Science Research and Application 3. To Explore the Role of Plants in Society and Industry 4. To Prepare Students for Career and Further Educational Opportunities				
Course Outcomes: After successful completion of this course students will be able to – CO 1: Students will be able to recall key historical milestones in botany, basic concepts of plant diversity, taxonomy, and systematics, and foundational knowledge of plant physiology and cell biology. CO 2: Students will demonstrate an understanding of how plants interact with their environment, the role of plants in agriculture and various industries, and the impacts of plants on environmental issues such as climate change and pollution. CO 3: Students will apply their knowledge of plant sciences to explore opportunities for advanced studies and careers in the corporate world, including preparation for competitive examinations and understanding the skills required in plant-based industries. CO 4: Students will analyze and critically evaluate modern concepts in plant sciences such as CRISPR/Cas9, synthetic biology, and the application of AI in plant phenotyping, along with the ethical and legal aspects of these innovations. CO 5: Students will be able to assess the effectiveness of innovative plant science technologies like artificial photosynthesis, hydrogen fuel harvesting, and plant-based meat alternatives, and make informed judgments about their potential impact on society and the environment. CO 6: Students will synthesize their knowledge and skills to develop original ideas or approaches in plant sciences, potentially leading to entrepreneurial opportunities or novel research projects. They will also demonstrate proficiency in communicating their scientific ideas effectively through writing and presentations.				
Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	1.1: Bridging Knowledge of Lower Classes, Historical context of Botany and its importance in the modern world, Basics of Diversity, Taxonomy and Systematics	8	8	Suitable pedagogic al strategies are separately annexed
	1.2: Plant interactions with their environment, (including ecosystems), Fundamentals of Physiological Process (Photosynthesis, respiration, plant hormones, and growth regulation)			
	1.3: Cell and Molecular Biology for Understanding plant cell structure, organelles, Differences from other living cells, Transformation of Phenotype from Genotype			
	1.4: Plant Breeding and Genetic Engineering, Mendelian inheritance, Modern plant breeding techniques, Creation of Genetically Modified Crops			

Unit II	2.1: Agricultural Botany, Role of plants in Agriculture, crop improvement programs, and Sustainable practices.	7	7	
	2.2: Plants as an Industry, Biomolecular, Food, Medicinal, Biofuels, Biomaterials, etc.			
	2.3: Environmental Botany, Impact Assessment, Climate Change and Pollution			
	2.4: Ultramodern Concepts in Plant Sciences, CRISPR/Cas9 and Advanced Genetic Editing, Synthetic Biology, Plant Neurobiology, Phenomics and High-Throughput Plant Phenotyping using Artificial Intelligence (AI)			
Unit III	3.1: Opportunities for Higher Studies in Master and Doctoral, Top Institutes of India and Abroad	8	8	
	3.2: Readiness for entry in to Corporate World of Industries, Plant based industries and their skills demands			
	3.3: Exploration of various lines of Research, prominent research institutes of National and International repute and their research contributions			
	3.4: Competitive Examinations for Plant Sciences, Entrance Exams for Higher Studies, International Flyers, and Entry in Services (Public and Corporate)			
Unit IV	4.1: Innovation in Plant Sciences like - Artificial Photosynthesis, Hydrogen Fuel Harvesting, Edible Vaccines, Phytoremediation, Biofortification, Plant-based Meat Alternatives, Responsive “Smart” Plants, etc.	7	7	
	4.2: Entrepreneurship Opportunities, Scope and Projections, Local and international Business (Case Study - One Each)			
	4.3: Communication Skills viz. Writing scientific papers, presenting research, and public speaking			
	4.4: Fellowships and Scholarships for Botany students.			

References:

DIGITAL RESOURCES:

- <http://www.theplantlist.org/> A comprehensive database of plant taxonomy and systematics.
- <https://www.plantae.org/> Webinars and educational resources on various plant biology topics.
- <https://www.ibiology.org/plant-biology/> iBiology Plant Biology Talks and lectures by leading researchers in plant cell and molecular biology.
- <https://www.nature.com/subjects/plant-sciences> Access to articles and latest research in plant science.
- <http://www.fao.org/elearning/#/elc/en> Courses on crop improvement and genetic engineering by FAO e-learning Centre.
- <https://gmoanswers.com/> Resource for information on genetically modified crops.
- AgriMOOC by AgriLife Learn: Online courses on modern agriculture, crop improvement, and sustainability.
- <https://www.sare.org/> Resources and courses on sustainable agricultural practices especially for Sustainable Agriculture Research & Education.

- <https://www.biotecharticles.com/> Articles on plant biotechnology in various industries.
- <https://plantbasednews.org/> Latest news and developments in plant-based industries.
- <https://www.environmentalscience.org/> E-content on environmental botany and related topics.
- <https://www.ted.com/topics/climate+change> Inspirational TED Talks on Climate Change and talks related to plants and environmental issues.
- Synthetic Biology MOOC by edX: Online course on synthetic biology, including plant applications.
- <https://www.plantae.org/research/crispr/> Information and updates on CRISPR technology in plants as Plantae's CRISPR Resources.
- <https://www.scholarship-positions.com/> Information on scholarships for higher studies in plant sciences.
- <https://www.linkedin.com/learning/> Courses on career development and industry readiness on LinkedIn Learning.
- <https://www.researchgate.net/> Platform to explore research papers and contributions from various institutes on ResearchGate.
- <https://www.kaggle.com/> Data science competitions and datasets relevant to plant sciences.
- <https://ocw.mit.edu/index.htm> Free course materials on topics like innovation and entrepreneurship by MIT Open Course Ware.
- <https://www.scidev.net/global/> Articles on science communication and the ethics of scientific research by SciDev.Net.

REFERENCE BOOKS, TEXT BOOKS, RESEARCH ARTICLES:

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National Case Studies:

- Patanjali Ayurved Limited
- Amul's Fodder Development Programs
- Nurture.Farm:
- Barrix Agro Sciences
- Tata Coffee's Sustainable Practices
- Padma Shri Subhash Palekar's Zero Budget Natural Farming (ZBNF)
- Sikkim's Organic Farming Revolution
- Punjab's Happy Seeder Innovation for Stubble Management
- Kerala's Jackfruit Revolution by James Joseph

International Case Studies:

- Netherlands' Greenhouse Horticulture
- Australia's Bush Heritage:
- Israel's Agricultural Innovation
- China's Medicinal Plant Industry and Traditional Chinese Medicine
- Costa Rica's Reforestation Efforts and Ecotourism

Model Questions:

Short Type Questions

1. Describe how the understanding of plant taxonomy and systematics has evolved from historical times to the modern era.
2. Explain how plant hormones affect growth regulation in response to environmental stimuli.
3. Outline the role of sustainable practices in modern agricultural botany.
4. Identify two key industries that significantly benefit from plant biomolecular research.
5. List two renowned institutes in India known for their advanced research in plant sciences.
6. Describe a key skill demanded by plant-based industries in today's corporate world.
7. Explain the concept of biofortification and its significance in addressing nutritional deficiencies.
8. Discuss one local and one international business that have successfully incorporated plant science innovations.

Long Type Question

1. Discuss the role of cell and molecular biology in understanding the transformation of phenotype from genotype in plants, with specific examples.
2. Evaluate the impact of climate change on plant species diversity and the role of environmental Botany in assessing this impact.
3. Discuss the role of prominent research institutes in shaping the future of plant science research, with examples of their contributions.
4. Elaborate on the importance of communication skills in disseminating plant science research, including both written and verbal forms.

Multiple Choice Questions (MCQs)

- 1. Which Mendelian principle is demonstrated when different genes independently separate from each other during the formation of gametes?**

A) Law of Segregation B) Law of Independent Assortment C) Law of Dominance D) Law of Uniformity

- 2. Genetically Modified Crops are primarily created to:**

A) Increase shelf life B) Enhance nutritional content C) Improve resistance to pests D) All of the above

- 3. CRISPR/Cas9 technology is primarily used for:**

A) Plant breeding B) Genome editing C) Enhancing photosynthesis D) Producing biofuels

- 4. Phenomics in plant science typically involves:**

A) Studying plant genetics B) Analyzing plant phenotype using AI C) Mapping plant ecosystems D) Developing synthetic biology applications

- 5. Entrance exams for higher studies in plant sciences often test knowledge in:**

A) Plant physiology and biochemistry B) Agricultural economics C) Basic mathematics D) World history

- 6. A career in public services related to plant science may involve roles in:**

A) Biotechnology firms B) Agricultural policy development C) Corporate sales D) IT services

- 7. Ethical considerations in plant genetic engineering include concerns about:**

A) Food safety B) Environmental impact C) Cross-breeding with wild species D) All of the above

- 8. Legal aspects in plant sciences primarily deal with:**

A) Patent laws B) Labor laws C) Taxation D) Import/export regulations

Pedagogical Strategies

To effectively teach and evaluate the course "Foundations of Plant Science and Career Development," a blend of classical and contemporary pedagogical strategies is essential. These strategies should be tailored to enhance the delivery and comprehension of the course content within each unit, aligning with the educational objectives and learning outcomes.

Teachers may adopt any one of the strategies suggested below as the time, space and classroom situations permits -

Unit I: Foundations of Botany and Plant Biology

1. Flipped Classroom Approach:

- Pre-class Assignments: Reading materials and video lectures on basic botany concepts.
- In-class Activities: Discussion forums, Q&A sessions, and interactive quizzes.

2. Project-Based Learning:

- Students can undertake projects on local flora, analyzing diversity, taxonomy, and systematics.
- Field trips to botanical gardens for practical taxonomy exercises.

3. Case Studies and Problem-Based Learning:

- Use case studies to explore historical and modern developments in botany.
- Problem-solving sessions focused on ecological challenges and physiological processes of plants.

4. Laboratory Work and Hands-on Experiments:

- Practical sessions on cell and molecular biology, including microscopy and genetic experiments.
- Experiments to observe physiological processes like photosynthesis and respiration.

Unit II: Applied Plant Sciences and Industry Perspectives

1. Interactive Lectures with Guest Speakers:

- Invite industry experts to discuss the role of plants in various industries.
- Seminars on agricultural botany and sustainable practices.

2. Group Projects and Collaborative Research:

- Students work in groups on projects related to environmental botany, crop improvement, or plant-based industries.
- Collaborative research projects using online databases and scientific literature.

3. Simulation and Modeling:

- Use of software tools to simulate genetic editing and plant breeding techniques.
- AI and Machine Learning models to understand phenomics and high-throughput phenotyping.

4. Virtual Field Trips and E-learning Tools:

- Virtual tours of biotech companies and agricultural fields.
- Online resources and interactive modules for learning advanced concepts.

Unit III: Career Development and Research Opportunities

1. Workshops and Career Counseling Sessions:

- Workshops on career planning, higher study opportunities, and understanding the corporate world in plant sciences.
- Counseling sessions focusing on skill development for industry readiness.

2. Mock Interviews and Resume Building Workshops:

- Practice sessions for competitive examinations and entrance tests.
- Guidance on building a professional resume and portfolio.

3. Research Paper Analysis and Group Discussions:

- Analyzing and discussing research papers from leading plant science institutes.
- Group discussions on various lines of research and their contributions.

4. Networking Events and Industry Visits:

- Organize networking events with alumni and professionals in the field.

- Visits to research institutes and corporate offices in the plant science sector.

Unit IV: Innovation, Communication, and Ethics in Plant Sciences

1. Case-Based Learning and Role-Playing:

- Case studies on innovations in plant sciences.
- Role-playing exercises to explore ethical dilemmas and legal aspects in biotechnology.

2. Entrepreneurship Workshops:

- Workshops on starting a business in plant-based industries, including case studies and market analysis.
- Pitching sessions for hypothetical start-up ideas.

3. Communication Skills Development:

- Training sessions on scientific writing, public speaking, and presentation skills.
- Conduct mock conferences where students present research papers or reviews.

4. Debate and Discussion Forums:

- Organize debates on controversial topics like GMOs, biofortification, and plant-based meat alternatives.
- Discussion forums to reflect on ethical, legal, and societal implications of plant science innovations.

Each of these strategies aims to engage students actively, foster critical thinking, and provide practical skills relevant to their future careers in plant sciences. Integrating these diverse teaching methods will cater to different learning styles and ensure a comprehensive understanding of the course material.

Lab / Practical – I: Foundations and Prospects of Plant Science

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	I	107202	Foundations and Prospects of Plant Science	2	60	4 Hrs	25 (Ext)+25 (Int)

Course Objectives:	1. Interdisciplinary Integration and Application: To foster an interdisciplinary approach by integrating principles from botany, microbiology, biotechnology, and environmental sciences. This will be achieved through collaborative projects and assignments that require students to apply concepts from these varied disciplines to solve complex problems in plant and microbial sciences. The aim is to encourage a holistic understanding of science that transcends traditional disciplinary boundaries, in line with NEP 2020's emphasis on broad-based, flexible learning. 2. Skill Development through Hands-On and Experiential Learning: To prioritize hands-on learning and practical skills development through extensive lab work, field visits, and the use of modern technologies like AI in plant sciences. This objective is designed to ensure that students not only understand theoretical concepts but are also proficient in practical applications and laboratory techniques. This aligns with NEP 2020's focus on skill development, ensuring that graduates are well-prepared for the workforce and research opportunities. 3. Promotion of Critical Thinking and Ethical Reasoning: To encourage critical thinking and ethical reasoning among students by engaging them in discussions and debates on contemporary issues in plant sciences, such as the use of GMOs, biopiracy, and the ethical implications of genetic engineering. Assignments and projects will be designed to challenge students to consider and evaluate the social, ethical, and environmental impacts of scientific advancements. This objective aligns with NEP 2020's emphasis on developing critical thinking and ethical and moral reasoning.
Course Outcomes:	Integrated Course Outcomes for Lab Course based on Major Theory Papers CO 1: Students will gain hands-on experience in both plant and microbial sciences, mastering techniques such as microscopic examination of plant cells and microbial structures, DNA extraction, and the study of photosynthesis and microbial diversity. CO 2: Engage in analytical exercises to interpret data from plant-based experiments, like respiration and seed germination, as well as microbial studies, including the observation of Bacteria, Fungi, and Viruses, fostering a deep understanding of biological processes. CO 3: Critically evaluate the impact and ethical considerations of modern biotechnologies such as genetic engineering, CRISPR in plants, and bacteriophage therapy, integrating knowledge from both plant and microbial sciences.

	CO 4: Encourage creativity by having students develop innovative research proposals or projects that blend concepts from plant and microbial sciences, such as using AI for plant phenotyping or designing experiments for studying plant-microbe interactions. CO 5: Develop communication skills through group activities like debates on GMOs and bio-piracy, presentations on disease management strategies, and collaboration in laboratory settings, ensuring an equitable emphasis on topics from both courses. CO 6: Apply theoretical knowledge to real-world situations through activities like field visits to botanical gardens or microbial cultivation projects, and engage in problem-solving exercises such as diagnosing plant diseases and designing Ecofriendly disease management strategies.
Contents	Incorporation of Pedagogies
Practical and Activities based on Major Theory Paper 1 Foundations of Plant Science and Career Development: Major Experiments: Conduct at least Seven Exercises from the following: 1. Microscopic Examination of Plant Cells and Tissues such as – Epidermal, Parenchyma, Sclerenchyma, Collenchyma, Xylem, Phloem, etc. 2. Study of different groups of plants on the basis of thallus structure- Algae, Fungi, Bryophytes and Pteridophytes 3. To study the vegetative and Floral parts of Monocot and Dicot Plant (One each) 4. To study Morphology and Taxonomy of any five medicinal plants (locally available) 5. To study the phenomenon of photosynthesis under different light conditions 6. To Study the Terrestrial and Aquatic Ecosystem (One Each) 7. To Study the Phenomenon of respiration using different substrates 8. Extraction of the DNA by Crude Method 9. To Study of the Process of Seed Germination 10. To Conduct Self and Cross Pollination 11. Phenological study of Any One Plant Species 12. Discuss and analyze case studies of CRISPR use in plants 13. To Study any one Patent Granted in the Plant Sciences 14. To Study any one Research Paper Published in the Plant Sciences Minor Experiments: Conduct at least Three Exercises from the following: 1. To study plant cell and organelles through model or animation or image. 2. Virtual protocol of Genetic Engineering for desired trait induction 3. To Develop a Mock Business Plan for a plant-based startup 4. Application of Artificial Intelligence (AI) in Plant Sciences 5. To study Ecosystem model depicting energy transformations 6. To simulate the role of Plants Hormones in Plant Growth 7. Construction of the Model: Plants as an Industry	Suitable pedagogical strategies are separately annexed

Activities: Conduct Any One or Two Activities from the following- 1. Organize debates or discussions on ethical dilemmas in plant sciences, such as GMOs or biopiracy 2. Analyze and present case studies on topics like Artificial Photosynthesis / Hydrogen Harvesting from Photosynthesis, Biofortification 3. Use AI software tools for image-based plant phenotyping to study plant traits. 4. Simulate the industrial processes for essential oils extraction / pigments / flavors from plant materials 5. Field visits to sustainable Business Ventures for Cultivation of the Medicinal Plants / Plant Product / Extraction Industry, etc.	
Digital Resources: • Amrita Vishwa Vidyapeetham & Virtual Labs - MHRD. (n.d.). Amrita Virtual Lab. Retrieved from http://vlab.amrita.edu/ • BioInteractive. (n.d.). Howard Hughes Medical Institute. Retrieved from https://www.biointeractive.org/ • Bioman Biology. (n.d.). Virtual Biology Labs. Retrieved from https://www.biomanbio.com/HTML5GamesandLabs/LabBiolabs.html • Coursera. (n.d.). Plant Science: An Introduction to Botany. Retrieved from https://www.coursera.org/learn/plant-science • EdX. (n.d.). Introduction to Plant Science. Retrieved from https://www.edx.org/ • Khan Academy. (n.d.). Biology. Retrieved from https://www.khanacademy.org/science/biology • Labster. (n.d.). Virtual Lab Simulations for Biology. Retrieved from https://www.labster.com/simulations/biology/ • Learn Genetics. (n.d.). Virtual Labs. University of Utah. Retrieved from https://learn.genetics.utah.edu/content/labs/ • Microbiology Online. (n.d.). Society for General Microbiology. Retrieved from https://microbiologyonline.org/ • PhET Interactive Simulations. (n.d.). University of Colorado Boulder. Retrieved from https://phet.colorado.edu/ • PlantFacts. (n.d.). Ohio State University. Retrieved from https://plantfacts.osu.edu/ • PlantingScience. (n.d.). Retrieved from https://www.plantingscience.org/ • The Concord Consortium. (n.d.). Planting Science. Retrieved from https://concord.org/our-work/research-projects/planting-science/ • The Plant Cell. (n.d.). Teaching Tools in Plant Biology. Retrieved from https://www.plantcell.org/ • The Science Bank. (n.d.). Virtual Plant Lab. Retrieved from https://thesciencebank.org/virtual-plant-lab • Virtual Labs. (n.d.). National Science Foundation. Retrieved from http://virtuallabs.stanford.edu/	

Question Paper for External Practical Course on Foundations and Prospects of Plant Science

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. I (Botany), SEMESTER – I (NEP)				
Lab/ Practical-1	Course Code: 107202	Foundations and Prospects of Plant Science	Max Marks: 25	Time: 4 Hrs.
Q.No.	Exercise			Marks
1.	Identification of the Cell types from the given Plant Sample			5
2.	Perform any One Exercise from Physiological Experiments			5
3.	Perform any One Exercise from Molecular Biology or AI			5
4.	Perform any One Exercise from Morphology and Taxonomy of any Medicinal plant.			5
5.	External Viva Voce			5

Assessment Rubric for Internal Practical Course on Foundations and Prospects of Plant Science

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. I (Botany), SEMESTER – I (NEP)			
Lab/Practical- 1	Course Code: 107202	Foundations and Prospects of Plant Science	Max Marks: 25
S. No.	Assessment Criteria		Marks
1	Record/ Assignments		5
2	Attendance		5
3	Participation in Activity/ Field visit		5
4	Students overall performance		5
5	Internal Viva Voce		5

GOEC Theory: Plant Health Care

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	I	107203	Plant Health Care	2	30	2 Hrs	30 (Ext)+20 (Int)

Course Objectives:	1. To Learn about significance of plant health 2. To learn about techniques of plant health care			
Course Outcomes:	CO 1: Students will be able to Recognize importance of plant health management. CO 2: Students will be able to classify plant diseases. CO 3: Students will apply knowledge to cure plant diseases and deficiency disorders. CO 4: Students will be able to categorize types of pest and weeds. CO 5: students will be able to plan strategies of integrated pest management. CO 6: Students will be able to develop their own plant pathology lab.			
Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Plant Health care and Plant Diseases	8	8	Suitable pedagogical strategies are separately annexed
	1.1 Introduction to Plant health care and its objectives in Home Garden, Kitchen Garden, Horticulture and Agriculture. Definition and concept of Plant disease.			
	1.2 Terminologies in plant Pathology – Host, Pathogen, Pathogenicity, Pathogenesis, Symptoms, Infection, Inoculation, Isolation, Incubation period, Etiology, Susceptibility, Immunity, Hypersensitivity and Resistance.			
	1.3 Classification of Plant Diseases – Based on a) Pathogens, b) Symptoms, c) Mode of transmission of pathogens through seed, soil, air and insects.			
	1.4 Factors affecting plant health.			
Unit II	Plant nutrients and Diseases	7	7	
	2.1 Pest-disease: definition, causes of pest outbreak, losses caused by insect pests, Categories of pests: Major pests, minor pests. Symptoms of damage and Management of some pests diseases.			
	2.2 Plant Diseases: Brief account on major types of plant diseases caused by Fungi, Bacteria and Viruses.			
	2.3 Role of Essential Nutrients in plant growth & development, critical nutrients, Critical concentration, nutrient toxicity.			
	2.4 Nutrient deficiencies diseases: 1) stunted growth; 2) chlorosis; 3) interveinal chlorosis; 4) necrosis.			
Unit III	Methods of Management of Insect pests and diseases.	8	8	
	3.1 Chemical Methods: Brief account and uses of Bactericides, Fungicides, Insecticides and Nematicides.			

	3.2 Biological Control: Introduction, biological control of Insect pests and diseases.			
	3.3 Legal (Plant - quarantine): Introduction, domestic quarantine and need of plant Quarantine in India			
	3.4 Weeds – types and classification; invasive species; weed control, common weeds of important medicinal plants.			
Unit IV	Integrated Plant management	7	7	
	4.1 Introduction to principles of integrated plant disease management			
	4.2 Scope and importance of integrated pest management (IPM).			
	4.3 Tools of pest management, their description and usage in IPM programs.			
	4.4 Biological and biotechnological approaches in disease management. Crop Resistance: General account of use of resistant varieties			
	4.5 Green pesticides / Botanical Pesticide: Definition, Preparation of pesticide from Neem, Chrysanthemum, and Tobacco. Advantages of use of Botanical pesticide or green pesticide			
Suggested Activities:				
Garden Walk: Organize a field trip to a local garden (could be a home garden, kitchen garden, or agricultural field) to identify various plants and discuss their health care requirements, focusing on the objectives of plant health care in different settings. Symptom Analysis Workshop: Students will examine plant specimens or images showing various disease symptoms and practice identifying the diseases based on the terminologies learned (e.g., pathogenicity, symptoms, infection). Pathogen Classification Activity: Using a mix of multimedia resources and real specimens, students classify plant diseases based on pathogens, symptoms, and mode of transmission, creating a visual chart or digital presentation. Environmental Factors Lab: Experiment to understand how different environmental factors (e.g., humidity, temperature, soil pH) affect plant health, focusing on a selected few plant species. Pest and Disease Management Planning: Students will select a crop and research pest-disease management strategies, creating a management plan that addresses identification, causes, and management of pests and diseases. Nutrient Deficiency Experiment: Set up an experiment to study the effects of nutrient deficiencies on plant growth. Students will grow plants under controlled conditions with varying levels of critical nutrients and document the symptoms. Disease Case Studies: Analyze case studies of major plant diseases caused by fungi, bacteria, and viruses, focusing on symptoms, transmission, and impact on plant health. Chemical vs. Biological Control Debate: Facilitate a debate or discussion on the use of chemical versus biological control methods, encouraging students to research and present arguments based on scientific evidence and case studies. Weed Identification and Control Activity: Organize a field trip or laboratory session for students to identify common weeds and invasive species, followed by a workshop on modern weed control techniques, including both chemical and non-chemical methods. Green Pesticide Workshop: Students participate in a workshop to prepare and test botanical pesticides from Neem, Chrysanthemum, and Tobacco, evaluating their effectiveness in pest control compared to synthetic pesticides.				

These activities are designed to engage students in practical and theoretical aspects of plant health care and disease management, fostering a comprehensive understanding of the subject matter through active learning and application.

References:

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4. Mandahar, C L, 1987: Introduction of Plant Virus
5. Chatterjee, P.B. 1997. Plant Protection Techniques. Bharati Bhawan (Publishers and Distributors), Patna
6. Matthews, G.A. 1979, Pesticide Application Method. Longman, London.
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Model Questions:

Short Type Questions

1. Write note on classification of plant diseases.
2. Write down the tools of pest management
3. write note on significance of plant health
4. Define essential elements and nutrient deficiencies.
5. Enlist the factors affecting plant health.
6. Add detailed note on Crop Resistance
7. Add note on viral plant diseases.
8. Add note on fungal plant diseases.
9. Add note on organic fertilizers.

Long Type Question

1. Explain Chemical and Biological way of disease management.
2. What are the organic fertilizers? Describe the role of organic fertilizers in plant health care.
3. Explain Integrated pest management in detail.
4. Describe biological and biotechnological approaches in disease management.

Multiple Choice Questions (MCQs)

1. What is the term used to describe the ability of a pathogen to cause disease in a host plant?
A) Pathogenicity
B) Pathogenesis
C) Symptoms
D) Etiology
2. Which term refers to the period between pathogen invasion and the appearance of disease symptoms in a plant?
A) Inoculation
B) Isolation
C) Incubation period
D) Immunity
3. Which category of pests causes the most significant damage among plants?
A) Major pests
B) Minor pests
C) Insects
D) Bacteria
4. What are the primary types of plant diseases caused by pathogens?
A) Fungi, insects, and Bacteria
B) Fungi, Bacteria, and Viruses

- C) Viruses, insects, and nematodes
D) Insects, Bacteria, and nematodes

5. Which method of pest control involves the use of Bactericides, Fungicides, and Insecticides?

- A) Chemical Methods
B) Biological Control
C) Plant Quarantine
D) Weed Control

6. What is the primary purpose of domestic quarantine in plant health care?

- A) Introduction of new species
B) Regulating trade
C) Managing biological control
D) Protecting native plants

7. What is the primary emphasis of Integrated Pest Management (IPM)?

- A) Exclusively using biological control
B) Minimizing chemical use
C) Eradicating all pests
D) Using only resistant plant varieties

8. Which approach in disease management involves using substances derived from Neem, Chrysanthemum, and Tobacco?

- A) Chemical pesticides
B) Biological control
C) Crop resistance
D) Botanical pesticides

Pedagogical Strategies:

1. Concept Mapping and Mind Mapping:

- For Unit Understanding: Create concept maps or mind maps illustrating relationships between concepts like pathogens, symptoms, modes of transmission, and factors affecting plant health. This visual aid helps in understanding and memorization.

2. Interactive Group Discussions:

- For Classification and Terminologies: Organize group discussions focusing on terminologies and classification of plant diseases based on pathogens, symptoms, and modes of transmission. Encourage debates on their significance in plant health care.

3. Case Studies and Real-life Examples:

- For Plant Nutrients and Diseases: Use case studies to illustrate the impact of nutrient deficiencies on plants, linking them to specific diseases like stunted growth, chlorosis, etc. Real-life examples can enhance understanding.

4. Hands-on Practical Activities:

- For Methods of Management: Conduct experiments or demonstrations showcasing the application of chemical methods (safely), biological control, and plant quarantine. This practical engagement reinforces theoretical concepts.

5. Problem-solving Exercises:

- For Integrated Plant Management: Design problem-solving exercises where students integrate knowledge of disease management principles to address hypothetical plant health issues. Encourage critical thinking.

6. Visual Learning Tools:

- For Essential Nutrients and Diseases: Use visual aids like charts, diagrams, and videos to demonstrate the role of essential nutrients in plant growth and connect them to nutrient deficiency diseases.

7. Collaborative Research Projects:

- For Biological and Biotechnological Approaches: Assign research projects exploring biotechnological approaches or the development of resistant varieties. Encourage collaboration and presentations.

8. Field Visits and Guest Lectures:

- For Weeds and Invasive Species: Plan field trips to identify common weeds, invasive species, and their impact on plant health. Invite experts for guest lectures.

GOEC Theory- Kitchen Gardening

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	I	107204	Kitchen Gardening	2	30	2 Hrs	30 (Ext)+20 (Int)

Course Objectives:	1. To Learn about techniques of Kitchen Gardening 2. To learn about importance and types of vegetable, fruit, and medicinal plant cultivation.			
Course Outcomes:	CO 1: Students will be able to illustrate the importance of kitchen gardening and their products. CO 2: Students will be able to understand methods of establishing kitchen gardens. CO 3: Students will apply knowledge to Water, fertilize, prune, maintain, and harvest produce from their home garden. CO 4: Students will be able to categorize fruit and vegetables according to season. CO 5: students will be able to plan crop rotation as per the season. CO 6: Students will be able to develop start their own kitchen garden			
Unit System	Contents	Workload Allotted (Hrs.)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	1.1: History and Development of Gardening in India; Case Studies on AID India's Kitchen Garden Project, Adivasi women’s kitchen gardening project in Western Ghats	8	8	Suitable pedagogical strategies are separately annexed
	1.2: Introduction to kitchen gardening, Gardening tools, Basic materials & machinery required for kitchen garden.			
	1.3: Current status of vegetables in India, cultivation of vegetables, limitations in vegetable cultivation			
	1.4 Scope of Kitchen Gardening. Kitchen gardening products.			
Unit II	2.1: Preparation of Garden site: Selection, size, place of site, Containers, garden equipment	7	7	
	2.2: Organic Farming Approach for Kitchen Garden Sowing, maintenance and harvest practices for roots and tubers, green leafy and green vegetables			
	2.3: Economic Evaluation of Kitchen Garden in order land, tillage, and production.			
	2.4: Different Operations for Maintaining Kitchen Garden viz- Land preparation, Planting, Weeding, Mulching, Irrigation, Staking, Fencing, Harvesting, Plant protection			
Unit III	3.1: Classification of vegetables (according to a source of plant parts and season) 1. Tropical vegetables- sweet potato, eggplant, tomato, okra, spinach etc., 2. Subtropical vegetables- Onion, garlic, sweet corn, pumpkin etc., 3. Temperate vegetables- Cabbage, cauliflower, peas, radish, carrot, beet etc.	8	8	

	3.2: Fruits: 1. Tropical fruits- Dragon fruit, Passion fruit, Jackfruit, Papaya etc., 2. Subtropical fruits- Banana, mango, guava, pineapple etc., 3. Temperate fruits- Apple, plum, pear, strawberry, grapes, blueberries etc.			
	3.3: Medicinal plants: 1. Aloe Vera, 2. Ashwagandha, 3. Brahmi 4. Tulsi, 5. Turmeric, 6. Shatavari, etc.			
	3.4: Micro-greens production, Hydroponics, Vertical farming, Landscaping, and kitchen garden.			
Unit IV	Maintenance & Importance	7	7	
	4.1: Tips for Maintaining a Kitchen Gardening: It includes Vertical growth, triangle shaped planting, use of seasonal plants, harvesting period, shade growing, Rainwater harvesting, and Companion plants.			
	4.2: Importance of organic fertilizers in gardening Composition of organic fertilizers, Benefits of organic fertilizers.			
	4.3: Types and use of growth regulators in Kitchen gardening, water management, Weed Management, & Nutrient management.			
	4.4: Importance of kitchen gardening Kitchen gardening includes the following importance. Recycling of Vegetables and Plant Scraps, Sustainable gardening, Healthier eating, Stress relief, Environmental benefits, financial savings, Fresh Organic Harvest, Nutritious Diet, Purification of Surrounding Air			
Activities: 1. Historical Garden Analysis: Research and present a case study on the history and development of gardening in India, focusing on significant projects like AID India's Kitchen Garden Project or the Adivasi women's kitchen gardening project in the Western Ghats. 2. Garden Tool Workshop: Host a hands-on workshop where students learn to use different gardening tools and machinery, understanding their purposes and maintenance requirements for effective kitchen gardening. 3. Vegetable Cultivation Project: Each student or group selects a vegetable to cultivate from start to finish, documenting the process, challenges, and solutions, including limitations in vegetable cultivation and how they overcame them. 4. Organic Farming Practicum: Implement an organic farming approach in a small garden plot or container, applying sowing, maintenance, and harvest practices for various types of vegetables, emphasizing green leafy and root vegetables. 5. Economic Analysis Assignment: Students conduct an economic evaluation of a kitchen garden project they design, considering land, tillage, production costs, and potential financial savings, leading to a presentation of their findings. 6. Garden Maintenance Simulation: Through a series of practical sessions, students engage in different operations for maintaining a kitchen garden such as land preparation, planting, weeding, mulching, irrigation, and harvesting.				

7. **Vegetable and Fruit Classification Exercise:** Organize a classification exercise where students classify a variety of vegetables and fruits according to the source of plant parts, season, and whether they are tropical, subtropical, or temperate.
8. **Medicinal Plant Workshop:** Create a workshop focusing on the cultivation, uses, and benefits of medicinal plants such as Aloe Vera, Ashwagandha, and Tulsi. This can include practical planting sessions and discussions on their health benefits.
9. **Innovative Gardening Techniques Demo:** Demonstrate and then practice innovative gardening techniques such as micro-greens production, hydroponics, and vertical farming, offering students a glimpse into the future of sustainable gardening.
10. **Sustainable Practices Project:** Students undertake a project to implement sustainable gardening practices, such as rainwater harvesting, the use of organic fertilizers, growth regulators, water, weed, and nutrient management in a kitchen garden setting. This project could culminate in a showcase day where students present their sustainable kitchen garden models and discuss their approaches to healthier eating, stress relief, environmental benefits, and financial savings.

These activities are designed to provide a comprehensive and practical learning experience, covering the theoretical aspects of kitchen gardening as well as hands-on practices that prepare students for real-world applications and innovations in gardening and sustainable agriculture.

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Model Questions:

Short Type Questions

1. What are Microgreens?
2. Explain Different Methods of Kitchen gardening.
3. Explain the environmental benefits of Kitchen Gardening?
4. what is weed management?
5. Differentiate vegetables based on Season.
6. Explain any two medicinal plants & their importance.
7. Explain Vertical Gardening.
8. How the nutrient requirement of the family can be satisfied by Kitchen Garden?

Long Type Question

1. Explain in detail the different methods of establishing a Kitchen Garden.
2. What are organic fertilizers? Describe the role of organic fertilizers in kitchen gardening.
3. What is Hydroponics? Explain the technique of hydroponics?
4. What are the Artificial Gardens?

Multiple Choice Questions (MCQs)

1. By what name is kitchen garden also known as?

- (a). Home garden
- (b). Nutrition garden
- (c). Vegetable garden
- (d). All of the above

2. Which type of vegetable plants are ideal for a kitchen garden?

- (a). Short duration vegetable crop
- (b). Long duration vegetable crop
- (c). Mid duration vegetable crop
- (d). None of the above

3. What is the main purpose of a kitchen garden?

- (a). Self-satisfaction
- (b). Commercial success
- (c). Both a and b
- (d). None of the above

4. Which vegetable variety is ideal?

- (a). Early variety
- (b). Late variety
- (c). Both a and b
- (d). Mid season variety

5. Which of the following is a part of KG?

- (a). Garden path and irrigation canal
- (b). Site for compost and store
- (c). Place for fruit plants and ornamental garden
- (d). All of the above

6. In which direction should the garden be established?

- (a). East-north
- (b). West-north
- (c). East-south
- (d). West-south

7. Which type of fruit-plants are ideal for a kitchen garden?

- (a). Late maturing varieties
- (b). Early maturing varieties
- (c). Mid maturing varieties
- (d). None of the above

8. What should be the required characteristic of a fruit plant?

1. It should be a dwarf variety
2. Less bearing fruit plant
3. Heavy bearer fruit plant
4. Less fruiting duration

- (a). 1, 2 and 3
- (b). Only 2 and 3
- (c). Only 3 and 4
- (d). 1, 2 and 4

Pedagogical Strategies:

1. **Field Visits and Case Studies:** Hands-on visits to successful kitchen gardens and projects, like those involving community initiatives, to bridge theory with real-world application. This encourages a deep understanding of gardening's practical and social aspects.
2. **Interactive Workshops on Tools and Techniques:** Engaging workshops where students get their hands dirty using gardening tools, understanding soil preparation, planting, and maintenance. This hands-on approach solidifies the practical skills necessary for successful gardening.
3. **Project-Based Learning for Garden Creation:** Students create their own mini kitchen gardens, applying concepts from site selection to organic farming practices. This comprehensive project integrates learning objectives into a tangible outcome.
4. **Thematic Gardens for Learning Plant Classification:** Developing sections within a garden to explore the diversity of plant life, from medicinal plants to different vegetable and fruit types. This living lab offers insights into plant care, environmental needs, and the benefits of biodiversity.
5. **Sustainability Projects:** Initiatives that focus on sustainable practices, such as composting, rainwater harvesting, and recycling. These projects highlight the environmental and economic benefits of kitchen gardening, fostering a sense of responsibility towards sustainable living.
6. **Expert Talks and Community Engagement:** Inviting experts to share insights on organic fertilizers, growth regulators, and innovative farming techniques. Additionally, community garden initiatives can serve as a capstone project, emphasizing teamwork, community service, and the practical application of gardening skills.

By focusing on these strategies, teachers will not just teaching gardening; they are nurturing minds to think critically, act sustainably, and appreciate the profound connection between nature and human well-being. Each approach is a step towards a more self-sufficient, environmentally conscious, and healthier society.

Skill Enhancement Course- Medicinal Plant Cultivation and Processing

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	I	107205	Medicinal Plant Cultivation and Processing	2	60	4 Hrs	50

Course Objectives:	1. To create opportunities for medicinal plant grower/student startup 2. To understand cultivation and processing skills of medicinal plants. 3. To promote cultivation of authentic species required for preparation of Ayurvedic, Yoga & naturopathy, Unani, Homeopathy and Siddha formulations. 4. To create awareness and involve local people in contract farming through various pharmacy companies.			
Course Outcomes:	After Completing the Course, the Students will be able to – CO 1: Identify and select site and quality planting material for medicinal plant cultivation CO 2: Undertake cultivation practices for medicinal plants CO 3: Demonstrate the propagation and harvesting techniques CO 4: Apply good harvesting practices and access the quality of medicinal plant produce CO 5: Analyze and compare subsidy and funding agencies for cultivation of medicinal plant CO 6: Design the calendar for cultivation and processing of medicinal plant			
Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Basic concept of cultivation of Medicinal Plant	15	12	Suitable pedagogical strategies are separately annexed
	1.1: Scope, Status and need of medicinal plants cultivation in India			
	1.2: Morphology and parts used of common/ cultivated medicinal plants.			
	1.3: Trade in medicinal plant- usage cum market demand			
	1.4: Good Agricultural Practices (GAP): Scope, principles and standards			
Unit II	Site selection, planting material & propagation techniques	15	12	
	2.1 Site selection & Soil conditions			
	2.2 Planting material – Seeds, Root and Stem cutting & rhizome			
	2.3 Proper identification and selection			
	2.4 Plant Propagation and Technique in Cultivation			
Unit III	Management for cultivation	15	12	
	3.1 Process of Field/ land preparation			
	3.2 Sowing and transplanting methods			
	3.3 Use of Manures and Fertilizers			
	3.4 Irrigation & protection			
Unit IV	Processing & traceability of medicinal Plants	15	14	
	4.1 Harvesting- Season for collection,			
	4.2 Primary processing- Washing, cleaning, sorting, and drying			

	4.3 Storage, Packaging, Transportation and Traceability			
	4.4 Subsidy, Funding agencies, Role of contract farming for cultivation and opportunities for medicinal plant grower			
Practical: Conduct at least THREE Exercises from Each Unit of the following:				
Unit I: 1. Study on Quality Control and Research Contributions in Medicinal Plants. 2. Preparation and Analysis of Locally Available/Cultivated Medicinal Plants List. 3. Characterization and Identification of Five Local/Cultivated Medicinal Plants. 4. Development of a Cultivation Site Map for Medicinal Plants.				
Unit II: 5. Soil Analysis for Medicinal Plant Cultivation. 6. Collection and Selection of Planting Material for Five Medicinal Plants. 7. Propagation Techniques for Selected Planting Materials. 8. Land Preparation Techniques for Medicinal Plant Cultivation. 9. Experimentation with Plant Propagation Using Cutting and Seed Methods.				
Unit III: 10. Study of the land preparation for cultivation of the Medicinal Plants 11. Study of the Sowing methods 12. Study of the transplantation methods 13. Method Assessment of Different Manures and Fertilizers on Medicinal Plants. 14. Determination and Experimentation of Water Demand for Medicinal Plant Cultivation. 15. Implementation and Evaluation of Plant Protection Techniques.				
Unit IV: 16. Identification and Harvesting Techniques for Medicinal Plant Parts. 17. Application of Various Cleaning Methods for Different Medicinal Plant Species. 18. Packaging Techniques for Harvested Medicinal Plant Material. 19. Preparation of a Medicinal Plant Cultivation and Processing Calendar. 20. Analysis of Funding Opportunities from Government & Non-Government Agencies for Medicinal Plant Cultivation.				
Activities (Any two from the following): Field visits 1) Visit to nearest biodiversity rich center. 2) Visit to medicinal plant garden. 3) Visit to different nurseries of medicinal plant. 4) Visit to medicinal plant cultivated farm (locally available) 5) Visit to soil testing/ seed testing laboratories/ research institute. Other activities – 1) Cultivation of minimum 5 medicinal plant in the college campus 2) Packaging of any 2 harvested medicinal plant material with label. 3) Preparation and submission of records of any one medicinal plant cultivated in college campus as per the GAP standard.				
Collaboration/ MoU- Conduct above activities in Collaboration / MoU with any medicinal plant nursery/ NGO/ Institute				
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- <http://m.youtube.com/watch?v=WyOZ14ufzkk>
- <http://m.youtube.com/watch?v=l25E78MSLWU>
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Career Opportunities and Scope:

- Employment in various research institutes and Pharmacy companies Self-employment through –
- Nursery of Medicinal plants.
- Commercially cultivated Medicinal plant.
- Production of Certified plant saplings and seeds.
- Involvement of locals in Contract manufacturing through various pharmacy companies.
- Trained Consultants for Medicinal plant gardens/ nursery Can avail National Medicinal Plant Board Scheme for Medicinal plant nursery and cultivation

Pedagogical Strategies:

1. **Field Experiences and Botanical Excursions:** Direct immersion in environments where medicinal plants are cultivated. This could include visits to local farms practicing sustainable agriculture, botanical gardens, or research institutions. Students can observe and engage with the entire process from cultivation to harvesting, providing real-world context to the theoretical knowledge of medicinal plants' scope, status, and cultivation practices.
2. **Interactive Workshops on Plant Morphology and Propagation:** Hands-on workshops where students learn to identify and use different parts of medicinal plants, along with techniques for planting material preparation (seeds, cuttings, rhizomes) and propagation. Activities like dissecting plants to study their morphology, and practicing propagation techniques, solidify understanding and skills in a tangible, memorable way.
3. **Research Projects on Medicinal Plant Trade and Market Demand:** Assign students to conduct research projects that explore the trade dynamics and market demand for medicinal plants. This could involve analyzing trade data, interviewing stakeholders in the medicinal plant supply chain, or developing case studies on successful medicinal plant marketing strategies. Such projects encourage students to connect economic concepts with the cultivation and trade of medicinal plants.
4. **Practical Application of Good Agricultural Practices (GAP):** Engage students in a project where they apply GAP principles to a real or simulated medicinal plant cultivation scenario. This could include designing a cultivation plan that incorporates sustainable soil management, irrigation, manure, and fertilizer use, as well as pest and disease management strategies. The project could culminate in a presentation or report that evaluates the application of GAP standards in their project, fostering critical thinking and practical skills.
5. **Capstone Project on Processing and Traceability:** A comprehensive project where students apply knowledge from harvesting, processing, storage, packaging, and transportation to create a traceable supply chain for medicinal plants. This project can involve partnerships with local medicinal plant growers or use of simulation tools to design a supply chain model. Incorporating elements like digital traceability systems, sustainable packaging solutions, and analysis of subsidy and funding opportunities, this project would offer students a holistic view of the challenges and opportunities in the medicinal plant industry.

Assessment Rubric for INTERNAL PRACTICAL Course on Medicinal Plant Cultivation and Processing

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. I (Botany), SEMESTER – I (NEP)				
Lab/ Practical-1	Course Code: 107205	Medicinal Plant Cultivation and Processing	Max Marks: 50	Time: 4 Hrs.
S.No.	Assessment Criteria			Marks
1	Performance of Any One Exercise from the List of Experiments			10
2	Performance of the Task on Any One of the List of Activities			10
3	Record/ Assignments			10
4	Attendance			5
5	Participation in Activity/ Field visit			5
6	Students overall performance			5
7	Internal Viva Voce			5

SEMESTER – II

Type of Course	Course Code	Course Name
Theory2	107206	Fundamental Life Processes in Plants
Lab/Practical-4	107207	Hands on Exploration of Life Processes
Theory2		-
Lab/Practical-5		-
Theory3	107208	Floriculture and Value Additions
Theory4	107209	AYUSH
Lab/Practical-6	107210	Commercialization of Medicinal Plant and Products
Lab/Practical-7	107211	Seed Development Technology

Major / Minor Course: Fundamental Life Processes in Plants

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	107206	Fundamental Life Processes in Plants	2	30	2 Hrs	30 (Ext)+20 (Int)

Course Objectives:	1. To illustrate knowledge of plant life process. 2. To deliver molecular understanding of primary and secondary metabolic processes. 3. To present perspectives of the current tools for application in biological system for physiological research. 4. To demonstrate the concept using different activities for building capacity.
Course Outcomes:	After Successful completion of the course, the student will be able to - CO-1: Understand Plant physiology, a sub discipline of Botany concerned with functional aspects of plants. CO-2: Remember all internal metabolic activities of plants. CO-3: Understand Photosynthesis, Transpiration, Respiration, reproduction, and plant growth process. CO-4: Explain the growth and development of plants using additional resources available on the internet using modern ICT tools.

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Fundamentals of Plant Life	8	8	Suitable pedagogical strategies are separately annexed
	1.1: Importance of Water: Role in plant growth and survival; Imbibition, Diffusion, Osmosis, Plasmolysis			
	1.2: Water-Absorbing Systems of the Plants; Organs Structures and their role in water Absorption			
	1.3: Basic Mechanism of Transpiration; Thermoregulation			
	1.4: Essential Elements (Macro and micronutrients) for plant growth; Mechanism of Nutrient uptake			
Unit II	Basic Unit of Life: Plant Cell	7	7	
	2.1: Basics of Plant cell and tissues – structure and function.			
	2.2: Cell organelles: Structure and function of the cell wall, plasma membrane, Mitochondria and Chloroplast.			
	2.3: Cell Differentiation and apoptosis in Plant development			
	2.4: Integration Metabolic Processes - Anabolism and Catabolism			
Unit III	Reproduction in plant	8	8	
	3.1: Vegetative reproduction in plants (Cutting, budding, grafting, Rhizome)			

	3.2: Flower Structure and organs			
	3.3: Pollination - Mechanisms and types			
	3.4: Fertilization and Seed Development			
Unit IV	Plant Growth	7	7	
	4.1: Growth – Definition, characters and growth phases (Sigmoid curve)			
	4.2 Plant Hormones: Physiological role & applications of Auxin, Gibberellins, Cytokinin and Ethylene			
	4.3: Basics of Photoperiodism and Vernalization			
	4.4: Factors Affecting Plant Growth and Development (Water, temperature and soil)			
Activities: 1. Kitchen Imbibition Experiment: Observe imbibition by soaking dry beans or peas in water and measuring their size increase over time. 2. Homemade Water Absorption Model: Create a model using a sponge, straw, and a glass of water to demonstrate how roots absorb water. 3. DIY Transpiration Experiment: Cover a leafy branch of a houseplant with a clear plastic bag and observe condensation to understand transpiration. 4. Edible Cell Model: Use fruits, jelly, and candies to build a model of a plant cell, representing different organelles. 5. Onion Cell Microscopy: Observe onion skin under a microscope or a magnifying glass to identify cell structures. 6. Apoptosis in Leaves Observation: Collect different leaves showing signs of aging or damage and discuss the concept of cell apoptosis. 7. Flower Dissection: Dissect a flower from a home garden or a bought bouquet to study its reproductive organs. 8. Pollination Simulation: Use a paintbrush to transfer pollen from one flower to another, simulating insect pollination. 9. Seed Germination Observation: Plant various seeds in cups and observe their germination and early growth stages. 10. Plant Growth Diary: Document the growth of a houseplant or a sprouting seed, recording observations and measurements. 11. Effect of Light on Plant Growth: Grow plants in different light conditions (sunlight, shade, artificial light) to observe variations in growth. 12. Kitchen Scrap Regrowth: Regrow kitchen scraps (like carrot tops, lettuce bases) in water to observe root development and new growth.				
References: 1. Bidwell, R. G. S. (n.d.). Plant Physiology (Revised ed.). 2. Curtis, H., & Clark, S. E. (n.d.). Introduction to Plant Physiology. 3. Dennis, D. T., Turpin, D. H., Lefebvre, D. D., & Layzell, D. B. (Eds.). (1997). Plant Metabolism (2nd ed.). Longman. 4. Devlin, R. M. (n.d.). Plant Physiology.				

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Model Questions:

Short Type Questions

1. What is Osmosis?
2. Explain structure of flower
3. Explain Vernalization.
4. What is Pollination?
5. Explain the meaning of transpiration.
6. What do you mean by Photoperiodism?
7. Explain Respiration
8. Explain structure of cell.

Long Type Question

1. Explain the mechanism of Transpiration
2. Explain the mechanism of Respiration
3. Explain the sexual reproduction in angiosperm
4. Explain the growth regulator and their types

Multiple Choice Questions (MCQs)

1. In the rainy season, doors get swelled up due to

- (a) Transpiration
- (b) Imbibition
- (c) Diffusion

(d) Respiration

2. Loss of water from plants in the form of water vapor is called _____

a) Surface tension

b) Cohesion

c) Ascent of sap

d) Transpiration

3. Flowers with both androecium and gynoecium are called

a) Bisexual flowers

b) Anther

c) Stamens

d) Unisexual flowers

4. The transfer of pollen from the anther to stigma is called

A) Pollination

b) Fertilization

c) Adoption

d) Diffusion

5. The male reproductive parts of a flower, the stamens, are collectively known as

a) Androecium

b) Filament

c) Anther

c) Gynoecium

6. Name the gas which is important for photosynthesis.

(a) Oxygen

(b) Carbon dioxide

(c) Nitrogen

(d) Carbon Monoxide

6. Leaves are green because they...

(a) Absorb green light

(b) They do not absorb green light but reflect it

(c) They use green light

(d) Absorb and reflect green light

7. Plants purify the air by which process?

(a) Desiccation

(b) Respiration

(c) Photosynthesis

(d) Transpiration

8. The instrument used to measure the growth rate of plants?

(a) Potometer

(b) Auxanometer

(c) Hydrometer

(d) Osmometer

Pedagogical Strategies:

Navigating through the vibrant ecosystem of plant life education, let's cultivate a fertile learning environment with these five experiential and research-based pedagogical strategies:

1. **Interactive Labs and Simulations:** Create a series of lab experiments and computer simulations that allow students to explore the fundamentals of plant life hands-on. For example:

- Conduct experiments on water's role in plant growth, demonstrating imbibition, diffusion, osmosis, and plasmolysis.
 - Use simulations to visualize the water-absorbing systems of plants and the mechanism of nutrient uptake.
 - These activities provide a tangible understanding of abstract concepts, making learning both engaging and effective.
2. **Microscopic Investigations:** Equip students with microscopes to examine the basic unit of life—the cell. Through guided activities, they can:
 - Identify types of cell organelles and plant cells, observing cell differentiation and the process of apoptosis.
 - Explore the metabolic processes of anabolism and catabolism, connecting the microscopic world to the plant's overall life processes.
 - This microscopic journey deepens their understanding of plant biology at the cellular level, bridging the gap between theory and observable reality.
 3. **Garden-based Learning Projects:** Utilize school gardens or collaborate with local botanical gardens to provide practical experiences in plant reproduction and growth. Activities could include:
 - Observing vegetative, asexual, and sexual reproduction in plants, with hands-on opportunities to pollinate flowers manually.
 - Monitoring the development of plants from germination to maturity, investigating the effects of growth regulators, photoperiodism, and vernalization.
 - These real-world experiences help students connect classroom knowledge with living examples, fostering a deeper appreciation for plant biology.
 4. **Research Projects on Plant Growth and Development:** Engage students in research projects that investigate specific aspects of plant growth and development. They could:
 - Experiment with different environmental conditions to study their impact on plant growth, such as varying water levels, nutrient availability, and light exposure.
 - Analyze the role of hormones in plant development or the effects of photoperiodism and vernalization on flowering.
 - These projects encourage critical thinking and scientific inquiry, allowing students to contribute original findings to their understanding of plant biology.
 5. **Exploratory Workshops on Miracles of the Plant World:** Host workshops that delve into the fascinating aspects of plant biology, such as:
 - Interactive sessions on the unique survival strategies of plants, the role of plants in ecosystems, and their importance to human life.
 - Discussions and presentations on groundbreaking research in plant science, exploring topics like genetic modification, plants in space, and sustainable agriculture.
 - These workshops inspire curiosity and wonder about the plant world, motivating students to explore biology beyond the curriculum.

Incorporating these strategies transforms the curriculum into a living, breathing ecosystem of knowledge, where students not only learn about plants but also experience the wonder of their world. By engaging with plant life both theoretically and practically, students cultivate a deep-rooted understanding and appreciation for the complexity and beauty of the natural world.

Lab / Practical – II: Hands on Exploration of Life Processes

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	107207		Hands on Exploration of Life Processes	60	4 Hrs	25 (Ext)+25 (Int)

Course Objectives:	1. To understand processes for plants survival, including key processes such as imbibition, diffusion, osmosis, and plasmolysis. 2. To explore the basic unit of plant life by examining plant cell structures, organelles, and the roles of different cell types, as well as understanding cell differentiation and metabolic processes. 3. To gain insights into various modes of plant reproduction, including vegetative, asexual, and sexual reproduction, and to understand the anatomy of flowers, pollination mechanisms, and seed development. 4. To analyze the characteristics of plant growth from germination to apoptosis, the role of growth regulators and hormones, and the importance of photoperiodism and vernalization in plant development.
Course Outcomes:	CO 1: Identify and describe key processes related to plant-water relations, such as osmosis, diffusion, and plasmolysis. CO 2: Explain the structure and function of various plant cell organelles and differentiate between types of plant cells. CO 3: Conduct experiments to observe plant cell behavior under different conditions and analyze the mechanisms of nutrient uptake. CO 4: Analyze the processes involved in plant reproduction, including flower structure, pollination, and seed development, and compare different methods of plant reproduction. CO 5: Evaluate the role of growth regulators and environmental factors such as photoperiodism and vernalization in plant growth and development. CO 6: Design and execute experiments to demonstrate key concepts in plant physiology, and synthesize findings to explain complex interactions in plant growth and development.

Major Experiments (Perform any SEVEN)

1. Investigating Imbibition, Diffusion, and Osmosis in Plant Tissues
2. Plasmolysis in Plant Cells: Observing Cell Membrane Behavior
3. Examining Water-Absorbing Structures in Plant Roots
4. Mechanisms of Transpiration and Thermoregulation in Plants
5. Role of Macronutrients in Plant Growth: A Case Study
6. To study the effect of Micronutrient Deficiencies (Iron, Magnesium and Zinc) on Plant growth.
7. Nutrient Uptake Mechanisms: Analyzing Root Functionality
8. Microscopic Analysis of Plant Cell Organelles
9. To study the structural differences between various types of plant cells.
10. Observation of Cell Differentiation and Apoptosis in Plant Development
11. Studying Anabolic and Catabolic Processes in Plant Metabolism
12. To study Vegetative Reproduction in Plants using various plant parts (Stem, leaf and root)
13. Anatomy of Flower Structure and Function of Organs
14. Mechanisms and Types of Pollination: A Practical Approach
15. Process of Fertilization and Seed Development in Plants.
16. To study the effect of nitrogen, phosphorus and potassium on the growth and development of plants.
17. To measure the CO₂ compensation point in a plant.
18. To study different types of flowers based on their reproductive structures.

Minor Experiments (Perform any FIVE)

1. Comparing Imbibition Rates in Different Plant Seeds
2. Diffusion Rates in Various Plant Tissues
3. Water Absorption Efficiency in Different Plant Species
4. To study the Phenomenon of Transpiration.
5. Effect of Macronutrient Deficiency on Plant Growth
6. To study the phenomenon of ascent of sap.
7. Apoptosis Observation in Plant Tissue Culture
8. Asexual Reproduction Techniques in Plants
9. Pollination Mechanisms: Self vs. Cross-Pollination
10. Studying Photoperiodism Effects on Plant Flowering.
11. Study of germination of seeds.
12. To study the T. S. of Ovary.

Activities (Perform any Three)

1. Demonstration of Osmosis Using Potato Cores

2. Creating Models of Water-Absorbing Plant Structures
3. Building a Simple Transpiration Experiment Setup
4. Nutrient Solution Preparation for Hydroponic Plants
5. Constructing Plant Cell Models with Different Organelles
6. Comparative Study of Different Plant Cell Types
7. Simple Experiments Demonstrating Plant Metabolism
8. Setting Up Asexual Propagation Methods in the Lab
9. Flower Dissection and Labeling of Flower Parts
10. Photoperiodism Experiment: Tracking Growth Responses

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Educational Software, Databases, etc.

- BioCyc: Encyclopedia of genomes and metabolic pathways. Available at: <https://biocyc.org/>
- KEGG: Kyoto Encyclopedia of Genes and Genomes. Available at: <https://www.genome.jp/kegg/>
- PDB: Protein Data Bank. Available at: <https://www.rcsb.org/>
- PlantGDB: The Plant Genome Database. Available at: <http://www.plantgdb.org/>
- Virtual Lab by Amrita Vishwa Vidyapeetham. Available at: <http://vlab.amrita.edu/?sub=3&brch=64>

Question Paper for External Practical Course on Hands on Exploration of Life Processes

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. I (Botany), SEMESTER – II (NEP)				
Lab/ Practical-3	Course Code: 107207	Hands on Exploration of Life Processes	Max Marks: 25	Time: 4 Hrs.
Q.No.	Exercise			Marks
1.	Perform Any One Major Experiment based on Physiological Processes			5
2.	Perform any One Exercise based on Microscopic observations			5
3.	Perform any One Exercise from Minor Experiments			5
4.	Spotting (Five Spots carrying 01 Mark from the entire curriculum)			5
5.	External Viva Voce			5

Assessment Rubric for Internal Practical Course on Hands on Exploration of Life Processes

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. I (Botany), SEMESTER – II (NEP)			
Lab/Practical- 1	Course Code: 107207	Hands on Exploration of Life Processes	Max Marks: 25
S. No.	Assessment Criteria		Marks
1	Record/ Assignments		5
2	Attendance		5
3	Participation in Activity/ Field visit		5
4	Students overall performance		5
5	Internal Viva Voce		5

GOEC Course- Floriculture and Value Additions

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	107208	Floriculture and Value Additions	2	30	2 Hrs.	30 (Ext)+20 (Int)

Course Objectives:	1. To learn cultivation practices in floriculture. 2. To develop proficiency in propagation techniques for flowering plants. 3. To identify the diseases and apply management strategies. 4. To deal in value addition and marketing of floriculture products. 5. To explore career opportunities in Floriculture.
Course Outcomes:	CO 1: Students will be able to understand and remember the scope of floriculture and value additions. CO 2: Students will demonstrate a working knowledge and appreciation of the diversity of plants. CO 3: Students will be able to apply floricultural principles to the successful growth and production of plants. CO 4: Students will acquire the required skills and analyze the economic aspects of the floriculture industry in value addition. CO 5: Students will be able to assess the value additions in floriculture and the potential of flowers in perfume, food, medicinal, and dye making. CO 6: Students will be capable of establishing a floriculture unit from planting to harvest and synthesize value-added products from flower crops for marketing.

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	1.1: Introduction to Floriculture: Definition, Importance, and scope of floriculture, Classification as per flowering season.	8	8	Suitable pedagogical strategies are separately annexed
	1.2: Environmental factors affecting crop growth; Post-harvest handling of Cut Flowers; pre-cooling, pulsing, packing, storage and transportation,			
	1.3: Facilities for commercial flower production; marketing and export potential. Identification of garden tools.			
	1.4: Commercial floriculture in India; Career opportunities in Floriculture			
Unit II	2.1: Cultivation practices of important flower crops: Plant propagation techniques: Vegetative methods- Rhizome, Corm, Bulb, Sucker, Offset, Tuber, Bulbils, etc. Artificial methods-Budding, Grafting, Cutting, Layering.	7	7	
	2.2: Cultivation of - Rose (<i>Rosa grandiflora</i>), Shevanti (<i>Chrysanthemum ver.</i>)			
	2.3: Pest and Disease Management of Rose and Shevanti.			

	2.4: Government Schemes, Programmes, and Policies for capacity building of farmers and entrepreneurs.			
Unit III	3.1: Value Additions: Concept and importance of value addition in floriculture. Product, Service-oriented, and Customer-Centric value Addition.	8	8	
	3.2: Properties of flowers for perfume and cosmetic production. Extraction techniques and application of floral essences in fragrance and skincare products. Example: - Rose (<i>Rosa centifolia</i>).			
	3.3: Product Development and Processing Techniques: Perfumes and Extracts; Processing methods: Cold Storage and Hydration and Conditioning.			
	3.4: Business opportunities in, Cosmetics, Perfumes and Aromatherapy. Resin Art.			
Unit IV	4.1: Medicinal and Therapeutic Applications: Extraction methods for creating herbal remedies, teas and natural health products. <i>Calendula</i> , <i>Hibiscus</i> , Rose	7	7	
	4.2: Culinary Delights: Edible products – “ <i>Gulkand</i> ” (Rose Petal Jam) Making Process, its Nutritional and Medicinal Value.			
	4.3: Natural Dyes from Traditional Flowers Color potentials of flowers. Dye extraction and application on different materials. Example: Chrysanthemum and local flowers e.g. Palas (<i>Butea monosperma</i>).			
	4.4: Case Studies and Practical Applications: Showcasing successful ventures and utilizing these specific flowers for value addition.			
Activities: (Any Five)				
1. Flower Classification Scavenger Hunt: Students identify and classify different flowers based on habit, life cycle, and flowering season in a garden or campus area.				
2. Cut Flower Workshop: An interactive session where students practice post-harvest handling techniques like pre-cooling, pulsing, packing, and storage with various flowers.				
3. Tool Identification Relay: Teams compete to correctly identify and explain the use of different garden tools and implements.				
4. Career Speed Dating in Floriculture: Professionals from various floriculture careers give short talks, followed by Q&A sessions with students, providing insights into career opportunities.				

5. **Propagation Lab:** Students propagate plants using different vegetative methods (like Rhizome, Corm, Bulb) and artificial methods (Budding, Grafting).
6. **Pest and Disease Detective Game:** A role-play activity where students diagnose and propose treatments for pest and disease issues in flower crops.
7. **DIY Floral Essence Extraction:** Extracting essences from flowers like Jasmine and Rose, and discussing their applications in fragrances and skincare products.
8. **Floral Kitchen Workshop:** Preparing edible flower products like “Gulkand” and exploring the culinary uses of flowers in making jams and jellies.
9. **Natural Dyeing Workshop:** Using flowers like Marigold and Cosmos to extract natural dyes and applying them to fabrics.
10. **Business Plan Challenge:** Students develop a business plan for a start-up in areas like cosmetics, perfumes, or aromatherapy using floral products, guided by case studies of successful ventures.

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Model Questions:

Short Answer Type Questions:

1. Define floriculture and explain its importance and scope.
2. Describe the classification of flowers based on habit, life cycle, and flowering season.
3. List and briefly explain different vegetative propagation techniques in floriculture.
4. Discuss the pest and disease management strategies for Jasmine (*Jasminum sambac*).
5. What is the concept of value addition in floriculture and why is it important?
6. Describe the properties of flowers used in perfume and cosmetic production, with examples.
7. Explain the medicinal and therapeutic applications of Jasmine in herbal remedies.
8. What are the culinary potentials of flowers, and how are they utilized in food products?

Long Answer Type Questions

1. Discuss the environmental factors affecting crop growth in floriculture and elaborate on the post-harvest handling techniques for cut flowers.
2. Provide a detailed overview of the cultivation practices, including plant propagation, for Rose (*Rosa grandiflora*) and Marigold (*Tagetes erecta*).
3. Explain the process of extraction and application of floral essences in fragrance and skincare products, with a focus on Jasmine (*Jasminum grandiflorum*) and Rose (*Rosa centifolia*).

4. Discuss the case studies and practical applications of traditional flowers in creating natural dyes, highlighting the properties, dye extraction, and application techniques.

Multiple Choice Questions (MCQs)

1. What is floriculture?

- a. Study of trees:
- b. Cultivation of flowers
- c. Science of soil:
- d. Breeding of vegetables

2. Which of the following is a common disease affecting flowers in floriculture?

- a. Rust:
- b. Frostbite:
- c. Drought:
- d. Sunburn

3. Which factor is essential for successful pollination in many flowering plants?

- a. Wind
- b. Rain:
- c. Artificial light:
- d. Soil fertility

4. What is the purpose of using mulch in floriculture?

- a. Control pests:
- b. Conserve water:
- c. Increase temperature:
- d. All of the above

5. What is the primary focus of understanding customer preferences in the floriculture industry?

- A) Creating innovative floral designs
- B) Tailoring services to meet customer demands
- C) Developing quality control protocols
- D) Implementing compliance with industry standards

6. Which aspect is crucial for creating visually appealing floral arrangements?

- A) Understanding market demands
- B) Compliance with industry regulations
- C) Attention to detail and balance
- D) Financial management strategies

7. Which flower is the best choice for perfume and cosmetic production due to its aromatic properties?

- A) Chrysanthemum
- B) Garbera
- C) Marigold (*Tagetes erecta*)
- D) Jasmine (*Jasminum officinale*)

8. What is the edible product derived from Rose (*Rosa rubiginosa*) that holds nutritional and medicinal value?

- A) Chrysanthemum Tea
- B) Rosewater
- C) Gulkand
- D) Marigold Jelly

Pedagogical Strategies:

This course for UG students, implementing innovative pedagogies can significantly enhance the learning experience. Here are five pedagogical approaches that blend well with the course content:

1. **Problem-Based Learning (PBL):** This approach involves presenting students with real-world problems related to floriculture. For instance, they could tackle issues like sustainable cultivation practices or the challenge of extending the shelf life of cut flowers. This method encourages critical thinking, problem-solving skills, and collaborative learning.
2. **Flipped Classroom:** In this model, traditional learning structures are 'flipped'. Students first engage with new content at home, typically through interactive online modules or video lectures. Then, classroom time is devoted to hands-on activities, discussions, and application of knowledge. This approach could work well for sections like plant propagation techniques and pest management, where students can study the theory at home and practice in a lab setting.
3. **Experiential Learning:** Central to floriculture, this pedagogy involves learning through experience. Activities like maintaining a flower garden, participating in flower arrangement workshops, or visiting commercial floriculture setups can be incredibly effective. These experiences not only reinforce theoretical knowledge but also provide valuable practical skills.
4. **Gamification:** Introducing game-like elements in learning can significantly increase engagement. For example, creating a competitive flower identification game, or a simulation game for managing a floriculture business can make learning more interactive and fun. Gamification can be particularly effective in teaching sections like environmental factors affecting crop growth or the business aspects of floriculture.
5. **Interdisciplinary Projects:** Floriculture intersects with many fields such as business, environmental science, and technology. Encourage students to undertake projects that require integrating knowledge from these different areas. For example, a project could involve developing a sustainable business model for a floriculture enterprise, which would require students to apply concepts from botany, business, and environmental sustainability.

By incorporating these pedagogies, the course can become more dynamic, interactive, and aligned with real-world applications, greatly enhancing the educational experience of the students.

GOEC Course- AYUSH

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	107209	AYUSH	2	30	2 Hrs	30 (Ext)+20 (Int)

Course Objectives :	1. Understand the Historical and Theoretical Foundations of AYUSH: Students will gain a comprehensive understanding of the concept, evolution, and historical perspectives of AYUSH. This includes exploring its origins, key principles, and comparative analyses with conventional medicines. 2. Explore the Relationship between Plant Sciences and Ayurveda: Students will delve into the history, fundamental principles of Ayurveda, and its scope, from the use of crude herbs to advanced micromolecules. This objective aims to enhance understanding of Ayurveda's reliance on botanicals. 3. Investigate Botanicals in Yoga, Naturopathy, Unani, Siddha, and Homeopathy: The course will cover the origins, modernization, and role of plants in these traditional practices, focusing on their contributions to physical and mental wellness. 4. Develop Practical Knowledge and Skills: Students will learn to identify commonly used herbs, understand their medicinal properties, and appreciate their role in traditional medicine practices, bridging the gap between theoretical knowledge and practical application.
Course Outcomes :	CO 1: Analytical Understanding of AYUSH and Conventional Medicine: Students will be able to critically analyze the differences and similarities between AYUSH and conventional Western medicine, including their theoretical foundations and practical applications. CO 2: Knowledge of Historical Impact: Students will demonstrate an understanding of the historical significance of AYUSH in healthcare, including key events where traditional practices played pivotal roles in disease management and eradication. CO 3: Comprehensive Knowledge of Ayurvedic Principles: Students will have a thorough understanding of Ayurvedic principles such as Panchmahabuta and Tridosha, and the use of herbs in Ayurvedic practices. CO 4: Application of Botanicals in Traditional Practices: Students will be able to identify and explain the use of specific plants in Yoga, Naturopathy, Unani, Siddha, and Homeopathy, including their therapeutic benefits and applications in modern wellness. CO 5: Practical Skills in Herb Identification and Usage: Students will acquire practical skills in identifying commonly used medicinal herbs, understanding their cultivation methods, and applying this knowledge in creating herbal remedies. CO 6: Integration of Traditional Knowledge with Modern Practices: Students will develop the ability to integrate traditional botanical knowledge with contemporary health practices, demonstrating an understanding of how ancient techniques can complement modern medicine and wellness approaches.

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Historical Perspective: AYUSH	8	8	Suitable pedagogical strategies are separately annexed
	1.1. Concept and prospective of AYUSH			
	1.2: Historical Perspective, Origins and Evolution of AYUSH			
	1.3: Historical Stories where AYUSH played a pivotal role in healthcare: a. Ayurveda: Eradication of Smallpox in India b. Yoga and Naturopathy: Rehabilitation of Polio Survivors			
	1.4: Historical Stories where AYUSH played a pivotal role in healthcare: c. Unani: Treatment of Malaria d. Siddha: Managing Leprosy in Ancient India e. Homeopathy: Cholera Epidemics in the 19th Century:			
Unit II	Relation of Plant Sciences with Ayurveda	7	7	
	2.1: History and Fundamental Principles of Ayurveda			
	2.2: Ayurveda's Scope: From Oral Remedies to Surgery..			
	2.3: Concepts of Panchmahabuta and Tridosha (Vata, Pitta, Kapha)			
	2.4: Commonly used Herbs in local practices of Ayurveda.			
Unit III	Botanicals in Yoga and Naturopathy	8	8	
	3.1: History and Modernization of Yoga			
	3.2: Role of plants in Yoga and Stress Management			
	3.3: History and Modernization of Naturopathy			
	3.4: Yoga and Naturopathy: Bridging Ancient Techniques with Modern Wellness, from Physical Fitness to Mental Health			
Unit IV	Herbal Foundations in Unani, Siddha, and Homeopathy	7	7	
	4.1: History and Foundations of Unani, Siddha and Homeopathy			
	4.2: Plants in Unani medicine and therapies			
	4.3: Plants in Siddha medicine and treatment			
	4.4: Plants in Homeopathic medicine and treatment			
Activities: (Any Five)				
1. Ayurvedic Cooking Workshop: Conduct a session where students prepare simple Ayurvedic recipes, learning about the dietary principles of Ayurveda.				

2. **AYUSH vs Conventional Medicine Debate:** Organize a structured debate on the differences and similarities between AYUSH and conventional medicine.
3. **Field Trip to Naturopathy Center:** Organize a visit to a local naturopathy center to observe the practical application of the therapies.
4. **Herbal Garden Project:** Students develop a small herbal garden, cultivating commonly used Ayurvedic herbs and learning about their properties.
5. **Homeopathy Dilution Experiment:** An experiment demonstrating the process of diluting substances as used in homeopathic medicine preparation.
6. **Interactive Timeline Creation:** Students create a visual timeline highlighting key events in the history of AYUSH and its evolution.
7. **Role-Play of Historical Cases:** Students enact roles of practitioners and patients in historical cases where AYUSH played a key role, such as smallpox eradication or cholera epidemics.
8. **Siddha Medicine Case Studies:** Students analyze case studies to understand the application of Siddha medicine in various health conditions.
9. **Unani Medicine Preparation Workshop:** A hands-on workshop where students prepare basic Unani medicinal formulations.
10. **Yoga and Meditation Sessions:** Regular yoga and meditation sessions to understand their role in stress management and wellness.

Study Materials:

Books:

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- The Holistic Principles of Ayurvedic Medicine. Publisher. Retrieved from https://www.google.co.in/books/edition/The_Holistic_Principles_of_Ayurvedic_Medicine/aexFAAAAYAAJ
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- Britannica's article on Siddha Medicine: <https://www.britannica.com/science/Siddha-medicine>
- Center for Inquiry's blog on World Homeopathy Week: https://centerforinquiry.org/blog/oh-great-its-world-homeopathy-week/?gclid=EAIaIQobChMI9KyBxNTAgwMVyxqDAXOrjAljEAAAYASAAEgIF5PD_BwE
- Delhi Government AYUSH's page on Yoga and Naturopathy: <https://ayush.delhi.gov.in/ayush/yoga-naturopathy>
- Information about Siddha from Kerala's ISM: <https://www.ism.kerala.gov.in/index.php/about-us/about-ism/about-sidha>
- Information about Unani medicine from Kerala's ISM: <https://www.ism.kerala.gov.in/index.php/about-us/about-ism/about-unani>
- Johns Hopkins Medicine's Ayurveda page: <https://www.hopkinsmedicine.org/health/wellness-and-prevention/ayurveda>
- NHS's information on Homeopathy: <https://www.nhs.uk/conditions/homeopathy/>
- NIH article on Yoga and Naturopathy: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5377479/>
- ScienceDirect Article on Alternative Medicine: <https://www.sciencedirect.com/science/article/abs/pii/S1543115003000309>
- Vikaspedia on Unani Medicine: <https://vikaspedia.in/health/ayush/unani>
- WebMD's page on Ayurvedic Treatments: <https://www.webmd.com/balance/ayurvedic-treatments>
- Wikipedia's Ayurveda page: <https://en.wikipedia.org/wiki/Ayurveda>
- Wikipedia's Homeopathy page: <https://en.wikipedia.org/wiki/Homeopathy>
- Wikipedia's Unani Medicine page: https://en.wikipedia.org/wiki/Unani_medicine

Long questions

1. Explain the different streams of AYUSH
2. Discuss in details Unani and Siddha medicines
3. Investigate the impacts of Yoga and Naturopathy on human health
4. Describe in details Ayurveda & its Branches

Short Questions

1. Summarize types of Yoga
2. Investigate the impacts of herbs in Ayurveda
3. Uses of drugs in herbs in Homeopathy
4. Comments on History of Unani and Siddha

5. Summarize the concept of AYUSH
6. Compare the Homeopathic medicine with Allopathic medicine
7. Assess the role of plants in the formulation drugs used in homeopathic medicine
8. Describe naturopathy and its importance in day to day life.

MCQs for Internal Assessment

- 1) The Hippocratic theory and Pythagorean theory is the principle of _____
 - A) Homeopathy system of medicine
 - B) Ayurveda system of medicine
 - C) Chinese system of medicine
 - D) Unani system of medicine
- 2) "Like can be treated by like" is the fundamental principle of _____
 - A) Homeopathy system of medicine
 - B) Ayurveda system of medicine
 - C) Chinese system of medicine
 - D) Unani system of medicine
- 3) The Word "Ayurveda" means _____
 - A) History of people
 - B) Science of life
 - C) Science of medicine
 - D) Knowledge of crude drugs
- 4) Panchamahabhuta is related to _____ system of medicine
 - A) Homeopathy
 - B) Unani
 - C) Ayurveda
 - D) Yoga
- 5) Who developed the homeopathic system of medicine
 - A) Hippocrates
 - B) Galen
 - C) C.A. Sydlar
 - D) Samuel Hanneman
- 6) Who was the father of Siddha medicine
 - A) Chakara
 - B) Agastya
 - C) Hippocrates
 - D) Galen
- 7) Hypothesis of Ayurveda is _____
 - A) Composed of 7 basic elements
 - B) Composed of 5 basic elements
 - C) Composed of 9 basic elements
 - D) Composed of 3 basic elements
- 8) In Unani system of medicine, treatment is based on
 - A) Treatment and Humors

- B) Treatment and Elements
- C) Humors and Elements
- D) None of the above

Pedagogical Strategies:

1. **Project-Based Learning (PBL):** Encourages students to gain knowledge and skills by working for an extended period to investigate and respond to complex questions, problems, or challenges.
2. **Case-Based Learning:** Involves students in real-world scenarios, encouraging them to analyze, discuss, and engage with practical issues, enhancing critical thinking and problem-solving skills.
3. **Inquiry-Based Learning:** Focuses on questioning, exploring, and posing explanations. It allows students to learn by asking questions, conducting investigations, and reflecting on their discoveries.
4. **Flipped Classroom:** Involves students in active learning through videos and readings outside class, and interactive, collaborative activities during class.
5. **Service-Learning:** Combines learning goals and community service to provide a pragmatic, progressive learning experience while meeting societal needs.

Vocational Skill Course- Commercialization of Medicinal Plant and Products

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	107210	Commercialization of Medicinal Plant and Products	2	60	4 Hrs	50

Course Objectives:	1. Understand the utility of Medicinal plants. 2. Understand the packing and bottling of medicinal plant products. 3. Understand the Basics of the Commercialization of Medicinal plants. 4. Explain Knowledge of commercialization of Medicinal plant products.
Course Outcomes:	After studying this course, the students will be able to: CO 1: Apply the various value addition techniques to Medicinal plant products & sell them on higher price in market. CO 2: Investigate the demand of medicinal plant-based products in market. CO 3: Develop a medicinal plant products processing unit or small-scale industry. CO 4: Create employment opportunities in area, rural health services and NGO related with health awareness

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies	
Unit I	Basics in commercialization of medicinal plants products:	15	12	Suitable pedagogical strategies are separately annexed	
	1.1: Scope and limitations for commercialization.				
	1.2: Marketing and promotion of medicinal plant products.				
	1.3: Value Addition Concept, Standardization and Quality control measures.				
	1.4: Precautions for adulteration and substitutions.				
Unit II	Powder Based medicinal plant Products	15	12		
	2.1: Methods of Drying & Moisture Regulation.				
	2.2: Methods of powder preparation.				
	2.3: Medicinal plant part (Fruits) used for powder preparation: Identification and utilization of: 1. Amla, 2. Behada, 3. Shikakai 4. Jambhul				
	2.4: Medicinal plant parts (Bark and Whole plant) used for powder preparation: 5. Arjun, 6. Cinnamon, 7. Safed Musali, 8. Mehandi, 9. Ashwagandha, & 10. Sarpagandha.				
Unit III	Decoction and Juice of plant Products	15	12		
	3.1: Methods of Decoction and Juice precreation.				
	3.2: Medicinal plant parts used for decoction preparation: Identification and utilization of: 1. Adulsa 2. Anantmul 3. Gulvel / Giloy, 4.Ginger 5.Basil				
	3.3: Medicinal plant parts used for juice preparation: 6. Arjun 7.Neem 8. Aloe				

	9. Brahmi & 10. Bael			
	3.4: Preservative techniques, Bottling, Packing and labelling of medicinal plant products.			
Unit IV	Essential Oil Based Plant Products	15	14	
	4.1 Medicinal plant Parts used to extract Essential Oil. Identification and utilization of: 1. Nilgiri, 2. Clove, 3.Fennel, 4.Lemon Grass, 5. Mint			
	4.2: Schemes of Central and State government and Funding Agencies for medicinal plant-based startup.			
	4.3: Guidelines for product preparation, Permission, and Certification.			
	4.4: Business registration, Support services, Profit and Loss.			

Experiments: At least THREE Experiments from Each Unit of following list:

Unit I:

1. Analyze case studies of successful and failed medicinal plant products.
2. Create a marketing plan for a hypothetical medicinal plant product.
3. Standardize a simple medicinal plant extract.
4. Test for common adulterants in herbal products.

Unit II:

5. Dry different plant parts and measure moisture content.
6. Prepare powders from various plant parts.
7. Identification and processing of Amla, Behada, Shikekai, Jambhul.
8. Process and analyze bark and whole plants like Arjun, Cinnamon, etc.

Unit III:

9. Prepare decoctions and juices from selected plants.
10. Work with Adulsa, Anantmul, Gulvel, etc., for decoction.
11. Extract juices from Arjun, Neem, Aloe, etc.
12. Apply different preservative techniques.

Unit IV:

13. Extract essential oils from Nilgiri, Clove, Lemon Grass, etc.
14. Create a mock proposal for funding.
15. Draft a product specification sheet.
16. Develop a basic business plan for a hypothetical product.

Activities (Any two from the following):

1. Group discussion on challenges faced in the market for medicinal plant products.
2. Design promotional materials for medicinal plant products.
3. Visit a local herbal processing unit to understand quality control measures.
4. Create a checklist for identifying pure vs adulterated products.
5. Compare traditional vs modern drying techniques.
6. Analyze the fineness and quality of prepared powders.
7. Study the traditional uses and modern applications of medicinal fruits.
8. Prepare sample powders and test their efficacy.
9. Study the stability and potency of decoctions and juices over time.

10. Compare traditional decoction methods vs modern techniques.
11. Test therapeutic properties and shelf life of plant juices.
12. Design labels and understand legal requirements for packaging.
13. Research and presentation on various government schemes for botanical startups.
14. Workshop on regulatory affairs and certification processes.
15. Interactive session with a botanical startup founder.

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- Suradkar, S.W., Deshmukh, M.M., Aher, S.R., Ukey, S.S., & Bajaj, G.S. (2025). Commercialization of Medicinal Plant and Products. Sai Jyoti Publication.

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- Agricorn. (2023, August). Value addition & preservation of food products. Retrieved from <https://www.agricorn.in/2023/08/value-addition-preservation-food-products.html>
- National Medicinal Plants Board. <https://nmpb.nic.in>

Research Paper

- Sahoo N, Manchikanti P. (2013): Herbal drug regulation and commercialization: an Indian industry perspective. J Altern Complement Med. 19(12):957-63.

Video Resources:

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- Solution-Pharmacy. (n.d.). Test for Alkaloids. [Video]. YouTube. Retrieved from <https://www.youtube.com/watch?v=uMxdSkKcO7U>
- Mishra, S. (n.d.). Essential oil extraction. [Video]. YouTube. Retrieved from <https://www.youtube.com/watch?v=-mYTauJtle0>
- Entrepreneur India TV. (n.d.). Aloe vera juice making. [Video]. YouTube. Retrieved from <https://www.youtube.com/watch?v=3xs8caUl-Kk>
- Tazeka Aromatherapy. (n.d.). Steam distillation process. [Video]. YouTube. Retrieved from <https://www.youtube.com/watch?v=OVQC-6qlq-Y>

Pedagogical Strategies:

1. Case Studies and Role Plays

- Application-Oriented Learning: Utilize case studies of successful and unsuccessful commercial ventures in medicinal plant products. Role plays can help students understand market scenarios and decision-making processes.

2. Industry Visits and Guest Lectures

- Real-World Exposure: Organize visits to medicinal plant processing units or invite industry experts for lectures. This provides practical insights into commercial production, quality control, and marketing strategies.

3. Project-Based Learning

- Hands-On Approach: Assign projects where students create a hypothetical business plan for a medicinal plant-based product. Include market research, product development, and marketing strategies.

4. Interactive Workshops

- Skill Enhancement: Conduct workshops on drying methods, powder preparation, decoction making, and essential oil extraction. Hands-on experience reinforces theoretical knowledge.

5. Collaborative Research Projects

- Exploring Innovations: Assign research projects on innovative methods of preserving medicinal plant products or exploring new markets for these products. Encourage teamwork and critical analysis.

6. Multimedia Presentations and Discussions

- Varied Learning Aids: Use multimedia presentations, documentaries, or infographics highlighting successful commercialization stories. Follow up with discussions to analyze market trends.

7. Industry-Relevant Assignments

- Application of Knowledge: Assign tasks simulating real industry scenarios, such as creating marketing campaigns, developing quality control measures, or drafting business proposals.

8. Field Trips and Experiential Learning

- Observational Learning: Arrange visits to medicinal plant gardens, farms, or nurseries to understand cultivation practices and the value chain.

9. Self-Assessment and Reflection

- Metacognitive Approach: Encourage students to reflect on their learning through journals or portfolios. Self-assessment tools help reinforce understanding.

10. Debates and Seminars

- Critical Thinking: Organize debates or seminars on topics like ethical considerations in commercialization, the role of government policies, or sustainable practices in the industry.

Assessment Rubric for Internal Practical Course on **Commercialization of Medicinal Plant and Products**

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. I (Botany), SEMESTER – II (NEP)				
Lab/ Practical-6	Course Code: 107210	Commercialization of Medicinal Plant and Products	Max Marks: 50	Time: 4 Hrs.
S.No.	Assessment Criteria			Marks
1	Performance of Any One Exercise from the List of Experiments			10
2	Performance of the Task on Any One of the List of Activities			10
3	Record/ Assignments			10
4	Attendance			5
5	Participation in Activity/ Field visit			5
6	Students overall performance			5
7	Internal Viva Voce			5

Skill Enhancement Course - Seed Development Technology

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	II	107211	Seed Development Technology	2	60	4 Hrs	50

Course Objectives:	1. To create opportunities of self-employment / students' startup through seed technology. 2. To introduce the concepts of experimental design in Seed Technology. 3. To enrich students training and knowledge that would be useful in the seed industry so that the farmers will get quality seeds. 4. To create awareness and involve local people in contract farming through various seed companies.			
Course Outcomes:	CO 1: Understand the concept of tools and techniques for seed production, seed quality control and processing CO 2: Demonstrate different methods of hybridization & seed production CO 3: Access the latest technologies used for seeds CO 4: Analyze and compare the seed companies / organization CO 5: Apply the Certification of seed for future uses CO 6: Design the own Plant & Seed Diagnostic Clinic.			
Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	UNDERSTANDING SCOPE OF SEED DEVELOPMENT TECHNOLOGY	15	12	Suitable pedagogical strategies are separately annexed
	1.1. History, scope and role of Seed development Technology in agriculture.			
	1.2 Indian, International seed industry and Opportunities in Seed development technology.			
	1.3 Seed development program in India (NSC, SSC), any private seed organization (e.g. MAHICO, MAHABEEJ and their role in seed industry etc)			
	1.4 Seed quality control organization in India. Principles of Quality seed production, Role and characteristics of quality seed.			
Unit II	PRODUCTION TECHNIQUES	15	12	
	2.1 Structure and Development of Dicotyledonous and Monocotyledon seeds			
	2.2 Selection Methods of Plant Breeding -Concept, procedure, achievements and types.			
	2.3 Hybridization and hybrid seed production – Concept, objectives and Techniques of hybridization: Selection and evaluation of parents, emasculation bagging and tagging, pollination, collection and storage of F 1 seeds and growing of F1 generation.			
	2.3 Hybrid seed production with respect to Source of seed Selection of field (Land requirement)			

	Isolation distance Sowing Cultural practices (Fertigation, Irrigation, plant protection) Rouging Harvesting and threshing.			
	2.4 Development of seeds by Parthenogenesis and Parthenocarpy, Genetic modification for seed quality improvement.			
Unit III	QUALITY CONTROL	15	12	
	3.1 Factors affecting seed set – temperature, relative humidity, day length, wind velocity and directions of flowering, anthesis, pollen viability, stigma receptivity, nutrition and irrigation.			
	3.2 Seed health Testing: dry seed examination, storage of reserve food & Chemical composition in seeds field and seed standards; designated diseases, detection methods for seed borne -fungi, bacteria, viruses and nematodes.			
	3.3. Viability, Vigour testing & Seed longevity.			
	3.4 Testing of GM seeds and trait purity, Preparation and dispatch of seed testing report.			
Unit IV	Unit-IV – PRIMARY PROCESSING	15	14	
	4.1 Post harvest handling of seeds - threshing methods & drying methods.			
	4.2 Seed for processing principles, Cleaner cum grader, Surface texture separation, Seed treatment.			
	4.3 Seed storage: Construction, operation and maintenance, insulation, storage aeration, air conditioning, dehumidification and stacking, moisture and heat roofing of seed storage structures, seed storage management, Methods to minimize seed aging and deterioration.			
	4.4 Indian Seeds Act, Seed Rules and Seed Order.			

Conduct at least THREE Practical's from each unit:

Unit - I

1. Search and Enlist opportunities in seed development technology in seed industry
2. Collection of information on seed organization
3. Preparation of the Flow Diagram of Seed Development Program in India
4. Study of Product profile of private seed organization
5. Preparation list of Seed quality control organization in India
6. Collection of seed on the basis of characteristics of quality seeds

Unit II

7. Study of the external and internal structures of monocot and dicot seed.
8. Seed sowing for parent selection (using cultural practices)
9. Experiments on selection methods (Pure line selection, Mass selection, and Clonal selection Study of tools and equipment required for plant breeding
10. Emasculation, Self-pollination and cross pollination

11. Bagging and tagging of selected parent plant
12. Demonstration of hybridization techniques in crops (any 2-3)
13. Seed production by parthenogenesis and parthenocarpy
14. Visit of foundation and certified seed plots study of the techniques of seed production

Unit III:

15. Experiments on factors affecting seed germination, temperature, moisture, light
16. Seed health Testing- Test for reserve food
17. Seed Viability Test
18. Seedling vigour & longevity tests
19. Detection of important seed borne fungi-various detection methods,
20. Detection of important seed borne bacteria- various methods.
21. Experiments on artificial seed production

Unit IV:

22. Preparation of seed testing report
23. Study of threshing machine and its use.
24. Methods of seed drying (wet dry seeds)
25. Determination of seed moisture content
26. Study of seed – pre-cleaner, maize sheller & dehusker.
27. Study of air screen cleaner cum grader, magnetic separator
28. Study of seed treatment machines
29. Hands on using methods to minimize seed aging & deterioration (ageing test)
30. Techniques and necessities of the Seed storage

Activities:

1. Field visits to different seed production farms /units, seed Production Company / seed processing & storage complex
2. Preparation of seed bank.
3. Collaboration/ MoU: To undertake activities establish Collaboration / MoU with any Seed company / related NGO/ Institute

Career Opportunities:

- Employment in various research institutes and seed companies
- Self-employment through –
- own Plant & Seed Diagnostic Clinic.
- Production of Certified plant saplings and seeds.
- Involvement of locals in Contract manufacturing through various seed companies.
- Trained Consultants for Seed grading
- Subsidy from various agencies for seed company

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- 1) Agrawal, P. K., & Dadlani, M. (1992). Techniques in seed science and technology (2nd ed.). South Asian Publication.
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- 2) Seed Quality Control Organization in India: Details on seed quality control measures. Resource available at the Ministry of Agriculture and Farmers Welfare: <https://agricoop.nic.in>
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Web Links for Seed Development and Quality Control:

- 1) Food and Agriculture Organization (FAO). (n.d.). Seed Quality Control. Retrieved from <http://www.fao.org>
- 2) International Seed Testing Association (ISTA): Offers guidelines and standards for seed testing. Website: <https://www.seedtest.org>

Database Links:

- 1) Germplasm Resources Information Network (GRIN): <https://npgsweb.ars-grin.gov>
- 2) Seeds of India program by ICAR: <http://www.icar.org.in>

Pedagogical Strategies:

For the effective delivery of the Seed Development Technology curriculum, consider integrating the following modern and innovative pedagogies:

- 1) **Blended Learning:** Combines online digital media with traditional classroom methods, allowing for both in-person and remote, self-paced learning experiences.
- 2) **Gamification:** Introduces game design elements in educational contexts to enhance student engagement and motivation.
- 3) **Flipped Classroom:** Students learn content online by watching video lectures, then apply the knowledge in the classroom through interactive activities.
- 4) **Problem-Based Learning (PBL):** Students learn about a subject through the experience of solving an open-ended problem presented in trigger material.
- 5) **Virtual Labs and Simulations:** Utilize software to simulate real-world seed development and testing scenarios, providing hands-on experience without the need for physical materials.

Assessment Rubric for Internal Practical Course on- Seed Development Technology

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. I (Botany), SEMESTER – II (NEP)			
Lab/Practical-7	Course Code: 10211	Seed Development Technology	Max Marks: 50
Q. No.	Exercise	Marks	
1	Demonstration of experiment based on hybridization techniques for seed production (any one):	10	
2	To demonstrate the test based on seed quality (any one)	10	
3	Comment on method of seed processing (any one method as per the list)	10	
4	Overall Performance throughout the semester	5	
5	Record Book	5	
6	Field visit / Activities under MoU or Collaboration report	5	
7	Viva Voce	5	
	Total	50	

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI



THREE /FOUR YEAR DEGREE OF BACHELOR OF SCIENCE

Bachelor of Science

SUBJECT: BOTANY

FACULTY: SCIENCE AND TECHNOLOGY

**(Courses effective from Academic Year 2026-2027)
Under Uniform NEP 2020**

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TLE Scheme for SECOND YEAR: SEMESTER – III

Subject	The Vertical	Course Code	Course Title	Credits	Workload	Theory/Practical				Theory/Pract (Total)	
						External		Internal			
						Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks
Botany	Major-T	107212	Microbial Diversity	2	2	30	9	20	6	50	20
Botany	Major-T	107213	Cryptogams and Gymnosperms	2	2	30	9	20	6	50	20
Botany	Major-P	107214	Techniques in Microbial Studies, Plant Diseases and Cryptogams and Gymnosperms	2	2	30	9	20	6	50	20
Botany	IKS-T	107215	Sacred Plant Heritage of Maharashtra	2	2	30	9	20	6	50	20
Botany	Minor-T	107216	Plant Diversity, Conservation and Forensic Botany	2	2	30	9	20	6	50	20
Botany	Minor-P	107217	Practical Approach towards Plant Diversity, Conservation and Forensic Botany	2	4	25	10	25	10	50	20
Botany	GOEC-T	107218	Traditional Health Care	2	2	30	9	20	6	50	20
Botany	VSC-P	107219	Supply Chain Management in Seed Products	2	4	-	-	50	20	50	20
Botany	FP/CES	10720	Botany Lab 9 (FP/ CEP in Botany - I)	2	4	-	-	50	20	50	20
Botany	CC		Separate SOP shall be consulted from University website	2	4	-	-	50	20	50	20

Important: * VSC Should be Complementary to Major

** SEC has to be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor

TLE Scheme for SECOND YEAR: SEMESTER – IV

Subject	The Vertical	Course Code	Course Title	Credits	Workload	Theory/Practical				Theory/Pract (Total)			
						External		Internal		Max. Marks	Min. Marks	Max. Marks	Min. Marks
						Max. Marks	Min. Marks	Max. Marks	Min. Marks				
Botany	Major-T	107221	Botanical Wealth – Economic Botany, Ethnomedicine and Phytochemistry	2	2	30	9	20	6	50	20		
Botany	Major-T	107222	Cellular Frontiers in Botany - Cell Biology, Cytogenetics and Molecular Biology	2	2	30	9	20	6	50	20		
Botany	Major-T	107230	Angiosperm Taxonomy	2	2	30	9	20	6	50	20		
Botany	Major-P	107223	Experimental Botany in Economic, Medicinal, Cellular, Molecular, Morphological and Taxonomic Studies	2	4	25	10	25	10	50	20		
Botany	Minor-T	107224	Plant Propagation and Growth	2	2	30	9	20	6	50	20		
Botany	Minor-P	107225	Investigations of Plant Life Sketch	2	4	25	10	25	10	50	20		
Botany	GOEC-T	107226	Wonders of Plant World	2	2	30	9	20	6	50	20		
Botany	VSC-P	107227	Nursery and Garden Management	2	4	-	-	50	20	50	20		
Botany	FP/CES	107229	Botany Lab 14 (FP/ CEP in Botany - II)	2	4	-	-	50	20	50	20		
Botany	CC		Separate SOP shall be consulted from University website	2	4	-	-	50	20	50	20		

Important:

- VSC Should be Complementary to Major
- SEC has to be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor

Notes:

- a. The strength of the batch of the Practical for UG Classes shall be 16 with an addition of 10% with the permission of Hon'ble Vice Chancellor. The number of the students required to constitute a batch or calculate the workload shall be in accordance with the relevant Government Resolution in force at the time, applicable to specific time, region, course type, mode of instruction, and other pertinent factors.
- b. 1 Credit shall mean 1 Hour Teaching per Week per Semester (Total 15 Hrs/ Semester), the duration of 1 Teaching Period will be 60 Minutes. For Practical 1 Credit shall mean 2 Hour Teaching per Week per Semester (Total 30 Hrs/ Semester).
- c. For Examination and Evaluation of Theory Courses, 40 % Marks shall be assigned to Internal Examination and 60% Marks shall be assigned to end-semester external university examination.
- d. **Co-curricular Courses:** Health and wellness, Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC, Fine/Applied/Visual/Performing Arts During Semester I, II, III, IV, V and VI. These courses may be taught by Physical Education Director or may be assigned to Language Teacher by the Principal of HEI based on the expertise of the concerned.
- e. **Value Education Courses** to be selected from the Basket of Courses provided by the University. These courses may be assigned to the Language Teacher by the Principal of HEI based on the expertise of the concerned.
- f. **Generic / Open Elective Courses (GE/OE):** Courses to be selected from the Basket of Courses provided by the University
- g. **Abbreviations:** Department Specific Core: DSC, Department Specific Elective: DSE, FSC: Faculty Specific Core, FSE: Faculty Specific Elective, Indian Knowledge System: IKS, Inter Faculty Specific Core: IFSC, Inter Faculty Specific Elective: IFSE, Theory: Th, Practical/Practicum: Pr, Environment Studies: ES, Pre-requisite Course mandatory if applicable: Prq, Laboratory: Lab (Practical), Generic/ Open Electives: OE; Vocational Skill and Skill Enhancement Courses: VSEC; Vocational Skill Courses: VSC; Skill Enhancement Courses: SEC; Ability Enhancement Courses: AEC; Value Education Courses: VEC; OJT: On Job Training: Internship/ Apprenticeship; Field projects: FP; Community Engagement and Service: CES; Co-curricular Courses: CC; RM: Research Methodology; Research Project: RP; MIL: Modern Indian Language

Examination and Assessment Process:

- i. The basic principle of the Credit framework is that Credits are a function of the successful completion of a program of study/ vocational education/ training and assessment. No Credit can be earned by the student unless the student is assessed for the achievement of the desired competencies and outcome of a program.
- ii. Exit options are provided with Certificate, Diploma and Basic Bachelor’s degrees to the students at the end of the second, fourth and sixth semesters of a Four Years Multidisciplinary Degree Programme. Students will receive a Bachelor’s degree with Honors/ Research on successfully completing of all eight semesters of the UG Program either at a stretch or with opted exits and re-entries.
- iii. For the smooth success of four-year degree programme with multiple entry and exit systems, the examination mode should be based on the combination of innovative trends in formative (informal and formal tests administered during the learning process) and summative (evaluation of students learning at the end of an instructional unit) examination modes in line with the UGC Report on ‘Evaluation Reforms in Higher Educational Institutions (2019).

Examination, Evaluation and Assessment Scheme

The total marks for each Course shall be based on Continuous Assessment and Semester End Examination. Each theory course of Major, Minor, GE/OE, AEC, IKS, VEC as mentioned in **Teaching Learning Scheme** prepared by the Board of Studies shall be evaluated as per the scheme as mentioned in the following table

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Examination, Evaluation and Assessment Scheme

Vertical No.	The Vertical	Mode of Examination, Evaluation & Assessment	Theory				Theory (Total)		Practical				Practical (Total)	
			External		Internal				External		Internal			
			Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks
a	Major	External & Internal	30	9	20	6	50	20	25	10	25	10	50	20
b	Minor		30	9	20	6	50	20	25	10	25	10	50	20
c	Generic/ Open Elective		30	9	20	6	50	20	--	--	--	--	--	--
d	VSC	Internal	--	--	--	--	--	--	--	--	50	20	50	20
	SEC	Internal	--	--	--	--	--	--	--	--	50	20	50	20
e	AEC (Eng. & One MIL Composite)	External & Internal	30	9	20	6	50	20	--	--	--	--	--	--
	IKS (Generic)	External & Internal	30	9	20	6	50	20	--	--	--	--	--	--
	VEC	External & Internal	30	9	20	6	50	20	--	--	--	--	--	--
F	FP/CEP	Internal	--	--	--	--	--	--	--	--	50	20	50	20
	Internship/ Apprenticeship		Assessment of these verticals shall be based on various activities/practices. It shall be evaluated by giving maximum marks of 50 per 2 Credit Course with separate activity weightages/levels. A detailed SOP for this assessment process is prescribed for Phase I and Phase II											
	CC													

Continuous Assessment Tests (CAT)

For internal assessment, the Continuous Assessment Tests (CAT) shall be conducted as under-

- i. Three CAT each of 8 / 10 Marks (Theory) as applicable and 10 Marks (Practical).
 - First on completion of 25% Syllabus of the course or on completion of 25 teaching days,
 - Second on completion of 50% Syllabus of the course or on completion of 50 teaching days,
 - Third on completion of 75% Syllabus of the course or on completion of 75 teaching days.
- ii. Each concurrent assessment (CAT-I, II & III) will be mapped to relevant Course Learning Outcome.
- iii. Total Performance in CAT (i.e. 40 %) shall be based on the **best two out of three** in CAT examinations
- iv. Internal assessment shall be carried out by the respective course teacher by choosing variety of assessment tools/methods such as class test, record book, seminar, case study, field work, mini project work, quiz or any innovative method, which may be deemed to be appropriate for assessing the relevant course outcome.

Conduction of the Examination:

As per the scheme of teaching, learning, examination and evaluation, theory/practical examinations of Semester-I, II, III, IV, V, VI, VII and VIII shall be conducted by the University (except for Internal Examinations as applicable) at the end of each semester.

The theory/practical examinations of all the Semesters shall be held as per the following Schedule –

Sr. No.	Name of the Examination	End Sem Examination	Supplementary Examination*
1	Semester-I, III, V and VII	Winter	Summer
2	Semester-II, IV, VI and VIII	Summer	Winter

* The University may evolve mechanism for conducting repeat end semester examination. Such repeat examinations shall have to be conducted within one month of the regular even semester examination and on demand examination.

1. The practical examination of all semesters shall be conducted by the University at the end of each semester. The HEI shall conduct the Practical examination of odd semesters as per the schedule announced by the University. **However, the appointment of the External and Internal Examiners shall be done by the Head or Principal of respective HEI to conduct external examination of the odd semester and the same should be communicated to the University before commencement of the practical examination.** The University shall conduct the external practical examination of all even semester by appointing external and internal examiners.
2. The examinations specified above shall be held twice in a year at such places and on such dates as may be prescribed by the University.
3. An applicant to an examination specified above, shall pursue a regular course of study in courses prescribed for the examination concerned for not less than one semester in a particular semester in a College/Institute/University department.
4. Provided that the student shall be eligible to appear for examination if -
 - a. He/she complies with the provisions of the Ordinance pertaining to the Examination in general from time to time.
 - b. He/she has prosecuted a regular course of study in a university department/college affiliated to the University.
 - c. He/she has in the opinion of the Principal shown satisfactory progress in his/her studies.
5. The provisions of Ordinance No. 6 and Ordinance No. 9 shall be *mutatis-mutandis* applicable to every collegiate/non-collegiate student.
6. The fees for each theory examination and practical examination conducted by the university shall be as prescribed by the University, from time to time.

SEMESTER – III

Type of Course	Course Code	Course Name
MJ-Theory	107212	Microbial Diversity and Cryptogams-I
MJ-Theory	107213	Cryptogams-II and Gymnosperms
MJ-Practical-8	107214	Techniques in Microbial Studies, Plant Diseases and Cryptogams and Gymnosperms
IKS -Theory	107215	Sacred Plant Heritage of Maharashtra
Mn-Theory	107216	Plant Diversity, Conservation and Forensic Botany
Mn-Practical-9	107217	Practical Approach towards Plant Diversity, Conservation and Forensic Botany
GOEC-Theory	107218	Traditional Health Care
Practical-10	107219	Supply Chain Management in Seed Products
Project	107220	Field Project / Community Engagement Services in Botany: Phase-I
Outdoor		Separate SOP will be released

Major Course: Microbial Diversity and Cryptogams I

Level	Semester	Course code	Course Name	Credits	Teaching Hrs	Exam Duration	Maximum Marks
5.0	III	107212	Microbial Diversity and Cryptogams-I	02	30	2.00 Hrs	30 (Ext.) 20 (Int)

Course Objectives:

- To impart the knowledge of diversity, life forms, life cycles, morphology, and the importance of microorganisms (Viruses, Bacteria, algae, and fungi).
- To illustrate the fundamentals of different groups of microbes in nature and their features and role in a balanced ecosystem and economic importance.
- To present perspectives about microbes and their ecological and economic applications.
- Foster critical thinking and skills through the study of microbes and encouraging students to apply this knowledge in suitable field.

Course Outcome

- Students would have an understanding of the classification, characteristic features, cell structure, and growth and reproduction in viruses, bacteria, algae, and fungi.
- Students would gain an understanding of the ecological and economic importance of different groups of microbes.
- Students will well verse with fundamental techniques of identification and culture of microbes.
- Students will be able to identify various plant diseases caused by microbes.
- Understand the basics of host-parasite relationship.
- Gain knowledge about various types of lichens and their importance.

Unit	Content	Workload Allotted (Hrs)	Weightage of Marks	Incorporation of pedagogies
I	Introduction to Microbial Diversity 1.1 Definition and scope of microbial diversity. General characters and morphology of Viruses 1.2 Replication of viruses (Lytic and lysogenic cycle) 1.3 TMV: Structure, composition, symptoms, transmission, and control. 1.4 Economic Importance of Viruses (Vaccine Production, Gene therapy, and Cancer therapy)	07	07	Use any pedagogical technique suitable for the topic
II	Bacterial Diversity 2.1 Archaeobacteria- General Characters, Major Types and Their Significance 2.2 General characters and cell structure of eubacteria 2.3 Cyanobacteria – Cell structure, reproduction of Nostoc and economic importance 2.4 Reproduction in bacteria (Conjugation, transformation and transduction)	07	07	

III	Thallophytes: Algae			
	3.1 Algae: General Characteristics and classification by F. E. Fritsch (1945)	08	08	
	3.2 General characters, thallus and reproductive structures of Chlorophyceae (<i>Oedogonium</i>) & Xanthophyceae (<i>Vaucheria</i>).			
	3.3 General characters, thallus and reproductive structures of Phaeophyceae (<i>Ectocarpus</i>) & Rhodophyceae (<i>Batrachospermum</i>)			
	3.4 Applications of Algae in various sectors (Food, Agriculture and Medicine)			
IV	Thallophytes: Fungi			
	4.1 General characteristics of fungi General characters of Mastigomycotina. Thallus and Reproductive structures of <i>Albugo</i> .	08	08	
	4.2 General characters, thallus and reproductive structures of Zygomycotina (<i>Rhizopus</i>) & Ascomycotina (<i>Aspergillus</i>).			
	4.3 General characters, thallus and reproductive structures of Basidiomycotina (<i>Agaricus</i>) & Deuteromycotina (<i>Alternaria</i>)			
	4.4 Lichen-General characters, types, and economic importance; Applications of Fungi in various sectors (Food, Agriculture and Medicine)			
Activities for Continuous Assessment Test (CAT):				
1.	Bacterial Gram Staining			
2.	Collect and identify algal forms from local sites.			
3.	Collection and identification of fungal forms from local sites			
4.	Culturing of some algal forms for mass production.			
5.	Culturing and identification of fungal forms			
References:				
	- Alexopolus, C. J. and Bold, H. C. (1967). Algae and Fungi., Macmillen Publishing, New York (Internet Archive) - Anantnarayan, R. and Paniker, J. (2024). A Text Book of Microbiology, 13th Edition. Universities Press, (India) Pvt. Ltd. - Awasthi, A. K. (2015). Textbook of Algae, Vikash Publishing India - Bendre, A. M. &Kumar, A. (2010). A Text Book of Practical Botany- I, Rastogi Publication - Dubey, R. C., and Maheshwari, D. K. (2014). A Text Book of Microbiology, S Chand Publisher - Dubey, R. C., and Maheshwari, D. K. (2014). Practical Microbiology, S Chand Publisher - Gangulee, H.C. and Kar, A.K., (2011). College Botany Vol. II- New Central Book Agency, Kolkata			

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1 Mark Questions (Answer in One Sentence) Unit I: Microbial Diversity 1. Define microbial diversity. 2. What is the structure of a virus? 3. Name two types of viral replication. 4. What is TMV? 5. State one symptom of YVMV. 6. Mention one economic use of viruses. Unit II: Bacterial Diversity 7. What are archaeobacteria? 8. Name any two types of archaeobacteria. 9. What is the composition of a eubacterial cell wall? 10. Name a cyanobacterium. 11. Mention any one method of bacterial reproduction. Unit III: Thallophytes – Algae 12. Define algae. 13. Who classified algae in 1945? 14. Name one member of Chlorophyceae. 15. Give an example of brown algae. 16. Which pigment is found in red algae? Unit IV: Thallophytes – Fungi 17. What is Albugo? 18. Name the asexual spore in Rhizopus. 19. Mention one medicinal use of fungi. 20. What is a lichen? 3 Mark Questions (Short Answer) Unit I: Microbial Diversity 1. Write a short note on microbial diversity. 2. Differentiate between lytic and lysogenic cycle. 3. Explain structure and symptoms of TMV. 4. Describe symptoms and control measures of YVMV. 5. Mention three applications of viruses. Unit II: Bacterial Diversity 6. List the major characteristics of archaeobacteria.	

7. Describe the cell structure of eubacteria.
8. Explain reproduction in Nostoc.
9. Write any three economic uses of cyanobacteria.
10. Explain conjugation, transformation, and transduction in bacteria.

Unit III: Thallophytes – Algae

11. Mention the general characters of algae.
12. Describe the thallus and reproduction of Oedogonium.
13. Write a short note on Vaucheria.
14. Describe structure and reproduction of Batrachospermum.
15. Write any three uses of algae in food, agriculture, or medicine.

Unit IV: Thallophytes – Fungi

16. Write general characteristics of fungi.
17. Describe thallus and reproduction in Albugo.
18. Explain the reproductive structure of Aspergillus.
19. Mention different types of lichens.
20. State three applications of fungi in various industries.

6 Mark Questions (Long Answer)

Unit I: Microbial Diversity

1. Explain lytic and lysogenic cycles in detail with diagrams.
2. Describe the symptoms, transmission, and control of TMV.
3. Discuss the economic importance of viruses in modern biotechnology.

Unit II: Bacterial Diversity

4. Write a detailed account on archaebacteria: types, characters, and significance.
5. Explain in detail the three types of bacterial reproduction.
6. Describe the cell structure and reproduction of Nostoc.

Unit III: Thallophytes – Algae

7. Explain F. E. Fritsch's classification of algae.
8. Compare thallus and reproduction in Oedogonium, Vaucheria, and Ectocarpus.
9. Describe thallus and reproductive organs in Oedogonium,
10. Describe thallus and reproductive organs in Vaucheria
11. Describe thallus and reproductive organs in Ectocarpus.
12. Discuss the applications of algae in food, agriculture, and medicine.

Unit IV: Thallophytes – Fungi

10. Describe thallus and reproductive structure of Albugo.
11. Describe thallus and reproductive structure of Rhizopus.
12. Describe thallus and reproductive structure of Aspergillus.
13. Explain general characters of Basidiomycotina and Deuteromycotina with examples.
14. Describe the types and economic importance of lichens.

Major Course: Cryptogams II and Gymnosperms

Level	Semester	Course code	Course Name	Credits	Teaching Hrs	Exam Duration	Maximum Marks
5.0	III	107213	Cryptogams II and Gymnosperms	02	30	2.00 Hrs	30 (Ext.) 20 (Int)
Course Objectives: - To recall general characteristics, classification, and contributions of botanists in Bryophytes, Pteridophytes, Gymnosperms, and Palaeobotany. - To understand morphological and reproductive structures of selected plant groups and their significance. - To apply knowledge for ecological and conservation importance of these plants. - To correlate fossil plants with their modern counterparts. - To examine contributions of eminent scientists in plant taxonomy. - To analyze evolutionary relationships among plant groups. - To evaluate the role of fossils and economic importance of these plants.							
Course Outcome - Recall and describe characteristics and contributions in plant taxonomy. - Illustrate and explain structures and reproduction of selected plants. - Apply practical knowledge in plant identification and preservation. - Differentiate evolutionary affinities among plant groups. - Evaluate economic and ecological importance of these plants. - Propose conservation strategies for endangered species.							
Unit	Content				Workload Allotted (Hrs)	Weightage of Marks	Incorporation of pedagogies
I	Bryophytes:				07	07	Use any pedagogical technique suitable for the topic
	1.1 General Characters, Classification (Smith, 1955)						
	1.2 Thallus & reproductive structure of <i>Marchantia</i>						
	1.3 Thallus & reproductive structure of <i>Funaria</i>						
	1.4 Economic and ecological importance of Bryophytes						
II	Pteridophytes				08	08	
	2.1 General Characters, Classification (K. R. Sporne, 1975)						
	2.2 Thallus & reproductive structure of <i>Equisetum</i> and <i>Marsilea</i> .						
	2.3 Types of stele, Heterospory, and Seed habit						
	2.4 Economic importance of Pteridophytes and Ornamental Pteridophytes.						
III	Gymnosperms				08	08	
	3.1 General Characters and Classification (Bierhorts, 1971).						
	3.2 Plant Body and Reproductive Structures of <i>Pinus</i>						

	3.3 Plant body and reproductive structures of <i>Gnetum</i>			
	3.4 Economic importance of gymnosperms and Endangered gymnosperms (<i>Ginkgo biloba</i>)			
IV	Paleobotany	07	07	
	4.1 Geological time scale and types of fossils.			
	4.1 Fossil Pteridophytes (<i>Rhynia</i>) Fossil Gymnosperms (<i>Lyginopteris</i>)			
	4.2 Contribution of Prof. Birbal Sahni Affinities of Bryophytes with Pteridophytes			
	4.3 Affinities of Pteridophytes with Gymnosperms and Affinities of Gymnosperms with Angiosperms			
Activities for Continuous Assessment Tests (CAT):				
1.	Collection and photography of various Cryptogams (Bryophytes and Pteridophytes) in your local area.			
2.	Survey the gymnosperms plants inhabiting in your area (Public, Institutional and Personal gardens), describe them, and prepare a report.			
3.	Microscopic observations of locally available bryophytes, pteridophytes and gymnosperms.			
4.	To understand the ecological importance of Cryptogams.			
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1-Mark Questions (Answer in One Sentence) Unit I: Bryophytes - What are bryophytes? - Name the classification system of bryophytes given by Smith. - Which bryophyte shows a thalloid plant body? - What is the sex organ in Marchantia? - Name the reproductive structure in Funaria. - Mention one ecological role of bryophytes. Unit II: Pteridophytes - What are pteridophytes? - Who gave the classification of pteridophytes in 1975? - Which type of stele is found in Equisetum? - Define heterospory. - Name an ornamental pteridophyte. - Mention one economic importance of pteridophytes. Unit III: Gymnosperms - Define gymnosperms. - Who classified gymnosperms in 1971? - Name the male reproductive structure in Pinus. - Name the gymnosperm with vessel elements. - Mention one economic product obtained from gymnosperms. - Give the name of an endangered gymnosperm. Unit IV: Paleobotany - What is paleobotany? - Define fossil. - Name a fossil pteridophyte. - Who was Prof. Birbal Sahni? - Name one similarity between bryophytes and pteridophytes. - Mention one affinity between gymnosperms and angiosperms. 3-Mark Questions (Short Answers) Unit I: Bryophytes - Describe general characters of bryophytes. - Write a short note on Smith's classification of bryophytes. - Describe the thallus structure in Marchantia. - Describe the reproduction in Marchantia - Describe the reproduction in Funaria. - Mention any three economic or ecological roles of bryophytes. Unit II: Pteridophytes - Describe the general characters of pteridophytes. - Write a note on K.R. Sporne's classification. - Describe the morphological structure of Equisetum. - Describe the reproduction of Equisetum. - Explain is heterospory with suitable example. - Mention three economic uses of pteridophytes. Unit III: Gymnosperms - Mention general characters of gymnosperms.	

14. Describe the morphological characters of Pinus 15. Describe the reproductive structures of Pinus. 16. Describe the morphological structure of Gnetum. 17. Explain the reproductive structures of Gnetum. 18. Write any three economic uses of gymnosperms.
Unit IV: Paleobotany 19. Draw and explain a geological time scale. 20. Write a short note on Rhynia as a fossil pteridophyte. 21. Explain the significance of Birbal Sahni in Indian paleobotany. 22. Mention three affinities between bryophytes and pteridophytes. 23. Describe any three similarities between gymnosperms and angiosperms.
6-Mark Questions (Long Answers) Unit I: Bryophytes 1. Describe in detail the classification of bryophytes by Smith (1955). 2. Explain the reproduction in Marchantia. 3. Describe the reproductive structures of Funaria. 4. Discuss the economic and ecological importance of bryophytes.
Unit II: Pteridophytes 5. Compare the thallus structure and reproduction in Equisetum and Marsilea. 6. Describe the morphology of Equisetum. 7. Describe the reproduction in Equisetum. 8. Describe the morphology of Marsilea. 9. Describe reproduction in Marsilea. 10. Explain various types of stele with suitable diagrams. 11. Describe heterospory and its role in the evolution of seed habit. 12. Explain the economic importance and ornamental value of pteridophytes.
Unit III: Gymnosperms 13. Explain the reproductive structures of Pinus 14. Explain the reproductive structures of Gnetum.
Unit IV: Paleobotany 15. Describe the geological time scale and types of fossils. 16. Write detailed notes on Rhynia and Lyginopteris as fossil plants. 17. Describe the affinities of bryophytes with pteridophytes. 18. Discuss the evolutionary links between pteridophytes and gymnosperms, and gymnosperms with angiosperms.

Assessment Rubric: Internal for Theory Course (Major/Minor)

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. II (Botany), SEMESTER – III (NEP)			
Theory	Course Code: _____	Course Title: _____	Max Marks: 20
S. No.	Assessment Criteria		Marks
1	Attendance in Theory Classes		5
2	Any One of the Activities suggested in Course (CAT-1)		5
3	Participation in Field Activity/ Visit (CAT-2)		5
4	Quiz/ MCQ Tests/Seminar/ Unit Test etc. based Theory Course (CAT-3)		5

Major Practical – 8: Techniques in Microbial Studies, Plant Diseases and Cryptogams and Gymnosperms

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	107214	Techniques in Microbial Studies, Plant Diseases and Cryptogams and Gymnosperms	2	60	4 Hrs	25(Ext) + 25(Int)

Course Objectives:

- To Understand basic microbiological techniques including smear preparation, staining, and microbial observations.
- To enable students to identify algal, fungal, bryophytic, pteridophytic, and gymnosperm specimens through morphological and anatomical features.
- To impart skills for algal culturing and microbial isolation from natural habitats.
- To help students understand the ecological and reproductive aspects of lower plant groups.
- To promote observational, analytical, and documentation skills through practical exposure.

Course Outcomes:

- Explain and demonstrate structural features of microorganisms such as viruses, bacteria, and fungi.
- Gain practical skills in slide preparation, staining, and microbial identification.
- Capable of isolating and culturing microorganisms using standard microbiological techniques.
- Identify common algal and fungal species microscopically using temporary slides.
- Understand algal culturing techniques and microbial population analysis methods such as plate count and turbidity.
- Demonstrate knowledge of the anatomical and reproductive structures of bryophytes, pteridophytes, and gymnosperms.
- Develop skills in collecting rhizosphere fungi and applying ecological sampling methods.

List of Exercises:

1. Preparation of Temporary Slides and Identification of Algal Forms –
(*Nostoc*, *Volvox*, *Oedogonium*, *Chara*, *Vaucheria*, *Ectocarpus*, *Batrachospermum*, *Sargassum* – Any Three)
2. Preparation of Temporary Slides and Identification of Fungal Forms
(*Mucor*, *Rhizopus*, *Aspergillus*, *Puccinia*, *Albugo*, *Agaricus*, *Alternaria*, *Cercospora* – Any Three)
3. Study of Thallus Structure, Anatomy and Reproductive Features of Bryophytes
(*Marchantia*, *Anthoceros*, *Funaria*, *Polytrichum* – Any Two)
4. Study of Thallus Structure, Anatomy and Reproductive Features of Pteridophytes
(*Psilotum*, *Selaginella*, *Lycopodium*, *Marsilea*, *Equisetum* – Any Two)
5. Study of Plant Botany, Anatomy of Leaf/Stem and Reproductive Features of Gymnosperms
(*Pinus*, *Taxus*, *Araucaria*, *Zamia*, *Gnetum* – Any two)

Activities (Any 4 of the following) -

1. Demonstration of Viral Structure
2. Preparation of a Bacterial Smear
3. Differentiation of Gram-Positive and Gram-Negative Bacteria
4. Identification of the Algal / Fungal Forms from the mixtures
5. Evolution of the Thallus in Algae / Bryophytes
6. Collect different types of gymnosperm cones, describe and identify the given gymnosperm material.

Any one activity of the following -

- a. Botanical Excursion and report submission
- b. Collection and identification of algal forms from local sites- report submission
- c. Collection of fungal/ bacterial/ viral diseased plant specimens/ photographs and identification- report submission

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2. Sharma, O.P. – *Microbiology and Phycology*, McGraw Hill Education
3. Alexopoulos, C.J., Mims, C.W., Blackwell, M. – *Introductory Mycology*, Wiley
4. Kumar, H.D. – *Introductory Phycology*, Affiliated East-West Press
5. Parihar, N.S. – *Bryophyta*, Central Book Depot
6. Puri, P. – *Bryophytes and Pteridophytes*, Atma Ram & Sons
7. Sporne, K.R. – *The Morphology of Pteridophytes*, B.I. Publications
8. Chamberlain, C.J. – *Gymnosperms: Structure and Evolution*, Dover Publications
9. Relevant Research Articles from journals like *Journal of Applied Phycology*, *Mycologia*, *Indian Journal of Microbiology*, etc.

E-Contents / E-Books (Free or Purchase Links)

10. NCERT Biology Textbooks – Free official e-books
11. NPTEL Courses – Botany/Microbiology – Free video lectures and content
12. Botany eBooks Library (Internet Archive) – Historic and modern books
13. *Introductory Phycology* by Kumar HD – Available on Amazon/Flipkart
14. *Microbiology: An Introduction* by Tortora et al. – Pearson (purchase)

Digital Resources / Web Links

15. [Botany Digital Herbarium – BSI](#)
16. [Microbiology Society – Resources & Journals](#)
17. [AlgaeBase – World-wide Electronic Publication](#)
18. Fungal Biodiversity Centre – CBS
19. [Khan Academy – Microbiology and Plant Biology](#)
20. [eFloras – Flora of India & other regions](#)

Educational Software, Databases, etc.

21. Virtual Labs – Amrita Vishwa Vidyapeetham (MHRD, Govt. of India) Website: <https://vlab.amrita.edu>

22. PhycoBank (Algae Database)Website: https://www.phycobank.org
23. MycoBank (Fungal Names Database)
24. Website: https://www.mycobank.org
25. Official fungal nomenclature and taxonomy database with literature links.
26. The Plant List / World Flora Online Website: http://www.theplantlist.org , http://www.worldfloraonline.org
27. Botanical Survey of India – Digital Flora and HerbariumWebsite: https://bsi.gov.in
28. Zotero (<i>Research Reference Manager</i>)
29. Website: https://www.zotero.org
30. ImageJ – Biological Image Analysis SoftwareWebsite: https://imagej.nih.gov/ij
31. iNaturalist
32. Website: https://www.inaturalist.org
33. Flora of India Mobile App (<i>by BSI</i>)
Google Lens / PlantNet App

Assessment Rubric: External Practical Course

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. II (Botany), SEMESTER – III (NEP)				
Practical-8	Course Code: 107214	Techniques in Microbial Studies, Plant Diseases and Cryptogams and Gymnosperms	Max Marks: 25	Time: 4 Hrs.
Q.No.	Exercise			Marks
1.	Preparation of Temporary Slides and Identification of Algal Forms (Any one)			4
2.	Preparation of Temporary Slides and Identification of Fungal Forms (Any one)			4
3.	Identification of Bryophyte (Any one)			4
4.	Identification of Pteridophyte (Any one)			4
5.	Identification of Gymnosperm (Any one)			4
6.	External Viva Voce			5

Assessment Rubric: Internal Practical Course

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. II (Botany), SEMESTER – III (NEP)			
Practical-8	Course Code: 107214	Techniques in Microbial Studies, Plant Diseases and Cryptogams and Gymnosperms	Max Marks: 25
S. No.	Assessment Criteria		Marks
1	Record/ Assignments		5
2	Attendance		5
3	Participation in Activity/ Field visit		5
4	Students' overall performance		5
5	Internal Viva Voce		5

IKS –Major Specific: Sacred Plant Heritage of Maharashtra

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	107215	Sacred Plant Heritage of Maharashtra	2	30	2 Hrs	30 (Ext.) 20 (Int)

Course Objectives:

- To provide opportunities for understanding the history of sacred plants, traditional festivals and rituals in Maharashtra and connecting them to ancient beliefs, rituals and practices.
- To improve critical thinking and problem-solving skills through the study of traditional conservation strategies of sacred groves.
- To create awareness of conservation of sacred plants.
- To encourage students to apply their knowledge in ecological, ethnobotanical and conservational contexts.

Course Outcomes:

After completing this course, the students will be able to:

- Explain the scope and importance of Traditional knowledge of sacred plants in India.
- Understand the importance and role of traditional festivals, rituals and cultures.
- Compare the traditional conservation strategies of sacred plants with today's modern approaches.
- Revealing the potential of sacred plants in modern medicine.
- Utilize this knowledge in future medicinal research.

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
I	Introduction to Plant Heritage	8	8	Suitable pedagogical strategies are separately annexed
	1.1 Holistic system of health and herbal remedies in Charak Sanhita, Sushruta Sanhita and Ashtang Hridaya			
	1.2 Herbal wealth in Ancient Indian Scriptures (Vedas, Upanishads and Puranas, Quran, Guru Granth Sahib, Kalpa Sutra, Jataka Tales, etc.)			
	1.3 Ancient practices in Agriculture (Vrikshayurveda by Surapal and Krishi Parashara by Parashara)			
	1.4 Socio-cultural and religious significance of plants and their Parts			
II	Sacred Plant Heritage:	7	7	
	2.1 Prithivi Sukta from Atharvaveda for ecological consciousness			
	2.2 Sacred Trees, their cultural and religious values and Significance			
	2.3 Role of plants in rituals, festivals and customs as food, ornaments, preparation etc.			
	2.4 Regional Sacred and Spiritual Plants with Holistic Approach – Durva (दूर्वा), Tulsi (तूळस), Shami (शमी), Banana (केळी), Palas (पळस), Peepal (पिंपळ), Banyan Tree (वड), Bel (बेल), Umber (ऊंबर),			

	Neem (कडू निम), Amala (आवळा), Jamun (जांभूळ), Coconut (नारळ), Mango (आंबा)			
III	Sacred Groves and Plant Conservation	8	8	
	3.1 Sacred Groves (देवराई): Role in Biodiversity and Ecological Conservation			
	3.2 Rules and Taboos for its protections			
	3.3 Heritage symbols: National and Maharashtra State Plant Symbols (Tree/Flower/Fruit/Medicinal Plant, etc.)			
	3.4 Integration of plants from traditional knowledge in AYUSH			
IV	Application and Modern Aspects	7	7	
	4.1 Scientific Temperament for Folk Beliefs and Practices			
	4.2 Ethical Practices in Commercialization and Exploitations plant wealth			
	4.3 Relevance of Ancient Indian Knowledge in the present time			
	4.4 Emerging trends and future research needs to explore Indian Traditional Knowledge			

Suggested Activities:

1. Interactive Lecture & Discussion: Introduce students to ancient plant-based knowledge systems. Highlight Ayurveda, the classification of medicinal plants, and their traditional uses. Provide examples of modern applications, like how traditional knowledge influences pharmaceutical discoveries today.

2. Task: Create Your Plant Codex: Divide students into groups. Assign each group a region of India and ask them to research, indigenous plants and their uses. Ask each group to compile their findings into a visual representation like a chart, info-graphic or booklet. Also prepare the diagram or poster showing different plant families & their characteristics.

3. Creative Task: Ask students to write or perform a short skit embodying one plant’s role in the scriptures. For example, dramatize the use of the Soma plant in rituals. Also create arts pieces using plant materials such as leaves, flowers or seeds.

4. Reflection Activity: Students write an essay on the integration of plant wisdom in ancient Indian spiritual practices.

5. Field Visit (if feasible): Take students to a nearby sacred grove or historical tree site. Discuss the traditions of tree worship, such as Kalpavriksha and its representation in Indian heritage. As well as collect plant specimens from sacred groves and identify them using keys/flora or other resources.

6. Organization of Workshop and Conferences: Invite a local historian or botanist to share insights on tree worship’s significance through time. To bring together researchers, policymakers and industry stakeholders to discuss the latest research & development in medicinal plants.

7. Group Project: Students collaborate to create a timeline showing the evolution of tree worship practices from the Indus Valley Civilization to modern India.

8. Hands-On Activity: Organize a ritual-recreation session where students enact and explain the cultural symbolism (e.g., Gudhi flags with mango/betel leaves or Tulsi’s ritual during Diwali).

9. Cultural Essays: Students will interview locals or grandparents to collect oral histories/stories about plants. Compile these into a class journal of plant heritage.

10. Introduction Discussion: Begin with a short story or video about a sacred plant, like the Tulsi plant's role in Indian households. Discuss the concept of sacredness in nature and why certain plants are considered sacred across different cultures.

- 11. Debate Activity: Ancient Beliefs vs. Modern Science:** Topic: "Are sacred trees revered more for their religious value or scientific/environmental benefits?" Divide the class into two teams to debate. Each side incorporates examples and findings from their research.
- 12. Storytelling Session:** Share historical accounts or myths surrounding sacred groves, such as the connection between sacred groves and village deities, or the cultural beliefs in protecting groves as abodes of gods.
- 13. Field Visit (if possible):** Organize a visit to a nearby sacred grove or biodiversity park or Devrai to observe: 1. Native plant species. 2. The untouched ecosystem.
- 14. Biodiversity Mapping:** Students document the different plants, birds, and insects found in the grove (using pictures and notes). Research, how such biodiversity is crucial for the local and global environment (e.g., as seed banks, oxygen park).
- 15. Case Studies:** Assign case studies on groves acting as natural refuges for endangered species. Students can research success stories where groves played an active role in ecological restoration. Also conduct a case study of specific sacred grove or plant, examining its history, cultural significance & conservation.
- 16. Experimental Workshop:** Students perform simple experiments, such as testing the antimicrobial properties of Tulsi or Neem leaves to evaluate traditional claims.

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1-Mark Questions (Answer in One Sentence)

Unit I: Introduction to Plant Heritage

1. Name any one Ayurvedic scripture that discusses herbal remedies.
2. Which scripture contains the concept of 'Vrikshayurveda'?
3. Mention one plant-related reference from the Vedas.
4. What is the main focus of Krishi Parashara?
5. State one socio-religious use of plants in Indian culture.

Unit II: Sacred Plant Heritage

6. What is Prithvi Sukta?
7. Name a sacred tree revered in Indian culture.
8. Which plant is commonly used in Indian festivals for making garlands?
9. Which tree is considered sacred and planted near temples?
10. Name one sacred plant used in rituals in Maharashtra.

Unit III: Sacred Groves and Plant Conservation

11. What are sacred groves called in Marathi?
12. State one role of sacred groves in biodiversity conservation.
13. Name the national tree of India.
14. Mention one rule or taboo followed in sacred groves.
15. Which system integrates traditional knowledge into health care in India?

Unit IV: Application and Modern Aspects

16. What is meant by scientific temperament?
17. Name one unethical practice in commercialization of plant wealth.
18. State one relevance of Indian plant heritage in today's world.
19. Mention one emerging trend in the study of Indian traditional plant knowledge.
20. What does AYUSH stand for?

3-Mark Questions (Short Answers)

Unit I: Introduction to Plant Heritage

1. Compare the herbal health approaches in Charak Sanhita and Sushruta Sanhita.
2. Describe any three references of herbal wealth from ancient scriptures.
3. Write a short note on Vrikshayurveda
4. Mention ancient Indian practices in agriculture.
5. Explain the religious use of any three plant parts in Indian tradition.

Unit II: Sacred Plant Heritage

6. Write about any three sacred trees and their cultural roles.
7. Describe the use of plants in Indian rituals and festivals.
8. Write a note on the spiritual value of Tulsi.
9. Write a note on the spiritual value of Bel.
10. Write a note on the spiritual value of Shami.
11. Explain the holistic approach behind the use of Banana
12. Explain the holistic approach behind the use of Neem and Mango in tradition
13. Explain the holistic approach behind the use of Mango in tradition
14. Describe holistic significance of regional sacred plant Tulsi.
15. Describe holistic significance of regional sacred plant Palas.
16. Describe holistic significance of regional sacred plant Bel.

Unit III: Sacred Groves and Plant Conservation

17. Describe any three ecological benefits of sacred groves.
18. Mention the rules and taboos that help preserve sacred groves.
19. Explain any three heritage plant symbols of India or Maharashtra.
20. Write a short note on the contribution of AYUSH in promoting traditional knowledge.
21. Describe the significance of Umber, Amala, and Jamun in ecological conservation.
22. Describe the significance of Amala, and Jamun in ecological conservation
23. Describe the significance of Umber and Jamun in ecological conservation

Unit IV: Application and Modern Aspects

24. How can scientific temperament help validate folk plant practices?
25. Write a short note on ethical vs unethical practices in plant commercialization.
26. Mention three modern applications of ancient Indian botanical knowledge.
27. Describe any three areas of research needed in traditional plant wisdom.
28. What role can education play in integrating traditional knowledge with modern science?

6-Mark Questions (Long Answers)

Unit I: Introduction to Plant Heritage

1. Explain the holistic systems of health and herbal treatment described in Charak, Sushruta, and Ashtang Hridaya.
2. Describe herbal references found in Vedas, Upanishads, Puranas, and other scriptures.
3. Discuss in detail the ancient agricultural practices mentioned in Vrikshayurveda and Krishi Parashara.
4. Write an essay on the religious and socio-cultural significance of plants in ancient India.

Unit II: Sacred Plant Heritage

5. Describe the ecological consciousness in the Prithvi Sukta from Atharvaveda.
6. Write detailed notes on sacred trees and their religious values in Indian tradition.
7. Explain the role of plants in rituals, festivals, and customs with examples.
8. Elaborate on the holistic significance of regional sacred plants Palas, Bel and Neem.
9. Elaborate on the holistic significance of regional sacred plants Tulsi, Peepal, and Palas,

Unit III: Sacred Groves and Plant Conservation

10. Describe the role of sacred groves (Devarai) in biodiversity and ecological conservation. 11. Explain the cultural taboos and traditional rules associated with sacred groves. 12. Discuss the heritage plant symbols of India and Maharashtra with their significance. 13. Describe how traditional knowledge systems have been integrated into AYUSH and plant-based healthcare. Unit IV: Application and Modern Aspects 14. Discuss the importance of developing scientific temperament to understand traditional plant practices. 15. Elaborate on ethical concerns in commercialization and exploitation of plant wealth. 16. Explain the relevance of ancient Indian botanical knowledge in the current era.

Assessment Rubric: Internal for IKS (Major Specific) Course

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. II (Botany), SEMESTER – III (NEP)			
Theory	Course Code: 107215	Course Title: Sacred Plant Heritage of Maharashtra	Max Marks: 20
S. No.	Assessment Criteria	Marks	
1	Attendance in Theory Classes	5	
2	Any One of the Activities suggested in Course (CAT-1)	5	
3	Participation in Field Activity/ Visit (CAT-2)	5	
4	Quiz/ MCQ Tests/Seminar/ Unit Test etc. based Theory Course (CAT-3)	5	

Minor Theory: Plant Diversity, Conservation & Forensic Botany

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	107216	Plant Diversity, Conservation & Forensic Botany	2	30	2 Hrs	30 (Ext.) 20 (Int)

Course Objectives: - To recall the fundamental characteristics of microbes, cryptogams, and phanerogams. - To understand the role of symbiotic associations like Mycorrhiza and Lichens in nature. - To comprehend the importance of plant conservation methods and biodiversity. - To apply the knowledge of microbes and plant diversity in agriculture, pharmaceuticals, and reclamation. - To use forensic botany knowledge for collecting and analyzing phyto-evidence. - To analyze the causes of plant extinction and loss of biodiversity. - To distinguish between Gymnosperms and Angiosperms based on reproductive and morphological features. - To evaluate the importance of phyto-evidence like pollen, seeds, and fibers in forensic investigations. - To design conservation models for biodiversity protection and resource utilization. - To develop case studies using DNA fingerprinting and forensic botany techniques.

Course Outcomes: After completing this course, the students will be able to: - Explain the general features of Bacteria, Cyanobacteria, Viruses, Fungi, Algae, Bryophytes, Pteridophytes, Gymnosperms, and Angiosperms. - Summarize the concept of biodiversity, extinction, and conservation methods like Ex-situ and In-situ conservation. - Understand the role of Mycorrhiza and Lichens in promoting plant growth and maintaining ecological balance. Demonstrate the application of microbes and plants in industries like agriculture, medicine, and environmental conservation. - Apply techniques of forensic botany to identify and assess plant-based evidence in criminal investigations. Evaluate the role of phyto-evidence (pollen, fibers, seeds, leaves) in solving criminal cases. - Analyze the causes and impact of biodiversity loss and propose conservation measures. - Assess the economic and ethnobotanical significance of plants like Wheat, Rice, Cotton, and medicinal plants. - Create and design conservation strategies for biodiversity preservation using in-situ and ex-situ conservation models.

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
I	Microbial and Cryptogamic Diversity	8	8	Suitable pedagogical strategies are separately annexed
	1.1 Microbial Diversity: General Characteristics features of microbe (Bacteria, Cyanobacteria, Viruses, Fungi, Algae)			
	1.2 Symbiotic Association: Mycorrhiza and Lichens			
	1.3 Bryophytes & Pteridophytes: General Characteristics features and Economic Importance			

	1.4 Microbes at Service of Mankind: Resource Exploitation and utilization (Agriculture, Pharmaceutical, Fertilizer, Reclamation)			
II	Phanerogams Diversity	7	7	
	2.1 Gymnosperm: General Character, Reproductive Structure (<i>Pinus</i> , <i>Cycas</i>), Economic Importance			
	2.2 Angiosperms: Structural / Morphological Diversity in Monocot and Dicot			
	2.3 Reproduction in Angiosperm: Types of Pollination, Seed dispersal			
	2.4 Economic and Ethnobotanical Plant: Economically significant Plant (wheat, cotton, sugarcane), Important Plant in Traditional Medicine System in Brief Tulsi and Adulsa			
III	Plant Conservation	8	8	
	3.1 Biodiversity: Concept and Significance			
	3.2 Extinction of Plants: Causes, Overview / Introduction to Red Data Book			
	3.3 Ex-situ and In-Situ Conservation: Concept and Scope, Seed Bank			
	3.4 Case Study: Conservation of <i>Gloriosa superba</i> - An example of science-policy-community synergy in Maharashtra			
IV	Forensic Botany	7	7	
	1.1 Forensic Botany: Scope, Concept and Limitations			
	1.2 Phyto-evidences and Offences: Pollen, Seeds, Fibres and leaves as phyto-evidences in offences and Importance			
	1.3 Application of Phyto-evidences: identification, Collection, Assessment in forensic Investigation			
	1.4 DNA fingerprinting: Techniques for phyto-evidences identification, Case Study			

1-Mark Questions (One-Sentence Answers)

Unit I: Microbial and Cryptogamic Diversity

1. Name any one characteristic of bacteria.

2. What is a mycorrhiza?

3. Write one use of cyanobacteria.

4. Name one economic use of pteridophytes.

5. Give one example of a symbiotic association in plants.

Unit II: Phanerogams Diversity

6. Name a gymnosperm with a well-defined cone.

7. What is the difference between monocot and dicot leaves? (any one)

8. Name any one pollinating agent.

9. Mention one seed dispersal mechanism.

10. Give the scientific name of Tulsi.

Unit III: Plant Conservation

11. What is biodiversity?

12. Name any one cause of plant extinction.
13. What is a seed bank?
14. Give one example of an ex-situ conservation site.
15. What is the full form of IUCN?

Unit IV: Forensic Botany

16. Define forensic botany
17. Mention one plant part used as phyto-evidence.
18. What is the use of DNA fingerprinting in forensic botany?
19. Name any one limitation of forensic botany.
20. Give an example of a forensic case solved using plant DNA.

3-Mark Questions (Short Answers)

Unit I: Microbial and Cryptogamic Diversity

1. Write general features of viruses.
2. Write general features of bacteria.
3. Write general features of fungi.
4. Describe mycorrhiza.
5. Describe lichen.
6. List the economic uses of bryophytes
7. List the economic uses of pteridophytes.

Unit II: Phanerogams Diversity

8. Describe general characters of Cycas.
9. Describe general characters of Pinus.
10. Describe reproductive structures in Cycas.
11. Describe reproductive structures Pinus.
12. Differentiate between monocot and dicot .
13. Explain the types of pollination with examples.
14. Write a note on seed dispersal by wind and animals.
15. Explain the medicinal importance of Adulsa.
16. Explain the medicinal importance of Tulsi.

Unit III: Plant Conservation

17. Explain importance of Biodiversity .
18. Describe causes of plant extinction
19. Explain ex-situ conservation .
20. Write a note on botanical gardens and their role.
21. Explain the concept of sacred groves with examples.

Unit IV: Forensic Botany

22. Explain scope of forensic botany.
23. Describe the role of pollen and fibres in criminal investigation.
24. How are seeds and leaves used as phyto-evidence?
25. Explain the procedure of collecting plant evidence at a crime scene.
26. Describe any technique used in DNA fingerprinting of plant samples.

6-Mark Questions (Long Answers)

Unit I: Microbial and Cryptogamic Diversity

1. Describe the general characteristics and significance of microbes: cyanobacteria.
2. Explain symbiotic associations: structure, types, and ecological importance of mycorrhiza.
3. Describe the characteristics feature and economic importance of bryophytes.
4. Describe the characteristics feature and economic importance of pteridophytes.

Unit II: Phanerogams Diversity

5. Discuss the general characters, reproductive structures of Cycas.
6. Discuss the general characters, reproductive structures of Pinus.
7. Compare the morphological features of monocot and dicot plants with suitable examples.
8. Explain the process of pollination, pollinating agents, and types of seed dispersal with examples.
9. Describe the economic importance of wheat and rice.

10. Describe the economic importance of cotton, and sugarcane.

11. Describe ethnobotanical uses of Tulsi and Adulsa.

Unit III: Plant Conservation

12. Define biodiversity and explain its significance in the ecosystem.

13. Explain the concepts, methods, and advantages of ex-situ conservation including seed banks.

14. Discuss in-situ conservation methods with examples of national parks, wildlife sanctuaries, botanical gardens, and sacred groves.

Unit IV: Forensic Botany

15. Explain the concept, scope, and limitations of forensic botany in crime investigation.

16. Discuss the use of phyto-evidences like pollen, seeds, fibres, and leaves in solving crimes.

17. Describe the collection, preservation, and role of phyto-evidence in forensic investigations.

18. Elaborate on DNA fingerprinting techniques and present a case study involving plant evidence.

Minor Practical – 9: Practical Approach towards Plant Diversity, Conservation and Forensic Botany

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	107217	Practical Approach towards Plant Diversity, Conservation and Forensic Botany	2	60	4 Hrs	25 (Ext) +25 (Int)

Course Objectives:

- Identify the general characteristics and economic importance of microbes, bryophytes, pteridophytes, and gymnosperms.
- Explain the role of microbes in agriculture, pharmaceuticals, and environmental reclamation.
- Describe the reproductive structures of angiosperms and gymnosperms with respect to their morphological diversity.
- Apply knowledge of traditional and ethnobotanical plants in health care and economic development.
- Use forensic botany techniques to collect, analyze, and interpret phyto-evidence from crime scenes.
- Analyze plant conservation methods through in-situ and ex-situ approaches.
- Differentiate between different types of pollination and their ecological significance.
- Design herbarium, plant charts, and infographics on plant diversity, economic plants, and traditional medicine practices.

Course Outcomes:

- Identify and classify different groups of microbes, cryptogams, and phanerogams based on their characteristics.
- Explain the reproductive structures, pollination mechanisms, and seed dispersal methods in angiosperms and gymnosperms.
- Apply practical knowledge in microbial culture, herbarium preparation, natural dye extraction, and forensic evidence collection.
- Analyze the economic importance of plants in traditional medicine, agriculture, and industry.
- Evaluate the role of conservation methods in biodiversity protection and sustainable utilization of plant resources.

Major Experiments (Perform any 6)

1. Preparation and observation of slides of algal material
2. Study of Gram staining techniques.
3. Preparation and observation of slides of fungal material
4. Study of the morphological and reproductive structures of Bryophytes
5. Study of the morphological and reproductive structures of Pteridophytes
6. Study of the morphological and reproductive structures of Gymnosperms
7. Comparative analysis of Monocot vs. Dicot Angiosperms.
8. Study of the structure of the flower in Monocot and Dicot
9. Study of Pollen Grain structure under microscope
10. To study the morphology and uses of ethnobotanical plants (Any one).

Minor Experiments (Perform any 4):

1. Simple staining of plant cells and observation under a microscope.
2. Identification of different types of lichens and their environmental significance.
3. Preparation of Herbarium of any five local plant specimens.
4. Identification of common natural fibres (cotton, jute) under a microscope.
5. Study of the standard techniques for handling soil samples
6. Preparation of the media for microbial culture.

- Extraction of natural dyes from leaves, flowers, and bark. - Demonstration of Agarose gel electrophoresis.
Activities (Perform any Two): - Observation and recording of various pollination mechanisms in angiosperms. - Collection, preservation, and microscopic analysis of seeds and plant fragments from mock crime scenes. - Visit of the National Park, Wildlife sanctuaries, Botanical Garden and Sacred grooves
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Question Paper for Minor External Practical Course on Practical Approach towards Plant Diversity, Conservation and Forensic Botany

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. II (Botany), SEMESTER – III (NEP-2020)				
Practical-9	Course Code: 107217	Practical Approach towards Plant Diversity, Conservation and Forensic Botany	Max Marks: 25	Time: 4 Hrs.
Q.No.	Exercise			Marks
1.	Perform Any One Major Experiment			10
2.	Perform any One Exercise from Minor Experiments			5
3.	Spotting (Five Spots carrying 01 Mark from the entire curriculum)			5
4.	External Viva Voce			5

Assessment Rubric for Internal Practical

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. II (Botany), SEMESTER – III (NEP) Minor			
Practical-9	Course Code: 107217	Practical Approach towards Plant Diversity, Conservation and Forensic Botany	Max Marks: 25
S. No.	Assessment Criteria		Marks
1	Record/ Assignments		5
2	Attendance		5
3	Participation in Field Activity/Visit		5
4	Students overall performance		5
5	Internal Viva Voce		5

GOEC Theory: Traditional Health Care

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	107218	Traditional Health Care	2	30	2 Hrs	30 (Ext.) 20 (Int)

Course Objectives:

- To provide opportunities for understanding the history of Traditional Health care system.
- To know about Traditional health practices.
- To learn how to use ethnographic techniques to understand the socio-cultural context of traditional health practices.
- To create awareness of conservation of medicinal plants.

Course Outcomes:

After completing this course, the students will be able to:

- Identify India's major systems of traditional health and trace their historical and theoretical roots.
- Explain the scope and importance of Traditional knowledge of plants in India.
- Understand how traditional medicine can be used to improve health and well-being.
- Apply the methods of observation, note-taking and interviewing in the completion of an ethically sound short field study project.
- Utilize this knowledge in future medicinal research.

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
I	Introduction, Historical Background and Perspective of Traditional Healthcare (THS)	8	8	Suitable pedagogical strategies are separately annexed
	1.1 History and Evolution of Traditional Healthcare System in India.			
	1.2 Concept and Scope of Traditional Health care			
	1.3 Indian System of Medicine (ISM)			
	1.4 Perspective and Policies in health care development.			
II	Role of plants and modern application in Traditional Healthcare system (THS)	7	7	
	2.1 Plant as a source of Medicines.			
	2.2 Identification and characterization of medicinal plants - any two from <i>Withania somnifera</i> (Ashwagandha), <i>Gloriosa superba</i> (Kalihari / Flame Lily), <i>Terminalia arjuna</i> (Arjuna), <i>Gymnema sylvestre</i> (Gudmar), <i>Tinospora cordifolia</i> (Giloy)			
	2.3 Role of Traditional Healthcare in Modern Society and Global Health.			
	2.4 Challenges and opportunities in implementation of traditional and modern health care.			
III	Plant based Traditional Healthcare and therapies	8	8	
	3.1 Internal Medicines (Decoction, Infusion, Tinctures, Powder).			

	3.2 External Medicines (Topical application, Baths and soaks, Compresses).			
	3.3 Dietary Practices (Herbal teas, Medicinal plant-based food).			
	3.4 Therapies (Aroma therapy, Herbalism, Phytotherapy).			
IV	Ethics and Traditional Medicine of THC	7	7	
	4.1 Ethics in use of Traditional Medicine.			
	4.2 Clinical trials and outcome measures for THC.			
	4.3 Need of documentation and validation of THC knowledge.			
	4.4 Voluntary Certification of Traditional Health Practitioner			
Suggested Activities: • Interactive Lecture & Discussion: Introduce students to history plant-based knowledge systems. • Task: Create Your Plant chart: Divide students into groups. Assign each group a region of India and ask them to research, medicinal plants and their characterization. Ask each group to compile their findings into a visual representation like a chart, info-graphic or booklet. Also prepare the diagram or poster showing different medicinal plant & their characteristics. • Essay Activity: Organize write an essay competition on the Global Health Awareness Day on the topic the recent developments in the public health care system. • Field Visit: Through visits to and interaction with organizations and individuals working in India's traditional healthcare system, students gain first-hand exposure to the practices and environments of these alternative systems of wellness. • Visit to Naturopathy Hospitals and clinics: Visit to Ayurveda, Naturopathy hospitals, clinics, and ashrams to observe traditional health practitioners. • Organize Workshops, Health Awareness Talk: Attend or organize workshops to learn about traditional medicines, raise awareness about health, nutrition, and early disease identification. • Group Project: Students collaborate to create a timeline showing the evolution of tree worship practices from the Indus Valley Civilization to modern India. • Hands-On Activity: Collection of Data: Homemade remedies and practices (Decoction, Kadhas) for health care suggested by Grannies medicine pouch. • Game-based learning activity: Engaging traditional health care terminology games to boost students motivation. • Interview with Traditional doctor/vaidu (local)- Through discussion students learn about the traditional treatment methods, plant and plant part used formulations of herbal drugs used by Traditional Healers (Vaidu). • Case Studies and Real-life Application: Assign case studies on groves acting as natural refuges for endangered species. Also conduct a case study of specific plant, examining its history, cultural significance & conservation. References: Reference Books, Text Books, Research Articles: • Agarwal, P., & Kumar, V. (2021). Indian knowledge systems: Ancient wisdom in contemporary times. <i>Springer</i>. • Amit Jha: (2011) Traditional Indian Medicine. • Amritpal Singh. (2019). A Textbook of Traditional Medicine. • Hoffmaster, K. (2016). Traditional medicine: Old methods for the new you. [Kindle edition]. https://www.amazon.com/dp/B01MSCMUBB				

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1–Mark Questions (One–Sentence Answers)

Unit I: Introduction, Historical Background and Perspective of THS

1. What is traditional healthcare? / पारंपरिक आरोग्य सेवा म्हणजे काय?
2. Name any two ancient medical texts of India. / भारतातील प्राचीन वैद्यकीय ग्रंथांची नावे लिहा.
3. What is ISM? / ISM म्हणजे काय?
4. Name one major contributor to Ayurvedic literature. / आयुर्वेद साहित्याचा एक प्रमुख योगदानकर्ता कोण?
5. What is the scope of traditional healthcare? / पारंपरिक आरोग्य सेवांचा काय व्याप्ती आहे?
6. Mention one policy related to healthcare development. / आरोग्यविकासाशी संबंधित एक धोरण नमूद करा.
7. Define holistic healthcare. / समग्र आरोग्यसेवा याची व्याख्या करा.

Unit II: Role of Plants and Modern Application in THS

8. Name any two medicinal plants. / कोणत्याही दोन औषधी वनस्पतींची नावे लिहा.
9. What is the source of most traditional medicines? / बहुतेक पारंपरिक औषधांचा स्रोत काय आहे?
10. What is pharmacognosy? / वनौषधीशास्त्र म्हणजे काय?
11. Name one modern use of herbal medicine. / वनस्पती औषधाचा एक आधुनिक उपयोग सांगा.
12. Give one example of plant-based pharmaceutical. / वनस्पती आधारित औषधाचा एक उदाहरण द्या.
13. What is global health? / जागतिक आरोग्य म्हणजे काय?
14. Name any one challenge in traditional medicine. / पारंपरिक औषधशास्त्रातील एक आव्हान सांगा.

Unit III: Plant–Based Traditional Healthcare and Therapies

15. What is decoction? / काथ म्हणजे काय?
16. Name any one external traditional remedy. / पारंपरिक बाह्य उपायांपैकी एकाचे नाव सांगा.
17. What is herbal infusion? / वनस्पती अर्क म्हणजे काय?
18. What is aromatherapy? / सुगंधोपचार म्हणजे काय?
19. What is phytotherapy? / वनस्पती चिकित्साशास्त्र म्हणजे काय?
20. Name one dietary practice used traditionally. / पारंपरिक आहार पद्धतीचे एक उदाहरण सांगा.
21. Define tincture. / टिंचर म्हणजे काय?

Unit IV: Ethics and Traditional Medicine of THS

22. What is meant by ethical use of traditional medicine? / पारंपरिक औषधांचा नैतिक वापर म्हणजे काय?
23. What are clinical trials? / नैदानिक चाचण्या म्हणजे काय?
24. Define validation of knowledge. / ज्ञानाचे प्रमाणीकरण म्हणजे काय?
25. What is documentation? / दस्तऐवजीकरण म्हणजे काय?
26. What is voluntary certification? / ऐच्छिक प्रमाणपत्र म्हणजे काय?
27. Name one ethical issue in traditional healthcare. / पारंपरिक आरोग्य सेवांमधील एक नैतिक मुद्दा सांगा.
28. What is outcome measure? / परिणाम मापन म्हणजे काय?

3–Mark Questions (Short Answers)

Unit I

1. Write a short note on the historical background of traditional healthcare in India. / भारतातील पारंपरिक आरोग्यसेवेचा ऐतिहासिक पार्श्वभूमीवर लघु लेखन करा.
2. Explain the concept of holistic healthcare. / समग्र आरोग्यसेवेची संकल्पना स्पष्ट करा.
3. State the significance of Charak Samhita in Indian healthcare. / भारतीय आरोग्यसेवेमधील चरक संहितेचे महत्त्व स्पष्ट करा.
4. Describe the concept and scope of traditional healthcare. / पारंपरिक आरोग्यसेवेची संकल्पना आणि व्याप्ती स्पष्ट करा.
5. Mention the contribution of Sushruta Samhita in surgery. / शल्यक्रियेत सुश्रुत संहितेचे योगदान नमूद करा.
6. Give an overview of Indian Systems of Medicine (ISM). / भारतीय वैद्यकीय प्रणाली (ISM) चे संक्षिप्त विवेचन करा.
7. What are the recent government initiatives in healthcare development? / आरोग्यविकासातील अलीकडील सरकारी उपक्रम कोणते?

Unit II

8. Write the medicinal uses of any two plants. / कोणत्याही दोन वनस्पतींचे औषधी उपयोग लिहा.
9. Describe the role of plants in traditional medicine. / पारंपरिक औषधांमध्ये वनस्पतींची भूमिका स्पष्ट करा.
10. Explain the importance of identifying medicinal plants. / औषधी वनस्पतींची ओळख पटविण्याचे महत्त्व स्पष्ट करा.
11. Write about the modern use of traditional medicine. / पारंपरिक औषधांचा आधुनिक उपयोग लिहा.
12. List any five medicinal plants and their uses. / कोणत्याही पाच औषधी वनस्पती व त्यांचे उपयोग लिहा.
13. What are the challenges in using traditional medicine in modern society? / आधुनिक समाजात पारंपरिक औषधांचा वापर करताना येणाऱ्या अडचणी कोणत्या?
14. How does traditional healthcare support global health? / पारंपरिक आरोग्य सेवा जागतिक आरोग्याला कशी मदत करते?

Unit III

15. Write short notes on decoctions and infusions. / काथ आणि अर्क यावर लघु टिपणी लिहा.
16. Describe three types of external medicines. / तीन प्रकारच्या बाह्य औषधांचे वर्णन करा.
17. Explain the use of compresses in traditional medicine. / पारंपरिक औषधांमध्ये शोक देण्याचा उपयोग स्पष्ट करा.
18. What are herbal teas and their benefits? / हर्बल चहा म्हणजे काय व त्याचे फायदे काय?
19. Discuss the use of medicinal plant-based foods. / औषधी वनस्पती आधारित अन्नाचा उपयोग स्पष्ट करा.
20. Differentiate between herbalism and phytotherapy. / हर्बलिझम आणि फाइटोथेरेपी यातील फरक स्पष्ट करा.
21. What is the significance of baths and soaks in therapy? / उपचारामध्ये स्नान व भिजवण्याचे महत्त्व काय?

Unit IV

22. Explain the ethics involved in traditional medicine usage. / पारंपरिक औषध वापरात असलेले नैतिक मुद्दे स्पष्ट करा.
23. Describe the role of clinical trials in THC. / पारंपरिक आरोग्य सेवांमध्ये नैदानिक चाचण्यांची भूमिका स्पष्ट करा.
24. Why is documentation important in traditional medicine? / पारंपरिक औषधात दस्तऐवजीकरण का महत्त्वाचे आहे?
25. What are the benefits of validating THC knowledge? / पारंपरिक आरोग्य ज्ञानाचे प्रमाणीकरण केल्याचे फायदे काय?
26. What is voluntary certification and who can get it? / ऐच्छिक प्रमाणपत्र म्हणजे काय व कोण ते घेऊ शकते?
27. Discuss ethical concerns in commercialization of THC. / पारंपरिक औषध व्यवसायीकरणातील नैतिक चिंता स्पष्ट करा.
28. What outcome measures are used in evaluating traditional therapies? / पारंपरिक उपचारांचे मूल्यमापन करताना कोणती मापन पद्धती वापरली जाते?

6-Mark Questions (Long Answers)

Unit I

1. Write in detail about the evolution of traditional healthcare systems in India. / भारतातील पारंपरिक आरोग्यसेवेच्या विकासावर सविस्तर लेखन करा.
2. Explain the role of Charak, Sushruta, and Ashtang Hridaya in the development of Ayurveda. / आयुर्वेदाच्या विकासात चरक, सुश्रुत व अष्टांग हृदय यांची भूमिका स्पष्ट करा.
3. Discuss the perspectives and policies related to health care in India. / भारतातील आरोग्याशी संबंधित दृष्टीकोन व धोरणे स्पष्ट करा.

Unit II

4. Explain in detail the role of plants in the Indian traditional healthcare system. / भारतीय पारंपरिक आरोग्य सेवांमध्ये वनस्पतींची भूमिका सविस्तर लिहा.
5. Describe the opportunities and limitations of using traditional plants in modern medicine. / आधुनिक औषधांमध्ये पारंपरिक वनस्पतींचा उपयोग करताना येणाऱ्या संधी व मर्यादा स्पष्ट करा.
6. Discuss the relevance of medicinal plants in pharmaceutical industries. / औषधनिर्माण उद्योगात औषधी वनस्पतींचे महत्त्व स्पष्ट करा.

Unit III

7. Describe the different types of internal and external medicines in traditional healthcare. / पारंपरिक आरोग्य सेवेमध्ये आंतर व बाह्य औषधांचे विविध प्रकार स्पष्ट करा.

8. Write in detail about dietary and therapeutic practices in plant-based healthcare. / वनस्पती आधारित आरोग्य सेवांमधील आहार व उपचार पद्धती सविस्तर लिहा.
9. Explain the scope and role of aroma therapy and herbalism in traditional healing systems. / पारंपरिक उपचार पद्धतीमध्ये सुगंधोपचार व हर्बलिझमची भूमिका व व्याप्ती स्पष्ट करा.

Unit IV

10. Explain the ethical guidelines required for responsible use of traditional medicine. / पारंपरिक औषधांच्या जबाबदार वापरासाठी आवश्यक नैतिक मार्गदर्शक तत्वे स्पष्ट करा.
11. Discuss the importance and process of clinical trials and documentation in THC. / पारंपरिक आरोग्य सेवेमध्ये नैदानिक चाचण्या व दस्तऐवजीकरणाचे महत्त्व व प्रक्रिया स्पष्ट करा.
12. Elaborate on voluntary certification and its significance for traditional healthcare practitioners. / पारंपरिक आरोग्य सेवा तज्ञांसाठी ऐच्छिक प्रमाणपत्राचे महत्त्व सविस्तर स्पष्ट करा.

VSC: Supply Chain Management of Seeds

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	107219	Supply Chain Management of Seeds	2	60	4 Hrs	50

Course Objectives:

- To create opportunities of self-employment / student's startup through supply chain management of seed.
- To enrich students training and knowledge that would be useful in the seed industry so that the farmers will get quality seeds.
- To create awareness and involve seed producers in supply chain management.

Course Outcomes:

- Understand the Scope of seed industry and Supply chain management
- Demonstrate different methods of seed priming and packaging
- Understand: The concepts and significance of seed quality control
- Access: Major players in Seed Supply Chain management
- Analyze and compare the field inspection methods and steps for seed sampling
- Design Seed Marketing supply chain for promotion of quality seeds

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
I	Fundamentals of Seed Supply chain management.	15	12	Suitable pedagogical strategies are separately annexed
	1.1 Introduction to Supply chain management, scope and opportunities.			
	1.2 Stakeholders in seed supply chain; Breeders, Producers, Distributors and farmers.			
	1.3 SATHI (Seed Analytics, Technology, and Holistic Integration): Role in enriching the digital ecosystem for Seed.			
	1.4 Importance and promotion of quality seed, seed demand and supply systems.			
II	Seed Quality Maintenance Technologies	15	12	
	2.1 Seed priming: Physiological and biochemical basis, Coating, Pelleting & Hardening seed tapes, seed mats, seed coloring, biopriming			
	2.2 Packaging and labeling of seeds, handling, stacking and Logistics.			
	2.3 Seed Types- Nucleus Seeds, Breeder Seeds, Foundation Seeds, Hybrid Seeds & Certified Seeds			
	2.4 Maintenance of seed processing records.			
III	Legislation and Certification	15	12	
	3.1 Regulatory mechanisms of seed quality control- Government and nongovernment organizations, seed legislation and seed law enforcement, role of Central Seed Certification Board			
	3.2 Seed Certification Procedures- Steps Involved in Seed Certification Application for seed production, Registration of sowing report.:			
	3.3 Field inspection, Seed processing, Seed sample and seed analysis, Tagging and sealing. Certification of seeds as organic.			

	3.4 Case Histories of Some Seed Developer and business ventures			
IV	Seed Marketing and management	15	14	
	4.1 Seed marketing and trade, seed pricing and its policy			
	4.2 Seed marketing intelligence and product mix, sales promotion, distribution channels, marketing costs and margins			
	4.3 National seed policies, Role of various sectors/agencies in efficient seed marketing, quality control and assurance programme.			
	4.4 Responsibilities of seed companies and dealers under Seed Act 1996 & IPR for seed trade, Seed industry linkages.			
Conduct at least THREE Practicals from each unit:				
Unit I:				
1. Case study analysis of seed industry/ industrialist 2. Prepare a list of seed industries in India 3. To study the major stakeholders in seed supply chain management 4. Study of success story in seed marketing and trade (Any one from each Global and Indian viz.: Bayer Crop Science, Corteva Agriscience, Syngenta Group, Mahyco, Advanta Seeds (UPL), Ankur Seeds Pvt. Ltd., Nirmal Seeds Pvt. Ltd., etc.				
Unit II:				
1. To study seed treatments – seed priming 2. To study seed coating, pelleting, seed colouring and biopriming 3. To study seed packaging, closing and stacking 4. Demonstration of preparation for nucleus seed, breeder seeds, and hybrid seeds 5. Preparation of report on seed processing (any one seed plant)				
Unit III:				
1. Study and use of regulatory mechanism of seed quality control by the preparation of Govt & Non govt organization list. 2. Preparation sowing report for registration (any one plant) 3. Preparation of the field record (any one plant) 4. Demonstration on seed sample collection, tagging and sealing 5. Preparation of the proposal for seed certification				
Unit IV:				
1. Demonstration for promotion of quality seed 2. To understand the process of calculation of the seed pricing 3. Preparation of distribution channel list and calculate marketing costs and margin 4. Understand and list the agencies involved in seed marketing and quality control 5. Seed industry linkages study (at least one)				
Conduct at least TWO Activities from the following:				
Field visits:				
1. Visit to seed Production Company/ Industry 2. Visit to a seed quality enhancement technology-based production unit 3. Visit to seed testing laboratories/ research institute 4. Visit to seed certification body 5. Visit to authorized nearest dealers in seed marketing				
Other activities –				
1. Preparation of report on seed supply chain management 2. Case study on use of SATHI 3. Preparation of maintenance and seed processing record (any one plant)				

4. Preparation field inspection report 5. Preparation of report on agencies involved in seed marketing Collaboration/ MoU- Conduct suggested activities in Collaboration / MoU with any seed company / related NGO/ Institute
References: Reference Books: • Agarwal, P. K. (Ed.). (1995). Handbook of Seed Technology for Genebanks - Volume II: Compendium of Specific Germination Information and Test Recommendations. International Board for Plant Genetic Resources. • Agarwal, R. L. (2018). Seed Technology. Oxford and IBH Publishing. • Baskin, C. C., & Baskin, J. M. (2014). Seeds: Ecology, Biogeography, and Evolution of Dormancy and Germination. Elsevier. This text offers an extensive review of seed ecology, an essential topic for understanding seed development and enhancement technologies. • Basra, A. S. (Ed.). (2007). Handbook of seed science and technology. Scientific Publishers. • Bewley, J. D., Bradford, K., Hilhorst, H., & Nonogaki, H. (2013). Seeds: Physiology of Development, Germination and Dormancy. Springer. This book covers the physiological aspects of seed development, germination, and dormancy, providing insights into the biochemical and environmental factors influencing these processes. • Black, M., & Bewley, J. D. (Eds.). (2000). Seed technology and its biological basis. Crc Press. • Dhore, M. M., Shende, S. H., More, J. P., Deshmukh, R., Bhagat, A., Gadkar, P. V., & Kulkarni, R. L. (2025). Supply chain management in seed products. Sai Jyoti Publication. • Justice, O. L., & Bass, L. N. (1978). Principles and Practices of Seed Storage. U.S. Department of Agriculture. This book provides foundational knowledge on seed storage techniques crucial for maintaining seed viability. • Khare, D., & Bhale, M. S. (2016). Seed technology. Scientific publishers. • McDonald, M. B., & Copeland, L. O. (1997). Seed Production: Principles and Practices. Springer. • Patel, J.B. & Vaddoria (2018). Seed Technology: Progress and Recent Advances. New India Publishing Agency. • Pichop, G. N. & Mndiga, H. S. (2007). Essentials of modern marketing management & supply chain systems for vegetable seed companies. AVRDC-World Vegetable Center. • Ram, H. H. (2021). Commercial Plant Breeding: Volume 01 Vegetable Crops. India: NEW INDIA PUBLISHING AGENCY- NIPA. • Stiller, S. F. (2011). Sustainable Seed Supply Chain Management: A Case Study on Syngenta's Indian Hybrid Vegetable Seed Supply Chain. (n.p.): CSM, Centre for Sustainability Management. Digital Resources and E-Contents: 1) FAO Seed Portal: Offers comprehensive resources on seed policies, quality control, and legislation. URL: http://www.fao.org/seeds/en/ 2) ISTA (International Seed Testing Association): Provides guidelines for seed testing and certification. URL: https://www.seedtest.org Web Links for Seed Quality Enhancement Technologies: 1) SeedQuest: Covers the latest in seed technology and industry news. URL: http://www.seedquest.com Database Links: 1) Germplasm Resources Information Network (GRIN): A database providing detailed information on various seed genetic resources. URL: https://npgsweb.ars-grin.gov/gringlobal/search.aspx

Pedagogies 1. Entrepreneurial Project Development, where students ideate, develop, and present a business plan related to the seed industry. This pedagogy combines market research, product development, and strategic planning. 2. Mentorship Programs with industry experts can provide personalized guidance, enhancing entrepreneurial skills and network building. These methods offer practical insights into business development, encouraging innovation and real-world application of course concepts. 3. Project-Based Learning (PBL): Engages students in real-world seed industry projects, enhancing their understanding and skills in a practical context. 4. Flipped Classroom: Utilizes online resources for theory, freeing up classroom time for interactive discussions, practical exercises, and guest lectures from industry professionals. 5. Simulation Games and Virtual Labs: Offers hands-on experience in seed production and quality control processes without the need for physical resources. 6. Case Studies and Role Plays: Encourages critical thinking and problem-solving through analysis of real-world challenges in the seed industry. 7. Internships and Industry Visits: Provides firsthand experience and insight into the operational aspects of seed companies and quality control organizations.

Question Paper for Internal Practical

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. II (Botany), SEMESTER – III (NEP)			
Practical-10	Course Code: 1071219	SUPPLY CHAIN MANAGEMENT IN SEED PRODUCTS	Max Marks: 50
Q. No.	Exercise	Marks	
1	Any one exercise on seed processing	10	
2	Preparation of any one report for submission to the official agency for certification/ registration/ pricing/ field inspection, etc.	10	
3	Comment on the demonstration of the experiment based on Seed Marketing and management (Any Two)	10	
4	Overall Performance throughout the semester	5	
5	Record Book	5	
6	Field visit / Activities under MoU or Collaboration report	5	
7	Viva Voce	5	
	Total	50	

Field Project / Community Engagement Services in Botany: Phase-I

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	III	107220	Field Project / Community Engagement Services in Botany: Phase-I	2	60	--	50

Course Objectives:

- To develop an appreciation of biodiversity, indigenous plant knowledge, and sustainable ecological practices among students.
- To expose students to the interdependence between rural communities and plant resources.
- To study local environmental challenges and identify plant-based, community-driven solutions.
- To enable students to apply theoretical Botany concepts in real-life settings, enhancing the quality of experiential learning.

Course Outcomes:

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

- Understand the ecological, medicinal, and agricultural importance of native plants in rural areas.
- Build connections with local communities and learn from traditional ecological knowledge.
- Identify and assess plant-related challenges (e.g., deforestation, crop failure, invasive species, etc.) and suggest sustainable interventions.
- Appreciate the role of community participation in biodiversity conservation and environmental stewardship.
- Document and disseminate knowledge regarding plant resources and their potential applications.

Guidelines/ SoP for FP/CEP

For understanding key principles of CE, forms of CE, operational guidelines and implementation strategy please refer https://www.ugc.gov.in/pdfnews/4187860_Revised-Final-Guidelines.pdf

As per NEP 2020, students of B Sc. II of Semester III and IV need to perform a Field Project (FP) for TWO (2) credits i.e. 50 Marks.

The guidelines regarding the field project are as follows:

1. Students must complete 60 hours of field engagement.
2. Work may be done individually or in groups of up to 4 students, each under a departmental faculty guide.
3. A survey or sample collection methodology must be chosen, with appropriate documentation tools: questionnaires, datasheets, plant specimen formats, etc.
4. Projects can be survey-based, experimental, observational, or intervention-based.
5. **Final report to include:** Title, Introduction, Materials & Methods, Results, Discussion, Conclusion, References.
6. Minimum 6 pages excluding cover page, certificate, acknowledgement, etc.
7. Poster/PPT presentation is mandatory and will be evaluated by an appointed examiner.

8. For a SURVEY based project related questionnaire (15 or more questions) shall be prepared.
9. The departmental coordinator/guide shall check the questions and finalize the questionnaire. The question that may create unnecessary complications should be avoided. The questions should be qualitative as well as quantitative.
10. If the project is related to work that does not involve survey work, then the questionnaire part can be replaced accordingly (e.g. Sample collection/Data collection/ Experimental base etc).
11. The total project work including preparation of questionnaire to presentation should be evaluated for 2 credits (50 Marks).

SUGGESTED FORMS OF COMMUNITY-ENGAGED PRACTICE IN BOTANY

Linking Botany with Community Service

- Create village herbariums with help from locals to preserve indigenous flora.
- Assist farmers in understanding plant disease identification and natural remedies.
- Educate school children on photosynthesis and plant care via live demonstrations.

Community-Based Plant Research

- Conduct field surveys on medicinal plants or invasive species in local ecosystems.
- Document ethnobotanical knowledge from tribal and rural elders.
- Study agroforestry systems and suggest botanical improvements.

Awareness & Knowledge Sharing

- Organize workshops on home gardening, composting, or afforestation.
- Conduct nutrition campaigns on the value of leafy greens, millets, and plant-based diets.
- Prepare easy-to-understand posters on medicinal plants and distribute in local schools/panchayats.

Social Innovation via Botanical Projects

- Build vertical gardens in limited-space households using low-cost materials.
- Create seed banks for climate-resilient plant varieties.
- Collaborate with local NGOs to restore degraded lands via native species plantation.

Examples of Botany-Specific Field Project Topics

1. Survey of endangered/rare plant species in a local forest area.
2. Study of plant-based home remedies and their community usage.

3. Soil and compost quality evaluation and its effect on vegetable growth.
4. Development of biodiversity gardens or butterfly parks in schools.
5. Leaf morphology variations and microclimate correlations in urban trees.
6. Promotion of millet-based agriculture and traditional grains.

Reference:

- Florida Department of Agriculture and Consumer Services. (n.d.). Science fair project ideas: Botany.
<https://www.fdacs.gov/Education/Planet-Ag-Agricultural-Topics-for-Science-Fair-Projects/Science-Fair-Project-Ideas-Botany>
- University Grants Commission. (2023). Revised guidelines for community engagement and social responsibility.
https://www.ugc.gov.in/pdfnews/4187860_Revised-Final-Guidelines.pdf
- American Chemical Society. (n.d.). Student community activities.
<https://www.acs.org/education/student-communities/activities.html>
- IndiaBioscience. (n.d.). Outreach. <https://indiabioscience.org/outreach>

Assessment Rubric for FP/CEP: Phase-I

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. II (Botany), SEMESTER – III (NEP)			
FP/CEP	Course Code: 107220	Field Project / Community Engagement Services in Botany: Phase-I	Max Marks: 50
Q. No.	Exercise	Marks	
1	Field Engagement & Participation (Attendance, hands-on involvement, and community interaction)	15	
2	Project Report Quality (Clarity, structure, scientific accuracy, originality, and referencing)	15	
3	Data Collection & Analysis (Depth, relevance, and quality of survey/sample collection and its analysis)	10	
4	Presentation (Poster or PPT) (Communication of findings, visual clarity, and confidence)	05	
5	Social Relevance & Innovation (Creative solutions, awareness campaigns, or community impact beyond data.)	05	

SEMESTER – IV

The Vertical	Course Code	Course Title
Major-T	107221	Botanical Wealth – Economic Botany, Ethnomedicine and Phytochemistry
Major-T	107222	Cellular Frontiers in Botany - Cell Biology, Cytogenetics and Molecular Biology
Major-T	107230	Angiosperm Taxonomy
Major-P	107223	Experimental Botany in Economic, Medicinal, Cellular, Molecular, Morphological and Taxonomic Studies
Minor-T	107224	Plant Propagation and Growth
Minor-P	107225	Investigations of Plant Life Sketch
GOEC-T	107226	Wonders of Plant World
VSC-P	107227	Nursery and Garden Management
FP/CES	107229	Botany Lab 14 (FP/ CEP in Botany - II)
CC		Separate SOP shall be consulted from University website

Major Course: Botanical Wealth: Economic Botany, Ethnomedicine and Phytochemistry

Level	Semester	Course code	Course Name	Credits	Teaching Hrs	Exam Duration	Maximum Marks
5.0	IV	107221	Botanical Wealth: Economic Botany, Ethnomedicine and Phytochemistry	2	2	2	30 (Ext.) + 20 (Int)

Course Objectives: • To study the economic value and varieties of important food, fiber, oilseed, and commercial crops. • To understand the traditional knowledge systems and cultural uses of plants among indigenous communities. • To explore the significance of spices, fruits, vegetables, and their application in food processing industries. • To learn the basic concepts and scope of pharmacognosy and phytochemistry in drug development. • To gain practical knowledge of phytochemical techniques like TLC and HPTLC. • To analyze and validate the ethnomedicinal uses of plants through phytochemical profiling.				
Course Outcome • Identify economically important plants and classify them based on their uses. • Explain the traditional knowledge systems and ethnobotanical significance of selected medicinal plants. • Demonstrate the applications of phytochemical techniques like TLC and HPTLC. • Analyze the ethnomedicinal data collected from ethnic communities. • Evaluate the pharmacognostic features and phytochemical contents of selected medicinal plants. • Create a scientific report that validates ethnobotanical claims using phytochemical evidence.				
Unit	Content	Workload Allotted (Hrs)	Weightage of Marks	Incorporation of pedagogies
I	Economic Botany	07	07	Use any pedagogical technique suitable for the topic
	1.1 Morphology, Varieties and Economic importance of Wheat and Arhar			
	1.2 Spices and Condiments: Cardamon and Turmeric.			
	1.3 Oilseed Crops: Soybean and Groundnut.			
	1.4 Commercial Crops: Economic importance of Banana and Sugarcane			
II	Economic Botany	08	08	
	2.1 Fiber-yielding crops: - Morphology, Varieties and economic importance of Cotton			
	2.2 Timber-yielding plants: Teak and Shisham			
	2.3 Vegetable & fruit plants: Mango and Potato			

	2.4 Applications of vegetables and fruits in food processing industry (Awala and Citrus).			
III	Ethnobotany			
	3.1 Definition, Ancient history and Importance of Ethnobotany. 3.2 Contribution of Indian ethnobotanists- Dr. S. K. Jain and Janaki Ammal.	08	08	
	3.3 Ethnomedicine uses Ashwagandha, Shatavari, Adulsa.			
	3.4 Role of ethnic groups (Gond, and Korku) in the development & Conservation of ethnomedicinal wealth. Ethnomedicinal Investigation: Study area and data collection (Documentation), Analysis & validation.			
IV	Pharmacognosy & Phytochemistry			
	4.1 Concept and scope of Pharmacognosy & Phytochemistry. Pharmacognosy of Adulsa and Shatavari.	07	07	
	4.2 Basic Techniques of Phytochemistry: Thin layer Chromatography and HPTLC (Principle, Working & Applications)			
	4.3 Major Phytochemicals: Types and application of Alkaloids, Phenolics, Flavonoids and Terpenes			
	4.4 Phytochemical profiling of Adulsa and Ashwagandha and validation of their ethnomedicinal uses.			

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Reference / Text Books / Research Articles

1. Jain, S.K. (1995). *Manual of Ethnobotany*. Scientific Publishers, Jodhpur.
2. Kochhar, S.L. (2016). *Economic Botany in the Tropics*. Macmillan Publishers India.
3. Trease, G.E. & Evans, W.C. (2009). *Pharmacognosy*. 16th Ed., Elsevier Health Sciences.
4. Wallis, T.E. (2004). *Textbook of Pharmacognosy*. CBS Publishers & Distributors.
5. Dey, P.M. & Harborne, J.B. (1997). *Plant Biochemistry*. Academic Press.
6. Farnsworth, N.R. (1966). *Biological and Phytochemical Screening of Plants*. Journal of Pharmaceutical Sciences, 55(3): 225-276.
7. Satpute, S. V., Koche, D. K., Kakpure, M. R., Madavi, S. V., Anmod, A., Theng, P. A. & Mhasal, S. S. (2026) Botanical wealth: Economic botany, ethnomedicine and phytochemistry. Sai Jyoti Publication.
8. Sharma, P.V. (1999). *Dravyaguna Vijnana* (Materia Medica – Ayurvedic). Chaukhamba Bharati Academy.

2. E-Contents / E-Books (Free & Paid Sources)

1. NCBI Bookshelf – <https://www.ncbi.nlm.nih.gov/books/>
2. SpringerLink – Access to journals and books on plant sciences and ethnobotany.
3. Elsevier's ScienceDirect – Paid source with free preview articles <https://www.sciencedirect.com>
4. ResearchGate – Articles and papers shared by authors. <https://www.researchgate.net>
5. Central Council for Research in Ayurvedic Sciences (CCRAS). (n.d.). E-books. Ministry of AYUSH, Government of India. <https://www.ccras.nic.in/content/e-books-0>

6. Ministry of AYUSH. (n.d.). AYUSH Research Portal. Government of India. <https://ayushportal.nic.in>
7. Pharmacopoeia Commission for Indian Medicine & Homoeopathy (PCIM&H). (n.d.). Home. Ministry of AYUSH, Government of India. <https://pcimh.gov.in>
8. Government of India. (n.d.). The Ayurvedic Pharmacopoeia of India, Part I, Volume I. <https://www.ayurveda.hu/api/API-Vol-1.pdf>
9. Government of India. (n.d.). The Ayurvedic Pharmacopoeia of India, Part I, Volume II. <https://www.ayurveda.hu/api/API-Vol-2.pdf>
10. Government of India. (n.d.). The Ayurvedic Pharmacopoeia of India, Part I, Volume VII (Minerals & Metals). <https://naturalingredient.org/wp/wp-content/uploads/API-Vol-7.pdf>
11. Government of India. (n.d.). The Ayurvedic Pharmacopoeia of India, Part II, Volume I (Formulations). <https://naturalingredient.org/wp/wp-content/uploads/API-II-Vol-1.pdf>.

3. Digital Resources & Weblinks

1. Plant List Database – <http://www.theplantlist.org>
2. NAPRALERT Database – Natural Products Alert (Ethnobotany, phytochemistry): <https://www.napralert.org>
3. AYUSH Research Portal – <https://ayushportal.nic.in>
4. ICMR-NIN & CSIR-NIScPR Resources – Scientific resources for medicinal plant research.
5. ePG Pathshala (Botany & Pharmacognosy Modules) – <https://epgp.inflibnet.ac.in/>
6. Digital Herbarium – Botanical Survey of India – <http://bsidb.nic.in>
7. PubMed Central (PMC) – Free access to biomedical and phytochemical research: <https://www.ncbi.nlm.nih.gov/pmc/>

Answer in one sentence - (1 Mark Questions)

Unit 1: Economic Botany – I

1. Name any two economically important varieties of wheat.
2. What is the botanical name of Arhar (Pigeon pea)?
3. Name two commonly used spices in Indian cuisine.
4. Which part of turmeric is used as a condiment?
5. Write one medicinal use of cardamom.
6. Name the oilseed crop known for its high protein content.
7. Which part of the soybean plant is used for oil extraction?
8. Name the commercial product obtained from groundnut.
9. Name one commercial product obtained from sugarcane.

Unit 2: Economic Botany – II

10. Name one important variety of cotton cultivated in India.
11. What is the botanical name of Teak?
12. Mention one use of Shisham wood.
13. Name one plant that yields vegetable fiber.
14. Name one vegetable that is botanically a stem.
15. Which fruit is known for its high Vitamin C content?
16. Mention one industrial product made from Amla (Awala).
17. Which part of Citrus is used in food processing?
18. Name one processed product of mango.

Unit 3: Ethnobotany

19. Define ethnobotany
20. Name one Indian ethnobotanist who pioneered the field.
21. Mention one therapeutic use of Ashwagandha.
22. Name one ethnic tribe that uses herbal medicine.
23. Write the botanical name of Shatavari.
24. What is the use of Adulsa in traditional medicine?
25. Name one ethnic group from Maharashtra involved in ethnomedicine.
26. What is meant by ethnomedicinal documentation?

27. Write one reason why ethnobotanical validation is important.

Unit 4: Pharmacognosy & Phytochemistry

28. What is the meaning of Pharmacognosy?
29. Name one technique used in Phytochemical analysis.
30. What is the full form of HPTLC?
31. Name one alkaloid found in Ashwagandha.
32. Write one medicinal property of Adulsa.
33. What is the function of flavonoids in plants?
34. Name a terpenoid found in medicinal plants.
35. What is the full form of TLC?

3-Mark Questions (Short Answers)

Unit 1: Economic Botany – I

1. Describe the economic uses of Arhar.
2. Mention the commercial uses of Wheat in food and non-food industries.
3. Describe the economic importance of Cardamom.
4. Explain the spice value and applications of Turmeric.
5. Mention the nutritional and industrial uses of Soybean.
6. Write a short note on the economic uses of Groundnut.
7. Describe the commercial significance of Banana in food and industry.
8. Explain the industrial applications of Sugarcane and its by-products.

Unit 2: Economic Botany – II

9. Write a short account of cotton varieties and their industrial value.
10. Describe the importance of Teak wood in the timber industry.
11. Mention three economic uses of Shisham (*Dalbergia sissoo*).
12. Discuss the role of Mango and Potato in food and agro-economy.
13. Write a short note on food processing products of Amla (*Awala*).
14. Explain the role of Citrus fruits in the food industry and health sector.

Unit 3: Ethnobotany

15. Describe the historical development and scope of ethnobotany.
16. Write a short note on Dr. S. K. Jain's contributions to ethnobotany.
17. Mention three medicinal uses of Shatavari.
18. Describe the traditional uses of Adulsa in local communities.
19. Explain the role of Gond tribe in ethnomedicinal practices.
20. Describe the methods of data collection and documentation in ethnobotany.

Unit 4: Pharmacognosy & Phytochemistry

21. Write a short note on the concept and scope of pharmacognosy.
22. Explain the principle and applications of Thin Layer Chromatography (TLC).
23. Mention the working and uses of HPTLC in plant drug research.
24. Write a short note on Alkaloids and their pharmaceutical importance.
25. Describe the health benefits of flavonoids and phenolics.
26. Explain the role of phytochemical profiling in validating medicinal uses.

6-Mark Questions (Long Answers)

Unit 1: Economic Botany – I

1. Describe the varieties and economic significance of Wheat in Indian agriculture.
2. Describe the varieties and economic significance of Arhar in Indian agriculture.
3. Give a detailed account of Cardamom as important spices and condiments.
4. Give a detailed account of Turmeric as important spices and condiments.
5. Explain the economic uses Soybean and Groundnut.
6. Elaborate the commercial and industrial applications of Banana and Sugarcane.

Unit 2: Economic Botany

7. Discuss the varieties and economic importance of cotton as a fiber crop.
8. Explain the timber value and industrial applications of Teak and Shisham.

9. Describe the nutritional and commercial uses of Mango and Potato.
10. Write a detailed account on the role of Amla and Citrus fruits in the food processing industry.

Unit 3: Ethnobotany

11. Define ethnobotany and explain its historical background and importance in modern science.
12. Elaborate the ethnomedicinal uses and pharmacological importance of Ashwagandha, and Adulsa.
13. Elaborate the ethnomedicinal uses and pharmacological importance of Shatavari and Adulsa.
14. Describe the contribution of Gond and Korku tribes in the conservation and use of ethnomedicinal plants.
15. Write a detailed account of ethnomedicinal investigation – from field documentation to validation.

Unit 4: Pharmacognosy & Phytochemistry

16. Describe the principle, procedure, and application of Thin Layer Chromatography and HPTLC.
17. Explain the classification, role, and therapeutic uses of alkaloids, phenolics, flavonoids, and terpenes.
18. Discuss the phytochemical profiling of Adulsa and Ashwagandha and validate their ethnomedicinal significance.

Major Course: Cellular Frontiers in Botany: Cell Biology, Cytogenetics and Molecular Biology

Level	Semester	Course code	Course Name	Credits	Teaching Hrs	Exam Duration	Max Marks
5.0	IV	107222	Cellular Frontiers in Botany: Cell Biology, Cytogenetics and Molecular Biology	2	2	2	30 (Ext.) 20 (Int)

Course Objectives: - Introduce cell theory, compare prokaryotic and eukaryotic cells, and describe the structure and function of cell organelles, including mitochondria and chloroplasts. - Explain the structure, types, and behavior of chromosomes, and outline the phases and significance of mitosis and meiosis. - Differentiate structural and numerical chromosomal aberrations, and analyze the role of semi-autonomous organelles in cell function. - Evaluate experimental evidence establishing DNA as genetic material, and interpret the mechanisms of DNA replication and gene regulation. - Integrate knowledge of the central dogma, transcription, translation, and transposable elements to understand gene expression and regulation mechanisms.				
Course Outcome - Understand the structure and organization of prokaryotic and eukaryotic cells. - Describe the structure and function of cell organelles and semi-autonomous organelles. - Explain the structure and classification of chromosomes and phases of the cell cycle. - Analyze chromosomal aberrations and their biological significance. - Justify DNA as the genetic material and explain its structure and replication. - Describe transcription, translation, and gene regulation in prokaryotes.				
Unit	Content	Workload Allotted (Hrs)	Weightage of Marks	Incorporation of pedagogies
I	Cell and Cellular Organelles	07	07	Use any pedagogical technique suitable for the topic
	1.1 The Cell: Historical background, Cell theory, structure and Comparative account of Prokaryotic and Eukaryotic cells.			
	1.2 Cell organelles: Structure and function of Nucleus, Ribosomes, Endoplasmic reticulum & Golgi complex			
	1.3 Mitochondrial and Chloroplast: Semi-autonomous cell organelles (mt DNA and cp DNA)			
	1.4 Cytoskeleton: Microfilament, microtubules and Intermediate filaments			
II	Cytogenetics			
	2.1 Structure and types of Chromosomes: General structure,	08	08	

	types - metacentric, submetacentric, acrocentric, telocentric			
	2.2 Cell cycle and phases of cell cycle: Mitosis, Meiosis and their significance.			
	2.3 Chromosomal aberrations (Structural): Deletion, Duplication, Inversion, Translocation, and their evolutionary significance			
	2.4 Chromosomal Aberrations (Numerical): Euploidy Triploidy, Tetraploidy & Polyploidy); Aneuploidy (Monosomy, Trisomy & Tetrasomy)			
III	Genetic Material			
	3.1 DNA as Genetic Material (Griffiths experiment and Hershey & Chase experiment)	08	08	
	3.2 Structure and Composition of DNA; Double helix model of DNA.			
	3.3 Replication of DNA: Mechanism in prokaryotes			
	3.4 Transposons- Types (IS elements, and Retrotransposons) and Ac/DS system in Maize			
IV	Gene Expression and Regulation			
	4.1 Central Dogma of Molecular biology	07	07	
	4.2 Transcription in prokaryotes and types of RNA			
	4.3 Genetic Code- Characteristics and Translation in Prokaryotes			
	4.4 Gene regulation: Operon concept (example-Lac Operon)			
References				
	- Bansod, P. G., Khadse, P.M., More, U. A. Narkhedkar, V., More, A. T., Khadse, P. M., Masatkar, P., (2026). Cellular frontiers in botany: Cell biology, cytogenetics and molecular biology. Sai Jyoti Publication. - Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc. - De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia. - Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA. - Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco. - Gupta, P.K. (2009). Genetics. Rastogi Publications, Meerut (India) - Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley & Sons Inc., India. 5 th edition. - Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9 th edition. - 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. 10 th edition.			

Model Questions: UNIT 1: Cell and Cellular Organelles 1 Mark Questions: 1. Who proposed the cell theory? 2. What is the basic difference between prokaryotic and eukaryotic cells? 3. Which cell organelle is known as the control center of the cell? 4. Name the organelle responsible for protein synthesis. 5. What is the function of the Golgi complex? 6. Which organelle contains hydrolytic enzymes? 7. What is the function of peroxisomes? 8. Name the DNA found in mitochondria. 9. What is the main function of microtubules? UNIT 2: Cytogenetics 1 Mark Questions: 10. Name the four types of chromosomes based on centromere position. 11. What is the shape of a metacentric chromosome? 12. What are the two main phases of the cell cycle? 13. During which phase does crossing over occur? 14. What is meant by chromosomal deletion? 15. Define duplication. 16. What is inversion? 17. Name two types of euploidy. 18. Define monosomy. 19. What is trisomy? UNIT 3: Genetic Material 1 Mark Questions: 20. Which experiment proved that DNA is the genetic material? 21. Name the scientists who performed the transformation experiment. 22. What is the full form of DNA? 23. Who proposed the double helix model of DNA? 24. In which direction does DNA replication occur? 25. What is the function of DNA polymerase? 26. What are IS elements? 27. Define retrotransposons. 28. What are Ac-DS elements? 29. Name the organism in which Ac-DS elements were discovered. UNIT 4: Gene Expression and Regulation 1 Mark Questions: 30. What is the central dogma of molecular biology? 31. Name the three types of RNA. 32. What is a codon? 33. Define genetic code. 34. What is meant by translation? 35. In which organism is the Lac operon studied? 36. What induces the Lac operon? 37. What is the function of tRNA? 38. Name the enzyme involved in transcription. 39. What is an operon? Short Answer - 3 Mark Questions: UNIT 1: Cell and Cellular Organelles	

1. Compare prokaryotic and eukaryotic cells.
2. Describe the structure and function of the nucleus.
3. Mention the functions of ribosomes and ER.
4. Write a note on the role of lysosomes and peroxisomes.
5. Explain the significance of mitochondrial and chloroplast DNA.
6. Describe the components and functions of the cytoskeleton in eukaryotic cells.

UNIT 2: Cytogenetics

7. Describe the general structure of a chromosome.
8. Write a short note on different types of chromosomes.
9. Describe the phases of mitosis.
10. Explain the significance of meiosis.
11. Describe Deletion
12. Describe Duplication
13. Describe Inversion
14. Describe Translocation
15. Describe aneuploidy
16. Explain Polyploidy
17. Differentiate Autopolyploidy and Allopolyploidy
18. Explain Trisomy

UNIT 3: Genetic Material

19. Describe Griffith's experiment and its outcome.
20. Write a short note on the Hershey and Chase experiment.
21. Describe the structure of DNA.
22. Describe the composition of DNA
23. Explain the concept of the double helix model.
24. Describe the process of DNA replication in prokaryotes.
25. Write a short note on types of transposons.

UNIT 4: Gene Expression and Regulation

26. Explain the central dogma of molecular biology.
27. Describe transcription in prokaryotes.
28. Describe the functions of RNA.
29. Explain structure of transfer RNA
30. Describe m- RNA
31. Explain the properties of the genetic code.
32. Describe the process of translation in prokaryotes.
33. Describe operon concept.
34. Explain Structural gene in operon

Long answer 6 Mark Questions:

UNIT 1: Cell and Cellular Organelles

1. Describe the historical background, differences between prokaryotic and eukaryotic cells.
2. Explain the structure and functions of cell organelle nucleus
3. Explain the structure and functions of ER, and Golgi complex.
4. Discuss the semi-autonomous nature of mitochondria and chloroplasts with special reference to their DNA.
5. Describe the components and functions of the cytoskeleton in eukaryotic cells.

UNIT 2: Cytogenetics

6. Describe the structure and classification of chromosomes based on centromere position.
7. Explain the stages of mitosis and their biological importance
8. Explain the stages of meiosis I.
9. Discuss structural chromosomal aberrations.
10. Describe polyploidy with suitable examples.

11. Describe aneuploidy in detail.

UNIT 3: Genetic Material

12. Describe the structure and double helix model of DNA.
13. Describe structure and composition of DNA
14. Explain the mechanism of DNA replication in prokaryotes.

UNIT 4: Gene Expression and Regulation

15. Discuss the central dogma of molecular biology and its significance.
16. Explain the process of transcription in prokaryotes.
17. Explain the types of RNA.
18. Describe the characteristics of the genetic code
19. Explain the mechanism of translation in prokaryotes.
20. Discuss gene regulation in prokaryotes with special reference to the Lac operon.

Major Course: Foundations of Plant Morphology & Angiosperm Taxonomy

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
4.5	IV	107230	Foundations of Plant Morphology & Angiosperm Taxonomy	2	30	2 Hrs	30 (Ext) + 20 (Int)

Course Objectives: 1. To introduce students to the fundamental concepts and scope of plant morphology. 2. To understand the external structure and organization of vegetative and reproductive plant parts. 3. To study morphological variations and modifications in plants as adaptations to environment. 4. To develop skills in plant observation, description, and identification based on morphology. 5. To correlate plant form with function and ecological significance. 6. To train students in plant identification using morphological characters and taxonomic keys. 7. To build a strong foundation for advanced studies in taxonomy, anatomy, and systematics				
Course Outcomes: After Successful completion of the course, the student will be able to – CO1: Explain basic concepts, terminology, and scope of plant morphology. CO2: Describe morphological features of root, stem, leaf, inflorescence, flower, fruit, and seed. CO3: Identify various modifications of plant organs and explain their significance. CO4: Use correct morphological terminology in plant description and classification. CO5: Analyze structural diversity among flowering plants through field observation. CO6: Apply morphological knowledge in plant identification and taxonomic studies.				
Unit System	Contents	Workload Allotted (Hrs)	Weight age of Marks Allotted	Incorporation of Pedagogies
Unit I	Plant Morphology	8	8	Suitable pedagogical strategies are separately annexed
1.1: Diversity in plant habits (annual, biennial & perennial). 1.2: Roots – Characteristics and Functions Types (Tap root and Adventitious root). 1.3: Modification of Roots: Storage - Fusiform, Napiform, Conical . 1.4: Modification of Roots: Respiration - Pneumatophore, Support - Prop and Stilt.				
Unit II	Plant Morphology	8	8	

2.1: Stem : Characteristics and functions of stem. Underground- Rhizome, bulb, Tuber. 2.2 Modification of stem : Aerial - Stem tendril, Thorns & Phylloclade. 2.3 Leaf- Parts of leaf, functions and types (Simple leaf and Compound leaf). 2.4 Leaf- Venation (reticulate and parallel), Phyllotaxy (Alternate, Opposite and Whorled). Leaf modification - Leaf tendril (<i>Pisum sativum</i>), Leaf spines.			
Unit III	Plant Morphology	7	7
3.1: Inflorescence Types: A. Racemose- Raceme, Spadix, Umbel, Capitulum, Spikelet. 3.2: B. Cymose- Monochasial cyme, Dichasial cyme, Polychasial cyme, C. Special Inflorescences- Cyathium, and Verticillaster. 3.3: Flower- Parts, symmetry, bract, Calyx- Structure and Function. 3.4: Corolla: Structure, Forms-Cruciform, Caryophyllaceous, Papilionaceous, Tubular, Bilabiate and Aestivation.			
Unit IV	Plant Morphology	7	7
4.1: Androecium - Structure, Cohesion and adhesion of stamens. 4.2: Gynoecium- Structure, Cohesion and adhesion, Placentation. 4.3: Fruits - Structure and types- A. Simple Fruits: Dry Fruits-Indehiscent (<i>Caryopsis, Nut</i>), Dehiscent (<i>Capsule, Legume</i>). 4.4: Fleshy Fruits- A. Drupe, Berry. B. Aggregate Fruits- custard apple and C. CompositeFruits- Sorosis			
Activities: (Perform Any Two as CAT) 1. Observation of Vegetative Plant Parts. 2. Herbarium Preparation and Plant Identification. 3. Survey flowering plants in campus/local area and prepare checklist. 4. Field Survey and Taxonomic Documentation of Campus Plant Diversity. 5. Quiz Competition on Plant Morphology and Taxonomy. 6. Preparation of Family wise Floral Charts with Economic Importance. 7. Collection and Classification of Different Leaf Types and Venation Patterns. 8. Preparation of Morphological Models of Flowers, Fruits and Seeds. 9. Hands on Study of Inflorescence types in Local Flowering Plants 10. Visit to Botanical Garden and preparation of taxonomic observation report. 11. Prepare digital plant album using Photographs and taxonomic descriptions. 12. Collect local plants and classify racemose, cymose, and special types of inflorescences. 13. Dissect flowers (<i>Hibiscus, Pea, lily</i>) and label whorls. 14. Prepare posters/maps on perianth, bracts, placentation, symmetry. 15. Bring fruits, classify into simple, aggregate, composite types.			
References: (APA Style) 1. Bresinsky, A., Körner, C., Kadereit, J. W., Neuhaus, G., &Sonnewald, U. (2013). <i>Strasburger's textbook of botany</i>. Springer. 2. Eames, A. J. (2009). <i>Morphology of angiosperms</i>. McGraw Hill. 3. Esau, K. (2006). <i>Plant anatomy</i> (3rd ed.). Wiley India.			

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Model Questions:
One Line Question (Suggestive At least 10) Unit-III - What is annual plant. - What are the different types of roots. - What are the main function of the stem. - Name any two example of underground modifications of stem. - Define inflorescence. - Give types of leaves. - Define phyllotaxy. - Define Venation. - Name any two example of racemose inflorescence. - Name the four floral whorls of a typical flower. - Define Aestivation. - Name the male reproductive part of the flower. And its part. - Name the parts of Gynoecium. - Define placentation. - Define Fruit..
Short Type Questions (Suggestive At least 10) Unit-III - Describe the modification of roots for the storage purpose. - Explain any two aerial modifications of stem. - Explain cymose inflorescence with a suitable diagram. - Cyathium Inflorescence. - Write short notes on calyx and corolla. - What is actinomorphic symmetry? Give one example. - Write a short note on perianth. - Differentiate between aggregate and composite/multiple fruits.
Long Type Question (Suggestive At least 10) Unit-III - Explain characteristic features and functions of root with types. - Describe the modification of roots . - Explain the modification of stems with suitable examples. - What is inflorescence. Explain Racemose inflorescence. - Describe special types of inflorescence with examples (cyathium, verticillaster). - Describe the structure and functions of the four floral whorls: calyx, corolla, androecium, and gynoecium. - Explain the role of androecium and gynoecium in reproduction with suitable diagrams. - Explain placentation in detail. Illustrate different types with diagrams.

9. Discuss floral symmetry. Differentiate between actinomorphic and zygomorphic flowers with examples. 10. Classify fruits into simple, aggregate, and composite/multiple. Explain each with examples and diagrams. 11. Differentiate between fleshy and dry fruits. Give examples of each type. 12. Explain dehiscent and indehiscent dry fruits with suitable examples.
Pedagogical Strategies: (Use At least one for each Units / Points included in curriculum) Plant Morphology – Teaching Strategies Inflorescence Types (3.1) 1. Use comparative diagrams/flowcharts; classify local specimens. Floral Whorls (3.2) 2. Hands-on flower dissection; label and note functions. Additional Features (3.3) 3. Create concept maps/posters linking features with examples. Fruit Types (3.4) 4. Organize fruit collection/exhibition; classify into types. Interactive Learning (All Topics) 5. Conduct quizzes/case studies; apply examples like Brassica, Citrus, Solanum. 6. Digital tools (Kahoot, Google Forms) can make quizzes engaging and track progress.

Major Practical – 11: Experimental Botany in Economic, Medicinal, Cellular, Molecular, Morphological and Taxonomic Studies

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	107223	Experimental Botany in Economic, Medicinal, Cellular, Molecular, Morphological and Taxonomic Studies	2	60	4 Hrs	25 (Ext)+ 25 (Int)

Course Objectives:

- 1.To introduce students to the economic, medicinal, and ethno-botanical importance of plants.
2. To understand the external morphology of vegetative and reproductive plant parts.
- 3.To develop skills in microscopic, morphological, anatomical, and biochemical analysis of plant materials and herbarium techniques.
- 4.To identify and describe different types of roots, stems, leaves, flowers and fruits based on morphological characters.
- 5.To promote conservation ethics through documentation of tribal and ethnomedicinal knowledge.
- 6.To enhance observation, analysis, and documentation skills through plant-based case studies.
- 7.Acquire practical knowledge of field observation, botanical terminology, and scientific documentation.

Course Outcomes:

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

- CO1- Identify and describe economic, medicinal importance of the plant and vegetative plant parts and their modifications using standard botanical terminology.
- CO2 -Analyze floral morphology through dissection and prepare floral formulae and floral diagrams accurately.
- CO3 -Differentiate various types of inflorescences, fruits, and seeds based on morphological characteristics.
- CO4 -Recognize and classify major angiosperm families using diagnostic morphological features.
- CO5 - Prepare herbarium sheets and maintain botanical records following scientific methods.
- CO6 -Apply field and laboratory skills for collection, preservation, observation, and documentation of plant specimens.

Practical List

Set -A (Any five) Economic Botany, Ethnomedicine and Phytochemistry

1. Morphological and Economic Study of Wheat (*Triticum aestivum*) and Arhar (*Cajanus cajan*).
2. Study and Identification of Spices and Oilseeds: Cardamom, Turmeric, Soybean, and Groundnut.
3. Identification and Evaluation of Economic Uses of Banana, Sugarcane, Cotton, and Jute.
4. Ethnomedicinal Study and Identification of Adulsa (*Justicia adhatoda*), Shatavari (*Asparagus racemosus*), and Ashwagandha (*Withania somnifera*).
5. Field-Based Documentation of Ethnobotanical Knowledge from Local Tribes or Ethnic communities.
6. Pharmacognostic Study of Crude Drugs – Ashwagandha and Adulsa (Microscopic and Organoleptic Analysis).
7. Preliminary Phytochemical Screening of Herbal Extracts (Adulsa and Ashwagandha)

for Alkaloids, Flavonoids, Phenolics, and Terpenes.

8. Demonstration of Thin Layer Chromatography for Phytochemical Analysis.

Set-B (Any five) Cellular and Molecular Studies

1. Squash preparation using Onion root tips (to observe stages of Mitosis).
2. Smear preparation using Rheo or Onion buds (to observe stages of Meiosis).
3. Study of special chromosomes (Polytene & Lampbrush) by either photograph or slides.
4. To study prokaryotic cells and eukaryotic cells.
5. Study of the photomicrographs of cell organelles (Nucleus, Mitochondria, Chloroplast, etc.).
6. Preparation of the karyotype and ideogram from given photograph of somatic metaphase chromosome.
7. Study of aneuploidy: Down's, Klinefelter's, and Turner's syndromes using charts/photographs.
8. Observation of photographs or permanent slides showing Translocation Ring, Laggards, and Inversion Bridge.

Set -C (Any five) Plant Morphology and Angiosperm taxonomy

Compulsory Practical:

Demonstrate the Bentham and Hooker's System of Classification using few plant samples available locally.

Any five of the Following:

1. To study of modification of roots for storage purpose, respiration and support.
(Each one)
2. To study the underground and aerial stem modifications. (Each one)
3. To study of morphology of typical leaf of the plant and Leaf modifications.
4. To study of Racemose, Cymose and special types of Inflorescences.
5. To study the types of Corolla.
6. To study of the reproductive part of the flower.
7. To study of Simple Fruits: Dry Indehiscent, dry Dehiscent and fleshy fruit (each one)
8. Identification and Plant description of the family Malvaceae.
9. Identification and Plant description of the family Apocynaceae.
10. Identification and Plant description of the family Liliaceae.

Activities (Perform any Two)

1. Botanical Study Tours, collection and Identification of plants, Field Note Books & Tour Reports.
2. Group Discussion on Diversity in plant habits.
3. Field Survey and Documentation of Campus Plant Diversity.
4. Quiz Competition on Plant Morphology.
5. Preparation of seminar on Modification of Roots, Stem and Leaf.
6. Collection and Classification of Different types of fruits.
7. Prepare comparative charts of parts of the plant -root, stem, leaf and flower.

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4. Jain, S. K. (1987). Manual of ethnobotany (2nd ed.). Scientific Publishers.
5. Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2008). Pharmacognosy (46th ed.). Nirali Prakashan.
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Journals:

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2. Indian Journal of Traditional Knowledge. (n.d.). Various articles. CSIR-NIScPR. Retrieved from <https://nopr.niscpr.res.in/handle/123456789/43>
3. Phytochemistry. (n.d.). Various articles. Elsevier. Retrieved from <https://www.sciencedirect.com/journal/phytochemistry>
4. A text book of Practical Botany vol 2 - Bendre and Kumar
5. Manual for studying of Morphology & Anatomy of Angiosperms plants (April 2024)
6. M.M.Barwant, V.G.Jadhav & Ruchita Shrivastava.

1. E-Contents / E-Books

1. NCERT Biology PDFs (Free): <https://ncert.nic.in>
2. NPTEL Lectures on Botany & Pharmacognosy: <https://nptel.ac.in>
3. Google Books / Internet Archive – Open access phytochemistry and ethnobotany books .
4. PubMed Central (Research articles): <https://www.ncbi.nlm.nih.gov/pmc/>
5. ResearchGate for accessing shared research articles by authors.
6. Plant Systematics by Michael G. Simpson.
7. Plant Systematics: A Phylogenetic Approach by Judd et al.
8. Taxonomy of Angiosperms by B. P. Pandey.
9. Taxonomy of Angiosperms by A. V. S. S. Sambamurty.
10. Morphology of Angiosperms, Taxonomy and Economic Botany.
11. A Textbook of Botany: Angiosperms.
12. Raven Biology of Plants

2. Digital Resources / Weblinks

1. Plant List Database: <http://www.theplantlist.org/>
2. India Biodiversity Portal: <https://indiabiodiversity.org/>
3. e-Flora of India: <https://efloraofindia.com/>
4. Kew Plant Database: <https://powo.science.kew.org/>
5. AYUSH Research Portal: <http://ayushportal.nic.in/>
6. Chromosome Atlas: <https://www.ncbi.nlm.nih.gov/genome/tools/karyoview/>
7. Virtual Microscopy for Mitosis/Meiosis: <https://www.cellsalive.com/>
8. Botanica Digital Herbarium Tools: <https://herbarium.univie.ac.at/>
9. e-PG Pathshala – Botany
10. SWAYAM Online Courses
11. Botanical Society of America.
12. Encyclopedia Britannica – Angiosperm.

13. Plants of the World Online (Kew Science). 14. International Plant Names Index (IPNI). 15. International Association for Plant Taxonomy (IAPT). 16. Biodiversity Heritage Library
3. Educational Software / Databases 1. PlantNet Plant Identification App 2. iNaturalist Species Identification Platform 3. The Plant List Database 4. World Flora Online 5. Tropicos Botanical Database 6. GBIF – Global Biodiversity Information Facility 7. NCBI Taxonomy Database 8. Flora of India Database 9. DELTA – Descriptive Language for Taxonomy

Question Paper for External Practical Course on Experimental Botany in Economic, Medicinal, Cellular, Molecular, Morphological and Taxonomic Studies

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. II (Botany), SEMESTER – IV (NEP)				
MJ- Practical-11	107223	Experimental Botany in Economic, Medicinal, Cellular, Molecular, Morphological and Taxonomic Studies	Max Marks: 25	Time: 4 Hrs.
Q.No.	Exercise			Marks
1.	Squash / Smear preparation			5
2.	Morphological and Economic Study of food crops/ oil seeds /Fibre crops (Any one)			5
3.	Pharmacognostic Study of Crude Drugs/ Preliminary phytochemical test (Any one)			5
4.	Spotting (5 spots – 1 -Ethnomedicinal plant, 2- Food crops / oil seeds/ spices / Fibre crops, 1 - cell organelles, 1 – Euploidy /Aneuploidy			5
5.	External Viva Voce			5

Assessment Rubric for Internal Practical Course on Experimental Botany in Economic, Medicinal, Cellular and Molecular Studies

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. II (Botany), SEMESTER – IV (NEP)			
Lab/ Practical-8	107223	Experimental Botany in Economic, Medicinal, Cellular, Molecular, Morphological and Taxonomic Studies	Max Marks: 25
S. No.	Assessment Criteria		Marks
1	Record/ Assignments		5
2	Attendance		5
3	Participation in Activity/ Field visit		5
4	Students overall performance		5
5	Internal Viva Voce		5

Minor Theory Course: Plant Propagation & Growth

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	107224	Plant Propagation & Growth	2	30	2 Hrs	30 (Ext.) 20 (Int)

Course Objectives:

- To identify various vegetative propagation methods like bulbs, runners, rhizomes, and suckers.
- To describe the process of growth at the cellular level, growth regulators, and their role in plant growth and development.
- To apply knowledge of photoperiodism and vernalization in controlling plant flowering and growth patterns.
- To analyze the various methods of pollination, fertilization, and post-fertilization development in angiosperms.
- To evaluate the significance of plant breeding techniques in enhancing plant growth, yield, and quality.

Course Outcomes:

- Identify and differentiate natural and artificial methods of plant propagation and their limitations.
- Explain the role of plant growth regulators, photoperiodism, and vernalization in plant growth and development.
- Apply various methods of measuring plant growth such as height, biomass, and growth index.
- Analyze the role of environmental factors, diseases, and stress conditions affecting plant growth.
- Evaluate the importance of plant breeding, tissue culture, and advanced growth methods in increasing plant productivity.
- Design and formulate plant growth assessments through case studies, growth measurement experiments, and practical demonstrations.
- Investigate the importance of greenhouses, polyhouses, and hydroponics in advanced plant growth.
- Develop practical skills in plant propagation, growth measurement, and plant breeding techniques.
- Implement advanced growth methods and develop solutions to counter plant stress and diseases.

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Plant Propagation Methods	8	8	Suitable pedagogical strategies are separately annexed
	1.1 Propagation Methods: Seed propagation and limitations			
	1.2 Vegetative propagation methods: bulbs, runners, rhizomes, and suckers			
	1.3 Propagation Media: Natural and Artificial			
	1.4 Micropropagation Techniques: Overview of plant tissue culture and economic importance			
Unit II	Plant Growth and Development	7	7	
	2.1 Plant Growth: Vegetative and Reproductive			

	2.2 Development: Shoot Apical Meristem (SAM) and Root Apical Meristem (RAM) – structure, zones, and role in primary growth			
	2.3 Vegetative to reproductive phase change: Transformation of vegetative shoot in to Reproductive structure			
	2.4 Stress Physiology: Factors causing stress in plants (Temperature, Salinity, Water)			
Unit III	Sexual Reproduction in Plants	8	8	
	3.1 Overall process of Sexual Reproduction in plants (Lower Plants to Higher Plants)			
	3.2 Male and Female Gametophytes in Angiosperms: Structure and functions of Pollen Grains and Embryo Sac			
	3.3 Fertilization: Double Fertilization and Triple Fusion in angiosperms and its significance			
	3.4 Post fertilization Development: Seed and fruits formation, Parthenocarp and its significance			
Unit IV	Plant Growth Assessment	7	7	
	4.1 Growth assessment: Techniques to measuring plant height, biomass, and leaf area, growth index			
	4.2 Plant Breeding: Conventional method for enhancement of growth and yield			
	4.3 Advanced growth methods: Greenhouses, polyhouses, and hydroponics			
	4.4 Factor affecting Growth and development: Environmental factor, disease causing organism, Case study of local plant diseases			
Suggested Activities (Any Two from the following: 1. Survey of Vegetative Propagation Techniques in Local Nurseries Students will visit nearby nurseries, botanical gardens, or local farms to observe and document various vegetative propagation methods such as grafting, budding, layering, rhizomes, and suckers. The goal is to analyze which techniques are most commonly used, why they are preferred, and their economic or ecological significance. Students will submit a field report with photographs, technique descriptions, and interviews (if applicable), thereby connecting classroom theory to real-world horticultural practices. 2. Artificial Propagation (Grafting/Layering/Cutting) In this hands-on activity, students will perform one artificial propagation technique—such as stem cutting, air layering, or wedge grafting—either in a controlled lab setting or at home under supervision. They will document the procedure step by step, record observations over a 1–2 week period, and reflect on success rates and challenges. This activity enhances practical understanding of plant regeneration techniques critical in both agriculture and conservation.				

3. Tracking Plant Growth Over Time

Students will grow a fast-germinating plant (such as mung bean or radish) and track its growth by measuring height, number of leaves, and visible biomass daily for two weeks. They will plot the data on a graph to visualize the growth curve, analyze growth stages, and comment on environmental variables affecting development. This exercise develops scientific observation, record-keeping, and analytical interpretation skills.

4. Presentation on Innovations in Plant Growth and Propagation

Students will prepare a brief (5–7 minute) oral or visual presentation on topics such as hydroponics, photoperiodism in agriculture, the use of plant hormones in horticulture, or micropropagation for biodiversity conservation. The presentation should include scientific content, applications, and challenges. This activity strengthens communication skills and deepens conceptual understanding through creative expression and peer learning.

5. Case Study on Local Plant Disease Affecting Growth

Students will research or interview local farmers to understand the occurrence and impact of a common plant disease (e.g., wilt in tomatoes, powdery mildew in cucurbits). They will document the disease's symptoms, causal organisms, transmission, prevention, and treatment practices. A short case study report or community-facing awareness poster will be submitted. This task builds diagnostic thinking and ties plant health to community well-being.

6. Quiz on Plant Growth Regulators and Reproduction Concepts

A short quiz will be conducted covering topics like auxins, gibberellins, reproductive structures, and tissue culture methods. Questions will include factual recall, true/false, matching, and application-based multiple-choice items. This ensures ongoing reinforcement of core concepts and provides feedback on student progress throughout the course.

7. Design a Home-Based Micropropagation Setup

Students will conceptualize and sketch a basic model of a micropropagation setup that could be used at home or in a low-resource setting. They will include necessary materials (e.g., glass jars, agar media, sterilization techniques), potential plants for culture, and economic feasibility. This thought experiment nurtures creativity and practical planning, especially relevant in regions where high-end lab facilities are not easily accessible.

8. Comparative Study of Growth Media

Students will grow the same plant species using different growth media—soil, cocopeat, compost, or hydrogel—and observe variations in growth over a two-week period. They will record parameters like germination time, root length, and shoot height, followed by a comparative analysis. This activity promotes experimental thinking and connects to environmental sustainability discussions.

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- Vashishta, B. R., Sinha, A. K., & Singh, V. P. (n.d.). *Botany for degree students: Plant physiology and metabolism*. S. Chand Publishing.

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- Chen, K., Li, G., Bian, X., Zheng, L., & Wang, Q. (2021). Effects of plant growth regulators on crop growth, yield, and quality: A review. *Journal of Plant Growth Regulation*, 41(2), 123-134. <https://doi.org/10.1007/s00344-020-10142-0>
- Rai, M., Pandey, S., & Soni, B. (2022). Hydroponics: A sustainable approach to modern agriculture. *International Journal of Agricultural Sciences*, 18(4), 356-365. <https://doi.org/10.1007/s40003-022-01045-9>
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Answer in one sentence - 1-Mark Questions:

Unit 1: Plant Propagation Methods

1. What is seed propagation?
2. Name a plant that propagates through bulbs.
3. Name one plant that propagates through rhizomes.
4. Define grafting.
5. What is budding in plant propagation?
6. Name any one artificial method of vegetative propagation.
7. What is micropropagation?
8. Mention one economic importance of micropropagation.

Unit 2: Plant Growth and Development

9. Define growth curve.
10. Name any two phases of the growth curve.
11. What are plant growth regulators?
12. Name any two plant hormones.
13. What is the role of ethylene in plants?
14. What is photoperiodism?
15. What is vernalization?
16. Name one stress factor affecting plant growth.

Unit 3: Sexual Reproduction in Plants

17. Name the male reproductive organ of a flower.
18. What is the female part of a flower called?
19. Define pollination.
20. Name one pollinating agent.
21. What is self-pollination?
22. Define fertilization in plants.
23. Define parthenocarpy.

Unit 4: Plant Growth Assessment

24. Name one technique used to measure plant height.
25. What is biomass in terms of plant growth?
26. Define growth index.
27. What is plant breeding?
28. What is a greenhouse?
29. Define polyhouse.
30. What is hydroponics?

Short Answer 3-Mark Questions:**Unit 1: Plant Propagation Methods**

1. Explain seed propagation and mention any two.
2. Describe vegetative propagation through bulbs and runners.
3. Write a short note on propagation using rhizomes and suckers.
4. Explain the process of grafting.
5. Describe budding
6. Write a short note on stem and root cuttings.
7. Explain micropropagation.
8. Explain the basic concept of plant tissue culture.
9. Importance of micropropagation.

Unit 2: Plant Growth and Development

10. Explain growth at the cellular level with an example.
11. Describe its phases of Growth curve
12. Write a short note on any two plant growth regulators.
13. Role of auxins.
14. Role of cytokinin.
15. Write a short note on the application of gibberellins in agriculture.
16. Explain photoperiodism.
17. Describe concept and significance of vernalization.
18. Explain how salinity affects plant growth.
19. Explain water stress affect physiological processes in plants

Unit 3: Sexual Reproduction in Plants

20. Describe the structure of a flower as a reproductive organ.
21. What are the different parts of a flower and their functions?
22. Explain self-pollination
23. Explain cross-pollination.
24. Explain different pollinating agents
25. Explain the process of fertilization in flowering plants.
26. Describe double fertilization
27. Define parthenocarpy.

Unit 4: Plant Growth Assessment

28. Write a note on techniques for measuring plant height and biomass.
29. What is growth index? How is it calculated?
30. Explain the method of measuring leaf area in plants.
31. Describe the role of plant breeding in improving crop yield.
32. Write a short note on conventional plant breeding techniques.
33. What are greenhouses? How do they support plant growth?
34. Explain the importance of polyhouses in horticulture.
35. What is hydroponics? Mention any two advantages.

36. Describe basics of hydroponics

Long answer for 6 Marks

Unit 1: Plant Propagation Methods

1. Describe seed propagation in detail. What are its advantages and limitations?
2. Explain various vegetative propagation methods with suitable examples of bulbs, runners, rhizomes, and suckers.
3. Discuss artificial propagation methods—grafting, budding and cuttings.
4. What is micropropagation? Describe the steps involved in plant tissue culture and its economic significance.

Unit 2: Plant Growth and Development

5. Explain plant growth at the cellular level. Describe the growth curve with a neat diagram and phases.
6. Describe role of plant growth regulators auxins and cytokinin.
7. Describe Physiological role of Gibberellins and ethylene
8. What is photoperiodism? Explain its role in flowering and classify plants based on light requirement.
9. Define vernalization. Explain its significance.

Unit 3: Sexual Reproduction in Plants

10. Describe the structure of a typical flower. Explain its reproductive parts and functions in detail.
11. Explain types of pollination and describe the role of different pollinating agents with examples.
12. Describe the process of fertilization in angiosperms. Mention the significance of double fertilization.

Unit 4: Plant Growth Assessment

13. Describe various techniques used for plant growth assessment including measurement of height, biomass, leaf area, and growth index.
14. What is plant breeding? Explain conventional breeding methods for improving plant growth and yield.
15. Describe modern plant growth systems hydroponics, with advantages.
16. Explain various factors affecting plant growth and development.

Minor Practical – 12: Investigations of Plant Life Sketch

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	107225	Investigations of Plant Life Sketch	2	60	4 Hrs	25 (Ext) +25 (Int)

Course Objectives:

- To understand the various natural and artificial methods of plant propagation.
- To study plant growth patterns and the role of plant growth regulators.
- To comprehend the mechanisms of reproduction in flowering plants.
- To analyze techniques for measuring plant growth and understand modern methods to enhance plant productivity.
- To identify and document local plant diseases and their impact on growth and development.

Course Outcomes:

- Differentiate and demonstrate seed, vegetative, and artificial propagation methods.
- Understand the stages of plant growth and interpret growth curves and regulators.
- Gain knowledge of floral structures, pollination mechanisms, fertilization, and fruit development.
- Acquire skills in measuring growth parameters and identifying plant diseases.
- Develop awareness of plant propagation technologies such as micropropagation and modern growth enhancement methods.

Practical List (Any 10)

1. Study of seed germination and seedling development in dicots and monocots.
2. Observation of vegetative propagation structures: bulbs, rhizomes, runners, suckers (with specimens).
3. Practice of artificial propagation methods: grafting, budding, layering, and cuttings (demonstration).
4. Demonstration of basic micropropagation technique using plant tissue culture materials.
5. Preparation of plant growth curve by measuring height over a period and plotting results.
6. Study of meristematic activity using permanent slides of root tips.
7. Observation of the effect of growth regulators (auxin/gibberellin) on seedling growth (visual/documentation-based).
8. Identification of major plant growth regulators and their uses in agriculture and horticulture.
9. Study of photoperiodic response in flowering plants: examples of SDP, LDP, and DNP plants.
10. Study of flower structure as a reproductive organ using dissected floral parts and diagrams.
11. Identification of pollination types and pollinators through flower adaptation and examples.
12. Study of fruit and seed formation stages with examples of parthenocarpy.
13. Measurement of plant growth parameters: plant height, leaf area, fresh and dry weight.
14. Identification and documentation of local plant diseases and their effects on plant development.

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2. e-PG Pathshala (<https://epgp.inflibnet.ac.in>) – Reproductive Biology and Growth Regulation
3. NCERT Biology Textbooks (Free Download – <https://ncert.nic.in/ebooks.html>)
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Digital Resources & Weblinks

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Question Paper for External Practical Course on Investigations of Plant Life Sketch

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. II (Botany), SEMESTER – IV (NEP)				
Mn-Practical- 12	107225	Investigations of Plant Life Sketch	Max Marks: 25	Time: 4 Hrs.
Q.No.	Exercise			Marks
1.	Artificial propagation methods: grafting, budding and cuttings (demonstration any one method).			5
2.	Study of flower structure as a reproductive organ using dissected floral parts			5
3.	Measurement of plant growth parameters: leaf area, fresh and dry weight (Any one)			5
4.	Spotting (5 spot as per the practical list)			5
5.	External Viva Voce			5

Assessment Rubric for Internal Practical Course on Investigations of Plant Life Sketch

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. II (Botany), SEMESTER – IV (NEP)			
Practical-12	107225	Investigations of Plant Life Sketch	Max Marks: 25
S. No.	Assessment Criteria		Marks
1	Record/ Assignments		5
2	Attendance		5
3	Participation in Activity/ Field visit		5
4	Students overall performance		5
5	Internal Viva Voce		5

GOEC Theory: Wonders of Plant World

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	107226	Wonders of Plant World	2	30	2 Hrs	30 (Ext.) 20 (Int)

Course Objectives:

- To identify various vegetative propagation methods like bulbs, runners, rhizomes, and suckers.
- To describe the process of growth at the cellular level, growth regulators, and their role in plant growth and development.
- To apply knowledge of photoperiodism and vernalization in controlling plant flowering and growth patterns.
- To analyze the various methods of pollination, fertilization, and post-fertilization development in angiosperms.
- To evaluate the significance of plant breeding techniques in enhancing plant growth, yield, and quality.

Course Outcomes:

- Identify and differentiate natural and artificial methods of plant propagation and their limitations.
- Explain the role of plant growth regulators, photoperiodism, and vernalization in plant growth and development.
- Apply various methods of measuring plant growth such as height, biomass, and growth index.
- Analyze the role of environmental factors, diseases, and stress conditions affecting plant growth.
- Evaluate the importance of plant breeding, tissue culture, and advanced growth methods in increasing plant productivity.
- Design and formulate plant growth assessments through case studies, growth measurement experiments, and practical demonstrations.
- Investigate the importance of greenhouses, polyhouses, and hydroponics in advanced plant growth.
- Develop practical skills in plant propagation, growth measurement, and plant breeding techniques.
- Implement advanced growth methods and develop solutions to counter plant stress and diseases.

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
I	Plant Wonders – Intelligence, Perception, and Communication	8	8	Suitable pedagogical strategies are separately annexed
	1.1: Telegraph Plant (<i>Codariocalyx motorius</i>) – The Dancing Plant, Venus Flytrap (<i>Dionaea muscipula</i>) – The Electric Hunter			
	1.2: <i>Mimosa pudica</i> – The Plant That Remembers, <i>Boquila trifoliolata</i> – The Leaf Imitator			
	1.3: Tallest and Largest Sequoias - Sequoia sempervirens and Sequoiadendron giganteum			
	1.4: <i>Dracaena cinnabari</i> Dragon’s Blood Tree,			

	Single Bloom Largest Flower <i>Rafflesia arnoldii</i>			
II	Magnificent Products	7	7	
	2.1: The Mystic Rhizome - <i>Curcuma caesia</i> (Black Turmeric), The Scented Scar - <i>Aquilaria malaccensis</i> (Agarwood)			
	2.2: The Billion-Dollar Orchid <i>Vanilla planifolia</i> , The Dangerous Healer – <i>Croton tiglium</i> (Jamalgota)			
	2.3: Ginseng – The Traditional Divine Medicine <i>Panax</i> Chinese, Australia, Korean and American The Pain and Peace Plant – <i>Papaver somniferum</i> (Opium Poppy)			
	2.4: Natural rooting hormone: <i>Salix tetrasperma</i> (Indian Willow)			
III	Extreme Survivors: Masters of hostile environments	7	7	
	3.1: The Two-Leafed Immortal: <i>Welwitschia mirabilis</i> , The Resurrection Plant: <i>Selaginella lepidophylla</i>			
	3.2: The Altitude Adapter: <i>Ephedra gerardiana</i> , The Extreme Cold Survivors: <i>Saussurea obvallata</i> (Brahma Kamal)			
	3.3: Saline Adapter: <i>Rhizophora mucronata</i> (Mangrove), Extreme Desert Dweller: <i>Lithops spp.</i> (Living Stones)			
	3.4: Watermeal fine plant: <i>Wolffia globosa</i> ,			
IV	Green Futuristic Instincts	8	8	
	The Self-Cleaning Wonder: <i>Nelumbo nucifera</i> (Lotus Leaf), The Vegan Future: Duckweed (<i>Lemna minor</i>)			
	The Biofactory and Vaccine Generator Plant: <i>Nicotiana benthamiana</i> and Engineered <i>Nicotiana tabacum</i>			
	The Vitamin A Factory: Golden Rice, The Injectable-Free Immunity Plant: Potato Vaccine			
	Solar Panel Tracking Systems: <i>Helianthus annuus</i> , Artificial Photosynthesis in Hydrogen Fuel Technology			
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Model Questions:

Unit –I

1–Mark Questions (Answer in one sentence)

1. What is the scientific name of the Telegraph Plant?
टेलिग्राफ वनस्पतीचे शास्त्रीय नाव काय आहे?
2. Which plant is nicknamed "The Electric Hunter"?
"इलेक्ट्रिक शिकारी" या टोपणनावाने ओळखली जाणारी वनस्पती कोणती?
3. Name the plant known for leaf-folding when touched.
स्पर्श केला असता पाने मिटवणारी वनस्पती कोणती?
4. What is the special ability of *Boquila trifoliolata*?
बोकीला ट्रायफोलियोलाटाची विशेष क्षमता काय आहे?
5. Which is the tallest tree species in the world?
जगातील सर्वात उंच झाड कोणते?
6. Name the species called Dragon's Blood Tree.
ड्रॅगनच्या रक्ताचे झाड म्हणून ओळखली जाणारी वनस्पती कोणती?
7. Which plant produces the world's largest single bloom?
जगातील सर्वात मोठे एकल फूल देणारी वनस्पती कोणती?
8. Which plant exhibits leaf imitation behavior?
पाने अनुकरण करणारी वनस्पती कोणती आहे?

3–Mark Questions (Short answers)

1. Describe the movement mechanism of the Telegraph Plant.
टेलिग्राफ वनस्पतीतील हालचालीची यंत्रणा स्पष्ट करा.
2. Explain how Venus Flytrap responds to touch and why.
व्हीनस फ्लायट्रॅप स्पर्शाला कसे प्रतिसाद देते आणि का?
3. Write a short note on memory-like behavior in *Mimosa pudica*.
मायमोसा पुडिकामध्ये आढळणाऱ्या स्मृतीसारख्या वर्तनावर थोडक्यात माहिती द्या.

4. Describe the adaptive mimicry shown by *Boquila trifoliolata*.
बोकीला ट्रायफोलियोलाटाने दाखवलेले रूपानुकरणाचे अनुकूलन स्पष्ट करा.
5. Highlight the ecological and size-related marvel of *Sequoia sempervirens*.
सेकोया सॅम्परव्हायरेन्सचे पर्यावरणीय व आकाराचे वैशिष्ट्य सांगा.
6. Write a note on the ecological uniqueness of *Dracaena cinnabari*.
ड्रॅसेना सिन्नाबारीच्या पर्यावरणीय वैशिष्ट्यावर टिपण लिहा.
7. Discuss pollination-related features of *Rafflesia arnoldii*.
रॅफ्लेशिया अर्नोल्डीच्या परागीकरणविषयक वैशिष्ट्यांवर चर्चा करा.

6-Mark Questions (Long Answer Type)

1. Compare and contrast intelligent behavior observed in *Codariocalyx motorius*, *Mimosa pudica*, and *Dionaea muscipula* with respect to plant perception and response.
कोडॅरिओकॅलक्स मोटोरियस, मायमोसा पुडिका, व डायोनेया मस्किपुला या वनस्पतींमध्ये आढळणाऱ्या बुद्धिमान वर्तनाची तुलना करा व स्पर्श/उत्तरे याबाबत चर्चा करा.
2. Explain in detail the concept of plant communication and mimicry with reference to *Boquila trifoliolata* and *Mimosa pudica*. बोकीला ट्रायफोलियोलाटा व मायमोसा पुडिका या वनस्पतींच्या उदाहरणासह वनस्पती संवाद व अनुकरण या संकल्पनांचे सविस्तर वर्णन करा.
3. Write an account on *Sequoia sempervirens* and *Sequoiadendron giganteum*, highlighting their size, age, ecological role, and significance in the plant kingdom. सेकोया सॅम्परव्हायरेन्स व सेक्वॉयाडेंड्रॉन जायंटियम या जगातील सर्वात उंच व विशाल वृक्षांबाबत त्यांचा आकार, वय, पर्यावरणीय भूमिका व वनस्पती राज्यातील स्थान स्पष्ट करा.
4. Describe the unique features of *Rafflesia arnoldii* and *Dracaena cinnabari*, emphasizing their reproduction, habitat, and ecological value. रॅफ्लेशिया अर्नोल्डी व ड्रॅसेना सिन्नाबारी या वनस्पतींच्या वैशिष्ट्यांवर प्रकाश टाका, त्यांच्या पुनरुत्पादन, अधिवास व पर्यावरणीय महत्त्व यावर चर्चा करा.
5. Discuss the idea of 'plant intelligence' with scientific explanation and examples from at least three species covered in this unit. 'वनस्पतींची बुद्धिमत्ता' या संकल्पनेचे वैज्ञानिक दृष्टिकोनातून स्पष्टीकरण द्या आणि या घटकातील किमान तीन वनस्पतींची उदाहरणे द्या.

Unit II: Magnificent Products

1-Mark Questions (Answer in one sentence)

1. Name the plant known as Black Turmeric.
काळी हळद म्हणून ओळखली जाणारी वनस्पती कोणती?
2. What is agarwood obtained from?
अगरवुड कोणत्या वनस्पतीपासून मिळवले जाते?
3. Which orchid is called the "Billion Dollar Plant"?
"बिलियन डॉलरस प्लंट" म्हणून ओळखली जाणारी ऑर्किड कोणती?

4. Name the poisonous medicinal plant *Croton tiglium* is commonly known as.

Croton tiglium या विषारी औषधी वनस्पतीचे सामान्य नाव काय आहे?

5. What is the source plant of Ginseng?
जिनसेंग या वनस्पतीचा मूळ स्रोत कोणता आहे?
6. Name the narcotic plant that also provides pain relief.
वेदना कमी करणाऱ्या आणि व्यसनाधीनतेस कारणीभूत ठरणाऱ्या वनस्पतीचे नाव सांगा.
7. Which Indian tree acts as a natural rooting hormone?
नैसर्गिक मुळे निर्माण करणारे भारतीय झाड कोणते?

3-Mark Questions (Short answers)

1. Describe the medicinal and cultural importance of *Curcuma caesia*.
कुर्कुमा कॅसिया (काळी हळद) याचे औषधी व सांस्कृतिक महत्त्व लिहा.
2. How is agarwood formed and what is its value?
अगरवुड कसे तयार होते आणि त्याचे महत्त्व काय आहे?
3. Explain the economic importance of *Vanilla planifolia*.
व्हॅनिला प्लॅनिफोलिया या ऑर्किडचे आर्थिक महत्त्व स्पष्ट करा.
4. Write a note on *Croton tiglium* as a dangerous healer.
Croton tiglium ही धोकादायक औषधी वनस्पती यावर टिपण लिहा.
5. Describe the pharmacological properties of *Panax ginseng*.
पॅनॅक्स जिनसेंग या वनस्पतीच्या औषधी गुणधर्मांचे वर्णन करा.
6. Write a short note on the uses and controversy around *Papaver somniferum*.
पॅपॅव्हर सोमनिफेरम (अफू) याच्या उपयोगांवर व वादांवर टिपण लिहा.
7. Explain the significance of *Salix tetrasperma* in propagation.
सॅलिक्स टेट्रास्पेर्मा या वनस्पतीचा वनस्पती प्रसारात होणारा उपयोग स्पष्ट करा.

6-Mark Questions (Long answers)

1. Discuss the significance of plant-derived products with reference to *Vanilla*, *Croton*, and *Papaver*.
व्हॅनिला, क्रोटॉन आणि पॅपॅव्हर या वनस्पतींच्या उदाहरणासह वनस्पती-जन्य उत्पादनांचे महत्त्व स्पष्ट करा.
2. Describe the chemistry and ethnobotany of *Ginseng* and *Agarwood*.
जिनसेंग आणि अगरवुड यांचे रासायनिक व पारंपरिक उपयोग सांगा.
3. Explain the role of *Salix tetrasperma* and *Black Turmeric* in natural agriculture and wellness.
सॅलिक्स टेट्रास्पेर्मा व काळी हळद यांचा नैसर्गिक शेती व आरोग्य सुधारण्यात होणारा उपयोग स्पष्ट करा.

Unit III: Extreme Survivors

1-Mark Questions (Answer in one sentence)

1. Name the plant with only two persistent leaves.
फक्त दोन कायमस्वरूपी पाने असलेली वनस्पती कोणती?
2. What is the resurrection plant known for?
रिझरेक्शन प्लॅंट कोणत्या वैशिष्ट्यासाठी ओळखला जातो?
3. Name a gymnosperm adapted to high altitude.
उंच प्रदेशात वाढणाऱ्या कोणत्या जिम्नोस्पर्मचे नाव द्या?

4. Which plant is called Brahma Kamal?
"ब्रह्म कमळ" म्हणून ओळखली जाणारी वनस्पती कोणती?
5. Name a true mangrove species.
खरी मॅन्ग्रोव्ह वनस्पती कोणती?
6. What are Lithops commonly known as?
लिथॉप्स या वनस्पतींना सामान्यतः काय म्हणतात?
7. Which is the smallest flowering plant?
सर्वात लहान फुलझाड कोणती आहे?

3-Mark Questions (Short answers)

1. Write a note on the survival strategy of *Welwitschia mirabilis*.
व्हेल्विट्सिया मिरॅबिलिस या वनस्पतीची टिकून राहण्याची युक्ती लिहा.
2. Explain the drought resilience in *Selaginella lepidophylla*.
सेलाजिनेला लेपिडोफायला या वनस्पतीची दुष्काळप्रतिकारक क्षमता स्पष्ट करा.
3. Describe cold survival adaptations in *Ephedra* and *Saussurea obvallata*.
इफेद्रा व सॉसुरिया ऑबव्हॅलेटा यामधील थंडीच्या अनुकूलतेचे वैशिष्ट्ये स्पष्ट करा.
4. Write a note on salt-tolerance in *Rhizophora mucronata*.
रायझोफोरा म्युक्रोनेटा मधील क्षार सहनशीलतेचे वैशिष्ट्य स्पष्ट करा.
5. Discuss the desert mimicry of *Lithops spp.*
लिथॉप्स मध्ये आढळणारे वाळवंटी नकलन स्पष्ट करा.
6. Describe the biological simplicity and utility of *Wolffia globosa*.
वोल्फिया ग्लोबोसा ची जैविक रचना आणि उपयोगिता स्पष्ट करा.

6-Mark Questions (Long answers)

1. Compare adaptations in *Welwitschia*, *Selaginella*, and *Lithops* in harsh environments.
व्हेल्विट्सिया, सेलाजिनेला, आणि लिथॉप्स यांच्या कठीण परिस्थितीत टिकून राहण्याच्या वैशिष्ट्यांची तुलना करा.
2. Discuss physiological and morphological adaptations in saline and alpine plants.
क्षारीय व थंड हवामानातील वनस्पतींमधील शारीरिक व रचनात्मक अनुकूलतेची चर्चा करा.
3. Evaluate the ecological role of extreme survivors in biodiversity conservation.
टिकाऊ वनस्पतींचे जैवविविधतेच्या संवर्धनातील योगदान स्पष्ट करा.

Unit IV: Green Futuristic Instincts

1-Mark Questions (Answer in one sentence)

1. Name the plant known for its self-cleaning leaf surface.
स्वयं-स्वच्छ पानांचा पृष्ठभाग असलेली वनस्पती कोणती?
2. Which aquatic plant is considered a vegan protein source?
वनस्पती आधारित प्रथिनांचा स्रोत असलेली जलीय वनस्पती कोणती?
3. Name the plant used in vaccine production via biotechnology.
जैवतंत्रज्ञानाद्वारे लसीकरणासाठी वापरली जाणारी वनस्पती कोणती?

4. What is Golden Rice rich in?
गोल्डन राईस मध्ये कोणता पोषक घटक मुबलक प्रमाणात असतो?
5. Which common plant shows heliotropic tracking of the sun?
सूर्याच्या दिशेनुसार हालचाल करणारी सामान्य वनस्पती कोणती?
6. What biological process inspired artificial photosynthesis?
कृत्रिम प्रकाशसंश्लेषणासाठी प्रेरणा देणारी नैसर्गिक प्रक्रिया कोणती?
7. Which plant is used to produce edible vaccines?
खाण्यायोग्य लस निर्माण करणाऱ्या वनस्पतीचे नाव काय आहे?

3-Mark Questions (Short answers)

1. Describe the nano-structural properties of the lotus leaf.
कमळाच्या पानांची सूक्ष्म संरचनात्मक वैशिष्ट्ये लिहा.
2. Write a note on the protein and biomass value of *Lemna minor*.
लेम्ना मायनर या वनस्पतीतील प्रथिने व जैवभाराचे महत्त्व स्पष्ट करा.
3. Explain how *Nicotiana benthamiana* is used in biotechnology.
निकोटियाना बेंथमियाना जैवतंत्रज्ञानात कसा वापरला जातो ते लिहा.
4. What is Golden Rice and why is it important?
गोल्डन राईस म्हणजे काय आणि ते महत्त्वाचे का आहे?
5. Describe the working of *Helianthus annuus* as a natural sun tracker.
हेलिअंथस अँन्युअस ही वनस्पती सूर्याचा मागोवा कशी घेते ते स्पष्ट करा.
6. Write a short note on artificial photosynthesis in energy tech.
उर्जासंबंधी तंत्रज्ञानात कृत्रिम प्रकाशसंश्लेषणाचे महत्त्व लिहा.

6-Mark Questions (Long answers)

1. Discuss how futuristic plant traits are being adapted for food, energy, and medicine.
अन्न, ऊर्जा आणि औषधासाठी वनस्पतींच्या भविष्यवादी गुणधर्मांचा कसा उपयोग केला जात आहे ते स्पष्ट करा.
2. Describe the concept and applications of bioengineered plants with reference to *Potato Vaccine* and *Golden Rice*.
पोटॅटो लस व गोल्डन राईस यांच्या उदाहरणासहित जैव-यांत्रिकृत वनस्पतींचे महत्त्व स्पष्ट करा.
3. Explain the role of *Nelumbo nucifera*, *Lemna*, and *Nicotiana* in sustainable and innovative botany.
नेलंबो, लेम्ना व निकोटियाना या वनस्पतींची शाश्वत व नाविन्यपूर्ण वनस्पतीशास्त्रातील भूमिका स्पष्ट करा.

VSC: Nursery and Garden Management

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	107227	Nursery and Garden Management	2	60	4 Hrs	50

Course Objectives:

1. To create opportunities for self-employment/student startup through Nursery and Garden Management.
2. To enrich students' training and knowledge that would be useful in the nursery and garden so that the stockholder will get a good profit.
3. To create awareness among nursery and garden developers or managers.

Course Outcomes:

1. Understand the Scope of Nursery and Garden Management.
2. Demonstrate different methods of plant propagation.
3. Understand: The concept of nursery and garden layout and planning.
4. Acquire knowledge about designing, maintenance, and landscaping
5. Analyze marketing, budgeting, and inventory management for a nursery business.
6. Design sustainable methods for nursery and garden management.

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Introduction to Nursery Management	15	12	Suitable pedagogical strategies are separately annexed
	1.1 Importance and scope of nurseries			
	1.2 Types of nurseries: Retail, wholesale, specialized, and home nurseries.			
	1.3 Selection of site for nursery establishment Preparation of nursery beds and its types			
	1.4 Layout and infrastructure: Propagation structures (greenhouses, shade nets, polyhouse etc)			
Unit II	Garden Management Principles	15	12	
	2.1 Types of gardens: Botanical, terrace gardens and kitchen garden			
	2.2 Garden component and tools: Lawns, hedges, shrubs, climbers, trees, flower beds and uses of tools			
	2.3 Garden maintenance: Soil mixture. Watering, pruning, weeding, manuring, pest and disease management.			
	2.4 Seasonal planting and rotation in gardens.			
Unit III	Commercial Aspects and Sustainable Practices			
	3.1 Nursery Business Management: Financial planning (cost management, pricing) production, marketing and record-keeping			
	3.2 Government Policies & Regulations: Government schemes, Licensing, certifications and compliance requirements for nursery and garden businesses.			
	3.3 Sustainable Practices: Organic media, water conservation, bio-manure preparation, solar-powered equipment and eco-friendly packaging alternatives.			
	3.4 Modern Technologies: Drip irrigation, Sprinkler, rain pipe, hydroponics, and vertical gardening.			

Unit IV	Entrepreneurship in Nursery Management			
	4.1 Planning & Establishing a Nursery: Financial management and sourcing.	15	14	
	4.2 Marketing & Branding: Online and offline marketing, customer management and sales strategies.			
	4.3 Project Management & Documentation: Business models, project proposals, nursery records and inventory management.			
	4.4 Practical Project: Creating a business plan for a nursery startup.			
Practical: Conduct at least three Exercises from Each Unit of the following: Unit I: 1. Design and prepare a basic nursery layout. 2. Preparation of Nursery beds (type of bed-flat /raised) 3. Study the construction and maintenance of propagation structures (poly houses/shade nets/ Green house) 4. Test and document soil pH and nutrient content for nursery use. Unit II: 5. Design small garden layouts incorporating lawns, flower beds, and pathways. 6. Perform maintenance activities: Lawn mowing, pruning, weeding, and pest control. 7. Propagate ornamental plants using appropriate techniques. 8. Demonstration of tools use in garden 9. To understand the design principles, features and maintenance practices of different types of gardens Unit III: 10. Prepare a step-by-step plan for obtaining nursery certifications. 11. Licensing & Legal Documentation Simulation for Nursery Setup 12. Preparation of Organic Potting Mix & Bio-Manure 13. Pest & Disease Control Using Organic Methods (Neem oil, bio-pesticides, etc.). 14. Ecofriendly packaging of saplings 15. Demonstration on Vertical Gardening 16. Hydroponics Demonstration UNIT IV : 17. Developing a Business Plan for a Nursery Startup 18. Branding & Packaging for Nursery Plants 19. Market Survey & Pricing Analysis of Nursery Products 20. Customer Interaction & Sales Strategy Role-Play				
Conduct at least TWO Activities from the following: Field visits: 1. Visit a commercial nursery or garden to study operations. Other activities – 1. Prepare a list of plants that are on high demand in nursery 2. Case Study on Government Nursery Policies & Subsidies 3. Nursery Market Survey & Pricing Analysis 4. Preparation Garden inspection report 5. Organize a workshop or hands on training Collaboration/ MoU- Conduct suggested activities in Collaboration / MoU with any Nursery / related NGO/ Garden.				

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• ICAR. (2022). <i>The role of modern irrigation techniques in nursery management: A case study from Karnataka.</i> • NABARD. (2021). <i>The success story of agri-startups in the nursery sector: Case studies from Maharashtra and Punjab.</i> • Patel, S. (2020). <i>Digital marketing strategies for plant nurseries: A case study from Gujarat.</i>
International Case Studies • Asian Development Bank. (2022). <i>The impact of government incentives on nursery entrepreneurship in Southeast Asia.</i> • European Horticulture Society. (2021). <i>Sustainable packaging solutions in the plant nursery industry: A study from Germany and the Netherlands.</i> • FAO. (2019). <i>Drip irrigation and water conservation in nursery management: A case study from Israel.</i> • USDA. (2022). <i>Best practices in greenhouse nursery management: Lessons from the USA and Canada.</i> United States Department of Agriculture
Pedagogies 1. Entrepreneurial Project Development, where students ideate, develop, and present a business plan related to the Nursery and garden. This pedagogy combines market research, product development, and strategic planning. 2. Mentorship Programs with professional experts can provide personalized guidance, enhancing entrepreneurial skills and network building. These methods offer practical insights into business development, encouraging innovation and real-world application of course concepts. 3. Project-Based Learning (PBL): Engages students in real-world nursery industry projects, enhancing their understanding and skills in a practical context. 4. Flipped Classroom: Utilizes online resources for theory, freeing up classroom time for interactive discussions, practical exercises, and guest lectures from industry professionals. 5. Simulation Games and Virtual Labs: Offers hands-on experience in nursery and garden development processes without the need for physical resources. 6. Case Studies and Role Plays: Encourages critical thinking and problem-solving through analysis of real-world challenges in the seed industry. 7. Internships and Industry Visits: Provides firsthand experience and insight into the operational aspects of nursery and Garden management.

Question Paper for Internal VSC Practical

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. II (Botany), SEMESTER – IV (NEP)			
Practical-13	Course Code 107227	Nursery and Garden Management	Max Marks: 50
Q. No.	Exercise	Marks	
1	Demonstration of preparation of organic potting mix/ Lawn mowing, pruning, weeding/ testing of soil pH (any one)	10	
2	Design layout and infrastructure of propagation structure (any one)	5	
3	Prepare a business plan / Startup plan for nursery or Garden	5	
4	Comment on Hydroponics/ Vertical Gardening.	5	
5	Attendance & overall Performance throughout the semester	10	
6	Record Book / Activity book	5	
7	Field visit / Activities under MoU or Collaboration- report	5	
8	Viva Voce	5	
	Total	50	

SEC: Skilling Botanists for Nursery and Garden Management

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	107228	Skilling Botanists for Nursery and Garden Management (Discontinued from 2026-27)	2	60	4 Hrs	50

Course Objectives: • To provide students with a comprehensive understanding of nursery and garden management. • To develop practical skills in plant propagation, nursery establishment, and garden maintenance. • To prepare students for careers in horticulture, landscaping, and related fields				
Course Outcomes: 1. Understand basics of nursery and garden management. 2. Apply sexual and asexual propagation techniques. 3. Analyze factors affecting propagation and manage nursery records. 4. Select nursery site and use digital tools for layout planning. 5. Identify and plan nursery infrastructure. 6. Perform soil preparation, irrigation, pruning, and weeding. 7. Practice organic gardening and integrated pest management. 8. Maintain biodiversity, hygiene, and systematic record-keeping.				
Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Introduction to Nursery and Garden Management	15	12	Suitable pedagogical strategies are separately annexed
	1.1 Overview of nursery and garden management			
	1.2 Role of nurseries in garden management			
	1.3 Nurseries: horticultural, forestry and ornamental, etc.			
	1.4 Basic concepts of garden design and layout			
Unit II	Plant Propagation Techniques	15	12	
	2.1 Sexual propagation: Seed collection, storage, and germination.			
	2.2 Asexual propagation: Cutting, grafting, budding, layering, and tissue culture.			
	2.3 Factors Affecting Propagation Success.			
	2.4 Basic costing, marketing of saplings, nursery record-keeping.			
Unit III	Nursery Establishment and Management	15	12	
	3.1 Site selection and preparation. Technology Tools: Mobile apps like Google SketchUp or Canva for garden design, sensors and automation kits			
	3.2 Infrastructure requirements (greenhouses, shade houses, irrigation systems)			
	3.3 Soil and media preparation, Soil preparation and fertilization, Irrigation and water management, Efficient irrigation techniques, Pruning, weeding, and			
	3.4 Nursery hygiene and pest management.			

Unit IV	Sustainable Practices in Nursery and Garden Management			
	4.1 Organic gardening practices, Composting and Organic Fertilizers, Natural Pest	15	12	
	4.2 Use of renewable resources and recycling, Integrated Pest Management (IPM)			
	4.3 Role of biodiversity in garden ecosystems			
	4.4 Maintain proper hygiene and record-keeping in nursery operations.			
Practical: Conduct at least three Exercises from Each Unit of the following: Unit I: 1. Design and prepare a nursery layout (Forest / Horticulture/ Ornamental any one) 2. Study the layout and infrastructure of a well-maintained garden. 3. Survey and Documentation of Local Nurseries 4. Classification and Tagging of Nursery Plants 5. Preparation and Maintenance of Nursery Records 6. Drawing a Basic Garden Layout on Graph Paper 7. Creation of a Miniature Garden Model Unit II: 1. To Collect seeds from local plants and prepare them for sowing. 2. To Sow seeds in seed trays and monitor germination rates. 3. Practice stem cutting, leaf cutting, and root cutting on plants like rose, money plant, and coleus. 4. Perform grafting (e.g., wedge grafting in mango) and budding (e.g., T-budding in roses). Unit III: 1. Site Selection and Layout Planning Using Mobile Apps (Google SketchUp/Canva) 2. Design and Setup of a Model Greenhouse or Shade House 3. Demonstration of Efficient Irrigation Techniques (Drip/Sprinkler Systems) 4. Pruning, Weeding, and Maintenance Practices in Nursery Plants 5. Assessment and Application of Nursery Hygiene and Pest Control Measures 6. Prepare different potting mixes using soil, sand, compost, and cocopeat 7. Preparation of Organic Potting Mix & Bio-Manure 8. Demonstration on Set up a rainwater harvesting system for garden use. UNIT IV: 1. Demonstrate mulching to reduce water evaporation 2. Identify beneficial insects and their role in pest control. 3. Prepare compost using kitchen waste, garden waste, and cow dung 4. Demonstrate vermicomposting using earthworms.				
Conduct at least TWO Activities from the following: Field visits: 1. Visit a commercial nursery or garden to study operations. Other activities – 1. Visit commercial nurseries, organic farms, and public gardens to observe best practices. 2. Visit local horticulture departments or agricultural universities for hands-on training and resources. 3. Prepare a budget for setting up a small nursery or garden Collaboration/ MoU- Conduct suggested activities in Collaboration / MoU with any Nursery / related NGO/ Garden.				
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Question Paper for Internal Practical of SEC Skilling Botanists for Nursery and Garden Management

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. II (Botany), SEMESTER – IV (NEP)			
Practical-14	Course Code – 107228	Skilling Botanists for Nursery and Garden Management	Max Marks: 50
Q.N.	Exercise	Marks	
1	Demonstration of Budding/ Grafting/Cutting (any one)	10	
2	Design Nursery / Garden layout as per requirements & area	5	
3	Prepare compost using kitchen waste	5	
4	Comment on irrigation technique/pruning/ weeding (any two)	5	
5	Attendance & overall Performance throughout the semester	10	
6	Record Book / Activity book	5	
7	Field visit / Activities under MoU or Collaboration- report	5	
8	Viva Voce	5	
	Total	50	

Field Project / Community Engagement Services in Botany: Phase-II

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	IV	107229	Field Project / Community Engagement Services in Botany: Phase-II	2	60	--	50

Course Objectives:

- To deepen field-based understanding of plant ecology, conservation practices, and community-linked botanical knowledge.
- To engage students in solving real-world problems through plant-based interventions and sustainability projects.
- To promote botanical innovation and outreach via community collaboration.
- To enhance project planning, execution, documentation, and dissemination skills.

Course Outcomes:

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

- Design and implement field-based botanical studies and service projects.
- Collaborate with rural/urban communities in addressing ecological challenges.
- Apply indigenous and scientific botanical knowledge for sustainable outcomes.
- Reflect on the social, ethical, and ecological impact of their interventions.
- Present findings effectively through reports, posters, and public engagement.

Guidelines/ SoP for FP/CEP

For understanding key principles of CE, forms of CE, operational guidelines and implementation strategy please refer https://www.ugc.gov.in/pdfnews/4187860_Revised-Final-Guidelines.pdf

As per NEP 2020, students of B Sc. II of Semester III and IV need to perform a Field Project (FP) for TWO (2) credits i.e. 50 Marks.

The guidelines regarding the field project are as follows:

Phase-I was about observation; Phase II is about transformation. This stage should empower students not just to study nature with curiosity, but to engage with communities in stewardship—even in small, humble ways.

Project Format and Deliverables

Component	Description
Duration	60 hours total (fieldwork + report writing + presentation)
Group Size	Individual or up to 4 students
Guide	Supervised by departmental faculty
Project Types	Survey-based, experimental, participatory, or interventionist
Final Output	Written report + Presentation + Community feedback
Evaluation	Internal (faculty) + External (appointed examiner) = 50 marks

Suggested Methodology:

Students should:

- Revisit and reflect on Phase I: What was observed? What problems or patterns emerged?
- Identify upgrade paths:

Phase I Focus	Phase II Upgrade
Documentation of medicinal plants	Trial plantation or awareness campaign
Survey of native species	Conservation/restoration initiative
Awareness posters on leafy greens	Live demos, kitchen gardens, nutrition drives
Soil/compost testing	Pilot cultivation trials in community

Suggested Project Types & Methodology

1. Problem-Solving/Intervention Projects

- Define a tangible issue (e.g., low seed germination, poor plant health, monoculture cropping).
- Design and implement a simple solution: improved propagation method, vermicompost trial, native seed packets, etc.
- Use before–after comparisons or control vs treatment plots.

2. Community Co-Creation

- Collaborate with local SHGs, farmers, school eco-clubs, or NGOs.
- Involve them in designing part of the project (planting, seed saving, garden design).
- Document shared knowledge and reciprocal learning.

3. Extended Surveys with Action

- Move from just documenting (Phase I) to evaluating & advising:

e.g., from “plants used by tribal communities” to “reviving forgotten uses through school campaigns.”

Or from “identifying rare species” to “creating signage for local plant trails.”

Field Protocol (Concise Steps)

1. Reassess Phase I findings: What insights, gaps, or opportunities emerged?
2. Design upgrade: Choose a focus: ecological impact, community outreach, practical testing and finalize objectives, participants, tools, and timeline
3. Execute fieldwork: Collect refined data and Conduct activities: planting trials, awareness sessions, school visits, community experiments
4. Monitor & Record: Use datasheets, photos, interviews, impact logs
5. Analyse: Compare results or outcomes (even in basic visual/statistical form)
6. Document & Present: Full report + visual presentation, Include community reflection or feedback if possible

Field-Based Work:

- Continued/advanced study from Phase-I or a fresh topic.
- Emphasis on data collection, analysis, and solution prototyping.

Report Format (Minimum 6 pages excluding Title, Certificate, Acknowledgement and appendices):

- 1. Title Page
- 2. Certificate
- 3. Acknowledgement
- 4. Main Report:
- 5. Introduction
- 6. Objectives
- 7. Methodology
- 8. Observations/Data
- 9. Discussion
- 10. Suggestions/Interventions
- 11. Conclusion
- 12. References

Example Upgrade Paths:

Phase I Topic	Phase II Upgrade
Medicinal plant documentation	Set up herbal home gardens or community demo plots
Compost testing	Promote low-cost compost units & track uptake
Awareness posters in schools	Interactive workshops & hands-on sessions
Survey of endangered species	Start digital herbarium or seed bank initiative

Suggested Project Themes:

Applied Botanical Solutions:

- 1. Designing a model medicinal garden in school or panchayat land
- 2. Seed bank or seed exchange initiatives for native/neglected crops
- 3. Botanical survey and mapping of urban green corridors

Experimental Community Work:

- 1. Demonstrating effects of composting methods on plant growth
- 2. Testing native vs hybrid seeds in vegetable gardens
- 3. Cultivation of insect-repelling plants and documentation of outcomes

Outreach and Advocacy:

- 1. Conducting awareness drives in schools/panchayats on medicinal plants
- 2. Publishing plant-care brochures in vernacular language
- 3. Training SHGs (Self Help Groups) on nursery skills or organic gardening

Ethics & Logistics

- Ensure voluntary community participation and informed consent.
- Avoid projects that may involve sensitive ecological areas or protected species without permissions.
- Encourage documentation in regional languages where applicable.

Assessment Rubric for FP/CEP Phase-II

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. II (Botany), SEMESTER – IV (NEP)			
FP/CEP	Course Code: 107229	Field Project / Community Engagement Services in Botany: Phase-II	Max Marks: 50
Q. No.	Exercise		Marks
1	Field Engagement & Application of Knowledge		10
2	Quality of Intervention/Innovation		10
3	Documentation & Report Writing		10
4	Outcome of the Project Work		10
5	Oral/Poster Presentation		10

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI



THREE /FOUR YEAR DEGREE OF BACHELOR OF SCIENCE

Bachelor of Science

SUBJECT: BOTANY

FACULTY: SCIENCE AND TECHNOLOGY

**(Courses effective from Academic Year 2026-2027)
Under Uniform NEP 2020 Scheme**

SYLLABUS

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Semester V Botany: Credits, Workload, Examination, Evaluation and Assessment Scheme

Level	The Vertical	Course Code	Course Title	Credits	Workload	Theory/Practical Marks				Theory/Pract (Total) Marks	
						External		Internal		Max.	Min.
						Max.	Min.	Max.	Min.		
5.5	Major-T	107231	Theoretical Foundations in Anatomy, Embryology, and Pharmacognosy	2	2	30	9	20	6	50	20
5.5	Major-T	107232	Innovative technologies of Genetics, Plant Breeding, Green Revolution and Biotechnology	2	2	30	9	20	6	50	20
5.5	Major-T	107234	Biochemistry and Plant Physiology	2	2	30	9	20	6	50	20
5.5	Major-P	107235	Practical Based on Major Theory Papers of Semester V	2	4	25	10	25	10	50	20
5.5	Major-Elective T1	107236	Plant Systematics - 1	2	2	30	9	20	6	50	20
5.5	Major-Elective P1	107237	Lab-Based Learning of Plant Systematics - 1	2	4	25	10	25	10	50	20
OR											
5.5	Major-Elective T2	107238	Molecular Biology and Genetic Engineering - 1	2	2	30	9	20	6	50	20
5.5	Major-Elective P2	107239	Lab-Based Learning of Mole.Bio. and Genetic Eng. - 1	2	4	25	10	25	10	50	20
OR											
5.5	Major-Elective T3	107240	Advance Plant Physiology - 1	2	2	30	9	20	6	50	20
5.5	Major-Elective P3	107241	Lab-Based Learning of Advance Plant Physiology - 1	2	4	25	10	25	10	50	20
OR											
5.5	Major-Elective T4	107242	Basic and Applied Mycology and Plant Pathology- 1	2	2	30	9	20	6	50	20
5.5	Major-Elective P4	107243	Lab-Based Learning of Basic and Applied Mycology and Plant Pathology- 1	2	4	25	10	25	10	50	20
5.5	Minor-T	107244	Biochemistry, Plant Physiology and Ecology	2	2	30	9	20	6	50	20
5.5	Minor-P	107245	Lab Techniques in Biochemi, Plant Physio. and Ecology	2	4	25	10	25	10	50	20
5.5	VSC-P	107246	Eco-Friendly Plant Products	2	4	-	-	50	20	50	20
5.5	SEC-P1	107247	Skilling Botanists for Nursery and Garden Management (from session 2027-2028 onwards)	2	4	-	-	50	20	50	20
OR											

5.5	SEC-P2	107248	Mushroom Culture Technology & Production (from 26-27)	2	4	-	-	50	20	50	20
OR											
5.5	SEC-P3	107249	Biofertilizer Technology (2026-27 Onwards)	2	4	-	-	50	20	50	20
OR											
	SEC-P4	107250	Herbs and Herbal Products	2	4	-	-	50	20	50	20
5.5	FP/CEP	107251	Botany Lab (Field Project / Community Engagement Program)	2	4	-	-	50	20	50	20
5.5	Non Credit		Foundation of Artificial Intelligence	NC	2			30+20	9+6	50	20

Important:

- **VSC Should be Complementary to Major**
- **SEC must be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor**
- As per Sant Gadge Baba Amravati University, Amravati Extra-Ordinary Notification No. No. 241/2025 Dated 24/12/2025 “Foundation of Artificial Intelligence” is the Mandatory **Non Credit Course** compulsory course for all the UG students in fifth semester of all undergraduate programs of all faculties in Sant Gadge Baba Amravati University, Amravati to earn their degree
- NC is Non Credit Course
- Students must select **Any One** of the Major-Elective Courses (T1 to T4) with respective Practical Course in Semester V and **same shall be continued** for Semester VI
- Students must select **Any One** of the SEC-P (P1 to P4) Course in Semester V and Semester VI

Semester VI Botany: Credits, Workload, Examination, Evaluation and Assessment Scheme

Level	The Vertical	Course Code	Course Title	Credits	Workload	Theory/Practical Marks				Theory/Pract (Total) Marks	
						External		Internal			
						Max.	Min.	Max.	Min.	Max.	Min.
5.5	Major-T	107252	Genomics, Proteomics and Metabolomics	2	2	30	9	20	6	50	20
5.5	Major-T	107253	Plant Ecology & Conservation Biology	2	2	30	9	20	6	50	20
5.5	Major-T	107254	Modern Tools and Techniques in Plant Sciences	2	2	30	9	20	6	50	20
5.5	Major-P	107255	Hands on Omics, Ecology & Modern Techniques	2	4	25	10	25	10	50	20
5.5	Major-Elective T1	107256	Plant Systematics - 2	2	2	30	9	20	6	50	20
5.5	Major-Elective P1	107257	Lab-Based Learning of Plant Systematics -2	2	4	25	10	25	10	50	20
OR											
5.5	Major-Elective T2	107258	Molecular Biology and Genetic Engineering - 2	2	2	30	9	20	6	50	20
5.5	Major-Elective P2	107259	Lab-Based Learning of Mole.Bio. and Genetic Eng. -2	2	4	25	10	25	10	50	20
OR											
5.5	Major-Elective T3	107260	Advance Plant Physiology - 2	2	2	30	9	20	6	50	20
5.5	Major-Elective P3	107261	Lab-Based Learning of Advance Plant Physiology - 2	2	4	25	10	25	10	50	20
OR											
5.5	Major-Elective T4	107262	Basic and Applied Mycology and Plant Pathology-2	2	2	30	9	20	6	50	20
5.5	Major-Elective P4	107263	Lab-Based Learning of Basic and Applied Mycology and Plant Pathology-2	2	4	25	10	25	10	50	20
5.5	Minor-T	107264	Molecular Biology, Genetic Engineering and Biotechnology	2	2	30	9	20	6	50	20
5.5	Minor-P	107265	Experimental Mole. Bio, Genetic Engi. & Biotech.	2	2	30	9	20	6	50	20
5.5	VSC-P	107266	Entrepreneurship for Botanists	2	4	-	-	50	20	50	20
5.5	Intern/Apprenticeship	107267	Botany Lab (Internship / Apprenticeship)	4	8	-	-	50	20	50	20

Important: VSC Should be Complementary to Major and SEC has to be selected from the Basket Provided by University, from the same Faculty/Discipline of the Major/Minor

Notes:

- a. The strength of the batch of the Practical for UG Classes shall be 16 with an addition of 10% with the permission of Hon'ble Vice Chancellor. The number of the students required to constitute a batch or calculate the workload shall be in accordance with the relevant Government Resolution in force at the time, applicable to specific time, region, course type, mode of instruction, and other pertinent factors.
- b. 1 Credit shall mean 1 Hour Teaching per Week per Semester (Total 15 Hrs/ Semester), the duration of 1 Teaching Period will be 60 Minutes. For Practical 1 Credit shall mean 2 Hour Teaching per Week per Semester (Total 30 Hrs/ Semester).
- c. For Examination and Evaluation of Theory Courses, 40 % Marks shall be assigned to Internal Examination and 60% Marks shall be assigned to end-semester external university examination.
- d. **Co-curricular Courses:** Health and wellness, Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC, Fine/Applied/Visual/Performing Arts During Semester I, II, III, IV, V and VI. These courses may be taught by Physical Education Director or may be assigned to Language Teacher by the Principal of HEI based on the expertise of the concerned.
- e. **Value Education Courses** to be selected from the Basket of Courses provided by the University. These courses may be assigned to the Language Teacher by the Principal of HEI based on the expertise of the concerned.
- f. **Generic / Open Elective Courses (GE/OE):** Courses to be selected from the Basket of Courses provided by the University
- g. **Abbreviations:** Department Specific Core: DSC, Department Specific Elective: DSE, FSC: Faculty Specific Core, FSE: Faculty Specific Elective, Indian Knowledge System: IKS, Inter Faculty Specific Core: IFSC, Inter Faculty Specific Elective: IFSE, Theory: Th, Practical/Practicum: Pr, Environment Studies: ES, Pre-requisite Course mandatory if applicable: Prq, Laboratory: Lab (Practical), Generic/ Open Electives: OE; Vocational Skill and Skill Enhancement Courses: VSEC; Vocational Skill Courses: VSC; Skill Enhancement Courses: SEC; Ability Enhancement Courses: AEC; Value Education Courses: VEC; OJT: On Job Training; Internship/ Apprenticeship; Field projects: FP; Community Engagement and Service: CES; Co-curricular Courses: CC; RM: Research Methodology; Research Project: RP; MIL: Modern Indian Language

**Subcommittees constituted in BoS Meeting Board of Studies in Botany
(Including Seed Technology) dated 2nd May 2026 for Preparation of Scheme
and Syllabus oof Semester V and VI for Implementation 2026 – 2027**

S.N.	Course	In Charge Member of BoS	Convener and Members
1.	Semester IV Major 3 with Practical including all three theory papers and New VSC and SEC for Semester V	Suchita Khodke	• Pochhi Vanita (C) • Pawar Digambar • Ukey Rahul Wasudeo • Dighe Suchita Wasudev • Patharkar Sampada P. • Phokmare Ashwini B. • Hiwarale Shilanand
2.	Semester V All Majors with Practical including all three theory papers	Mangesh Dagawal	• Dhore Mukund (C) • Hedawoo G.B. • Khadse Pramod • Wadankar Gajanan • Chavhan Vinod N. • More Ananta Tukaram • Deshmukh Pranjali J. • Dhawale Snehal Nagorao
3.	Semester VI All Majors with Practical including all three theory papers	Deepak Koche	• Bansod P. G (C) • Kakpure Manoj R. • Dhokne Kunal Babarao • Rokade Simeet Subhash • Masatkar Priyanka A. • More Umesh • Madavi Shailendra Vasanta • Pundkar Swati V.
4.	Semester V and VI Minors with Practicals	Rekha Maggirwar	• Gulhane Y. V. (C) • Khapekar Pradnya • Tathod Swati • Kulkarni Ramchandra L. • Thorat Sanjay B. • Shaikh Farah Tahesin • Kecher Minal
5.	Semester V and VI Plant Systematics Electives with Practicals	Sanjay Deosthale	• Padghan A.V. (C) • Kanherkar S. H. • Satpute S.V. • Dharkar Ninad • Makode Keshav • Iqbal Mohammad Nafees • Undal Vinod S • Patil Shrikant P
6.	Semester V and VI Molecular Biology Electives with Practicals and VSC for Semester VI	Dinesh Khedkar	• Bajaj Gokul Suresh (C) • Ghurde M. U. • Shende Sujata • Mahendra Bhise • Deshmukh Rakhi • Pravin Theng • Deshmukh Nutanvarsha P. • Ukey Sanghadeep S. • Kale Ankit S.

7.	Semester V and VI Plant Physiology Electives with Practicals	Tushar Wankhede	• Kanerkar U R (C) • Narkhedkar Vivek R. • Jaiswal Himanshu S • Oke Anand V • Rajurkar Ajay
8.	Semester V and VI Fungal Systematics Electives with Practicals	Dilip Hande	• Sahare N.H. (C) • Patil Rasika Narayan • Dekate Sunanda M. • Suradkar Kishor P. • Patil V. S.
9.	Additions, Deletions, Corrections in the Scheme and Syllabus of Semester I to IV (Botany) Seed technology: Major and VSC for semester V and VI	Suruchi Kadu	• Kokate Ujwala Ramesh (C) • Dr. Pankaj Kahate (C) Seed Tech. • Suradkar Santosh • Kakpure Manoj • Samartha Vivek • Roakde Simit • Sardar Pravin • Deshmukh Prashant

Examination and Assessment Process:

- The basic principle of the Credit framework is that Credits are a function of the successful completion of a program of study/ vocational education/ training and assessment. No Credit can be earned by the student unless the student is assessed for the achievement of the desired competencies and outcome of a program.
- Exit options are provided with Certificate, Diploma and Basic Bachelor’s degrees to the students at the end of the second, fourth and sixth semesters of a Four Years Multidisciplinary Degree Programme. Students will receive a Bachelor’s degree with Honors/ Research on successfully completing of all eight semesters of the UG Program either at a stretch or with opted exits and re-entries.
- For the smooth success of four-year degree programme with multiple entry and exit systems, the examination mode should be based on the combination of innovative trends in formative (informal and formal tests administered during the learning process) and summative (evaluation of students learning at the end of an instructional unit) examination modes in line with the UGC Report on ‘Evaluation Reforms in Higher Educational Institutions (2019).

Examination, Evaluation and Assessment Scheme

The total marks for each Course shall be based on Continuous Assessment and Semester End Examination.

Each theory course of Major, Minor, GE/OE, AEC, IKS, VEC as mentioned in **Teaching Learning Scheme** prepared by the Board of Studies shall be evaluated as per the scheme as mentioned in the following table -

Vertical No.	The Vertical	Mode of Examination, Evaluation & Assessment	Theory				Theory (Total)		Practical				Practical (Total)	
			External		Internal				External		Internal			
			Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks
a	Major	External & Internal	30	9	20	6	50	20	25	10	25	10	50	20
b	Minor		30	9	20	6	50	20	25	10	25	10	50	20
c	Generic/ Open Elective		30	9	20	6	50	20	--	--	--	--	--	--
d	VSC	Internal	--	--	--	--	--	--	--	--	50	20	50	20
	SEC	Internal	--	--	--	--	--	--	--	--	50	20	50	20
e	AEC (Eng. & One MIL Composite)	External & Internal	30	9	20	6	50	20	--	--	--	--	--	--
	IKS (Generic)	External & Internal	30	9	20	6	50	20	--	--	--	--	--	--
	VEC	External & Internal	30	9	20	6	50	20	--	--	--	--	--	--
F	FP/CEP	Internal	--	--	--	--	--	--	--	--	50	20	50	20
	Internship/ Apprenticeship		Assessment of these verticals shall be based on various activities/practices. It shall be evaluated by giving maximum marks of 50 per 2 Credit Course with separate activity weightages/levels. A detailed SOP for this assessment process is prescribed.											
	CC													

Continuous Assessment Tests (CAT)

For internal assessment, the Continuous Assessment Tests (CAT) shall be conducted as under-

- i. Three CAT each of 8 / 10 Marks (Theory) as applicable and 10 Marks (Practical).
 - First on completion of 25% Syllabus of the course or on completion of 25 teaching days,
 - Second on completion of 50% Syllabus of the course or on completion of 50 teaching days,
 - Third on completion of 75% Syllabus of the course or on completion of 75 teaching days.
- ii. Each concurrent assessment (CAT-I, II & III) will be mapped to relevant Course Learning Outcome.
- iii. Total Performance in CAT (i.e. 40 %) shall be based on the **best two out of three** in CAT examinations
- iv. Internal assessment shall be carried out by the respective course teacher by choosing variety of assessment tools/methods such as class test, record book, seminar, case study, field work, mini project work, quiz or any innovative method, which may be deemed to be appropriate for assessing the relevant course outcome.

Rubric for Internal Assessment of the Major / Major Electives / Minor Theory Courses

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI THEORY INTERNAL ASSESSMENT B.Sc. III (Botany), SEMESTER – V/VI (NEP)				
Theory		Course Code	Course Title	Max Marks:
MJ/ MJ-E/ Minor				20
Sr. No.	Assessment Criteria			Marks
1	Attendance in Theory Classes			5
2	Any One of the Activities suggested in Course (CAT-1)			5
3	Participation in Field Activity/ Visit (CAT-2)			5
4	Quiz/ MCQ Tests/Seminar/ Unit Test etc. based Theory Course (CAT-3)			5

Conduction of the Examination:

As per the scheme of teaching, learning, examination and evaluation, theory/practical examinations of Semester-I, II, III, IV, V, VI, VII and VIII shall be conducted by the University (except for Internal Examinations as applicable) at the end of each semester.

The theory/practical examinations of all the Semesters shall be held as per the following Schedule –

Sr. No.	Name of the Examination	End Sem Examination	Supplementary Examination*
1	Semester-I, III, V and VII	Winter	Summer
2	Semester-II, IV, VI and VIII	Summer	Winter

The University may evolve mechanism for conducting repeat end semester examination. Such repeat examinations shall have to be conducted within one month of the regular even semester examination and on demand examination.

1. The practical examination of all semesters shall be conducted by the University at the end of each semester. The HEI shall conduct the Practical examination of odd semesters as per the schedule announced by the University. **However, the appointment of the External and Internal Examiners shall be done by the Head or Principal of respective HEI to conduct external examination of the odd semester and the same should be communicated to the University before commencement of the practical examination.** The University shall conduct the external practical examination of all even semester by appointing external and internal examiners.
2. The examinations specified above shall be held twice in a year at such places and on such dates as may be prescribed by the University.
3. An applicant to an examination specified above, shall pursue a regular course of study in courses prescribed for the examination concerned for not less than one semester in a particular semester in a College/Institute/University department.
4. Provided that the student shall be eligible to appear for examination if -
 - a. He/she complies with the provisions of the Ordinance pertaining to the Examination in general from time to time.
 - b. He/she has prosecuted a regular course of study in a university department/college affiliated to the University.
 - c. He/she has in the opinion of the Principal shown satisfactory progress in his/her studies.
5. The provisions of Ordinance No. 6 and Ordinance No. 9 shall be *mutatis-mutandis* applicable to every collegiate/non-collegiate student.
6. The fees for each theory examination and practical examination conducted by the university shall be as prescribed by the University, from time to time.

COURSES OF SEMESTER - V

The Vertical	Course Code	Course Title
Major-T	107231	Theoretical Foundations in Anatomy, Embryology, and Pharmacognosy
Major-T	107232	Innovative technologies of Genetics, Plant Breeding, Green Revolution and Biotechnology
Major-T	107234	Biochemistry and Plant Physiology
Major-P	107235	Practical Based on Major Theory Papers of Semester V
Major-Elective T1	107236	Plant Systematics - 1
Major-Elective P1	107237	Lab-Based Learning of Plant Systematics - 1
OR		
Major-Elective T2	107238	Molecular Biology and Genetic Engineering - 1
Major-Elective P2	107239	Lab-Based Learning of Mole.Bio. and Genetic Eng. - 1
OR		
Major-Elective T3	107240	Advance Plant Physiology - 1
Major-Elective P3	107241	Lab-Based Learning of Advance Plant Physiology - 1
OR		
Major-Elective T4	107242	Basic and Applied Mycology and Plant Pathology- 1
Major-Elective P4	107243	Lab-Based Learning of Basic and Applied Mycology and Plant Pathology- 1
Minor-T	107244	Biochemistry, Plant Physiology and Ecology
Minor-P	107245	Lab Techniques in Biochemi, Plant Physio. and Ecology
VSC-P	107246	Eco-Friendly Plant Products
SEC-P1	107247	Skilling Botanists for Nursery and Garden Management (from session 2027-2028 onwards)
OR		
SEC-P2	107248	Mushroom Culture Technology & Production (from 26-27)
OR		
SEC-P3	107249	Biofertilizer Technology (2026-27 Onwards)
OR		
SEC-P4	107250	Herbs and Herbal Products
FP/CEP	107251	Botany Lab (Field Project / Community Engagement Program)
Non Credit		Artificial Intelligence

Major Courses

Course Type	Course Code	Course Title	Credits	Workload	Exam Duration	Maximum Marks
Major-T	107231	Theoretical Foundations in Anatomy, Embryology, and Pharmacognosy	2	2	2.00 Hrs	30 (Ext.) 20 (Int)

Course Objectives:

1. To provide comprehensive understanding of plant anatomy including developmental, vascular, root, stem and leaf structures.
2. To develop knowledge of reproductive biology of angiosperms through detailed embryological concepts.
3. To introduce pharmacognosy, medicinal plant resources, authentication and herbal drug standardization.
4. To integrate classical and modern botanical applications for higher education, research and industrial relevance.

Course Outcomes:

After Successful completion of the course, the student will be able to –

CO-1: Understand developmental and structural organization of vegetative plant organs.

CO-2: Explain reproductive development, fertilization, embryo formation and seed biology in angiosperms.

CO-3: Identify medicinally important plant resources and evaluate pharmacognostic characteristics.

CO-4: Apply botanical knowledge in taxonomy, forensic Botany, medicinal plant sciences and pharmaceutical industries.

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Plant Anatomy – Developmental, Vascular and Root Anatomy	8	8	Suitable pedagogical strategies are separately annexed
1.1: Structure, organization and functional significance of Shoot Apical Meristem (SAM) and Root Apical Meristem (RAM) – 1.2: Structure and functions of xylem and phloem and types of Vascular bundles 1.3: Primary structure of Dicot (Sunflower) and Monocot (Maize) root 1.4: Secondary growth in Dicot root and its biological significance.				
Unit II	Plant Anatomy – Stem, Leaf and Applied Anatomy	8	8	
2.1: Primary structure of Dicot (Sunflower) and Monocot (Maize) stem 2.2: Normal secondary growth in Dicot stem and anomalies in <i>Bignonia</i> and <i>Dracaena</i> stem. 2.3: Leaf anatomy – internal structure of Dicot (<i>Nerium</i>) and Monocot (<i>Maize</i>) leaf. 2.4: Plant anatomical biomarkers and role of anatomy in taxonomy and forensic Botany.				
Unit III	Embryology of Angiosperms	8	8	
3.1: Microsporangium- Structure, microsporogenesis and development of male gametophyte. 3.2: Megasporangium- Structure, ovule types (Orthotropous and Antropous), megasporogenesis, development of female gametophyte and Polygonum type embryo sac. 3.3: Pollen-pistil interaction, double fertilization and triple fusion. 3.4: Development of Dicot embryo and seed; endosperm types and polyembryony				

Unit IV	Pharmacognosy	7	7	
4.1: Introduction to pharmacognosy –History, scope and importance 4.2: Crude drugs- Sources and Classification based on morphology, major chemical constituents and pharmacological (Therapeutic). 4.3: Pharmacognostic authentication- Drug adulteration, evaluation - organoleptic, microscopic, chemical and biological 4.4: Quality control and standardization of drugs, WHO guidelines for herbal drugs				
Activities: (Any three applicable to use as CAT) 1. Comparative anatomical studies through charts and microscopic observations. 2. Diagrammatic representation of root, stem, and leaf anatomy. 3. Test based on syllabus content 4. Identification and classification of medicinal plant materials. 5. Herbarium preparation of medicinally important species. 6. Case studies on herbal drug adulteration and standardization. 7. Field visit to medicinal plant gardens/herbal industries. 8. Seminar on forensic Botany and anatomical applications. 9. Group discussion on - Pharmacognosy. 10. Preparation of pharmacognostic specimen collections.				
References:				
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Model Questions:				
One Line Question 1. Define meristematic tissue. 2. What is sapwood? 3. Define anomalous secondary growth. 4. What is microsporogenesis? 5. Define double fertilization. 6. What is Polygonum type embryo sac? 7. Define pharmacognosy. 8. What is crude drug? 9. Define heartwood. 10. What is adulteration?				
Short Type Questions 1. Describe primary structure of Dicot root. 2. Write note on growth rings.				

3. Anatomy in forensic Botany . 4. Describe structure of male gametophyte. 5. Explain development of embryo sac. 6. Discuss endosperm types. 7. Explain sources of crude drugs. 8. Scope of Pharmacognosy 9. Describe primary structure of Monocot root. 10. Anomalies in Bignonia stem
Long Type Question 1. Explain normal secondary growth in Dicot stem. 2. Describe anomalous secondary growth in detail. 3. Explain embryology of angiosperms comprehensively. 4. Describe double fertilization and triple fusion. 5. Discuss pharmacognosy and classification of crude drugs. 6. Explain medicinal importance of plant-based drugs. 7. Write detailed notes on adulteration and drug evaluation. 8. Describe secondary growth in Dicot root 9. Explain internal structure of Dicot leaf 10. Explain internal structure of Monocot leaf
Pedagogical Strategies: 1. Interactive lectures with digital anatomical illustrations. 2. Microscopic demonstrations and slide observations. 3. Field visits to botanical gardens and herbal centers. 4. Chart/model-based teaching for embryological processes. 5. Assignment-based herbarium and pharmacognostic specimen studies.

Course Type	Course Code	Course Title	Credits	Workload	Exam Duration	Maximum Marks
Major-T	107232	Innovative technologies of Genetics, Plant Breeding, Green Revolution and Biotechnology	2	2	2.00 Hrs	30 (Ext.) 20 (Int)

Course Objectives: 1. To illustrate the fundamental principles of genetics, plant breeding, green revolution and biotechnology. 2. To deliver comprehensive knowledge of classical and modern technologies used in crop improvement and genetic research. 3. To present perspectives of current biotechnological tools for practical applications and scientific research. 4. To demonstrate concepts through practical activities, case studies and innovative approaches for capacity building.				
Course Outcomes: After Successful completion of the course, the student will be able to – CO-1: Understand the principles of genetics, inheritance, plant breeding and biotechnology. CO-2: Remember the concepts of Green Revolution, breeding technologies, recombinant DNA tools CO-3: Explain the role of innovative technologies in sustainable agriculture, crop development and biotechnology. CO-4: Develop analytical, technical and practical skills related to genetics, breeding and biotechnological applications.				
Unit	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Fundamentals of Genetics	8	8	
1.1 History of Genetics - History, Mendel’s Experiments and contribution; Dihybrid and Monohybrid cross 1.2 Laws of Inheritance - Law of Dominance, Law of Segregation and Law of Independent Assortment 1.3 Gene Interactions - Allelic interactions – incomplete dominance and codominance 1.4 Gene Interactions -Non-allelic interactions – complementary genes, supplementary genes and epistasis				
Unit II	Plant Breeding and Green revolution	8	8	
2.1 Plant Breeding: Concept, objectives, scope and significance of plant breeding. 2.2 Plant Breeding Methods: Selection methods (mass selection and pure line selection), hybridization – objectives, types and techniques 2.3 Improved Crop Varieties and Heterosis: Concept of heterosis, hybrid vigour, development of improved crop varieties and significance in agriculture. 2.4 Green Revolution: Historical background, major pioneers (Norman Borlaug and M.S. Swaminathan), achievements and impact in India and role of high yielding varieties (HYVs).				
Unit III	Fundamentals aspects of Biotechnology	7	7	
3.1 Introduction to Plant Biotechnology: Concept, scope and importance of plant biotechnology. 3.2 Plant Tissue Culture Basics and Techniques: Introduction, plant cell and tissue explants, laboratory design, essential equipment (Laminar Air Flow Cabinet and Autoclave) and sterilization techniques. 3.3 Culture Media and Morphogenesis: Culture media (MS medium), role of plant growth regulators, cellular totipotency, differentiation,				12

organogenesis and morphogenesis.			
3.4 Tissue Culture Methods and Applications: Callus culture, organ culture, haploid culture, protoplast culture and micropropagation.			
Unit IV	Modern Biotechnology	7	7
4.1 Recombinant DNA Technology: Concept of recombinant DNA technology, tools -restriction endonuclease and cloning vectors. 4.2 Transgenic Plant: Agrobacterium mediated gene transfer and development of transgenic plants 4.3 Genetically Modified Crops: Bt cotton, Flavr Savr tomato, Golden rice and biosafety regulations of genetically modified crops. 4.4 Applications of Biotechnology: In agriculture, pharmaceutical industry, Health care and conservation.			
Activities: (Any 4 to use for CAT) 1. Preparation of Mendelian trait inheritance charts 2. Demonstration and analysis of monohybrid and dihybrid crosses through models or charts 3. Case study on plant breeding and hybridization techniques 4. Comparative study of Green Revolution impacts in India 5. Seminar on transgenic plants and genetically modified crops 6. Poster presentation on Plant breeding techniques, GMO etc 7. Group discussion on biosafety and ethical concerns of GM crops 8. Assignment on Genetics and Plant Breeding 9. Unit test / class test			
References: 1. Ahluwalia, K. B. (2005). <i>Genetics</i> (1st ed.). New Age International Publishers. 2. Allard, R. W. (2010). <i>Principles of plant breeding</i> (2nd ed.). Wiley India. 3. Bhojwani, S. S. (1990). <i>Plant tissue culture: Applications and limitations</i>. Elsevier Science Publishers. 4. Dubey, R. C. (2018). <i>A textbook of biotechnology</i>. S. Chand Publishing. 5. Fukui, K., & Nakayama, S. (1996). <i>Plant chromosomes: Laboratory methods</i>. CRC Press. 6. Gardner, E. J., Simmons, M. J., & Snustad, D. P. (1991). <i>Principles of genetics</i>. John Wiley & Sons. 7. Gupta, P. K. (2013). <i>Cytogenetics</i> (1st ed.). Rastogi Publications. 8. Gupta, P. K. (2018). <i>Genetics</i> (5th ed.). Rastogi Publications. 9. Gupta, P. K. (2018). <i>Molecular biology and biotechnology</i>. Rastogi Publications. 10. Kumar, S., & Singh, H. (2008). <i>Molecular biology and biotechnology</i>. Pragati Prakashan. 11. Lewin, B. (2008). <i>Genes IX</i> (9th ed.). Jones and Bartlett Publishers. 12. Old, R. W., & Primrose, S. B. (1989). <i>Principles of gene manipulation</i>. Blackwell Scientific Publications. 13. Reneberg, R., & Berkling, V. (2017). <i>Biotechnology for beginners</i>. Academic Press. 14. Satyanarayana, U., & Chakrapani, U. (2022). <i>Biotechnology</i>. Books and Allied Publications. 15. Singh, B. D. (2010). <i>Biotechnology</i>. Kalyani Publishers. 16. Singh, B. D. (2018). <i>Genetics</i> (4th ed.). Kalyani Publishers. 17. Singh, B. D. (2019). <i>Plant breeding: Principles and methods</i> (10th ed.). Kalyani Publishers. 18. Smith, R. H. (2000). <i>Plant tissue culture: Techniques and experiments</i>. Academic Press. 19. Snustad, D. P., & Simmons, M. J. (2015). <i>Principles of genetics</i> (7th ed.). Wiley. 20. Stansfield, W. D. (2002). <i>Theory and problems of genetics</i>. McGraw-Hill. 21. Tamarin, R. H. (2002). <i>Principles of genetics</i> (7th ed.). Tata McGraw-Hill. 22. Vasil, I. K., & Thorpe, T. A. (1994). <i>Plant cell and tissue culture</i>. Kluwer Academic Publishers.			
Model Questions:			
One Line Question 1. Who is known as the Father of Genetics? 2. Define codominance. 3. What is supplementary gene interaction?			

4. State the Law of Segregation. 5. Define hybridization in plant breeding. 6. Who led the Green Revolution in India? 7. Write Dihybrid genotypic ratio 8. Define heterosis 9. Define totipotency 10. What is micropropagation
Short Type Questions 1. Explain Mendel's pea plant experiments. 2. Describe Mendel's Laws of Inheritance. 3. Differentiate incomplete dominance and codominance. 4. Explain supplementary gene interaction. 5. Discuss plant breeding objectives. 6. Explain Green Revolution achievements in India. 7. Describe recombinant DNA tools. 8. Explain emasculation techniques 9. Discuss transgenic plants. 10. Application of Autoclave .
Long Type Question 1. Explain the history of genetics and Mendel's contributions. 2. Discuss Laws of Inheritance with examples. 3. Explain gene interactions and modified Mendelian ratios. 4. Describe sterilization techniques 5. Critically analyze the Green Revolution in India. 6. Explain recombinant DNA technology tools and techniques. 7. Describe gene direct transfer methods. 8. Explain hybridization techniques in plants 9. Discuss genetically modified crops and biosafety concerns. 10. Describe applications of biotechnology with reference to BT cotton
Pedagogical Strategies: 1. Interactive Lectures: Use diagrams, animations, and PPT-based conceptual teaching. 2. Case Study Method: Green Revolution, GM crops, and biotechnology applications. 3. Laboratory Demonstrations: DNA extraction, PCR simulation, gene transfer methods. 4. Project-Based Learning: Germplasm conservation, transgenic crop development, biotechnology innovations. 5. ICT-Enabled Learning: Virtual labs, webinars, e-resources, and digital biotechnology platforms.

Course Type	Course Code	Course Title	Credits	Workload	Exam Duration	Maximum Marks
Major-T	107234	Biochemistry and Plant Physiology	2	2	2.00 Hrs	30 (Ext.) 20 (Int)

Course Objectives: 1. To provide fundamental understanding of plant biochemistry, including biomolecules and enzymatic processes. 2. To develop conceptual clarity regarding plant water relations, mineral nutrition and translocation systems. 3. To explain core physiological metabolic pathways such as photosynthesis and respiration. 4. To introduce plant growth, hormonal regulation, flowering, movement and stress responses.
Course Outcomes: After Successful completion of the course, the student will be able to – CO-1: Understand biomolecules, enzymes and biochemical mechanisms essential for plant life. CO-2: Explain absorption, translocation, mineral nutrition and physiological transport systems. CO-3: Describe photosynthesis, respiration and plant metabolic energy systems. CO-4: Analyze plant growth, development, flowering, biological rhythms, movements and stress adaptation.

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporati on of Pedagogies
Unit I	Biochemistry	8	8	Suitable pedagogical strategies are separately annexed
1.1 Biomolecules: Carbohydrates- Structure, classification and functions; Lipids- Classification and functions in plants. 1.2 Bioenergetics: Concept of energy-rich compounds, ATP as the energy currency of the cell and its significance in plant metabolism. 1.3 Enzymes: Concept, nomenclature and classification of enzymes with major classes and suitable examples. 1.4 Mechanism and Properties of Enzymes: Mechanism of enzyme action: Lock and Key model and Induced Fit theory.				
Unit II	Water Relations and Mineral Nutrition	7	7	
2.1 Absorption and Translocation of Water: Water potential, root absorption (Active and Passive), ascent of sap. 2.2 Mineral Nutrition: Role and deficiency symptoms of selected macronutrients (N, P, K, Mg) and micronutrients (Fe, Cl, Mn, Zn) in plants. 2.3 Translocation of Solutes: Phloem transport (Loading and unloading), source-sink relationship. 2.4 Applied Plant Nutrition: Hydroponics, nutrient management and sustainable agricultural applications.				
Unit III	Metabolism	8	8	
3.1 Photosynthesis: Photochemical reaction- Photosynthetic apparatus, pigments, nature and role of light, photophosphorylation. 3.2 Carbon Fixation Pathways: Calvin cycle (C3), C4 pathway, CAM pathway 3.3 Respiration: Mitochondria as respiration site, Mechanism- glycolysis, TCA cycle 3.4 Electron transport system, oxidative phosphorylation, ATP generation and anaerobic respiration.				

Unit IV	Plant Responses and Growth	7	7	
4.1 Flowering Physiology: Photoperiodism, role of florigen and phytochromes in flowering. 4.2 Senescence and abscission: concept, causes and mechanism 4.3 Plant Movement: Phototropism, Geotropism and nastic movements. 4.4 Plant Hormones: Physiological role and applications of auxins, gibberellins, cytokinins and ethylene.				
Activities: (Any three applicable to use as CAT) 1. Unit Assignments: Short written assignments based on biomolecules, enzymes, mineral nutrition, photosynthesis, respiration and plant growth. 2. Seminar Presentation: Topic-based on syllabus 3. Group Discussion: Classroom discussion on climate adaptation, nutrient management, and applied plant physiology. 4. Case Study Analysis: Analysis of plant physiological problems related to drought, nutrient deficiency or crop productivity. 5. Chart / Poster Preparation: Preparation of educational charts on enzyme action, photosynthesis pathways, respiration or hormonal regulation. 6. Quiz / Class Tests: Regular objective or descriptive assessments for conceptual reinforcement. 7. Field Observation Report: Documentation of plant responses such as deficiency symptoms, tropic movements or stress adaptation in field conditions. 8. Problem-Solving Exercises: Application-based questions on physiological mechanisms and agricultural relevance. 9. Model Preparation / Educational Display: Preparation of simple teaching models on chloroplast structure, ATP synthesis, nutrient cycles, or biological clock				
References: 1. Anasane, P. Y., Dagwal, M. J., Kanherkar, U. R., Gopkar, N. S., & Deshmukh, O. S. (2018). A textbook of Botany: B.Sc. fifth semester plant physiology and ecology. DnyanPath Publication. 2. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry and molecular biology of plants (2nd ed.). Wiley Blackwell. 3. Chaudhari, M. A., & Gupta, K. K. (2009). Practical plant physiology. New Central Book Agency. 4. Dennis, D. T., Turpin, D. H., Lefebvre, D. D., & Layzell, D. B. (Eds.). (1997). Plant metabolism (2nd ed.). Longman. 5. Devlin, R. M., & Witham, F. H. (1983). Plant physiology (4th ed.). CBS Publishers & Distributors. 6. Galston, A. W. (1989). Life processes in plants. Scientific American Library. 7. Harper, C., Varma, S. K., & Verma, M. (2014). Plant physiology, biochemistry and biotechnology (4th ed.). S. Chand Publishing. 8. Hopkins, W. G., & Hüner, N. P. A. (2008). Introduction to plant physiology (4th ed.). John Wiley & Sons. 9. Jain, V. K. (2017). Fundamentals of plant physiology. S. Chand Publishing. 10. Kochhar, S. L., & Gujjar, S. K. (2020). Plant physiology: Theory and applications. Cambridge Publications. 11. Lea, P. J., & Leegood, R. C. (1999). Plant biochemistry and molecular biology. John Wiley & Sons. 12. Lincoln, T., & Zeiger, E. (2003). Plant physiology (3rd ed.). Panima Publishing Corporation. 13. Mohr, H., & Schopfer, P. (1995). Plant physiology (4th ed.). Springer. 14. Moore, T. C. (1989). Biochemistry and physiology of plant hormones. Springer-Verlag. 15. Nelson, D. L., & Cox, M. M. (2017). Lehninger principles of biochemistry (7th ed.). W. H. Freeman. 16. Sadasivam, S., & Manickam, A. (2008). Biochemical methods (3rd ed.). New Age International Publishers. 17. Salisbury, F. B., & Ross, C. W. (1992). Plant physiology (4th ed.). Wadsworth Publishing Company. 18. Singhal, G. S., Renger, G., Sopory, S. K., Irrgang, K. D., & Govindjee. (1999). Concepts in				

photobiology: Photosynthesis and photomorphogenesis. Narosa Publishing House. 19.Taiz, L., & Zeiger, E. (2018). Plant physiology and development (6th ed.). Sinauer Associates. 20.Verma, S. K., & Verma, M. (2007). A textbook of plant physiology, biochemistry and biotechnology. S. Chand Publishing.
Model Questions:
One Line Question 1. Write name of micronutrients (Any two) 2. Define macronutrients 3. What are carbohydrates? 4. What is Lipids? 5. Write name of fruit ripening hormone 6. What is Enzyme? 7. What are micronutrients? 8. What is photosynthesis? 9. What is respiration? 10. Define phototropism
Short Type Questions 1. Structure and function Monosaccharide- Glucose 2. Explain Ascent of sap 3. Describe role of micronutrients (any two nutrient) 4. Cyclic Photophosphorylation 5. Non Cyclic phosphorylation 6. Nature and role of light in photosynthesis 7. Photosynthetic pigments 8. HSK Pathway 9. Glycolysis 10. Physiological role of Auxin and gibberellins. 11. Describe photoperiodism 12. Explain geotropism
Long Type Question 1. Describes the structure and functions of polysaccharide 2. What is lock and key hypothesis? Write down in detail. 3. Write down in detail induced fit theory. 4. Describe in detail Phloem loading and unloading 5. Write down in detail photophosphorylation. 6. What is glycolysis? Write down it in details. 7. What is TCA cycle? Explain it in details. 8. Give the physiological role of auxins and gibberellins. 9. What are nastic movements? Give in details with example. 10. Explain mechanism of senescence
Pedagogical Strategies: 1. Interactive Classroom Teaching: Concept-based lectures supported by diagrams, flowcharts, and multimedia tools for effective understanding of biomolecules, enzymes, metabolism, and physiological processes. 2. ICT-Enabled Teaching Learning: Use of animations, digital simulations, virtual labs, and presentation tools for explaining complex mechanisms such as photosynthesis, respiration, hormonal action, and biological rhythms. 3. Problem-Based Learning: Analytical discussions and case studies related to nutrient deficiency, stress physiology, sustainable agriculture, and climate adaptation to develop critical thinking. 4. Field-Based Observation and Experiential Learning: Observation of plant growth patterns, deficiency symptoms, tropic movements, and environmental responses in natural or agricultural settings. 5. Collaborative Learning Approaches: Group discussions, seminars, poster presentations, and peer-learning activities on emerging topics like hydroponics, biofertilizers, and plant stress management.

Course Type	Course Code	Course Title	Credits	Workload	Exam Duration	Maximum Marks
Major-P	107235	Practical Based on Major Theory Papers of Semester V	2	4	4.00 Hrs	25 (Ext.) 25 (Int)

Course Objectives:

1. To develop practical understanding of plant anatomy, embryology and pharmacognosy.
2. To provide hands-on training in genetics, plant breeding and biotechnology.
3. To strengthen experimental skills in plant biochemistry and physiology.
4. To build scientific observation, laboratory competence and analytical skills.

Course Outcomes:

CO-1: Perform anatomical, embryological and pharmacognostic practical investigations.

CO-2: Apply principles of genetics, breeding and biotechnology through practical exercises.

CO-3: Conduct biochemical and physiological experiments effectively.

CO-4: Develop practical competencies relevant to research, higher education and industry.

Paper I: Anatomy, Embryology and Pharmacognosy Major Practicals: (Any three)

1. Preparation of double stained permanent slides of root and stem (Sunflower and Maize)
2. Preparation of double stained permanent slides of Dicot and Monocot leaf (*Nerium*, Maize)
3. Preparation of double stained permanent slides of Bignonia and Dracaena stem.
4. Mounting of T.S. of anther, Pollen grains and pollinia.
5. Pharmacognostic study of medicinally important plants (Any two)
6. Pharmacognostic authentication and evaluation of crude drugs through organoleptic method.
7. Pharmacognostic authentication and evaluation of crude drugs through , microscopic methods.
8. Test for secondary metabolites- Alkaloids, Phenolics, Tannin and Flavonoids

Minor Practicals: (Any three)

1. Study of Shoot Apical Meristem (SAM),
2. Study of Root Apical Meristem (RAM) and
3. Study of root anatomy through permanent slides.
4. Identification of vascular tissues – Xylem and phloem
5. Identification of vascular bundles
6. Permanent slide study of root, stem and leaf anatomy.
7. Study through permanent slides of T.S. of anther and L.S. of ovule and types
8. Study through permanent slides of types of endosperms and embryo of *Capsella*
9. Identification of medicinally important crude drugs
10. Herbarium preparation of medicinal plants.
11. Detection of adulteration in crude drugs.

Paper II: Genetics, Plant Breeding and Biotechnology Major Practicals: (Any three)

1. To prove Mendel's Monohybrid ratio and Dihybrid ratio.
2. Problems based on Interaction of genes (Complementary/ Supplementary/Epistasis)
3. Emasculation techniques in self and cross pollinated plants
4. Demonstrate hybridization techniques in self and cross pollinated plants
5. Isolation of Protoplast by Mechanical Method
6. Preparation of Tissue culture media
7. Sterilization of Explant
8. Inoculation of Explant
9. Demonstration of the technique of Micropropagation

Minor Practicals: (Any Three)

1. Preparation of Mendels experiment on pea plant chart (Characters).
2. Study of vital floral structures for plant breeding self and cross pollinated plants
3. Perform Bagging and Tagging methods in plants
4. Working Principle and application of Autoclave
5. Working Principle and Application of Laminar Air Flow
6. Cleaning and Sterilization of Glassware
7. Demonstration of hardening of tissue culture plant

Paper III: Biochemistry and Plant Physiology Major Practicals (Any Three):

1. To demonstrate test of glucose, sucrose and starch
2. To demonstrate test for lipid
3. To study the activity of enzyme catalase
4. To determine water potential of plant tissue.
5. To determine rate of photosynthesis under varying quality and CO₂ concentration by using Willmott's bubbler.
6. To study the rate of photosynthesis in terrestrial plants with the help of Ganongs Potometer.
7. Separation of chloroplast pigments by paper chromatography method.
8. To determine the rate of respiration by Ganongs respirometer.
9. Effect of IAA and Gibberellins on seed germination.

Minor Practicals:

1. To determine the path of water (Ascent of sap)
2. Observation of nutrient deficiency symptoms in plants (macronutrients in any one plant)
3. Observation of nutrient deficiency symptoms in plants (micronutrients in any one plant)
4. To demonstrate light is necessary for photosynthesis
5. To demonstrate anaerobic respiration in germinating seeds.
6. To demonstrate the evolution of CO₂ in respiration.
7. To demonstrate the phenomenon of nastic movement with the help of *Mimosa pudica* or *Biophytum sensitivum*.

Activities (Any Three)

Note: Botanical excursion/visit to research institutes, industries, seed companies, or relevant organizations shall be compulsory for all students and the report shall be submitted during practical examination.

1. Botanical Excursion / Study Tour Report

Submission of report based on botanical excursion, short tour or long tour.

2. Submission of Double-Stained Permanent Slides

Preparation and submission of any two double-stained permanent slides.

3. Germplasm Collection

Collection and documentation of locally available crop germplasm.

4. Case Study

Case study on Green Revolution or genetically modified (GM) crops.

5. Submission of Plant Specimens Showing Nutrient Deficiency Symptoms Collection and submission of any two plant specimens showing nutrient deficiency symptoms.**Bibliography:**

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External Practical Paper

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. III (Botany), SEMESTER – V (NEP)				
Lab/ Practical-	Course Code: 107235	Practical Based on Major Theory Papers of Semester V	Max Marks: 25	Time: 4 Hrs.
Q.No.	Exercise		Marks	
1.	Perform Any One Major Experiment from Paper I		5	
2.	Perform Any One Major Experiment from Paper II		5	
3.	Perform Any One Major Experiment from Paper III		5	
4.	Perform any One Exercise from Minor Experiments		5	
5.	External Viva Voce		5	

Internal Practical Evaluation

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. III (Botany), SEMESTER – V (NEP)			
Lab/Practical-	Course Code: 107235	Practical Based on Major Theory Papers of Semester V	Max Marks: 25
S. No.	Assessment Criteria		Marks
1	Record/ Assignments		5
2	Attendance		5
3	Participation in Activity/ Field visit		5
4	Student's overall performance		5
5	Internal Viva Voce		5

Major Elective Courses

Course Type	Semester	Course code	Course name	Credits	Teaching Hrs	Exam Duration	Maximum Marks
Major-T	V	107236	Plant Systematics-1	02	30	2.00 Hrs	30 (Ext) + 20 (Int)
Course Objectives 1. To introduce students to the basic concepts, scope and importance of plant systematics and taxonomy; taxonomic tools such as floras, monographs, manuals, herbarium techniques and botanical gardens. 2. To familiarize students with principles and rules of botanical nomenclature according to the International Code of Nomenclature (ICN). 3. To explain different systems of classification and the significance of phylogenetic relationships in angiosperms. 4. To study the systematic position, distinguishing characters, floral features and economic importance of selected angiosperm families and to provide knowledge about economically important plants belonging to major Dicotyledonous and Monocotyledonous families.							
Course Outcomes After successful completion of the course, students will be able to: 1. Understand the fundamentals and significance of plant taxonomy and systematics. 2. Demonstrate knowledge of herbarium preparation, botanical gardens and their applications in plant research and conservation. 3. Describe the APG-IV system of classification along with its merits and limitations. 4. Explain the floral characteristics, economic importance and representative examples of major angiosperm families. 5. Develop practical skills in plant identification, classification and scientific documentation.							
Unit	Content				Workload Allotted (Hrs)	Weightage of Marks	Incorporation of pedagogies
Unit I	Plant Systematics				8	8	Suitable pedagogical strategies are separately annexed
1.1: Concept and scope of plant systematics and taxonomy. 1.2: Taxonomic literature: Floras, Monographs and Manuals. 1.3: Taxonomic Hierarchy-(Kingdom to Species with example) 1.4: Herbarium: Preparation and importance, Botanical Garden and their roles.							
Unit II:	Botanical nomenclature				7	7	
2.1: Binomial nomenclature 2.2: International Code of Botanical Nomenclature (ICBN/ICN): Principle and Rules. 2.3: Ranks of taxa, Typification, Valid publication. 2.4: Principle of priority, Conservation of names, Author citation							
Unit III:	Classification and Angiosperm Systematics				8	8	
3.1: Types of classification: Natural, Artificial and Phylogenetic. 3.2: APG System of Classification-Introduction, Principles, Classification of APG-IV, Merits and Demerits 3.3: Systematic study and economic importance of families: Dicotyledons (Polypetaleae): Brassicaceae 3.4: Systematic study and economic importance of families: Dicotyledons (Polypetaleae): Fabaceae							
Unit IV:	Angiosperm systematics				7	7	
4.1: Systematic study and economic importance of families: Dicotyledons (Gamopetaleae): Solanaceae 4.2: Systematic study and economic importance of families: Dicotyledons (Gamopetaleae): Lamiaceae 4.3: Systematic study and economic importance of families: Dicotyledons (Monochlamydeae): Amaranthaceae 4.4: Systematic study and economic importance of families: Monocotyledons: Poaceae							

Activities for Continuous Assessment Tests (CAT):

1. Herbarium specimen collection and botanical garden visit report.
2. Quiz on binomial nomenclature and ICN rules.
3. Practical identification of plants from Brassicaceae, Fabaceae, Solanaceae, Lamiaceae, Amaranthaceae, Poaceae
4. Field visit and submission of plant identification record.

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1. Singh, G. (2016). *Plant Systematics: Theory and Practice*. Oxford & IBH Publishing, New Delhi.
2. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. & Donoghue, M.J. (2016). *Plant Systematics: A Phylogenetic Approach* (4th ed.). Sinauer Associates.
3. Simpson, M.G. (2010). *Plant Systematics*. Academic Press (Elsevier).
4. Vasishta, P.C. (2006). *Taxonomy of Angiosperms*. S. Chand Publishing, New Delhi.
5. Sharma, O.P. (2017). *Plant Taxonomy*. Tata McGraw-Hill Education.
6. Lawrence, G.H.M. (1951). *Taxonomy of Vascular Plants*. Macmillan.
7. Cronquist, A. (1981). *An Integrated System of Classification of Flowering Plants*. Columbia University Press.
8. Takhtajan, A. (1997). *Diversity and Classification of Flowering Plants*. Columbia University Press.

1-Mark Questions (Answer in One Sentence)

Unit I: Introduction to Systematics

1. Define plant taxonomy.
2. What is plant systematics?
3. What is the main aim of taxonomy?
4. Define flora.
5. What is a monograph?
6. Define manual in taxonomy.
7. What is taxonomic hierarchy?
8. Name the highest taxonomic rank.
9. What is a herbarium?
10. Mention one importance of botanical gardens.

Unit II: Botanical Nomenclature

1. What is binomial nomenclature?
2. Who proposed binomial nomenclature?
3. Expand ICN.
4. What is typification?
5. Define valid publication.
6. What is author citation?
7. State the principle of priority.
8. What is conservation of names?
9. Define taxon.
10. What is a species?

Unit III: Classification and Angiosperm Systematics

1. Define artificial classification.
2. What is natural classification?
3. Define phylogenetic classification.
4. Name the authors of natural classification system.
5. Mention one merit of APG-IV system of classification.
6. Name one economic plant of Brassicaceae.
7. Give floral formula of Fabaceae.
8. Name one medicinal plant of Fabaceae.
9. What type of fruit occurs in Fabaceae?
10. Name one characteristic feature of Brassicaceae.

Unit IV: Angiosperm Systematics

1. Name one medicinal plant of Lamiaceae.
2. What is the inflorescence in Solanaceae?
3. Name one economic plant of Amaranthaceae.

4. What type of fruit is found in Poaceae?
5. What is the inflorescence of Lamiaceae.
6. What is the floral formula of Solanaceae?
7. Mention one characteristic feature of Poaceae.
8. Name one plant of Solanaceae.
9. Name one example of Poaceae
10. Give one economic importance of Poaceae.

3-Mark Questions (Short Answers)

Unit I: Introduction to Systematics

1. Differentiate between taxonomy and systematics.
2. Write a short note on floras.
3. What is a monograph? Explain briefly.
4. Define taxonomic hierarchy.
5. Write the importance of herbarium.

Unit II: Botanical Nomenclature

1. What is binomial nomenclature?
2. Write a short note on ICN.
3. Define typification.
4. What is valid publication?
5. Explain principle of priority.

Unit III: Classification and Angiosperm Systematics

1. Differentiate between artificial and natural classification.
2. Write merits of APG-IV system.
3. Mention important characters of Brassicaceae.
4. Write economic importance of Fabaceae.
5. List floral characters of Fabaceae.

Unit IV: Angiosperm Systematics

1. Write important characters of Lamiaceae.
2. Mention floral characters of Solanaceae.
3. Write economic importance of Amaranthaceae.
4. Give characteristic features of Poaceae.
5. Write a short note on Solanaceae.

6-Mark Questions (Long Answers)

Unit I: Introduction to Systematics

1. Explain the concept, scope and importance of plant systematics.
2. Describe different types of taxonomic literature.
3. Explain taxonomic hierarchy with suitable examples.
4. Describe herbarium preparation and its importance.
5. Discuss the role of botanical gardens in plant conservation.

Unit II: Botanical Nomenclature

1. Explain principles and rules of ICN.
2. Describe binomial nomenclature and its significance.
3. Explain ranks of taxa, typification and valid publication.
4. Discuss principle of priority and conservation of names.
5. Write a detailed note on author citation.

Unit III: Classification and Angiosperm Systematics

1. Explain different types of classification (artificial, natural, phylogenetic).
2. Describe APG-IV System with merits and demerits.
3. Give a systematic account of Brassicaceae with economic importance.
4. Describe Fabaceae family with floral characters and uses.
5. Compare Brassicaceae and Fabaceae families.

Unit IV: Angiosperm Systematics

1. Describe Amaranthaceae family with economic importance.
2. Explain Solanaceae family with floral characters and uses.
3. Give a detailed account of Lamiaceae family.
4. Describe Poaceae family with examples and economic importance.

Level	Semester	Course code	Course name	Credits	Teaching Hrs	Exam Duration	Maximum Marks
5.5	V	107237	Lab based Learning of Plant Systematics-1	02	60	4 Hrs	25(Ext) + 25(Int)

Course Objectives

1. To train students in describing plants in technical botanical language and identifying them up to family level.
2. To provide hands-on experience in collection, preservation, mounting and cataloguing of plant specimens.
3. To enhance observational and analytical skills through field visits and botanical excursions.
4. To study economically important plants and understand their uses in daily life and industry and to introduce students to the morphological diversity of Dicot and Monocot families.

Course Outcomes

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

1. Distinguish important diagnostic features of families such as Brassicaceae, Fabaceae, Solanaceae, Lamiaceae, Amaranthaceae and Poaceae.
2. Collect, preserve, mount, and maintain herbarium specimens using standard botanical methods.
3. Prepare botanical monographs and document plant information systematically.
4. Demonstrate knowledge of specimen preservation and herbarium cataloguing techniques.
5. Analyze morphological characters of Monocot plants for systematic study.
6. Develop field skills through botanical excursions and recognize the importance of biodiversity documentation and conservation.

List of Exercises:

Major Experiments

- Description of any five plants belonging to different families in technical language and identification upto family level.
1. Brassicaceae- *Brassica*
 2. Fabaceae- *Tephrosia, Clitoria*
 3. Solanaceae- *Datura, Solanum*
 4. Lamiaceae- *Ocimum, Hyptis*
 5. Amaranthaceae- *Amaranthus, Chenopodium*
 6. Poaceae- Any one grass
 7. Botanical Excursion or Field visit is important.
 8. Identification and Economical importance of plants using Local Flora
 9. To demonstrate Morphology and Floral Diagram through sketches of any one plant from each family mentioned in theory syllabus.

Minor Experiments

1. Prepare a data of atleast five locally available plants of different families mentioned above listing their Botanical names, common names and specific economic uses.
2. Preparation of Monographs.

3. Preparation of Herbarium of any 10 plants.
4. Study methods of specimen preservation, mounting and cataloguing.
5. Study selected members of Monocots using morphological data.

Activities (Any 2 of the following) –

1. Collect specimens from families like Brassicaceae, Fabaceae, Solanaceae, Lamiaceae, Amaranthaceae, Poaceae.
2. Herbarium Sheet Preparation Activity
3. Field Visit / Botanical Excursion Activity- Submit a structured excursion report with photographs.
4. Learn techniques of drying, pressing, and chemical preservation.
5. Observe selected Monocot plants.-Record morphological characters and prepare comparative notes.

Any One activity of the following-

1. Group presentation on medicinal plants of local flora.
2. Quiz on plant families and identification features.
3. Poster making on importance of herbarium and biodiversity conservation.
4. Field sketching of floral structures and plant habit.
5. Digital herbarium creation using mobile apps or online tools.

Bibliography

Reference / Text Books / Research Articles

1. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. & Donoghue, M.J. (2016). *Plant Systematics: A Phylogenetic Approach* (4th ed.). Sinauer Associates, USA.
2. Simpson, M.G. (2010). *Plant Systematics* (2nd ed.). Academic Press, Elsevier.
3. Singh, G. (2016). *Plant Systematics: Theory and Practice*. Oxford & IBH Publishing, New Delhi.
4. Vasishta, P.C. (2006). *Taxonomy of Angiosperms*. S. Chand Publishing, New Delhi.
5. Lawrence, G.H.M. (1951). *Taxonomy of Vascular Plants*. Macmillan, New York.

Nomenclature & Modern Tools

1. Turland, N.J. et al. (2018). *International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code)*.
2. Stace, C.A. (2010). *Plant Taxonomy and Biosystematics*. Cambridge University Press.

Practical & Field Manuals

1. Jain, S.K. & Rao, R.R. (1977). *A Handbook of Field and Herbarium Methods*. Today & Tomorrow's Printers.
2. Lawrence, G.H.M. (1951). *Taxonomy of Vascular Plants*. Macmillan.
3. Botanical Survey of India (BSI) Publications – Flora of India Series.

Modern & Digital Resources

1. IPNI (International Plant Names Index): <https://www.ipni.org>
2. The Plant List / Plants of the World Online (Kew): <https://powo.science.kew.org>
3. GBIF (Global Biodiversity Information Facility): <https://www.gbif.org>
4. Tropicos (Missouri Botanical Garden): <https://www.tropicos.org>

External Practical Paper

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. III (Botany), SEMESTER – V (NEP)				
Major Elective P1	Course Code: 107237	Lab based Learning of Plant systematics-1	Max Marks: 25	Time: 4 Hrs.
Q.No.	Exercise			Marks
1.	Description of given Angiospermic plant in technical language. Identification upto Family, Floral formula and Floral diagram.			10
2.	Preparation of Monograph			5
3.	Spotting			5
4.	External Viva Voce			5

External Assessment

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. III (Botany), SEMESTER – V (NEP)			
Major Elective P1	Course Code: 107237	Lab based Learning of Plant systematics-1	Max Marks: 25
Sr. No.	Assessment Criteria		Marks
1	Record/ Assignments		5
2	Attendance		5
3	Participation in Activity/ Field visit		5
4	Students overall performance		5
5	Internal Viva Voce		5

Level	Course Code	Course Title	Credits	Workload	Exam Duration	Maximum Marks
5.5	107238	Molecular Biology and Genetic Engineering - 1	2	2	2.00 Hrs	30 (Ext.) 20 (Int)

Course Objectives: After completion of the course, students will be able to: 1. Understand the structure, organization, and functions of nucleic acids and the molecular basis of genetic continuity. 2. Apply knowledge of molecular techniques and recombinant DNA technology in understanding biological systems. 3. Analyze molecular processes such as DNA replication, mutation, repair, and genome maintenance. 4. Evaluate the importance of molecular tools and genetic engineering techniques in modern biological sciences. 5. Develop scientific aptitude and problem-solving ability related to molecular biological applications and experimental methodologies.				
Course Outcomes: After Successful completion of the course, the student will be able to – CO1: Explain the structure and organization of genetic material. CO2: Understand factors responsible for maintaining genome stability. CO3: Explain the principles and methodologies of recombinant DNA technology. CO4: Understand important molecular biology techniques and their applications. CO5: Develop conceptual readiness for advanced Molecular Biology and Genetic Engineering.				
Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporat ion of Pedagogie s
Unit I	Molecular Basis of Life	8	8	Suitable pedagogical strategies are separately annexed
1.1 Structural organization of DNA and RNA; unusual DNA structures and RNA types.				
1.2 Gene organization in prokaryotes and eukaryotes; split genes and overlapping genes.				
1.3 Chromatin organization and epigenetic regulation: Euchromatin, heterochromatin and nucleosome remodeling.				
1.4 Central dogma, reverse transcription and gene expression.				
Unit II	DNA: Replication, Mutation and Stability	8	8	
2.1 DNA Replication: Mechanism in prokaryotes and Eukaryotes, Structure and Function of Replication Enzymes				
2.2 Mutations and Mutagens: Molecular basis, types and biological significance.				
2.3 DNA repair mechanisms (viz. Photoreactivation, SOS repair)				
2.4 DNA Recombination, Genome Stability and Mobile Genetic Elements				
Unit III	Advanced Genetic Engineering	7	7	
3.1 Principles, strategies, and steps involved in recombinant DNA technology and gene cloning.				
3.2 Molecular tools: Restriction enzymes, ligases and selectable markers.				
3.3 Characteristics and types of cloning vectors including Plasmids, bacteriophages, cosmids, BACs and YACs.				

3.4 Direct and Indirect Gene transfer techniques, Selection of transformed cells.			
Unit IV	Advanced Molecular Techniques in Genetic Engineering	7	7
4.1 Principle, components, methodology and applications of PCR and RT-PCR. 4.2 Basic principles and applications of Next-Generation Sequencing (NGS). 4.3 DNA Barcoding: Principle, methodology and applications in species identification. 4.4 Applications of DNA sequencing technologies in medicine, agriculture and biodiversity studies.			
Activities: (Conduct any Three as CAT) 1. Seminar presentation on recent advances in Molecular Biology and Genetic Engineering. 2. Preparation of charts/models on DNA replication, mutation, repair, and recombinant DNA technology. 3. Case study analysis of genetic engineering applications in agriculture, medicine, and industry. 4. Research article review and discussion related to Molecular Biology techniques. 5. Bioinformatics database exploration and gene sequence analysis activity. 6. Group discussion on ethical issues and biosafety in Genetic Engineering. 7. Visit to biotechnology/research laboratories or virtual laboratory tours with report writing. 8. Scientific report writing and presentation on recombinant DNA technology applications.			
References: (APA Style) 1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2015). Molecular biology of the cell (6th ed.). Garland Science. 2. Brown, T. A. (2021). Gene cloning and DNA analysis: An introduction (8th ed.). Wiley-Blackwell. 3. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2017). Molecular biotechnology: Principles and applications of recombinant DNA (5th ed.). ASM Press. 4. Griffiths, A. J. F., Wessler, S. R., Carroll, S. B., & Doebley, J. (2015). Introduction to genetic analysis (11th ed.). W.H. Freeman. 5. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2018). Lewin's genes XII. Jones & Bartlett Learning. 6. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., & Martin, K. C. (2021). Molecular cell biology (9th ed.). W. H. Freeman. 7. Mitra, S. (2015). Genetic engineering: Principles and practice (2nd ed.). McGraw Hill Education. 8. Pevsner, J. (2015). Bioinformatics and functional genomics (3rd ed.). Wiley-Blackwell. 9. Primrose, S. B., & Twyman, R. M. (2013). Principles of gene manipulation and genomics (7th ed.). Wiley-Blackwell. 10. Snustad, D. P., & Simmons, M. J. (2015). Principles of genetics (7th ed.). Wiley. 11. Verma, P. S., & Agarwal, V. K. (2009). Genetic engineering. S. Chand Publishing. 12. Verma, P. S., & Agarwal, V. K. (2022). Cell biology, genetics, molecular biology, evolution and ecology. S. Chand Publishing. 13. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2013). Molecular biology of the gene (7th ed.). Pearson.			

Model Questions:
One Line Question 1. Define mutation. 2. What is the role of restriction enzyme? 3. Expand the term PCR. 4. Expand the term RT-PCR 5. Name any one cloning vector. 6. What is reverse transcriptase? 7. Define DNA fingerprinting. 8. Write any one application DNA Barcoding. 9. Name any one DNA repair mechanism. 10. Name any one Gene transfer techniques. 11. What is NGS?
Short Type Questions 1. Explain the significance of nucleic acids in living organisms. 2. Explain prokaryotic DNA replication. 3. Describe the types of mutations. 4. Explain mismatch repair mechanism. 5. Write a short note on restriction endonucleases. 6. Describe the characteristics of an ideal cloning vector. 7. Explain the applications of PCR. 8. Write a short note on agarose gel electrophoresis. 9. Explain the applications of DNA fingerprinting. 10. Explain DNA Barcoding.
Long Type Question 1. Explain the mechanism of DNA replication with suitable diagrams. 2. Describe different DNA repair mechanisms and their significance. 3. Explain the factors responsible for genome stability and maintenance. 4. Discuss the role of restriction enzymes and DNA modifying enzymes in Genetic Engineering. 5. Explain the principles and steps involved in recombinant DNA technology. 6. Describe different transformation techniques used in Genetic Engineering. 7. Explain the methodology and applications of PCR in Molecular Biology. 8. Explain the methodology and applications of RT-PCR in Molecular Biology. 9. Discuss electrophoresis and blotting techniques with their applications. 10. Explain NGS in detail. 11. Describe DNA fingerprinting and its applications in biological sciences.
Pedagogical Strategies: (use any one of the following while teaching each Unit) Unit I — 1. Human DNA Double Helix Activity: Students physically construct a DNA double helix using colored cards, ribbons, or beads to understand complementary base pairing and antiparallel strands. 2. Chromatin Compression Challenge: Students use threads, beads, and clips to model nucleosome formation and DNA packaging inside the nucleus. 3. “Build a Gene” Classroom Simulation: Students assemble gene components such as promoter, exons, introns, and terminator using charts/models to understand gene organization. 4. Central Dogma Theatre: Roleplay-based activity where students simulate replication, transcription, and translation processes to visualize flow of genetic information.

Unit II —

1. DNA Replication Relay Race: Students simulate the functions of helicase, DNA polymerase, ligase, and primase using paper DNA strands to understand replication mechanisms.

2. Mutation Casino Game: Interactive card-based activity demonstrating substitution, insertion, deletion, and frameshift mutations and their biological effects.

3. DNA Repair Escape Room: Problem-solving activity where students identify DNA damage types and match them with suitable repair mechanisms.

4. Genome Stability Debate: Group discussion on beneficial versus harmful effects of mutations in evolution, adaptation, and disease development.

Unit III

1. Restriction Enzyme Scissor Lab: Students simulate restriction digestion using paper DNA strips to understand sticky ends and recombinant DNA formation.

2. Recombinant DNA LEGO Activity: Construction of recombinant DNA models using LEGO blocks or colored pieces to demonstrate cloning strategies.

3. “Become a Plasmid” Simulation: Roleplay activity illustrating plasmid vectors, selectable markers, and bacterial transformation processes.

4. Genetic Engineering Ethics Courtroom: Mock debate on genetically modified organisms and biotechnology applications to encourage scientific and ethical reasoning.

Unit IV —

1. PCR Dance Cycles: Students physically demonstrate denaturation, annealing, and extension phases to understand PCR amplification cycles.

2. Gel Electrophoresis Human Race: Students simulate DNA fragment migration based on fragment size to visualize electrophoretic separation principles.

3. DNA Fingerprinting Mystery Case: Forensic simulation activity where students analyze DNA banding patterns to identify suspects or biological relationships.

4. Bioinformatics Treasure Hunt: Hands-on activity using NCBI and BLAST databases for sequence retrieval, species identification, and molecular analysis.

Level	Course Code	Course Title	Credits	Workload	Exam Duration	Maximum Marks
5.5	107239	Lab-Based Learning of Mole.Bio. and Genetic Eng. - 1	2	4	4.00 Hrs	25 (Ext.) 25 (Int)

Course Objectives:

1. Remember and understand the principles, methodology, and applications of molecular biology and genetic engineering techniques used in biological research.
2. Apply laboratory skills for isolation, estimation, separation, amplification, and analysis of nucleic acids and other biological molecules.
3. Demonstrate experimental techniques related to recombinant DNA technology, PCR, electrophoresis, microbial culture handling, and molecular analysis.
4. Analyze experimental observations and interpret molecular biological data obtained through laboratory investigations and bioinformatics tools.
5. Develop laboratory competency, scientific aptitude, biosafety awareness, and problem-solving skills required in Molecular Biology and Genetic Engineering laboratories.

Course Outcomes:

- CO1. Perform basic molecular biology and microbiological techniques including DNA isolation, nucleic acid estimation, microbial culture handling, and media preparation.
- CO2. Demonstrate practical skills in electrophoresis, PCR, bacterial transformation, restriction digestion, and recombinant DNA–related methodologies.
- CO3. Understand applications of molecular biology techniques such as DNA fingerprinting, blotting techniques, cloning strategies, and genomic library construction.
- CO4. Analyze and interpret experimental data, electrophoretic patterns, and bioinformatics-based molecular information.
- CO5. Apply laboratory safety practices, scientific documentation, and experimental problem-solving skills in Molecular Biology and Genetic Engineering research activities.

MAJOR EXPERIMENTS

A. Molecular Biology Experiments (Perform any FOUR)

1. Preparation of Watson and Crick DNA double helix model using DIY tools
2. Isolation of genomic DNA from plant material.
3. Preparation DNA Replication Fork using paper models/colored ribbons.
4. Preparation of the Transcription and Translation Flow using Codon-Anticodon-Amino Acid cards/models.
5. Demonstration of Agarose gel electrophoresis for separation and visualization of DNA.
6. Demonstration of Polymerase Chain Reaction (PCR) and analysis of amplified products after 10 Cycles.
7. Estimation of nucleic acids using spectrophotometric or colorimetric methods.
8. Preparation and analysis of bacterial growth curve.
9. Study of mutagenic effects using physical or chemical mutagens on microorganisms.
10. Demonstration of Southern blotting through charts/models/videos.
11. Bioinformatics-based sequence retrieval and analysis from genomic databases.

B. Genetic Engineering Experiments (Perform any THREE)

1. Construction and interpretation of recombinant DNA models and cloning strategies.
2. Demonstration and Construction Diagrammatic Genomic Library.
3. Demonstration and Construction Diagrammatic cDNA Library
4. Restriction digestion of DNA using restriction enzymes.
5. Demonstration of bacterial transformation using plasmid vectors.

6. Demonstration of DNA ligation techniques using models/simulations.
7. DNA fingerprinting pattern analysis using simulated gel data.

MINOR EXPERIMENTS

A. Molecular Biology Experiments (Perform any THREE)

1. Preparation and sterilization of microbiological culture media.
2. Micropipette handling and calibration techniques.
3. Gram staining of bacterial cultures.
4. Observation of bacterial colonies on selective media.
5. Demonstration of photoreactivation and DNA repair mechanisms using models.
6. Preparation of standard curves for nucleic acid estimation.
7. Observation and interpretation of electrophoretic band patterns.
8. Qualitative test of DNA.
9. Study and Preparation of the nucleosome model using Clay Balls and Thread/Wire
10. Study and Preparation of the Flow of Genetic information: Central Dogma

B. Genetic Engineering Experiments (Perform any TWO)

1. Study of restriction enzymes and cloning vectors using charts/models.
2. Laboratory biosafety and waste disposal practices in Molecular Biology laboratories.
3. Study of recombinant DNA technology workflow using charts/models.
4. Design Primers for DNA Amplification Diagrammatically.

Activities (Consider as CAT: Perform any Three)

1. Seminar presentation on recent advances in Molecular Biology and Genetic Engineering.
2. Preparation of charts/models on DNA replication, mutation, repair, and recombinant DNA technology.
3. Case study analysis of genetic engineering applications in agriculture, medicine, and industry.
4. Research article review and discussion related to Molecular Biology techniques.
5. Bioinformatics database exploration and gene sequence analysis activity.
6. Group discussion on ethical issues and biosafety in Genetic Engineering.
7. Visit to biotechnology/research laboratories or virtual laboratory tours with report writing.
8. Scientific report writing and presentation on recombinant DNA technology applications.

Reference/Text Books/Research Articles

1. Sambrook, J., & Russell, D. W. (2001). Molecular cloning: A laboratory manual (3rd ed.). Cold Spring Harbor Laboratory Press.
2. Wilson, K., & Walker, J. (2018). Principles and techniques of biochemistry and molecular biology (8th ed.). Cambridge University Press.
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6. Jain, A., Jain, R., & Jain, S. (2020). Basic techniques in biochemistry, microbiology and molecular biology: Principles and techniques. Springer.
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Assessment Rubric for External Practical Course

ANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. III (Botany), SEMESTER – V (NEP)				
Lab/ Practical- Major Elective P2	Course Code: 107239	Lab-Based Learning of Molecular Biology and Genetic Engineering - I	Max Marks: 25	Time: 4 Hrs.
Q.No.	Exercise		Marks	
1.	Perform Any One Major Experiment from Molecular Biology		10	
2.	Perform Any One Major Experiment from Genetic Engineering		5	
3.	Perform any One Exercise from Minor Experiments		5	
4.	External Viva Voce		5	

Assessment Rubric for Internal Practical Course

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL INTERNAL ASSESSMENT B.Sc. III (Botany), SEMESTER – V (NEP)			
Lab/ Practical- Major Elective P2	Course Code: 107239	Lab-based learning of molecular biology and genetic engineering - I	Max Marks: 25
S. No.	Assessment Criteria		Marks
1	Record/ Assignments		5
2	Attendance		5
3	Participation in Activity/ Field visit		5
4	Students overall performance		5
5	Internal Viva Voce		5

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	107240	Advance Plant Physiology – 1	2	30	2 Hrs	30 (Ext) + 20 (Int)

Course Objectives: 1. To illustrate the physiological, biochemical, and molecular mechanisms involved in water relations, photosynthesis, respiration, and plant signal transduction. 2. To deliver fundamental and advanced concepts of plant metabolism, energy generation, hormonal regulation, and stress physiology. 3. To present perspectives of current tools, techniques, and applications in plant physiology, bioenergetics, and plant biotechnology research. 4. To demonstrate plant physiological concepts through laboratory experiments, model-based learning, field activities, and problem-solving approaches for capacity building.				
Course Outcomes: After successful completion of the course, the student will be able to – CO-1: Understand the mechanisms of water balance, mineral absorption, photosynthesis, respiration, and hormonal regulation in plants. CO-2: Remember the structure, functions, pathways, and regulatory mechanisms involved in plant physiological and metabolic processes. CO-3: Explain the role of signal transduction, gene regulation, stress physiology, and energy metabolism in plant growth and adaptation. CO-4: Develop experimental, analytical, and application-oriented approaches for studying plant physiological processes and their biotechnological significance.				
Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Water Balance and Solute Movement in Plants	8	8	Suitable pedagogical strategies are separately annexed
1.1 Physiological regulation of water absorption and role of aquaporins: Mechanism of Absorption of water, Factors affecting Water absorption, Role of Aquaporin in water diffusion. 1.2 Absorption of minerals and its regulation under adaptive conditions and assimilation: Introduction, Mechanism of Minerals Absorption, Active and Passive absorption of Mineral salts, Factors affecting Mineral absorption. 1.3 Mechanism of transpiration, Soil–Plant–Atmosphere Continuum (SPAC): Introduction, Types of Transpiration, Mechanism of Stomatal Transpiration, Factor’s affecting Stomatal Movement, Significance of Transpiration, Components of SPAC, Mechanism of water movement in SPAC, Importance of SPAC. 1.4 Translocation of Organic Solutes: Introduction, Path of Translocation of Organic Solutes, Mechanism of Translocation through Phloem, Phloem loading-unloading mechanisms, Assimilates Partitioning, Factors controlling Translocation and Assimilates Partitioning.				
Unit II	Title Dynamics of Photosynthesis	8	8	
2.1 Origin and Evolution of Photosynthesis: Origin, concept, and evolutionary aspects of photosynthesis in bacteria, algae, and plants; Chemosynthesis. 2.2 Light Reactions and Photophosphorylation: Role of light in photosynthesis; Electromagnetic absorption and action spectra; Structure of LHC I and LHC II; Mechanisms of electron and proton transport; Photophosphorylation. 2.3 Carbon Assimilation and Photorespiration: Carbon assimilation through C3, C4, and CAM pathways; Evolutionary significance of C4 and CAM pathways; Photorespiration.				

2.4 Photodamage and Photoprotection: Concept of photodamage and repair in photosynthetic organisms; Role of pigment-based photoprotectants in cyanobacteria and higher plants.			
Unit III	Advances in Plant Respiration	7	7
3.1: Regulation of Respiratory Metabolism: Regulation of glycolysis, Tricarboxylic acid (TCA) cycle, and oxidative phosphorylation; Integration and control of respiratory pathways; Industrial and biotechnological applications of respiratory metabolism. 3.2: Chemiosmosis and ATP Generation: Chemiosmotic theory and proton motive force; Structure and mechanism of ATP synthase; Stoichiometry and energy yield of electron transport chain: Applications in bioenergetics and biotechnology. 3.3: Alternative Respiratory Pathways in Plants: Alternative oxidase (AOX) pathway and cyanide-resistant respiration; Energetic and physiological significance of alternative respiratory pathways. 3.4: Mitochondrial Biogenesis and Functional Regulation: Mitochondrial biogenesis and organization; Structure and regulation of mitochondrial genome; Regulation and coordination of mitochondrial metabolic pathways.			
Unit IV	Plant Signal Transduction and Hormonal Regulation	7	7
4.1 Basics of Signal Transduction and Receptors: Introduction to cell signaling and signal transduction; Primary and secondary messengers; Types and mechanism of receptors; Role of secondary messengers, protein phosphorylation, kinase cascades, and G-proteins in signaling. 4.2 Signal Transduction Mechanisms of Plant Hormones: Signal transduction pathways of Auxin, Cytokinin, Gibberellin (GA), Absciscic acid (ABA), and Ethylene; Role of DELLA proteins in GA signaling. 4.3 Gene Regulation via Hormonal Signaling: Gene regulation via Auxin, Cytokinin, Gibberellin (GA), Absciscic acid (ABA), and Ethylene signaling. 4.4 Hormonal Regulation of Stress Responses: Role of Salicylic acid (SA), Jasmonic acid (JA), Ethylene, and Absciscic acid (ABA) in biotic and abiotic stress responses; Hormonal crosstalk in stress tolerance.			
Activities: (CAT) - Homemade Water Absorption Model: Create a model using a sponge, straw, and a glass of water to demonstrate how roots absorb water. - DIY Transpiration Experiment: Cover a leafy branch of a houseplant with a clear plastic bag and observe condensation to understand transpiration. - Observation of water holding capacity in different types of soil. - Group discussion on the importance of water to the plants. - Visit to a botanical garden/agricultural field to observe mineral deficiency symptoms in plants and submission of a field report. - Assignment on how the plant prepare organic solutes and its translocation from source to every part of the plant. - Group discussions and panel discussion activity based on innovations like Artificial photosynthesis system. - Debates, seminars drama on issues like Environmental and climate change effects on vegetation and ecological adaptations of photosynthetic pathways - Preparations of flowcharts to demonstrate physiological phenomenon among students - Demonstrations of small experiments on physiological process to school students around and near your institute under school connect program. - Environment Awareness rallies, flashmobs, street plays like outdoor activities - Students visit an agricultural input store to observe auxin, cytokinin and ABA-based plant growth regulators available for crops. - Students prepare questionnaires and interview farmers about use of rooting hormones, fruit ripening agents and growth promoters. - Students visit fields affected by drought, salinity or disease and identify visible stress symptoms.			

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Model Questions:**One Line Questions**

1. What is water absorption in plants?
2. Define aquaporins.
3. What is transpiration?
4. What is phloem translocation?
5. What is oxygenic photosynthesis?
6. Define chemosynthesis.
7. What is the role of LHC II in photosynthesis?
8. What is photorespiration?
9. Explain regulation of respiratory metabolism.
10. Describe chemiosmotic theory and ATP synthesis.
11. What is the AOX pathway?
12. Explain mitochondrial biogenesis.
13. What is signal transduction?
14. What are primary and secondary messengers?
15. What are auxin receptors?
16. Which hormone is mainly associated with drought stress?

Short Type Questions

1. Explain Active Osmotic absorption of water?
2. Explain External factors affecting Absorption of water?
3. Explain Passive absorption of water?
4. Differentiate between active and passive absorption of water.
5. Describe the movement of water through xylem.
6. Explain facilitated diffusion through aquaporins
7. Explain the process of ion exchange in plants.
8. Explain the importance of mineral nutrition in plants.
9. Explain the evolutionary origin of photosynthesis in bacteria and plants.
10. Define chemosynthesis and discuss its ecological significance.
11. Differentiate absorption spectrum and action spectrum of photosynthesis.
12. Explain the mechanism of electron transport and photophosphorylation in chloroplast
13. Compare C3, C4 and CAM pathways with reference to their adaptive significance.
14. Explain the mechanism and significance of photorespiration.
15. Explain the concept of photodamage and repair in photosynthetic organisms.
16. Describe the role of pigment-based photoprotectants in cyanobacteria and higher plants.
17. Explain the regulation of glycolysis in plant cells.
18. Describe the regulation of the TCA cycle.
19. Describe industrial applications of respiratory metabolism.
20. Explain the chemiosmotic theory proposed by Peter Mitchell.
21. Describe the structure and mechanism of ATP synthase.
22. Discuss applications of bioenergetics in biotechnology.

23. Explain the alternative oxidase (AOX) pathway in plants. 24. Discuss the physiological significance of alternative respiratory pathways. 25. Explain mitochondrial biogenesis in plants. 26. Describe the structure and regulation of the mitochondrial genome. 27. Explain the coordination of mitochondrial metabolic pathways 28. How auxin regulate gene expression in plants? 29. Write a short note on the role of salicylic acid in pathogen defense. 30. Explain the role of ABA in abiotic stress tolerance in plants.
Long Type Question 1. Explain the mechanism of stomatal transpiration. 2. Describe the mechanism of Active Absorption of Water? 3. Describe mechanism of Mineral absorption. 4. Discuss Phloem loading and Unloading concept. 5. Discuss the origin and evolutionary development of photosynthesis in bacteria, algae and higher plants. 6. Explain the structure of LHC I and LHC II and discuss the mechanism of electron transport and photophosphorylation. 7. Compare and explain the C₃, C₄ and CAM pathways with their evolutionary significance. 1. Discuss the role of pigment-based photoprotectants in cyanobacteria and higher plants under stress conditions 2. Describe the regulation and integration of glycolysis, TCA cycle, and oxidative phosphorylation in plants. Add a note on industrial and biotechnological applications of respiratory metabolism. 3. Explain the chemiosmotic theory and proton motive force in detail. Describe the structure and mechanism of ATP synthase. 4. Describe the electron transport chain in plant mitochondria with reference to stoichiometry, ATP yield, and applications in bioenergetics and biotechnology. 5. Explain the alternative oxidase (AOX) pathway and cyanide-resistant respiration in plants. Discuss their energetic and physiological significance. 6. Describe mitochondrial biogenesis and organization in plants. Explain the structure and regulation of the mitochondrial genome. 7. Discuss the regulation and coordination of mitochondrial metabolic pathways in plants. 8. Explain in detail the structure, function, and mechanism of auxin receptors. 9. Explain in detail the structure, function, and mechanism of cytokinin receptors. 10. Describe the signal transduction pathways of auxin with suitable diagrams. 11. Discuss hormonal regulation of gene expression with reference to auxin and cytokinin signalling pathways. 12. Explain the role of SA, JA, ethylene, and ABA in biotic and abiotic stress management in plants.
Pedagogical Strategies: (Suggestive At least 5 concerning to the Units and Points included in each unit) 1. ICT-enabled teaching: use ICT-enabled teaching methods such as animations, videos, and simulations to explain water transport, photosynthesis, respiration, and signal transduction pathways in plants. 2. AI-Assisted Learning – use of AI tutors, adaptive learning systems and personalized feedback for students. 3. Technology Enhanced Active Learning (TEAL) – smart classrooms with interactive digital tools and participation-based teaching. 4. Interdisciplinary Learning – integrating biology, AI, environment and biotechnology together for applied understanding 5. Peer Learning and Assessment: Promote peer teaching, quizzes, and student presentations to strengthen conceptual understanding and communication skills. 6. RADEC Learning Model – Read, Answer, Discuss, Explain and Create approach for conceptual learning. 7. Research-Oriented Learning: Integrate assignments and literature reviews on recent advances in photosynthesis, respiration, plant hormones, and stress physiology.

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	107241	Lab-Based Learning of Advance Plant Physiology – 1	2	60	4 Hrs	25 (Ext)+ 25 (Int)

Course Objectives: 1. To provide practical knowledge of plant physiological processes related to water relations, photosynthesis, respiration, and hormonal regulation. 2. To develop experimental skills for studying physiological, biochemical, and metabolic activities in plants. 3. To familiarize students with laboratory instruments, analytical techniques, and experimental approaches used in plant physiology research. 4. To encourage scientific observation, data analysis, model preparation, and field-based learning in plant physiology and stress biology.
Course Outcomes: CO 1: Identify and describe physiological processes related to water absorption, photosynthesis, respiration, and hormonal signaling in plants. CO 2: Explain the principles and mechanisms involved in transpiration, photosynthesis, respiration, and plant growth regulation. CO 3: Conduct experiments to observe water movement, pigment separation, respiration, and hormonal effects in plants. CO 4: Analyze physiological and biochemical processes involved in plant metabolism, stress responses, and energy generation. CO 5: Evaluate the effects of environmental factors and plant hormones on growth, photosynthesis, and respiration. CO 6: Design and execute experiments and models to demonstrate key concepts of plant physiology, bioenergetics, and hormonal signaling.
Major Experiments (Perform any SEVEN) 1. To study the effect of temperature on water absorption. 2. To study the effect of light on stomatal opening. 3. To understand movement of water through SPAC. 4. To demonstrate translocation of organic solutes through phloem. 5. Extraction of chloroplast pigments from leaves and preparation of absorption spectrum of chlorophylls 6. To determine chlorophyll a, chlorophyll b and total chlorophyll ratio in C3 & C4 plants. 7. Separation of Photosynthetic Pigments by Thin Layer Chromatography (TLC) 8. Effects of high light intensity on chloroplast activities 9. To compare the rate of transpiration of the two surfaces of a dorsiventral leaf by calcium chloride method. 10. To isolate mitochondria from plant tissues by differential centrifugation (demonstration). 11. To compare respiration rates in fresh and stressed plant tissues. 12. To study the effect of auxin on cell elongation. 13. To study the effect of gibberellic acid on seed germination. 14. To study the role of ethylene in fruit ripening. 15. To demonstrate the triple response caused by ethylene. Minor Experiments (Perform any FIVE) 1. Preparations of different buffer solutions 2. Principles and working of Spectrophotometer, Calorimeter and Flame photometer 3. To study the effect of light intensity and sodium bicarbonate concentration on O2 evolution in Photosynthesis. 4. To demonstrate the process of fermentation by Kunhe’s vessel. 5. Effect of various salts on the permeability of the plasma membrane 6. To prepare and interpret a flowchart/model of electron transport chain and chemiosmosis.

7. To demonstrate aerobic and anaerobic respiration in plant material.
8. To study auxin-mediated bending of shoots toward light.
9. To study the effect of cytokinin on leaf aging.
10. To demonstrate hormonal signaling during biotic stress.

Activities (Perform any Two as CAT)

1. Field study of leaf adaptations of plants for photosynthesis and measurement of environmental factors affecting photosynthesis.
2. Aquatic photosynthesis field studies and pollution causing studies of algal blooms around water bodies.
3. Identification of C₃, C₄ and CAM Plants and their leaves by taking anatomical sections to show Kranz like special features.
4. Draw plant hormone signal transduction using sketches or cardboard models
5. Prepare model of stomatal closure by ABA

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Assessment Rubric for External Practical Course

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. III (Botany), SEMESTER – V (NEP)				
Practical- Major-Elective P3	Course Code: 107241	Lab-Based Learning of Advance Plant Physiology – 1	Max Marks: 25	Time: 4 Hrs.
Q. No.	Exercise			Marks
1.	Perform Any One Major Experiment from the list on Plant Stress Physiology.			7
2.	Perform Any One Minor Experiment from the list			5
3.	Comment/Demonstration of any One experiment from the list.			5
4.	Spotting			3
5.	External Viva Voce			5

Assessment Rubric for Internal Practical Course

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL INTERNAL ASSESSMENT B.Sc. III (Botany), SEMESTER – V (NEP)			
Practical- Major- Elective P3	Course Code: 107241	Lab-Based Learning of Advance Plant Physiology – 1	Max Marks: 25
S. No.	Assessment Criteria		Marks
1	Record/ Assignments		5
2	Attendance		5
3	Participation in Activity/ Field visit		5
4	Students' overall performance		5
5	Internal Viva Voce		5

Course Type	Course Code	Course Title	Credits	Workload	Exam Duration	Maximum Marks
Major-Elective T4	107242	Basic and Applied Mycology and Plant Pathology- 1	2	2	2.00 Hrs	30 (Ext.) 20 (Int)

Course Objectives: 1. To illustrate the fundamental concepts of fungal biology, diversity, classification, and reproductive mechanisms. 2. To deliver comprehensive knowledge regarding lower and higher fungi and their economic importance in agriculture, food, and medicine. 3. To present perspectives of the current tools, techniques, and applications of fungi in agriculture, biotechnology, and environmental research. 4. To demonstrate mycological concepts through different academic activities for developing scientific understanding and capacity building among students.				
Course Outcomes: After Successful completion of the course, the student will be able to – CO-1: Understand the basic concepts, structure, classification, nutrition, and reproduction of fungi. CO-2: Remember the characteristics, diversity, and economic importance of lower and higher fungi. CO-3: Explain the role of fungi in agriculture, food, medicine, mycorrhiza, and endophytic associations. CO-4: Develop scientific understanding and analytical skills regarding fungal applications, identification, and applied mycology.				
Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Introduction to Fungi	8	8	Suitable pedagogical strategies are separately annexed
1.1: General account of fungi Including modifications of mycelia and Reproduction 1.2: Mode of nutrition in fungi - Parasitic, Saprophytic and Symbiotic 1.3: Classification of fungi proposed by Ainsworth (1973) 1.4: Role of fungi in Agriculture (With reference to fungal diseases on crop plants and fungi as a Biocontrol agent- <i>Trichoderma</i>)				
Unit II	Diversity of Lower Fungi	8	8	
2.1: General characters of Myxomycotina, Thallus and reproductive structures of <i>Stemonitis</i> 2.2: General characters of Mastigomycotina, Thallus and reproductive structures of <i>Phytophthora</i> 2.3: General characters of Zygomycotina, Thallus and reproductive structures of <i>Mucor</i> 2.4: Fungal infections- Mucormycosis and Aspergillosis				
Unit III	Diversity of Higher Fungi	7	7	
3.1: General characters of Ascomycotina, Thallus and reproductive structure of <i>Penicillium</i> 3.2: General characters of Basidiomycotina, Thallus and reproductive structure of <i>Puccinia graminis</i> 3.3: General characters of Deuteromycotina, Thallus and reproductive structure of <i>Cercospora</i> 3.4: Applications of fungi in food and medicine				

Unit IV	Applied Mycology	7	7	
4.1: Mycorrhiza and its types 4.2: Applications of Mycorrhiza in agriculture and forestry 4.3: Endophytic fungi as a natural reservoir 4.4: Applications of endophytic fungi in production of secondary metabolites				
Activities: (Suggestive 10 applicable to use as CAT - Perform any Three) 1. Collection and identification of common fungi from local surroundings. 2. Preparation of charts/models on classification and life cycle of fungi. 3. Field survey of fungal diseases in nearby agricultural crops. 4. Seminar presentation on useful and harmful fungi. 5. Preparation of herbarium of fungal specimens. 6. Poster presentation on applications of fungi in food, medicine, and agriculture. 7. Group discussion on fungal diseases and their control measures. 8. Demonstration of simple mushroom cultivation techniques. 9. Assignment on mycorrhiza and endophytic fungi applications. 10. Preparation and exhibition of fungal culture photographs/microscopic observations.				
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Model Questions:				
One Line Question 1. Define mycology. 2. What is mycelium? 3. Define hyphae. 4. Name two saprophytic fungi. 5. What is symbiosis? 6. Define spore. 7. Name one fungal plant disease. 8. What is budding in yeast? 9. Name one edible mushroom. 10. Define mycorrhiza. 11. What is an endophytic fungus? 12. Name one fungus used in medicine. 13. What is fermentation? 14. Name one biocontrol fungus. 15. What is Potato Dextrose Agar (PDA)?				
Short Type Questions 1. Differentiate between septate and aseptate mycelium. 2. Explain saprophytic nutrition in fungi with examples.				

- Write a short note on fungal reproduction. - Describe the economic importance of fungi in agriculture. - General characters of Myxomycotina - General characters of Ascomycotina - General characters of Deuteromycotina - Write a short note on mucormycosis. - Write a short note on Aspergillosis - Write on Uredial stage in <i>Puccinia</i> - Write on Telial stage in <i>Puccinia</i> - Write short notes on <i>Cercospora</i> and its importance. - Write note on Ectotrophic mycorrhiza - Write note on Endotrophic mycorrhiza - Write a short note on endophytic fungi
Long Type Question - Explain the general characteristics, structure, and reproduction in fungi. - Describe different modes of nutrition in fungi with suitable examples. - Explain the classification of fungi according to Ainsworth (1973). - Discuss the role of fungi in agriculture and as biocontrol agents. - Describe the thallus and reproductive structures of <i>Stemonitis</i>. - Explain the morphology and reproduction in <i>Phytophthora</i>. - Describe the structure and reproduction of <i>Mucor</i> with diagrams. - Write a detailed note on mucormycosis and aspergillosis. - Explain the thallus and reproductive structures of <i>Penicillium</i>. - Describe the stages of <i>Puccinia</i> associate with primary host - Explain the structure and economic importance of <i>Cercospora</i>. - Discuss the applications of fungi in food and medicine. - Explain different types of mycorrhiza with suitable examples. - Discuss the applications of mycorrhiza in agriculture and forestry - Write an essay on endophytic fungi and their applications in production of secondary metabolites.
Pedagogical Strategies: (Suggestive At least 5 concerning to the Units and Points included in each unit) Lecture Method with ICT Support Use charts, PowerPoint presentations, videos, and diagrams to explain fungal structure, classification, reproduction, and diversity. Demonstration-Based Teaching Demonstrate microscopic observations, fungal culturing, slide preparation, and mushroom cultivation techniques for better conceptual understanding. Field Visits and Survey Method Organize visits to agricultural fields, nurseries, compost units, or mushroom cultivation centers to study fungal diseases and beneficial fungi. Activity and Project-Based Learning Assign preparation of herbarium, charts, models, posters, and mini-projects on fungal applications in agriculture, food, and medicine. Group Discussion and Seminar Method Conduct seminars, student presentations, and group discussions on mycorrhiza, endophytic fungi, fungal diseases, and biocontrol applications. Laboratory Experimental Learning Encourage hands-on practical work such as fungal isolation, staining, culturing, and observation of fungal structures using simple laboratory methods. Problem-Solving and Case Study Approach Discuss case studies related to plant fungal diseases, food spoilage, mycoses, and agricultural applications of fungi. Collaborative Learning Strategy Promote teamwork through group practical, surveys, assignments, and preparation of educational materials related to mycology.

Course Type	Course Code	Course Title	Credits	Workload	Exam Duration	Maximum Marks
Major-Elective P4	107243	Lab-Based Learning of Basic and Applied Mycology and Plant Pathology- 1	2	4	4.00 Hrs	25 (Ext.) 25 (Int)

Course Objectives: 1. To develop basic laboratory skills for observation, isolation, culturing, and identification of fungi. 2. To provide hands-on training in microscopic techniques and preparation of fungal slides and culture media. 3. To acquaint students with practical applications of fungi in agriculture, food, medicine, and biotechnology. 4. To enhance scientific attitude and experimental skills through field studies, fungal collection, and simple mycological experiments.
Course Outcomes: CO 1: Identify and describe different fungal structures, hyphae, mycelium, spores, and reproductive bodies using microscopic techniques. CO 2: Explain the morphology, diversity, and distinguishing characters of lower and higher fungi through practical observations. CO 3: Conduct experiments to prepare culture media, isolate fungi, and observe fungal growth using simple laboratory methods. CO 4: Analyze fungal associations, plant diseases, and the role of fungi in agriculture, food fermentation, and medicine through experimental studies. CO 5: Evaluate the importance of mycorrhiza, endophytic fungi, and beneficial fungi in sustainable agriculture and biotechnology applications. CO 6: Design and execute practical experiments related to fungal collection, culturing, identification, preservation, and applied mycological techniques.
Major Experiments (Perform any SEVEN) 1. Study of fungal colonies from different substrates 2. Temporary mount preparation of any available fungal specimen 3. Study of septate and aseptate mycelium (microscopic slide or photograph) 4. Study of saprophytic, parasitic and symbiotic fungi 5. Microscopic study of <i>Stemonitis</i> 6. Microscopic study of <i>Phytophthora</i> 7. Microscopic study of <i>Mucor</i> 8. Observation of bread mold development 9. Isolation of fungi from soil by dilution plate method 10. Microscopic study of <i>Penicillium</i> 11. Study of <i>Puccinia graminis</i> morphology 12. Preparation of mushroom spore print 13. Study of reproductive stages in <i>Cercospora</i> 14. Study of ectomycorrhiza and endomycorrhiza 15. Isolation of endophytic fungi from leaves 16. Preparation of Potato Dextrose Agar (PDA) medium 17. Study of fungi used in food and medicine 18. Simple mushroom cultivation using straw bags Minor Experiments (Perform any FIVE) 1. Isolation and preservation of fungal specimens 2. Preparation of temporary slide using Lactophenol Cotton Blue 3. Observation of fungal spores under microscope 4. Study of conidia and sporangia in fungi 5. Demonstration of vegetative reproduction in fungi 6. Observation of fungal growth on different food materials 7. Study of symptoms of fungal diseases on crop plants 8. Preparation of wet mount of infected plant material

9. Study of edible and poisonous mushrooms
10. Observation of fungal culture characteristics on PDA medium
11. Isolation of airborne fungi by settle plate method
12. Study of *Aspergillus* colony morphology
13. Demonstration of sterilization techniques in mycology laboratory
14. Observation of mycorrhizal association in plant roots

Activities (Perform any Three activities as CAT)

1. Isolation of fungi from crop plants in local agricultural fields
2. Preparation of fungal specimen e-herbarium
3. Chart preparation on classification of fungi
4. Field visit for observation of fungal plant diseases
5. Preparation of models of fungal structures
6. Observation and photography of mushrooms in natural habitats and submission of e-herbarium
7. Preparation of posters on useful and harmful fungi
8. Demonstration of simple mushroom cultivation
9. Seminar/presentation on applications of fungi in agriculture and medicine

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19. Kunwar, I. K. *Mycology, Plant Pathology and Microbial Biotechnology*. BSP Books Pvt. Ltd.
20. Dube, H. C. *An Introduction to Fungi* (4th ed.). Scientific Publishers.
21. Mishra, S. R. *Textbook of Mycology*. Discovery Publishing House.
22. Thind, K. S. *Fungi and Allied Microorganisms*. Scientific International.
23. Sharma, O. P. *Textbook of Fungi*. McGraw Hill Education.
24. Vashishta, B. R. *Botany for Degree Students: Fungi*. S. Chand Publications.
25. Kiffer, E., & Morelet, M. *The Deuteromycetes: Mitosporic Fungi*. Repro Books.
26. Ajay Kumar et al. *Fungi Classification and Identification*. New India Publishing Agency.

E-Contents, E-Books (Free Available or Purchase Links)

- NCERT Biology e-Books – <https://ncert.nic.in/textbook.php>
Basic concepts of fungi, plant pathology, symbiosis, and microorganisms.

- National Digital Library of India (NDLI) – <https://ndl.iitkgp.ac.in/>
Free access to mycology, plant pathology, microbiology, and biotechnology books and articles.
- Internet Archive – Mycology Books – <https://archive.org/details/texts>
Free downloadable classic books on fungi, plant diseases, and fungal taxonomy.
- Google Books – Mycology and Plant Pathology – <https://books.google.com/>
Preview and purchase links for standard mycology and plant pathology textbooks.
- SpringerLink – Mycology Resources – <https://link.springer.com/>
Research books and chapters on fungal diversity, mycorrhiza, and medical mycology.
- Elsevier eBooks – Plant Pathology and Mycology – <https://www.elsevier.com/books-and-journals>
Advanced references on fungi, fungal diseases, and agricultural applications.
- NPTEL Biotechnology and Microbiology Courses – <https://nptel.ac.in/courses>
Video lectures on mycology, plant pathology, fermentation technology, and microbiology.
- FAO Mushroom Cultivation Manual – <https://www.fao.org/>
Mushroom cultivation methods and applications of edible fungi.

Digital Resources like Weblinks

- American Phytopathological Society (APS) – <https://www.apsnet.org/>
Plant disease images, fungal pathogen information, and teaching resources.
- MycoBank – <https://www.mycobank.org/>
International database for fungal taxonomy and nomenclature.
- USDA Fungal Databases – <https://nt.ars-grin.gov/fungaldatabases/>
Authenticated fungal species and classification database.
- Centers for Disease Control and Prevention – Fungal Diseases – <https://www.cdc.gov/fungal/index.html>
Information on fungal infections including aspergillosis and mucormycosis.
- Microbe Notes – <https://microbenotes.com/>
Easy notes on fungal classification, reproduction, and microbiology practicals.
- Indian Council of Agricultural Research (ICAR) – <https://icar.org.in/>
Agricultural disease management and fungal biocontrol resources.
- Tamil Nadu Agricultural University Agritech Portal – <https://agritech.tnau.ac.in/>
Plant disease symptoms and crop disease management information.
- PubMed – <https://pubmed.ncbi.nlm.nih.gov/>
Authentic research articles on mycology, mycorrhiza, endophytic fungi, and medical mycology.

Educational Software, Databases, etc.

- ImageJ Software – <https://imagej.net/ij/>
Free image analysis software useful for fungal microscopy observations.
- Motic Microscope Software – <https://www.motic.com/>
Digital microscopy software for fungal specimen observation.
- MycoPortal Database – <https://mycoportal.org/>
Online fungal specimen and herbarium database.
- NCBI Database – <https://www.ncbi.nlm.nih.gov/>
Molecular biology and fungal gene sequence database.
- CAB Direct Database – <https://www.cabdirect.org/>
Agricultural, plant pathology, and microbiological literature database.
- Virtual Microscope Lab – <https://www.olympus-lifescience.com/en/microscope-resource/>
Online microscopy learning and fungal observation guides.
- MycoCosm Fungal Genomics Resource – <https://mycocosm.igi.doe.gov/>
Fungal genome database and comparative genomics platform.
- Fungal Databases – USDA ARS – <https://data.nal.usda.gov/dataset/usda-ars-culture-collection>
Authenticated fungal culture and taxonomy database.

Question Paper for External Practical Course

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. III (Botany), SEMESTER – V (NEP)				
Major-Elective P4	107243	Lab-Based Learning of Basic and Applied Mycology and Plant Pathology- 1	Max Marks: 25	Time: 4 Hrs.
Q.No.	Exercise			Marks
1.	Perform Any One Major Experiment from Paper I			5
2.	Perform Any One Major Experiment from Paper II			5
3.	Perform Any One Major Experiment from Paper II			5
4.	Perform any One Exercise from Minor Experiments			5
5.	External Viva Voce			5

Assessment Rubric for Internal Practical Course

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. III (Botany), SEMESTER – V (NEP)			
Major-Elective P4	107243	Lab-Based Learning of Basic and Applied Mycology and Plant Pathology- 1	Max Marks: 25
S. No.	Assessment Criteria		Marks
1	Record/ Assignments		5
2	Attendance		5
3	Participation in Activity/ Field visit		5
4	Students overall performance		5
5	Internal Viva Voce		5

Minor Course: Biochemistry, Plant Physiology and Ecology

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	107244	Biochemistry, Plant Physiology and Ecology	2	30	2 Hrs	30 (Ext) + 20 (Int)

Course Objectives:

1. To impart foundational Knowledge of plant biomolecules, enzymes and Secondary metabolite
2. To study the vital plant physiological activities.
3. To understand Fundamental Plant Processes
4. To Interpret physiological responses under environmental conditions,
5. To differentiate Ecosystem Components

Course Outcomes: After Successful completion of the course, the student will be able to –
CO-1: Explain and analyze biomolecular structure and functions, Evaluate ecological interactions and ecosystem functions like Carbohydrates and lipids
CO-2: Connect basic Biochemistry knowledge to entrepreneurship in the pharma, food and biotech industry
CO-3: Understand the importance of water to plants, mineral uptake, photosynthesis and respiration
CO-5: Understand core ecological concepts

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Biochemistry	8	8	Suitable pedagogical strategies are separately annexed
1.1 Fundamentals of Biochemistry and Biomolecules: Origin of Life, Biomolecules: Structure and Function of Glucose, Sucrose, Starch, Cellulose and Lipids. 1.2: Enzymes: Definition, Concept, Nomenclature, Mechanism of Enzyme Action-Induced fit concept, Enzymes in Plant Industry 1.3: Secondary Metabolites: Functional Roles of secondary metabolites in plant defense and metabolism 1.4: Advanced applications: Definition, Scope and applications in Drug discovery (e. g. Nobel Drug Artemisinin) Nutraceuticals (e. g. Turmeric, Tinospora and Moringa)				
Unit II	Water Relations and Mineral Nutrition	8	8	
2.1 Absorption and Translocation of Water: Water potential, root absorption (Active and Passive) Ascent of sap. 2.2 Mineral Nutrition: Macro and Micronutrients role and deficiency symptoms of in plants, nutrient uptake and transport mechanisms. 2.3 Translocation of Solutes: Phloem transport (Loading and unloading), source-sink relationship. 2.4 Applied Plant Nutrition: Hydroponics, nutrient management and sustainable agricultural applications.				
Unit III	Metabolism and Growth	7	7	
3.1: Photosynthesis: Light and Dark Reaction, Comparative account of C3 and C4 cycle, CAM Pathway. 3.2: Respiration: Glycolysis, TCA cycle, electron transport system and ATP generation.				

3.3: Growth: Phases of growth and Growth curve. Physiological role of hormones (Auxins, Gibberellins, Cytokinins, Absciscic acid and Ethylene). 3.4: Plant Movement: Epinasty and Hyponasty, phototropism, Geotropism and nastic movements.				
Unit IV	Ecology	7	7	
4.1: Introduction to Ecology: Scope and History, Atmosphere: Structure and Composition of the Atmosphere. Role and Concept of Ecosystem: Biotic (Producers, Consumers, Decomposers) and Abiotic (Climatic factors: Light, Water and Edaphic factors: Soil types, Soil Profile) 4.2: Ecological Adaptations and Successions: Morphological and Anatomical Adaptations of Hydrophytes (<i>Hydrilla</i> and <i>Nelumbo</i>) Xerophytes (<i>Nerium</i> and <i>Opuntia</i>). Ecological Succession. 4.3: Global issues: Greenhouse gases, Ozone depletion (Ozone hole over Antarctica), Acid rain (Taj Mahal corrosion, Mathura refinery), El Niño 4.4: Applied Ecology/ Conservation/ GIS application: eDNA, AI Camera Traps, NDVI for Forest Cover, Mapping Ecologically Sensitive areas (ESAs)- Western Ghats.				
Activities: (Conduct any three as CAT) Flashcards for the Must-memorise: Prepare Flashcards for 20 amino acids, DNA bases and key enzymes used daily for 5 minutes to memorize it all Physical Models: Use pipe cleaners for protein folding, clay for substrate fitting enzymes. Photosynthesis experiment: By destarching the leaf by giving the dark treatment to enable the chlorophyll pigment to do photosynthesis. Treat the area with the iodine solution. The portion of the leaf exposed to sunlight turns blue while the covered portion turns black brown, indicating the loss of starch due to a lack of photosynthesis. Transpiration, Show loss of water in the form of vapours: Cover the leaf of a healthy plant with a polythene bag, and keep it in sunlight for 3 hours. A water droplet observed in a bag indicates the condensation of water vapour from leaves during transpiration. Respiration: To demonstrate that CO₂ is released during respiration, cover the germinating seeds in a conical flask containing KOH, and keep it for a few hours. CO₂ released by germinating seeds turn the lime water milky. Plasmolysis: The process can be studied by using vegetables such as bitter gourd and raw mangoes, by giving the salt treatment. Cut veggies were kept in salt for a few hours; it was observed that the veggies released water and shrank, which indicates exo-osmosis. Imbibition Experiment: Observe the imbibition by soaking dry seeds or beans in water and measuring their sizes and weight. Ecosystem: Demo or laboratory set up a closed jar ecosystem with pond water and small snails. Track O₂, CO₂, Producers/Consumers/Decomposers Ecosystem Model/ Chart: Prepare. With the help of sticky notes like Lion, Fungi, Sunlight, Clay Soil, Rainfall, Students should build a forest ecosystem map on the wall, grouping into Producers, Consumers, Decomposers, Climatic, and Edaphic. Shows interdependence visually Model: Hydrosere and Xerosere stages using Charts/ Specimens				
References: - Chaudhari, M.A., & Gupta, K.K. (2009). Practical plant physiology. New Central Book Agency Ltd. - Curtis, H., & Clark, N. (Year). Introduction to plant physiology. [Edition]. [Publisher]. - Devlin, R.M. (Year). Plant physiology. [Edition]. [Publisher]. - Galston, A.W. (1989). Life processes in plants. Scientific American Library/Springer-Verlag.				

- Harper, C., Varma, S.K., & Verma, M. (2014). Plant physiology, biochemistry and biotechnology (4th ed.). S Chand Publication. - Hopkins, W.G. (1995). Introduction to plant physiology. John Wiley & Sons, Inc. - Hopkins, W.G., & Huner, N.P.A. (2008). Introduction to plant physiology. John Wiley & Sons. - Jain, V.K. (Year). Fundamentals of plant physiology. S. Chand Publication. - Kochhar, S.L., & Gujjar, S.K. (2020). Plant physiology: Theory and applications. Cambridge Publications. - Lincoln, T., & Zeiger, E. (2003). Plant physiology (3rd ed.). Panima Publishing Corporation. - Mayer, A., & Anderson, J.B. (1952). Plant physiology. Digitized Edition 2009. Van Nostrand. - Miller, W.R., & Donahue, R.L. (1992). Soils: An introduction to soils and plant growth (6th ed.). Prentice Hall of India Pvt. Ltd. - Mohr, H., & Schopfer, P. (1995). Plant physiology (4th ed.). Wordsworth. - Moore, T.C. (1989). Biochemistry and physiology of plant hormones. Springer-Verlag. - Salisbury, F.B., & Ross, C.W. (1992). Plant physiology (4th ed.). Wadsworth Publishing Company. - Sharma, P.D. (2003). Ecology and environment. Rastogi Publications. - Singh, A. (1967). Plant physiology. Asia Publishing House. - Singhal, G.S., Renger, G., Sopory, S.K., Irrgang, K.D., & Govindjee. (1999). Concepts in photobiology: Photosynthesis and photomorphogenesis. Narosa Publishing House. - Smith, L.R., & Smith, T.M. (1998). Elements of ecology (4th ed.). An imprint of Addison Wesley Longman, Inc. - Taiz, L., & Zeiger, E. (1998). Plant physiology (2nd ed.). Sinauer Associates, Inc. Publishers. - Tyler, M.G., Jr. (1997). Environmental science: Working with Earth (6th ed.). Wadsworth Publishing Co. - Verma, S.K., & Verma, M. (2007). A textbook of plant physiology, biochemistry and biotechnology. S. Chand Publishing. - Weaver, J.E., & Clements, F.E. (1966). Plant ecology
Model Questions:
One Line Question - What are Lipids - Define enzyme - Write name of micronutrients (any two) - Define macronutrients - What is photosynthesis? - What is Ascent of Sap? - What is the function of Auxin's? - Write name of fruit ripening hormone - What is Phloem? - What is significance of Calvin cycle? - Define phototropism - What is geotropism? - What are the two main Components of an Ecosystem - Name the types of Consumers in an Ecosystem - What is an Edaphic Factor - Give one Example of a Decomposer - What are greenhouse gases - What is Ozone layer and why is it important? - What is El Nino?
Short Type Questions - Define lipids and give their main functions in Plants - What is Monosaccharide's? - List four factors affecting enzyme activity - Explain the induced fit concept - How are plant secondary metabolites used in drug discovery? Give two examples.

6. Write importance of water in plant life. 7. Factors affecting Transpiration 8. Mechanism of Ascent of Sap. 9. Passive absorption 10. Active Absorption. 11. .What is respiration? Mention its Types. 12. Phases of Growth. 13. Physiological role of Auxin. 14. Physiological role of Gibberellins 15. Define Nutraceuticals and give any two plant-based examples with benefits 16. What is the scope of Ecology 17. Differentiate between climatic and edaphic factors with examples. 18. Why are decomposers important even though they are not visible in food chain diagram. 23.If all producers are removed from a forest ecosystem, what will happen? 24.What is Miyawaki method 25.Describe anatomical adaptations of Hydrilla. 26.Describe anatomical adaptation of Nerium leaf 27.How is Nelumbo (Lotus) adapted to aquatic life 28.Explain the stages of hydrosere with examples 29.How does Opuntia survive desert conditions 30.What is eDNA and how is it used in Conservation 31.How do AI camera traps differ from traditional camera traps? 32.What are challenges of AI camera traps in Indian forests? 33.What are ESAs and how were they identified in Western ghats 34.What are greenhouse gases? Name Major ones? 35.How do GHGs cause global warming? 36.What causes Ozone depletion? 37.Why does Ozone hole form over Antarctica? 38.What is Acid Rain and How it is formed
Long Type Question 1. Differentiate between glucose and sucrose in terms of structure and function 2. Role of Secondary Metabolites in Plant defences 3. Describe in detail process of transpiration and its theory. 4. Describe in details mechanism of ascent of sap. 5. Write down in detail induced fit theory. 6. Describe in detail Phloem transport theory. 7. Describe C4 pathway with examples. 8. Describe Glycolysis 9. What is TCA cycle? Explain it in details. 10. Describe Physiological Role of Plant Growth Hormones. 11. Application of AI in plant growth and development. 12. Describe various growth phases. 13. Describe the concept of ecosystem as given by Odum. Explain biotic and abiotic components. 14. Briefly explain the role of producers in an ecosystem 15. What are hydrophytes? classify them based on their relation to water 16. Why Corporations Adopted Miyawaki method 17. What are xerophytes? Give morphological adaptations of <i>Nerium</i> 18. Define ecological succession. Differentiate hydrosere and xerosere. 19. What are the Ecological Benefits of Miyawaki forest? 20. How is NDVI used for monitoring forest cover in India
Pedagogical Strategies: 1. Connect to Every product: Caffeine in coffee, menthol in gum, aspirin in willow, morphine from poppy, taxol from yew trees.

2. Color and Smell lab : Extract Anthocyanins from red cabbage or Limonen from orange peel. Change pH, see color shift. Crush mint, smell Menthol. Secondary metabolites are sensory. Lab experiences beat diagrams
3. Inquiry- Based Labs: Implement experiments where students formulate hypotheses, collect data and write reports on topic like nutrient uptake or stomatal behaviour, respiration, transpiration and photosynthesis.
4. At-Home Labs: Utilize laboratory kits for remote learning, fostering skills in hypothesis generation, data collection and analysis at home.
5. Cooperative learning: Organize small group work, such as dissecting physiological processes or conducting plant-based games, to promote collaborative knowledge construction.
6. Reverse Field Trips: Bring the field Inside. Soil samples, pond water, leaf litter. Put microscope on Benches and find 5 things alive in that samples.
7. Time laps ecology: Show 10 years of satellite images of one spot. Deforestation, Urbanization, glacier retreat. Then ask : “ What species lost? What species won? What didn’t change?

Minor Lab: Techniques in Biochemistry, Plant Physiology and Ecology

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	V	107245	Techniques in Biochemistry, Plant Physiology and Ecology	2	60	4 Hrs	25 (Ext)+ 25 (Int)

Course Objectives:

1. To perform fundamental techniques of Biochemistry.
2. To evaluate, study, record and graph data by performing experiments on pH, temperature effects on enzyme
3. To provide hands-on experience and develop technical skills for analysing fundamental biological processes.
4. To describe the ecological adaptations and vegetation

Course Outcomes:

- CO 1: Technical Skill Development: To gain proficiency in using scientific laboratory equipment.
- CO 2: Students will be able to relate the experiment to a real-world example, such as food, disease and medicines.
- CO 3: Understand the vital physiological processes in plants: To demonstrate and verify principles of water potential, stomatal movement, transpiration rates and mineral uptake.
- CO 4: Apply ecological concepts to real issues

Major Biochemistry, Physiology and Ecology Experiments (Any Eight)

Biochemistry Experiments (Any Two)

1. Quantitative tests for Glucose by the DNS method.
2. Quantitative tests for Starch by the Anthrone method.
3. Study of reducing and non- reducing sugars
4. Identification and Estimation of Lipids
5. Effect of pH on Enzyme Activity
6. Effect of Temperature on Enzyme Activity

Physiology Experiments (Any Five)

1. To determine the path of water (ascent of sap).
2. Study of Translocation Through Ringing (Girdling) Experiment
3. To determine the rate of transpiration by Ganong's potometer.
4. Extraction and Separation of Chlorophyll Pigments by Paper Chromatography
5. To determine the photosynthesis under varying quality of light and CO₂ concentration by using Willmott's bubbler.
6. Demonstration of Nastic Movement in *Mimosa pudica*
7. To study the rate of photosynthesis in aquatic plants.
8. To determine R.Q using the different substrates.
9. Measurement of respiration rate using germinating seeds and flower buds with a simple respiroscope.
10. Identification of Deficiency Symptoms in Local Crop Plants
11. Effect of IAA and Gibberellins on seed germination.

Ecology Experiments (Any Two)

1. Study Morphological and Anatomical adaptations of Hydrophytes, e.g. *Hydrilla* (Stem), *Nelumbo* (Petiole), *Eichhornia* (Petiole) and *Pistia* (Leaf) (Any Two)
2. Study Morphological and Anatomical adaptations of Xerophytes e.g. *Nerium* (Leaf), *Calatropis* (Leaf), *Opuntia* (Phylloclade) and *Aloe vera* (Leaf) (Any Two)

3. To study Physical characteristics (temperature, colour and texture by the sieve method) of soil sample
4. Determination of water holding capacity of different soils.
5. Study of vertical section of Soil showing different Horizons.
6. Determination of pH of different soils and water samples by pH papers/ pH meter.
7. To study the ecological role of secondary metabolites in plants for e.g fresh leaves of *Azadirachta indica*, *Ocimum sanctum* and *Acacia* bark

Minor Biochemistry, Physiology and Ecology Experiments (Any Six)

Biochemistry Experiments (Any Two)

1. To demonstrate the test of glucose/sucrose
2. To demonstrate a test for starch
3. To demonstrate a test for cellulose
4. To study the activity of the enzyme catalase
5. To demonstrate a test for lipid
6. Qualitative test of Secondary Metabolites (Any Two)

Physiology Experiments (Any Two)

1. To demonstrate osmosis by the potato osmoscope /egg osmoscope.
2. To demonstrate the transpiration by Bell Jar.
3. To demonstrate anaerobic respiration in germinating seeds.
4. To demonstrate the evolution of CO₂ in respiration in germinating seeds.
5. Demonstration of Plasmolysis and Deplasmolysis in the peel of the *Rhoeo discolor* leaf.
6. Observe the temporary mount of leaf peel to show stomata.
7. To investigate the diffusion of particles in solid/liquid/gas.
8. Demonstration of Phototropism
9. Demonstration of Hydroponics

Ecology Experiments (Any Two)

1. To study the biotic and abiotic components of a terrestrial ecosystem (College Garden, Forest patch) or an aquatic ecosystem (Pond)
2. To study the use of AI camera traps in wildlife monitoring
3. To study Vegetation, cover in a given area
4. To determine the porosity of soil.
5. To determine the transparency of water.
6. To study the effect of acid rain on plant growth/ seed germination/marble and limestone
7. To prepare simulated acid rain and compare its pH with normal rainwater using universal indicator/pH paper
8. Estimation of the salinity of different water samples

Activities (Any Two)

1. Collect and identify 5 Medicinal plants from the College Campus. Note and Report which secondary metabolites they are known for.
2. Survey and collection of crop plants under nutrient deficiency from local fields
3. Diagnosis/ identification of stress condition on the basis of specific symptoms and submission.
4. Field visit to study the local pond for Hydrosere stages
5. Prepare charts for a comparative study of Hydrilla vs Nerium leaf with descriptions and Diagrams
6. Mini Project / Field Project- NDVI comparison of: college campus, urban area, nearby agricultural field

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1. Salisbury, F.B., & Ross, C.W. (1991). Plant Physiology. Wadsworth Publishing Co. Ltd. 4. Taiz, L., & Zeiger, E. (2006). Plant Physiology (4th ed.). MA: USA, Sinauer Associates Inc.
2. Chaudhari, M.A., & Gupta, K.K. (2009). Practical plant physiology. New Central Book Agency Ltd.
3. Jain, V.K. (Year). Fundamentals of plant physiology. S. Chand Publication. 16. Kochhar, S.L., & Gujjar, S.K. (2020). Plant physiology: Theory and applications. Cambridge Publications.
4. <https://www.bdu.ac.in/cde/SLM/B.Sc.%20Botany/III%20Year/B.Sc.Botany Plant%20Physiology%2C%20Biochemistry%20%26%20Biophysics Practical-IV III-Year SPS%20%281%29.pdf>
5. <https://biology4isc.weebly.com/plant-physiology-experiments.html>

Reference/Text Books/Research Articles**Textbooks:**

1. Lehninger, A.L. Principles of Biochemistry - Covers biomolecules, enzymes, metabolism.
2. Taiz, L. & Zeiger, E. Plant Physiology and Development - Secondary metabolites, plant enzymes.
3. Buchanan, B.B., Gruissem, W. & Jones, R.L. Biochemistry & Molecular Biology of Plants.

Research Articles / Reviews:

1. Erb, M. & Kliebenstein, D.J. "Plant Secondary Metabolites as Defenses, Regulators, and Primary Metabolites"
2. Al-Khayri, J.M. et al. (2023) "Plant Secondary Metabolites: The Weapons for Biotic Stress Management" Metabolites
3. Dahiya, D. & Nigam, P.S. (2021) "An overview of three biocatalysts of pharmaceutical importance" AIMS Microbiology
4. Choi, J.M. et al. (2015) "Industrial applications of enzyme biocatalysis" Biotechnology Advances
5. Gunjal, A.B. (2023) "Immobilized enzymes for nutraceuticals production" Nepal J Environ Sci 110b43f34a927d6e

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. III (Botany), SEMESTER – V (NEP)				
Lab/ Practical-	Course Code: 107245	Techniques in Biochemistry, Plant Physiology and Ecology	Max Marks: 25	Time: 4 Hrs.
Q. No.	Exercise			Marks
1.	Perform Any One Major Experiment from Biochemistry			5
2.	Perform Any One Major Experiment from Physiology			5
3.	Perform Any One Major Experiment from Ecology			5
4.	Perform any One Exercise from Minor Experiments			5
5.	External Viva Voce			5

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI Assessment Rubric for Internal Practical Course B.Sc. III (Botany), SEMESTER – V (NEP)			
Lab/Practical-	Course Code: 107245	Techniques in Biochemistry, Plant Physiology and Ecology	Max Marks: 25
S. No.	Assessment Criteria		Marks
1	Record/ Assignments		5
2	Attendance		5
3	Participation in Activity/ Field visit/ Mini Project		5
4	Students overall performance		5
5	Internal Viva Voce		5

Vocational Skill Enhancement Course

Course Type	Semester	Course Code	Course Title	Credits	Workload	Exam Duration	Maximum Marks
VSC-P	V	107246	Eco-Friendly Plant Products	2	4	4.00 Hrs	25 (Ext.) 25 (Int)

Course Objectives:

1. To illustrate the methods of preparation of various eco-friendly plant-based products using locally available raw materials.
2. To deliver hands-on training in herbal cosmetics, natural cleansers, bio-fertilizers and bio-pesticides.
3. To present perspectives of the current tools for application and research.
4. To demonstrate the concept using different activities for building capacity.

Course Outcomes:

After Successful completion of the course, the student will be able to –

CO-1: Understand the principles and significance of eco-friendly plant products as alternatives to synthetic chemicals.

CO-2: Remember the botanical sources, key phytoconstituents and traditional methods of preparation of herbal products.

CO-3: Explain the step-by-step procedure for preparation of herbal Holi colors, natural dyes, vermicompost and areca leaf plates.

CO-4: Develop skills to prepare, standardize and market plant-based products for small-scale enterprise.

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Nutraceutical and Functional Food Products	15	10	Suitable pedagogical strategies are separately annexed
1.1 Moringa Nutraceutical Products Botanical and nutritional importance of Moringa; Raw material procurement and quality assessment; Preparation of leaf powder, capsules and fortified products; Costing, packaging, branding, marketing and export opportunities				
1.2 Herbal Tea and Wellness Beverages Commercial importance of Tulsi, Lemongrass and Mint; Raw material cultivation and processing; Preparation of herbal tea blends and wellness drinks; Packaging, market analysis, profit estimation and business expansion				
1.3 Plant-Based Health Powders Importance of Beetroot, Ginger and Turmeric products; Drying, grinding and standardization techniques; Preparation of nutraceutical powders and supplements; Costing, quality control, branding and commercialization				
1.4 Millet and Functional Food Products Scope of millet-based industries; Processing and value addition technologies; Preparation of ready-to-use health products; Entrepreneurship opportunities and international markets				
Unit II	Herbal Cosmetics and Personal Care Products	15	10	
2.1 Aloe Vera Cosmetic Products Botanical source and active constituents; Extraction and processing techniques; Preparation of gels, creams and moisturizers; Packaging, licensing, marketing and profit analysis				
2.2 Herbal Hair Care Products				

Commercial importance of Shikakai, Hibiscus and Amla; Raw material sourcing and processing; Preparation of herbal shampoo and hair oil; Costing, branding and business development 2.3 Herbal Skin Care Products Uses of Sandalwood, Rose and Multani Mitti; Formulation of face packs and beauty products; Quality control and shelf-life management; Packaging and commercialization strategies 2.4 Herbal Soap and Natural Cleanser Industry Role of Neem, Reetha and Citrus products; Manufacturing process of herbal soaps and cleaners; Product standardization and quality assurance; Marketing, e-commerce and export opportunities				
Unit III	Agro and Industrial Products	15	10	
3.1 Biofertilizer Production Technology Importance of organic farming inputs; Preparation of Vermicompost, Jeevamrut and organic formulations; Quality standards and certification; Cost-benefit analysis and enterprise development; 3.2 Biopesticide Production Technology Commercial importance of Neem and Karanj products; Extraction and formulation methods; Product efficacy testing and quality control; Market demand and business opportunities 3.3 Natural Dye Industry Dye-yielding plants such as Indigo, Turmeric, Marigold and Henna; Extraction and application technologies; Textile and handicraft applications; Branding and export potential 3.4 Essential Oils and Aromatic Products Commercial aromatic plants and their products; Extraction and processing technologies; Product diversification and value addition; Domestic and international marketing opportunities				
Unit IV	Green Packaging and Plant-Based Entrepreneurship	15	10	
4.1 Bamboo-Based Product Technology Resource availability and sustainability; Processing and product manufacturing; Furniture, handicrafts and utility products; Business planning and export opportunities 4.2 Banana Fibre and Natural Fibre Products Fibre extraction and processing; Preparation of eco-friendly products; Costing, packaging and value addition; Market linkage and enterprise development 4.3 Areca Leaf and Biodegradable Packaging Industry Raw material sourcing and processing; Manufacturing of plates, bowls and packaging materials; Quality control and certification; Profit estimation and commercialization 4.4 Entrepreneurship and Business Expansion Business model preparation for plant products; Licensing, MSME registration and financial planning; Digital marketing, branding and e-commerce; National and international business expansion strategies				
Experiments: Perform at least Four Experiments on Each Unit, preferably one on each subpoint: Unit I: Nutraceutical and Functional Food Products 1. Preparation of Moringa Leaf Powder. 2. Preparation of Moringa Nutraceutical Capsules. 3. Preparation of Tulsi-Lemongrass Herbal Tea Blend. 4. Preparation of Mint-Based Wellness Beverage Mix. 5. Preparation of Beetroot Health Powder. 6. Preparation of Ginger and Turmeric Nutraceutical Powder. 7. Preparation of Millet-Based Nutritional Supplement Mix.				

8. Packaging, Labeling and Cost Analysis of Nutraceutical Products.

Unit II: Herbal Cosmetics and Personal Care Products

1. Preparation of Aloe Vera Gel.
2. Preparation of Herbal Moisturizing Cream.
3. Preparation of Herbal Shampoo using Shikakai and Amla.
4. Preparation of Herbal Hair Oil using Hibiscus and Amla.
5. Preparation of Herbal Face Pack using Rose and Multani Mitti.
6. Preparation of Herbal Soap using Neem Extract.
7. Preparation of Natural Cleaner using Reetha and Citrus Peel.
8. Packaging, Labeling and Shelf-Life Evaluation of Herbal Cosmetic Products.

Unit III: Agro and Industrial Products

1. Preparation of Vermicompost from Organic Waste.
2. Preparation of Jeevamrut Biofertilizer.
3. Preparation of Neem-Based Biopesticide.
4. Preparation of Karanj Seed Extract Biopesticide.
5. Extraction of Natural Dye from Turmeric.
6. Extraction of Natural Dye from Marigold or Henna.
7. Extraction of Essential Oil from Aromatic Plants.
8. Preparation of Herbal Mosquito Repellent using Essential Oils.

Unit IV: Green Packaging and Plant-Based Entrepreneurship

1. Preparation of Bamboo-Based Utility Product.
2. Extraction of Banana Fibre.
3. Preparation of Banana Fibre Eco-Friendly Product.
4. Preparation of Areca Leaf Plates or Bowls.
5. Preparation of Biodegradable Packaging Material from Plant Residues.
6. Design and Development of Eco-Friendly Product Packaging.
7. Preparation of Business Model Canvas for a Plant-Based Product.
8. Preparation of Digital Marketing and E-Commerce Plan for Plant-Based Products.

Activities (Perform any Two):

1. Preparation and Exhibition of Eco-Friendly Plant Products

Development, display, and demonstration of nutraceuticals, herbal cosmetics, biofertilizers, natural dyes, and biodegradable products.

2. Industrial Visit to Herbal, Food Processing, or Eco-Friendly Product Manufacturing Unit

Study of raw material procurement, production processes, packaging, quality control, and marketing practices.

3. Market Survey and Consumer Preference Analysis

Collection and analysis of data on demand, pricing, branding, packaging, and customer preferences for plant-based products.

4. Entrepreneurship and Business Plan Development

Preparation of a business proposal including product selection, costing, profit estimation, branding, licensing, and marketing strategy.

5. Product Packaging, Branding and Digital Marketing Workshop

Designing product labels, eco-friendly packaging, promotional materials, and social media/e-commerce marketing strategies.

References: (APA Style)

1. **Digital Resources**

A. Ministry of AYUSH, Government of India. (2024). Guidelines for manufacturing of herbal cosmetics and natural products. https://ayush.gov.in B. National Medicinal Plants Board. (2023). Cultivation and value addition of medicinal & aromatic plants. https://www.nmpb.nic.in C. Khadi and Village Industries Commission. (2023). Project profiles for eco-friendly plant-based industries. https://www.kvic.gov.in D. Food Safety and Standards Authority of India. (2022). FSSAI manual for herbal food products and nutraceuticals. https://www.fssai.gov.in 2. Reference Book A. Pandey, A. (2021). Herbal technology: Concepts and applications. Scientific Publishers. A. Tiwari, S. (2020). Natural products: Chemistry and applications. CRC Press. B. Sharma, P. P. (2019). Cosmetics: Formulation, manufacturing and quality control (5th ed.). Vandana Publications. 3. Text Books A. Jain, S. K., & Jain, V. (2023). A textbook of eco-friendly plant products. Rastogi Publications. B. Kumar, N. (2022). Green chemistry and plant-based products (2nd ed.). New Age International. C. Dutta, A. C. (2021). Botany for degree students: Applied Botany (Rev. ed.). Oxford University Press. D. Agarwal, O. P. (2020). Natural dyes and their applications. Kalyani Publishers.
Pedagogical Strategies: (Suggestive At least 5 concerning to the Units and Points included in each unit) 1. Demonstration Method Teacher demonstration of extraction techniques, packaging methods and quality control procedures. 2. Project-Based Learning Mini-projects on eco-friendly products, herbal industries, branding, labeling and entrepreneurship models. 3. Problem-Solving and Inquiry-Based Learning Identification of environmental issues and development of plant-based sustainable alternatives. 4. Discussion and Seminar Method Student seminars, group discussions and presentations on sustainable development and herbal entrepreneurship. 5. Skill-Oriented Training Training in preparation, preservation, packaging, labeling and marketing of herbal products. 6. Community Engagement and Extension Activities Awareness programs, exhibitions and workshops on eco-friendly products and organic practices.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI INTERNAL PRACTICAL EXAMINATION B.Sc. III (Botany), SEMESTER – V (NEP)			
Lab/ Practical	Course Code: 107246	Course Name: Eco-friendly Plant Products	Max Marks: 50 Time: 4 Hours
S. No.	Assessment Criteria		Marks
1	Preparation of Any One Eco-friendly Plant Product (Nutraceutical / Cosmetic / Biofertilizer / Biopesticide / Natural Dye / Packaging Product)		10
2.	Packaging, Labeling, Branding and Cost Estimation of the Prepared Product		05
3.	Demonstration of Any One Activity from the Prescribed Activity List		05
4.	Comment on Any Two Eco-friendly Plant Products / Raw Materials / Commercial Samples		05
5.	Record Book / Product Development Journal		05
6.	Field Visit / Industrial Visit / MoU Activity Report		05
8.	Attendance and Overall Performance Throughout the Semester		10
9.	Internal Viva-Voce		05
	Total		50

Skill Enhancement Courses

Course Type	Semester	Course Code	Course Title	Credits	Workload	Exam Duration	Maximum Marks
SEC-P1	V	107247	Skilling Botanists for Nursery and Garden Management (From session 2027-2028 onwards)	2	4	4.00 Hrs	25 (Ext.) 25 (Int)

Course Objectives: • To provide students with a comprehensive understanding of nursery and garden management. • To develop practical skills in plant propagation, nursery establishment, and garden maintenance. • To prepare students for careers in horticulture, landscaping, and related fields				
Course Outcomes: CO 1: Understand basics of nursery and garden management. CO 2: Apply sexual and asexual propagation techniques. CO 3: Analyze factors affecting propagation and manage nursery records. CO 4: Select nursery site and use digital tools for layout planning. CO 5: Identify and plan nursery infrastructure. CO 6: Perform soil preparation, irrigation, pruning, and weeding. CO 7: Practice organic gardening and integrated pest management. CO 8: Maintain biodiversity, hygiene, and systematic record-keeping.				
Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Introduction to Nursery and Garden Management	15	13	Suitable pedagogical strategies are separately annexed
1.1 Overview of nursery and garden management 1.2 Role of nurseries in garden management 1.3 Nurseries: horticultural, forestry and ornamental, etc. 1.4 Basic concepts of garden design and layout				
Unit II	Plant Propagation Techniques	15	13	
2.1 Sexual propagation: Seed collection, storage, and germination. 2.2 Asexual propagation: Cutting, grafting, budding, layering, and tissue culture. 2.3 Factors Affecting Propagation Success. 2.4 Basic costing, marketing of saplings, nursery record-keeping.				
Unit III	Nursery Establishment and Management	15	12	
3.1 Site selection and preparation. Technology Tools: Mobile apps like Google SketchUp or Canva for garden design, sensors and automation kits 3.2 Infrastructure requirements (greenhouses, shade houses, irrigation systems) 3.3 Soil and media preparation, Soil preparation and fertilization, Irrigation and water management, Efficient irrigation techniques, Pruning, weeding 3.4 Nursery hygiene and pest management.				
Unit IV	Sustainable Practices in Nursery and Garden Management	15	12	

4.1 Organic gardening practices, Composting and Organic Fertilizers, Natural Pest 4.2 Use of renewable resources and recycling, Integrated Pest Management (IPM) 4.3 Role of biodiversity in garden ecosystems 4.4 Maintain proper hygiene and record-keeping in nursery operations.	
Practical: Conduct at least three Exercises from Each Unit of the following: Unit I: 1. Design and prepare a nursery layout (Forest / Horticulture/ Ornamental anyone) 2. Study the layout and infrastructure of a well-maintained garden. 3. Survey and Documentation of Local Nurseries 4. Classification and Tagging of Nursery Plants 5. Preparation and Maintenance of Nursery Records 6. Drawing a Basic Garden Layout on Graph Paper 7. Creation of a Miniature Garden Model Unit II: 1. To Collect seeds from local plants and prepare them for sowing. 2. To Sow seeds in seed trays and monitor germination rates. 3. Practice stem cutting, leaf cutting, and root cutting on plants like rose, money plant, and coleus. 4. Perform grafting (e.g., wedge grafting in mango) and budding (e.g., T-budding in roses). Unit III: 1. Site Selection and Layout Planning Using Mobile Apps (Google SketchUp/Canva) 2. Design and Setup of a Model Greenhouse or Shade House 3. Demonstration of Efficient Irrigation Techniques (Drip/Sprinkler Systems) 4. Pruning, Weeding, and Maintenance Practices in Nursery Plants 5. Assessment and Application of Nursery Hygiene and Pest Control Measures 6. Prepare different potting mixes using soil, sand, compost, and cocopeat 7. Preparation of Organic Potting Mix & Bio-Manure 8. Demonstration on Set up a rainwater harvesting system for garden use. UNIT IV: 1. Demonstrate mulching to reduce water evaporation 2. Identify beneficial insects and their role in pest control. 3. Prepare compost using kitchen waste, garden waste, and cow dung 4. Demonstrate vermicomposting using earthworms.	
Conduct at least TWO Activities from the following: Field visits: 1. Visit a commercial nursery or garden to study operations. Other activities – 1. Visit commercial nurseries, organic farms, and public gardens to observe best practices. 2. Visit local horticulture departments or agricultural universities for hands-on training and resources. 3. Prepare a budget for setting up a small nursery or garden Collaboration/ MoU- Conduct suggested activities in Collaboration / MoU with any Nursery / related NGO/ Garden.	
References: Books: 1. Adams, C. R., Bamford, K. M., & Early, M. P. (2008). Principles of horticulture (5th ed.). Routledge. 2. Clarke, G. (2001). The complete book of plant propagation. Lorenz Books. 3. Forest Development Corporation of Maharashtra. (n.d.). Horticulture plant nursery handbook. https://www.fdcn.nic.in/PDF/horticulture%20plant%20nursery.pdf 4. Gupta, S. M. (1968). Plant myths and traditions in India. Munshiram Manoharlal Publishers. 5. Kumar, N. (2014). Introduction to horticulture (2nd ed.). Rajalakshmi Publications.	

6. Kumar, V. (1999). Nursery and planting practices in forestry (2nd ed., pp. 110–158). Scientific Publishers. 7. Lal, D., Nayyer, M. A., Meena, J. K., & Meena, D. C. (2023). Nursery management & horticultural crops. Satish Serial Publishing House. https://www.satishserial.com/book/9789394023864/nursery-management-horticulture-crops 8. Lokare, P., & Keshamma, E. (2021). Plant nursery development & management: An innovative way of self-employment. Pothi Self-Publishing. https://store.pothi.com/book/priya-lokare-plant-nursery-development-management/ 9. Manandhar, N. P. (2002). Plants and people of Nepal. Timber Press. 10. Manjunath, B. T. (2023). Nursery management and gardening (Course document). Scribd. https://www.scribd.com/document/837010832/NURSERY-MANAGEMENT-AND-GARDENING-1 11. Simeone, V. A. (2008). Sustainable gardening: The new organic growing. Creative Homeowner Press. 12. Singh, A. K. (2011). Nursery management: A guide to plant propagation and nursery establishment. Agrotech Publishing Academy. 13. Whitman, A., DeJohn, S., & The National Gardening Association. (2009). Organic gardening for dummies. Wiley Publishing. 14. YCMOU School of Agricultural Sciences. (n.d.). Resource book on horticulture nursery management. Yashwantrao Chavan Maharashtra Open University.	Pedagogies 1. Entrepreneurial Project Development, where students ideate, develop, and present a business plan related to the Nursery and garden. This pedagogy combines market research, product development, and strategic planning. 2. Mentorship Programs with professional experts can provide personalized guidance, enhancing entrepreneurial skills and network building. These methods offer practical insights into business development, encouraging innovation and real-world application of course concepts. 3. Project-Based Learning (PBL): Engages students in real-world nursery industry projects, enhancing their understanding and skills in a practical context. 4. Flipped Classroom: Utilizes online resources for theory, freeing up classroom time for interactive discussions, practical exercises, and guest lectures from industry professionals. 5. Simulation Games and Virtual Labs: Offers hands-on experience in nursery and garden development processes without the need for physical resources. 6. Case Studies and Role Plays: Encourages critical thinking and problem-solving through analysis of real-world challenges in the seed industry. 7. Internships and Industry Visits: Provides firsthand experience and insight into the operational aspects of nursery and Garden management.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. III (Botany), SEMESTER – V (NEP)			
Practical- SEC	Course Code – 107247	Skilling Botanists for Nursery and Garden Management	Max Marks: 50
Q.N.	Exercise		Marks
1	Demonstration of Budding/ Grafting/Cutting (any one)		10
2	Design Nursery / Garden layout as per requirements & area		5
3	Prepare compost using kitchen waste		5
4	Comment on irrigation technique/pruning/ weeding (any two)		5
5	Attendance & overall Performance throughout the semester		10
6	Record Book / Activity book		5
7	Field visit / Activities under MoU or Collaboration- report		5
8	Viva Voce		5
	Total		50

Course Type	Semester	Course Code	Course Title	Credits	Workload	Exam Duration	Maximum Marks
SEC-P2	V	107248	Mushroom Culture Technology & Production (From 2026-27 Onwards)	2	4	4.00 Hrs	25 (Ext.) 25 (Int)

Course Objectives:				
1. To understand the biology, taxonomy, life cycle, and economic importance of edible, medicinal, and poisonous mushrooms. 2. To develop knowledge of commercially important mushroom species and their cultivation in relation to climatic conditions, nutritional value, and market demand. 3. To evaluate the role of mushrooms in sustainable agriculture, waste recycling, and myco-remediation for environmental management. 4. To acquire practical skills in mushroom cultivation techniques, including media preparation, spawn production, substrate preparation, inoculation, incubation, crop management, and harvesting.				
Course Outcomes:				
After Successful completion of the course, the student will be able to –				
CO-1: Understand the fundamental biology, classification, and nutritional importance of various edible and medicinal mushrooms. Focus on the fungal life cycle, the role of fungi in the ecosystem, and the health benefits of mushroom consumption.				
CO-2: Remember the essential terminology, sterilization protocols, and specific environmental requirements for different mushroom species, able to recall the names of common pests, the specific temperatures for incubation (e.g., 25°C), and the components of various growth media like Potato Dextrose Agar (PDA).				
CO-3: Explain the technical procedures involved in spawn production, substrate preparation, and post-harvest management to know the processes, pasteurization is necessary to kill competitors while keeping beneficial microbes alive.				
CO-4: To develop a functional mushroom cultivation unit and formulate a business plan for commercial production, physically prepare bags, inoculate them with spawn, manage the cropping room, and create a marketing strategy for the final product.				
Unit System	Contents	Workload Allotted (Hrs.)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Introduction to Mushroom Science:	15	13	Suitable pedagogical strategies are separately annexed
1.1: Mycology Basics: Definition, history, and general morphology of mushrooms. Classification: Edible, medicinal, and poisonous mushrooms (Toadstools).				
1.2: Nutritional Value: Detailed study of proteins, amino acids, vitamins, and minerals in mushrooms.				
1.3: Medicinal Properties: Antioxidant, anti-tumor, and cholesterol-lowering properties.				
1.4: Layout and Design of a Functional Mushroom Farm				
Unit II	Infrastructure and Laboratory Setup:	15	13	
2.1: Site Selection: Requirements for a commercial mushroom farm. Farm Layout: Design of the cropping room, pasteurization chamber, and incubation area.				
2.2: Instrumentation: Operation of Autoclave, Laminar Air Flow (LAF), Humidity control systems, and pH meters.				

2.3: Aseptic Techniques: Sterilization of glassware, media, and tools. 2.4: Culture Media: Preparation of Potato Dextrose Agar (PDA) and Malt Extract Agar (MEA). Isolation Techniques: Spore print, tissue culture, and sub-culturing. Mother Spawn: Preparation of grain-based spawn (Wheat, Sorghum, or Paddy). Storage: Preservation of cultures and commercial spawn longevity.			
Unit III	Cultivation of Major Species:	15	12
3.1: Oyster Mushroom (<i>Pleurotus</i> spp.): Substrate preparation (straw treatment), bagging, and spawning. Button Mushroom (<i>Agaricus bisporus</i>): 3.2: Composting (Long vs. Short method), Casing (soil layer), and Pinning. Milky Mushroom (<i>Calocybe indica</i>): High-temperature cultivation requirements. 3.3: Paddy Straw Mushroom (<i>Volvariella volvacea</i>): Bed preparation 3.4: Seasonal management.			
Unit IV	Crop Protection and Management:	15	12
4.1: Environmental Factors: Regulating temperature (15°C–30°C), humidity (80%–90%), and CO₂ levels. Pest Control: Management of Sciurid flies, Phorid flies, and mites. 4.2: Disease Control: Recognition of Green Mold, Cobweb, and Brown Plaster mold. Weed Fungi: Identification and prevention. 4.3: Post-Harvest and Entrepreneurship: Harvesting: Proper stage and method for picking. Preservation: Cold storage, drying (sun vs. mechanical), and canning. 4.4: Value Addition: Processing into pickles, soup powder, and biscuits. Business Skills: Market survey, Project Report (DPR) preparation, and government subsidies (e.g., NABARD).			
Experiments: Perform At least Four Experiments on Each Unit: Unit I: 1. Identification of Edible and Poisonous Mushrooms 2. Sterilization Techniques and Glassware Preparation. 3. Preparation of Grain Spawn (Mother Spawn) 4. Substrate Treatment (Chemical & Hot Water) 5. Layout and Design of a Functional Mushroom Farm Unit II: 6. Operation and maintenance of Autoclave. 7. Composting and Casing for Button Mushroom 8. Chemical treatment of wheat straw using Formalin and Bavistin. 9. Preparation and Sterilization of Culture Media 10. Substrate Sterilization: Chemical vs. Thermal Methods Unit III: 11. Casing Technique for Button Mushrooms 12. Preservation and Storage methods 13. Composting and Casing for Button Mushroom 14. Chemical treatment of wheat straw using Formalin and Bavistin. 15. Bed Preparation for Paddy Straw Mushroom Unit IV: 16. Harvesting, Grading, and Packaging 17. Monitoring Environmental Parameters and Pest Control 18. Identification and Handling of Laboratory Equipment. 19. Market survey plans and NABARD schemes. 20. Hands-on practice of "Layer Spawning" in polythene bags. Activities (At Least Five to Perform any Two): 1. Prepare a list of Mushroom suppliers, demand and supply. 2. Visit commercial outlets and stalls and arrange stalls for sale.			

- Visit local farmers plot or agricultural universities for hands-on training and resources. - Prepare a budget for Mushroom farm and equipment's. - Make a Collaboration/ MoU-
Pedagogical Strategies: Experiential Learning: Pre-Lab Videos: Students watch videos on how to operate an autoclave and maintain a Laminar Air Flow (LAF) bench before entering the clean room. The "Adoption" Model: Each student or pair is assigned 5–10 bags. They are responsible for the substrate treatment, spawning, and daily monitoring of those specific bags. Students maintain a "Mushroom Diary," recording CO₂ levels, humidity, and temperature. This teaches them to correlate environmental data with biological growth. Inquiry-Based Learning (Research Component) Diagnostic Pedagogy: Intentionally introduce (in a controlled container) common contaminants like <i>Trichoderma</i> (Green Mold). Students must identify it under a microscope and suggest a management strategy. Entrepreneurial Pedagogy (Business Simulation) Students must create a brand name, design packaging, and draft a marketing plan for their harvest. They calculate the "Break-even Point." For instance, if spawn costs 150/kg and straw 10/kg, at what selling price does the unit become profitable? Teaching students to process a "perishable" into a "durable" (e.g., turning fresh Oyster mushrooms into sun-dried powder or pickles). Social & Extension Pedagogy: Students visit local villages or Self-Help Groups (SHGs) to demonstrate low-cost mushroom bed preparation. Teaching others reinforces their own learning. Pedagogy should emphasize the "Zero Waste" model converting agricultural residue into protein, and then converting the Spent Mushroom Substrate (SMS) into organic manure References: - Chang, S. T., & Miles, P. G. (2004). <i>Mushrooms: Cultivation, nutritional value, medicinal effect, and environmental impact</i> (2nd ed.). - Marshall, E., & Nair, N. G. (2009). <i>Make money by growing mushrooms</i>. Food and Agriculture Organization of the United Nations (FAO). - Pandey, A., Sanromán, M. A., Du, G., Soccol, C. R., & Dussap, J. P. (Eds.). (2018). <i>Current developments in biotechnology and bioengineering: Food and beverages industry</i>. Elsevier. - Renato Gutierrez Reyes, Sofronio Perez Kalaw, Dana Gutierrez Vera Cruz, Kanya Tokunaga. (2018) A PRACTICAL GUIDE TO MUSHROOM PHARMING, Published by: SEAMEO BIOTROP Southeast Asian Regional Centre for Tropical - Stamets, P., & Chilton, J. S. (1983). <i>The mushroom cultivator: A practical guide to growing mushrooms at home</i>. Agarikon Press. - Ahlawat, O. P., Kumar, S., Arumuganathan, T., & Tewari, R. P. (2008). <i>25 Years of AICRP (Mushroom)</i>. National Research Centre for Mushroom (ICAR). http://dmrsolan.res.in/25_Years_of_Mushroom_AICRIP_.pdf - Besufekad, Y., et al. (2020). Selection of appropriate substrate for production of oyster mushroom (<i>Pleurotus ostreatus</i>). <i>Journal of Yeast and Fungal Research</i>, 11(1), 15–25. https://doi.org/10.5897/jyfr2019.0187 - Hanko, J. (2001). <i>Mushroom cultivation for people with disabilities: a training manual</i>. Food and Agriculture Organization of the United Nations. https://openknowledge.fao.org/handle/20.500.14283/ab497e - Sangeeta, Sharma, D., Ramniwas, S., Mugabi, R., Uddin, J., & Nayik, G. A. (2024). Revolutionizing Mushroom processing: Innovative techniques and technologies. <i>Food Chemistry: X</i>, 23, 101774. https://doi.org/10.1016/j.fochx.2024.101774 - Stamets, P., & Chilton, J. S. (1983). <i>The mushroom cultivator: A practical guide to growing mushrooms at home</i>. Agarikon Press.

Educational Software & Interactive Tools: Mycology (Free/Open Source),Velosio Silver Leaf, AI Mycology Workshops (NTHRYS), ICAR - Directorate of Mushroom Research (DMR): Links: Academic: DMR Training Calendar, Jagat Guru Nanak Dev Punjab State Open University (PSOU): Link: PSOU Mushroom Cultivation Course, Udemy: Link: Udemy Mushroom Cultivation Search Books: 1. Food and Agriculture Organization of the United Nations. (n.d.). Mushroom cultivation training manual. FAO Knowledge Repository. Retrieved May 31, 2026, from https://www.fao.org 2. National Center for Appropriate Technology. (n.d.). Mushroom cultivation guide. ATTRA Sustainable Agriculture Program. Retrieved May 31, 2026, from https://attra.ncat.org 3. Lynch, T. (2018). Mushroom cultivation: An illustrated guide to growing your own mushrooms. Quarry Books. 4. Stamets, P., & Chilton, J. S. (1983). The mushroom cultivator: A practical guide to growing mushrooms at home. Agarikon Press.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. III (Botany) SEMESTER – V (NEP)				
Lab/ Practical- SEC	Course Code: 107248	Mushroom Culture Technology & Production	Max Marks: 50	Time: 4 Hrs.
Q.No	Exercise			Marks
1.	Perform Any One Experiment on Unit No I			05
2.	Perform Any One Experiment on Unit No II			05
3.	Perform Any One Experiment on Unit No III			05
4.	Perform Any One Experiment on Unit No IV			05
5.	Comment on media and equipment. (any two).			05
6.	Attendance & overall Performance throughout the semester.			10
7.	Record Book / Activity book			05
8.	Field visit / Activities under MoU or Collaboration- report.			05
9.	External Viva Voce			05
	Total			50

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam. Duration	Max Marks
5.5	V	107249	Biofertilizer Technology (From 2026-27 Onwards)	2	60	4 Hrs	50 Marks
Course Objectives: 1. To illustrate the basic concepts and importance of biofertilizers. 2. To Learn different types of biofertilizers used in agriculture. 3. To deliver fundamental knowledge about soil microorganisms, biofertilizer production, and methods of application. 4. To present perspectives on the current tools, techniques, and modern approaches used in biofertilizer application and research. 5. To demonstrate the concepts of biofertilizer technology through laboratory activities, field practices, and awareness programs for capacity building.							
Course Outcomes: After Successful completion of the course, the student will be able to – CO-1: Understand the basic concepts, importance, and types of bio-fertilizers used in agriculture. CO-2: Remember the role of beneficial microorganisms in soil fertility and plant growth promotion. CO-3: Explain the methods of production, application, and quality control of bio-fertilizers. CO-4: Develop self-employment opportunities in biofertilizer technology.							
Unit System	Contents			Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies	
Unit I	Introduction to Biofertilizers			15	12	Suitable pedagogical strategies are separately annexed	
1.1: Definition, history, and scope of biofertilizers in agriculture. 1.2: Classification: Bacterial, fungal, and algal biofertilizers. 1.3: Principle and working, applications of Autoclave. 1.4: Principle and working, applications of laminar air flow.							
Unit II	Nitrogen Fixing Biofertilizers			15	12		
2.1 Sterilization technique and any one media preparation. 2.2 Rhizobium: Isolation, identification, classification, and mass multiplication. 2.3 <i>Azotobacter</i> : Characteristics, isolation, and benefits. 2.4 <i>Azolla</i> (BGA): Morphology and role as a biofertilizer.							
Unit III	Phosphate & Potash Solubilizers			15	13		
3.1 Mycorrhizal association: Endo-Mycorrhizae (VAM/AM fungi) and significance. 3.2 Mycorrhizal Inoculum Production and Inoculation Methods 3.3 Phosphate solubilizing Microorganisms. (PSM) 3.4.Benefits of VAM and PSB.							
Unit IV	Mass production and quality control			15	13		
4.1 Methods of isolation, purification and mass multiplication of microbes. 4.2 Carrier-based inoculants- (Peat, Lignite, Charcoal) and liquid formulations. 4.3 Methods of Application- Seed treatment, soil application, root dip method, foliar spray. 4.4 Benefits and Limitations of biofertilizers- soil fertility and Yield improvement, short shelf-life, storage problems, environmental sensitivity.							
Experiments: At least THREE Experiments on Each Unit: Unit I: 1 Survey and Market Mapping of Local Biofertilizers. 2 Morphological Identification of Microbial Groups.							

- 3 Demonstration of sterilization methods- sterilization of glassware.
- 4 Study and Preparation of any one Culture Media
- 5 Study and Comment on Laboratory Equipment Used in Biofertilizer Production.
- 6 Collection of soil samples from different crop fields.

Unit II:

- 1 Collection of leguminous plant roots.
- 2 Isolation and identification of Rhizobium from root nodules of leguminous plants (e.g., moong, soyabean).
- 3 Simple Carrier-Based Mass Multiplication.
- 4 Isolation of Free living Azotobacter from rhizospheric soil samples.
- 5 Observation of *Azotobacter* and *Azospirillum* using microscope.
- 6 Microscopic Study and Identification of blue-green algae (*Nostoc*, *Anabaena*) from water logged field or moist soil surface.

Unit III:

- 1.To Demonstrate phosphate solubilization by simple liquid tube method.
2. Collection and staining of roots for mycorrhizal association.
3. Screening Fungal PSM using a Simple Agar Plate Assay
4. Preparation of carrier-based biofertilizer using locally available materials.
5. Preparation of simple liquid biofertilizer formulation.
6. Observation of microbial growth by turbidity method.

Unit IV:

- 1.Study of Seed Inoculation Technique Using Biofertilizer Culture
- 2.To Study the storage conditions and shelf-life of biofertilizers.
3. Design a mock business plan for establishing a small-scale biofertilizer production unit.
5. Preparation of Carrier-Based Biofertilizer Inoculant.
6. Sterilization Techniques for Carrier Materials.

Activities (Perform any Two):

1. Field Survey and Awareness Campaign- Interview 5 local farmers, nursery owners using a simple questionnaire. Ask about their awareness of biofertilizers, types used, costs, and any issues they face.
2. Soil Health Diagnostic and Field Sampling Activity.
3. Industrial Visit to a Biofertilizer Manufacturing Unit.
4. Market Inventory & Agri-Retail Survey. (Local agricultural input retail stores (Krishi Seva Kendras). Document available biofertilizer brands, microbial strains, pricing, shelf life, and sales volume compared to chemical inputs.).
5. Group Discussion: "Chemical Fertilizers vs. Biofertilizers"
6. Classroom Biofertilizer Quiz Competition.
7. Organise Chart and Poster Making Exhibition on the topics include the Rhizobium, nitrogen-fixation cycle, the mechanism of phosphate solubilization, or the morphology of Azolla etc.
8. Organic Farming Awareness Rally.
9. To organise logo and Product Label Design Challenge competition.
10. Farmer Awareness Campaign & Village Outreach activity.
11. Mock business plan of the biofertilizer unit.

References: (APA Style)

1. Dubey, R. C. (2005). *A textbook of biotechnology*. S. Chand Publishing.
2. Subba Rao, N. S. (2017). *Biofertilizers in agriculture and forestry* (4th ed.). Medtech Publishers.
3. Alexander, M. (1977). *Introduction to soil microbiology* (2nd ed.). John Wiley & Sons.
4. Kannaiyan, S. (Ed.). (2002). *Biofertilizers biotechnology*. Scientific Publishers.
5. Rangaswami, G., & Bagyaraj, D. J. (2004). *Agricultural microbiology*. PHI Learning Pvt. Ltd.
6. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (1993). *Microbiology: Concepts and applications*. McGraw-Hill.
7. Sylvia, D. M., Fuhrmann, J. J., Hartel, P. G., & Zuberer, D. A. (2005). *Principles and applications of soil microbiology* (2nd ed.). Pearson.Education.
8. Manufacture of Biofertilizer and Organic Farming. by -Dr. Himadri Panda.

9. Vessey, J. K. (2003). Plant growth promoting rhizobacteria as biofertilizers. <i>Plant and Soil</i> , 255(2), 571–586.
10. Bhattacharyya, P. N., & Jha, D. K. (2012). Plant growth-promoting rhizobacteria (PGPR): Emergence in agriculture. <i>World Journal of Microbiology and Biotechnology</i> , 28(4), 1327–1350.
Pedagogical Strategies: (Suggestive: At least 5 concerning to the Units and Points included in each unit) 1. Laboratory-Based Learning: Students perform isolation, culture, and identification of beneficial microorganisms to develop practical skills in biofertilizer technology. 2. Project-Based Learning (PBL): Students undertake small projects related to biofertilizer preparation, soil fertility improvement, and sustainable agriculture practices. 3. Demonstration Method: Teachers demonstrate preparation, application, and quality testing of biofertilizers for better conceptual understanding. 4. Field Visits and Industry Interaction: Visits to agricultural farms, compost units, biofertilizer production centers, and organic farming fields to understand real-life applications. 5. Case Studies and Group Discussions: Analysis of successful biofertilizer use in crop production and discussions on challenges in sustainable agriculture. 6. Flipped Classroom Approach: Students study theoretical concepts through digital resources and classroom time is used for practical discussions and activities. 7. Simulation and Model-Based Learning: Use of charts, models, videos, and virtual demonstrations to explain microbial processes and biofertilizer production methods. 8. Internship and Community Awareness Programs: Students participate in farmer awareness activities, seed treatment demonstrations, and extension programs related to biofertilizers.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. III (Botany) SEMESTER – V (NEP)				
Lab/ Practical-	Course Code: 107249	Bio-fertilizer Technology	Max Marks: 50	Time: 4 Hrs.
Q.No	Exercise	Marks		
1.	Demonstrate the isolation technique of any one biofertilizer organism from the given list (<i>Rhizobium</i> , <i>Azotobacter</i> , Blue Green Algae (Cyanobacteria), PSB, Mycorrhiza.)	10		
2.	Design a mock business plan for establishing a small-scale biofertilizer production unit.	05		
3.	Application of Biofertilizer Inoculation (Any One)	05		
4.	Comment on media and equipment. (Any Two).	05		
5.	Attendance & overall Performance throughout the semester.	10		
6.	Record Book / Activity book	05		
7.	Field visit / Activities under MoU or Collaboration- report.	05		
8.	External Viva Voce	05		
	Total	50		

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam. Duration	Max Marks
5.5	V	107250	Herbs and Herbal Products (From 2026-27 Onwards)	2	60	4 Hrs	50 Marks

Course Objectives: 1. To equip students with strong fundamentals in subject domain knowledge. 2. Students can explore the cutting-edge technologies and skills currently used in Herbal science and technology. 3. To spread awareness of social, environmental issues and significance of subject for natural societal benefit. 4. To create interest and awareness about natural herbal products so that students can save natural resources.				
Course Learning Outcomes: Upon successful completion of the course, students will be able to: CO 1: Demonstrate proficiency in a range of modern analytical techniques used in the evaluation of natural products and herbal formulations. CO 2: Understand and apply the fundamental principles of pharmacognosy in the identification and authentication of medicinal plants. CO 3: Analyze the quality, purity, and safety of herbal drugs using standard protocols and instrumentation. CO 4: Develop a strong foundation in herbal drug technology, including formulation, standardization, and quality control of herbal medicines.				
Unit System	Content	Workload in Hrs	Weightage of Marks Allotted	Pedagogies
Unit- I	Introduction to Herbal Sciences	15	13	Suitable pedagogical strategies are separately annexed
1.1 Historical Background, Present Status, and Scope of Herbal Science 1.2 Medicinal Botany and Folklore Medicine 1.3 Introduction, History and Basic Doctrine of Ayurveda 1.4 Future scope and integration of traditional medicine with modern medicine				
Unit- II	Phytochemistry and Pharmacognosy	15	13	
2.1 History, Scope, and Importance of Phytochemistry 2.2 Classification and General uses of Phytochemicals 2.3 Phytochemical extract methods; Solvent extraction method; Factors to be considered while solvent extraction. 2.4 Common methods of extraction of medicinal plants; Maceration, Infusion, Digestion, Decoction; Percolation, Soxhlet extraction				
Unit- III	Introduction to Herbal Drug	15	12	
3.1 Herbal drug- Definition, Herbalism 3.2 Importance of herbal drugs and herbal therapies 3.3 Herbal versus conventional drugs 3.4 Safety and Toxicity of herbal drugs				
Unit- IV	Medicinal plants and Drug evaluation	15	12	
4.1 Status of medicinal plants in the world and India 4.2 Morphological, Organoleptic, and Microscopic Evaluation of <i>Phyllanthus niruri</i> & <i>Withania somnifera</i> 4.3 Causes and types of drug adulteration				

4.4 Adulteration and substitution in some common drug powders- Haridra (<i>Curcuma longa</i>) & Salai (<i>Boswellia serrata</i>)	
Practicals : (Any 03) 1. Macroscopic and Microscopic Examination of Crude Drugs • Identification of whole drugs based on: ◦ Shape, size, color, odor, and texture ◦ Examples: <i>Zingiber officinale</i> (Ginger), <i>Curcuma longa</i> (Turmeric), • Preparation of transverse and longitudinal sections • Study of diagnostic characters (trichomes, stomata, oil glands, vessels) 2. Taxonomic Identification of Medicinal Plants • Field collection and herbarium preparation • Morphological identification using taxonomic keys • Use of flora manuals (e.g., <i>The Flora of Maharashtra</i>) • Documentation of local medicinal plants and folklore uses 3. Extraction and Preparation Techniques • Aqueous and organic solvent extraction (maceration, percolation, Soxhlet) • Preparation of: ◦ Herbal decoctions (Kashayam) ◦ Powders (Churna) ◦ Oils (Tailam) 4. Preliminary Phytochemical Screening • Qualitative tests for: ◦ Alkaloids (Mayer's test) ◦ Flavonoids (Shinoda test) ◦ Saponins (Foam test) ◦ Tannins (Ferric chloride test) ◦ Glycosides, Terpenoids, Steroids 5. Adulteration Detection in Herbal Drugs • Organoleptic and microscopic examination for adulterants • Microscopy of powdered drugs (foreign matter, starch, stone, synthetic materials) • Ash value, extractive value, moisture content 6. Preparation of Herbarium and Monographs • Collection of 15–20 local medicinal plants • Preparation of herbarium sheets with field notes • Writing plant monographs: botanical name, family, local name, part used, medicinal use, phytoconstituents 7. Standardization and Quality Control • Determination of: ◦ Total ash, acid-insoluble ash ◦ Water/alcohol soluble extractive value ◦ pH and refractive index of herbal formulations • Testing as per Ayurvedic Pharmacopoeia of India (API)	
Activities (Any two) 1. Prepare Herbarium specimen of any five medicinal plants from your area. 2. Visit Any Ayurvedic firm/ Pharma company 3. Interview any Vaidoo/ traditional herbal healer and make a report on how they administer the plant derived herbal drugs. 4. Chemo-profiling of any locally available herbal drug.	
References: 1. Gupta, R., Keshri, G., & Singh, S. (2022). <i>Pharmacognostic, phytochemical and antimicrobial investigations of Withania somnifera (L.) Dunal roots</i>. Pharmacognosy Journal, 14(1), 120–125. 2. Kaushik, D., & Goyal, P. (2011). <i>Herbal drug adulteration: a burning issue</i>. International Journal of Pharmaceutical Research and Development, 3(5), 1–6. 3. Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2019). <i>Pharmacognosy</i> (50th ed.). Pune: Nirali Prakashan. 4. Kumar, V., & Kaushik, P. (2021). <i>Adulteration and substitution in Ayurvedic herbs: Strategies for detection and control</i>. Asian Journal of Pharmaceutical and Clinical Research, 14(3), 30–37. 5. Kumari, A., & Rajasekaran, A. (2022). <i>Adulteration in herbal drugs: a major threat to</i>	

<i>consumer safety</i>. Journal of Applied Pharmaceutical Science, 12(6), 120–126. 6. Ministry of AYUSH, Government of India (2016). <i>National Policy on Indian Systems of Medicine and Homoeopathy</i>. 7. Mishra, P., et al. (2008). <i>DNA barcoding: an efficient tool for authentication of medicinal plants</i>. Phytochemistry Reviews, 7(3), 371–383. 8. Patwardhan, B., Warude, D., Pushpangadan, P., & Bhatt, N. (2005). <i>Ayurveda and traditional Chinese medicine: A comparative overview</i>. Evidence-Based Complementary and Alternative Medicine, 2(4), 465–473. 9. Rastogi, S., & Pandey, M.M. (2015). <i>Indian traditional medicine: scientific validation and quality control</i>. Pharmacognosy Reviews, 9(17), 87–95. 10. Sharma, A., & Chandrul, K.K. (2011). Pharmacognostic and phytochemical evaluation of <i>Tinospora cordifolia</i>. International Journal of Pharmaceutical Sciences Review and Research, 7(2), 41–44. 11. Sharma, P. V. (1996). <i>History of Medicine in India</i>. Indian National Science Academy. 12. Tiwari, P. (2011). <i>Ayurvedic Herbs: A Clinical Guide to the Healing Plants of Traditional Indian Medicine</i>. Haworth Press. 13. Trease, G. E., & Evans, W.C. (2009). <i>Pharmacognosy</i> (16th ed.). Saunders Elsevier. 14. Varier, P. V. (1994). <i>Indian Medicinal Plants – A Compendium of 500 Species</i> (Vol. 1–5). Orient Longman. 15. World Health Organization (2021). <i>WHO Global Report on Traditional and Complementary Medicine 2021</i>. 16. World Health Organization (WHO) (2002). <i>Traditional Medicine Strategy 2002–2005</i>.
Pedagogies: • Project-Based Learning (PBL): Engages students in real-world nursery industry projects, enhancing their understanding and skills in a practical context. • Flipped Classroom: Utilizes online resources for theory, freeing up classroom time for interactive discussions, practical exercises, and guest lectures from industry professionals. • Entrepreneurial Project Development: where students ideate, develop, and present a business plan related to the Nursery and garden. This pedagogy combines market research, product development, and strategic planning. • Industry Visits: Provides firsthand experience and insight into the operational aspects of medicinal herbs and herbal drugs.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. III (Botany) SEMESTER – V (NEP)				
Lab/ Practical-	Course Code: 107250	Herbs and Herbal Products	Max Marks: 50	Time: 4 Hrs.
Q.No	Exercise			Marks
1.	Macroscopic and Microscopic Examination of Crude Drugs (Any two)			10
2.	Preliminary Phytochemical Screening			05
3.	Identification of given Medicinal plant			05
4.	Detect adulteration in given crude drug			05
5.	Attendance & overall Performance throughout the semester.			10
6.	Record Book / Activity book			05
7.	Field visit / Activities under MoU or Collaboration- report.			05
8.	External Viva Voce			05
	Total			50

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.0	V	107251	Field Project / Community Engagement Program	2	60	--	50

Course Objectives:

1. To develop an appreciation of biodiversity, indigenous plant knowledge, and sustainable ecological practices among students.
2. To expose students to the interdependence between rural communities and plant resources.
3. To study local environmental challenges and identify plant-based, community-driven solutions.
4. To enable students to apply theoretical Botany concepts in real-life settings, enhancing the quality of experiential learning.

Course Outcomes:

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

- CO 1: Understand the ecological, medicinal, and agricultural importance of native plants in rural areas.
- CO 2: Build connections with local communities and learn from traditional ecological knowledge.
- CO 3: Identify and assess plant-related challenges (e.g., deforestation, crop failure, invasive species, etc.) and suggest sustainable interventions.
- CO 4: Appreciate the role of community participation in biodiversity conservation and environmental stewardship.
- CO 5: Document and disseminate knowledge regarding plant resources and their potential applications.

Guidelines/ SoP for FP/CEP

For understanding key principles of CE, forms of CE, operational guidelines and implementation strategy please refer https://www.ugc.gov.in/pdfnews/4187860_Revised-Final-Guidelines.pdf

As per NEP 2020, students of B Sc. III of Semester V need to perform a Field Project (FP) / Community Engagement Program for TWO (2) credits i.e. 50 Marks.

The guidelines regarding the field project are as follows:

1. Students must complete 60 hours of field engagement.
2. Work may be done individually or in groups of up to 4 students, each under a departmental faculty guide.
3. A survey or sample collection methodology must be chosen, with appropriate documentation tools: questionnaires, datasheets, plant specimen formats, etc.
4. Projects can be survey-based, experimental, observational, or intervention-based.
5. **Final report to include:** Title, Introduction, Materials & Methods, Results, Discussion, Conclusion, References.
6. Minimum 6 pages excluding cover page, certificate, acknowledgement, etc.
7. Poster/PPT presentation is mandatory and will be evaluated by an appointed examiner.
8. For a SURVEY based project-related questionnaire (15 or more questions) shall be prepared.
9. The departmental coordinator/guide shall check the questions and finalize the questionnaire. The question that may create unnecessary complications should be avoided. The questions should be qualitative as well as quantitative.

10. If the project is related to work that does not involve survey work, then the questionnaire part can be replaced accordingly (e.g. Sample collection/Data collection/Experimental base etc).
11. The total project work including preparation of questionnaire to presentation should be evaluated for 2 credits (50 Marks).

SUGGESTED FORMS OF COMMUNITY-ENGAGED PRACTICE IN BOTANY

Linking Botany with Community Service

- Create village herbariums with help from locals to preserve indigenous flora.
- Assist farmers in understanding plant disease identification and natural remedies.
- Educate school children on photosynthesis and plant care via live demonstrations.

Community-Based Plant Research

- Conduct field surveys on medicinal plants or invasive species in local ecosystems.
- Document ethnobotanical knowledge from tribal and rural elders.
- Study agroforestry systems and suggest botanical improvements.

Awareness & Knowledge Sharing

- Organize workshops on home gardening, composting, or afforestation.
- Conduct nutrition campaigns on the value of leafy greens, millets, and plant-based diets.
- Prepare easy-to-understand posters on medicinal plants and distribute in local schools/panchayats.

Social Innovation via Botanical Projects

- Build vertical gardens in limited-space households using low-cost materials.
- Create seed banks for climate-resilient plant varieties.
- Collaborate with local NGOs to restore degraded lands via native species plantation.

Examples of Botany-Specific Field Project Topics

1. Survey of endangered/rare plant species in a local forest area.
2. Study of plant-based home remedies and their community usage.
3. Soil and compost quality evaluation and its effect on vegetable growth.
4. Development of biodiversity gardens or butterfly parks in schools.
5. Leaf morphology variations and microclimate correlations in urban trees.
6. Promotion of millet-based agriculture and traditional grains.

Reference:

- Florida Department of Agriculture and Consumer Services. (n.d.). Science fair project ideas: Botany.
<https://www.fdacs.gov/Education/Planet-Ag-Agricultural-Topics-for-Science-Fair-Projects/Science-Fair-Project-Ideas-Botany>
- University Grants Commission. (2023). Revised guidelines for community engagement and social responsibility.
https://www.ugc.gov.in/pdfnews/4187860_Revised-Final-Guidelines.pdf
- American Chemical Society. (n.d.). Student community activities.
<https://www.acs.org/education/student-communities/activities.html>
- IndiaBioscience. (n.d.). Outreach. <https://indiabioscience.org/outreach>

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. III (Botany), SEMESTER – V (NEP)			
FP/CEP	Course Code: 107251	Field Project / Community Engagement Services in Botany	Max Marks: 50
Q. No.	Exercise	Marks	
1	Field Engagement & Participation (Attendance, hands-on involvement, and community interaction)	15	
2	Project Report Quality (Clarity, structure, scientific accuracy, originality, and referencing)	15	
3	Data Collection & Analysis (Depth, relevance, and quality of survey/sample collection and its analysis)	10	
4	Presentation (Poster or PPT) (Communication of findings, visual clarity, and confidence)	05	
5	Social Relevance & Innovation (Creative solutions, awareness campaigns, or community impact beyond data.)	05	

Level	Course Code	Course Title	Credits	Workload	Exam Duration	Maximum Marks
5.5		Foundation of Artificial Intelligence	Non Credit	2	2	30 (Ext) + 20 (Int)

Introduction :

The National Education Policy (NEP) 2020 emphasizes the integration of Artificial Intelligence (AI) across all undergraduate levels and disciplines to foster digital literacy and problem-solving skills. ‘It can enhance the employability of the youth and prepare professionals in cutting-edge areas.’(pg. 46, R.D Kulkarni Report)

The Foundations of Artificial Intelligence course offers an overview of the key concepts, structures, applications, and ethical aspects of AI. It helps learners understand how intelligent systems work and shape modern life. The course covers AI’s definition, evolution, types, and practical uses, along with its basic architectures like rule-based systems, machine learning, and neural networks. Learners will explore AI’s role in education, healthcare, and commerce while reflecting on ethical and social concerns such as privacy, bias, and automation. In line with NEP 2020, it fosters digital literacy and responsible AI awareness for all disciplines.

A) Objective

- i) Introduce all undergraduate students of all the faculties to the basic concepts, uses, and importance of AI.
- ii) Enable learners to understand AI’s principles, applications, limitations, and effectively use AI tools.
- iii) Encourage students to recognize AI’s role in enhancing life and engage with its social and ethical implications.

B) Outcomes

- i) Understand the fundamental concepts, types, and evolution of Artificial Intelligence.
- ii) Apply basic AI techniques and tools to real-world problems across different domains.
- iv) Evaluate the social, ethical, and professional implications of AI in everyday life.

C) Implementation of Syllabus, Scheme of Examination and Teaching.

- 1) Curriculum, Teaching and Examination Scheme Given in Appendix A
- 2) This course given in Appendix A shall be compulsory course in **fifth semester** of all undergraduate programs of all faculties in Sant Gadge Baba Amravati University, Amravati.
- 2) Medium of instruction, paper setting and writing of Answer paper shall be in English, Marathi and Hindi.
- 3) Question paper shall be set and valued by the College/ Department.
- 4) Duration of external examination shall be of 2 hours and paper shall be of 30 marks.
- 5) Internal 20 marks shall be distributed, 5 to attendance, 15 marks to assignment/class test/viva voce/presentation.
- 6) Distribution of 30 external marks shall be based on 4 units, 15 marks to short and 15 marks to long answer type questions.
- 7) It shall be obligatory on part of the college/department to conduct examination on prescribed date by the university and submit the candidate wise information as follows on university portal on due date after valuation answer books.
Grade A -- mark secured 30 to 50,
Grade B -- 25 to 29,
Grade C -- 20 to 24,
FAIL 19 and below
- 8) The final Grade shall be determined by the combined performance in internal and external assessments. A student must secure a minimum of 30% in the internal assessment, 30% in the external assessment, and at least 40% overall to pass. Failure to meet any of these criteria will result in a grade of "Fail."
- 9) In case of failure, student need to appeared in backlog examination by paying prescribed fees.
- 10) Valuated answer book shall be kept in college custody for one academic year and random verification may be done by the University if required.
- 11) Result of final year of respective degree shall not be declared of an examination unless secured any of the grades out of A to C in Foundation of Artificial intelligence.
- 12) Grade secured by an examinee in examination of said course shall be shown on fifth and last semester marksheet.
- 13) The candidates shall have to pay Rs 150 /- in 5th semester to the college to meet out the expenses by the college on teaching of course, question paper setting and printing, paper valuation, providing answer sheet, and filling grade on University portal. In case of failure student need to pay Rs 20 /- for conduction of examination. There shall not have any facility of revaluation of answer book.
- 14) For teaching of the subject person having PG degree in any faculty with second class shall be considered eligible, provided priority shall be given to Ph.D., NET, SET, regular teacher.

15) Format of question paper

Distribution of 30 external marks shall be based on 4 units, 15 marks to short and 15 marks to long answer type questions with internal choice.

- 1a) Long or short answer questions based on unit number 1 having 8 marks

Or

- 1b) Long or short answer questions based on unit number 1 having 8 marks
2a) Long or short answer questions based on unit number 2 having 7 marks

Or

- 2b) Long or short answer questions based on unit number 2 having 7 marks
3a) Long or short answer questions based on unit number 3 having 8 marks

Or

- 3b) Long or short answer questions based on unit number 3 having 7 marks
4a) Long or short answer questions based on unit number 4 having 8 marks

Or

- 4b) Long or short answer questions based on unit number 4 having 8 marks

Program:				Semester:	V	
Course:				Code:		
Teaching Scheme				Evaluation Scheme		
Level	Lecture	Hours	Credit	Internal	External	Total
5.5	2	2	2	20	30	50
Methods of Internal Assessment: 15 Marks to Class Tests, /Assignments/ Viva voce/ Presentation & 5 Marks to Attendance						
Course Objectives: To introduce AI concepts in a simple, real-life way with focus on understanding applications, ethics, and future opportunities.						
Course Outcomes: After completion of the course, the students will be able to:						
CO	Course Outcomes				BT Level	
CO-1	Explain the basic concepts, history, and types of AI with real-life examples.				L1 – Knowledge, L2 – Understanding	
CO-2	Describe AI structures and architectures using simple real-world analogies.				L2 – Understanding, L3 – Application	
CO-3	Identify and analyze applications of AI in the area of arts, commerce, humanities, and daily life.				L3 – Application, L4 – Analysis	
CO-4	Evaluate ethical, social issues and predict future opportunities of AI in their own fields.				L4 – Analysis, L5 – Evaluation	

Unit 1: Introduction to Artificial Intelligence (8 Hours)

Definition of AI: What is Intelligence? Natural vs. Artificial, Simple definition of AI; History & Evolution of AI: From early computers to modern AI; Types of AI: Narrow AI vs. General AI vs. Super AI; AI in Everyday Life: Google Maps, E-commerce suggestions, Chatbots, Social Media feeds; Key Components: Data, Algorithms, Computing Power

Unit 2: AI Structures, Architectures & Techniques (7 Hours)

Basic Structure of an AI System; AI Architectures (Simplified): Rule Based System, Machine Learning, Neural Networks; Key Concepts: Knowledge Representation (using symbols, facts), Search & Problem Solving (maze example, finding shortest route), Natural Language Understanding (Google Translate, chatbots)

Unit 3: Applications of AI in Society (7 Hours)

AI in Different Fields: Education (Personalized learning apps, plagiarism checkers), Healthcare (Disease prediction, medical chatbots), Commerce (Fraud detection in banking, stock market predictions, customer support), Daily Life (Smart home devices, language translation, travel assistants); AI & Decision Making: Hiring, Loan Approval, Court Decisions; Advantages of AI, Limitations of AI

Unit 4: Ethical, Social & Future Aspects of AI (8 Hours)

Ethical Concerns in AI: Privacy issues (CCTV, online data), Bias & Fairness (AI preferring certain groups), Job Displacement (automation replacing humans); Responsible AI: Transparency, Accountability, Human oversight; Future Trends in AI: Self-driving cars, AI in governance, creative industries; AI and You (Career Perspective): Opportunities in Digital Marketing, Content Creation, Business Analytics, HR Tech, Creative Industries (non-programming roles)

Textbook:

Melanie Mitchell – *Artificial Intelligence: A Guide for Thinking Humans*

Reference Books:

1. Boden, Margaret A., *Artificial Intelligence: A Very Short Introduction*
2. Elaine Rich – *Artificial Intelligence* (3rd Edition)
3. Godbole, Achyut, *Artificial Intelligence* (आर्टिफिशियल इंटेलिजन्स), Bookganga Publication.
4. Kulkarni, Dr Anand, आर्टिफिशियल इंटेलिजन्सच्या वाटेवर, Sakal Media Pvt. Ltd.
5. Stuart Russell – *Human Compatible* (2019)
6. Thorpe, Josh, *AI for Students: Creative Hacks for Academic Success*, Promptly Books

COURSES OF SEMESTER – VI

The Vertical	Course Code	Course Title
Major-T	107252	Genomics, Proteomics and Metabolomics
Major-T	107253	Plant Ecology & Conservation Biology
Major-T	107254	Modern Tools and Techniques in Plant Sciences
Major-P	107255	Practical Based on Major Theory Papers of Semester VI
Major-Elective T1	107256	Plant Systematics - 2
Major-Elective P1	107257	Lab-Based Learning of Plant Systematics -2
OR		
Major-Elective T2	107258	Molecular Biology and Genetic Engineering - 2
Major-Elective P2	107259	Lab-Based Learning of Mole.Bio. and Genetic Eng. -2
OR		
Major-Elective T3	107260	Advance Plant Physiology - 2
Major-Elective P3	107261	Lab-Based Learning of Advance Plant Physiology - 2
OR		
Major-Elective T4	107262	Basic and Applied Mycology and Plant Pathology-2
Major-Elective P4	107263	Lab-Based Learning of Basic and Applied Mycology and Plant Pathology-2
Minor-T	107264	Molecular Biology, Genetic Engineering and Biotechnology
Minor-P	107265	Experimental Mole. Bio, Genetic Engi. & Biotech.
VSC-P	107266	Entrepreneurship for Botanists
Intern/Apprenticeship	107267	Botany Lab (Internship / Apprenticeship)

Major Theory Courses

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	107252	Genomics, Proteomics & Metabolomics	2	30	2 Hrs	30 (Ext) + 20 (Int)

Course Objectives:				
1. Understand the fundamental concepts, principles, and scope of genomics, proteomics, metabolomics, and integrated omics sciences.				
2. Acquire knowledge of modern omics technologies, including genome sequencing, protein analysis, metabolite profiling, and bioinformatics tools used in biological research.				
3. Develop the ability to analyze, interpret, and integrate omics data for applications in agriculture, medicine, environmental biology, and biotechnology.				
4. Understand the applications, emerging trends, ethical issues, and future prospects of omics technologies in modern biological sciences.				
Course Outcomes:				
After successful completion of the course, students will be able to:				
CO 1: Explain the organization, mapping, sequencing, and functional analysis of genomes along with their applications in diverse biological fields.				
CO 2: Demonstrate understanding of protein separation, identification, characterization, and proteomics-based approaches in clinical, agricultural, and pharmaceutical sciences.				
CO 3: Analyze metabolomics data, interpret metabolic pathways, and evaluate the role of metabolites in plant biology, nutrition, and environmental studies.				
CO 4: Apply bioinformatics tools and multi-omics integration approaches for genome, proteome, and metabolome analysis in systems biology research.				
CO 5: Evaluate recent advances such as CRISPR-Cas technology, synthetic biology, single-cell omics, and AI-based omics research along with their ethical and societal implications.				
Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Fundamentals of Genomics	8	8	Suitable pedagogical strategies are separately annexed
1.1: Introduction to Omics: Definition and concept of omics; Branches of omics – genomics, transcriptomics, proteomics, metabolomics; Importance of omics in modern biology				
1.2: Concept to Genomics: History and scope of genomics; Genome organization in prokaryotes and eukaryotes; Structural, functional, and comparative genomics.				
1.3: Functional Genomics: DNA sequencing methods: Sanger sequencing Method, Gene expression analysis; Transcriptomics; epigenomics.				
1.4: Applications of Genomics: Medical genomics and personalized medicine; Agricultural genomics; Microbial and environmental genomics				
Unit II	Fundamentals of Proteomics	8	8	
2.1: Introduction to Proteomics: Overview and scope of proteomics; Structural and functional proteomics; Protein databases and resources.				
2.2: Protein Separation and Identification Techniques: Gel electrophoresis: SDS-PAGE; Mass spectrometry: principles and instrumentation, Peptide mass fingerprinting				

2.3: Protein Characterization and Analysis: Protein folding and stability; Protein–protein interactions; Quantitative and comparative proteomics 2.4: Applications of Proteomics: Clinical and diagnostic proteomics; Herbal Drug target identification; Proteomics in agriculture and food sciences			
Unit III	Fundamentals of Metabolomics	7	7
3.1: Introduction to Metabolomics: Definition and importance of metabolomics, Types of metabolites: primary and secondary metabolites 3.2: Metabolite Profiling Techniques: Chromatographic techniques: Principle, working and applications of GC-MS and Nuclear Magnetic Resonance (NMR) spectroscopy 3.3: Data Analysis in Metabolomics: Metabolomics databases (HMDB); Basic statistical and multivariate analysis; Pathway analysis and interpretation 3.4: Applications of Metabolomics Role in plant disease diagnosis; Plant stress biology and metabolomics; Environmental applications of metabolomics			
Unit IV	Integrated Omics and Bioinformatics	7	7
4.1: Bioinformatics in Omics Sciences: Biological databases: GenBank, UniProt.; Sequence alignment and BLAST; Genome and proteome analysis tools 4.2: Systems Biology and Multi-Omics Integration: Concept of systems biology; Integration of genomics, proteomics, and metabolomics; Computational biology approaches 4.3: Omics Technologies in Modern Biology: Synthetic biology and genome editing; CRISPR-Cas9 technology; Artificial intelligence in omics research 4.4: Emerging Trends and Future Perspectives: Single-cell omics; Big data challenges in omics; Ethical and societal implications of omics technologies.			
Activities: (Suggestive to use as CAT - Perform any Three) 1. Online genome database exploration activity 2. DNA Sequencing Technology Comparison Assignment 3. Proteomics Case Study Presentation 4. Metabolomics Pathway Mapping Exercise 5. Research Paper Review Assignment 6. Group Discussion on Ethical Issues in Omics 7. Online Omics Data Interpretation Activity			
References: 1. Bagchi, D., Swaroop, A., & Bagchi, M. (2016). <i>Genomics, proteomics and metabolomics in nutraceuticals and functional foods</i> (2nd ed.). Wiley Wiley-Blackwell. 2. Husen, A., & Ahmad, A. (Eds.). (2023). <i>Genomics, transcriptomics, proteomics and metabolomics of crop plants</i>. Academic Press. 3. Koche, D. K. (2026). <i>Fundamentals of Cell Biology and Genetics</i>, B. P. International Publisher, Kolkata, India. 4. Lesk, A. M. (2023). <i>Introduction to genomics</i> (4th ed.). Oxford University Press. 5. Mount, D. W. (2021). <i>Bioinformatics: Sequence and genome analysis</i> (3rd ed.). Cold Spring Harbor Laboratory Press. 6. Nelson, D. L., & Cox, M. M. (2021). <i>Lehninger principles of biochemistry</i> (8th ed.). W. H. Freeman. 7. Pevsner, J. (2024). <i>Bioinformatics and functional genomics</i> (4th ed.). Wiley-Blackwell. 8. Primrose, S. B., & Twyman, R. M. (Indian adaptation). (2023). <i>Principles of gene manipulation and genomics</i> (7th Indian adaptation ed.). Bizkart Publications. 9. Rout, A. K., Singh, R. K., Shukla, A. K., & Behera, B. K. (Eds.). (2025). <i>Advances in omics technologies: Exploring genomics, proteomics, and metabolomics</i>. Springer Singapore.			

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E- Content:

1. ISAAA (2026). 'Omics' Sciences: Genomics, Proteomics, and Metabolomics.
2. SWAYAM (2021). Genetics and Genomics
3. SWAYAM (2022). Introduction to Proteogenomics
4. SWAYAM (2024). Computational Genomics
5. SWAYAM (2026). Genomics and Proteomics
6. NPTEL (2022). Introduction to Proteomics
7. Biology Libre Texts, Lecture 23: Genomics, Proteomics and Metabolomics.

Model Questions:

Very short/ One sentence questions (1 Mark)

1. What is genomics?
2. Define genome.
3. What is DNA sequencing?
4. Name one major outcome of the Human Genome Project.
5. What is proteomics?
6. Define proteome.
7. What does SDS-PAGE separate?
8. Name one mass spectrometry technique used in proteomics.
9. What is metabolomics?
10. Define metabolome.
11. Name one technique used in metabolite analysis.
12. What is a primary metabolite?
13. What is bioinformatics?
14. Define systems biology.
15. What is BLAST?
16. Name one biological database used in genomics.

Short Questions (3 Marks)

1. Differentiate between genetic and physical mapping.
2. Write a brief note on next-generation sequencing (NGS).
3. What is genome annotation?
4. Mention three applications of genomics in agriculture.
5. What is the difference between proteomics and genomics?
6. Briefly explain 2D gel electrophoresis.
7. What are post-translational modifications?
8. List any three applications of proteomics in medicine.
9. Differentiate between primary and secondary metabolites.
10. What is GC-MS used for in metabolomics?
11. Write a short note on metabolite profiling.
12. Mention three applications of metabolomics in plant science.
13. What is the role of KEGG database?
14. Write a short note on sequence alignment.
15. What is multi-omics integration?
16. Mention three applications of CRISPR technology.

Long Questions (6 Marks)

1. Explain the structure and organization of the eukaryotic genome.

2. Describe the Sanger sequencing method with a diagram.
3. Discuss the role of functional genomics in gene regulation studies.
4. Explain the applications and ethical issues of human genomics.
5. Explain the principle and working of mass spectrometry in proteomics.
6. Describe protein–protein interactions and their biological importance.
7. Discuss the methods used for protein separation and identification.
8. Explain biomarker discovery using proteomics.
9. Explain the principles of NMR spectroscopy in metabolomics.
10. Describe the workflow of metabolomic analysis.
11. Discuss the role of metabolomics in disease diagnosis.
12. Explain integration of metabolomics with genomics and proteomics.
13. Explain the concept of systems biology and its importance.
14. Describe the role of bioinformatics in omics research.
15. Discuss CRISPR-Cas9 technology and its applications.
16. Explain the integration of genomics, proteomics, and metabolomics in precision medicine.

Suggestive Pedagogies:

1. Interactive lectures with ICT-enabled teaching
2. Demonstration of omics tools, databases, and analytical techniques
3. Case study–based learning on medical, agricultural, and environmental applications
4. Group discussions, seminars, and student presentations on recent advances
5. Hands-on training in bioinformatics tools and data analysis
6. Problem-solving and project-based learning approaches

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	107253	Plant Ecology and Conservation Biology	2	30	2Hrs	30 (Ext)+ 20 (Int)

Course Objectives:

1. To illustrate the basic concepts and principles of ecology and conservation biology.
2. To deliver knowledge regarding ecosystem structure, biodiversity and environmental sustainability.
3. To present perspectives of current ecological tools and conservation approaches for application and research.
4. To demonstrate ecological concepts using activities and field-based learning for capacity building among students.

Course Outcomes:

After Successful completion of the course, the student will be able to –

CO-1: Understand the basic principles and scope of ecology and conservation biology.

CO-2: Remember ecosystem components, biodiversity levels, and conservation methods.

CO-3: Explain ecological interactions, environmental issues and sustainable development strategies.

CO-4: Develop awareness and practical approaches toward biodiversity conservation and environmental management.

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporat ion of Pedagogie s
Unit I:	Fundamentals of Plant Ecology	8	8	Suitable pedagog ical strategie s are separately annexed
1.1	Introduction to Ecology: Definition, Scope and branches of ecology, Levels of ecological organization - organism population, community, ecosystem, biome and biosphere.			
1.2	Ecological Factor (Edaphic factors): Soil Formation and Soil Profile.			
1.3	Plant Adaptations and Population Ecology: Morphological and anatomical adaptations in Hydrophytes and Xerophytes. Characteristic features of Mesophytes, Halophytes and Epiphytes.			
1.4	Plant Communities: Characteristics of Plant communities, structure and stratification, Ecotone and Edge effect, Ecological niche.			
Unit II	Ecosystem Ecology	8	8	
2.1	Structure and Components of Ecosystem: Abiotic and biotic components - Producers, consumers, decomposers, Types of ecosystems.			
2.2	Plant Succession and climax concept: Primary & Secondary Succession, Climax concept, Hydrosere and Xerosere.			
2.3	Energy Flow in Ecosystem: Food chain and food web, Ecological pyramids (Pyramids of number and biomass), Energy flow models.			

2.4		Ecosystem Services and Productivity: Primary and secondary productivity, Ecosystem services, Ecological importance of ecosystems.	
Unit III	Biodiversity	7	7
3.1	Introduction and levels of Biodiversity: Definition and importance of Biodiversity, Levels of biodiversity - genetic, species, ecosystem diversity. Global and Indian species diversity.		
3.2	Threats to Biodiversity: Habitat destruction, Pollution and Climate Change, Invasive species and overexploitation.		
3.3	Biodiversity Conservation: In-situ conservation – Biosphere reserve, National parks and Sanctuaries, Sacred groves. Ex-situ conservation- Botanical gardens, Seed banks and Gene banks.		
3.4	Biodiversity of India: Floral diversity of India, Endemic and Endangered species, Biodiversity hotspots, Western Ghats and Himalayan biodiversity.		
Unit IV	Conservation Biology and Sustainable Development	7	7
4.1	Principles of Conservation Biology: Need and importance, Conservation ethics, Conservation strategies.		
4.2	Environmental Pollution: Air pollution, Water pollution, Soil pollution and control measures.		
4.3	Sustainable Development: Concept and goals, Sustainable resource utilization, Renewable and Non-Renewable Resources, Global Warming, Environmental education and awareness.		
4.4	Environmental Management and Policies: Environmental Impact Assessment (EIA), Wildlife protection measures, Role of NGOs, Public participations and awareness.		
Activities: (Applicable to use as CAT – Any Three)			
1. Assignment on local biodiversity documentation			
2. Field visit to forest, lake or botanical garden			
3. Preparation of herbarium specimens			
4. Seminar presentation on environmental issues			
5. Group discussion on climate change			
6. Poster presentation on biodiversity conservation			
7. Preparation of food web and ecological pyramid charts			
8. Survey of pollution sources in local area			
9. Case study analysis on endangered species			
10. Quiz competition on ecology and conservation biology			
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Reference Books			
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2. Bharucha, E. (2019). Textbook of Environmental Studies. Universities Press.			

3. Chapman, J. L., & Reiss, M. J. (2013). *Ecology: Principles and Applications*. Cambridge University Press.
4. Cunningham, W. P., & Cunningham, M. A. (2015). *Environmental science: A global concern* (13th ed.). McGraw-Hill Education.
5. Dasmann, R. F. (1984). *Environmental conservation* (5th ed.). John Wiley & Sons.
6. Krebs, C. J. (2016). *Ecology: The Experimental Analysis of Distribution and Abundance*. Pearson Education.
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9. Raven, P. H., Berg, L. R., & Johnson, G. B. (2015). *Environment*. Wiley Publications.
10. Sharma, P. D. (2018). *Ecology and Environment*. Rastogi Publications.
11. Singh, J. S., Singh, S. P., & Gupta, S. R. (2017). *Ecology, environment and resource conservation*. Anamaya Publishers.
12. Smith, T. M., & Smith, R. L. (2015). *Elements of ecology* (9th ed.). Pearson Education.

Text Books

1. Bharucha, E. (2019). *Textbook of environmental studies* (3rd ed.). Universities Press.
2. Dash, M. C. (2001). *Fundamentals of ecology* (2nd ed.). Tata McGraw-Hill.
3. Eugene, P. O. (2004). *Basic ecology*. Saunders College Publishing.
4. Kormondy, E. J. (2017). *Concepts of ecology* (4th ed.). Pearson Education.
5. Mishra, D. D. (2010). *Fundamental concepts in environmental studies*. S. Chand Publishing, New Delhi.
6. Ricklefs, R. E. (2008). *The economy of nature* (6th ed.). W.H. Freeman.
7. Sharma, P. D. (2020). *Environmental biology and toxicology*. Rastogi Publications.
8. Southwick, C. H. (2012). *Global ecology in human perspective* (2nd ed.). Oxford university Press.
9. Verma, P. S., & Agarwal, V. K. (2016). *Environmental biology*. S. Chand Publishing, New Delhi.
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Research Articles

1. Cardinale, B. J., et al. (2012). Biodiversity loss and its impact on humanity. *Nature*, 486(7401), 59–67.
2. Dirzo, R., et al. (2014). Defaunation in the Anthropocene. *Science*, 345(6195), 401–406.
3. Foley, J. A., et al. (2005). Global consequences of land use. *Science*, 309(5734), 570–574.
4. Hooper, D. U., et al. (2012). A global synthesis reveals biodiversity loss impacts ecosystem services. *Nature*, 486(7401), 105–108.
5. Millennium Ecosystem Assessment. (2005). Ecosystems and human well-being. *Nature*, 438(7066), 245–250.
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2. NPTEL. (2024). *Ecology and environment lectures*. IIT Madras.
3. e-PG Pathshala. (2024). *Ecology and biodiversity modules*. UGC.
4. CEC-UGC. (2024). *Environmental science e-content*. Consortium for Educational Communication.
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6. DIKSHA Portal. (2024). *Environmental education resources*. Government of India.
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8. edX. (2024). *Conservation biology online course*. edX Learning Platform.
9. Khan Academy. (2024). *Ecology and ecosystems tutorials*. Khan Academy.
10. FutureLearn. (2024). *Climate change and sustainability courses*. FutureLearn.

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2. Begon, M., Harper, J. L., & Townsend, C. R. (2009). *Ecology: Individuals, populations and communities*. Wiley-Blackwell.
3. Gaston, K. J., & Spicer, J. I. (2013). *Biodiversity: An introduction*. Wiley-Blackwell.
4. Groom, M. J., Meffe, G. K., & Carroll, C. R. (2006). *Principles of conservation biology*. Sinauer Associates.
5. Molles, M. C. (2019). *Ecology: Concepts and applications*. McGraw-Hill Education.
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8. Smith, R. L., & Smith, T. M. (2012). *Elements of ecology*. Pearson Education.
9. Sodhi, N. S., & Ehrlich, P. R. (2010). *Conservation biology for all*. Oxford University Press.
10. Wilson, E. O. (2016). *Half-earth: Our planet's fight for life*. Liveright Publishing.

Web Links

1. [United Nations Environment Programme \(UNEP\)](#)
2. [International Union for Conservation of Nature \(IUCN\)](#)
3. [Convention on Biological Diversity \(CBD\)](#)
4. [World Wildlife Fund \(WWF\)](#)
5. [Food and Agriculture Organization \(FAO\)](#)
6. [Intergovernmental Panel on Climate Change \(IPCC\)](#)
7. [Ministry of Environment, Forest and Climate Change, India](#)
8. [National Biodiversity Authority, India](#)
9. [Encyclopedia of Life](#)
10. [Global Biodiversity Information Facility \(GBIF\)](#)

Pedagogical Strategies:

1. ICT-enabled teaching using PPTs, animations and videos.
2. Field visits and experiential learning activities.
3. Group discussions and collaborative learning.
4. Project-based and problem-solving learning methods.
5. Seminar presentations and peer teaching techniques.
6. Use of charts, models, and ecological case studies.
7. Blended learning through online resources and assignments.

Model Questions:

One Sentence Questions:

1. Define ecology.
2. What is an ecosystem?
3. Define biodiversity?

4. What is ecological succession?
5. Name any two biodiversity hotspots in India?
6. What is a food chain?
7. Define sustainable development?
8. What are hydrophytes?
9. What is global warming?
10. Define *in-situ* conservation?
11. What is EIA?

Short Type Questions:

1. Explain the scope of ecology?
2. Describe biotic factors with examples?
3. Differentiate between food chain and food web?
4. Explain ecological pyramids?
5. Write a note on biodiversity hotspots?
6. Explain nitrogen cycle?
7. Discuss the causes of air pollution?
8. Describe ecological adaptations in xerophytes?
9. Explain ecosystem services?
10. Write short notes on sustainable development?

Long Type Questions:

1. Explain ecological factors affecting plant growth?
2. Describe in detail the structure and functions of ecosystem?
3. Explain ecological succession with suitable examples.
4. Discuss energy flow in ecosystem?
5. Explain levels and importance of biodiversity?
6. Describe threats to biodiversity and conservation measures?
7. Discuss *in-situ* and *ex-situ* conservation strategies?
8. Explain climate change and its environmental impacts?
9. Discuss principles and applications of conservation biology?
10. Explain sustainable development and resource management strategies?
11. Describe in detail Environmental Impact Assessment (EIA)?

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	107254	Modern Tools & Techniques in Plant Sciences	2	30	2 Hrs	30 (Ext) + 20 (Int)

Course Objectives:

- Understand the principles, scope, and applications of forensic Botany and modern analytical techniques in plant sciences.
- Acquire knowledge of chromatographic, spectroscopic, molecular, and imaging techniques used in biological and forensic investigations.
- Develop practical understanding of DNA isolation, PCR, blotting, sequencing, and bioinformatics tools for plant and molecular studies.
- Familiarize with modern microscopy, nanotechnology, and digital approaches including GIS and remote sensing in forensic and biological research.
- Interpret scientific data generated through analytical and biotechnological techniques for research and industrial applications.
- Enhance analytical, technical, and problem-solving skills relevant to forensic science, biotechnology, plant sciences, and interdisciplinary research.

Course Outcomes:

After Successful completion of the course, the student will be able to –

CO-1: Understand and Explain the scope, importance, and applications of forensic Botany in crime investigation and legal studies.

CO-2: Describe the principles, working mechanisms, and applications of chromatographic and spectroscopic techniques like TLC, HPLC, UV-Visible spectrophotometry, and AAS.

CO-3: Perform and interpret molecular biology techniques such as DNA extraction, gel electrophoresis, PCR, blotting, and DNA sequencing.

CO-4: Understand the working and applications of advanced imaging techniques including SEM, TEM, and CLSM.

CO-5: Utilize and Analyze bioinformatics databases and sequence analysis tools for biological data retrieval and interpretation.

CO-6: Explain the basics of nanotechnology and green synthesis of nanoparticles along with their applications in biological sciences.

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Forensic Botany	8	8	Suitable pedagogical strategies are separately annexed
1.1: Definition, scope, and history of forensic Botany; role of botanists in crime scene investigation. 1.2: Plant Anatomy & Identification in Forensic Context, forensic palynology 1.3: Forensic Applications of Plant Toxicology & EthnoBotany 1.4: Molecular and Digital Forensic Botany- DNA barcoding of plant material, Remote sensing and GIS applications in forensic Botany				
Unit II	Separation and Analytical Techniques	8	8	
2.1: Chromatography- Principle, Working and Applications of Paper Chromatography (PC) and Thin Layer Chromatography (TLC) 2.2: Column and Ion-Exchange Chromatography- Principle, Working and applications 2.3: High Performance Liquid Chromatography (HPLC)- Principle, Working and applications 2.4: Spectroscopy- Principle, Working and Applications of UV-Visible Spectrophotometer and Atomic Absorption Spectrophotometer (AAS)				
Unit III	Molecular & Biotechnological Techniques	7	7	

3.1: DNA Extraction & Quantification- Principles of DNA isolation from plant tissues, Quantification method (DPA method), Gel Electrophoresis (Principle, Working and Application)			
3.2: Polymerase Chain Reaction (PCR)- Principle, required components of PCR-DNA polymerase, Working mechanism and Applications of PCR			
3.3: Blotting Techniques- Principle, working and Applications of Southern (DNA), Northern (RNA), and Western (protein) blotting			
3.4: DNA sequencing – Sangers method (Principle, Components, Applications)			
Unit IV	Imaging, Bioinformatics & Emerging Tools	7	7
4.1: Scanning & Transmission Electron Microscopy (SEM & TEM)- Principle, Working and Applications			
4.2: Confocal Laser Scanning Microscopy (CLSM)- Principal, Working and Applications			
4.3: Introduction to Nanotechnology- Green Synthesis of Nanoparticles & Their General Applications			
4.4: Biostatistics: Central tendencies, Standard Deviation, ANOVA (Chi-square test)			
Activities: (Applicable to use as CAT)			
1. Forensic Pollen Case Study - students solve a mock forensic scenario using pollen slides they prepare themselves 2. Pigment Separation Challenge - groups identify an unknown plant from its TLC pigment fingerprint 3. DNA Detective - students deduce a restriction map by matching calculated fragment sizes to a gel image 4. Virtual Bioinformatics - a guided BLAST + ClustalW + MEGA exercise on any computer with internet 5. One Topic, Three Formats - students present a topic as a talk, a diagram, and a plain-language summary 6. Green synthesis of Nanoparticles using plant extracts 7. Biostatic analysis of given data.			
References:			
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Model Questions:
One Line Question 1. Define forensic Botany. 2. What is forensic palynology? 3. Name two DNA barcoding markers used in plant forensics. 4. What does the Rf value indicate in chromatography? 5. State Beer-Lambert law. 6. Expand the term CTAB in the context of DNA extraction. 7. What is the role of Taq polymerase in PCR? 8. How does SDS-PAGE separate - DNA, RNA, or proteins? 9. What is the function of the pinhole aperture in confocal microscopy? 10. Name the database used for plant genome annotation (Arabidopsis). 11. What is nano particle? 12. What is green synthesis? 13. Define Mean. 14. Define Median.
Short Type Questions 1. Describe the types of plant evidence used in forensic investigations with suitable examples. 2. Explain the principle of thin layer chromatography (TLC) and how Rf value is calculated. 3. Write a note on Principal and applications of High Performance Liquid Chromatography (HPLC) 4. Distinguish between RT-PCR and quantitative real-time PCR (qRT-PCR). 5. What is SDS-PAGE? How is molecular weight of a protein estimated using this technique? 6. Write a note on DNA barcoding and its applications in plant forensics. 7. Explain the principle and sample preparation steps for Scanning Electron Microscopy (SEM). 8. Explain the principle and applications of Transmission Electron Microscopy (TEM). 9. Describe the BLAST tool - what it does, what inputs it accepts, and what the E-value signifies. 10. Green synthesis of nanoparticles 11. Describe central tendencies. 12. Explain Chi-square test.
Long Type Question 1. Give a detailed account of the scope of forensic Botany. Discuss how pollen analysis (forensic palynology) and wood anatomy are used in crime scene investigation with examples. 2. Describe the principle and procedure of High Performance Liquid Chromatography (HPLC). How is it applied in the analysis of secondary metabolites in plant extracts? 3. With a neat labelled diagram, explain the principle and procedure of Polymerase Chain Reaction (PCR). Discuss the factors that affect PCR efficiency and describe two important variants of PCR. 4. Write an essay on gel electrophoresis techniques used in plant molecular biology. Include agarose gel electrophoresis for DNA and SDS-PAGE for proteins — principles, procedure, and interpretation of results. 5. Explain the construction and working of a Confocal Laser Scanning Microscope (CLSM). How does it differ from conventional fluorescence microscopy? Discuss its applications in plant cell and developmental biology.

- Describe the workflow of bioinformatics analysis of a plant gene sequence — from retrieval of sequence from NCBI GenBank to BLAST analysis, multiple sequence alignment using ClustalW, and phylogenetic tree construction using MEGA. Explain the significance of bootstrap values in phylogenetic trees. - Discuss the role of Transmission Electron Microscopy (TEM) in plant cell biology. Describe sample preparation steps for TEM and explain how it has contributed to our understanding of chloroplast and cell wall ultrastructure. - Write a comprehensive account of recombinant DNA technology in plants. Include restriction enzymes, cloning vectors, transformation methods, and the significance of selectable markers. Give examples of genetically modified crop plants. - Describe Gas Chromatography coupled with Mass Spectrometry (GC-MS). Explain its principle, instrumentation, and applications in the identification of volatile compounds and essential oils from medicinal plants. - Write a detailed note on Green synthesis of nanoparticles - Give details of biostatistical analysis of biological data with reference to central tendencies and Standard deviation.
Pedagogical Strategies - Lecture Method - Demonstration Method - Laboratory/ Hands on Training - Case study - Problem based Learning (PBL) - Seminar presentation - Collaborative Learning - Project Based learning

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	107255	Hands on Omics, Ecology & Modern Techniques	2	60	4 Hrs	25 (Ext)+ 25 (Int)

Course Objectives: 1. Develop practical skills in ecological, biochemical, molecular, and omics-based laboratory techniques. 2. Understand ecological concepts through field studies, biodiversity assessment, vegetation analysis, and environmental monitoring. 3. Perform experiments related to phytochemical analysis, chromatography, microscopy, DNA isolation, PCR, electrophoresis, and protein analysis. 4. Apply bioinformatics tools and biological databases for retrieval, analysis, and interpretation of genomic and proteomic data. 5. Develop scientific skills in data collection, interpretation, documentation, report writing, and presentation of experimental results. 6. Understand the applications of ecology, applied Botany, and omics technologies in environmental conservation, biotechnology, agriculture, and research.
Course Outcomes: Upon successful completion of the course, students will be able to: CO 1: Conduct ecological studies including biodiversity assessment, vegetation analysis, ecosystem evaluation, and environmental parameter measurements using standard methods. CO 2: Perform laboratory techniques such as microscopy, chromatography, phytochemical testing, DNA isolation, PCR, electrophoresis, and protein analysis with accuracy and safety. CO 3: Analyze and interpret biological data obtained from ecological surveys, biochemical experiments, and omics-based investigations. CO 4: Use bioinformatics databases and computational tools for sequence retrieval, BLAST analysis, protein visualization, and omics data interpretation. CO 5: Prepare scientific reports, herbarium specimens, charts, presentations, and field documentation following standard scientific procedures. CO 6: Demonstrate scientific attitude, teamwork, communication skills, and awareness regarding biodiversity conservation, sustainability, and modern biological applications.
Major Experiments- Plant Ecology (Any Three) 1. To study ecological adaptations in hydrophytes, xerophytes, and mesophytes. 2. To determine soil pH and soil moisture from different habitats. 3. Estimation of plant population density and frequency using quadrat method. 4. To study vegetation analysis by quadrat sampling technique. 5. To determine total dissolved oxygen in different water samples. 6. To study food chain and food web in a pond or grassland ecosystem. 7. Estimation of primary productivity in aquatic ecosystem. 8. To analyse physico-chemical properties of water. 9. To study biodiversity indices in local habitats. 10. To carry out field survey and documentation of local flora and fauna. 11. To study ecological succession in local habitats.

12. To assess pollution sources and environmental impact in nearby area.

Minor Experiments- Plant Ecology (Any Two)

1. Demonstration of ecological instruments used in field ecology.
2. To Measure light intensity and temperature of different habitats.
3. Identification of common hydrophytes, xerophytes and halophytes.
4. Preparation of herbarium specimens of local plants.
5. Observation of stomatal frequency in different plants.
6. To study pond ecosystem components.
7. Preparation of ecological pyramids and food web charts.
8. Collection and identification of soil organisms.
9. Preparation of posters/models on biodiversity conservation.
10. Visit report on botanical garden, national park or wildlife sanctuary.
11. To study waste management practices in campus / locality.
12. To carry out awareness activity on environmental conservation and sustainability.

Activities- Plant Ecology (Any Two)

1. **Field Visit and Report Writing:** Visit to a pond, grassland, botanical garden, biodiversity park, wildlife sanctuary or nearby ecosystem and submission of field report.
2. **Herbarium Preparation:** Collection, preservation, identification and mounting of local plant specimens.
3. **Poster / Model Presentation:** Preparation of posters or models on biodiversity conservation, pollution control, climate change or sustainable development.
4. **Ecological Survey Activity:** Conduct survey of local flora or pollution sources and prepare documentation report.
5. **Seminar / Group Discussion:** Presentation on ecological topics such as ecosystem services, endangered species or conservation strategies.
6. **Awareness Campaign:** Organizing environmental awareness activities like tree plantation, plastic-free campus campaign or water conservation drive.
7. **Data Collection and Analysis:** Measurement and interpretation of ecological parameters such as soil pH, moisture, temperature or biodiversity indices.
8. **Preparation of Food Web / Ecological Pyramid Charts:** Chart or digital presentation showing trophic relationships in ecosystems.
9. **Case Study Assignment:** Study of local environmental issues such as waste management, water pollution or habitat degradation.
10. **Nature Documentation Activity:** Photography and documentation of local biodiversity with scientific names and ecological importance.

Major Experiments- Applied Botany (Any Three)

1. Collection, mounting, and microscopic examination of pollen from at least 5 plant species; preparation of pollen slides
2. Microscopic study of wood sections (TS and LS) - identification of vessel elements, fibres, and rays; comparison of two timber samples
3. Phytochemical spot tests for detection of alkaloids (Dragendorff's), tannins (FeCl_3), and cardiac glycosides in plant extracts
4. TLC screening of a suspected plant-based material; R_f value calculation and comparison with authentic standards
5. Paper chromatography of amino acid mixture using butanol: acetic acid: water solvent system; detection by ninhydrin spray and R_f calculation

6. TLC separation of plant pigments (chlorophyll a/b, carotenoids) from spinach; petroleum ether: acetone solvent system; R_f comparison
7. Column chromatography - isolation of β-carotene from carrot extract using alumina column; fraction monitoring by colour and TLC
8. UV-Vis spectrophotometry - estimation of total chlorophyll content from a plant extract using Arnon's method; absorbance at 663 nm and 645 nm
9. Isolation of genomic DNA from fresh plant leaf tissue using CTAB method; assessment of yield and purity by agarose gel and A260/A280 ratio
10. PCR amplification of a housekeeping gene (e.g., 18S rRNA or actin) from isolated plant DNA; gel electrophoresis and documentation
11. SDS-PAGE of total plant protein extract; Coomassie staining; estimation of band molecular weights using prestained protein ladder
12. Restriction digestion of plasmid DNA using EcoRI and HindIII; gel analysis of digest fragments; fragment size calculation
13. Preparation of plant material for SEM — fixation, dehydration series, air/critical point drying demonstration; study of SEM images of pollen and leaf surfaces
14. Preparation of stained sections for light/fluorescence microscopy — DAPI staining of root tip nuclei; observation of cell division stages
15. Bioinformatics exercise — retrieval of a plant gene sequence from NCBI GenBank; BLAST search; interpretation of alignment results and E-values

Minor Experiments- Applied Botany (Any Two)

1. Preparation of pollen slides from 3 plant species; microscopic observation and sketching of pollen morphology
2. Phytochemical spot tests on a plant extract - alkaloids (Dragendorff's reagent), tannins (FeCl₃), saponins (froth test)
3. TLC separation of plant pigments (chlorophyll a, b, carotenoids) from spinach using petroleum ether: acetone; R_f value calculation
4. Estimation of total chlorophyll content from a plant extract by UV-Vis spectrophotometry at 663 nm and 645 nm
5. Isolation of genomic DNA from fresh plant leaf tissue using CTAB method; quality check by agarose gel electrophoresis
6. PCR amplification of a target gene from isolated plant DNA; gel documentation and band size estimation using 1 kb DNA ladder
7. Bioinformatics exercise — retrieval of a plant gene sequence from NCBI GenBank; BLAST search; interpretation of alignment scores and E-values

Activities (Perform any Two)

1. Forensic Pollen Case Study - students solve a mock forensic scenario using pollen slides they prepare themselves
2. Pigment Separation Challenge - groups identify an unknown plant from its TLC pigment fingerprint
3. DNA Detective - students deduce a restriction map by matching calculated fragment sizes to a gel image
4. Virtual Bioinformatics - a guided BLAST + ClustalW + MEGA exercise on any computer with internet
5. One Topic, Three Formats - students present a topic as a talk, a diagram, and a plain-language summary

Major Experiments- Omics (Perform any 3)

1. Isolation and quantification of genomic DNA from plant material

2. Agarose gel electrophoresis for DNA analysis
3. Demonstration of PCR amplification of selected gene fragments
4. Extraction and estimation of total proteins from plant tissues
5. Separation of proteins using SDS-PAGE
6. Protein structure visualization using bioinformatics tools
7. Extraction of primary and secondary metabolites from plant samples
8. Thin Layer Chromatography (TLC) profiling of plant metabolites
9. Demonstration of GC-MS and LC-MS data interpretation
10. Retrieval of nucleotide and protein sequences from GenBank and UniProt

Minor Experiments- Omics (Perform any 2)

1. Preparation of DNA extraction buffers
2. Observation of chromosome organization models
3. Study of protein databases (PDB, UniProt)
4. Preparation of plant extracts for metabolite analysis
5. Identification of pigments using chromatography
6. Study of metabolomics databases
7. Database searching in GenBank and UniProt
8. Demonstration of CRISPR-Cas mechanism

Activities- Omics (Perform any Two)

1. Online genome database exploration activity
2. DNA Sequencing Technology Comparison Assignment
3. Proteomics Case Study Presentation
4. Metabolomics Pathway Mapping Exercise
5. Research Paper Review Assignment
6. Group Discussion on Ethical Issues in Omics
7. Online Omics Data Interpretation Activity
- 8.

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SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. III (Botany), SEMESTER – VI (NEP)				
Lab/ Practical-	Course Code:	Course Title	Max Marks	Time:
	107255	Hands on Omics, Ecology & Modern Techniques	25	4 Hrs.
Q. No.	Exercise		Marks	
1.	Perform Any One Major Experiment from Paper I- Omics		5	
2.	Perform Any One Major Experiment from Paper II- Ecology		5	
3.	Perform Any One Major Experiment from Paper III- Applied Botany		5	
4.	Perform any two Exercise from Minor Experiments		5	
5.	External Viva Voce		5	
	Total		25	

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI Internal Practical Course B.Sc. III (Botany), SEMESTER – VI (NEP)		
Lab/Practical-	Course Code: 107254	Max Marks: 25
S. No.	Assessment Criteria	Marks
1	Record/ Assignments	5
2	Attendance	5
3	Participation in Activity/ Field visit	5
4	Student’s overall performance	5
5	Internal Viva Voce	5
	Total	25

Major Elective Courses

Course Type	Course Code	Course Title	Credits	Workload	Exam Duration	Maximum Marks
Major-Elective T1	107256	Plant Systematics - 2	2	2	2.00 Hrs	30 (Ext.) 20 (Int)

Course Objectives

1. Introduce modern concepts in plant systematics such as phylogenetics, cladistics, and phenetics.
2. Familiarize students with advanced taxonomic tools like cytotaxonomy, chemotaxonomy, numerical and molecular taxonomy.
3. Provide knowledge of modern plant identification techniques including digital herbarium, GIS, and remote sensing.
4. Create awareness about the role of BSI in plant conservation and taxonomy.
5. Introduce AI and ML applications in plant systematics and biodiversity studies.
6. Highlight the importance of taxonomy in biodiversity conservation.

Course Outcomes

CO 1: Understand modern trends and scope of plant systematics.
CO 2: Explain phylogenetics, cladistics and phenetics in plant classification.
CO 3: Demonstrate knowledge of digital herbarium and plant documentation.
CO 4: Understand the significance of biosystematics in plant evolution.
CO 5: Describe the contributions of BSI in taxonomy and conservation.
CO 6: Evaluate AI and ML tools in plant identification and classification.
CO 7: Appreciate the role of taxonomy in biodiversity conservation and environmental management.

Unit	Content	Workload Allotted (Hrs)	Weightage of Marks	Incorporation of pedagogies
I	Plant Systematics	8	8	Suitable pedagogical strategies are separately annexed
1.1 Introduction, scope and importance of plant systematics 1.2 Basic concept of Phylogenetics and Phylogenetic tree 1.3 Cladistics: Concept and its application 1.4 Phenetics: Concept and its application				
II	Modern concept in plant taxonomy	7	7	
Definition, features and significance 2.1 Cytotaxonomy- (Karyotype analysis) 2.2 Chemotaxonomy 2.3 Numerical Taxonomy 2.4 Molecular Taxonomy- (DNA barcoding)				
III	Plant Identification techniques	8	8	
3.1 Dichotomous key for identification of plants of Brassicaceae and Lamiaceae 3.2 Digital Herbarium- Definition, features and application 3.3 Geographic Information System software- Definition and application 3.4 Remote sensing- Definition and application				
IV	Advances in Plant Systematics	7	7	

4.1 Biosystematics- Concept and application 4.2 Major contribution of BSI 4.3 Application of AI ML in plant systematics 4.4 Role of taxonomy and plant systematics in biodiversity conservation	
Activities for Continuous Assessment Tests (Perform Any Two as CAT):	
1. Prepare herbarium specimens of locally available plants. 2. Observation of chromosome structure using microscopic slides, Karyotype preparation and interpretation exercise. 3. Laboratory demonstration of phytochemical tests. 4. Create a mini digital herbarium using photographs, Upload plant specimen details into spreadsheet/databases 5. Seminar on remote sensing in forest monitoring and Agricultural lands. 6. Field survey for plant diversity assessment. 7. Seminar on floristic surveys conducted by BSI. 8. Preparation of checklist of medicinal plants from local region.	
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1-Mark Questions (Answer in One Sentence)	
Unit I: Introduction to Plant Systematics	
- Define plant systematics. - What is taxonomy? - Who is known as the father of taxonomy? - What is nomenclature? - Define classification. - Define phylogeny. - What is a phylogenetic tree? - Define cladistics. - What is a cladogram? - Define phenetics.	
Unit II: Modern Concept in Plant Taxonomy	
- What is Cytotaxonomy? - What is Chemotaxonomy? - What is Numerical Taxonomy? - What is Molecular Taxonomy? - What is DNA barcoding? - What is a karyotype?	

6. Name one feature studied in Cytotaxonomy.
7. Which taxonomy method uses chemical compounds?
8. State one significance of Chemotaxonomy.
9. State one importance of Molecular Taxonomy.

Unit III: Plant Identification Techniques

1. What is a dichotomous key?
2. Which family includes mustard plants?
3. Which family includes mint plants?
4. What is a digital herbarium?
5. State one feature of a digital herbarium.
6. Give one application of a digital herbarium.
7. What is GIS software?
8. Mention one application of GIS in Botany.
9. What is remote sensing?
10. State one application of remote sensing.

Unit IV: Advances in Plant Systematics

1. What is Biosystematics?
2. State one application of Biosystematics.
3. What is the full form of BSI?
4. Mention one contribution of BSI.
5. What is the role of AI in plant systematics?
6. What is the role of ML in taxonomy?
7. Define biodiversity conservation.
8. How does taxonomy help biodiversity conservation?
9. Why is plant systematics important?
10. Name one modern tool used in plant systematics?

3-Mark Questions (Short Answers)

Unit I: Plant Systematics

1. Explain the scope and importance of plant systematics.
2. Describe the basic concept of phylogenetics.
3. Explain the structure and importance of a phylogenetic tree.
4. Write a short note on cladistics and its applications.
5. Explain phenetics and its significance in taxonomy.

Unit II: Modern Concept in Plant Taxonomy

1. Define Cytotaxonomy and explain its significance.
2. Write a short note on Chemotaxonomy.
3. Explain the principles of Numerical Taxonomy.
4. Describe DNA barcoding and its applications.
5. Explain karyotype analysis in Molecular Taxonomy.

Unit III: Plant Identification Techniques

1. Explain the use of dichotomous keys in plant identification.
2. Write a short note on Digital Herbarium.
3. Describe the features and applications of GIS software.
4. Explain remote sensing and its applications in Botany.
5. Differentiate between Brassicaceae and Lamiaceae using key characters.

Unit IV: Advances in Plant Systematics

1. Explain the concept of Biosystematics and its applications.
2. Write a short note on the contributions of BSI.
3. Explain the role of AI and ML in plant systematics.
4. Describe the importance of taxonomy in biodiversity conservation.
5. Explain the role of plant systematics in conservation biology.

6-Mark Questions (Long Answers)

Unit I: Plant Systematics

1. Explain the scope, importance, and applications of plant systematics.

2. Describe phylogenetics and explain the significance of phylogenetic trees.
3. Explain cladistics and its applications in plant classification.
4. Describe phenetics and its importance in taxonomy.
5. Differentiate between cladistics and phenetics.

Unit II: Modern Concept in Plant Taxonomy

1. Explain Cytotaxonomy with its features and significance.
2. Describe Chemotaxonomy and its role in plant classification.
3. Explain the principles and applications of Numerical Taxonomy.
4. Describe Molecular Taxonomy with suitable examples.
5. Explain DNA barcoding and karyotype analysis in taxonomy.

Unit III: Plant Identification Techniques

1. Explain the use of dichotomous keys in identification of plants.
2. Describe the important characteristics of Brassicaceae and Lamiaceae.
3. Explain Digital Herbarium with its features and applications.
4. Describe GIS software and its applications in plant studies.
5. Explain remote sensing and its applications in biodiversity assessment.

Unit IV: Advances in Plant Systematics

1. Explain the concept and applications of Biosystematics.
2. Describe the major contributions of BSI in plant taxonomy.
3. Explain the role of AI and ML in plant systematics.
4. Discuss the importance of taxonomy in biodiversity conservation.
5. Explain the role of plant systematics in conservation and sustainable use of biodiversity.

Course Type	Course Code	Course Title	Credits	Workload	Exam Duration	Maximum Marks
Major-Elective P1	107257	Lab-Based Learning of Plant Systematics -2	2	4	4.00 Hrs	25 (Ext.) 25 (Int)

Course Objectives 1. Provide training in modern plant identification and classification techniques. 2. Develop skills in constructing and using dichotomous keys. 3. Train students in identification of local flora, especially Brassicaceae and Lamiaceae. 4. Introduce QR coding, AI, and ML applications in plant taxonomy. 5. Develop understanding of phylogenetic trees and plant evolution. 6. Provide practical knowledge of karyotype analysis. 7. Encourage use of digital tools in biodiversity documentation and conservation.
Course Outcomes After completion of the practical course, students will be able to: CO 1: Use dichotomous keys for plant identification. CO 2: Prepare and manage digital herbarium records. CO 3: Apply taxonomic methods for accurate plant identification. CO 4: Identify plants of Brassicaceae and Lamiaceae families. CO 5: Interpret phylogenetic trees and evolutionary relationships. CO 6: Document and study local flora through field observations. CO 7: Perform basic karyotype analysis in taxonomy. CO 8: Use AI and ML tools in plant identification. CO 9: Create online databases for plant documentation.
List of Exercises: Major Experiments 1. Construction and use of Dichotomous key. 2. Preparation of Digital Herbarium. 3. Learn methods of plant identification (including preparation of taxonomic keys) 4. Identification of local plants of family Brassicaceae and Lamiaceae. 5. Techniques preparation of QR for plant identification. 6. Reading and interpretation of Phylogenetic trees. 7. Study of Local flora. 8. Karyotype analysis. Minor Experiments 1. AI tools and their application in plant identification. 2. ML tools and their application in plant identification. 3. Preparation of online database of any 2 plants.
Activities (Any 4 of the following) – 1. Prepare a dichotomous key for five local plants based on observable characters. 2. Collect plant specimens and create a simple digital herbarium with photographs and scientific names. 3. Visit a nearby garden or field and identify plants using taxonomic keys. 4. Compare the floral characters of plants belonging to Brassicaceae and Lamiaceae families. 5. Design and generate a QR code containing information about a selected plant species. 6. Draw and interpret a simple phylogenetic tree showing relationships among selected plants. 7. Conduct a local flora survey and prepare a checklist of commonly found plants. 8. Observe chromosome arrangements from prepared slides and perform basic karyotype analysis. Any one activity of the following- 1. Organize a field visit for collection and identification of medicinal plants in the locality. 2. Conduct a group activity on classification of plants using morphological characters. 3. Prepare a presentation on the importance of digital tools in modern plant systematics.

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7. Molecular Systematics of Plants by Pamela Soltis et al., Springer Publications.
8. Botanical Survey of India publications and floras for local plant identification studies.
9. The Plant List — Online database for plant names and classification.
10. [Plants of the World Online](#) — Online resource for plant taxonomy and identification.
11. [GBIF \(Global Biodiversity Information Facility\)](#) — Biodiversity database useful for flora and distribution studies.
12. [iNaturalist](#) — AI-supported platform for plant identification and biodiversity observations.

Question Paper for External Practical Course

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. III (Botany), SEMESTER – VI (NEP)				
Major Elective P1	Course Code: 107257	Lab based Learning of Plant Systematics-2	Max Marks: 25	Time: 4 Hrs.
Q.No.	Exercise			Marks
1.	Perform any one exercise from Major Experiments			10
2.	Perform any one exercise from Minor Experiments			5
3.	Karyotype analysis.			5
4.	External Viva Voce			5

Internal Practical Course

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. III (Botany), SEMESTER – VI (NEP)			
Major Elective P1	Course Code: 107257	Lab based Learning of Plant systematics-2	Max Marks: 25
Sr. No.	Assessment Criteria		Marks
1	Record/ Assignments		5
2	Attendance		5
3	Participation in Activity/ Field visit		5
4	Students overall performance		5
5	Internal Viva Voce		5

Course Type	Course Code	Course Title	Credits	Workload	Exam Duration	Maximum Marks
Major-Elective T2	107258	Molecular Biology and Genetic Engineering - 2	2	2	2.00 Hrs	30 (Ext.) 20 (Int)

Course Objectives: After completion of the course, students will be able to: 1. Remember and describe advanced molecular biology concepts and genetic engineering methodologies. 2. Understand the mechanisms of gene expression and molecular regulation. 3. Apply molecular biology techniques in genomics, proteomics, and bioinformatics. 4. Analyze transgenic technology, genome editing, and molecular applications. 5. Evaluate the applications and implications of modern biotechnology and develop critical understanding regarding ethical, biosafety, and societal aspects of Molecular Biology and Genetic Engineering.				
Course Outcomes: After successful completion of the course, students will be able to: CO1: Explain transcription, translation, and regulation of gene expression. CO2: Understand genomics, proteomics, and bioinformatics tools. CO3: Explain advanced genetic engineering methodologies and genome editing techniques. CO4: Analyze applications of Molecular Biology in medicine, agriculture, and industry. CO5: Evaluate ethical and biosafety concerns associated with biotechnology and develop preparedness for higher studies and research in Molecular Biology and Biotechnology				
Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporati on of Pedagogies
Unit I	Gene Expression and Regulation	8	8	Suitable pedagogical strategies are separately annexed
1.1 Mechanism and regulation of transcription in prokaryotes and eukaryotes. 1.2 RNA processing, maturation and post-transcriptional modifications. 1.3 Genetic code and molecular mechanism of protein synthesis. 1.4 Comparative regulation of gene expression in prokaryotes and eukaryotes with reference to Lac Operon and RNA Interference (RNAi).				
Unit II	Genomics and Genome sequencing	8	8	
2.1 Function, analysis and dynamics of genome. 2.2 Human Genome Project, microarray technology and functional genomics. 2.3 Automated DNA synthesis and its applications in molecular biology. 2.4 Applications of Genomics in medicine, agriculture, and forensic science				
Unit III	Advanced Genetic Engineering	7	7	
3.1 Agrobacterium-mediated plant transformation and development of transgenic plants (viz. Bt-cotton). 3.2 Molecular Biomarkers: Concept, types and applications. 3.3 Cytoplasmic Genome Engineering: Concept, principles and applications with special reference to chloroplast and mitochondrial DNA. 3.4 Synthetic Biology: Concept and applications with special reference to Golden Rice and synthetic microorganisms.				
Unit IV	Applied Molecular Biology and Emerging Biotechnology	7	7	
4.1 Molecular diagnosis of pathogens and genetic disorders using molecular tools. 4.2 Principles and applications of ELISA in research and diagnostics. 4.3 Molecular pharming: Concept and applications with special reference to transgenic plants for the production of biopharmaceuticals, industrial enzymes and recombinant proteins. 4.4 Ethical issues, biosafety guidelines, and Intellectual Property Rights in biotechnology.				

Activities: (Conduct any Three as CAT)

1. Designed Sequence of Nucleotides as special Gene for its analysis and interpretation exercises related to gene expression and mutations.
2. Demonstration and exploration of bioinformatics databases and genome analysis tools.
3. Preparation and interpretation of phylogenetic trees using molecular sequence data.
4. Case study analysis of transgenic plants and genome-engineered crops (viz. Bt-cotton, Golden Rice).
5. Seminar presentation on recent advances in synthetic biology, genome engineering or molecular diagnostics.
6. Comparative analysis of gene regulation mechanisms in prokaryotes and eukaryotes.
7. Review writing on applications of functional genomics, molecular pharming or genome engineering.
8. Assignment on molecular biomarkers and their applications in diagnostics and biotechnology.
9. Preparation of models/charts illustrating RNA interference (RNAi), cytoplasmic genome engineering or molecular pharming.
10. Database retrieval and analysis of chloroplast or mitochondrial genome sequences.
11. Case study discussion on ethical issues, biosafety and Intellectual Property Rights in biotechnology.
12. Group discussion or poster presentation on emerging trends in molecular biology and synthetic biology.

References: (APA Style)

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2015). Molecular biology of the cell (6th ed.). Garland Science.
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4. Campbell, A. M., & Heyer, L. J. (2007). Discovering genomics, proteomics, and bioinformatics (2nd ed.). Benjamin Cummings.
5. Cox, M. M., Doudna, J. A., & O'Donnell, M. (2015). Molecular biology: Principles and practice. W. H. Freeman.
6. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2017). Molecular biotechnology: Principles and applications of recombinant DNA (5th ed.). ASM Press.
7. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (2018). Lewin's genes XII. Jones & Bartlett Learning.
8. Lesk, A. M. (2017). Introduction to genomics (3rd ed.). Oxford University Press.
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10. Pevsner, J. (2015). Bioinformatics and functional genomics (3rd ed.). Wiley-Blackwell.
11. Primrose, S. B., & Twyman, R. M. (2013). Principles of gene manipulation and genomics (7th ed.). Wiley-Blackwell.
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13. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant biotechnology: The genetic manipulation of plants (2nd ed.). Oxford University Press.
14. Stewart, C. N., Jr. (2016). Plant biotechnology and genetics: Principles, techniques, and applications (2nd ed.). Wiley-Blackwell.
15. Voet, D., Voet, J. G., & Pratt, C. W. (2016). Fundamentals of biochemistry: Life at the molecular level (5th ed.). Wiley.
16. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2013). Molecular biology of the gene (7th ed.). Pearson.
17. Wilson, K., & Walker, J. (2018). Principles and techniques of biochemistry and molecular biology (8th ed.). Cambridge University Press.

Model Questions:
One Line Question 1. Define RNA interference (RNAi). 2. What is post-transcriptional modification? 3. Expand HGP. 4. What is functional genomics? 5. Define automated DNA synthesis. 6. What is a molecular biomarker? 7. What is meant by cytoplasmic genome engineering? 8. Define synthetic biology. 9. What is molecular pharming? 10. Expand ELISA. 11. What is a transgenic plant? 12. Name one application of RNAi in plants.
Short Type Questions 1. Differentiate between transcription in prokaryotes and eukaryotes. 2. Explain RNA processing and post-transcriptional modifications. 3. Describe the molecular mechanism of protein synthesis. 4. Write a short note on RNA interference (RNAi). 5. Explain the Lac operon model of gene regulation. 6. Describe the significance of the Human Genome Project. 7. Explain the applications of microarray technology. 8. Write a short note on automated DNA synthesis. 9. Describe Agrobacterium-mediated plant transformation. 10. Explain the concept and applications of molecular biomarkers. 11. Write a short note on cytoplasmic genome engineering. 12. Explain the applications of ELISA in diagnostics and research. 13. Describe synthetic biology with suitable examples. 14. Explain the concept of molecular pharming.
Long Type Question 1. Explain the mechanism and regulation of transcription in prokaryotes and eukaryotes. 2. Describe RNA processing, maturation and post-transcriptional modifications in eukaryotes. 3. Discuss the genetic code and molecular mechanism of protein synthesis with suitable diagrams. 4. Explain comparative regulation of gene expression in prokaryotes and eukaryotes with reference to Lac operon and RNA interference (RNAi). 5. Discuss the Human Genome Project, microarray technology and their applications in functional genomics. 6. Explain genome function, analysis and dynamics with suitable examples. 7. Describe automated DNA synthesis and discuss its applications in molecular biology. 8. Explain Agrobacterium-mediated plant transformation and development of transgenic plants with reference to Bt-cotton. 9. Discuss cytoplasmic genome engineering with special reference to chloroplast and mitochondrial DNA. 10. Explain synthetic biology and discuss its applications with special reference to Golden Rice and synthetic microorganisms. 11. Discuss molecular pharming and its applications with special reference to transgenic plants used for the production of biopharmaceuticals, industrial enzymes and recombinant proteins. 12. Explain molecular diagnosis of pathogens and genetic disorders using molecular tools. 13. Discuss the principles and applications of ELISA in research and diagnostics. 14. Explain ethical issues, biosafety guidelines and Intellectual Property Rights in biotechnology.

Pedagogical Strategies: (At least one class per Units shall be using following Pedagogies)

Unit I –

1. RNAi Gene Silencing Simulation: Students use colored cards/models to demonstrate siRNA-mediated gene silencing and post-transcriptional regulation.

2. Protein Synthesis Roleplay Activity: Students simulate ribosome assembly, codon recognition, tRNA interaction, and peptide bond formation to visualize translation.

3. Comparative Gene Regulation Workshop: Interactive comparison of prokaryotic and eukaryotic gene regulation using Lac operon and RNAi models/charts.

4. RNA Processing Model Preparation: Students prepare DIY models showing capping, tailing, and RNA splicing events in eukaryotic cells.

Unit II –

5. Genome Annotation Activity: Students identify coding and non-coding regions from simplified genome sequences using bioinformatics tools.

6. Microarray Data Interpretation Exercise: Hands-on analysis of simulated microarray outputs to compare gene expression patterns.

7. Automated DNA Synthesis Workflow Demonstration: Flowchart/model-based activity illustrating oligonucleotide synthesis and applications in modern biotechnology.

8. Human Genome Project Timeline Activity: Students construct scientific timelines highlighting milestones, discoveries, and applications of the Human Genome Project.

Unit III –

9. Transgenic Plant Case Study Discussion: Comparative analysis of Bt-cotton, Golden Rice, and other transgenic crops focusing on molecular strategies and applications.

10. Cytoplasmic Genome Engineering Model Activity: Preparation of chloroplast and mitochondrial genome models demonstrating organelle-based genetic engineering.

11. Molecular Biomarker Diagnostic Simulation: Students analyze hypothetical disease or crop datasets using biomarker-based identification strategies.

12. Synthetic Biology Design Challenge: Students design hypothetical synthetic microorganisms or engineered plants for agriculture, medicine, or environmental applications.

Unit IV –

13. ELISA Demonstration and Diagnostic Interpretation: Students perform or interpret ELISA-based diagnostic outcomes using simulated datasets/charts.

14. Molecular Pharming Concept Mapping: Preparation of concept maps linking transgenic plants with production of recombinant proteins, enzymes, and biopharmaceuticals.

15. Biotechnology Ethics Debate: Debate on biosafety, GM crops, intellectual property rights, and ethical concerns in molecular biotechnology.

16. Future Biotechnology Seminar Series: Student seminars on emerging technologies such as synthetic biology, personalized medicine, molecular diagnostics, and engineered therapeutics.

Course Type	Course Code	Course Title	Credits	Workload	Exam Duration	Maximum Marks
Major-Elective P2	107259	Lab-Based Learning of Mole.Bio. and Genetic Eng. -2	2	4	4.00 Hrs	25 (Ext.) 25 (Int)

Course Objectives: 1. To develop advanced understanding of gene expression, RNA processing, functional genomics, and molecular regulation in prokaryotes and eukaryotes. 2. To understand modern molecular biology and genome engineering approaches including automated DNA synthesis, cytoplasmic genome engineering, synthetic biology, and molecular pharming. 3. To apply molecular biology, bioinformatics, immunodiagnostic, and genetic engineering techniques in genome analysis, molecular diagnostics, and biotechnology-related studies. 4. To evaluate the applications of functional genomics, transgenic technologies, molecular biomarkers, synthetic biology, and molecular pharming in agriculture, medicine, industry, and forensic science. 5. To develop scientific attitude, analytical thinking, biosafety awareness, ethical understanding, and problem-solving abilities related to emerging molecular biotechnology and genome engineering technologies.
Course Outcomes: CO1: Explain the principles and mechanisms of gene expression, RNA processing, functional genomics, molecular biomarkers, and synthetic biology. CO2: Apply molecular biology, immunological, bioinformatics, and genome analysis techniques in molecular diagnostics, functional genomics, and biotechnology-related studies. CO3: Analyze genome-related data including microarray outputs, molecular markers, genome annotations, bioinformatics databases, and molecular diagnostic results. CO4: Evaluate the applications and limitations of transgenic plants, cytoplasmic genome engineering, molecular pharming, synthetic biology, and functional genomics in agriculture, medicine, industry, and environmental biotechnology. CO5: Demonstrate scientific communication, ethical awareness, biosafety practices, critical thinking, and interpretation of experimental and bioinformatics data in molecular biology and biotechnology studies.
MAJOR PRACTICALS A. Molecular Biology Practicals (Perform any FOUR) 1. Isolation of genomic DNA from plant material by CTAB method. 2. Separation of DNA by agarose gel electrophoresis. 3. Estimation of RNA from Lab Grade Chemical. 4. Analysis of gene expression using microarray data demonstration. 5. ELISA test for detection of antigen or antibody. 6. Protein separation using SDS-PAGE demonstration. 7. Bioinformatics analysis using NCBI databases and BLAST tool. 8. Demonstration of RNA interference (RNAi) mechanism using suitable models/software simulation. 9. Genome annotation and sequence analysis using bioinformatics tools. 10. Diagrammatic construction and interpretation of GM crops (viz. Bt-cotton and Golden Rice). B. Genetic Engineering Practicals (Perform any THREE) 1. Restriction digestion of DNA using restriction endonucleases. 2. Blue-white screening technique for recombinant selection. 3. Study of molecular markers (RAPD/RFLP/SSR) using electrophoretic patterns. 4. Agrobacterium-mediated plant transformation using explants/models. 5. Demonstration of automated DNA synthesis using charts/software simulation.

6. Preparation of chloroplast genome engineering model using cardboard/paper tools.
7. Demonstration of synthetic biology applications using charts/models/software simulation.
8. Preparation and interpretation of genome maps and molecular datasets.

MINOR PRACTICALS

A. Molecular Biology Practicals (Perform any THREE)

1. Preparation of agarose gel for electrophoresis.
2. Calculation of DNA concentration using OD values.
3. Identification of codons using genetic code table.
4. Demonstration of transcription using suitable models/charts.
5. Demonstration of translation using genetic code charts/models.
6. Comparative study of prokaryotic and eukaryotic transcription.
7. Demonstration of RNA splicing and post-transcriptional modifications using models.
8. Study of molecular diagnostic techniques used in medicine and agriculture.
9. Demonstration of RNA interference (RNAi) using charts/models.
10. Comparative study of chloroplast and mitochondrial genomes using charts/models.

B. Genetic Engineering Practicals (Perform any TWO)

1. Preparation of Lac operon model using charts/cardboard tools.
2. Study of different vectors used in genetic engineering.
3. Study of transgenic plants and their applications using specimens/charts.
4. Observation of bacterial transformation through virtual lab/video demonstration.
5. Preparation of restriction enzyme digestion map.
6. Demonstration of DNA fingerprinting process using charts/software.
7. Study of ethical issues and biosafety symbols in biotechnology laboratories.
8. Preparation of synthetic biology workflow charts/models.

Activities (Perform Any Two as CAT)

1. Seminar presentation on synthetic biology and its applications.
2. Preparation of model/chart on Lac operon or RNA interference (RNAi).
3. Assignment on applications of functional genomics in medicine, agriculture and forensic science.
4. Bioinformatics database searching and genome annotation activity using NCBI/GenBank.
5. Case study on genetically modified crops, molecular pharming and biosafety concerns.
6. Poster presentation on Human Genome Project and functional genomics.
7. Preparation of flowchart/model for protein synthesis or RNA processing.
8. Group discussion on ethical issues, biosafety guidelines and Intellectual Property Rights in biotechnology.
9. Virtual laboratory activity on ELISA, microarray analysis or molecular diagnostics.
10. Review and presentation of a recent research article related to synthetic biology, molecular pharming or genome engineering.

Reference/Text Books/Research Articles

1. Molecular Biology of the Gene – James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine and Richard Losick, Pearson Education.

2. Molecular Cell Biology – Harvey Lodish, Arnold Berk, Chris A. Kaiser et al., W.H. Freeman and Company.
3. Genes XII – Benjamin Lewin, Jones and Bartlett Publishers.
4. Principles of Gene Manipulation and Genomics – Sandy B. Primrose and Richard Twyman, Blackwell Publishing.
5. Molecular Biology – David P. Clark, Nanette J. Pazdernik and Michelle R. McGehee, Elsevier.
6. Genomes – T. A. Brown, Garland Science.
7. Introduction to Genetic Analysis – Griffiths, Wessler, Carroll and Doebley, W.H. Freeman.
8. Recombinant DNA: Genes and Genomes – A Short Course – James D. Watson et al., W.H. Freeman.
9. Molecular Biotechnology: Principles and Applications of Recombinant DNA – Bernard R. Glick, Jack J. Pasternak and Cheryl L. Patten, ASM Press.
10. Biotechnology – U. Satyanarayana, Books and Allied Pvt. Ltd.
11. Biotechnology: Expanding Horizons – B. D. Singh, Kalyani Publishers.
12. Principles of Genetics – D. Peter Snustad and Michael J. Simmons, Wiley.
13. Essential Genetics and Genomics – Daniel L. Hartl, Jones & Bartlett Learning.
14. Initial sequencing and analysis of the human genome – Published in *Nature* (2001), landmark paper on the Human Genome Project.
15. A Programmable Dual-RNA-Guided DNA Endonuclease in Adaptive Bacterial Immunity – Jennifer A. Doudna and Emmanuelle Charpentier, *Science* (2012), foundational CRISPR-Cas9 research article.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. III (Botany), SEMESTER – VI (NEP)				
Lab/ Practical-	Course Code: 107259	Lab-Based Learning of Mole.Bio. and Genetic Eng. - 2	Max Marks: 25	Time: 4 Hrs.
Q.No.	Exercise		Marks	
1.	Perform Any One Major Experiment from Molecular Biology		10	
2.	Perform Any One Major Experiment from genetic Engineering		5	
3.	Perform any One Exercise from Minor Experiments		5	
4.	External Viva Voce		5	

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. III (Botany), SEMESTER – V (NEP)			
Lab/Practical-	Course Code: 107259	Lab-Based Learning of Mole.Bio. and Genetic Eng. - 1	Max Marks: 25
S. No.	Assessment Criteria		Marks
1	Record/ Assignments		5
2	Attendance		5
3	Participation in Activity/ Field visit		5
4	Students overall performance		5
5	Internal Viva Voce		5

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	107260	Advance Plant Physiology – 2	2	30	2 Hrs	30 (Ext) + 20 (Int)

Course Objectives:				
1. To illustrate the fundamental concepts of plant stress physiology, metabolic processes, and plant-environment interactions.				
2. To deliver in-depth knowledge of plant physiological mechanisms, including stress responses, nutrient assimilation, and signaling pathways.				
3. To present perspectives of current tools, techniques, and applications in plant physiology and related research areas.				
4. To demonstrate core concepts using experimental approaches and learning activities for skill and capacity building in plant sciences.				
Course Outcomes:				
After successful completion of the course, the student will be able to –				
CO-1: Understand the principles of plant stress physiology, plant interactions, nutrient assimilation, and photobiology.				
CO-2: Remember and describe key physiological processes, metabolic pathways, and signaling mechanisms in plants.				
CO-3: Explain plant responses to environmental stresses, nitrogen metabolism, secondary metabolism, and light-mediated regulation.				
CO-4: Develop analytical and experimental skills to investigate plant physiological processes and apply them in agriculture and research contexts.				
Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Plant Stress Physiology	8	8	Suitable pedagogical strategies are separately annexed
1.1 Introduction to plant stress physiology: concept of stress, acclimation and adaptation; types of abiotic stresses - drought, salinity, heat, cold and heavy metal stress.				
1.2 Physiological and biochemical responses of plants to stress: water relations, stomatal regulation, photosynthesis, oxidative stress and reactive oxygen species (ROS).				
1.3 Protective mechanisms in plants under stress: osmoprotectants, antioxidants, stress proteins, phytochelatin, role of membrane lipids in stress tolerance, and accumulation of phytoalexins as antimicrobial defense compounds.				
1.4 Stress signalling and plant defense responses: plant hormones in stress responses (ABA, ethylene, salicylic acid); Hypersensitive Response (HR), Systemic Acquired Resistance (SAR), and role of phytoalexins in induced defense mechanisms.				
Unit II	Plant Interactions, Secondary Metabolism and Nutritional Factors	8	8	
2.1 Secondary Metabolites in Plants: Types and functions of secondary metabolites; major classes including alkaloids, flavonoids, terpenoids, tannins and phenolics; biosynthetic precursors and their role in plant metabolism and ecological interactions.				
2.2 Plant–Microbe Interactions and Secondary Metabolism: Biological nitrogen fixation and the role of flavonoids in signaling; plant–microbe symbiosis; effect of mycorrhizal associations on medicinal plants with emphasis on enhancement of secondary metabolite production.				
2.3 Plant–Plant Interactions: Concept of plant–plant interactions; competitive and facilitative relationships; allelopathy and its ecological significance in plant growth, survival and ecosystem regulation.				

2.4 Antinutritional Factors in Plants: General characteristics of antinutritional factors; role of compounds such as phytic acid and tannins; their impact on nutritional quality and the strategies used for their elimination in plant-based foods			
Unit III	Nitrogen Assimilation and Sustainable Agriculture	7	7
3.1: Nitrogen Fixation: Natural and artificial nitrogen fixation. Concept and significance of biological nitrogen fixation. Free-living and symbiotic nitrogen-fixing microorganisms and their role in plant nutrition. 3.2: Mechanism of Nitrogen Fixation and Symbiosis: Nod factors, nif genes and establishment of symbiosis in leguminous plants. Structure and function of nitrogenase enzyme complex in nitrogen fixation. 3.3: Carbon–Nitrogen Balance and Nutrient Assimilation: C/N balance signaling in plants under elevated CO₂ conditions. Sulfur and phosphate assimilation and their relationship with plant metabolism and growth. 3.4: Applications of BNF in Agriculture: Role of biological nitrogen fixation in sustainable agriculture and crop improvement. Use of biofertilizers and nitrogen-fixing organisms for enhancing soil fertility and crop productivity.			
Unit IV	Sensory Photobiology and Plant Light Responses	7	7
4.1: Photoreceptors in Plants: Types, structure and properties of plant photoreceptors with special reference to phytochromes, cryptochromes and phototropins. Distribution, chromophore composition and physiological significance of photoreceptors in plant development. 4.2: Light Perception and Signal Transduction: Mechanism of light perception and signal transduction mediated by phytochromes, cryptochromes and phototropins. Molecular responses induced by light signaling pathways and regulation of gene expression by light. 4.3: Photoregulated Plant Responses: Photoregulation of stomatal movement and its significance in photosynthesis and transpiration. Mechanism and physiological importance of phototropism and photoperiodic responses in plants. 4.4: Biological Clocks and Circadian Rhythms: Concept and mechanism of biological clocks and circadian rhythms in plants. Role of circadian rhythms in flowering, growth, metabolism and environmental adaptation.			
Activities: (CAT) 1. Observation and recording of stress symptoms in local crop or garden plants under drought, salinity or heat conditions. 2. Comparative study of seed germination under normal and saline conditions using locally available seeds. 3. Group discussion on the impact of climate change on plant stress and agricultural productivity. 4. Visit to a botanical garden/agricultural field to observe stress adaptation in plants and submission of a field report. 5. Assignment on economically important stress-resistant crop varieties developed for drought or salinity tolerance. 6. Students prepare a model to show root nodules, nod factors, nif genes and nitrogenase enzyme system. 7. Students conduct a survey on the use of nitrogen-fixing biofertilizers in local agriculture and submit a short report. 8. Students prepare and present posters on carbon–nitrogen balance and nutrient assimilation under elevated CO₂ conditions. 9. Students participate in a group discussion or debate on the importance of biofertilizers compared to chemical fertilizers in sustainable agriculture. 10. Students interview local farmers about their seasonal planting schedules for different crops, then create a simple "Day-Length Planting Guide". 11. Autobiographical Representation of Alkaloids/Flavonoids (as secondary metabolites) 12. Panel Discussion on “Impact of Mycorrhizal Associations on Medicinal Plants for Enhanced Secondary Metabolite Production”. 13. Dramatic Representation of Allelopathy in Plant–Plant Interactions.			

14. Debate on Antinutritional Factors: Beneficial or Harmful in Plant-Based Foods.
15. Group Discussion on Biological Nitrogen Fixation and Its Agricultural Significance.
References: 1. Hopkins, W. G., & Hüner, N. P. A. (2008). Introduction to plant physiology (4th ed.). John Wiley & Sons. 2. Taiz, L., Møller, I. M., Murphy, A., & Zeiger, E. (2022). Plant physiology and development (7th ed.). Sinauer Associates; Oxford University Press. 3. Bhatla, S. C., & Lal, M. A. (2023). *Plant physiology, development and metabolism* (2nd ed.). Springer Nature Singapore. 4. Cordell, G. A., & Choi, T. (2011). Alkaloids and their biosynthesis. Phytochemistry and pharmacognosy section. Chemical sciences, engineering and technology resources, Encyclopedia of Life Support Systems (EOLSS) developed under the auspices of the UNESCO, EOLSS Publishers, Oxford. 5. Jemo, M., Nkenmegne, S., Buernor, A. B., Raklami, A., Ambang, Z., Souleyamanou, A., ... & Hafidi, M. (2023). Mycorrhizas and Trichoderma fungi increase the accumulation of secondary metabolites in grain legume leaves and suppress foliar diseases in field-grown conditions of the humid forest of Cameroon. <i>BMC Plant Biology</i>, 23(1), 582. 6. Amani Machiani, M., Javanmard, A., Habibi Machiani, R., & Sadeghpour, A. (2022). Arbuscular mycorrhizal fungi and changes in primary and secondary metabolites. <i>Plants</i>, 11(17), 2183. 7. Rashidi, S., Yousefi, A. R., & Mastinu, A. (2024). Mycorrhizal Symbiosis Can Change the Composition of Secondary Metabolites in Fruits of <i>Solanum nigrum</i> L. <i>Chemistry & Biodiversity</i>, 21(7), e202400208. 8. Zhao, Y., Cartabia, A., Lalaymia, I., & Declerck, S. (2022). Arbuscular mycorrhizal fungi and production of secondary metabolites in medicinal plants. <i>Mycorrhiza</i>, 32(3), 221-256. 9. Hussain, W. S. (2020). Allelopathy: allelochemicals a brief review. <i>Plant Archives</i> Volume 20 No. 2, pp. 5556-5560 10. Bai, S. K., Ashwini, R. N., & Geetha, K. N. (2022). Allelopathy in Weed Management-A Review. <i>Mysore Journal of Agricultural Sciences</i>, 56(3), 1.
Model Questions:
One Line Question 1. What is meant by plant stress? 2. Define acclimation in plants. 3. What are reactive oxygen species (ROS)? 4. Name any two Osmoprotectants found in plants. 5. Expand HR and SAR in plant defense responses. 6. Define Secondary metabolite 7. Which suffix is used for alkaloid i? 8. Which is the commonly observed flavonoid in plants ? 9. Name the secondary metabolite secreted for attracting nitrogen fixing bacteria 10. Define Allelopathy 11. Define Allelobiosis 12. Define Anti Nutritional factors 13. Give the types of Mycorrhizae 14. Give the names of Nitrogen fixing organisms(any two) 15. What is nitrogen fixation? 16. What is biological nitrogen fixation? 17. Name one free living nitrogen-fixing bacteria. 18. What are nodules in plants? 19. What is nitrogenase? 20. What are biofertilizers? 21. Define photoperiodism. 22. What are photoreceptors? 23. Which photoreceptor controls phototropism in plants? 24. What is meant by circadian rhythm? 25. Name one plant response controlled by phototropins.

Short Type Questions

1. Differentiate between acclimation and adaptation in plants.
2. Explain the role of membrane lipids in temperature stress tolerance.
3. Describe the effects of drought stress on photosynthesis.
4. Write a short note on phytochelatins and their significance.
5. Explain the role of salicylic acid in plant defense responses.
6. What are the secondary metabolites?
7. Role of Alkaloids in plants
8. Role of Flavonoids in plants
9. Applications of Allelopathy in agriculture
10. Anti-Nutritional effect of Tannin
11. Anti-Nutritional effect of Phytic acid
12. Explain the concept of nitrogen fixation and its importance in plant nutrition.
13. Differentiate between free-living and symbiotic nitrogen-fixing microorganisms.
14. Describe the role of Rhizobium in leguminous plants.
15. What are root nodules and how are they formed?
16. Explain the function of nod factors in symbiosis.
17. What is the nitrogenase enzyme complex and what is its role?
18. Explain the significance of nif genes in nitrogen fixation.
19. explain the mechanism of light perception in plants.
20. How do photoreceptors regulate gene expression in plants?
21. What is stomatal movement and how is it regulated by light?
22. Explain the structure of phytochrome.
23. Describe the role of phototropins in plants.
24. Explain the role of phytochrome in seed germination.
25. What is phototropism? Explain with an example.

Long Type Question

1. Discuss the physiological and biochemical responses of plants under heat and cold stress.
2. Explain the role of antioxidants and stress proteins in plant stress tolerance.
3. Describe the mechanism of stress signalling in plants with reference to ABA and ethylene.
4. Explain the causes, effects and tolerance mechanisms of heavy metal stress in plants.
5. Discuss Systemic Acquired Resistance (SAR) and its importance in plant defense mechanisms.
6. Explain alkaloids in plants with reference to their types, functions and significance.
7. Describe flavonoids in plants, including their classification, functions and biological importance.
8. Discuss the effect of mycorrhizal associations on secondary metabolite production in medicinal plants.
9. Explain anti-nutritional factors in plants in detail, including their types and methods of reduction.
10. Discuss the role of flavonoids in plant–microbe communication and symbiotic relationships.
11. Describe plant–plant interactions with reference to competition, facilitation and allelopathy.
12. Explain the role of secondary metabolites (phenolics, terpenoids and tannins) in plant defense.
13. Discuss the importance of plant interactions and secondary metabolites in ecosystem functioning and agriculture.
14. Explain the process of biological nitrogen fixation and its significance in plant nutrition.
15. Describe the role of free-living and symbiotic nitrogen-fixing microorganisms in soil fertility.
16. Explain the mechanism of symbiotic nitrogen fixation in leguminous plants.
17. Discuss the structure and function of nitrogenase enzyme complex in nitrogen fixation.
18. Explain the applications of biological nitrogen fixation in sustainable agriculture and crop improvement.

19. Describe the types, structure and functions of phytochromes, cryptochromes and phototropins. 20. Explain the mechanism of light perception and signal transduction mediated by phytochromes. 21. Explain the role of phototropins in phototropism and stomatal movement. 22. Discuss phototropism and the role of photoreceptors in directional growth of plants. 23. Explain photoperiodism and its significance in flowering responses of plants. 24. Write a detailed account of biological clocks and circadian rhythms in plants. 25. Discuss the role of circadian rhythms in flowering, growth and environmental adaptation.
Pedagogical Strategies: (Suggestive At least 5 concerning to the Units and Points included in each unit) 1. Flipped Classroom with Conceptual Reinforcement: Pre-lecture learning through curated digital resources followed by in-class deep discussions on plant stress physiology, metabolic integration, and signaling networks. 2. ICT-Driven Simulation Learning: Use of advanced animations, molecular simulations, and virtual labs to model nitrogen fixation, photoreceptor signaling, ROS dynamics, and circadian regulation. 3. Case-Based and Problem-Solving Pedagogy: Real-world agricultural and ecological case studies on climate stress, nutrient imbalance, biofertilizer efficiency, and crop adaptation strategies. 4. Inquiry and Research-Oriented Learning: Student-led mini investigations on plant stress responses, secondary metabolite variation, and microbial interactions using hypothesis-driven approaches. 5. Experiential and Field-Embedded Learning: Direct observation and analysis of plant physiological responses in agro-ecosystems, including stress symptoms, allelopathy, and biofertilizer application sites.

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
5.5	VI	107261	Lab-Based Learning of Advance Plant Physiology - 2	2	60	4 Hrs	25 (Ext)+ 25 (Int)

Course Objectives: 1. To develop practical skills in plant stress physiology and plant–microbe interaction studies. 2. To train students in basic laboratory and microscopy techniques related to plant physiological experiments. 3. To familiarize students with simple methods for studying secondary metabolites, stress responses and biological nitrogen fixation. 4. To enhance observational, analytical and field-based learning skills through experiments and activities.
Course Outcomes: The students will be able to - CO 1: Identify and describe different plant stress responses, secondary metabolites, plant–microbe interactions and photomorphogenic phenomena. CO 2: Explain the physiological and biochemical mechanisms involved in stress tolerance, biological nitrogen fixation and plant interactions. CO 3: Conduct experiments to observe seed germination responses, nodulation, phototropic responses and stress-induced physiological changes in plants. CO 4: Analyze the processes of biological nitrogen fixation, allelopathy, secondary metabolite production and plant adaptation under stress conditions. CO 5: Evaluate the role of environmental factors, beneficial microbes and antinutritional factors in plant growth and development. CO 6: Design and execute experiments to demonstrate key concepts related to plant stress physiology, plant–microbe interactions and light-mediated growth responses.
Major Experiments (At least 15 out of which Perform any SEVEN) 1. Estimation of chlorophyll content under stress conditions. 2. Effect of salinity/drought stress on seed germination and seedling growth. 3. Effect of heavy metal stress on seed germination. 4. Qualitative tests for major secondary metabolites in plant materials (alkaloids, tannins, flavonoids, phenols and terpenes). 5. Demonstration of allelopathic effect of plant extracts on seed germination and seedling growth. 6. Study of root nodules in leguminous plants and observation of biological nitrogen fixation. 7. Separation and identification of alkaloids from plant extract using Thin Layer Chromatography (TLC). 8. Comparative growth study of leguminous and non-leguminous plants under nitrogen-deficient conditions. 9. Isolation and observation of <i>Rhizobium</i> bacteria from legume root nodules. 10. To demonstrate the growth response of a plant shoot toward light (phototropism). 11. To study seedling de-etiolation under light exposure. 12. To study red and blue light responses in germinating seedlings. 13. Measurement of hypocotyl elongation under different conditions light and dark. 14. Comparative study of seed germination after soaking/boiling treatment to demonstrate reduction of antinutritional factors. 15. Study of plasmolysis and deplasmolysis in plant cells under different salt concentrations. Minor Experiments (At least 10 out of which Perform any FIVE) 1. Study of stomatal response under water stress using leaf peel technique. 2. Estimation of Relative Water Content (RWC) under drought stress. 3. Collection and comment on medicinal plants rich in secondary metabolites. 4. Observation of mycorrhizal association in plant roots using stained root samples.

5. Observation on mycorrhizal association using permanent slide.
6. Observation and diagrammatic study of nitrogenase enzyme complex and root nodule structure using charts/models/slides.
7. Comparative observation of plant growth under normal and elevated CO₂ conditions using simple enclosed chamber setup.
8. Microscopic observation of infection threads and nodules in legume roots using permanent slides.
9. To demonstrate chloroplast movement in response to light intensity.
10. Demonstration of shade avoidance response in seedlings.

Activities (Perform at least any Two as CAT)

1. Collection and documentation of xerophytic or stress-tolerant plants from nearby areas, highlighting their adaptive features.
2. Survey and documentation of allelopathic plants found in the local area.
3. Collection and observation of root nodules from different leguminous plants.
4. Observations of competitive interactions among weeds and crop plants in nearby fields or gardens.
5. Group discussion on biological nitrogen fixation by free living and symbiotic bacteria

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1. https://www.researchgate.net/publication/369196458_Plant_Physiology-Practical_Mannual- BOT-232
2. <https://open.umn.edu/opentextbooks/textbooks/1891>
3. https://openlibrary.org/books/OL7251302M/Practical_physiology_of_plants
4. https://commons.wikimedia.org/wiki/File%3AExperimental_plant_physiology_for_beginners_%28IA_cu31924000661532%29.pdf
5. https://commons.wikimedia.org/wiki/File%3APractical_plant_biology%3B_a_course_of_elementary_lectures_on_the_general_morphology_and_physiology_of_plants_%28IA_practicalplantbi00dixorich%29.pdf
6. https://www.biodiversitylibrary.org/item/199736?utm_source=chatgpt.com#page/5/mode/1up

Digital Resources like Weblinks

1. <https://global.oup.com/academic/product/plant-physiology-and-development-9780197614204>
2. <https://link.springer.com/book/10.1007/978-981-19-6436-9>
3. <https://link.springer.com/book/10.1007/978-94-009-5570-7>
4. <https://link.springer.com/book/10.1007/978-3-642-96168-7>

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. III (Botany), SEMESTER – VI (NEP)				
Lab/ Practical-Major-Elective P3	Course Code: 107261	Lab-Based Learning of Advance Plant Physiology - 2	Max Marks: 25	Time: 4 Hrs.
Q.No.	Exercise		Marks	
1.	Perform Any One Major Experiment from the list on Plant Stress Physiology.		7	
2.	Perform Any One Minor Experiment from the list		5	
3.	Perform qualitative tests (any two) for major secondary metabolites in plant materials.		5	
4.	Comment/Demonstration of any One experiment from the list.		3	
5.	External Viva Voce		5	

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI Internal Practical Assessment B.Sc. III (Botany), SEMESTER – VI (NEP)			
Lab/Practical-	Course Code: 107261	Lab-Based Learning of Advance Plant Physio logy - 2	Max Marks: 25
S. No.	Assessment Criteria		Marks
1	Record/ Assignments		5
2	Attendance		5
3	Participation in Activity/ Field visit		5
4	Students overall performance		5
5	Internal Viva Voce		5

Course Type	Sem	Course Code	Course Title	Credits	Workload	Exam Duration	Maximum Marks
Major-Elective T4	VI	107262	Basic and Applied Mycology and Plant Pathology-2	2	2	2.00 Hrs	30 (Ext.) 20 (Int)

Course Objectives:				
1. To illustrate the role of fungi in soil fertility, plant growth promotion, Mycoremediation, and sustainable agricultural practices.				
2. To deliver knowledge regarding medicinal fungi, human fungal diseases, mycotoxins, and the ethnic importance of fungi in human welfare.				
3. To present perspectives of fungal applications in fermentation technology, bakery production, Myconanotechnology, and mushroom cultivation industries.				
4. To demonstrate the concepts of plant pathology, disease symptoms, disease management, and important plant diseases through different academic activities for capacity building.				
Course Outcomes:				
After Successful completion of the course, the student will be able to –				
CO-1: Understand the role of fungi in agriculture, soil fertility, plant growth promotion, Mycoremediation, and biological control.				
CO-2: Remember the medicinal importance of fungi, types of human fungal diseases, mycotoxins, and ethnic values of fungi.				
CO-3: Explain the industrial applications of fungi in fermentation technology, bakery production, Myconanotechnology, and mushroom cultivation.				
CO-4: Develop scientific understanding and analytical skills regarding plant diseases, disease symptoms, disease management, and applied plant pathology.				
Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Agriculture Mycology	8	8	Suitable pedagogical strategies are separately annexed
1.1: Role of fungi in soil fertility - fungi as a decomposer				
1.2: Fungi as a plant growth promoter <i>Gibberella fujikuroi</i>				
1.3: Mycoremediation and soil quality				
1.4: Mycopesticides, Mycoherbicides, and Nematophagous fungi				
Unit II	Medical Mycology	8	8	
2.1: Medicinal mushroom <i>Ganoderma</i> and <i>Cordyceps</i>				
2.2: Types of human fungal diseases (mycoses) – Superficial, Subcutaneous and Systemic				
2.3: Mycotoxins and their types- Aflatoxins and Ochratoxins				
2.4: Ethnic values of fungi				
Unit III	Industrial Mycology	7	7	
3.1: Role of fungi in Fermentation technology				
3.2: Role of fungi in Bakery production				
3.3: Concept and applications of Myconanotechnology				
3.4: Cultivation technology of <i>Pleurotus</i> spp. and its nutraceutical values				
Unit IV	Plant Pathology	7	7	
4.1: Introduction to plant pathology with reference to definition and history, Plant pathology institute in India (IARI, Pusa, New Delhi)				
4.2: Plant disease symptoms – Viral, Bacterial, Fungal and Phytoplasmal				
4.3: Disease management – Cultural, Biological, Host resistance and Chemical				

4.4: Disease study- i) Leaf curl of Papaya, ii) Citrus canker, iii) Tikka disease of Groundnut, iv) Little leaf of Brinjal	
Activities: (Suggestive 10 applicable to use as CAT- Perform any Three) 1. Preparation of charts on agricultural, medical, industrial, and plant pathogenic fungi. 2. Poster presentation on useful and harmful fungi. 3. Seminar on medicinal mushrooms and their applications. 4. Assignment on mycotoxins and fungal diseases. 5. Group discussion on the role of fungi in agriculture and industry. 6. Preparation of models showing fungal structures and plant disease symptoms. 7. Survey report on common plant diseases in local crops. 8. Presentation on mushroom cultivation and nutraceutical values. 9. Preparation of herbarium of infected plant specimens. 10. Case study/report writing on disease management methods and fungal applications.	
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Model Questions: One Line Question 1. Define Mycoremediation. 2. Name one fungus used as a plant growth promoter. 3. What are Mycopesticides? 4. Name one medicinal mushroom. 5. Define mycoses. 6. What is aflatoxin? 7. Name one fungus used in fermentation. 8. What is Myconanotechnology? 9. Name one edible mushroom cultivated commercially.	

10. What is plant pathology? 11. Define disease triangle. 12. Name one bacterial plant disease. 13. What is Citrus canker? 14. Name one fungal disease of groundnut. 15. What is little leaf disease of Brinjal?
Short Type Questions 16. Explain the role of fungi in soil fertility. 17. Write a short note on <i>Gibberella fujikuroi</i> . 18. What is Mycoremediation? Explain briefly. 19. Write short notes on Mycopesticides. 20. Describe the medicinal importance of <i>Ganoderma</i> . 21. Explain different types of mycoses. 22. Write a short note on aflatoxins. 23. Explain the ethnic values of fungi. 24. Describe the role of fungi in fermentation technology. 25. Write short notes on bakery products prepared using fungi. 26. Explain the concept of Myconanotechnology. 27. Describe the cultivation method of <i>Pleurotus</i> spp. 28. Write a short note on disease triangle. 29. Explain different methods of plant disease management. 30. Describe symptoms of Citrus canker.
Long Type Question 1. Explain the role of fungi in soil fertility and decomposition. 2. Discuss the importance of <i>Gibberella fujikuroi</i> as a plant growth promoter. 3. Describe the concept and applications of mycoremediation. 4. Explain mycopesticides, mycoherbicides, and nematophagous fungi. 5. Write a detailed note on medicinal mushrooms with reference to <i>Ganoderma</i> and <i>Cordyceps</i> . 6. Explain different types of human fungal diseases (mycosis). 7. Describe mycotoxins and their types with special reference to aflatoxins and ochratoxins. 8. Write an essay on ethnic values of fungi. 9. Explain the role of fungi in fermentation technology. 10. Describe the role of fungi in bakery production. 11. Explain the concept and applications of myconanotechnology. 12. Discuss the cultivation technology and nutraceutical values of <i>Pleurotus</i> spp. 13. Define plant pathology and explain its history and importance. 14. Explain different plant disease symptoms and disease management methods. 15. Describe symptoms, causal organism, and control measures of Leaf curl of Papaya, Citrus canker, Tikka disease of Groundnut, and Little leaf of Brinjal.
Pedagogical Strategies: (Suggestive At least 5 concerning to the Units and Points included in each unit) Lecture Method with ICT Support Use charts, PPTs, videos, and diagrams to explain agricultural, medical, industrial, and plant pathological aspects of fungi. Demonstration Method Demonstrate mushroom cultivation, fungal cultures, disease symptoms, and fermentation processes for better practical understanding. Field Visit and Survey Method Organize visits to agricultural fields, nurseries, mushroom units, or local farms for observation of fungi and plant diseases. Activity and Project-Based Learning Encourage preparation of posters, charts, herbarium, disease models, and assignments related to fungi and plant pathology. Group Discussion and Seminar Method

Conduct discussions and student seminars on medicinal fungi, mycotoxins, mycoremediation, and disease management.

6. Experimental and Laboratory Learning

Provide hands-on experience in fungal observation, slide preparation, culture techniques, and disease identification.

7. Problem-Solving and Case Study Approach

Discuss case studies related to crop diseases, fungal infections, and industrial applications of fungi.

8. Collaborative Learning Strategy

Promote teamwork through group practicals, field surveys, presentations, and mini-project activities.

Course Type	Sem	Course Code	Course Title	Credits	Workload	Exam Duration	Maximum Marks
Major-Elective P4	VI	107263	Lab-Based Learning of Basic and Applied Mycology and Plant Pathology-2	2	4	4.00 Hrs	25 (Ext.) 25 (Int)

Course Objectives: 1. To develop basic laboratory skills for observation, isolation, culturing, and identification of agriculturally, medically, and industrially important fungi. 2. To provide hands-on training in microscopic techniques, fungal slide preparation, culture media preparation, and mushroom cultivation methods. 3. To acquaint students with practical applications of fungi in agriculture, fermentation technology, bakery production, medicine, and plant disease management. 4. To enhance scientific attitude and experimental skills through field surveys, fungal collection, disease symptom studies, and simple mycological experiments.
Course Outcomes: CO 1: Identify and describe fungal structures, spores, medicinal mushrooms, and plant disease symptoms using simple laboratory techniques. CO 2: Explain the morphology, applications, and economic importance of agricultural, medical, and industrial fungi through practical observations. CO 3: Conduct experiments related to fungal culturing, fermentation, mushroom cultivation, and observation of fungal growth using basic laboratory methods. CO 4: Analyze the role of fungi in soil fertility, medicine, bakery production, plant disease development, and disease management through experimental studies. CO 5: Evaluate the importance of beneficial fungi in agriculture, biotechnology, medicine, and environmental applications. CO 6: Design and execute practical experiments related to fungal isolation, cultivation, disease identification, preservation, and applied mycological techniques.
Major Experiments (Perform any SEVEN) 1. Observation of fungi from soil samples. 2. Study of decomposer fungi from leaf litter. 3. Observation of <i>Gibberella fujikuroi</i> culture/specimen. 4. Study of mycopesticidal fungi using charts/specimens. 5. Observation of medicinal mushrooms – <i>Ganoderma</i> and <i>Cordyceps</i>. 6. Study of fungal disease symptoms in humans using charts/models. 7. Observation of aflatoxin-producing <i>Aspergillus</i> species. 8. Demonstration of yeast fermentation using sugar solution. 9. Demonstration of dough rising by yeast in bakery products. 10. Observation of <i>Pleurotus</i> mushroom morphology. 11. Simple cultivation of <i>Pleurotus</i> on straw substrate. 12. Study of viral disease symptoms in plants. 13. Observation of Citrus canker infected leaves. 14. Observation of Tikka disease symptoms in groundnut leaves. 15. Observation of Little leaf disease of brinjal. Minor Experiments (Perform any FIVE) 1. Study of instruments- Descending and Binocular microscope 2. Study of instruments- Oven and Autoclave 3. Study of instruments- Incubation chamber 4. Study of instruments- Laminar air flow 5. Observation of fungal hyphae and mycelium. 6. Preparation of temporary fungal slide. 7. Observation of fungal spores under microscope.

8. Study of septate and aseptate mycelium.
9. Preparation of Potato Dextrose Agar (PDA) medium.
10. Observation of edible mushrooms.
11. List of fungi used as Mycopesticides, Mycoherbicides and Nematophages
12. Prepare the list of Rhizosphere fungi and their roles as decomposer

Activities (Perform any Two as CAT)

1. Preparation of e-herbarium of common fungi from soil, bread, fruits, or infected plants.
2. Preparation of charts/posters on useful and harmful fungi.
3. Survey and observation of plant diseases in nearby agricultural fields.
4. Seminar/presentation on medicinal and industrial importance of fungi.
5. Observation and photographs of fungal growth on different food materials.
6. Field visit for pathological survey
7. Visit to Agriculture / plant pathology institute

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- National Digital Library of India (NDLI) – <https://ndl.iitkgp.ac.in/>
- Internet Archive – Mycology Books – <https://archive.org/details/texts>
- Google Books – Introductory Mycology – <https://books.google.com/>
- Elsevier eBooks – Plant Pathology – <https://www.elsevier.com/books-and-journals>
- SpringerLink – Medical Mycology Resources – <https://link.springer.com/>
- FAO Mushroom Cultivation Manual – <https://www.fao.org/>
- NPTEL Biotechnology Courses – <https://nptel.ac.in/courses>

Digital Resources like Weblinks

- [American Phytopathological Society \(APS\)](#) - Plant disease images, fungal pathogen information, and teaching resources.
- [MycoBank](#) -For fungal taxonomy and nomenclature.
- [Centers for Disease Control and Prevention – Fungal Diseases](#) – For human fungal diseases and pathogenic fungi.
- [Microbe Notes](#) - Simple practical microbiology protocols, fungal identification notes, and diagrams.
- [Tamil Nadu Agricultural University Agritech Portal](#) - For plant disease symptoms, fungal diseases, and management practices for agricultural crops.

Educational Software, Databases, etc.

- ImageJ Software – <https://imagej.net/ij/> - Free image analysis software useful for fungal microscopy observations.
- Motic Microscope Software – <https://www.motic.com/> - Digital microscopy software for observing fungal specimens and laboratory slides.
- MycoPortal Database – <https://mycoportal.org/> - Online fungal specimen and taxonomy database.
- NCBI Database – <https://www.ncbi.nlm.nih.gov/> - Molecular biology and microbiology database useful for fungal research.
- Virtual Microscope Lab – <https://www.olympus-lifescience.com/en/microscope-resource/> - Educational microscopy demonstrations and fungal observation guides.

Question Paper for External Practical Course

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. III (Botany), SEMESTER – VI (NEP)				
Major-Elective P4	Course Code: 107263	Lab-Based Learning of Basic and Applied Mycology and Plant Pathology-2	Max Marks: 25	Time: 4 Hrs.
Q.No.	Exercise			Marks
1.	Perform Any One Major Experiment			10
2.	Perform Any One Minor Experiment			5
3.	Spotting (Five Spots One Mark Each)			5
4.	External Viva Voce			5
5.				25

Assessment Rubric for Internal Practical Course

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. III (Botany), SEMESTER – VI (NEP)			
Major-Elective P4	Course Code: 107263	Lab-Based Learning of Basic and Applied Mycology and Plant Pathology-2	Max Marks: 25
S. No.	Assessment Criteria		Marks
1	Record/ Assignments		5
2	Attendance		5
3	Participation in Activity/ Field visit		5
4	Students overall performance		5
5	Internal Viva Voce		5

Minor Course: Molecular Biology, Genetic Engineering and Biotechnology

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.5	VI	107264	Molecular Biology, Genetic Engineering and Biotechnology	2	30	2 Hrs.	30 (Ext) + 20 (Int)

Course Objectives:

1. To illustrate the basic cellular processes of plants at molecular level and principles of Plant tissue culture.
2. To deliver practical skills
3. To present perspectives of the current tools for application and research.
4. To demonstrate the concept using different activities for building capacity.

Course Outcomes:

After Successful completion of the course, the student will be able to –

CO-1: Analyze molecular structure and organization of genome

CO-2: Evaluate the basic principles and history of plant tissue culture

CO-3: Apply the importance of aseptic techniques

CO-4: Demonstrate skills in plant regeneration and hardening

CO-5: Interpret the role of genetic engineering in crop improvement

CO-6: Critically assess the various methods of direct DNA transfer

CO-3: Critically assess the various methods of direct DNA transfer				
Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporati on of Pedagogies
Unit I	Fundamentals of Molecular Biology	8	8	Suitable pedagogica l strategies are separately annexed
1.1: History and scope of Molecular Biology; Nucleic acids as genetic material: Griffith's experiment, Chemical composition and structural organization of DNA and RNA. 1.2: Overview of DNA replication; Semi-conservative replication, replication fork and Okazaki fragments 1.3: Gene Expression: Transcription, Genetic code and Translation (protein synthesis) 1.4: Regulation of gene expression in prokaryotes: Lac Operon concept				
Unit II	Genetic Engineering	8	8	
2.1: Concept and scope of recombinant DNA Technology. 2.2: Tools – Enzymes, Cloning vectors: Properties and types of vectors. 2.3: Methods of gene transfer – Electroporation and Gene Gun method. 2.4: PCR, CRISPR-Cas 9 system of gene editing, Gene therapy, Biosafety, bioethics and environmental concerns of genetic engineering				
Unit III	Plant Tissue Culture and Applications	7	7	
3.1: History, Concept and scope of Plant Tissue Culture 3.2: Organization of tissue culture laboratory and aseptic conditions, Essential equipment and materials: Laminar Air Flow, Autoclave, Growth Chamber and Hot Air Oven, Sterilization methods and preparation of culture media (MS Media) 3.3: Totipotency and differentiation, Callus culture and organogenesis, Micropropagation and its stages 3.4: Tissue Culture Applications: Anther and Pollen culture, Protoplast Culture, , Somatic Hybridization, Germplasm conservation.				
Unit IV	Biotechnology and Crop Improvement	7	7	

4.1: Role of biotechnology in sustainable agriculture, Conventional plant breeding versus modern biotechnology, Crop improvement strategies 4.2: Introduction to transgenic plants (Bt Cotton), Biofortified crops, Advantages and limitations of GM crops 4.3: Edible vaccines - Concept and Mechanism of action, advantages and disadvantages 4.4: Nanobiotechnology: Introduction, Principle and Synthesis of Nanoparticle, Applications of nanomaterials in plant drug delivery.	
Activities: (Conduct any Three as CAT) 1. Micro teaching activity on biotechnology concepts 2. Industry/Research laboratory visit and report writing 3. Group discussion on recent advances in biotechnology 4. Demonstration of explant sterilization techniques 5. Student seminar and scientific presentation 6. Unit test / Quiz / Objective assessment 7. Explore Protein Data Bank (PDB) to visualize protein 3D structures and study molecular interactions 8. Study of plant databases and biological repositories (NCBI, TAIR, GenBank, KEGG etc.) 9. Demonstration/virtual simulation of Agrobacterium-mediated gene transfer in plants 10. Poster presentation on molecular biology and genetic engineering applications 11. Assignment on biosafety and bioethics in biotechnology 12. Visit to nursery, tissue culture laboratory or agricultural biotechnology center 13. Preparation of flow charts/models of recombinant DNA technology	
References: (APA Style) 1. Alberts, B. Bray, D. Lewis, J. Raff, M. Roberts, K. and Watson, I. D. (1999). Molecular Biology of Cell - Garland Publishing Co. Inc New York, U.S.A. 2. Bhojwani, S. S. (Ed.). (2012). Plant tissue culture: applications and limitations (Vol. 19). Elsevier. 3. Chauhan, A. K. (2009). A textbook of molecular biotechnology. IK International Pvt Ltd. 4. Clark, D. P., & Pazdernik, N. J. (2015). Biotechnology. Newnes. 5. Chauhan, A. K. (2009). A textbook of molecular biotechnology. IK International Pvt Ltd. 6. Devi, P. (2000). Principles and Methods of Plant Molecular Biology, Biochemistry and Genetics, Agrobios, Jodhpur, India. 7. Dubey, R. C. (2022). A textbook of Biotechnology. S. Chand Publishing. 8. Gardner, E.J.; Simmons, M.J. ; Snustad,,D.P.(1991).Principles of Genetics, John Wiley & Sons, India 9. & Sons, India 10. Gene-IX, 9th edition. Benjamin Lewin, Jones and Bartlett Publisher, 2008. 11. Gupta, P. K. (1999). A Text book of Cell and Molecular Biology, Rastogi Publication, Meerut, India. 12. Gupta, P. K. (2008). Microbiology Cell Physiology and Biotechnology. Rastogi Publications. 13. Gupta P. K. (2018) Molecular Biology and Biotechnology, Rastogi Publication. 14. Karp,G.(2010). Cell Biology, John Wiley & SonsU.S.A. 6th edition. 15. Lea, P. J. and Leegood, R. C. (1999). Plant Biochemistry and Molecular Biology. John Wiley & Sons, Chichester, England. 16. Nair, A. J. (2004). Basics of biotechnology. Firewall Media. 17. Pathak, R. (2007). Introduction to biotechnology. Atlantic Publishers & Dist. 18. Principles of Genetics, 7th Edition, Robert H. Tamarin. 2002. TATA- Mc Graw Hill publication 19. Renneberg, R. (2023). Biotechnology for beginners. Academic Press. 20. Smith, R. H. (2013). Plant tissue culture: techniques and experiments. academic press. 21. Singh, B D. (2010). Biotechnology. Kalyani Publisher 22. Theory and Problems of Genetics. W. D. Stansfield. 2002. TATA_Mc Graw Hill Publication	

Model Questions:
One Line Question 1. What is DNA. 2. Define the process of Transcription. 3. Name the enzymes that joins DNA molecule together. 4. Name the Bacteria Used for Griffiths experiment. 5. Role of Auxins in Tissue Culture 6. Importance of Aseptic conditions in tissue culture 7. What is Callus 8. What is Culture Media 9. Write name of growth hormones for Plant tissue culture 10. Totipotency 11. What is Micropropagation 12. What is mean by Sterilization 13. Define Explant 14. Define Differentiation 15. What is mean by Protoplast 16. Transgenic plant 17. Somatic hybridization 18. What are edible vaccines 19. What are GMOs 20. Which bacteria is used in Bt technology 21. What is gene
Short Type Questions 1. Griffiths Experiment 2. Chemical Composition of DNA. 3. Enzymes of DNA Replication 4. Genetic Code 5. Discuss the role of Plant growth regulators in plant tissue culture 6. Explain the significance of macronutrients and micronutrients in the culture medium 7. Describe role of Autoclave in Plant tissue culture 8. Explain role of Laminar Air Flow in Plant tissue culture 9. Write about Callus culture 10. Explain Cellular Totipotency 11. Explain Haploid production 12. Importance of Autoclave 13. Importance of Growth chamber 14. Describe Anther culture 15. Explain Protoplast culture 16. Write about artificial seeds 17. Give the mechanism of action of Bt Cotton
Long Type Question 1. Describe the double helical model of DNA. 2. Describe the mechanism of translation. 3. Explain Gene Regulation in Eukaryotes. 4. Explain in detail sterilization techniques used in Plant tissue culture 5. Describe in detail Preparation of media 6. Explain stages of Micropropagation 7. Describe growth hormones used in plant tissue culture 8. Explain anther and pollen culture 9. Describe somatic hybridization in detail 10. Explain in detail polymerase Chain reaction
Pedagogical Strategies: (Suggestive At least 5 concerning the Units and Points included in each unit) 1. Demonstration Cum-Hands on Laboratory Training

Plant tissue culture requires precise sterile handling, which students learn best through guided demonstrations.

Strategies:

- 1.Live demonstrations
2. Video-assisted demonstrations
3. Stepwise protocol modeling
4. Project Based Learning for better understanding of Molecular Biology.
5. Case Studies on how plant mitigate to abiotic stress and pathogens.

Main Skills to Demonstrate

- 1.Laminar airflow usage
- 2.Sterilization procedures
- 3.Media pouring
- 4.Explant inoculation
- 5.Subculturing

2.Collaborative Working

PTC labs naturally support teamwork.

Strategy

Assign students to small groups with rotating responsibilities:

- Media preparation
- Sterilization
- Inoculation
- Observation recording
- Data analysis

Benefit

Builds communication and laboratory management skills.

3.Visual & Multimedia Working

Plant tissue culture processes are dynamic and microscopic.

Use:

- 1.Time-lapse videos of callus/shoot formation
- 2.Microscopy images
- 3.Virtual lab simulations
- 4.Animated hormone interaction models

Topics for Visualization:

- 1.Somatic embryogenesis
- 2.Organogenesis
- 3.Contamination pathways
- 4.Hormonal regulation

4.Flipped Classroom Strategy

Before Class

Students watch:

- 1.Short videos
- 2.Protocol walkthroughs
- 3.Safety tutorials

During Class

Use time for:

- 1.Discussion
- 2.Troubleshooting
- 3.Hands-on work
- 4.Data interpretation

Advantage

Maximizes active learning during limited laboratory hours.

Minor Practical: Experimental Molecular Biology, Genetic Engineering and Biotechnology

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.5	VI	107265	Experimental Molecular Biology, Genetic Engineering and Biotechnology	2	60	4 Hrs.	25 (Ext)+ 25 (Int)

Course Objectives:

1. Understand and apply fundamental laboratory techniques
2. Develop practical skills in handling biological materials
3. Perform experimental procedures accurately and systematically
4. Demonstrate aseptic techniques and biosafety practices

Course Outcomes:

- CO 1: Identify and describe experimental errors
 CO 2: Explain the principles and applications of basic techniques
 CO 3: Conduct experiments to observe
 CO 4: Analyze the processes
 CO 5: Evaluate the accuracy and effectiveness of preparation methods for culture media
 CO 6: Design and execute experiments to demonstrate key

Major Experiments (Any TEN)

1. DIY (Do it Yourself) Preparation of Double Helical model of DNA
2. Isolation of plant genomic DNA by crude extraction method
3. Estimation of DNA by Diphenylamine method
4. Separation of DNA by Agarose Gel Electrophoresis
5. Estimation of RNA by Orcinol Reagent
6. Extraction and Partial purification of Protein from plant source by Ammonium sulphate precipitation.
7. Preparation of Murashige and Skoog (MS) culture media
8. Surface sterilization of explants for tissue culture
9. In vitro carrot propagation / carrot callus culture
10. Isolation of protoplast by Mechanical method
11. Preparation of artificial seeds using sodium alginate method
12. Synthetic seed germination study
13. DIY preparation of simple centrifuge model using locally available materials
14. Demonstration of PCR workflow through charts/videos/virtual lab
15. Preparation of flow charts/models of recombinant DNA technology
16. DNA fingerprinting pattern analysis using photographs/simulated data
17. Preparation of nanoparticle models using clay/chart materials
18. Green synthesis of silver nanoparticles using plant extract
19. Observation of color change during nanoparticle synthesis

Minor Experiments (ANY FIVE)

1. Study of the effect of abiotic stress (salinity/drought/temperature) on seed germination
2. Preparation of DNA Amplification Flow in PCR for Ten Cycles
3. Study of the principle, working and applications of centrifuge
4. Study of the principle, working and applications of spectrophotometer
5. Study of the principle, working and applications of autoclave
6. Study of the principle, working and applications of Laminar Air Flow cabinet
7. Sterilization of media and glassware used in tissue culture
8. Demonstration of the technique Micropropagation technique
9. Pollen viability test using suitable stains
10. Seed germination test under nanoparticle treatment

Activities (Conduct any Two as CAT)

1. Micro teaching activity on molecular biology or biotechnology concepts
2. Comparison of DNA or RNA molecules of different material by size using Agarose Gel Electrophoresis (demonstration/data interpretation)
3. Identification of amino acids from given mRNA codons using genetic code chart
4. Industry/Research laboratory/Tissue culture laboratory visit and report writing
5. Group discussion on recent advances in biotechnology and genetic engineering
6. Poster presentation on GM crops, edible vaccines or nanobiotechnology
7. Seminar presentation on applications of biotechnology in agriculture and medicine
8. Assignment on transgenic crops and their agricultural importance
9. Debate on advantages and limitations of genetically modified organisms (GMOs)
10. Case study discussion on biosafety and bioethics in genetic engineering

Bibliography:**Reference/Text Books/Research Articles**

1. Bhojwani, S. S., & Razdan, M. K. (1986). Plant tissue culture: theory and practice (Vol. 5). Elsevier.
2. Chawla, H. S. (2011). Introduction to plant biotechnology (3/e). CRC Press.
3. Green, M. R and Sambrook, J. (2012). Molecular cloning: A Laboratory Manual Vol 1, 2 and 3 CSHL, Press, New York.
4. Lindsey, K. (Ed.). (2013). Plant Tissue Culture Manual-Supplement 7: Fundamentals and Applications. Springer Science & Business Media.
5. Mamatha D. M, Suvarnalatha A and Shree Santhi S. (2016). Laboratory Manual for Molecular Biology. International E- Publication, Indore.
6. Pullaiah, T., Rao, M. S., & Sreedevi, E. (2017). Plant Tissue Culture: Theory & Practicals 2nd Ed. Scientific Publishers.
7. Sathyanarayana, B. N., & Varghese, D. B. (2007). Plant tissue culture: practices and new experimental protocols. IK International Pvt Ltd.
8. Trigiano, R. N., & Gray, D. J. (2016). Plant tissue culture, development, and biotechnology. CRC Press.

E-Contents, E-Books (Free Available or Purchase Links)

1. Smith, R. H. (2013). Plant tissue culture: techniques and experiments. academic press.
2. Bhojwani, S. S., & Razdan, M. K. (1986). Plant tissue culture: theory and practice (Vol. 5). Elsevier.
3. Reinert, J., & Yeoman, M. M. (2012). Plant cell and tissue culture: a laboratory manual. Springer Science & Business Media.
4. Pullaiah, T., Rao, M. S., & Sreedevi, E. (2017). Plant Tissue Culture: Theory & Practicals 2nd Ed. Scientific Publishers.
5. Birch, R. G. (1997). Plant transformation: problems and strategies for practical application. Annual review of plant biology, 48(1), 297-326.

Digital Resources like Weblinks

1. https://www.youtube.com/shorts/b7_NzxsOTLo
2. <https://www.youtube.com/shorts/HEKpqhS6mrY>
3. <https://www.youtube.com/shorts/I-YglUUNYTO>
4. <https://www.instagram.com/reel/DKJLLHvhytE/>
5. <https://www.facebook.com/newyeargardenlab/videos/-step-by-step-guide-to-preparing-plant-explants-for-surface-sterilization-laying/1087229450131094/>
6. https://www.reddit.com/r/Horticulture/comments/1qeir6r/plant_tissue_culture_how_i_micropropagate/
7. <https://www.instagram.com/reel/DUNy1ByjcPb/>
8. <https://www.genome.gov/about-genomics/teaching-tools/Transcription-Translation>

9. <https://research.sanfordhealth.org/sanford-promise/resources/printables/transcription-translation-looping-activity>

Educational Software, Databases, etc.

<https://www.arabidopsis.org/>

<https://cincinnatizoo.org/exceptional-plant-conservation-network/tools-for-exceptional-plant-in-vitro-research/comparative-in-vitro-civ-database/>

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION B.Sc. III (Botany), SEMESTER – VI (NEP)				
Lab/ Practical-	Course Code: 107265	Experimental Molecular biology, Genetic Engineering and Biotechnology	Max Marks: 25	Time: 4 Hrs.
Q.No.	Exercise		Marks	
1.	Perform Any One Major Experiment from Mole. Bio		5	
2.	Perform Any One Major Experiment from Plant Tissue Culture		5	
3.	Perform Any One Major Experiment from Nanobiotechnology		5	
4.	Perform any One Exercise from Minor Experiments		5	
5.	External Viva Voce		5	

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Lab/Practical-	Course Code: 107265	Experimental Molecular biology, Genetic Engineering and Biotechnology	Max Marks: 25
S. No.	Assessment Criteria		Marks
1	Record/ Assignments		5
2	Attendance		5
3	Participation in Activity/ Field visit		5
4	Students overall performance		5
5	Internal Viva Voce		5

Vocational Skill Enhancement Courses

Course Type	Sem	Course Code	Course Title	Credits	Workload	Exam Duration	Maximum Marks
VSC-P	VI	107266	Entrepreneurship for Botanists	2	4	4.00 Hrs	25 (Ext.) 25 (Int)

Course Objectives:

1. To illustrate the fundamental concepts, scope, and opportunities of entrepreneurship in Botany and plant-based industries.
2. To deliver knowledge of entrepreneurial skills, business planning, innovation, and sustainable utilization of botanical resources.
3. To present perspectives of the current tools, technologies, and research applications related to plant biotechnology, herbal products, biofertilizers, floriculture, and allied sectors.
4. To demonstrate entrepreneurial concepts through different practical activities, case studies, field visits, and capacity-building exercises for self-employment and startup development.

Course Outcomes:

After Successful completion of the course, the student will be able to –

CO-1: Understand the basic principles, scope, and opportunities of entrepreneurship in Botany and allied plant-based industries.

CO-2: Remember the concepts of business management, startup planning, intellectual property rights, and governmental support schemes related to botanical enterprises.

CO-3: Explain the applications of modern tools, technologies, and research innovations in entrepreneurship related to medicinal plants, biotechnology, floriculture, biofertilizers, and sustainable resource utilization.

CO-4: Develop entrepreneurial skills, business models, and capacity-building strategies for establishing self-employment and plant-based enterprises.

Unit System	Contents	Workload Allotted (Hrs)	Weightage of Marks Allotted	Incorporation of Pedagogies
Unit I	Fundamentals of Entrepreneurship in Botany	15	13	Suitable pedagogical strategies are separately annexed
1.1: Introduction to Entrepreneurship Meaning, concept, and characteristics of entrepreneurship; Types of entrepreneurs and entrepreneurial traits; Role of entrepreneurship in economic and rural development 1.2: Entrepreneurship Opportunities in Botany Plant-based industries and green entrepreneurship; Scope in medicinal plants, floriculture, nursery management, mushroom cultivation, biofertilizers, and herbal products; Agri-biotechnology and sustainable plant resource utilization 1.3: Entrepreneurial Skills and Innovation Leadership, communication, and decision-making skills; Creativity, innovation, and risk management; Business ethics and environmental sustainability 1.4: Government Policies and Support Entrepreneurship development programs in India; Role of MSME, Startup India, and Skill India; Financial literacy and funding opportunities				
Unit II	Unit II: Plant-Based Business Planning and Startup Process	15	13	
2.1 Business Idea Development Identification of business opportunities in Botany; Market survey and feasibility analysis; Selection of products and services; Rural and tribal entrepreneurship opportunities 2.2 Business Startup Process				

Business and Startup: Concept and Differences; Steps involved in starting a plant-based enterprise; Preparation of business plan and project report; Location selection, infrastructure, and resource management 2.3 Registration and Legal Procedures MSME and Udyam Registration; GST registration and PAN requirements; Trade license, FSSAI registration, and local permissions; Intellectual Property Rights (IPR), patents, trademarks, and copyrights 2.4 Financial Management Sources of finance and bank loans; Government subsidies and startup grants; Budget preparation, cost analysis, and profit estimation			
Unit III	Project Proposal, Funding and Supporting Agencies	15	12
3.1 Preparation and Design of Project Proposal Types, structure and role of project proposals in business development; Steps in designing and preparing plant-based business proposals; Market survey, feasibility study, Review and analysis of business opportunities; Budget preparation and documentation 3.2 Presentation to the Investors for support Preparation and presentation of startup pitch deck; Elevator pitch exercise; Mock investor interaction 3.3 Supporting Agencies and Infrastructure Development Government supporting agencies: Startup India, MSME, NABARD, BIRAC, NMPB, Atal Innovation Mission; Private supporting agencies: incubators, accelerators, consultancy and CSR organizations e.g. Private Tissue culture laboratories, digital marketing and agri-support services; Infrastructure development for plant-based enterprises; Outsourcing agencies for packaging, branding, production and marketing 3.4 Entrepreneurial Challenges Financial and funding challenges; Marketing and competition-related problems; Technical and infrastructure issues; Legal, registration and licensing difficulties; Risk management and sustainability challenges			
Unit IV	Marketing, Scaling and Enterprise Management	15	12
4.1 Marketing and E-Commerce Social media marketing for plant-based products; Use of WhatsApp Business and online marketplaces; Basics of product photography and content creation; Digital marketing and online business platforms; Customer relationship and market networking 4.2 International Expansion Export and Global Market Opportunities; Export potential of medicinal and aromatic plants; International standards and certifications; Organic certification and quality control; Global herbal and nutraceutical market trends 4.3 Skill Development and Training Entrepreneurship skill development programs; Field visits, industrial exposure, and internships; Startup incubation and mentoring support 4.4 Case Studies and Practical Exposure Successful botanical entrepreneurs in India; Preparation of model business proposals; Seminar, project work, and group discussion activities			
Experiments: At least Four Experiments on Each Unit: Unit I: Fundamentals of Entrepreneurship in Botany 1. Identification and listing of plant-based business opportunities in the local region. 2. Preparation of a report on entrepreneurial traits and skills. 3. Survey of medicinal plant nurseries, or floriculture enterprises nearby. 4. SWOT analysis of a selected botanical enterprise. 5. Preparation of a chart/model showing entrepreneurship development programs in India.			

6. Group discussion on innovation and sustainable green entrepreneurship.
7. Case study analysis of successful botanical entrepreneurs.
8. Seminar presentation on eco-friendly plant-based industries.

Unit II: Plant-Based Business Planning and Startup Process

9. Preparation of a model business plan for a plant-based startup.
10. Demonstration of the Udyam Registration process for MSME enterprises.
11. Preparation of a project report for herbal products or nursery business.
12. Market survey and feasibility study of plant-based products.
13. Demonstration of GST registration and documentation requirements.
14. Preparation of cost estimation, budgeting, and profit analysis for a startup.
15. Drafting a simple business proposal for bank loan or startup funding.
16. Study of Intellectual Property Rights (IPR), patents, and trademarks through case examples.

Unit III: Project Proposal, Funding and Supporting Agencies

17. Preparation of a project proposal for a plant-based startup.
18. Designing the structure and SMART objectives of a business proposal.
19. Conducting market survey and feasibility study for herbal or nursery products.
20. Preparation of budget, cost analysis and documentation for plant-based enterprise.
21. Preparation and presentation of a startup pitch deck.
22. Study of venture capital and funding agencies for plant-based startups.
23. Visit report and study of government/private supporting agencies and infrastructure facilities.
24. Analysis of entrepreneurial challenges related to finance, marketing and competition in plant-based business.

Unit IV: Entrepreneurship Development and Capacity Building

25. Preparation of digital marketing content for plant-based products.
26. Demonstration of online selling platforms and e-commerce tools.
27. Interaction with local entrepreneurs or startup founders.
28. Preparation of branding and promotional material for a botanical enterprise.
29. Field visit to MSME, NABARD-supported unit, or incubation center.
30. Organization of seminar/workshop on entrepreneurship skill development.
31. Preparation and presentation of startup pitch for plant-based enterprise.
32. Compilation of government schemes, subsidies, and institutional support agencies related to botanical startups.

Activities (At Least Five to Perform any Two):

1. Prepare a detailed business plan for a plant-based startup such as a nursery, herbal product unit, mushroom cultivation, or biofertilizer production unit.
2. Visit to a nursery, medicinal plant cultivation center, herbal industry, MSME unit, or floriculture enterprise followed by submission of a field report.
3. Demonstration and practice of Udyam Registration, GST registration basics, preparation of startup documents, and business proposal drafting.
4. Preparation, packaging, labeling, branding, and digital marketing of a plant-based product through posters, brochures, or social media promotion.
5. Present innovative botanical business ideas through seminars, group discussions, or startup pitch presentations for capacity building and entrepreneurial skill development.

References: (APA Style)

1. Khanka, S. S. (2018). *Entrepreneurship development* (S. Chand Publishing).
2. Desai, V. (2019). *Dynamics of entrepreneurial development and management*. Himalaya Publishing House.
3. Hisrich, R. D., Peters, M. P., & Shepherd, D. A. (2020). *Entrepreneurship* (11th ed.). McGraw-Hill Education.
4. Gupta, C. B., & Srinivasan, N. P. (2017). *Small scale industries and entrepreneurship*. Sultan Chand & Sons.
5. Chawla, H. S. (2019). *Introduction to plant biotechnology* (4th ed.). CRC Press.

6. Kirtikar, K. R., & Basu, B. D. (2006). <i>Indian medicinal plants</i>. International Book Distributors. 7. Randhawa, G. S., & Mukhopadhyay, A. (2014). <i>Floriculture in India</i>. Allied Publishers. 8. Ministry of Micro, Small and Medium Enterprises. (2024). <i>MSME schemes and entrepreneurship guidelines</i>. Government of India. 9. Startup India. (2024). <i>Startup India learning and support resources</i>. Government of India. 10. Government of India. (2024). <i>Udyam registration portal for MSMEs</i>. 11. National Bank for Agriculture and Rural Development (NABARD) NABARD. (2024). <i>Entrepreneurship and rural development schemes</i>. 12. Biotechnology Industry Research Assistance Council (BIRAC) BIRAC. (2024). <i>Innovation and startup support in biotechnology</i>. Government of India.
Pedagogical Strategies:(Suggestive At least 5 concerning to the Units and Points included in each unit) 1. Interactive Lectures and ICT-Based Teaching Use of multimedia presentations, videos, digital platforms, and case studies to explain concepts of entrepreneurship, startup development, and plant-based industries. 2. Field Visits and Experiential Learning Organized visits to nurseries, herbal industries, floriculture units, MSME enterprises, incubation centers, and medicinal plant cultivation sites for practical exposure. 3. Project-Based and Problem-Solving Learning Preparation of business plans, startup models, feasibility reports, and market surveys to develop analytical and entrepreneurial skills. 4. Hands-on Training and Demonstration Methods Demonstrations of Udyam registration, product preparation, packaging, branding, vermicomposting, mushroom cultivation, and digital marketing techniques. 5. Seminars, Group Discussions, and Startup Pitch Activities Student seminars, group discussions, role plays, and startup pitch presentations to enhance communication, leadership, innovation, and decision-making abilities. 6. Case Study and Industry Interaction Approach Analysis of successful botanical entrepreneurs, interaction with industry experts, and guest lectures from startup founders and MSME professionals. 7. Collaborative and Capacity-Building Activities Team-based assignments, workshops, and entrepreneurship skill development programs for promoting creativity, networking, and self-employment opportunities.

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Lab/ Practical-	Course Code: 107266	Entrepreneurship for Botanist	Max Marks: 50	Time: 4 Hrs.
S. No.	Assessment Criteria		Marks	
1	Preparation and Presentation of a Business Plan / Project Proposal for a Plant-Based Enterprise (Nursery, Herbal Products, Mushroom Cultivation, Biofertilizer, Floriculture, etc.)		10	
2.	Startup Pitch Presentation (Pitch Deck / Elevator Pitch / Investor Interaction Simulation)		05	
3.	Demonstration of Any One Activity from the Prescribed Activity List		05	
4.	Comment on Any Two: Business Models / Government Support Schemes / Startup Case Studies / Marketing Strategies / Funding Agencies		05	
5.	Record Book / Entrepreneurship Development Journal		05	
6.	Field Visit / Industrial Visit / Nursery / MSME / Startup Incubation Centre Report		05	
8.	Preparation of Marketing, Branding, Packaging and Cost Analysis Plan for a Selected Plant-Based Product		05	
9.	Attendance and Overall Performance Throughout the Semester		05	
	Internal Viva-Voce		05	
	Total		50	

Guidelines for Internship / Apprenticeship/ On Job Training

Course Type	Sem	Course Code	Course Title	Credits	Workload	Exam Duration	Maximum Marks
Intern/ Apprent/ OJT	VI	107267	Internship / Apprenticeship/ On Job Training	4	80	-	100

Course Objectives:	1. To provide hands-on training in Botany-related industries, laboratories, and research organizations. 1. To expose students to industrial practices, instrumentation, quality control, and safety 2. procedures. 2. To enhance problem-solving, teamwork, communication, and technical skills. 3. To create awareness regarding entrepreneurship and employment opportunities in Botany.
Course Outcomes:	Upon successful completion of this course, students will be able to: 1. Apply theoretical Botany concepts in practical and industrial environments. 2. Operate and understand basic analytical instruments and laboratory techniques. 3. Demonstrate professional ethics, laboratory safety, and teamwork. 4. Analyze chemical processes, observations, and experimental data effectively. 5. Prepare technical reports and communicate scientific findings professionally. 6. Explore employability and entrepreneurship skills in Botany-related sectors.

Guidelines/ SoP for Internship / Apprenticeship/ OJT

For understanding key principles of Internship/Apprenticeship/OJT operational guidelines and implementation strategy please refer

1. https://www.ugc.gov.in/pdfnews/2051511_Internship-Research-Internship-Guidelines.pdf
2. <https://www.sgbau.ac.in/pdf/1092Internship%20Policy.pdf>

As per NEP 2020, students of B Sc. III need to undertake Internship / Apprenticeship/ OJT for FOUR (4) credits i.e. 100 Marks.

The guidelines for Internship / Apprenticeship/ OJT are as follows:

1. Credit: 04
2. Duration: 120 Hrs
3. Internship Period: Ideally, the internship should be completed during the summer break between the second and third year. Students who are unable to complete the internship during this period must ensure its completion by the end of the VI semester, either in a part-time manner during Semester V, or during the Diwali break, or winter break or through an alternative arrangement subject to prior approval by the parent institution (University School/College).
4. Internship Categories:
- i. Internship for enhancing the employability: Employability is a set of skills and attributes developed through a range of experiences at workshops and workplaces.
- ii. Internship for developing the research aptitude: Research internship aims at providing hands-on training to work on research tools, techniques, methodologies, equipment, policy framework and various other aspects in pursuing quality research.
5. Implementation and assessment: For implementation and assessment of this vertical a separate SoP or relevant document that may be provided by the University will be applicable.

6. These can be implemented through:

1. Industries
2. Research labs
3. Government testing laboratories
4. Colleges/departments
5. MSMEs and startups
6. Online/virtual internships with report and viva evaluation

Some Suggested Forms of Internship / Apprenticeship / OJT for Botany

A. Plant Laboratory and Analytical Training

1. Plant tissue culture laboratory internship
2. Seed testing and quality assessment laboratory training
3. Soil and plant nutrient analysis training
4. Herbal drug identification and quality control laboratory exposure
5. Plant pathology and disease diagnostic laboratory training
6. Micropropagation and nursery management apprenticeship
7. Environmental monitoring and biodiversity assessment internship
8. Botanical survey and plant identification laboratory training

B. Plant Industry-Based OJT

1. Internship in commercial plant tissue culture industries
2. Nursery, floriculture, and landscape management training
3. Medicinal and aromatic plant cultivation industry exposure
4. Seed production and seed processing industry apprenticeship
5. Biofertilizer and biopesticide production unit training
6. Mushroom cultivation and spawn production industry exposure
7. Food processing and plant-based product manufacturing training
8. Herbal, cosmetic, and phytopharmaceutical industry internship

C. Research and Academic Exposure

1. Internship in university, botanical garden, research laboratories, or premier institutes such as IITs, IISERs, CSIR laboratories, ICAR institutes, BSI, and ICFRE centres
2. Plant biotechnology and molecular biology laboratory training
3. Plant taxonomy, herbarium techniques, and botanical documentation training
4. Biodiversity conservation and ecological field research exposure
5. Scientific documentation, data analysis, and laboratory management training

D. Entrepreneurship and Skill-Based OJT

1. Production of eco-friendly plant products such as biofertilizers, biopesticides, natural dyes, herbal cosmetics, nutraceuticals, and biodegradable packaging materials
2. Nursery entrepreneurship and ornamental plant production training
3. Mushroom cultivation and value-added mushroom product development
4. Medicinal plant cultivation, processing, and marketing exposure
5. Herbal product formulation, packaging, branding, and quality assurance training
6. Floriculture, landscaping, and garden consultancy entrepreneurship
7. Organic farming, vermicomposting, and sustainable agriculture training
8. Preparation, packaging, and marketing of plant-based value-added products

E. Digital Botany and Informatics

1. GIS and Remote Sensing applications in vegetation mapping
2. Digital herbarium development and management
3. Biodiversity database creation and management
4. Plant image analysis and identification using AI tools

5. Ecological modelling and species distribution mapping

6. Botanical data visualization and scientific reporting

F. Science Communication and Botanical Education

1. Development of botanical educational content and learning resources

2. Botanical illustration and scientific sketching

3. Scientific photography and videography of plants

4. Nature interpretation and eco-guiding training

5. Museum and botanical garden education programmes

6. Science outreach and biodiversity awareness campaigns

G. Regulatory, Intellectual Property and Documentation Training

1. Plant variety protection and farmers' rights exposure

2. Intellectual Property Rights (IPR) in plant sciences

3. Biodiversity Act and Access & Benefit Sharing (ABS) documentation

4. Environmental legislation and compliance training

5. Preparation of project proposals and technical reports

6. Documentation and management of biological resources

H. Ecotourism and Nature-Based Services

1. Ecotourism centre management exposure

2. Nature trail planning and interpretation

3. Botanical garden curation and visitor management

4. Eco-guide and biodiversity tourism training

5. Development of educational nature trails

6. Conservation awareness programme management

I. Community Engagement and Rural Development

1. Participation in village biodiversity documentation

2. Community-based natural resource management projects

3. Farmer training and extension programme assistance

4. School biodiversity education initiatives

5. Sustainable livelihood and self-help group projects based on plant resources

6. Awareness programmes on conservation and sustainable resource utilization

J. Green Infrastructure and Urban Ecology

1. Urban forestry and avenue plantation projects

2. Green belt planning and development

3. Landscape ecology and urban biodiversity assessment

4. Vertical gardening and green wall systems

5. Urban ecosystem restoration projects

6. Campus greening and sustainability initiatives

K. Climate Change and Ecosystem Services

1. Climate resilience assessment of plant communities

2. Carbon stock estimation and ecosystem service valuation

3. Monitoring of phenological changes under climate change

4. Restoration ecology and degraded habitat recovery projects

5. Climate adaptation strategies in agriculture and forestry

6. Ecosystem-based approaches to sustainability planning

L. Plant Resource Management and Policy Exposure

1. Exposure to forest and biodiversity management plans

2. Biological resource inventory and assessment projects

3. Natural resource conservation planning

4. Participation in biodiversity management committee activities

5. Sustainable utilization of plant resources projects

6. Policy implementation related to biodiversity and conservation

Field-Based and Conservation-Oriented Exposure

1. Internship in botanical gardens, biodiversity parks, and nature conservation centres

2. Forest nursery and afforestation programme training

3. Biodiversity documentation and ecological survey participation

4. Exposure to wildlife sanctuaries, national parks, and ecosystem restoration projects

5. Training in GIS, remote sensing, and digital tools for plant resource management

References	https://www.ugc.gov.in/pdfnews/2051511_Internship-Research-Internship-Guidelines.pdf https://www.sgbau.ac.in/pdf/1092Internship%20Policy.pdf
Model Questions:	NA