SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

TWO YEAR POSTGRADUATE PROGRAMME

M.Sc. BOTANY

FACULTY: SCIENCE AND TECHNOLOGY

Revised Curriculum

(Effective for MSc I and II from Academic Year 2024-2025)

SYLLABUS

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TWO YEAR POSTGRADUATE PROGRAMME

M.Sc. BOTANY

FACULTY: SCIENCE AND TECHNOLOGY

Sant Gadge Baba Amravati University

FACULTY: Science and Technology

(Two Years PG Degree Programme)

Preamble

The Post Graduate Program in Botany at M.Sc. level is meticulously designed to impart a profound understanding of plant sciences, combining rigorous theoretical frameworks with extensive practical applications and research-oriented learning. The curriculum aims to cultivate a holistic perspective on plant biology, encompassing areas from the molecular intricacies of cells to the complex interactions within ecosystems. This comprehensive approach ensures that students are well-prepared to address contemporary challenges in botany and related fields.

This program emphasizes the integration of cutting-edge scientific research with practical skills, fostering innovation and critical thinking. By covering a wide range of topics including cell and molecular biology, plant physiology, biochemistry, plant genetics, and biotechnology, students will develop a versatile skill set. Additionally, the program delves into the evolutionary history and taxonomy of various plant groups, providing a robust foundation for understanding plant diversity and its significance.

A unique feature of this program is its focus on the commercial applications of botanical knowledge. Courses on economic botany, resource utilization, and applied botany highlight the practical implications of botanical research in industries such as agriculture, pharmaceuticals, and environmental management. Furthermore, the curriculum includes an essential component on intellectual property rights (IPR), preparing students to navigate the ethical and legal landscapes of botanical research and innovation.

Prospects of the Program

Job Opportunities:

- Research Scientist: Positions in government research institutions, universities, and private sector research labs.
- Botanist: Roles in botanical gardens, conservation organizations, and environmental consultancies.
- Plant Breeder: Employment in agricultural companies, focusing on developing new plant varieties.
- Ecologist: Working with environmental agencies and NGOs to study and manage ecosystems.

Self-Employment:

- Consultant: Offering expert advice on plant-related issues to agricultural businesses, landscaping firms, and environmental organizations.
- Freelance Researcher: Conducting independent research projects and contributing to scientific publications.

Entrepreneurship:

- Startup Founder: Establishing ventures in plant biotechnology, sustainable agriculture, or herbal products.
- Agribusiness Entrepreneur: Developing innovative solutions for crop improvement, pest management, and soil health.

- Biotech Innovator: Creating new technologies or products based on plant genetic engineering and molecular biology.

Other Opportunities:

- Education: Teaching positions at secondary and higher education institutions, contributing to the next generation of botanists.
- Pharmaceutical Industry: Roles in the development and testing of plant-based medicines and supplements.
- Environmental Advocacy: Working with organizations to promote plant conservation and sustainable practices.

This program equips graduates with the skills and knowledge to excel in various professional paths, fostering a new generation of botanists who can contribute significantly to scientific research, environmental conservation, and innovative industries.

Core Competencies:

1. Advanced Understanding of Plant Biology: Gain in-depth knowledge of cell and molecular biology, plant physiology, and biochemistry.
2. Diversity and Evolution: Understand the evolution, diversity, and taxonomy of various plant groups, including microbes, algae, fungi, bryophytes, pteridophytes, gymnosperms, and angiosperms.
3. Research and Analytical Skills: Develop robust research methodologies, including experimental design, data analysis, and interpretation.
4. Biotechnology and Genetic Engineering: Apply advanced techniques in plant biotechnology, genetic engineering, and molecular biology.
5. Ecology and Environmental Dynamics: Analyze ecological interactions, environmental dynamics, and the impact of human activities on plant ecosystems.
6. Economic and Applied Botany: Explore the economic importance of plants, resource utilization, and commercial applications.
7. Intellectual Property and Ethical Practices: Understand the principles of intellectual property rights and their application in botanical research and commercialization.

Curriculum Framework

The M.Sc. Botany program offers a robust and comprehensive curriculum designed to provide students with a profound understanding of plant sciences. Major courses, categorized as Discipline Specific Core (DSC), cover essential topics such as cell and molecular biology, plant physiology, biochemistry, genetics, and biotechnology. These core courses are designed to build a strong foundation in botanical sciences, ensuring students gain in-depth theoretical knowledge and practical skills. Additionally, specialized courses on the evolution, diversity, and taxonomy of various plant groups, including microbes, algae, fungi, bryophytes, pteridophytes, gymnosperms, and angiosperms, enrich students' understanding of plant diversity and its significance.

To cater to diverse interests and career aspirations, the program offers six Discipline Specific Elective (DSE) courses. Students can choose from Angiosperm Taxonomy, Phytochemistry, and Pharmacognosy; Molecular Systematics of Plants; Plant Tissue Culture; Advanced Plant Physiology; Basic and Applied Mycology; and Molecular Biology, Biotechnology & Plant Breeding. These electives provide ample choice for students to specialize in areas that align with their career goals and personal interests. The continuous study of the selected elective course throughout the program ensures in-depth knowledge and expertise in the chosen field.

The curriculum emphasizes the development of research skills and attributes essential for scientific inquiry. Courses such as Research Methodology and IPR in the first semester and Technological Advancements in Botanical Research in the third semester are specifically

designed to enhance students' research capabilities. These courses equip students with the necessary tools to design and conduct independent research projects, analyze data, and understand the ethical and legal aspects of botanical research and intellectual property rights.

A significant component of the program is the Research Project, which is initiated in the third semester (Phase I) and completed in the fourth semester (Phase II). This project provides students with the opportunity to apply their knowledge and research skills to real-world problems, culminating in a thesis or dissertation. The research project fosters critical thinking, problem-solving, and innovation, preparing students for careers in academia, research institutions, and industry.

To bridge the gap between academic knowledge and practical experience, the program includes on-job training, internships, apprenticeships, and field projects totaling 120 hours. These practical experiences allow students to gain hands-on experience, develop professional skills, and build industry connections. Engaging in real-world projects enhances employability and provides valuable insights into potential career paths.

In addition to the rigorous academic curriculum, the program incorporates co-curricular courses aimed at promoting holistic development. Activities in health and wellness, yoga education, sports and fitness, cultural activities, NSS/NCC, and fine/applied/visual/performing arts are integrated into the curriculum across all semesters. These activities not only foster physical and mental well-being but also encourage creativity, teamwork, and leadership skills, ensuring that graduates are well-rounded individuals ready to excel in their professional and personal lives.

This curriculum framework is designed to attract students seeking comprehensive career development in botanical sciences. By offering a blend of theoretical knowledge, practical experience, research opportunities, and co-curricular activities, the program prepares graduates for diverse career opportunities, including research, teaching, industry roles, self-employment, and entrepreneurship. The holistic approach ensures that students are not only experts in their field but also equipped with the skills necessary to thrive in a dynamic and evolving job market.

Graduate Attributes

Graduates of the M.Sc. Botany program will emerge as well-rounded, knowledgeable, and skilled professionals who are equipped to tackle complex challenges in plant sciences. They will possess a blend of theoretical knowledge, practical experience, research capabilities, and soft skills that are essential for success in various professional arenas. These attributes ensure that graduates are not only experts in their field but also capable of contributing positively to society and the environment.

Critical Thinking and Problem-Solving: Graduates will have the ability to critically analyze scientific data, identify key issues, and develop innovative solutions to complex problems in plant sciences. They will be adept at applying logical reasoning and scientific methods to address challenges.

Research Proficiency: Graduates will be skilled in designing, conducting, and managing independent research projects. They will be proficient in using modern laboratory techniques and tools, analyzing data, and presenting their findings clearly and effectively.

Technical Expertise: Graduates will have a strong command of contemporary techniques and technologies in botanical research, including molecular biology, biotechnology, and plant physiology. Their technical expertise will enable them to excel in various scientific and industrial roles.

Ethical Awareness and Responsibility: Graduates will understand the ethical implications of their work and the importance of intellectual property rights. They will be committed to conducting research and professional activities with integrity and responsibility.

Effective Communication: Graduates will possess excellent communication skills, enabling them to convey complex scientific concepts to diverse audiences, including peers, professionals, and the general public. They will be proficient in both written and oral communication.
Lifelong Learning and Adaptability: Graduates will be committed to continuous learning and professional development. They will be adaptable to new technologies and methodologies, ensuring they remain at the forefront of advancements in their field.
Teamwork and Leadership: Graduates will be capable of working collaboratively in multidisciplinary teams and taking on leadership roles when required. They will have the skills to manage projects, mentor peers, and contribute effectively to team objectives.
Environmental and Social Responsibility: Graduates will be aware of the environmental impact of their work and the importance of sustainable practices. They will be prepared to contribute to the conservation and sustainable use of plant resources, promoting biodiversity and ecological balance.

The curriculum framework is designed to attract students seeking comprehensive career development in botanical sciences. By offering a blend of theoretical knowledge, practical experience, research opportunities, and co-curricular activities, the program prepares graduates for diverse career opportunities, including research, teaching, industry roles, self-employment, and entrepreneurship. The holistic approach ensures that students are not only experts in their field but also equipped with the skills necessary to thrive in a dynamic and evolving job market.

Program Outcomes

Program Outcomes for an Post Graduate 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. **Mastery of Core Concepts**: Graduates will have a thorough understanding of the core concepts in cell and molecular biology, plant physiology, biochemistry, and genetics.
2. **Application of Knowledge**: Graduates will be able to apply their knowledge to solve practical problems in plant sciences and related industries.
3. **Research Competence**: Graduates will be capable of designing and conducting independent research, utilizing appropriate methodologies and analytical tools.
4. **Technological Innovation**: Graduates will be proficient in using advanced technologies in botanical research and applications.
5. **Biodiversity and Conservation**: Graduates will understand the importance of biodiversity, conservation, and the sustainable use of plant resources.
6. **Environmental Stewardship**: Graduates will be able to assess and address the impacts of environmental changes and human activities on plant ecosystems.
7. **Professional and Ethical Responsibility**: Graduates will be aware of their professional and ethical responsibilities, including the protection of intellectual property.

TWO YEAR POSTGRADUATE PROGRAMME

M.Sc. BOTANY under FACULTY: SCIENCE AND TECHNOLOGY

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

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

TWO YEAR POSTGRADUATE PROGRAMME

M.Sc. BOTANY

UNDER FACULTY: SCIENCE AND TECHNOLOGY

Subcommittees Constituted by BoS for Curriculum Development

1. Subcommittee for Preparation of the Scheme of Teaching, Learning, Examination and Evaluation for PG (Botany) in alignment of the Recent Guidelines of NEP- 2020

Objectives:

1. To prepare the Scheme of Teaching, Learning, Examination and Evaluation for PG (Botany)
2. To decide all the DSC Titles for Four Semesters (Twelve Papers)
3. To decide Course Codes for DSC (Twelve) and DSE (Six)
4. To prepare **suggestive outline** of the Course Contents
5. To Prepare SOPs for Internal Assessment for Theory and Practical

Constitution of the Committee

1. **Dr. Varsha Nathar (Convener)**
2. Dr. Dinesh Khedkar (Chairman, BoS)
3. Dr. Dilip Hande, Member
4. Dr. Rekha Maggirwar, Member
5. Dr. Deepak Koche, Member
6. Dr. Ashok Padghan, Member
7. Dr. Narendra Shahare, Member
8. Dr. Ganesh Hedawoo, Member
9. Dr. Mukund Dhore, Member
10. Dr. Vanita Pochhi, Member
11. Dr. Manik Dhore, Member
12. Dr. Girish Kamble, Member
13. Dr. Yugandhara Gulhane, Member

2. Subcommittees for Preparation of the Detailed Curriculum of Elective Courses for Four Semesters

i. PLANT TAXONOMY

1. **Dr. Mukund Dhore, (Convener)**
2. Dr. Suchita Khodke
3. Dr. Ashok Padghan
4. Dr. Manik Dhore
5. Dr. Ashok Deore
6. Dr. Sanjay Satpute
7. Dr. Manjusha Wath
8. Dr. Santosh Patole
9. Dr. Yugandhara Gulhane
10. Dr. Prashant Anasane

ii. MOLECULAR SYSTEMATICS

1. **Dr. Prashant Gawande (Convener)**
2. Dr. Kamalakar More

iii. PLANT TISSUE CULTURE

1. **Dr. Varsha Nathar (Convener)**
2. Dr. Kamalakar More

iv. ADVANCED PLANT PHYSIOLOGY

1. **Dr. M. A. Shahjad (Convener)**
2. Dr. Sanjay Deosthale
3. Dr. Tushar Wankhede
4. Dr. Mangesh Dagawal
5. Dr. Prafulla Bansod
6. Dr. Vaishali Badgujar
7. Dr. Pramod Khadse
8. Dr. Umesh Kanerkar

v. BASIC AND APPLIED MYCOLOGY

1. **Dr. Narendra Sahare (Convener)**
2. Dr. Dilip Hande

vi. MOLECULAR BIOLOGY, BIOTECHNOLOGY & PLANT BREEDING

1. **Dr. Deepak Koche (Convener)**

3. Dr. Suchita Khodke
4. Dr. Suruchi Kadu
5. Dr. Sanjeev Ishwarkar
6. Dr. Ganesh Hedawoo
7. Dr. Vaishali Patil (Dandge)
8. Dr. Ninad Dharkar
9. Dr. Santosh Mhasal

2. Dr. Kamalakar More
3. Dr. Prafulla Bansod
4. Dr. Ravindra Dhande
5. Prof. Gokul Bajaj
6. Dr. Avinash Darsimbe
7. Dr. Nutanvarsha Deshmukh
8. Dr. Ankit Kale
9. Dr. Anand Oke
10. Dr. Pankaj Pulate

3. Subcommittees for DSC Curriculum Designing

S. N.	DSC	Teachers Incharge and the Expert Group
	Semester I	
1	Research Methodology and IPR	• **Dr Ankit Kale (C)** • Prof Gokul Bajaj • Prof Avinash Darsimbe • Prof Himanshu Jaiswal • Prof Vivek Narkhedkar
2	Cell and Molecular Biology	• **Dr. Ravi Dhande (C)** • Dr. K. C. More • Dr. Prafulla Bansod • Dr. Pankaj Pulate
3	Evolution, Diversity and Commercial Application of Microbes, Algae, Fungi and Plant Pathology	• **Dr. G. B. Hedawoo (C)** • Dr. Dilip Hande • Dr. Rekha Maggirwar • Dr. Suchita Khodke • Dr. Narendra Sahare • Dr. Sanjeev Ishwarkar • Dr. Vaishali Patil (Dandge) • Dr. Ninad Dharkar • Dr. Santosh Mhasal
4	Plant Development, Economic Botany and Resource Utilization	• **Dr. Suruchi Kadu (C)** • Dr. Monali Ghurde • Dr. R. N. Patil • Prof. Bharat P. Nagare • Dr. Shrikant Patil
	Semester II	
1	Biochemistry and Plant Physiology	• **Dr. Umesh Kanerkar (C)** • Dr. Prafulla Bansod • Dr. Mangesh Dagwal • Dr. Vaishali Badgujar • Dr. Pramod Khadse • Anjali Sangole • Prof. Ashwini Phokmare
2	Evolution, Fossils and Diversity of Bryophytes, and Pteridophytes	• **Dr. Swati Pundkar(C)** • Dr. Nutanvarsha Deshmukh • Dr. Nikhil Choukhande • Dr. Suchita Dighe • Dr. Pranjali Deshmukh
3	Plant Genetics and Breeding	• **Prof. Gokul Bajaj (C)** • Prof. Avinash Darsimbe • Dr. Monali Ghurde • Dr. Anand Oke • Dr. Dnyaneshwar K. Sherkar

Semester III		
1	Technological Advancements in Research	• **Dr. Deepak Koche (C)** • Dr. Ankit Kale • Prof Avinash Darsimbe • Prof Himanshu Jaiswal • Prof Vivek Narkhedkar • Prof Gokul Bajaj • Dr. P. G. Dhawale
2	Paleobotany, Gymnosperm and Origin of Angiosperms	• **Dr. Ashok Padghan (C)** • Dr. Nanasaheb Kutemate • Dr. Santosh Mhasal • Dr. Suchita Dighe • Dr. Mangesh Bobade • Dr. Nandkishor More • Dr. V. J. Watile
3	Angiosperms Systematics and Anatomy	• **Dr. Mukund Dhore (C)** • Dr. Suchita Khodke • Dr. Ashok Padghan • Dr. Manik Dhore • Dr. Ashok Deore • Dr. Santosh Patole • Dr. Prashant Anasane
4	Diversity Conservation, Ethnobotany, Palynology and Phytogeography	• **Dr Yugandhara Rajgure (C)** • Dr. Minal Keche • Mr. S. A. Rathod • Miss. Vijaya P. Chavan • Dr. A.A. Sangole • Dr. A.V. Rajurkar
Semester IV		
1	Applied Botany	• **Dr. Girish Kamble (C)** • Dr. Mangesh Dagwal • Dr. Sarika Jaisingpure • Mr. N. B. Choukhande • Mr. S.V. Madavi • Dr. Kailash S. Sontakke • Dr. Sujata Shende
2	Plant Ecology and Environmental Dynamics	• **Dr. S. V. Satpute (C)** • Dr. Sanjay M Deosthale • Dr. Prabhakar D. Wanjare • Dr. Shital V. Surve • Dr. M. Nafees Iqbal • Dr. Snehal N. Dhawale
3	Plant Biotechnology and Genetic Engineering	• **Dr. Prashant Deshmukh (C)** • Dr. Gajanan Wadankar • Dr. Pranav V Gadkar • Dr. Kishor B Theng • Dr. Shivdas R. Aher

Teaching and Learning Scheme: for the Degree of Master of Botany

Revised Scheme of Teaching, Learning & Examination leading to

Two Years PG Degree

Master of Science in the Programme Botany w.e.f. 2024-25

Two Years- Four Semesters Master's Degree Programme- NEPv24.1

with Exit and Entry Option for

M.Sc. Botany

T, L & E Scheme for Semester – I

S. N.	Subject	Type of Course	ubject Code	Teaching & Learning Scheme							Duration Of Exam Hours	Examination & Evaluation Scheme							
				Teaching Period Per Week				Credits				Maximum Marks					Minimum Passing		
												Theory		Practical		Total Marks			
				L	T	Pr	Total	L/T	Practical	Total		Theory Internal	Theory +MCQ External	Internal	External		Marks Internal	Marks External	Grade
0	*Pre-Requisite Course(s) if applicable/MOOC/Internship/Field Work cumulatively. If students wish to opt Minor Course of UG as Major for PG, balance 12 Credits Course will have to be completed. **(As and when applicable)**	Th-Prq		0	0	0	0	Additional Credits to be earned = (1) minus (2) (1). Credits from Major DSC Courses in UG (minus) (2). The Credits already earned from the Course as Minor at UG, now to be opted as Major at PG			2	15	35			50	06	14	P
1	Research Methodology and IPR	Th RM01	BOT 01	2			2	2		2	2	40	60			100	16	24	P
2	DSC-I.1 Cell and Molecular Biology	Th	BOT 101	4			4	4		4	3	40	60			100	16	24	P
3	Evolution, Diversity and Commercial Application of Microbes, Algae, Fungi and Plant Pathology	Th	BOT 102	4			4	4		4	3	40	60			100	16	24	P
4	DSC-III.1 Plant Development, Economic Botany and Resource Utilization	Th	BOT 103	3			3	3		3	3	40	60			100	16	24	P
5	DSE-I Any one Opted by Student/MOOC (Elective Options)	Th	BOT 104	3			3	3		3	3	40	60			100	16	24	P
5a	DSE-I -Angiosperm Taxonomy, Phytochemistry and Pharmacognosy-I	Elective	BOT 104-A																
5b	DSE-I -Molecular Systematics of Plants-I	Th	BOT 104-B																
5c	DSE-I -Plant Tissue Culture-I	Elective	BOT 104-C																
5d	DSE-I -Advanced Plant Physiology-I	Th	BOT 104-D																
5e	DSE-I -Basic and Applied Mycology-I	Elective	BOT 104-E																

5 f	*DSE-I* -Molecular Biology, Biotechnology &Plant Breeding-I	Th	BOT 104-F																	
6	**Lab – I:** based on DSC-I.1 and II.1 (Cell and Molecular Biology and Evolution, Diversity and Commercial Application of Microbes, Algae, Fungi and Plant Pathology)	Pr				4	4		2	2	6			50	50	100	50		P
6	**Lab – II:** based on DSC-III and DSE Opted by Student (Plant Development, Economic Botany and Resource Utilization following DSE) a. Angiosperm Taxonomy, Phytochemistry and Pharmacognosy-I b. Molecular Systematics of Plants-I c. Plant Tissue Culture-I d. Advanced Plant Physiology-I e. Basic and Applied Mycology-I f. Molecular Biology Biotechnology & Plant Breeding-I	Pr				4	4		2	2	6			50	50	100	50		P
7	# On Job Training, Internship/ Apprenticeship; Field projects **Related to Major @ during vacations cumulatively**	Related to DSC	**120 Hours cumulatively during vacations of Semester I and Semester II**					4*									P*			
8	**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 and IV**	Generic Optional	**90 Hours Cumulatively From Sem I to Sem IV**																	
	TOTAL									22						700		700+50*		

L: Lecture, T: Tutorial, P: Practical/Practicum

Pre-requisite Course mandatory if applicable: Prq, Theory: Th, Practical/Practicum: Pr, Faculty Specific Core: FSC, Discipline Specific Core: DSC, Discipline Specific Elective: DSE, Laboratory: Lab, OJT: On Job Training: Internship/ Apprenticeship; Field projects: FP; RM: Research Methodology; Research Project: RP, Co-curricular Courses: CC

Note : # On Job Training, Internship/ Apprenticeship; Field projects Related to Major (During vacations of Semester I and Semester II) for duration of 120 hours mandatory to all the students, to be completed during vacations of Semester I and/or II. This will carry 4 Credits for learning of 120 hours. Its credits and grades will be reflected in Semester II credit grade report.

Note: Co-curricular Courses: In addition to the above, CC also include but not limited to Academic activities like paper presentations in conferences, Aavishkar, start-ups, Hackathon, Quiz competitions, Article published, Participation in Summer school/ Winter School/ Short term course, Scientific Surveys, Societal Surveys, Field Visits, Study tours, Industrial Visits, online/offline Courses on Yoga (Yoga for IQ development, Yoga for Ego development, Yoga for Anger Management, Yoga for Eyesight Improvement, Yoga for Physical Stamina, Yoga for Stress Management, etc.). These can be completed cumulatively during Semester I, II, III and IV. Its credits and grades will be reflected in semester IV credit grade report.

T, L & E Scheme for Semester – II

S. N.	Subject	Type of Course	Subject Code	Teaching & Learning Scheme							Duration of Exam Hours	Examination & Evaluation Scheme							
				Teaching Period Per Week				Credits				Maximum Marks					Minimum Passing		
												Theory		Practical		Total Marks			
				L	T	Pr	Total	L/T	Practical	Total		Theory Internal	Theory +MCQ External	Internal	External		Marks Internal	Marks External	Grade
1	DSC-I.2 Biochemistry and Plant Physiology	Th	BOT 201	4			4	4		4	3	40	60			100	16	24	P
2	DSC-II.2 Evolution and Diversity of Bryophytes, and Pteridophytes	Th	BOT 202	4			4	4		4	3	40	60			100	16	24	P
3	DSC-III.2 Genetics and Plant Breeding	Th	BOT 203	3			3	3		3	3	40	60			100	16	24	P
4	DSE-II Any one Opted by Student /MOOC (Elective Option)	Th Elective	BOT 204	3			3	3		3	3	40	60			100	16	24	P
4a	DSE-II -Angiosperm Taxonomy, Phytochemistry and Pharmacognosy-II	Th Elective	BOT204-A																
4b	DSE-II -Molecular Systematics of Plants-II	Th Elective	BOT 204-B																
4c	DSE-II -Plant Tissue Culture-II	Th Elective	BOT 204-C																
4d	DSE-II-Advanced Plant Physiology-II	Th Elective	BOT204-D																
4e	DSE-II -Basic and Applied Mycology-II	Th Elective	BOT 204-E																
4f	DSE-II -Molecular Biology, Biotechnology &Plant Breeding-II	Th Elective	BOT 204-F																
5	Lab – III: based on DSC-I.2 and DSC-II.2 (Biochemistry and Plant Physiology, Evolution and Diversity of Bryophytes and Pteridophytes)	Pr				4	4		2	2	6			50	50	100	50		P
6	Lab – IV: based on DSC III.2 and DSE Opted by Student (Genetics and Plant Breeding and following DSE)	Pr				4	4		2	2	6			50	50	100	50		P

	a. Angiosperm Taxonomy, Phytochemistry and Pharmacognosy b. Molecular Systematics of Plants c. Plant Tissue Culture-I d. Advanced Plant Physiology Elective e. Basic and Applied Mycology f. Molecular Biology Biotechnology & Plant Breeding																	
7	**#** On Job Training, Internship/ Apprenticeship; Field projects **Related to Major @ during vacations cumulatively**	**Related to Major**		120 Hours cumulatively during vacations of Semester I and Semester II				**4***									**P***	
8	**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 and IV**	Generic **Optional**		90 Hours Cumulatively From Sem I to Sem IV														
9				Exit Option with a PG Diploma with 4 Credits On-the-job training/internship in the respective Major subject Student has to earn Total minimum 4 Credits cumulatively during Vacations of Semester I and Semester II from internship in order to exit after First Year with PG Diploma (42-44 Credits) after Three Year UG Degree													
	TOTAL										**18+4***				600			

L: Lecture, T: Tutorial, P: Practical/Practicum

Pre-requisite Course mandatory if applicable: Prq, Theory : Th, Practical/Practicum: Pr, Faculty Specific Core: FSC, Discipline Specific Core: DSC, Discipline Specific Elective: DSE, Laboratory: Lab, OJT: On Job Training: Internship/ Apprenticeship; Field projects: FP; RM: Research Methodology; Research Project: RP, Co-curricular Courses: CC

Note : # On Job Training, Internship/ Apprenticeship; Field projects Related to Major (During vacations of Semester I and Semester II) for duration of 120 hours mandatory to all the students, to be completed during vacations of Semester I and/or II.

This will carry 4 Credits for learning of 120 hours. Its credits and grades will be reflected in Semester II credit grade report.

Note: Co-curricular Courses: In addition to the above, CC also include but not limited to Academic activities like paper presentations in conferences, Aavishkar, start-ups, Hackathon, Quiz competitions, Article published, Participation in Summer school/ Winter School / Short term course, Scientific Surveys, Societal Surveys, Field Visits, Study tours, Industrial Visits, online/offline Courses on Yoga (Yoga for IQ development, Yoga for Ego development, Yoga for Anger Management, Yoga for Eyesight Improvement, Yoga for Physical Stamina, Yoga for Stress Management, etc.). These can be completed cumulatively during Semester I, II, III and IV. Its credits and grades will be reflected in semester IV credit grade report.

T, L & E Scheme for Semester – III

S. N.	Subject	Type of Course	Subject Code	Teaching & Learning Scheme							Duration of Exam Hours	Examination & Evaluation Scheme							
				Teaching Period Per Week				Credits				Maximum Marks					Minimum Passing		
												Theory		Practical		Total Marks			
				L	T	P	Total	L/T	Practical	Total		Theory Internal	Theory+ MCQ External	Internal	External		Marks Internal	Marks External	Grade
1	Technological Advancements in Botanical Research	Th	BOT02	2			2	2		2	2	40	60			100	16	24	P
2	DSC-I.3 Paleobotany, Evolution of Gymnosperms and Origin of Angiosperms	Th	BOT300	4			4	4		4	3	40	60			100	16	24	P
3	DSC-II.3 Systematics and Taxonomy of Angiosperms	Th	BOT301	4			4	4		4	3	40	60			100	16	24	P
4	DSC-III.3 Diversity Conservation, Ethnobotany, Palynology and Phytogeography	Th	BOT302	3			3	3		3	3	40	60			100	16	24	P
5	DSE-III Any one Opted by Student / MOOC (Elective Option)	Th Elective	BOT303	3			3	3		3	3	40	60			100	16	24	P
5 a	DSE-III- Angiosperm Taxonomy, Phytochemistry and Pharmacognosy-II	Th Elective	BOT304-A																
5b	DSE-III -Molecular Systematics of Plants-III	Th Elective	BOT 304-B																
5 c	DSE- III -Plant Tissue Culture- III	Th Elective	BOT 304-C																
5d	DSE-III-Advanced Plant Physiology- III	Th Elective	BOT304-D																
5e	DSE-III -Basic and Applied Mycology-III	Th Elective	BOT 304-E																
5f	DSE-II -Molecular Biology, Biotechnology &Plant Breeding-III	Th Elective	BOT 304-F																
																	Minimum Passing Marks		

6	**Lab – V:** based on DSC-I.3 and DSC-II.3 Paleobotany and Evolution of Gymnosperms and Systematics and Taxonomy of Angiosperms	**Pr**				4	4		2	2	6			50	50	100	50		P
7	**Lab – VI:** based on DSE Opted by Student a. Angiosperm Taxonomy, Phytochemistry and Pharmacognosy-III b. Molecular Systematics of Plants-III c. Plant Tissue Culture-III d. Advanced Plant Physiology -III e. Basic and Applied Mycology-III f. Molecular Biology Biotechnology & Plant Breeding-III	**Pr**				4	4		2	2	6			50	50	100	50		P
8	**Research Project Phase I**	Project **(Internal)**				4	4		4	4	3		-	50	-	50	25		P
9	**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 and IV**	Generic **Optional**		**90 Hours Cumulatively From Sem I to Sem IV**																
	TOTAL									**22**						**750**				

L: Lecture, T: Tutorial, P: Practical/Practicum

Pre-requisite Course mandatory if applicable: Prq, Theory : Th, Practical/Practicum: Pr, Faculty Specific Core: FSC, Discipline Specific Core: DSC, Discipline Specific Elective: DSE, Laboratory: Lab, OJT: On Job Training: Internship/ Apprenticeship; Field projects: FP; RM: Research Methodology; Research Project: RP, Co-curricular Courses: CC

Note: Co-curricular Courses: In addition to the above, CC also include but not limited to Academic activities like paper presentations in conferences, Aavishkar, start-ups, Hackathon, Quiz competitions, Article published, Participation in Summer school/ Winter School / Short term course, Scientific Surveys, Societal Surveys, Field Visits, Study tours, Industrial Visits, online/offline Courses on Yoga (Yoga for IQ development, Yoga for Ego development, Yoga for Anger Management, Yoga for Eyesight Improvement, Yoga for Physical Stamina, Yoga for Stress Management, etc.). These can be completed cumulatively during Semester I, II, III and IV. Its credits and grades will be reflected in semester IV credit grade report.

T, L & E Scheme for Semester – IV

S. N.	Subject	Type of Course	Subject Code	Teaching & Learning Scheme							Duration Of Exam Hours	Examination & Evaluation Scheme							
				Teaching Period Per Week				Credits				Maximum Marks					Minimum Passing		
												Theory		Practical		Total Marks			
				L	T	P	Total	L/T	Practical	Total		Theory Internal	Theory+ MCQ External	Internal	External		Marks Internal	Marks External	Grade
1	DSC-I.4 Applied Botany	Th	BOT401	4			4	4		4	3	40	60			100	16	24	P
2	DSC-II.4 Plant Ecology and Environmental Dynamics	Th	BOT402	4			4	4		4	3	40	60			100	16	24	P
3	DSC- III.4 Plant Biotechnology and Genetic Engineering	Th	BOT403	3			3	3		3	3	40	60			100	16	24	P
4	DSE-III Any one Opted by Student / MOOC (Elective Option)	Th Elective	BOT404	3			3	3		3	3	40	60			100	16	24	P
4 a	DSE-II -Angiosperm Taxonomy, Phytochemistry and Pharmacognosy-IV	Th Elective	BOT405-A																
4 b	DSE-III -Molecular Systematics of Plants- IV	Th Elective	BOT405-B																
4 c	DSE- III -Plant Tissue Culture- IV	Th Elective	BOT405-C																
4 d	DSE-III-Advanced Plant Physiology- IV	Th Elective	BOT405-D																
4 e	DSE-III -Basic and Applied Mycology- IV	Th Elective	BOT405-E																
4 f	DSE-II -Molecular Biology, Biotechnology & Plant Breeding- IV	Th Elective	BOT405-F																
																	Minimum Passing Marks		
5	Lab –VII: based on DSC-I.4, DSC-II.4, DSC III.4 and DSE Opted by Student – a. Angiosperm Taxonomy, Phytochemistry and Pharmacognosy- IV b. Molecular Systematics of Plants- IV c. Plant Tissue Culture- IV	Pr				4	4		4	4	6			50	50	100	50		P

	d. Advanced Plant Physiology - IV e. Basic and Applied Mycology-IV f. Molecular Biology Biotechnology & Plant Breeding- IV																		
9	Lab – VIII: Research Project Phase-II	Project			2	8	10	2	4	6	3			75	75	150	75		P
10	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 and IV	Generic Optional		90 Hours Cumulatively From Sem I to Sem IV															
	TOTAL									24						750			

L: Lecture, T: Tutorial, P: Practical/Practicum

Pre-requisite Course mandatory if applicable: Prq, Theory : Th, Practical/Practicum: Pr, Faculty Specific Core: FSC, Discipline Specific Core: DSC, Discipline Specific Elective: DSE, Laboratory: Lab, OJT: On Job Training: Internship/ Apprenticeship; Field projects: FP; RM: Research Methodology; Research Project: RP, Co-curricular Courses: CC

Note: Co-curricular Courses: In addition to the above, CC also include but not limited to Academic activities like paper presentations in conferences, Aavishkar, start-ups, Hackathon, Quiz competitions, Article published, Participation in Summer school/ Winter School / Short term course, Scientific Surveys, Societal Surveys, Field Visits, Study tours, Industrial Visits, online/offline Courses on Yoga (Yoga for IQ development, Yoga for Ego development, Yoga for Anger Management, Yoga for Eyesight Improvement, Yoga for Physical Stamina, Yoga for Stress Management, etc.). These can be completed cumulatively during Semester I, II, III and IV. Its credits and grades will be reflected in semester IV credit grade report.

Credit Framework for Two Years PG Programme

Table A: Credit Distribution

Year (2 Yr PG)	Level	Sem. (2 Yr)	Major		RM	OJT / FP	RP	CC (Optional)	Cum. Cr. Offered	Degree
			Mandatory	Electives						
I	6.0	Sem I	14	4	4				22	PG Diploma (after 3 Yr Degree)
		Sem II	14	4		Cum. 4			22	
Cum. Cr. For PG Diploma			28	08	4	4	-		44	
a) Exit option: PG Diploma (42-44 Credits) after Three Year UG Degree upon completion of on-the-job training/internship of 04 credits during summer break in the respective Major Subject										
II	6.5	Sem III	14	4			4		22	PG Degree After 3- Yr UG
		Sem IV	14	4			6	From Sem to Sem IV 3* Credits Cum.	24	
Cum. Cr. for 2 Yr PG Degree			28	08			10		+3*	
Years-4 Sem. PG Degree (88 credits) after Three Year UG Degree										

Table B: Course wise Credit Distribution across Two Years PG Degree Programme

Sr. No.	Type of Course		Total Credits Offered	Minimum Credits Required
1	MAJOR			
	i. DSC	56	56	56
	ii. DSE	16	16	16
	TOTAL		72	72
2	Research Methodology and IPR		04	04
3	On Job Training, Internship/ Apprenticeship; Field projects		04 (120 Hours OJT/ FP cum.)	02 (Minimum 60 Hours OJT/FP is mandatory)
4	Research Project		10	10
OPTIONAL				
Co-Curricular Courses (offline and/or online as applicable): Co-curricular Courses: Health and wellness, Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC, Fine/ Applied/ Visual/ Performing Arts. CC also include but not limited to Academic activities like paper presentations in conferences, Aavishkar, start-ups, Hackathon, Quiz competitions, Article published, Participation in Summer school / Winter School / Short term course, Field Visits, Study tours, Industrial Visits, online/ offline Courses on Yoga (Yoga for IQ development, Yoga for Ego development, Yoga for Anger Management, Yoga for Eyesight Improvement, Yoga for Physical Stamina, Yoga for Stress Management, etc.)			03 (Limited to Max 90 Hours [3 Credits] of CC cumulatively only)	00
Total			93	88

Instructions and Rubric for Internal Assessment

Rubric for Internal Assessment for All the Theory Courses

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI Internal Assessment M.Sc. (Botany), SEMESTER – I/II/III/IV (NEP)			
Course Code:		Course Title:	Max Marks: 40
S.N.	Assessment Criteria		Marks
1.	Regularity (Attendance, Performance in Theory/Practical)		05
2.	Academic Explorations: Seminar / GD/ Quiz / Workshops		05
3.	Participation in Activities, Field visit / Field visit/ Botanical tour /Industrial Visits etc.		10
4.	CO Testing Unit tests / Assignments		10
5.	Internal Viva Voce		10

Rubric for Internal Assessment for the Research Project

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI Internal Assessment M.Sc. (Botany), SEMESTER –III (NEP)		
Research Project Phase I		Max Marks: 50
S.N.	Assessment Criteria	Marks
1.	Research Proposal: Clarity and Focus	10
2.	Literature Review	10
3.	Methodology	10
4.	Experimental Design	10
5.	Internal Viva Voce by Supervisor	10

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI Internal Assessment M.Sc. (Botany), SEMESTER –III (NEP)		
Research Project Phase II		Max Marks: 75
S.N.	Assessment Criteria	Marks
1.	Regularity and reporting	20
2.	Innovative approach	20
3.	Performance in Laboratory	20
4.	Target Attainment	10
5.	Internal Viva Voce by Supervisor	05

TWO YEAR POSTGRADUATE PROGRAMME

M.Sc. BOTANY

FACULTY: SCIENCE AND TECHNOLOGY

SEMESTER – I COURSES

1	RM01: Research Methodology and IPR
2	DSC-I.1 Cell and Molecular Biology
3	DSC-II.1 Evolution, Diversity and Commercial Application of Microbes, Algae, Fungi and Plant Pathology
4	DSC-III.1 Plant Development, Economic Botany and Resource Utilization
5	DSE-I Any one Opted by Student/MOOC (Elective Options)
5a	DSE-I -Angiosperm Taxonomy, Phytochemistry and Pharmacognosy-I
5b	DSE-I -Molecular Systematics of Plants-I
5c	DSE-I -Plant Tissue Culture-I
5d	DSE-I -Advanced Plant Physiology-I
5e	DSE-I -Basic and Applied Mycology-I
5f	*DSE-I* -Molecular Biology, Biotechnology &Plant Breeding-I
6	Lab – I: based on DSC-I.1 and II.1 (Cell and Molecular Biology and Evolution, Diversity and Commercial Application of Microbes, Algae, Fungi and Plant Pathology)
6	Lab – II: based on DSC-III and DSE Opted by Student (ECONOMIC BOTANY, RESOURCE UTILIZATION AND PLANT DEVELOPMENT and following DSE) a. Angiosperm Taxonomy, Phytochemistry and Pharmacognosy-I b. Molecular Systematics of Plants-I c. Plant Tissue Culture-I d. Advanced Plant Physiology-I e. Basic and Applied Mycology-I f. Molecular Biology Biotechnology & Plant Breeding-I

RM01: Research Methodology and IPR

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.0	I	BOT 01	Research Methodology and IPR	2	30	2 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. Understand the fundamental concepts of research methodology
2. Explore the research process and its components
3. Develop proficiency in research design
4. Gain insights into intellectual property rights
5. Acquire skills in data analysis and basic statistics

Course Outcomes:

CO 1: Students will be able to Demonstrate Proficiency in Research Methodology
CO 2: Students will be able to Design Effective Research Studies
CO 3: Students will be able to Utilize Various Data Collection Methods
CO 4: Students will be able to Analyze and Interpret Data
CO 5: Students will be able to Understand Intellectual Property Rights (IPR) and Patentability
CO 6: Students will be able to Apply Ethical Principles in Research

Detailed Curriculum:

Unit – I: Introduction to Research Methodology

1.1: Definition and importance of research
1.2: Types of research: Basic and applied research
1.3: Research process and its components
1.4: Formulating research questions and objectives
1.5: Research and Scientific Methods, Research Process, Criteria of Good Research
1.6: Research Problem: Concept, need and Identification

Unit – II: Research Design

2.1: Types of research designs: Experimental, descriptive, correlational, and qualitative
2.2: Sampling techniques and sample size determination
2.3: Validity and reliability in research
2.4: Basic principles of Experimental Design
2.5: Various methods of Research
2.6: Case study for research design

Unit – III: Intellectual Property Rights (IPR) and Patent

3.1: Introduction to IPR: Patents, copyrights, trademarks, and trade secrets
3.2: Importance of IPR in innovation and commercialization
3.3: International conventions and treaties related to IPR
3.4: Requirements for patentability
3.5: Case Study of Patent application process
3.6: Patent infringement and litigation

Unit – IV: Copyrights, Trademarks, Trade Secrets and Research Ethics

4.1: Copyright protection and registration
4.2: Trademark registration and infringement
4.3: Protection of trade secrets and confidential information
4.4: Research ethics: Informed consent, confidentiality, data management
4.5: Ethical considerations in IPR: Plagiarism, infringement
4.6: Case study of Plagiarism analysis using online software

Proposed Pedagogies:

1. Teaching Methodologies:

Lectures, Case Studies, Group discussion, Guest lectures, Seminars

2. Learning Methodologies:

Problem-Based Learning, Experimental Learning, Self-Directed Learning, Collaborative Projects

3. Evaluation Methodologies:

Assessments, Research projects, Presentations, Internal and external examinations

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6. Kothari, C. R. (n.d.). *Research methodology: Methods and techniques*.
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9. Booth, W. C., Colomb, G. G., & Williams, J. M. (n.d.). *The craft of research*.
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11. Aplin, T., & Davis, J. (n.d.). *Intellectual property law: Text, cases, and materials*.
12. Goldstein, P., & Dinwoodie, G. B. (n.d.). *Global intellectual property law*.
13. Chisum, D. S., Jacobs, M. A., & Ochoa, T. T. (n.d.). *Understanding intellectual property law*.
14. Singh, G. R. (n.d.). *Intellectual property rights: Text and cases*.
15. Vaidhyanathan, S. (n.d.). *Intellectual property: A very short introduction*.

Model Questions:

Unit I: Introduction to Research Methodology

Long Questions (10 Marks)

A. Explore the relationship between research and scientific methods. How do researchers ensure the validity and reliability of their findings?

B. Discuss the concept of a research problem, its significance, and methods for identifying research problems in different disciplines.

Long Questions (5 Marks)

A. Discuss the definition of research and explain its importance in various fields of study.

B. Explain the process of formulating research questions and objectives.

Short Questions (3/4Marks)

A. Differentiate between basic research and applied research.

B. What are the components of the research process?

C. Why formulating research questions crucial in research?

Unit II: Research Design

Long Questions (10 Marks)

A. Discuss the basic principles of experimental design and their application in research.

B. Explain various methods of research and their suitability for different research objectives.

Long Questions (5 Marks)

A. Compare and contrast experimental, descriptive, correlational, and qualitative research designs. Provide examples to illustrate each.

B. Explain the importance of validity and reliability in research design.

Short Questions (3/4Marks)

A. Define sampling techniques and explain their significance in research.

B. What are the criteria for selecting a sampling technique in research?

C. How can researchers ensure validity and reliability qualities in their studies?

Unit III: Intellectual Property Rights (IPR) and Patentability

Long Questions (10 Marks)

A. Explore the international conventions and treaties related to intellectual property rights (IPR)?

B. Discuss the significance of patentability requirements in protecting inventions and promoting technological innovation.

Long Questions (5 Marks)

A. Discuss the importance of intellectual property rights (IPR) in fostering innovation and commercialization.

B. Explain the process of patent application and the requirements for patentability.

Short Questions (3/4Marks)

A. Define intellectual property rights (IPR) and explain their significance.

B. What are the requirements for patentability?

C. Provide examples of how IPR protection impacts industries?

Unit IV: Copyrights, Trademarks, Trade Secrets, and Research Ethics

Long Questions (10 Marks)

A. Explore the ethical considerations related to informed consent and data management in research?

B. Discuss the implications of plagiarism and infringement in intellectual property rights (IPR)?

Long Questions (5 Marks)

A. Discuss the significance of copyright, trademark, and trade secret protection?

B. Explain the ethical considerations in research and intellectual property?

Short Questions (3/4Marks)

A. Define copyright, trademark, and trade secret.

B. What are the ethical considerations in intellectual property rights (IPR) infringement?

C. How can researchers ensure integrity and accountability in their work?

DSC-I.1 Cell and Molecular Biology

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.0	I	BOT 101	Cell and Molecular Biology	4	60	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. To understand the structural organization in cell and role of cell organelle
2. To understand the basics of chromosomal organization, DNA, RNA and cell cycle
3. To get insights of central dogma and basic cellular processes
4. To understand different levels of gene regulations in prokaryotes and eukaryotes
5. To understand concepts in Genomics and Proteomics

Course Outcomes:

CO 1: Ability to understand the molecular basis of various cellular processes
CO 2: Ability to understand diverse mechanisms in gene regulation
CO 3: Knowledge is useful in laboratory experimentation
CO 4: Acquainted with computational biology

Detailed Curriculum:

Unit – I: Cellular components and Organelles:

1.1: Structure, composition and functions of prokaryotic and eukaryotic cell wall
1.2: Mechanism of cell wall synthesis, Bacterial cell divsion
1.3: Structure, composition and functions of plasma membrane
1.4: Transporters: ion channels, active and passive transport; membrane pumps.
1.5: Structural and functional aspects of cellular organelles
1.6: Cytoskeletons; microtubules, intermediate filaments, microfilaments and their role in motility, Plasmodesmata.

Unit-II: Cell cycle, Division and Cellular Communication:

2.1: Cell cycle; Steps in cell cycle, roles of Cyclins and Cyclin Dependent Kinases,
2.2: Checkpoints; regulation of mitosis and meiosis in *S. cerevisiae* and *S. pombe*, chromosome congression, cell plate formation and cell division.
2.3: Cellular communication: signal transduction; types of signals molecules, types of receptors; G-proteins, GPCRs,
2.4: Second messengers, Tyrosine, Serine, Threonine and Histidine Kinases mediated signaling.
2.5: Plant two- component systems, light signaling in plants.
2.6: Bacterial chemotaxis and quorum sensing

Unit-III: Chromosomal Organization

3.1: Chromosomal Organization: DNA packaging, histone modifications . Chromatin structure: heterochromatin, euchromatin
3.2: Epigenetics: concept, Post translational modification of histone, chromatin remodeling, RNA-based mechanism
3.3: Organization of Centromeres and Telomeres. Role of telomerase.
3.4: Specialized Chromosomes: Polytene, Lampbrush, B Chromosomes.
3.5: Genome size, Organization; C-value paradox, Cot curve, re-association kinetics, hypochromic effect.
3.6: Transposable elements, Transposable elements in bacteria; Transposable elements in eukaryotes, P element and Retrotransposons

Unit-IV: DNA replication, Repair and Recombination

4.1: DNA replication: Semiconservative replication, Replicons and origin of replication

4.2: DNA replication in *Ecoli*, Telomere replication, Rolling circle replication

4.3: Replication of mitochondrial DNA

4.4: DNA Repair: Direct repair, Excision repair, Mismatch repair

4.5: Recombinational repair, Repair of double stranded break, Gene conversion, SOS repair

4.6: Homologous recombination, site specific recombination

Unit-V: Transcription and Gene Regulation

5.1: Transcription Unit: Monocistronic, polycistronic, RNA polymerases

5.2: Bacterial RNA polymerases, Nuclear RNA polymerases and organelle RNA polymerases.

5.3: Process of transcription in *E coli*, antibiotic inhibitors of transcription.

5.4: Eukaryotic transcription: Promoter, regulatory promoter elements, role of RNA polymerases, role of activators and coactivators, regulatory elements and role of enhancer.

5.6: Regulation of gene expression in Prokaryotes: Operon model; Lac Operon; tryptophan Operon in E.coli, Riboswitches

Unit-VI: RNA interference (RNAi), epigenetics and protein synthesis

6.1: RNA interference, types, mi RNA, si RNA, mi mediated RNAi, si RNA mediated RNAi

6.2: Genetic code, features, universal code, unusual code and their occurrence, codon bias

6.3: Protein synthesis in prokaryotes: Ribosomes; types, Initiation; steps, initiation factors, elongation; factors, proof reading mechanism, termination, role of release factors.

6.4: Protein synthesis in Eukaryotes: preinitiation complex, elongation and termination.

6.5:. Regulation of translation, Translational frame shifting.

6.6: Post translational modifications of proteins: types and mechanism

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16. Hall, J.L. and Moore, A.L. 1983. Isolation of Membranes and Organelles from Plant Cells. Academic Press, London, U.K.
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18. https://www.technologynetworks.com/proteomics/articles/proteomics-principles-techniques-and-applications-343804
19. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC309050/ (RNA interference)

PRACTICALS:

MAJOR EXERCISES: (Minimum any 8)

1. Preparation of Nuclear Stains
2. To prepare slide of mitosis
3. To prepare slide for meiosis
4. To determine mitotic index.
5. Preparation of cytological slides for chromosomal non-disjunction in *Rheo/ Tradescantia*
6. Isolation and extraction of cell organelles like mitochondria/ chloroplast.
7. Differential Centrifugation for isolation of cell fractions
8. Isolation and purification of genomic DNA from plant materials by CTAB Method.
9. Quantitative estimation of genomic DNA and RNA using spectrophotometer
10. Restriction Digestion of lambda DNA / Plasmid DNA.
11. Agarose gel electrophoresis of genomic DNA and RNA and detection using gel documentation system.
12. PCR amplification
13. Isolation and purification of RNA from plants.
14. Isolation of Plant DNA and prepare Cot curve.
15. SDS PAGE electrophoresis for separation of seed storage proteins.
16. Browse, search, retrieve, and use proteomics data from widely used public proteomics data repositories.

MINOR EXERCISES:

1: Retrieval and use of gene sequences from gene banks.
2. Visit to Advanced Research Laboratory to study latest techniques or sophisticated equipment.
3. Study of permeability of living cell to acids and bases.
4. 5. Demonstration of western blotting.
6. Study of electron micrographs of cell organelles.

DSC-II.1 Evolution, Diversity and Commercial Application of Microbes, Algae, Fungi and Plant Pathology

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.0	I	BOT 102	Evolution, Diversity and Commercial Application of Microbes, Algae, Fungi and Plant Pathology	4	60	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. Study the origin, evolution, diversity and applications of microbes.
2. Understand the general characters / parameters (Habitat, thallus range, pigments, reserve food, reproduction, life cycles) and classification in Algae.
3. Study the different groups and representative genera in Algae.
4. The applications of Algae in diversified areas.
5. Understand the general characters/ parameters (Mycelia types, nutrition, mode of reproduction, fruiting bodies) and classification in Fungi.
6. Cover the different groups and representative genera in Fungi, their applications.
7. Exposure to Phytopathology including Indian contribution, symptoms, regional crop diseases and control measures, quarantine, educational and research aspects.

Course Outcomes:

CO 1: Develop knowledge regarding origin, evolution, diversity of microbial world, harmful effects and their applications in industries and in traditional practices.

CO 2: Understanding of different habitats, develop the techniques of collection of algae, preservation, identification, classification, use and commercial production also.

CO 3: Acquire the knowledge regarding the occurrence of micro/macro fungi, fruiting bodies in nature, collection of Fungi and edibility nature of Mushrooms.

CO 4: Develop the sterilization, media preparation, culture techniques of Fungi, preservation, identification, classification, use and commercial production also.

CO 5: By frequent field visits to nature will create the interest, confidence and practical knowledge in them.

CO 6: Develop the knowledge to understand the symptoms, identify the disease, precautions and control the disease.

CO 7: Acquire the recent and research knowledge/techniques will be beneficial for further project/research work.

Detailed Curriculum:

Unit I: Evolution, Diversity and Commercial Applications of Microbes

1.1 -Origin and evolution of microorganisms

1.2 -General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and cellular microorganisms (Bacteria, Algae, Fungi and Protozoa)

1.3 **-Viruses** – Discovery, general structure, transmission, replication (Lytic Cycle)

1.4 **-Bacteria** –General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction)

1.5 -Role of viruses in vaccine production

1.6 -Role of bacteria in soil fertility, industry and Harmful activities of bacteria

Unit II: Algae

2.1 -Habitat, Range of thallus organization, pigments, reserve food, reproduction and life cycle patterns

2.2 -Classification of algae proposed by F. E. Round (1973)

2.3 -**Cyanophyta**- General characters, ultra structure of cell and reproduction

2.4 -**Chlorophyta and Charophyta** –General characters, Thallus structure and reproduction in *Chlorella, Volvox, Zygnema, Pithophora , Ulva, Chara*

2.5 -Role of Cyanobacteria in soil fertility

2.6 -Spirulina cultivation and health benefits

Unit III: Algae

3.1 -**Xanthophyta –** General characters, Thallus structure and reproduction in *Vaucheria*

3.2 -**Bacillariophyta-** General characters and Economic importance of Diatomite

3.3 -**Phaeophyta –** General characters, Thallus structure and reproduction in *Ectocarpus, Dictyota, Sargassum*

3.4 -**Rhodophyta–** General characters, Thallus structure and reproduction in *Batrachospermum, Porphyra, Polysiphonia*

3.5 - Algae as a food, Commercial products of algae

Unit IV: Fungi

4.1 -Mycelium structure and types, mode of nutrition, types of flagella, types of reproduction, and fruiting bodies in different groups

4.2 -Classification proposed by Ainsworth (1973)

4.3 **-Myxomycotina** – General characters, Thallus structure and reproduction in *Stemonites, Plasmodiophora*

4.4 **-Mastigomycotina** - General characters, Thallus structure and reproduction in *Synchytrium, Phytophthora*

4.5 -**Zygomycotina -** General characters, Thallus structure and reproduction in *Pilobolus, Syncephalastrum*

4.6 -Mycorrhizae types and applications

Unit V: Fungi

5.1 **-Ascomycotina** – General characters, Thallus structure and reproduction in *Phyllactinia, Aspergillus*

5.2 -Fruiting bodies (Ascocarps) of *Xylaria, Claviceps, Peziza, Morchella*

5.3 **-Basidiomycotina -** General characters, Thallus structure and reproduction in *Ustilago, Agaricus*

5.4 -Fruiting bodies (Basidiocarps) of *Polyporus, Lycoperdon, Geastrum, Cyathus*

5.5 **-Deuteromycotina** – General characters, Thallus structure and reproduction in *Alternaria, Cercospora, Fusarium*

5.6 - Mushrooms - Natural biodegraders, as a food and medicine

Unit VI: Plant Pathology

6.1 -Phytopathology in India

6.2 -Symptoms associated with plant diseases

6.3 -Regional crop diseases and their control (Fungal, Viral, Bacterial and Phytoplasma)

6.4 -Plant and seed quarantine

6.5 -Biological disease control

6.6 -Educational aspects in Phytopathology (including journals, websites, National and International centers for Agricultural research)

Proposed Pedagogies:

1. Teaching Methodologies:
   a) Interactive Multimedia Resources(Virtual Labs, Documentaries and Videos)
   b) Guest Lectures and Expert Talks
   c) Integration with Current Research
   d) Practical Applications and Industry Relevance
2. Learning Methodologies:
   a) Case Studies and Problem-Based Learning
   b) Role-playing and Gamification
   c) Field Trips and Visits
   d) Hands-on Demonstrations and Experiments(Microscopy Sessions, Culturing Experiments)
3. Evaluation Methodologies:
   a) Methodological Rigor(Experimental Design, Data Collection, Statistical Analysis)
   b) Quality of Evidence
   c) Ethical Considerations
   d) Interpretation of Results

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Model Questions:

Long Type for 10 Marks:

Unit- I – Describe the cell structure and various reproduction modes with examples in Bacteria. Describe the chemical nature, replication of viruses and their role in vaccine production.

Unit- II – Explain in detail the thallus range in Algae with examples.

Unit- III –Describe the thallus structure and different types of asexual and sexual reproduction in *Vaucheria.*

Unit- IV –Define mycorrhiza? Explain types of mycorrhizae and their applications in Agriculture sector.

Unit- V – Write on the general characters of Ascomycotina, thallus structure and reproduction in *Phyllactinia*.

Unit- VI –Describe in detail any two fungal diseases on regional crops and their control measures.

Long Type for 05 Marks:

Unit- I – Role of viruses in vaccine production.

Unit- II – Reproduction in Cyanobacteria.

Unit- III –Sexual reproduction in *Sargassum*.

Unit- IV – Types of reproduction in Fungi.

Unit- V – Thallus structure and reproduction in *Alternaria.*

Unit- VI – Plant and seed quarantine.

Short Type for 3/4Marks:

Write on-

Unit- I – General characteristics of Viruses.
- Role of bacteria in soil fertility.
- Harmful activities of Bacteria.

Unit- II – Pigmentation in Algae.
- Health benefits of *Spirulina*.
- Scalariform conjugation in *Zygnema*.

Unit- III – Economic importance of Diatomite.
- Thallus structure of *Polysiphonia.*
- General characters of Rhodophyta.

Unit- IV – Modes of nutrition in Fungi.
- Sporangium of *Stemonites.*
- Asexual reproduction in *Pilobolus.*

Unit- V – Ascocarp of *Morchella.*
- Basidiocarp of *Cyathus.*
- Mushrooms as natural biodegraders.

Unit- VI –Difference between Powdery and Downy mildew.
- Biological disease control.
- Phytoplasma disease and its control.

MAJOR EXERCISES: (Including Field Study/Activities)

Major 1: Visit the water reservoir, collect the algal samples, prepare the slide and identify the algal genera.
Major 2: Spirulina cultivation/culture technology in laboratory.
Major 3: Visit the forest, collect the mushrooms, preserve and identify.
Major 4: Visit the field, collect the diseased specimens, photography, slide preparation and identification of pathogen.
Major 5: Sterilization techniques, preparation of media, inoculation of fungi/Bacteria.
Major 6: Preparation of Pathology Herbarium.
Major 7: Preparation the Photo Album of Mushrooms.
Major 8: Symptom study of fungal, viral, bacterial, Phytoplasma diseased specimens.
Major 9: Gram staining of Bacteria.
Major 10: Symptom study, section cutting, slide preparation, identification and monograph.

MINOR EXERCISES:

Minor 1: Morphological studies and Monographs of Algae: (Any 12 of the following).

[*Nostoc, Anabaena, Oscillatoria, Spirulina, Gleotricha, Chlamydomonas, Chlorella, Eudorina, Volvox, Closterium, Hydrodictyon, Pediastrum, Cladophora, Pithophora, Zygnema, Draparnaldia, Cosmarium, Acetabularia, Ulva, Chara, Nitella, Vaucheria, Diatoms, Laminaria, Sargassum, Dictyota, Padina, Ectocarpus, Batrachospermum, Gracillaria, Gellidium, Porphyra, Polysiphonia*].

Minor 2: Morphological studies and Monographs of Fungi: (Any 12 of the following).

[*Stemonitis, Plasmodiophora, Saprolegnia, Synchytrium, Perenosora, Phytophthora, Albugo, Mucor, Rhizopus, Pilobolus, Syncephalastrum, Saccharomyces, Aspergillus, Penicillium, Trichoderma, Erysiphe, Phyllactinia, Uncinula, Taphrina, Chaetomium, Phoma, Claviceps, Xylaria, Peziza, Morchella, Ustilago, Puccinia, Melampsora, Uromyces, Ravenallia, Agaricus, Polyporus, Lycoperdon, Geastrum, Cyathus, Alternaria, Helminthosporium, Drechslera, Curvularia, Cercospora, Colletotrichum, Fusarium*].

Minor 3: Permanent Slides or Cultures of following fungal forms:

[*Mucor, Rhizopus, Syncephalastrum, Aspergillus, Penicillium, Trichoderma, Chaetomium, Phoma, Alternaria, Helminthosporium, Drechslera, Curvularia, Cercospora, Colletotrichum, Fusarium*].

Minor 4: Symptomology and study of some diseased plants: (Any 5 of the following).

[White rust of Crucifers, Downy mildews, Powdery mildews, Ergot, Rusts, Smuts on regional crops, Tikka disease of Groundnut, Red rot of Sugarcane, Wilt diseases, Citrus canker, Angular leaf spot of Cotton, Leaf mosaic of Bhindi /Papaya, Leaf curl of Tomato/Potato/Papaya, Phyllody, Witches Broom, Little leaf of Brinjal].

DSC-III.1 Plant Development, Economic Botany and Resource Utilization

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.0	I	BOT 103	Plant Development, Economic Botany and Resource Utilization	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. To understand the various aspects of plant development.
2. To understand the mechanism of seed germination and seed growth
3. To understand sexual incompatibility and types of endosperms.
4. To find ways that will allow the plant to be used sustainably.
5. To provide an idea to establish a plant-based natural product industry.

Course Outcomes:

CO 1: Deals with the regulation of growth and development of plants through bio-molecular interaction

CO 2: Study the origin, divarication, utility, and conservation strategies & natural resources

CO 3: Study the importance of food, fiber, medicines &oil-yielding plants.

CO 4: Study the plants and their value in the service & mankind.

CO 5: Study the conservation of biodiversity.

CO 6: Perform the techniques in anatomy.

Detailed Curriculum:

Unit – I: Embryology

1.1: Introduction to Plant Embryology: Definition and scope of plant embryology.

1.2: Reproductive Structures in Plants: Morphology and anatomy of flower parts involved in reproduction, Pollination and its types, Pollen pistil Interaction, and Process of Fertilization.

1.3: Microsporogenesis, Megasporogenesis, Double fertilization and triple fusion.

1.4: Seed Development and Maturation: Formation and maturation of seeds, Seed coat, and Seed dormancy.

1.5: Embryo Differentiation and Growth: Primary meristems and embryonic tissues, Endosperm development and its type.

1.6: Applied Aspects of Plant Embryology: Micropropagation, somatic embryogenesis, Role of embryology in plant breeding and genetic modification.

Unit – II: Plant Development

2.1: Plant growth kinetics and patterns of growth.

2.2: Seedling growth: Tropisms; Photomorphogenesis of seedling; hormonal control of seedling growth.

2.3: Shoot Development: Organization of shoot apical meristem (SAM); cytological and molecular analysis of SAM; regulation of cell fate in meristem; tissue differentiation in the shoot.

2.4: Root Development: Organization of root apical meristem (RAM); vascular tissue differentiation; lateral root hairs; root microbe interactions.

2.5: Stomatal Development: organization and development of stomata, stomatal development and environmental factors.

2.6: Nutrient Management for desired Growth and Development of the Plants

Unit – III: Plant Development

3.1: Leaf growth and differentiation: Determination; phyllotaxy; control of leaf form; differentiation of epidermis (with special reference to stomata & trichomes) and mesophyll.

3.2: Flower Development: Physiology of flowering, florigen concept and photoperiodism, Genetics of floral organ differentiation; homeotic mutants in Arabidopsis and Antirrhinum.

3.3: Structure of anther, role of tapetum, pollen development, pollen tube development and guidance.

3.4: Development of female gametophyte: Ovule development, organization of embryo sac and its types (mono, bi, tetra etc.)
3.5: Pollination mechanisms and vectors.
3.6: Endosperm development and imprinting.

Unit – IV: Economic Botany

4.1: Plant resources: Concept, status, utilization & concerns.
4.2: World Centers of Primary Diversity of Domesticated Plants.
4.3: Origin, evolution, Botany, Cultivation, Chemotaxonomy and economic importance of i) Cereals and Millets (wheat, paddy, maize) ii) Legumes/ pulses (Soybean, black gram, cowpeas) iii) Sugar yielding crops (Sugarcane, beetroot, sweet potato)
4.4: Morphology, varieties and economic importance of oil, Fiber, Forage & fodder crops.
4.5: Spices & Condiments: Ginger, Turmeric, Cardamom, Clove, pepper, Cumin.
4.6: Narcotics: Classification of drugs, drugs obtained from roots, underground stems, barks, leaves, flowers, fruits and seeds.

Unit – V: Resource Utilization

5.1: Green and Evergreen Revolution: Concept, concerns, benefits and adverse consequences.
5.2: Plants and their value in the service of mankind
5.3: General account and parts from which these are obtained, extraction methods and uses, paper making Tannins, Dyes, Gum and Resins, Rubber & Latex.
5.4: Firewood & Timber woods their identification properties and users, Teak, Shisam, Sal, Neem, Mango, Babul.
5.5: Plants used as Avenue trees for shade and aesthetics.
5.6: Innovative approaches for meeting world food demands modern agricultural approach.

Unit – VI: Technological Advances

6.1: Nonalcoholic Beverages: origin, evolution, domestication and processing of tea and coffee, fruits and vegetable juices.
6.2: Alcoholic Beverages: origin, evolution and processing of fermented alcoholic beverages.
6.3: Psychoactive drugs: sources, chemistry of action, use and misuse of Papaver somniferous and Cannabis sativa Fumitories and masticatories: A general account, their medicinal importance
6.4: Agricultural innovation for meeting food demands: agricultural biotechnology, synthetic crops, agriculture in arid zones.
6.5: Smart Agriculture: Integrating AI and IoT for Enhanced Plant Growth and Sustainability.
6.6: Food Adulteration

Proposed Pedagogies:

Teaching (T) Methodologies

1. **Flipped Classroom**:
    - Students review lecture materials (videos, readings) at home.
    - Class time is used for hands-on activities, discussions, and problem-solving.
    - Example: For topics like microsporogenesis and megasporogenesis, students watch explanatory videos before class and then engage in lab activities to reinforce their understanding.
2. **Guest Lectures and Webinars**:
    - Experts from academia and industry provide insights into specialized topics.
    - Example: Inviting a researcher to discuss the latest advances in plant embryology or agricultural biotechnology.
3. **Interactive Workshops**:
    - Hands-on sessions focused on techniques such as micropropagation, somatic embryogenesis, and tissue culture.
    - Example: Workshops on the practical applications of plant embryology in breeding and genetic modification.

Learning (L) Methodologies

1. **Field Studies and Virtual Tours**:

- Visits to botanical gardens, research institutions, and agricultural sites.
- Virtual tours of significant botanical locations for students unable to travel.
- Example: A virtual tour of a plant breeding facility to understand the applied aspects of embryology.

2. Collaborative Projects:
   - Group projects on topics like seed development, phytohormones, and economic botany.
   - Example: A project where students create a comprehensive report on the economic importance of specific crops.
3. Journal Clubs:
   - Regular meetings to discuss recent research papers related to course topics.
   - Example: Reviewing and debating recent studies on phytohormones and their role in plant development.

Evaluation (E) Methodologies

1. E-Portfolios:
   - Students compile their findings, reflections, and project outcomes into a digital portfolio.
   - Example: Portfolios that include lab reports, project results, and reflections on field trips.
2. Case Study Analysis:
   - Students analyze real-world cases and present their solutions.
   - Example: Analyzing the impact of the Green Revolution on modern agriculture and proposing sustainable practices.
3. Research Proposals:
   - Students write and present proposals for research projects on specific aspects of plant development or economic botany.
   - Example: Proposals for innovative methods to improve crop yield using modern agricultural technologies.

Integration Across Units

- Unit I: Embryology: Utilize flipped classrooms for theoretical concepts, followed by lab workshops on reproductive structures and embryo development.
- Unit II & III: Plant Development: Conduct field studies and collaborative projects on plant growth patterns, shoot and root development, and hormonal control.
- Unit IV: Economic Botany: Leverage guest lectures and journal clubs to explore the economic significance of various crops, supplemented by case study analyses.
- Unit V: Resource Utilization: Interactive workshops and research proposals focusing on sustainable practices and resource management.
- Unit VI: Technological Advances: Field studies, virtual tours, and collaborative projects to understand the latest innovations in agricultural biotechnology and crop improvement.

These methodologies aim to foster a comprehensive, engaging, and practical understanding of the course content, preparing students for both academic and industry challenges in botany.

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Model Questions:

Long type 10marks:

1) Explain in detail microsporogenesis and mega sporogenesis.
2) Describe double fertilization and triple fusion.
3) Describe in detail Somatic Hybridization.
4) Discuss in detail on differentiation and development of leaf.
5) Discuss in detail on type of embryo sac and its significance in plant reproduction.
6) Describe in brief Avenue trees for pollution control and aesthetic plants.
7) Describe in brief various innovative approaches for meeting world food demand.
8) Add note on Modem Agriculture practices.

Long type 05 marks:

1) Importance and significance of double fertilization.
2) Origin, cultivation and uses of Wheat.
3) Fiber crops andd their uses.
4) Cultivation and uses of food plants.
5) Uses of oil yielding plant

PRACTICALS:

MAJOR EXERCISES:

Major1: Comparative anatomy of dicot and monocot stem.

Major 2: Study of types of trichomes, stomata and hairs.

Major 3: Pollen viability (Tetrazolium test) and Germination: Calculation of percentage germination in different media using hanging drop method

Major 4: Microtomy.

Major 5: To study the morphology of the part used of various representative crops like rice, wheat, maize, potato, pulses and fruits.

Major 6: Study of viability of various crop seeds using germination and T.Z Test Study of seed vigor using standard methods.

Major 7: In vivo germination of pollen grains on stigma.

Major 8: Study of food reserves in different food crops using microchemical tests.

Major 9: Morphology, microscopic study of oil-yielding tissues and test for oil (mustard, groundnut, soybean, linseed, coconut, sunflower, castor, sesame and cashew nut)

MINOR EXERCISES:

Minor 1: Study of vascular tissues.

Minor 2: Study of T.S of anther

Minor 3: Study of types of Ovules

Minor 4: Study of any five important fodder and forage crops.

Minor 5: Study of source spice and condiments (source, part used, active components)

Minor 6: Ethnobotanical aspects of various local products.

Minor 7: Study of various types of fibres viz. cotton. coir, hemp etc.

Minor 8: Study of comparative characteristics of the grains of cereals, millets and pulses.

DSE-I -Angiosperm Taxonomy, Phytochemistry and Pharmacognosy-I

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.0	I	BOT104A	Angiosperm Taxonomy, Phytochemistry and Pharmacognosy-I	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. Understand the scope, aims, principles, and historical development of plant taxonomy.
2. Gain knowledge of the APG system of classification and taxonomic literature, including DNA barcoding.
3. Learn the International Code of Botanical Nomenclature and its application in herbarium preparation and botanical gardens.
4. Explore modern concepts and trends in plant taxonomy, including cytotaxonomy, chemotaxonomy, and molecular taxonomy.
5. Develop skills in phytochemical techniques, including extraction, isolation, and spectrophotometric analysis of phytochemicals.

Course Outcomes:

CO 1: Recall the basic principles and historical development of plant taxonomy.
CO 2: Explain the APG system of classification and the importance of taxonomic literature and keys.
CO 3: Apply the International Code of Botanical Nomenclature in the preparation and use of herbarium and digital herbarium.
CO 4: Analyze various modern concepts and trends in plant taxonomy, including cytotaxonomy, chemotaxonomy, and cladistics.
CO 5: Evaluate the taxonomic evidence from wood anatomy, floral anatomy, embryology, and palynology to understand plant relationships.
CO 6: Design experiments using chromatographic and spectrophotometric techniques to extract, isolate, and analyze phytochemicals.

UNIT I:

1.1: Scope, Aims, Principles of Taxonomy,
1.2: Historical Development of Plant Taxonomy;
1.3: Study of Basic Principles and Recent Angiosperm Phylogeny Group (APG) System of Classification.
1.4: Taxonomic Literature: Checklist, Catalogue, Floras, Monographs, Indices and Journals,
1.5: Taxonomic Keys
1.6: DNA Barcoding

UNIT II:

2.1: International code of Botanical Nomenclature
2.2: Type method, valid publication,
2.3: Rule of priority, Author citation,
2.4: Conservation of names and rejection of names,
2.5: Herbarium Preparation and use, Digital Herbarium, Role of Botanical Garden,
2.6: Different theories of origin of angiosperms.

UNIT III:

3.1: Modern concepts and trends in plant taxonomy
3.2: Elementary treatment of Cytotaxonomy,
3.3: Chemotaxonomy,
3.4: Numerical Taxonomy,
3.5: Molecular Taxonomy,
3.6: Cladistics

UNIT IV:

4.1: Taxonomic evidence:
4.2: Wood anatomy, Floral Anatomy,
4.3: Embryology, Palynology,
4.4: Cytotaxonomy,

4.5: Biosystematics,
4.6: A brief account of major contribution made by the following Taxonomists: Carl Linnaeus, Joseph Dalton, Hooker, William Roxburgh, John Friminger, and Duthie.

UNIT V:
5.1: Basic principles of phytochemical techniques,
5.2: Classification of Phytochemicals.
5.3: Extraction and Isolation of Phytochemicals,
5.4: Spectrophotometry - Principle and application,
5.5: UV Visible and Infra-Red Spectroscopy.

UNIT VI :
6.1: Chromatographic techniques-
6.2: Paper chromatography,
6.3: Thin Layer Chromatography (TLC),
6.4: High Performance Liquid Chromatography (HPLC),
6.5: Gas Liquid Chromatography (GLC).

Suggested Readings:

1: Alston, R. E., & Turner, B. L. (1963). Biochemical systematics. Prentice Hall.
2: Bailey, L. H. (1949). Manual of cultivated plants (2nd ed.). Macmillan.
3: Beck, C. B. (Ed.). (1976). Origin and early evolution of angiosperms. Columbia University Press.
4: Beck, C. B. (Ed.). (1976). Origin and early evolution of angiosperms. Columbia University Press.
5: Benz, G., & Santesson, J. (Eds.). (1976). Chemistry in botanical classification. Nobel Symposia: Medicine and Natural Science, Academic Press.
6: Corner, E. J. H. (1976). The seeds of dicotyledons (Vols. I & II). Cambridge University Press.
7: Cotton, C. M. (1996). Ethnobotany: Principles and applications. John Wiley & Sons Ltd.
8: Cronquist, A. (1981). An integrated system of classification of flowering plants. Columbia University Press.
9: Cunningham, A. B. (2001). Applied ethnobotany. Earthscan Publishers Ltd.
10: Davis, P. H., & Heywood, V. H. (1963). Principles of angiosperm taxonomy. D. Van Nostrand.
11: Eames, A. J. (1961). Morphology of the angiosperms. McGraw-Hill.
12: Erdtman, G. (1952). Pollen morphology and plant taxonomy: Angiosperms. Almqvist & Wiksell.
13: Evans, W. C. (2009). Trease and Evans' pharmacognosy (16th ed.). Saunders.
14: Harborne, J. B., & Turner, B. L. (1984). Plant chemotaxonomy. Academic Press.
15: Heywood, V. H. (Ed.). (1971). Taxonomy and ecology. Academic Press.
16: Houghton, P. J. (2009). Traditional plant medicines as sources of new drugs. In Trease and Evans' pharmacognosy (16th ed.). Elsevier.
17: Hughes, N. F. (1976). Paleobiology of angiosperm origins. Cambridge University Press.
18: Hutchinson, J. (1959). The families of flowering plants (Vols. I & II). Oxford University Press.
19: Hutchinson, J. (1973). Evolution and phylogeny of flowering plants. Academic Press.
20: Jain, S. K. (1981). Glimpses of Indian ethnobotany. Oxford & IBH Publishing Co. Pvt. Ltd.
21: Judd, W. S., Campbell, C. S., Kellogg, E. A., & Stevens, P. F. (2008). Plant systematics: A phylogenetic approach (3rd ed.). Sinauer Associates, Inc.
22: Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2019). Pharmacognosy. Nirali Prakashan.
23: Kumar, S. (1997). Chromosome atlas of the flowering plants of the Indian subcontinent. International Book Distributors.
24: Lawrence, G. H. M. (1951). Taxonomy of vascular plants. Macmillan.
25: Moreira, M. (1992). An introduction to ethnobotany. Moredale Publishing.
26: Naik, V. N. (1984). Taxonomy of angiosperms. Tata McGraw-Hill.
27: Saldhana, C. J., & Rao, C. K. (1977). A punched card key to the dicot families of South India. Arvind Publishers.
28: Sneath, P. H. A., & Sokal, R. R. (1973). Numerical taxonomy: The principles and practice of numerical classification. W.H. Freeman & Co.
29: Solbrig, O. T. (1970). Evolution and systematics. Macmillan.
30: Sporne, K. R. (1974). Morphology of angiosperms. Hutchinson.
31: Swain, T. (1973). Comparative phytochemistry. Academic Press.
32: Takhtajan, A. (1969). Flowering plants: Origin and dispersal. Oliver & Boyd.
33: Voss, E. G. (Ed.). (1983). International code of botanical nomenclature. Regnum Vegetabile,

Utrecht.
34: Young, D. J., & Seigler, D. S. (1981). Phytochemistry and angiosperm phylogeny. Praeger.

Digital Resources:

1: https://learn.concord.org/
2: https://learn.concord.org/eresources/1274.run_resource_html
3: https://learn.concord.org/eresources/3013.run_resource_html
4: https://www.google.com.in

Additional Indian References:

1: Singh, G., & Jain, S. K. (2013). Ethnobotany: The renaissance of traditional herbal medicine. Scientific Publishers.
2: Khare, C. P. (2007). Indian medicinal plants: An illustrated dictionary. Springer.
3: Warrier, P. K., Nambiar, V. P. K., & Ramankutty, C. (1995). Indian medicinal plants: A compendium of 500 species (Vols. 1-5). Orient Longman.

Model Questions:

Long Type Questions:

1. Discuss the historical development of plant taxonomy and how it has evolved to the current APG system of classification. Include in your discussion the principles and significance of the APG system.
2. Explain the International Code of Botanical Nomenclature, focusing on the type method, valid publication, rule of priority, and conservation and rejection of names. How do these principles ensure consistency and accuracy in botanical nomenclature?
3. Analyze the role of modern concepts and trends in plant taxonomy, such as cytotaxonomy, chemotaxonomy, numerical taxonomy, and molecular taxonomy. How have these methodologies contributed to our understanding of plant relationships and classification?
4. Describe the various types of taxonomic literature, including checklists, catalogues, floras, monographs, indices, and journals. How do these resources contribute to the field of plant taxonomy and the work of taxonomists?
5. Discuss the principles and techniques involved in the extraction, isolation, and analysis of phytochemicals. Include in your discussion the applications of spectrophotometry (UV-Visible and Infra-Red spectroscopy) and chromatographic techniques (paper chromatography, TLC, HPLC, GLC) in phytochemical studies.
6. Evaluate the contributions of major taxonomists such as Carl Linnaeus, Joseph Dalton Hooker, William Roxburgh, John Friminger, and Duthie to the field of plant taxonomy. How have their works influenced modern taxonomy and the classification of plants?

Short Type Questions:

1. Define the scope and aims of plant taxonomy.
2. What are taxonomic keys, and how are they used in plant identification?
3. Explain the concept of DNA barcoding and its application in plant taxonomy.
4. Describe the process of herbarium preparation and the role of digital herbaria in botanical studies.
5. What are the different theories regarding the origin of angiosperms?
6. Outline the principles of numerical taxonomy and its significance in classifying plants.
7. How does wood anatomy provide taxonomic evidence for plant classification?
8. Briefly explain the basic principles of phytochemical techniques and the classification of phytochemicals.

List of laboratory experiments:

1) Identification of families mentioned in the syllabus with the help of salient features
2) Preparation of dichotomous key
3) ICN problems
4) Name of the plant using Gamble
5) Submission of 30 herbarium sheets
6) Field trip for minimum of 3 days for collection of plants and preparation of herbarium
7) Study of local flora
8) Spotters related to Theory

DSE-I -Molecular Systematics of Plants-I

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.0	I	BOT104B	Molecular Systematics of Plants-I	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Outcomes:

On completion of the course, the student should be able to –

CO 1: Discuss and apply principles of delimitation and identification of species and other taxa
CO 2: Account for the central concepts of the field and principles of phylogenetic analysis, especially based on the parsimony criterion
CO 3: Discuss and apply methods to generate relevant molecular data, mainly sequence data.
CO 4: Choose and apply existing software in the included course parts, from generating relevant molecular data to phylogenetic analysis
CO 5: Critically analyse, evaluate, compile, and present the results of phylogenetic analysis.

Unit-I	1.1 Plants and kingdoms of life: two, three, five, six and seven kingdom systems. 1.2 Taxonomy and systematics: Concepts; components and comparative account. Phylogeny: concept, historical prospectives and significance.
Unit-II	2.1. Taxonomic classification: Artificial (Carl Linaeus); Natural (Bentham and Hooker); phenetic systems with merits and demerits. 2.2. Phylogenetic systematics: Classification based on Angiosperm Phylogeny Group (APG I-V).
Unit-III	3.1. Taxonomic evidences: Morphological, palynological, chromosomal and phytochemical and their distinctive features. 3.2. Taxonomic literature - Floras, Monographs, Indices, Keys and Journals. Field and Herbarium Methods. Importance of Botanical gardens
Unit-IV	4.1. Botanical nomenclature: Need for scientific names, botanical code; components, ICBN. concepts of taxa (Binomials, trinomials); genes and species, type method. 4.2. Taxonomic hierarchy: taxonomic categories (supra-specific, species, and intra-specific).
Unit-V	5.1. Types of variations: Developmental; environmental and genetic variations, Analysis of variance (ANOVA), standard deviation. 5.2. Molecular evolution: Genetic drift, natural selection, evolution of species, isolating mechanisms (pre. post zygotic), sympatric and allopatric speciation.
Unit-V	6.1 Angiosperm Taxonomy: Salient features and economic importance of the angiosperm's families. 6.2 Descriptive studies: Magnoliaceae, Rosaceae, Rubiacae, Liliaceae, Poaceae, Orchidaceae and Ranunculaceae.

Suggested Reading:

1. Felsenstein, J. (2004). *Inferring phylogenies*. Sunderland, MA: Sinauer Associates, Inc.
2. Hall, B. G. (2011). *Phylogenetic trees made easy: A how-to manual* (4th ed.). Sunderland, MA: Sinauer Associates.
3. Hillis, D. M., Moritz, C., & Mable, B. K. (Eds.). (1996). *Molecular systematics*. Sunderland, MA: Sinauer Associates.
4. Kitching, I. J., Forey, P. L., Humphries, C. J., & Williams, D. M. (1998). *Cladistics: The theory and practice of parsimony analysis*. Oxford: Oxford University Press.
5. Li, W.-H. (1997). *Molecular evolution*. Sunderland, MA: Sinauer Associates.
6. Schuh, R. T. (2000). *Biological systematics*. Ithaca, NY: Comstock Publishing Associates.
7. Soltis, P. S., Soltis, D. E., & Doyle, J. J. (Eds.). (1992). *Molecular systematics of plants*. New York: Chapman and Hall.
8. Soltis, D. E., Soltis, P. S., & Doyle, J. J. (Eds.). (1998). *Molecular systematics of plants II: DNA sequencing*. Boston: Kluwer Academic Publishers.
9. Williams, D. M., & Ebach, M. C. (2008). *Foundations of systematics and biogeography*. New York: Springer.
10. Yang, Z. (2006). *Computational molecular evolution*. Oxford: Oxford University Press.
11. Kormondy, E. J. (1996). *Concepts of ecology* (4th ed.). Upper Saddle River, NJ: Prentice Hall.
12. Sharma, P. D. (2010). *Ecology and environment*. Meerut, India: Rastogi Publications.
13. Simpson, M. G. (2006). *Plant systematics*. San Diego, CA: Elsevier Academic Press.
14. Singh, G. (2012). *Plant systematics: Theory and practice* (3rd ed.). New Delhi: Oxford & IBH Pvt. Ltd.

Learning Outcome:

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

- Understand historical development of taxonomy.
- Explain concept of species. Order sub and super categories of species according to Linne hierarchy.

Laboratory Exercises Major Experiments

1. Live plants/ Herbarium specimens of the following families will be provided in the class for description and identification (classification based on APG II, 2003):
2. Basal Angiosperm and Magnoliids: Nymphaeaceae, Magnoliaceae
3. Basal Monocots: Araceae, Alismataceae
4. Petaloid monocots: Liliaceae, Smilacaceae, Alliaceae, Orchidaceae
5. Preparation of identification keys for at least 10 specimens based on morphological features.
6. Use of palynological, chemical methods in taxonomy

Minor Experiments

7. Writing exercise
8. Nomenclature exercise
9. Classification exercise
10. Cladogram construction and analysis

DSE-I -Plant Tissue Culture-I

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.0	I	BOT 104C	Plant Tissue Culture-I	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Outcomes:

On completion of the course, the student should be able to

CO 1: To learn the basic principles of plant tissue culture
CO 2: To demonstrate the methods in Plant Tissue Culture
CO 3: Understand the applicability of Plant Tissue culture in relation to presentday problems.
CO 4: To gain the Knowledge about laboratory organization for plant tissue culture.
CO 5: Understand various Aseptic techniques for plant tissue culture

Unit-I	1.1 History of plant tissue culture research - basic principles of plant tissue culture. 1.2 Laboratory organization, design and layout, equipment's (Laminar air flow, autoclave, distillation unit, pH meter,orbital shaker, microscope, deep freezer, growth chamber) and their working principles, laboratory ethics and practices.
Unit-II	2.1. Nutrient media and their types, importance, 2 2 Preparation ofstocks, pH and Buffers and their significance in media. 2.3 Media Constituents: Vitamins, Unidentified supplements, (carbohydrate for energy source, Nitrogen source and organic supplements, complex substances, hormones, Activate charcoal)
Unit-III	3.1 Concept of totipotency,cells differentiation and dedifferentiation. Factors affecting vascular tissue differentiation 3.2 Callus culture: induction of callus, transfer, subcultures,morphological features and growth kinetics.
Unit-IV	4.1 Concepts of Morphogenesis, organogenesis 4.2 Hardening and Acclimatization their steps, needs, packaging, exportations and quality maintenance. 4.3 Pathogen (Virus) indexing-significance, methods, advantages,applications.
Unit-V	5.1 Micropropagation: steps, advantages, applications andchallenges 5.2 Meristem culture, organ culture, axillary bud proliferationtechnique and applications 5.3 Synthetic seed- technique, advantages, applications. Asepticseed germination
Unit-VI	6.1 Somatic embryogenesis: steps, induction, direct and indirectsomatic embryogenesis, 6.2 Factors affecting somatic embryogenesis, 6.3 Comparative account with zygotic embryogenesis and applications.

Suggested Reading:

1. Bhojwani, S. S. (1990). *Plant tissue culture: Theory and practical* (Revised ed.). New York, NY: Elsevier Science Publishers.
2. Bhojwani, S. S. (1996). *Plant tissue culture: Application and limitations*. New York, NY: Elsevier Science Publishers.
3. Vasil, I. K., & Thorpe, T. A. (1994). *Plant cell and tissue culture*. The Netherlands: Kluwer Academic Publishers.
4. Shantharam, S., & Montgomery, J. F. (1999). *Biotechnology, biosafety and biodiversity*. New Delhi, India: Oxford & IBH Publishing Co. Pvt. Ltd.
5. Glick, B. R., & Thomson, J. E. (1993). *Methods in plant molecular biology and biotechnology*. Boca Raton, FL: CRC Press.
6. Dubey, R. C. (n.d.). *A text book of biotechnology*. New Delhi, India: S. Chand Publication.
7. Smith, R. H. (2013). *Plant tissue culture: Techniques and experiments* (3rd ed.). Boston, MA: Academic Press.
8. Dixon, R. A. (Ed.). (1994). *Plant cell culture: A practical approach*. Oxford, UK: Oxford University Press.

Learning Outcome:

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

a. List out, identify and handle various equipments in plant tissue culture lab.
b. Demonstrate the procedures of preparation of media.
c. Exhibit skills on inoculation, establishing callus culture and micropropagation.

d. Acquire skills in observing and measuring callus grows.

Laboratory Exercises

1. Handling and Instrumentation of Plant Tissue Culture
2. Principals and applications of- Autoclave, Laminar Airflow, Hot Air Oven.
3. Sterilization techniques for glass ware, tools etc.,
4. MS medium - Preparation of different stock solutions; media preparation
5. Explant preparation, inoculation and initiation of callus from carrot.
6. Experiment on Micropropagation
7. Experiment on somatic embryogenesis.
8. Callus formation, growth measurements.
9. Cytological study of calli cells and their sub culturing
10. In vitro meristem culture
11. Synthesis of artificial seeds
12. Preparation of mother plants for collection of explants
13. Maturation and conversion of somatic embryos into plantlets.
14. Primary hardening of tissue culture plants for their acclimatization

DSE-I -Advanced Plant Physiology-I

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.0	I	BOT 104D	Advanced Plant Physiology-I	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. Understand the mechanisms of water and mineral uptake and transport in plants, including hydraulic conductance and aquaporins.
2. Explore the evolutionary dynamics and diversity of photosynthesis across different organisms.
3. Analyze the processes involved in the light reaction and the Calvin cycle, including electron pathways and key enzymes.
4. Investigate the role of light in the activation of dark phase enzymes and the regulation of C4 and CAM photosynthesis.
5. Examine the translocation of photosynthates, including signaling mechanisms, phloem unloading, and the source-to-sink transition.

Course Outcomes:

CO 1: Explain the physiological regulation of mineral homeostasis and adaptive strategies under different environmental conditions.

CO 2: Describe the evolution and diversity of photosynthesis, including carbon-concentrating mechanisms and photo-protectant systems.

CO 3: Analyze the light reaction and Calvin cycle, detailing the involvement of reaction centers and electron pathways.

CO 4: Evaluate the regulation of dark phase enzymes and the mechanisms of C4 and CAM photosynthesis.

CO 5: Discuss the evolutionary timeline and distribution of Rubisco, photorespiratory bypasses, and the potential for artificial photosynthesis.

CO 6: Assess the regulation and mechanisms of translocation of photosynthates, including factors affecting translocation and the role of sieve elements and companion cells.

Unit-I: Water, minerals uptake and transport

Physiological regulation of mineral homeostasis, absorption and adaptive strategies under different environmental conditions; Soil–Plant–Atmosphere Continuum. Hydraulic conductance, Aquaporins.

Unit-II: Evolutionary dynamics of photosynthesis

Evolution and diversity of photosynthesis from bacteria to higher plants, Carbon-concentrating mechanisms in bacteria, algae and plants.

Damage avoidance and repair; photo-protectant in cyanobacteria and higher plants.

Stoichiometry of electron transport yields.

Unit-III: Light Reaction

Path of carbon: Light Reaction, Involvement of reaction centre,

Kelvin cycle, Sources ribulose and Sedoheptulose. Electron Pathways.

Unit-IV: Evolutionary dynamics of photosynthesis

Role of light in the activation of dark phase enzymes, regulation of RUBISCO, PEPcase, light effect, modulators and coordination of light , dark phase. C4 Photosynthesis: inter and intra-cellular transport of metabolites, carbonic anhydrase, PEPcase, NADP-MDH and PPDK. Regulation of CAM through transport of metabolites.

Unit-V: Evolutionary dynamics of photosynthesis

Evolutionary timeline and phylogenetic distribution of Rubisco; Photorespiratory bypasses and energy cost, facultative CAM, Economically important C4 and CAM species, Turbocharging rice, Artificial photosynthesis, Photosynthetic fungi and animals

Unit-VI: Translocation of Photosynthates

Regulation of translocation of photosynthates, signaling mechanism for transport of photo assimilates flow; factors affecting translocation, sieve elements sealing, P-proteins; companion cells as reservoir; comparative account of source to sink transport in symplastic and apoplastic phloem leaders

Role of Sucrose–H+ symporter; polymer-trapping model; Phloem Unloading; sink-to-source transition.

Suggested Reading:

1. Davies, P.J. (2004). Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands.
2. Jordan, B.R. (2006). The Molecular Biology and Biotechnology of Flowering, 2nd Edition, CAB International, Oxfordshire, U.K.
3. Nelson, D.L. and Cox, M.M. (2008). Lehninger Principles of Biochemistry (5thed.). New York
4. Buchanan, Gruissem and Jones. 2002. Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.
5. Annual Review of Plant Biology (formerly Annual Review of Plant Physiology and Plant Molecular Biology).
6. BASIC REFERENCES: Alberts et al., Molecular Biology of the Cell (parts related to plants); Salisbury and Ross, Plant Physiology; Taiz and Zeiger, Plant Physiology; Hopkins and Huner, Introduction to Plant Physiology.
7. CURRENT LITERATURE (JOURNAL ARTICLES): Plant Physiology, The Plant Cell, Journal of Plant Physiology, Physiologia Plantarum, Plant Physiology and Biochemistry, Postharvest Biology and Technology, Hortscience, Journal of the American Society for Horticultural Science, Science, Nature, Scientific American etc.
8. Many plant physiology journals can be viewed via the net. The URL of one of the sites listing these journals is: http://www.e-journals.org/botany/

Learning Outcome:

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

1. The students will learn and demonstrate the physiological mechanisms of Water, minerals uptake and transport; they can correlate with present day's challenges for plant growth, development and survival.
2. The students will understand the evolutionary history of photosynthetic organisms and their adaptability in changing environmental conditions; they can interpret the photosynthetic productivity in relation to changing climatic conditions and food security
3. They will acquire the knowledge and demonstrate the various mechanisms of translocation of photosynthetic products to different sink
4. The students will learn various plant responses against environmental changes and challenges; they can understand unique strategies of plants to resolve the various stresses

List of Experiments:

1. Assay of catalase, peroxidase and ascorbic acid oxidase activity; determination of Km value of Urease.
2. Complexometric assay of Calcium and Magnesium
3. Colorimetric estimation of IAA.
4. Isolation of chloroplast and assay of Hill activity
5. Tetrazolium test of seed viability
6. Estimation of total phenolic content from seeds.
7. Colorimetric estimation of amino groups by Ninhydrin reaction.

DSE-I -Basic and Applied Mycology-I

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.0	I	BOT 104E	Basic and Applied Mycology-I	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. To demonstrate a systematic, extensive and coherent knowledge an understanding of basic and applied mycology.
2. To links to other disciplinary areas of the study; including critical understanding of the established theories, principles and concepts of a number of advanced and emerging issues in the field of mycology.
3. To demonstrate procedural knowledge that creates different types of professionals in the field of Botany like research and development in the field of medical mycology and plant pathology and drug discovery and various research institutes of mycology, teaching government and public services e.g. conservationist.
4. Developing skills and ability to use knowledge efficiently in areas related to mycology and current updates in the subject.
5. Demonstrate comprehensive knowledge about fungi, current research, scholarly and professional literature of advanced learning areas of mycology

Course Outcomes:

Upon completion of this course successfully, students would be able to:

CO 1: Understand advanced knowledge of structure and diversity of different fungal groups.
CO 2: Analyzed different fungal forms and classify into different groups on the basis of microscopic and macroscopic observations.
CO 3: Apply the knowledge of mycology for research and development.
CO 4: Create the database for advanced studies in the field of mycology
CO 5: Apply knowledge in the field of medical mycology, plant pathology and related and interdisciplinary areas

Detailed Curriculum:

Unit – I: Diversity of Fungi

1.1 Habitat- aquatic fungi, soil fungi, root-inhibiting fungi, coprophilous fungi, lignocolous fungi, cellulolytic fungi,keratinophilic fungi, entomogenous fungi, predacious fungi, phylloplane fungi, psychrophilic fungi, thermophilic fungi and ambrosia fungi.
1.2 Vegetative phase - Thallus and kind of mycelia,Types of septa, structures associated with mycelia and aggregations of mycelia.
1.3 Reproduction – vegetative, asexual and sexual, types of fructifications
1.4 Nutrition in fungi- Saprotrophs, Biotrophs,Necrotrophs, Symbiotrophs
1.5 Fungal Cytology and Genetics: Cell structure , Heterothallism, Heterokaryosis and Parasexuality
1.6 Taxonomy of fungi : Classification by Ainsworth G.C. (1973), Alexopoulos and C. W. Mims (1979), Current phylogenetic classification

Unit – II: Bioprospecting of fungi in Agriculture and Industry

2.1 Types of Mycorrhizae and role of AM fungi in agriculture.
2.2 Mycoinsecticides and mycopesticides
2.3 *Trichoderma* and other fungal antagonistic as a biocontrol agents.
2.4 Role of fungi in the production of alcohol, organic acids and enzymes
2.5 Fermentation methods and biomass production of fungi
2.6 Principle and production of antibiotics

Unit – III: Fungi as a Food

3.1 Edible mushrooms and their cultivation practices
3.2 Cultivation and economics of *Agaricus bisporus, Pleurotus and Volvoriella*
3.3 Medicinal and nutritional value of edible mushrooms
3.4 The mycelium as food (SCP)
3.5 Quorn as mycoprotein
3.6 Fermented food products

Unit – IV: Medical Mycology

4.1 Dermatophytosis and the dermatophytes
4.2 Histoplasmosis and Blastomycosis
4.3 Coccidiodomycosis and Coccidiodomycosis
4.4 Aspergillosis and mucormycosis
4.5 Fungal Allergies and Mushroom Poisonings
4.6 Mycotoxins

Unit – V: Division-Myxomycota

5.1 General characters and classification of Myxomycota
5.2 General characters of Acrasiomycetes and Hydromyxomyctes
5.3 General characters of Myxomycetes
5.4 General characters of Plasmodiophoromycetes
5.5 Life cycles of *Stemonitis*
5.6 Life cycle of *Plasmodiophora*

Unit – VI: Subdivision -Mastigomycotina and Zygomycotina

6.1 General characters of Chitridiomycetes and Hypochytridiomycetes
6.2 Life cycle of ***Synchytrium***
6.3 Oomycetes- Life cycle of ***Peronospora***
6.4 General characters and classification of **Zygomycotina**
6.5 Zygomycetes general characters and Life cycle of *Mucor*
6.6 Trichomycetes –general characters

Proposed Pedagogies:

1. **Teaching Methodologies:**
   Classroom teaching, power point presentation, group discussions, quiz field visits,visits to research institutes and natural habitats, mushroom cultivation units fermentations industries etc.

2. **Learning Methodologies:**
   e-Herbarium preparation and collection of wild mushrooms, seminars, projects etc.

3. **Evaluation Methodologies:**
   Assessment by –assignments, unit test and semester end examinations

Suggested Reading:

1. Ulloa, M., & Aguirre-Acosta, E. (2019). *Illustrated generic names of fungi*. APS Press.
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15. Gupta, V. K., & Behl, M. K. (1994). *Indian plant viruses and mycoplasma*. Kalyani Publishers.
16. Jha, D. K. (1993). *A textbook of seed pathology*. Vikas Publication House.
17. Manibhushan Rao, K., & Mahadevan, A. (n.d.). *Recent development in biocontrol of plant pathogens*. Today and Tomorrow Publishers.
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21. Rangaswamy, G., & Mahadevan, A. (1999). *Diseases of crop plants in India*. Prentice Hall of India.
22. Singh, R. S. (1994). *Plant pathology*. Oxford and IBH Publication Co.
23. Thind, T. S. (1998). *Diseases of field crops and their management*. National Agricultural Technology Information Centre.
24. Manoharachary, C., Tilak, K. V. B. R., Mallaiah, K. V., & Kunwar, I. K. (2016). *Mycology and microbiology*. Scientific Publishers.
25. Aneja, K. R., & Mehrotra, R. S. (2015). *An introduction to mycology*. New Age International Private Limited.
26. Dubey, H. C. (2017). *Introduction to fungi, bacteria and viruses*. Agribios.
27. Gupta, R. C., & Sharma, O. M. P. (2010). *Textbook of fungi*. Oxford Publication.
28. Sharma, O. M. P. (1989). *Textbook of fungi*. Tata McGraw-Hill Publishing Company.

Websites:

- www.drfungus.org
- www.mycobank.org
- www.mycologyonline.org
- www.aspergillus.org.uk
- www.fungusfocus.com
- www.mycology.adelaide.edu.au

Model Questions:

Long Type for 10 Marks:

1. Describes types of fruiting bodies in fungi.
2. Explain asexual reproduction in different divisions of fungi.
3. Explain cell structure in fungi
4. Explain classification of fungi propsed by Alexopous and Mims
5. Explain the types of Mycorrizha and role of AM F in agriculture.
6. Describe edible mushrooms and its cultivation practices
7. Explain aspergellosis and mucormycosis
8. Explain general characters of myxomycetes fungi
9. Explain reproduction in *Stemonitis*
10. Explain general characters and classification of Zygomycotina

Long Type for 05 Marks:

1. Explain Heterothallism in fungi
2. Explain Heterokaryosis and Parasexuality in fungi
3. Explain production of antibiotics
4. Explain Dermatophytosis and dermatophytes
5. Explain general characters of acrasiomycetes
6. Explain sexual reproduction in *Peronospora*

Short Type for 3/4Marks:

Explain –

1. Keratinophillic fungi
2. Saprotrophs
3. Symbiotrops
4. Trichoderma
5. Mycoproteins
6. Histoplasmosis
7. Mycotoxins
8. Thallus of *Mucor*

PRACTICALS:

MAJOR EXERCISES: (Any ten)

1. **Demonstration on Cultivation of Fungi**
   - 1.1 Washing and sterilization of glasswares,
   - 1.2 PDA preparation,
   - 1.3 pouring, preparation of slants and sterilization, inoculation, staining techniques
2. **Microscopic examination of fungi**

   21.Transferring of fungi to Petri dishes and slants

   2.2 Slide culture technique

   2.3 Single spore cultures

   2.4 Hanging drop

   2.5 Temporary mounts
3. Isolation of aquatic fungi
4. Isolation Rhizosphere fungi by serial dilution technique
5. Isolation of soil fungi by Warcup method
6. Isolation of Phyllosphere
7. Isolation of Coprophilous fungi
8. Isolation of keratinophilic fungi
9. Study of aeromycoflora from different localities
10. Isolation of mycorrhizal spores from soil

11. Demonstration of antagonism in fungi.
12. Cultivation of *Agaricus sp. Or Pleurotus* sp.
13. Study of the following genera
    a. Myxomycotina – *Gymnomycota* (Dictyostelium)
    b. Mastigomycotina- Coelomycetes- (*Langenidium, Achlya, Phytopthora, Perenospora,Plasmodiophora*),
    c. Zygomycotina- (*Mucor, Rhizopus Synephalastrum, Blakesla, Cunninghamella, Entomorphthora*

Minor exercises (any five)

1. Preparation of database of fungi on the basis of nutrition (Saprotrophs, Biotrophs,Necrotrophs, Symbiotrophs)
2. Monograph writing of fungi
3. Collection of infected plant parts
4. Camera lucida drawing of fungi
5. Microphotography of Fungal specimens
6. Identification of different cultivated mushroom species
7. Collection and identification of wild mushrooms
8. Identification of human pathogenic fungi

DSE-I -Molecular Biology, Biotechnology & Plant Breeding-I

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.0	I	BOT104F	Molecular Biology, Biotechnology & Plant Breeding-I	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. To make acquainted with various latest genetic engineering
2. Explain the basics, methodology and applications of plant tissue culture.
3. Design experiments for functional characterization of plant genes and to identify
4. Conceptualize plant transformation, selection of desirable genes for crop improvement.

Course Outcomes:

CO 1: To learn the basic principles of molecular biology & plant breeding
CO 2: To demonstrate the methods in molecular biology & plant breeding
CO 3: To gain the Knowledge about laboratory organization for molecular biology
CO 4: Understand various Aseptic techniques for plant tissue culture

Detailed Curriculum:

Unit – I: Nucleic Acids:

1.1: Importance of nucleic acid in living systems
1.2: General composition of nucleic acids, purine and pyrimidine bases
1.3: Tautomer forms of bases, reactions of purines and pyrimidines.
1.4: Structure of nucleoside and nucleotide, oligonucleotides, cyclic nucleotides and polynucleotides.
1.5: Watson and Crick model for DNA.
1.6: Different types of DNA and RNA

Unit – II: DNA Replication:

2.1: Introduction Basic concept of molecular biology and genetics.
2.2: DNA Replication in Prokaryotic and eukaryotic replication. Models of replication, theta mode of replication, rolling circle model of replication, Bidirectional replication, replication of linear DNA, Unidirectional replication
2.3: Functions of various proteins involved in prokaryotic replication of DNA and eukaryotic replication.
2.4: Properties of various replication enzymes.
2.5: Replication of telomeres and enzymes involved in telomere replication
2.6: Replication repair mechanisms

Unit – III: Plant Tissue Culture:

3.1: Introduction to cell and tissue culture as a technique to produce novel plants and hybrids;
3.2: Tissue culture media (composition and preparation).
3.3: Initiation and maintenance of callus and suspension culture, single cell clones. Organogenesis, Ssomatic embryo genesis, transfer and establishment of cut whole plant in soil Shoot tip culture
3.3 Rapid clonal propagation and production of virus free plants; Embryo culture and embryo rescue;
3.4: Protoplast isolation, culture and fusion selection of hybrid cells and regeneration of hybrid plants, symmetric and asymmetric hybrids, cybrids.
3.5 Anther, pollen and ovary culture for production of haploids plants and homozygous line; Cryopreservation, slow growth and DNA banking for germ plasma conservation;
3.6: Green house and green home technology.

Unit – IV: Genetic Engineering.

4.1: Milestones of inventions in Genetic Engineering;
4.2: DNA chemical synthesis,
4.3: Separation by electrophoresis, various types of agarose used in electrophoresis and PAGE,
4.4: Denaturating agents used in gel electrophoresis, cloning, control of expression of cloned genes, cloning and patenting of life forms.

4.5: Guidelines on experimentation in genetic engineering.
4.6: Guidelines of bio- safety according to WHO (Geneva Convention) and DBT India.

Unit – V: Molecular tools:

5.1: Polymerase enzymes,
5.2: Nucleic acid modifying enzymes, nucleic acid ligases,
5.3: Proteases,
5.4: Types of restriction enzymes and their sub types and application,
5.5: Various types of DNA and RNA markers
5.6: Methods of calculation of molecular weight of nucleic acids.

Unit – VI: Plant Breeding:

6.1: History of Plant Breeding (Pre- and post-Mendelian era);
6.2: Objectives of plant breeding,
6.3: Characteristics improved by plant breeding.
6.4: Patterns of Evolution in Crop Plants- Centers of Origin-biodiversity and its significance.
6.5: Genetic basis of breeding self- and cross-pollinated crops including mating systems
6.6: Response to selection - nature of variability,

Proposed Pedagogies:

8. Teaching Methodologies:

Lecture, Explaining, Demonstration, Discussion, Assignment, Project, Audio visual,

9. Learning Methodologies:

Retrieval, Iinterleaving, Varied Practice, Elaborationn, Reflectionn, Spaced Repetition

10. Evaluation Methodologies:

Formative and Summative,

Bibliography: Reference/Text Books/Research Articles:

1. Sambrook, J., Fritsch, E. F., & Maniatis, T. (2000). *Molecular cloning: A laboratory manual*. Cold Spring Harbor Laboratory Press.
2. Glover, D. M., & Hames, B. D. (1995). *DNA cloning: A practical approach*. IRL Press.
3. Kaufman, P. B., Wu, W., Kim, D., & Cseke, L. J. (1995). *Molecular and cellular methods in biology and medicine*. CRC Press.
4. Berger, S. L., & Kimmel, A. R. (1998). *Methods in enzymology: Vol. 152. Guide to molecular cloning techniques*. Academic Press.
5. Goeddel, D. V. (1990). *Methods in enzymology: Vol. 185. Gene expression technology*. Academic Press.
6. Mickloss, D. A., & Freyer, G. A. (1990). *DNA science: A first course in recombinant technology*. Cold Spring Harbor Laboratory Press.
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10. Kingsman, S. M., & Kingsman, A. J. (1998). *Genetic engineering: An introduction to gene analysis and exploitation in eukaryotes*. Blackwell Scientific Publications.
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12. Kreuzer, H., & Massey, A. (n.d.). *Recombinant DNA and biotechnology: A guide for teachers*.
13. Gimble, J. M. (n.d.). *Academia to biotechnology: Career changes at any stage*.
14. Thomas, J. A. (n.d.). *Biotechnology and safety assessment*.
15. Schweizer, M. (n.d.). *Methods in biotechnology*.
16. Mepham, T. B. (n.d.). *Bioethics: An introduction for the biosciences*.
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22. Roy, D. (2003). *Plant breeding: Analysis and exploitation of variation*. Narosa Publishing House.
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32. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (n.d.). *Molecular biology of the gene*. Benjamin-Cummings Publishing Co.
33. Springer. (n.d.). *Link to book*.
34. Springer. (n.d.). *Link to journal*.
35. Canvas. (n.d.). *The LMS for easy learning and productivity*.
36. Blackboard Learn. (n.d.). *The LMS for assessment and content reporting*.
37. Workday Student. (n.d.). *A web-hosted campus management tool*

Model Questions:

Long Type for 10 Marks:

1. Describe in details DNA structure and Composition
2. Describe mechanism of DNA Replication in Prokaryotic and eukaryotic replication.
3. Describe the culture as a technique to produce novel plants and hybrids;
4. Give an account of Anther & pollen culture for production of haploids plants and homozygous line
5. Describe in details control of expression of cloned genes.
6. Give the account of types of restriction enzymes and their sub types.

Long Type for 05 Marks:

1. cyclic nucleotides,
2. replication of linear DNA.
3. Organogenesis,
4. cloning and patenting of life forms.

Short Type for 3/4Marks:

DBT India.

PRACTICALS:

MAJOR EXERCISES:

Major 1: Quantitation of nucleic acids.
Major 2: Isolation of plasmid DNA.
Major 3: Isolation of RNA
Major 4: SDS – PAGE.
Major 5: Protoplast fusion using polyethylene glycol solution.
Major 6. Mechanical isolation of mesophyll protoplasts.

MINOR EXERCISES:

Minor 1: Principles of spectrophotometry,
Minor 3: Emasculation and bagging of flowers of Brasicaceae, Malvaceae, and liliaceae,
Minor 4: Preparation of stocks - macronutrients, micronutrients, vitamins and hormones, filter sterilization of hormones and antibiotics. Preparation of Murashige and Skoog medium.

Lab – I: Based on DSC-I.1 and II.1 (Cell and Molecular Biology and Evolution, Diversity and Commercial Application of Microbes, Algae, Fungi and Plant Pathology)

Level	Semester	Course Name	Credits	Practical Hours	Exam Duration	Max Marks
6.0	I	Cell and Molecular Biology and Evolution, Diversity and Commercial Application of Microbes, Algae, Fungi and Plant Pathology	2	60	6 Hrs	50 (Int) + 50 (Ext)

Practical Question Paper

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
PRACTICAL EXAMINATION
M.Sc. I (Botany), SEMESTER – I (NEP) DSC-I & II
PRACTICAL I:
Cell and Molecular Biology and Evolution, Diversity and Commercial Application of Microbes, Algae, Fungi and Plant Pathology

Time: 6 hrs. **Marks:** 50

Q.1. Perform Any One Major Experiment on Cytology	10M
Q.2. Perform Any One Major Experiment on Molecular Biology	10M
Q.3. Perform Any One Minor Experiment on Cell and Molecular Biology	05M
Q4. Isolation and Identification of any two Algal forms from the given material.	10M
Q.5. Isolation and Identification of any two Fungal forms from the given material.	10M
Q.6. Spotting on Algae and fungi	05M

Lab – II: Based on DSC-III and DSE Opted by Student

Level	Semester	Course Name	Credits	Practical Hours	Exam Duration	Max Marks
6.0	I	Plant Development, Economic Botany and Resource Utilization following DSE	2	60	6 Hrs	50 (Int) + 50 (Ext)

Practical Question Paper

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
PRACTICAL EXAMINATION
M.Sc. I (Botany), SEMESTER – I (NEP) DSC-I & II
PRACTICAL II

Time: 6 hrs. **Marks:** 50

Part A
Plant Development, Economic Botany and Resource Utilization

Q1. Morphology, Botanical identification and Economic importance of food/fiber crop (Any One) 10 M
Q2. Perform Phytochemical Test (Any Two) 05M
Q3. Setting and working of any Major experiment based on Plant Development 10M

Part B
DSE: _____

Q1. Question based on Major Exercises (Any Two) 20 M
Q2. Question based on Minor Exercises (Any One) 05 M

TWO YEAR POSTGRADUATE PROGRAMME

M.Sc. BOTANY

FACULTY: SCIENCE AND TECHNOLOGY

SEMESTER – II COURSES

S.N.	Subject
1	DSC-I.2 Biochemistry and Plant Physiology
2	DSC-II.2 Evolution, Fossils and Diversity of Bryophytes, and Pteridophytes
3	DSC-III.2 Plant Genetics and Breeding
4	DSE-II Any one Opted by Student /MOOC (Elective Option)
4a	DSE-II -Angiosperm Taxonomy, Phytochemistry and Pharmacognosy-II
4b	DSE-II -Molecular Systematics of Plants-II
4c	DSE-II -Plant Tissue Culture-II
4d	DSE-II-Advanced Plant Physiology-II
4e	DSE-II -Basic and Applied Mycology-II
4f	DSE-II -Molecular Biology, Biotechnology &Plant Breeding-II
5	Lab – III: based on DSC-I.2 and DSC-II.2 (Plant Physiology, Evolution and Diversity of Bryophytes and Pteridophytes)
	Lab – IV: based on DSC III.2 and DSE Opted by Student (Plant Biochemistry, Genetics and Plant Breeding and following DSE) a. Angiosperm Taxonomy, Phytochemistry and Pharmacognosy b. Molecular Systematics of Plants c. Plant Tissue Culture-I d. Advanced Plant Physiology Elective e. Basic and Applied Mycology f. Molecular Biology Biotechnology & Plant Breeding

DSC-I.2 Biochemistry and Plant Physiology

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.0	II	BOT201	Biochemistry and Plant Physiology	4	60	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. Explain the structure, function, and interactions of key biomolecules, including proteins, nucleic acids, lipids, and carbohydrates.
2. Analyze the major metabolic pathways, their regulation, and their integration within the cell.
3. Understand the principles of enzyme kinetics and the mechanisms of enzyme action.
4. Develop the ability to integrate biochemical knowledge and apply it to solve real-world problems.
5. Explain the biochemical processes of photosynthesis and respiration in plants.
6. Understand the role of plant hormones in regulating growth, development, and responses to environmental stimuli.
7. Investigate how plants perceive and respond to environmental changes, including light, temperature, water, and biotic factors.
8. Apply knowledge of plant physiology to real-world problems in agriculture, horticulture, and environmental science.

Course Outcomes:

CO 1: Students will be able to design and conduct experiments to investigate physiological processes in plants.

CO 2: Students will be able to discuss the physiological and biochemical mechanisms plants use to adapt to their environment.

CO 3: Students will be able to describe the major plant hormones and explain their roles in plant development and stress responses.

CO 4: Students will be able to apply their understanding of biochemistry to address issues in health, disease, biotechnology, and environmental science.

CO 5: Students will be able to describe how enzymes catalyze reactions, interpret kinetic data, and discuss factors that influence enzyme activity.

CO 6: Students will be able to describe the chemical properties and biological roles of different biomolecules and understand their relevance to cellular processes.

CO 7: Students will be able to use their understanding of plant physiology to address issues such as crop improvement, sustainable agriculture practices, and environmental conservation.

Detailed Curriculum:

Unit –I (a): Thermodynamics and enzyme kinetics

2.1: Thermodynamics: concepts of entropy, enthalpy and Gibbs's free energy

2.2: Enzymes: Discovery, structure; mechanism of enzyme catalysis, types and nomenclature.

2.3: Enzyme kinetics: Michaelis-Menten equation, Growth curve and allosteric enzymes, regulators and inhibitors.

(b) Structure, classification, metabolism and functions of:

2.4: 1.1: Carbohydrates,

2.5: 1.5: Amino acids:

2.6: 1.4: Proteins:

Unit II: Structure, classification, metabolism and functions of

Structure, classification, metabolism and functions of:

2.1: Fatty acids

2.2: Lipids

2.3: Secondary metabolites: structure, types, properties and classification

2.4: Secondary metabolites: role in defense mechanism

2.5: Phosphate assimilation and metabolism

2.6: Plant pigments: types and role in plants

Unit – III: Photosynthesis

3.1: Historical account, evolution of photosynthetic apparatus from bacteria to higher plants.
3.2: Electromagnetic radiation, photons, absorption spectrum, action spectrum.
3.3: Antenna pigment system, energy funneling, photoprotective mechanisms
3.4: Mechanisms of electron transport; photophosphorylation, photosynthesis inhibitors and its action.
3.5: Carbon assimilation: C3, C4 and CAM pathways; their evolutionary significance.
3.6: Photorespiratory pathways; C2 cycle and its significance.

Unit – IV: Respiration and Stress Physiology

4.1: Overview, historical account, evolution of anaerobic and aerobic respiration.
4.2: Aerobic respiration: Glycolysis and its regulation, TCA cycle, Pentose phosphate pathway.
4.3: Plant mitochondrial electron transport and ATP synthesis, alternative oxidase system.
4.4: Anaerobic respiration: Alcoholic and Lactic acid fermentation
4.5: Gluconeogenesis, glyoxylate pathway and Hexose monophosphate Shunt.
4.6: Stress Physiology: Mechanism of biotic and abiotic stress tolerance, Heat shock proteins.

Unit – V: Plant hormones; photomorphogenesis and stress physiology

5.1: Structure, signaling and mechanism of action of phytochrome, Cryptochrome and Phototropins.
5.2: Photoperiodism: Circadian rhythms: SDP, LDP and DNP.
5.3: Role of Florigen in floral induction, vernalization and its mechanism.
5.3: Plant movements: types and physiological mechanism and its significance.
5.4: Biosynthesis, storage, transport and mechanism of action of:
I) Auxins, Gibberellins, Cytokinins, Ethylene and Abscisic acid.
5.5: ii) Brassinosteriods, Jasmonic acids and Salicylic acid.
5.6: Senescence and PCD: Mechanism, types and significance.

Unit – VI: Solute transport and photo assimilate translocation

6.1: Uptake and transport of water, minerals, ions, solutes and macromolecules from soil through cells, xylem and phloem.
6.2: Role of membrane transport proteins; active and passive transport.
6.3: Mechanisms of loading and unloading of photo assimilates, Sucrose–H+ symporter,
6.4: Factors affecting translocation, sieve elements sealing, P-proteins;
6.5: Assimilation of nitrate, ammonia and Sulphur

Proposed Pedagogies:

11. **Teaching Methodologies:** Flipped Classroom, **Think-Pair-Share,** Laboratory Investigations, Case studies, Plant physiology field trips, Interdisciplinary Approach and peer teaching.
12. **Learning Methodologies:** Group projects, Interactive quizzes and flash cards, Field Experiments, Incremental Learning and **Guided Practice**
13. **Evaluation Methodologies: Formative Assessments and peer review**

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3. Databases: Protein Data Bank (PDB), Plant Physiology Database, BRENDA (BRaunschweigENzymeDAtabase), & ExPASy (Expert Protein Analysis System).
4. Davies, D. D. (Ed.). (1987). *The biochemistry of plants* (Vol. II). Academic Press, London.
5. Educational Software: PyMOL, Jmol, RasMol, BioRender, & Visual Molecular Dynamics.
6. Goodwin, T. W., & Mercer, E. I. (1998). *Introduction to biochemistry*. CBS Publishers, New Delhi.
7. Hooykaas, P. J. J., Hall, M. A., & Libbenga, K. R. (Eds.). (1999). *Biochemistry and molecular biology of plant hormones*. Elsevier, Amsterdam, Netherlands.
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9. Interactive Learning Platforms: Labster, BioInteractive, & Virtual Biology Lab.
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11. Jain, V. K. (2022). *Fundamentals of plant physiology* (20th ed.). S. Chand Publications, New Delhi.
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Websites:

- Plant Physiology Taiz 2002
- Life Science Study Material
- NSDL
- UOU Study Material

Model Questions:

Long Questions (10 Marks each)

1. Give an account of different classes of lipids (e.g., phospholipids, glycolipids, cholesterol) and their chemical structures.
2. How do different types of enzyme inhibitors (competitive, non-competitive, and uncompetitive) affect the Km and Vmax values?
3. Describe in detail the process of glycolysis.
4. Explain in detail the Calvin cycle.

Short Questions (05 Marks each)

1. Define enzymes and discuss the different theories proposed for the mechanism of enzyme-substrate complex formation.
2. Explain in detail photorespiration.
3. Define vernalization and discuss its practical applications along with photoperiodism.
4. Describe the types, structure, and functions of photosystems.

Very Short Questions (03 Marks each)

1. Explain why photorespiration does not take place in C4 plants.
2. What is the biological role of vitamins?
3. Describe the CAM pathway.
4. What is florigen?

PRACTICALS:

MAJOR EXERCISES (Minimum any 10)

1. Extraction of chloroplast pigments from leaves and preparation of absorption spectrum of chlorophylls and carotenoid.
2. To determine chlorophyll a, chlorophyll b and total chlorophyll ratio in C3 & C4 plants.
3. Estimation of sodium and potassium in plant material by flame photometry.
4. Determination of Ca: Mg ratio by spectrophotometry in plant tissue.
5. Determination of Isoelectric point of Legumin.
6. Effect of GA/IAA on plant growth.
7. Isolation of intact chloroplasts and estimation of chloroplast proteins by spot protein assay.
8. Separation of proteins by SDS PAGE

9. Estimation of protein content in extracts of plant material by Lowry's Method
10. Estimation of Plant Protein by Bradford Method.
11. To study the effect of light intensity and bicarbonate concentration on O2 evolution in
12. Photosynthesis.
13. Separation of amino acids or sugars from the phloem sap using paper chromatography or
14. TLC.
15. Preparation of the standard curve of proteins (BSA) by Biurets method.
16. Estimation of sodium and potassium in plant material by flame photometry.
17. Estimation of free fatty acids by Titration method.
18. Estimation of Ascorbic Acid in the given material.
19. Estimation of reducing, non-reducing and total sugars.
20. Effect of pH on enzyme activity.
21. Estimation of PPO oxidase from plant sample.
22. Estimation of Riboflavin
23. Determination of Nitrate reductase activity
24. Estimation of ascorbate peroxidase enzyme from plants
25. Separation of anthocyanin from flower petals using TLC
26. Extraction and estimation of lycopene.
27. Identification and Estimation of Lipids.
28. Separation of proteins by SDS-PAGE
29. Qualitative estimation of secondary metabolites

MINOR EXERCISES: (Minimum any 5)

1. To determine acid value of fats.
2. Determination of enzyme activity: Amylase/ Catalase/ Peroxidase.
3. To demonstrate the process of antagonism.
4. To demonstrate the process of fermentation by Kunhe's vessel.
5. Effect of various salts on the permeability of the plasma membrane.
6. Estimation of carbon dioxide liberated during respiration.
7. To determine the structure, size and frequency of stomata in mesophytic and xerophytic leaves.
8. To determine the rate of transpiration of plant i. Weight ii. Potometer method
9. Effect of various salts on the permeability of the plasma membrane.
10. To determine the rate of transpiration by Cobalt Chloride paper method and to calculate transpiration index (TI), Transpiration efficiency (TE) of various leaves
11. Effect of temperature on enzyme activity.

DSC-II.2 Evolution and Diversity of Bryophytes, and Pteridophytes

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.0	II	BOT202	Evolution and Diversity of Bryophytes, and Pteridophytes	4	60	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. Explore the evolutionary history and relationships of bryophytes and pteridophytes within the broader context of plant evolution.
2. Understanding the taxonomy of these plants is crucial for recognizing their evolutionary relationships and ecological roles.
3. Students will explore conservation strategies and the importance of preserving these plants for biodiversity and ecosystem.
4. Developing practical skills in field identification, specimen collection, and laboratory techniques for studying bryophytes and pteridophytes
5. Encouraging critical thinking through discussions of current research topics, controversies, and gaps in understanding related to the evolution and diversity of bryophytes and pteridophytes.

Course Outcomes:

CO 1: Students will gain a comprehensive understanding of the diversity of bryophytes and pteridophytes in terms of morphology, anatomy, ecology, and distribution

CO 2: Students will learn how to interpret the fossil record of bryophytes and pteridophytes

CO 3: Understand its significance in reconstructing past ecosystems, evolutionary relationships, and the history of life on Earth.

CO 4: Through hands-on activities and laboratory sessions, students will develop skills in comparing the morphology and anatomy of different bryophyte and pteridophyte taxa.

CO 4: Students will understand the phylogenetic relationships of bryophytes and pteridophytes.

CO 5: Students will examine the conservation status of bryophyte and pteridophyte species, threats to their survival, and strategies.

CO 6: Students will gain the rich biological diversity of bryophytes and pteridophytes, their importance in ecosystems worldwide.

Detailed Curriculum:

Unit – I: Introduction and classification of Bryophytes.

1.1: General Characteristics and Distribution of Bryophytes.

1.2: Origin and evolution of Bryophyta with reference to habitat and form.

1.3: Classification of Bryophytes- G. M. Smith.

1.4: Reproduction, Life Cycle and Alternation of generations in Bryophytes.

1.5: Contribution of Shiv Ram Kashyap and S. C. Srivastava in Bryology

1.6: Affinities with Algae and Pteridophytes.

Unit – II: Distribution, Morphology, Anatomy and Reproduction.

2.1: Marchantiales- *Riccia*.

2.2: Sphaerocarpales- *Sphaerocarpus*.

2.3: Jungermanniales- *Porella*.

2.4: Calobryales- *Calobryum.*

2.5: Sphagnales- *Sphagnum*

2.6: Takakiales –*Takakia*.

Unit – III: Bryophytes: Applied aspects

3.1: Agriculture, medicine, Food technology and environmental aspects.

3.2: Application of Bryophytes in Forensic studies

3.3: Importance of Bryophytes in Industries

3.4: Economic importance of Bryophytes as monitors of mineral deposition, Air pollution indicator

3.5: Cultivation and methods of preservation of Bryophytes
3.6: Any one case studies (Morphological or Anatomical Mosses, liverworts, Hornworts)

Unit – IV: Origin, Evolution &Fossil Pteridophytes

4.1: The geological time scale and a study of fossil Pteridophytes
4.2: Fossil Pteridophyta: *Rhynia, Calamites,*
4.3: Origin of Pteridophytes from algal and bryophytes ancestors.
4.4: Apospory and apogamy, their significance in Pteridophytes
4.5: Telome theory, Stelar System and Evolution.
4.6: Heterospory and seed habit in Pteridophytes.

Unit – V: Diversity in structure and reproduction of Pteridophytes

Morphology, Anatomy, Reproduction & life cycle of following Class

5.1: Classification of Pteridophytes by G.M. Smith
5.2: Psilopsida :- *Psilotum*
5.3: Lycopsida:- *Lycopodium*
5.4: Sphenopsida:- *Equisetum*
5.5: Filicopsida:Ophioglossum
5.6: Pteropsida: - Pteris

Unit – VI: Application of Pteridophytes

6.1: Cultivation and Maintenance of Pteridophyta.
6.2: Economic importance of pteridophytes.
6.3: Emerging source for herbal remedies
6.4: Diversity of ferns: an ecological perspective Ethnomedicinal uses of pteridophyte
6.5: Usability of pteridophytic material in forensic studies
6.6: Conservation of Pteridophytes

Proposed Pedagogies:

1. Teaching Methodologies:

Conducting practicals mostly with freshly collected specimens.
Visit to the field to study distribution of Bryophytic and Pteridophytic forms.
Monographic and Photographic presentation of Bryophytic and Pteridophytic material.

2. Evaluation Methodologies:

Small Project, Seminars, Unit test

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Model Questions:

Long type 10marks:

1. Describe Classification of Bryophytes proposed by G. M. Smith.
2. Explain Sexual Reproduction in *Riccia*
3. Describe Origin and evolution of Bryophyta with reference to habitat and form.
4. Explain External structure of *Anthoceros with* well labeled diagrams.
5. Describe General Characteristics of Bryophytes.
6. Explain Evolution of Sporophyte
7. Describe Contribution of Shiv Ram Kashyap in Indian Bryology.
8. Explain Asexual reproduction in Anthoceros.
9. Explain in detail sporophyte of Funaria
10. Write down the advance characters of Takakiales.

Long type 05 marks:

1. Role of Bryophytes in ecological succession
2. Role of Bryophytes in medicine
3. Role of Bryophytes in soil conservation
4. Role of Bryophytes as a source of food.
5. Describe the morphology, structure and reproduction of Rhynia
6. Discuss the various views regarding the Stelar Evolution among Pteridophytes
7. Explain Telome Theory

8. Explain Apospory & Apogamy
9. Explain the Heterospory & seed habit in Pteridophytes
10. What is meant by the term Geological Time scale
11. Describe the morphology, structure and reproduction of Pteris
12. Describe briefly Systematic position, morphology and Sexual reproduction of Lycopodium
13. Explain Classification of Pteridophytes According to Smith
14. Discuss on the Economic importance of Pteridophytes
15. Explain the Prothallus Organization
16. Give the Structure of Sporophytes of Pteridophyte

Short type 04/3 marks:

1. Role of Bryophytes in medicine
2. Peat and its uses
3. Economic importance of pteridophytes
4. Ethnomedicinal uses of pteridophyte
5. Pteridophya in forensic studies
6. Conservation of Pteridophytes

PRACTICALS:

MAJOR EXERCISES:

Major 1: Morphological, anatomical and reproductive studies of the following orders (available specimens/slides): Marchantiopsida: Marchantiales, Ricciales and Sphaerocarpales; Jungermanniopsida: Fossombroniales, Jungermanniales, and Metgeriales; Anthocerotopsida: Anthocerotales, Notothyladales Bryopsida: Sphagnales, Funariales and Polytrichales.

Major 2: Morphological, anatomy and reproductive studies of the following members (available specimens/ slides) (Extant): Psilotales: Psilotum; Lycopodiales: Lycopodium, Lycopodiella; Selaginallales: Selaginella; Isoetales: Isoetes; Equisetales: Equisetum; Filicales: Microsorum, Pteris; Marattiales: Angiopteris; Salviniales: Salvinia, Marsilea, Azolla

Major 3: Field Visit to study of Bryophytic and pteridophytic plant material

Major 4: Monographic and photographic presentation of Bryophytes and Pteridophytes material

MINOR EXERCISES:

Minor 1: Study of Fossils in Bryophytes by permanent slides

Minor 2: Study of Fossils in Pteridophytes by permanent slides (Study of sporophyte, Study of Stele, Study of Rhizome and petiole, Study of rhizoids in bryophytes, Study of roots in pteridophytes)

DSC-III.2 Genetics and Plant Breeding

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.0	II	BOT203	Genetics and Plant Breeding	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. Identify the basic principles and current trends in classical genetics and plant breeding
2. Recognize the historical process of the evolution of molecular genetics from classical genetics.
3. Develop theoretical background on molecular genetics to provide a strong support for the student for future research and employability.
4. To impart theoretical knowledge and practical skills about plant breeding objectives, and genetic consequences, breeding methods for crop improvement.
5. To identify gene locus and construct gene map.

Course Outcomes:

CO 1: Students will know the Fundamentals of Mendelian and post-Mendelian Genetics.

CO 2: Students will understand concept of plant breeding

CO 3: Students will develop their analytical, quantitative and problem solving skills from classical to molecular genetics.

CO 4: Students will be able to understand the knowledge base of plant genetic resources and its conservation.

CO 5: Students will be able to understand the techniques of hybrid varieties development and biometrical techniques in plant breeding

CO 6: Students will be able to demonstrate knowledge and scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyze and interpret data and provide solutions

Detailed Curriculum:

Unit – I: Mendelian, Neo Mendelism, Cytoplasmic Inheritance

1.1: Concepts of gene, phenotype, genotype, heredity and variation, allele

1.2: Mendelian inheritance: history, experiments, Law of segregations and Independent assortment.

1.3: Neo-mendelian inheritance: codominance, incomplete dominance; epistasis and pleiotropism; lethals and sub-lethals; multiple alleles,

1.4: Gene interactions: types and suitable examples

1.5: Cytoplasmic inheritance: genetics of mitochondria and chloroplasts, male sterility in Maize

1.6: Genomic imprinting and maternal effect.

Unit-II Chromosomal Aberrations, Segregation and disorders

2.1: Chromosome structure; aberrations; deletion, duplication, inversion, translocation, complex translocation.

2.2: Chromosomal Numerical aberrations, Euploidy and aneuploidy and their genetic implications

2.3: Polyploidy: Types, origin and meiotic behavior.

2.4: Karyotype analysis; method and evolution; banding patterns, applications

2.5: Sex linked, sex-limited and sex-influenced characters, Sex Chromosome and sex determination, dosage compensation of X-linked genes

2.6: Genetic disorders: Chromosomal (Down syndrome, Klinefelter syndrome) Complex disorders: (Alzheimer's disease.), monogenic (Sickle cell disease, Cystic fibrosis)

Unit-III: Genetic Mapping and Mutations

3.1: Linkage, recombination and crossing over

3.2: Detection of linkage in experimental organisms: Tetrad analysis in fungi, mapping in ordered tetrads in Neurospora, cytogenetic mapping in Drosophila

3.3: Restriction mapping, Fluorescence In situ hybridization (FISH)

3.4: Gene mutation: mutagens; chemical, physical and biological mutagens

3.5: Types of mutation: induced, spontaneous mutations and mechanism of mutagenesis

3.6: gene mapping with two-point and three-point test cross, recombination frequency and genetic map distance, coincidence and interference analysis

Unit-IV: Population Genetics and Biostatistics

4.1: Population genetics: concept, allele frequencies and genotype frequencies, random mating

4.2: Hardy-Weinberg principle, Implications of HardyWeinberg principle and applications
4.3: Natural selection; change in gene frequency, migration and random genetic drift.
4.4: Biological Data analysis: Random and non-random variables; collection, tabulation and representation of data (graphical and tabular).
4.5: Statistical Methods: Frequency distribution, measures of central tendency and dispersion; Probability distributions.
4.6: Binomial and Poisson distribution and Chi-square test

Unit – V: Introduction to Plant Breeding

5.1: Definition, Scope and Objectives and History of Plant breeding
5.2: Patterns of Evolution in crop plants- centers of origin, biodiversity and its significance
5.3: Characteristics improved by plant breeding
5.4: Self-pollinated crops: pure line theory, sources of variation in pure line, pure line selection, mass selection, pedigree method, bulk, and single seed decent method.
5.5: Cross-pollinated crops: genetic structure of cross pollinated crops, system of mating, population improvement methods, synthetic and composite varieties, hybrid varieties.
5.6: Hybrid breeding: genetic basis of Heterosis, Inbreeding depression and commercial utilization.

Unit – VI: Methods in plant breeding and applications

6.1: Breeding methods in asexually/clonally propagated crops, clonal selection, apomixes
6.2: Self-incompatibility and male sterility in crop plants and their applications
6.3: Concept of plant ideotype and its role in crop improvement; transgressive breeding
6.4: Breeding techniques- Mutation breeding; Breeding for abiotic and biotic stresses, concepts of MAS, polyploidy, wide hybridization and doubled haploidy.
6.5: Cultivar development- testing, release and notification, maintenance breeding, participatory Plant Breeding.
6.6: Plant breeders' rights and regulations for plant variety protection and farmers rights.

Proposed Pedagogies:

Teaching Methodologies:

• Power point presentation • Chalk and Board • Smart board • Lectures • Assignments, quiz • Group tasks, student's presentations

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Model Questions:

Long Type for 10 Marks:

1. Write a short note on euploidy and aneuploidy.
2. Write a short note on incomplete dominance and codominance
3. Write a short note on types of mutagens with examples

4. Define pedigree analysis. Explain how hemophilia is carried to next generations if a female is diseased and male is carrier (upto 3 generations)
5. Explain heterosis and inbreeding depression.
6. Write a short note on breeding for abiotic and biotic stress.

Short Type for 3/4Marks:

Unit 1
1.Types of chromosomes
1.Polytene chromosomes
Unit 2
2. Mendel's 3 laws of inheritance
2. Supplementary and complementary genes
Unit 3
3. Elaborate sex determination in human
3.Write a short note on cystic fibrosis
Unit 4
4. Write a short note on causes of change in frequency of genes and genotype
4. Give a brief account on metagenomics
Unit 5
5. Write a short note on pure line theory
5. Elaborate mass selection pedigree method of selection
Unit 6
6. Explain breeding methods in clonally propogated plants
6. Write a short note on plant ideotypes and their role in crop improvement

3 marks questions

Unit 1
1. How chromosomes are prepared for the karyotyping?
1. Explain multiple alleles along with example.
Unit 2
1. Elaborate polygenic inheritance with example
1. Write a short note on test cross.
Unit 3
3. Write a short note on sex influenced and sex limited traits
3.Write a short note on types of linkage
Unit 4
4. Within a population of butterflies, the color brown (B) is dominant over the color white (b). And , 40% of all butterflies are white. Given this simple information, which is something that is very likely to be on an exam, calculate the following:
A. The percentage of butterflies in the population that are heterozygous.
B. The frequency of homozygous dominant individuals.

4. Write a short note on epigenetics
Unit 5
5. Give a brief account on scope of plant breeding
5. Elaborate role of biodiversity in evolution of crop plants
Unit 6
6. Write a short note on plant breeders rights and regulations for plant variety protection
6. Elaborate doubled haploidy

PRACTICALS:

MAJOR EXERCISES: (Minimum any 10)

1. Preparations of Stains, Dyes, Preservatives, Fixatives and pre-treatment for the material
2. To prove Mendel's Monohybrid / Dihybrid/Trihybrid ratio.
3. To prepare the Karyotype and Idiogram with formula of the given material
4. To study any one Banding techniques using Giemsa, Orcein, Florescent dyes.
5. Induction of mitotic abnormalities through mutagens.
6. Study the Meiotic configurations in maize, Alliums', *Rheo, Tradescantia, Aloe* etc.
7. Study of chromosomal aberrations in irradiated material.
8. Induction of polyploids in suitable plant material using Colchicine.

9. Emasculation and hybridization techniques in crops
10. To check the pollen viability and sterility using Potassium iodide, aniline blue, TTC etc
11. Estimating gene frequencies in population, estimation of heterozygote frequencies, pedigree analysis.
12. Study of Floral Biology of some crops
13. Study of quality traits in some local crops cotton, soybeans, Wheat , *Brassica* etc.
14. Problems based on Biostatics
15. Problems based on Interaction of genes, Multiple alleles, Gene mapping using two point and three-point test crosses.
16. Problems related to codominance, multiple alleles, lethal alleles, epistasis, complementation analysis, X linkage, sex-limited and sex influenced inheritance.

MINOR EXERCISES:

1. Plant Breeder's kit, Study of germplasm of various crops
2. Study of floral structure of self-pollinated and cross-pollinated crops
3. Hybridization techniques - Emasculation, Bagging
4. Study of special chromosomes (polytene & lampbrush) either by slides or photographs.
5. Study of hybridization technique in cotton and maize.

DSE-I -Angiosperm Taxonomy, Phytochemistry and Pharmacognosy-II

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.0	II	BOT104A	Angiosperm Taxonomy, Phytochemistry and Pharmacognosy-II	4	60	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. Understand the data sources in taxonomy, including embryology, palynology, anatomy, and molecular taxonomy with a focus on DNA barcoding.
2. Learn about the tools of taxonomy and the application of GIS, GNSS, and remote sensing in botany.
3. Study the characteristics and importance of various plant families.
4. Explore the occurrence, distribution, chemical constituents, and therapeutic efficacy of various medicinal drugs and plants.
5. Gain knowledge of secondary metabolites, their chemistry, biological activity, and role in plants.

Course Outcomes:

CO 1: Recall and describe the different data sources in taxonomy.
CO 2: Explain the use and importance of GIS and GNSS tools in botanical research.
CO 3: Identify and characterize important plant families and their significance.
CO 4: Analyze the chemical constituents and therapeutic efficacy of various medicinal plants.
CO 5: Evaluate the biological activities of different secondary metabolites and their roles in plants.
CO 6: Apply knowledge of pharmacognostic studies to identify, analyze, and utilize medicinal plants.

UNIT I :
Data sources in Taxonomy: Embryology, Palynology, Anatomy, Molecular taxonomy –DNA barcoding. Tools of Taxonomy: Application of GIS and GNSS, (Remote Sensing) in Botany.

UNIT II :
Some Important Families: Magnoliaceae, Nymphaeceae, Myrtaceae, Asclepiadaceae, Poaceae, Scrophulariaceae, Verbanaceae, Loranthaceae, Cannabinaceae, Sallicaceae, Cucurbitaceae, Primulaceae, Fagaceae, Araceae, Alisimaticeae, Orchidaceae

UNIT III :
Occurrence, distribution, organoleptic evaluation, chemical constituents including tests wherever applicable and therapeutic efficacy of following categories of drugs. (a) Laxatives: *Aloes*. Rhuburb. Castor Oil. *Ispaghula*. (b)Cardiotonic- *Digitalis Arjuna*. (c) Carminatives and G.I. regulators. Umbelliferous fruits, *Coriander*, Cardamom, Ginger, Black pepper, *Asafoetida*, Nutmeg and Clove. (d) Astringents: Catechu € Drugs acting on nervous systems – Belladonna, Aconite, *Withania somnifera*, Ephedra and Opium.(f) Anti diabetics- *Pterocarpus*, *Gymnema sylvestre*.

UNIT IV :
Study of Following Secondary Metabolites With Respect To Their Chemistry, Biological Activity And Role- Terpenes, Flavonoids, Simple Phenolics, Phenolic Glycosides, Tannins, Anthraquinone, Saponins, Steroids And Alkaloids, Pigments (anthocyanin and betacyanin),,Resins, Gums And Volatile Compound.

UNIT V :
Definition, history, scope and objectives, development and applications of Pharmacognosy ,Medicinal plants cultivation and its benefits Pharmacognostic studies of following drug plants .
Nomenclature, Morphology, Anatomy, Chemistry, Uses and Adultrants) *Tinospora cordifolia, Boerhavia diffusa, Plumbago zeylanica, Cissus quadraungaris Withania somnifera, Adhatoda zeylanica* Ethnobotany: Defination, scope and significance.

UNIT VI :

Definition, history, scope and objectives, development and applications of Pharmacognosy ,Medicinal plants cultivation and its benefits Pharmacognostic studies of following drug plants

Nomenclature, Morphology, Anatomy, Chemistry, Uses and Adultrants) *Datura metel, Solanum surattense, Zingiber officinale,Ocimum sanctum, Centella asiatica , Asparagus racemosus,Commiphora weightii*

Model Questions:

Long Type Questions:

1. Discuss the various data sources in taxonomy, such as embryology, palynology, anatomy, and molecular taxonomy, and their significance in botanical classification.
2. Explain the application of GIS, GNSS, and remote sensing in botany. How do these tools aid in the study and classification of plants?
3. Describe the characteristics, distribution, and importance of the plant families Magnoliaceae, Nymphaeaceae, and Poaceae. Include specific examples and their economic significance.
4. Analyze the occurrence, chemical constituents, and therapeutic efficacy of laxatives and cardiotonic drugs. Provide detailed information on specific examples such as Aloes, Rhubarb, and Digitalis.
5. Discuss the chemistry, biological activity, and roles of secondary metabolites such as terpenes, flavonoids, and alkaloids in plants.
6. Explain the history, scope, objectives, and development of pharmacognosy. Discuss the cultivation, benefits, and pharmacognostic studies of medicinal plants such as Tinospora cordifolia and Withania somnifera.

Short Type Questions:

1. Define DNA barcoding and its application in molecular taxonomy.
2. What is the significance of palynology in plant taxonomy?
3. Describe the role of GIS in botanical research.
4. List the key characteristics of the family Scrophulariaceae.
5. Explain the therapeutic uses of Ginger and Black Pepper.
6. What are the main chemical constituents of the drug plant Belladonna?
7. Briefly describe the biological activity of flavonoids.
8. What are the benefits of medicinal plant cultivation?

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10. Cunningham, A. B. (2001). Applied ethnobotany. Earthscan Publishers Ltd.
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13. Erdtman, G. (1952). Pollen morphology and plant taxonomy: Angiosperms. Almqvist & Wiksell.
14. Evans, W. C. (2009). Trease and Evans' pharmacognosy (16th ed.). Saunders.
15. Gokhale, S. B. (2008). Pharmacognosy. Pragati Books Pvt. Ltd.
16. Harborne, J. B., & Turner, B. L. (1984). Plant chemotaxonomy. Academic Press.

17. Heywood, V. H. (Ed.). (1971). Taxonomy and ecology. Academic Press.
18. Houghton, P. J. (2009). Traditional plant medicines as sources of new drugs. In Trease and Evans' pharmacognosy (16th ed.). Elsevier.
19. Hughes, N. F. (1976). Paleobiology of angiosperm origins. Cambridge University Press.
20. Hutchinson, J. (1959). The families of flowering plants (Vols. I & II). Oxford University Press.
21. Hutchinson, J. (1973). Evolution and phylogeny of flowering plants. Academic Press.
22. Jain, S. K. (1981). Glimpses of Indian ethnobotany. Oxford & IBH Publishing Co. Pvt. Ltd.
23. Judd, W. S., Campbell, C. S., Kellogg, E. A., & Stevens, P. F. (2008). Plant systematics: A phylogenetic approach (3rd ed.). Sinauer Associates, Inc.
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25. Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2019). Pharmacognosy. Nirali Prakashan.
26. Kumar, S. (1997). Chromosome atlas of the flowering plants of the Indian subcontinent. International Book Distributors.
27. Lawrence, G. H. M. (1951). Taxonomy of vascular plants. Macmillan.
28. Moreira, M. (1992). An introduction to ethnobotany. Moredale Publishing.
29. Naik, V. N. (1984). Taxonomy of angiosperms. Tata McGraw-Hill.
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34. Swain, T. (1973). Comparative phytochemistry. Academic Press.
35. Takhtajan, A. (1969). Flowering plants: Origin and dispersal. Oliver & Boyd.
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Digital Resources:

1. https://learn.concord.org/
2. https://learn.concord.org/eresources/1274.run_resource_html
3. https://learn.concord.org/eresources/3013.run_resource_html
4. https://www.google.com.in

Laboratory exercises:

1) Workout of plant specimens and description of vegetative and reproductive characters from representative families locally available.
2) Training in identification of specimens described in classes using relevant literatures and herbaria.
3) Study of various taxa of a genus, determining key characters and preparation of keys at species level.

DSE-I -Molecular Systematics of Plants-II

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.0	II	BOT104B	Molecular Systematics of Plants-II	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Outcomes:

On completion of the course, the student should be able to

CO 1: Discuss and apply principles of delimitation and identification of species and other taxa

CO 2: Account for the central concepts of the field and principles of phylogenetic analysis, especially based on the parsimony criterion

CO 3: Discuss and apply methods to generate relevant molecular data, mainly sequence data

CO 4: Choose and apply existing software in the included course parts, from generating relevant molecular data to phylogenetic analysis

CO 5: Critically analyse, evaluate, compile, and present the results of phylogenetic analyses.

Unit-I	1.1 Role molecular markers in systematics: criteria for selection of suitable markers. 1.1 1.2 Comparative account and suitability of multigene markers over single gene marker in phylogenetic analysis.
Unit-II	2.1 Nucleotide and protein databases, steps in sequence retrieval, analysis of sequence quality, BLAST analysis, gene annotation and their significance. 2.2 Multiple Sequence Alignments: Analysis of aligned sequences, homoplasy, synapomorphy.
Unit-III	3.1 Phylogenetic tree, steps in constriction of phylogenetic tree, description of phylogenetic tree, outgroups and their effect. 3.2. Tree terminology, Types of trees. Gene tree, Species tree. Dendrogram, Binary and multistate characters, Operational Taxonomic Units (OTU).
Unit-IV	4.1 Distance and characters-based methods: UPGMA, NJ, Maximum Parsimony, Maximum likelihood methods. 4.2 Analysis of transition, transversion, DNA polymorphism.
Unit-V	5.1 Location of molecular data: Chloroplast, Mitochondrial and Nuclear DNA; Fine structure analysis of their genomes; criterions for identification of molecular markers. 5.2Evolutionary origin of plastid and mitochondrial genome.
Unit-VI	3.1 Taxonomic data bases; their importance, Taxonomic Databases Working Group (TDWG), tree of life. 3.2 Integrated Taxonomic Information Systems: Databases at the Royal Botanical Garden, online herbaria, ETI database.

1. Suggested Reading:

2. Felsenstein, J. 2004. Inferring phylogenies. Sunderland, Mass., Sinauer Associates, Inc. Hall, B. G. 2011. Phylogenetic trees made easy: a how-to manual (4th edition). Sunderland: Sinauer Associates. Hillis, D. M., C. Moritz and B. K. Mable, eds. 1996.
3. Molecular systematics. Sunderland, Mass.: Sinauer Associates. Kitching, I. J., P. L. Forey, C. J. Humphries and D. M. Williams. 1998. Cladistics: the theory and practice of parsimony analysis. Oxford: Oxford University Press.
4. Li, W.-H. 1997. Molecular evolution. Sunderland, Mass.: Sinauer Associates. Schuh, R. T. 2000. Biological systematics. Comstock Publishing Associates, Ithaca. Soltis, P. S., D. E. Soltis and J. J. Doyle, eds. 1992. Molecular systematics of plants. New York: Chapman and Hall. Soltis, D. E., P. S. Soltis and J. J. Doyle, eds. 1998.
5. Molecular systematics of plants II DNA sequencing. Boston: Kluwer Academic Publishers. Williams, D. M. and M. C. Ebach. 2008. Foundations of systematics and biogeography. New York, Springer. Yang, Z. 2006. Computational molecular evolution. Oxford, Oxford University Press.
6. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
7. Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 2. Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A.
1. Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.

Learning Outcome:
After successful completion of this course, students will be able to:
1. Understand historical development of taxonomy.
2. Explain concept of species. Order sub and super categories of species according to Linne hierarchy.

Laboratory Exercises:

1. Retrieval of gene sequences from NCBI
2. BLAST analysis of gene sequences
3. Analysis of transition / transversion mutations in aligned sequences
4. Construction of phylogenetic tree by using molecular data
5. Gene annotation using online software's
6. Preparation of binary data set based on taxonomic key characters of the species belongs to any plant family under study.
7. Construction of dendrogram from binary data set
8. *In silico* analysis of phylogenetic relationship between species of following families by using appropriate gene markers.
   Commelinids: Commelinaceae, Poaceae, Cyperaceae
   Basal Eudicots and Caryophyllids: Ranunculaceae, Caryophyllaceae
   Rosids: Euphorbiaceae, Rosaceae, Fabaceae, Cucurbitaceae
   Asterids: Solanaceae, Lamiaceae, Apiaceae, Asteraceae

DSE-I -Plant Tissue Culture-II

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.0	II	BOT 104C	Plant Tissue Culture-II	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course outcomes:

On completion of the course, the student should be able to

CO 1: Acquire a critical knowledge on applications of plant tissue culture.

CO 2: Demonstrate skills related to haploid culture through hands on experience

CO 3: Understand the cell culture technique for production of secondary metabolites.

CO 4: Comprehend the applications of plant hormones in plant tissue culture

Unit-I	1.1 Somaclonal variations: explant source, effect ofgenotypes, and media components, causes, advantages and applications. 1.2 Genetic basis of somaclonal variation. 1.3 Detection of somaclonal variations using markers.
Unit-II	2.1 Role of Plant hormones (auxins, cytokinins, abscissic acid, ethylene and Gibberellins) in In-vitro cultures. 2.2 Role of Jasmonates in Plants under in vitro conditions 2.3 The journey and new breakthroughs of plant growth regulators in tissue culture
Unit-III	3.1 Distant hybridization: concept and applicability in haploid production. 3.2 Pollen Culture technique, *In-vitro* Monoploid and Polyploid Culture. Screening methods for selection of haploid cells. Triploid production (Endosperm culture). 3.3 Role of haploid and polyploids in plant improvement.
Unit-IV	4.1 Cell culture: Isolation of Single cell, different techniques for Single Cell Culture (SCC), advantages of SCC. 4.2 Suspension culture: types of suspension culture 4.3 Cell growth measurement, viability tests, synchronization of cultures, applications, factors affecting single cell culture
Unit-V	5.1 Endosperm culture: culture requirements, steps and applications 5.2 Embryo culture, culture requirements, steps applications, Embryo rescue technique, steps and its applications. 5.3 Production of pathogen free plants; virus- elimination through *in-vitro* technique.
Unit-VI	6.1 Haploid production: steps, culture requirements,significance. In-*vitro* pollination and fertilization 6.2 Androgenesis: Anther culture, culture requirements,steps, screening of haploids and applications 6.3 Gynogenesis: Ovule and ovary culture and applications

Suggested Reading:

1. Pullaiah, T., & Subba Rao, M. V. (2009). *Plant tissue culture*. New Delhi, India: Scientific Publishers.
2. Bhojwani, S. S., & Razdan, M. K. (1996). *Plant tissue culture: Theory and practice*. Amsterdam, The Netherlands: Elsevier Science.
3. Glick, B. R., & Pasternak, J. J. (2003). *Molecular biotechnology: Principles and applications of recombinant DNA*. Washington, DC: ASM Press.
4. Bhojwani, S. S., & Bhatnagar, S. P. (2011). *The embryology of angiosperms* (5th ed.). New Delhi, India: Vikas Publication House Pvt. Ltd.
5. Snustad, D. P., & Simmons, M. J. (2010). *Principles of genetics* (5th ed.). Hoboken, NJ: John Wiley & Sons.
6. Stewart, C. N., Jr. (2008). *Plant biotechnology and genetics: Principles, techniques, and applications*. Hoboken, NJ: John Wiley & Sons.

Learning Outcome:

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

1. Understand the invitro culture techniques and their applicability.
2. Acquire the necessary skills for establishment of in vitro culture

Laboratory Exercises:

1. Experiment on Soma clonal variations
2. In vitro study of pollen culture
3. In vitro study of anther culture
4. In vitro study of ovary culture
5. In vitro study embryo culture
6. In vitro study of triploid production
7. To study the technique of Embryo rescue
8. To study single cell culture and cell suspension culture
9. Embryo and Endosperm culture
10. Effects of Hormone Balance on Explant Growth and Morphogenesis
11. Embryo / Endosperm/ Ovules and anther Cultures
12. Establishment of embryogenic/ non embryogenic cell suspension cultures

DSE-I -Advanced Plant Physiology-II

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.0	II	BOT 104D	Advanced Plant Physiology-II	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. Understand the biochemical pathways involved in plant respiration, including glycolysis, TCA cycle, and oxidative phosphorylation.
2. Explore the concepts of photoperiodism, phytochrome function, and practical applications of vernalization and photoperiodism.
3. Analyze plant responses to environmental challenges, including signal perception, transduction, and responses to various stresses.
4. Investigate the mechanisms of oxidative stress and the role of scavenging systems, osmoprotectants, and stress proteins in plant stress tolerance.
5. Study the regulation of photomorphogenesis and skotomorphogenesis, including wavelength-specific photoreceptors and signal cascades for morphogenic responses.

Course Outcomes:

CO 1: Explain the processes and pathways involved in plant respiration, including glycolysis, anaerobic respiration, TCA cycle, and oxidative phosphorylation.
CO 2: Describe the mechanisms of photoperiodism, phytochrome function, and the effects of red and far-red light on photomorphogenesis.
CO 3: Analyze plant signal perception, transduction, and responses to environmental changes such as water, light, temperature, CO2, and mineral toxicity.
CO 4: Evaluate the roles of osmoprotectants, stress proteins, and reactive oxygen species scavenging systems in plant stress responses.
CO 5: Discuss the regulation of photomorphogenesis, including the roles of phytochromes, cryptochromes, phototropins, and the crosstalk among growth regulators.
CO 6: Assess the sensory physiology of plants, including biochemical and biophysical mechanisms of sense perception, defense, and stimuli-triggered movements.

Unit-I	**Respiration:** Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.
Unit-II	**Photoperiodism:** Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization. Practical applications of vernalization and photoperiodism
Unit-III	**Plant responses against environmental challenges:** Signal perception, transduction and responses against different environmental changes and challenges (water, light, temperature, elevated CO2, mineral toxicity and salt).
Unit-IV	**Plant responses against environmental challenges:** Osmoprotectants, stress proteins, Oxidative stress: reactive oxygen species (ROS) – role of scavenging systems (SOD, catalase etc.). Functions of HSPs chilling stress. Phytochelatins, role of membrane lipids in high temperance tolerance. Molecular regulation and crosstalk among different signalling pathways.
Unit-V	**Photomorphogenesis** Regulation of Photomorphogenesis and skotomorphogenesis Wavelength-specific photoreceptors (Phytochromes, Cryptochromes, Phototropins etc), E3 ubiquitin ligases and TFs crosstalk; signal cascade for morphogenic responses. Synergic effect of BRs and Auxins and other growth regulators

Unit-VI	Sensory physiology Sensory physiology: Biochemical and biophysical mechanisms of sense of touch, electric self-defense, taste, light, explosion, sleeping and rhythms. Stimuli/mechanical force triggered movements; actin-myosin motors; neurotransmitters in plants.

Suggested Reading:

1. Davies, P.J. (2004). Plant Hormones: Biosynthesis, Signal Transduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands.
2. Jordan, B.R. (2006). The Molecular Biology and Biotechnology of Flowering, 2nd Edition, CAB International, Oxfordshire, U.K.
3. Nelson, D.L. and Cox, M.M. (2008). Lehninger Principles of Biochemistry (5thed.). New York
4. Buchanan, Gruissem and Jones. 2002. Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.
5. Annual Review of Plant Biology (formerly Annual Review of Plant Physiology and Plant Molecular Biology).
6. **BASIC REFERENCES:** Alberts et al., Molecular Biology of the Cell (parts related to plants); Salisbury and Ross, Plant Physiology; Taiz and Zeiger, Plant Physiology; Hopkins and Huner, Introduction to Plant Physiology.
7. **CURRENT LITERATURE** (JOURNAL ARTICLES): Plant Physiology, The Plant Cell, Journal of Plant Physiology, Physiologia Plantarum, Plant Physiology and Biochemistry, Postharvest Biology and Technology, Hortscience, Journal of the American Society for Horticultural Science, Science, Nature, Scientific American etc.
8. Many plant physiology journals can be viewed via the net. The URL of one of the sites listing these journals is: http://www.e-journals.org/botany/

Learning Outcome:

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

1. The students will learn and demonstrate the physiological mechanisms of Water, minerals uptake and transport; they can correlates with present day's challenges for plant growth, development and survival.
2. The students will understand the evolutionary history of photosynthetic organisms and their adaptability in changing environmental conditions; they can interpret the photosynthetic productivity in relation to changing climatic conditions and food security
3. They will acquire the knowledge and demonstrate the various mechanisms of translocation of photosynthetic products to different sink
4. The students will learn various plant responses against environmental changes and challenges; they can understand unique strategies of plants to resolve the various stresses

List of Experiments:

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Demonstration of transpiration with the help of photometers.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Demonstration of activity of catalase and study of effect of pH and enzyme concentration.
5. To study the effect of light intensity and bicarbonate concentration on O2 evolution in photosynthesis.
6. Comparison of the rate of respiration in any two parts of a plant.
7. Separation of photosynthetic pigments by paper chromatography.
8. To determine the RQ of different respiratory substances.

DSE-I -Basic and Applied Mycology-II

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.0	II	BOT 104E	Basic and Applied Mycology-II	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. To demonstrate a systematic, extensive and coherent knowledge an understanding of basic and applied mycology.
2. To links to other disciplinary areas of the study; including critical understanding of the established theories, principles and concepts of a number of advanced and emerging issues in the field of Mycology
3. To demonstrate procedural knowledge that creates different types of professionals in the field of Botany like research and development in the field of medical mycology and plant pathology and drug discovery and various research institutes of mycology, teaching government and public services e.g. conservationist
4. Developing skills and ability to use knowledge efficiently in area related to mycology and current updates in the subject.
5. Demonstrate comprehensive knowledge about fungi, current research, scholarly and professional literature of advanced learning areas of mycology

Course Outcomes:

Upon completion of this course successfully, students would be able to

CO 1: Understand advanced knowledge of structure and diversity of different fungal groups.
CO 2: Analyze different fungal forms and classify into different groups on the basis of microscopic and macroscopic observations.
CO 3: Apply the knowledge of mycology for research and development.
CO 4: Create the database for advanced studies in the field of mycology
CO 5: Apply knowledge in the field of medical mycology, plant pathology and related and interdisciplinary areas

Detailed Curriculum:

Unit – I: Subdivision-Ascomycotina

1.1 Asomycotina: General characteristics and classification

General characteristics of following classes with life cycle and economic importance of representative genus-

1.2 Hemiascomycetes – *Taphrina deformans*
1.3 Plectomycetes – form genus-*Penicillium*
1.4 Pyrenomycetes- *Erysiphe, Phyllectinia, Cordyceps*
1.5 Discomycetes- *Morchella*
1.6 Laboulbeniomycetes and Loculoasomycetes (only general characters with example)

Unit – II: subdivision-Basidimycotina

2.1 Basidiomycotina : General characteristics and classification

General characteristics of following classes with life cycle and economic importance of representative genus

2.2 Teliomycetes- *Uromyces, Ustilago*
2.3 Hymenomycetes- *Termitomyces, Pleurotus,*
2.4 Hymenomycetes -*Ganoderma, Polyporus,*
2.5 Gasteromycetes - *Lycoperdon Geastrum*
2.6 Economic importance of fungi of Basidiomycota

Unit – III: Subdivision- Deuteromycotina

3.1 Deuteromycotina: General characteristics and classification

General characteristics of following classes with life cycle and economic importance of representative genus

3.2 Blastomycetes: *Candida, Cryptococcus*

3.3 Hypomycetes*: Cercospora,Helminthosporium*

3.4 Hypomycetes: *Curvularia,Alternaria,Fusaruim*

3.5 Coelomycetes: *Colletotrichum, Phoma*

3.6 Economic importance of Deuteromycota

Unit – IV: Applied Mycology

4.1 Lichen: types and economic importance

4.2 Role of *Saccharomyces cerevisiae* in brewing industry

4.3 Medicinal potential of *Ganoderma lucidum*

4.4 Functions and Applications of Fungal Chitinases

4.5 Mycoparasitic and Nematophagous fungi

4.6 Fungi in pharmaceuticals

Unit – V: Advanced mycology

5.1 Secondary metabolites from fungal endophytes

5.2 Introduction to Myconanotechnology

5.3 Fungal Conservation

5.4 Genetic manipulation of fungi

5.5 Role of fungi in Element cycles and Bio-conservation

5.6 The fungal genome sequencing

Unit – VI: Fungi and Entrepreneurship

6.1 Fungal nutraceuticals

6.2 Fungal cosmetics

6.3 Mycoremediation

6.4 Fungal biofertilizer

6.5 Plant extracts as a fungal biocontrol agent

6.6 Fungi as the antibiotics

Proposed Pedagogies:

Teaching Methodologies:

Classroom teaching, power point presentation, group discussions, quiz field visits, visits to research institutes and natural habitats, mushroom cultivation units fermentations industries etc.

Learning Methodologies:

e-Herbarium preparation and collection of wild mushrooms, seminars, projects etc.

Evaluation Methodologies:

Assessment by –assignments, unit test and semester end examinations

Suggested Reading:

1. Shukla, A. C. (Ed.). (2022). *Applied mycology: Entrepreneurship with fungi*. Springer. https://link.springer.com/book/10.1007/978-3-030-90649-8#overview
2. Rai, M., & Bridge, P. D. (2009). *Applied mycology*. Wallingford, UK: CABI International.
3. Alexopoulos, C. J., Mims, C. W., & Blackwell, M. (1996). *Introductory mycology* (4th ed.). New York, NY: John Wiley & Sons.
4. Ulloa, M., & Aguirre-Acosta, E. (2019). *Illustrated generic names of fungi*. St. Paul, MN: APS Press.
5. Ulloa, M., & Hanlin, R. T. (2000). *Illustrated dictionary of mycology*. St. Paul, MN: American Phytopathological Society.
6. Alexopoulos, C. J., Mims, C. W., & Blackwell, M. (2007). *Introductory mycology* (4th ed.). New Delhi, India: Wiley India.
7. Aneja, K. R. (2015). *An introduction to mycology* (2nd ed.). New Delhi, India: New Age International.
8. Wolfenbarger, L. L. (2003). *Environmental and ecological impacts from transgenic plants: Unintended effects*. Blacksburg, VA: Information Systems for Biotechnology, Virginia Tech.
9. Varshney, R. K., & Tuberosa, R. (Eds.). (2007). *Genomics-assisted crop improvement* (Vol. 1). Dordrecht, The Netherlands: Springer.
10. Slater, A., Scott, N. W., & Fowler, M. R. (2004). *Plant biotechnology: The genetic manipulation of plants* (1st ed.). New York, NY: Oxford University Press.
11. George, E. F. (2007). *Plant propagation by tissue culture: Vol. 1. The background*. New York, NY: Springer.
12. Vasil, I. K. (1980). *Cell culture and somatic cell genetics of plants*. New York, NY: Academic Press Inc.
13. Pierik, R. L. M. (1987). *In vitro culture of higher plants*. Boston, MA: Martinus Nijhoff Publishers.
14. De, K. (1997). *An introduction to plant tissue culture*. Calcutta, India: New Central Book Agency.
15. Glick, B. R., & Pasternak, J. J. (2003). *Molecular biotechnology: Principles and applications of recombinant DNA*. Washington, DC: ASM Press.
16. Ainsworth, G. C., & Sussman, A. S. (Eds.). (1979). *The fungi: An advanced treatise* (Vol. I-IV). New York, NY: Academic Press.
17. Aneja, K. R. (1993). *Experiments in microbiology, plant pathology, and tissue culture*. New Delhi, India: Wishwa Prakashan.
18. Bessey, E. A. (1950). *Morphology and taxonomy of fungi*. Philadelphia, PA: The Blakiston Co.
19. Bilgrami, K. S., & Dube, H. C. (1985). *A text book of modern plant pathology*. New Delhi, India: Vikas Publication House.
20. Butler, E. J., & Jones, S. J. (1949). *Plant pathology*. New York, NY: Macmillan & Co.
21. Dube, R. C., & Maheshwari, D. K. (2000). *Practical microbiology*. New Delhi, India: S. Chand & Co. Ltd.
22. Gupta, V. K., & Behl, M. K. (1994). *Indian plant viruses and mycoplasma*. Ludhiana, India: Kalyani Publishers.
23. Jha, D. K. (1993). *A text book of seed pathology*. New Delhi, India: Vikas Publication House.
24. Rao, K. M., & Mahadevan, A. (Eds.). (1997). *Recent developments in biocontrol of plant pathogens*. New Delhi, India: Today and Tomorrow Publishers.
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PRACTICALS:

MAJOR EXERCISES: (Any 15- 5from each division)

Morphological and microscopic studies of following genera

1. Ascomycota –

1. *Taphrina,*
2. *Emericella,*
3. *Chaetomium,*
4. *Morchella,*
5. *Neurospora,*
6. *Erysiphe*,
7. *Uncinula,*
8. *Phyllactinia,*
9. *Sphaerotheca* and
10. *Claviceps*.
11. Aspergillus
12. *Penicillium*

2. Basidiomycota-

1. *Puccinia,*
2. *Ustilago,*
3. *Termitomyces,*
4. *Pleurotus,*
5. *Polyporus,*
6. *Ganoderma*
7. *Auricularia,*
8. *Ganoderma*
9. *Polyporus*
10. *Uromyces*
11. *Lycoperdon,*
12. *Dictyophora,*
13. *Geastrum,*
14. *Cyathus,*

3. Deuteromycota

1. *Alternaria*,
2. *Fusarium*,
3. *Colletotrichum*,
4. *Curvularia*,
5. *Helminthosporium*,
6. *Phoma,*
7. *Phyllosticta,*
8. *Ascochyta*
9. *Botryodiplodia,*

10. Macrophoma,

11. Diplodia,

12. Cercospora

4. Isolation of Endophytic fungi.
5. Isolation of Secondary Metabolites from fungi.
6. Synthesis of Nanoparticles from fungi
7. Demonstration of Mushroom Cultivation

Minor exercises (any five)

1.Study of types of lichen
2. Study of *Saccharomyces cerevisiae* culture
3. Study of *Ganoderma lucidum* fruiting body
4.Antibiotic properties of Penicillin
5.Keratinolytic activities of fungi
6.Entomopathogenic fungi in soil
7. Detection of Aflatoxin Contamination Produced by *Aspergillus* Species in Food Products
8. Inter Fungal Parasitic Relationships: Mycoparasitism
9. Observation of Mycorrhizae

Model Questions:

Long Type for 10 Marks:

1. Describes types of fruiting bodies in Ascomycota
2. Explain sexual reproduction in *Taphrina deformans*
3. Explain asexual reproduction in *Penicillum*
4. Explain the economic importance of Basidiomycota
5. Describe life cycle of *Pleurotus*
6. Explain conidial stage in *Alternaria*
7. Explain types and economic importance of lichen
8. Explain asexual stage in *Colletotrichum*
9. Explain Fungal genome sequencing
10. Explain myco-remediation

Long Type for 05 Marks:

1. Explain life cycle in *Morchella* .
2. Explain sexual reproduction in *Uromyces*
3. Explain spore structure in *Helminthosporium*
4. 4.Explain medicinal potential of *Ganoderma lucidum*
5. Explain fungal cosmetics
6. Explain genetic manipulation of fungi

Short Type for 3/4Marks:

Explain –

1. Conidial stage of *Erysiphae*
2. Fruiting body of *Polyporus*
3. *Lycoperdon*
4. Spore structure in *Curvularia*
5. Nematophagus fungi
6. Myconanotechnology
7. Mycocosmetics
8. Fungal conservation

DSE-I -Molecular Biology, Biotechnology & Plant Breeding-II

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.0	II	BOT104F	Molecular Biology, Biotechnology & Plant Breeding-II	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

On completion of the course, the student should be able to:-

1. To learn the basic principles of molecular biology, biotechnology & plant breeding
2. To demonstrate the methods in molecular biology, biotechnology & plant breeding
3. Understand the applicability of molecular biology, biotechnology & plant breeding in
4. relation to present-day problems.
5. To gain the Knowledge about laboratory organization for molecular biology and
6. biotechnology.

Course Outcomes:

CO 1: Acquire theoretical knowledge in the tools, techniques, applications and safety measures in the field of genetic engineering.

CO 2: Describes and analyze the genome mapping and sequencing methods

CO 3: Describe the mechanism of action and the use of restriction enzymes in biotechnology research and recombinant protein production.

CO 4: Improvise /Create various new methods for the improvement of self and cross-pollinated crops.

Detailed Curriculum:

Unit – I: Transcription:

1.1 Prokaryotic transcription:

1.1.1 Transcription unit – (start site, upstream promoter regions, terminator);

1.1.2 Structure and function of RNA polymerases, sigma factors;

1.1.3 Mechanism of transcription-initiation, elongation and termination (Rho-Dependant and independent termination) ;

1.1.4 Anti-termination and inhibitors of transcription.

1.2 Eukaryotic transcription

1.2.1 RNA polymerases I, II, III - structure and assembly;

1.2.2 Basal transcription apparatus for the three polymerases with specific promoters and transcription factors,

1.2.3 Transcriptional factors – general features, motifs - zinc fingers, leucine zippers, helix-turn helix, homeodomains etc.

1.2.5 Post-transcriptional Modification: Splicing and RNA editing

Unit – II: Translation:

2.1 Translation machinery – ribosomes; charging of tRNA molecules and formation of aminoacyl tRNA;

2.2 Mechanism of translation - initiation, elongation, and termination,

2.3 Posttranslational modifications of proteins – glycosylation, amidation, lipidation, processing of pre- proteins

2.4 Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation,

2.5 Inhibitors of protein translation.

2.6 Genetic code – Universality and degeneracy, Wobble hypothesis

Unit – III: Nucleic Acid sequencing, DNA Microarray and DNA Profiling

3.1 **Nucleic acid sequencing**: Maxum & Gilbert method, Sangers method.

3.2 DNA microarray: Principle of DNA microarray technique, Types of DNA microarrays (cDNA-based microarray and Oligonucleotide-based microarrays),

3.3 Applications of Microarrays.

3.4 DNA Profiling: Principles of DNA Profiling, Methods of DNA Profiling (RFLP-based and PCR-based),

3.5 Applications of DNA profiling.

Unit – IV: Restriction mapping:

4.1 Construction of restriction map

4.2 Analysis of restriction fragments and their application;

4.3 cDNA synthesis: mRNA enrichment, digestion using restriction enzymes or mechanical shearing,

4.4 Selection of appropriate vector, preparation of genomic library, use of linkers and adapters,
4.5 Method of screening of library and chromosome walking and chromosome jumping strategies.
4.6 STS tagging

Unit – V: Plant breeding for crop improvement

5.1 Plant breeding for improvement of self-pollinated Crops

5.1.1 Pire line Selection Method
5.1.2 Mass selection method
5.1.3 Hybridization (Pedigree, back cross and bulk methods)

5.2 Breeding for vegetatively propagated plants

5.2.1 Clonal Selection method
5.2.2 Distant hybridization method
5.2.3 Other in-vitro techniques

Unit – VI: Plant Breeding for Crop improvement

6.1 Plant breeding for improvement of cross-pollinated crops: Introduction
6.2 Mass selection method
6.3 Progeny selection method
6.4 Recurrent selection method (Simple recurrent, Recurrent selection for GCA & SCA and reciprocal recurrent selection.
6.5 Hybridization (Interspecific and inter-varietal hybridization)
6.6 Genetical and Physiological Basis of Heterosis and Inbreeding

Proposed Pedagogies:

1. **Teaching Methodologies:**

- Lecture, Direct Instructions, Demonstrations and technology-based teaching.

2. **Learning Methodologies:**

- Reading and writing, Auditory Learning, Visual Learning, Kinesthetic and Interpersonal learning.

3. **Evaluation Methodologies:**

- Formative, Summative and Outcome based evaluation.

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Model Questions:

Long Type: (For 10 Marks):

1) Discuss the mechanism of prokaryotic transcription.
2) Give details of eukaryotic transcription mechanism.
3) Give details of translation mechanism.
4) Discuss post-translational modification in detail.
5) Explain Maxam and Gilbert's method of DNA sequencing.

6) Discuss principles, techniques, and applications of DNA microarray.
7) Give details of DNA profiling.
8) Elaborate on how to construct a restriction map of a given sequence.
9) Explain various plant breeding methods used for the improvement of self-pollinated crops
10) Explain various methods of plant breeding used for improvement of cross-pollinated crops.

Long Type: (For 05 marks)

1) Give detail account of structure and function of RNA polymerase
2) Discuss the mechanism of transcription termination
3) Discuss various transcription factors in Eukaryotes
4) Explain initiation and elongation of translation
5) Explain protein turnover and degradation
6) Discuss properties of genetic code
7) Give brief account of Sangers method of DNA sequencing
8) Discuss different types of DNA microarrays
9) Discuss DNA profiling in detail
10) Explain preparation of genomic libraries
11) Give details of STS tagging
12) Discuss pure line selection and its applications.
13) Explain clonal selection and its advantages.
14) Discuss recurrent selection method.
15) Explain genetic basis of inbreeding and heterosis

Short type questions: (3/4 marks)

1) Transcription Unit
2) Sigma factor
3) Transcription inhibitor
4) Assembly of RNA polymerase III
5) Lucine zippers
6) RNA editing
7) Protein stability
8) Wobble hypothesis
9) Molecular chaperons
10) Principle of DNA microarray
11) Applications of DNA microarray
12) Principle of DNA profiling
13) Applications of DNA profiling
14) Linkers and adaptors
15) Chromosome walking
16) Chromosome jumping
17) Mass selection
18) Bulk method
19) Progeny selection
20) Interspecific hybridization
21) Intervarietal hybridization

Major Exercise:

1. Isolation of genomic DNA
2 Southern blotting
3. Isolation of RNA
4. Preparation of tissue culture medium.
5. Cell fusion with PEG.
6. Isolation of plasmid DNA.
7. Artificial seed preparation.
8 Incompatibility – Pollen viability test
   a. *In vitro* a. Brewbaker's medium preparation
   b. Staining test in acetocarmine

Minor Exercise:

1. Principles of PCR,
2. Principles of Electrophoresis
3. Demonstration of western Blotting.

Lab – III: Based on DSC-I.2 and DSC-II.2 (Biochemistry and Plant Physiology, Evolution and Diversity of Bryophytes and Pteridophytes)

Level	Semester	Course Name	Credits	Practical Hours	Exam Duration	Max Marks
6.0	II	Biochemistry and Plant Physiology, Evolution and Diversity of Bryophytes and Pteridophytes	2	60	6 Hrs	50 (Int) + 50 (Ext)

Practical Question Paper

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
PRACTICAL EXAMINATION
M.Sc. I (Botany), SEMESTER – II (NEP) DSC-I.2 & II.2
PRACTICAL III:
Biochemistry and Plant Physiology, Evolution and Diversity of Bryophytes and Pteridophytes

Time: 6 hrs. **Marks:** 50

Q.1: Perform Major Experiment in Plant Physiology/Biochemistry. 10M
Q.2: Perform Minor Experiment in Plant Physiology/Biochemistry 10M
Q.3: Identification of given Bryophytic material form on basis of Morphology, Anatomy, and Reproductive organs from given material (One double stained slide preparation). 10M
Q.4. Identification of given Pteridophytic material on basis of morphology anatomy and reproductive organs (one double-stained slide preparation). 10M
Q.5. Comment on one Plant Physiology experiment set up. 05M
Q.6. Spotting (Bryophytes (02), Pteridophytes (02) and Fossil specimen (01) 05M

Lab – IV: based on DSC III.2 and DSE Opted by Student

Level	Semester	Course Name	Credits	Practical Hours	Exam Duration	Max Marks
6.0	II	Genetics and Plant Breeding and following DSE	2	60	6 Hrs	50 (Int) + 50 (Ext)

Practical Question Paper

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
PRACTICAL EXAMINATION
M.Sc. I (Botany), SEMESTER – II (NEP) DSC-III.2 & DSE
PRACTICAL IV

Time: 6 hrs. **Marks:** 50

Part A
Genetics and Plant Breeding

Q1. Karyotype Analysis. 10M
Q2. Perform Any One experiment on Mutation and Plant Breeding 07M
Q3. Problem (Any Two) 08M

Part B
DSE: _____

Q1. Question based on Major Exercises (Any Two) 20 M
Q2. Question based on Minor Exercises (Any One) 05 M

TWO YEAR POSTGRADUATE PROGRAMME

M.Sc. BOTANY

FACULTY: SCIENCE AND TECHNOLOGY

SEMESTER – III COURSES

S. N.	Subject
1	RM 02: Technological Advancements in Botanical Research
2	DSC-I.3 Paleobotany, Evolution of Gymnosperms and Origin of Angiosperms
3	DSC-II.3 Systematics and Taxonomy of Angiosperms
4	DSC-III.3 Diversity Conservation, Ethnobotany, Palynology and Phytogeography
5	DSE-III Any one Opted by Student / MOOC (Elective Option)
5a	DSE-III -Angiosperm Taxonomy, Phytochemistry and Pharmacognosy-II
5b	DSE-III -Molecular Systematics of Plants-III
5c	DSE- III -Plant Tissue Culture- III
5d	DSE-III-Advanced Plant Physiology- III
5e	DSE-III -Basic and Applied Mycology-III
5f	DSE-II -Molecular Biology, Biotechnology &Plant Breeding-III
6	Lab – V: based on DSC-I.3 and DSC-II.3 Paleobotany and Evolution of Gymnosperms and Systematics and Taxonomy of Angiosperms
7	Lab – VI: based on DSE III DSE Opted by Student a. Angiosperm Taxonomy, Phytochemistry and Pharmacognosy-III b. Molecular Systematics of Plants-III c. Plant Tissue Culture-III d. Advanced Plant Physiology -III e. Basic and Applied Mycology-III Molecular Biology Biotechnology & Plant Breeding-III
8	Research Project Phase I

RM02: Technological Advancements in Botanical Research

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.5	III	BOT02	Technological Advancements in Botanical Research	2	30	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. **Develop Advanced Knowledge and Understanding:** Gain a comprehensive understanding of both classical and modern aspects of botany, including taxonomy, anatomy, and paleobotany, as well as cutting-edge technologies such as genomics, synthetic biology, and precision agriculture.
2. **Enhance Technical and Research Skills:** Acquire practical skills in using advanced molecular biology techniques, bioinformatics tools, and modern imaging technologies to conduct independent research and solve complex problems in plant science.
3. **Promote Critical Thinking and Innovation:** Foster the ability to critically evaluate recent research findings, technological advancements, and their applications in plant science. Encourage innovative thinking for developing new approaches and solutions in plant research and biotechnology.
4. **Integrate Multidisciplinary Approaches:** Understand the integration of multidisciplinary approaches, including nanotechnology, AI, and systems biology, in studying and addressing plant science challenges. Develop the ability to apply these approaches in a cohesive and effective manner.
5. **Prepare for Future Trends and Careers:** Equip students with the knowledge and skills necessary to stay abreast of future trends and advancements in plant science. Prepare them for careers in academia, research institutions, biotechnology companies, and agricultural industries by providing a solid foundation and hands-on experience in modern plant science techniques and technologies.

Course Outcomes:

CO 1: Students will be able to list and describe key terms, principles, and historical advancements in plant taxonomy, anatomy, and embryology.

CO 2: Students will be able to explain how technologies like CRISPR and genome sequencing work and their significance in advancing plant science research.

CO 3: Students will be able to conduct experiments using techniques like RNA-Seq, gene editing, and metabolomics to investigate plant physiology and genetics.

CO 4: Students will be able to interpret experimental results, perform data analysis using bioinformatics tools, and identify patterns and relationships within the data.

CO 5: Students will be able to formulate research hypotheses, design experiments, and propose novel applications of modern technologies for crop improvement and sustainability.

CO 6: Students will be able to assess the quality and relevance of scientific publications, critique methodologies, and discuss the implications of research findings on future plant science and biotechnology.

Detailed Curriculum:

Unit – I: Classical Botany and Modern Innovations

1.1 Advanced Plant Taxonomy and Systematics

- Molecular phylogenetics and DNA barcoding
- Automated taxonomic identification systems using AI

1.2 Innovations in Plant Anatomy

- Advanced imaging techniques (confocal microscopy, MRI)
- 3D reconstruction of plant tissues and organs

1.3 Modern Approaches in Plant Embryology

- In vitro fertilization and embryo culture techniques
- Molecular regulation of embryogenesis

1.4 Cutting-edge Paleobotany

- Molecular paleobotany and ancient DNA analysis
- Digital reconstruction of fossil plants

1.5 Advances in Plant Morphology

- Application of geometric morphometrics
- Evolutionary developmental biology (Evo-Devo) techniques

1.6 Ethnobotany in the Genomic Era

- Genomic approaches to studying traditional plant uses

- Digital ethnobotany databases and their applications

Unit – II: Plant Physiology and Biochemistry

2.1 Photosynthesis Enhancement Technologies

- Artificial photosynthesis systems
- Genetic engineering for improved photosynthetic efficiency

2.2 Hormonal Pathways and Biotechnology

- Manipulating hormonal pathways for crop improvement
- Hormone biosensors and their applications

2.3 Nutrient Uptake and Transport Innovations

- Use of nanotechnology in nutrient delivery
- Genetic engineering for enhanced nutrient uptake

2.4 Plant Stress Physiology and Biotechnology

- Genetic and biochemical approaches to stress resistance
- Biotechnological innovations in stress tolerance

2.5 Secondary Metabolite Engineering

- Metabolic engineering for enhanced secondary metabolite production
- Biotechnological applications of plant secondary metabolites

2.6 Signal Transduction Technologies

- Advances in signal transduction research tools
- Synthetic biology approaches to plant signaling

Unit – III: Molecular Biology and Genomics

3.1 Next-Generation Plant Genome Sequencing

- Single-cell genomics in plant research
- Advances in genome assembly and annotation

3.2 Transcriptomics and Beyond

- Single-cell RNA sequencing
- Long-read RNA sequencing technologies

3.3 Future Biotechnological Applications

- Advances in plant tissue culture and micropropagation
- Gene drives, terminator technology, and synthetic biology for ecological engineering

3.4 CRISPR and Genome Editing Advances

- Base editing and prime editing technologies
- Applications of CRISPR in plant synthetic biology

3.5 Synthetic Biology and Plant Engineering

- Design and construction of synthetic gene networks
- Synthetic pathways for novel metabolite production

3.6 Systems Biology in Plants

- Multi-omics integration and network analysis
- Computational modeling of plant systems

Unit – IV: Emerging Technologies and Future Trends

4.1 Plant-Microbe Interactions and Innovations

- Metagenomics and microbiome engineering
- Synthetic biology approaches to plant-microbe interactions

4.2 Precision Agriculture and Plant Science

- Use of drones and sensors in plant monitoring
- IoT and big data analytics in agriculture

4.3 Climate Change Adaptation Technologies

- Genetic approaches to developing climate-resilient crops
- Biotechnological solutions for carbon sequestration in plants

4.4 Nanotechnology in Plant Science

- Applications of nanomaterials in plant protection and growth enhancement
- Nano-enabled delivery systems for agrochemicals and nutrients

4.5 Artificial Intelligence in Plant Research

- AI-based tools for plant disease diagnosis and crop management
- Machine learning models for predicting plant responses to environmental changes

4.6 Seed Technologies

- Advances in seed priming and coating technologies
- Development of hybrid and genetically modified seeds for improved traits

Proposed Pedagogies:

Teaching Methodologies

1. **Lectures and Interactive Sessions:** Traditional lectures combined with interactive Q&A sessions to ensure understanding and engagement. Use multimedia presentations, case studies, and real-world examples to illustrate complex concepts. Encourage student participation through discussions and in-class activities.
2. **Laboratory Practical Sessions**: Hands-on experience with advanced techniques and tools in plant science research. Organize laboratory sessions where students can perform experiments related to genome sequencing, CRISPR editing, advanced microscopy, and other modern technologies. Provide detailed protocols and guidance from instructors.
3. **Workshops and Seminars:** Intensive sessions focused on specific advanced topics or skills, often featuring guest speakers from the field. Conduct workshops on topics such as bioinformatics tools, AI applications in plant science, and synthetic biology. Invite researchers and industry experts to deliver seminars and share their latest findings and insights.

Learning Methodologies

1. **Project-Based Learning:** Students work on projects that apply theoretical knowledge to practical problems or research questions. Assign projects that involve designing experiments, analyzing data, or developing new tools and techniques. Encourage collaboration and regular progress presentations.
2. **Flipped Classroom:** Students review lecture materials and readings at home and engage in active problem-solving and discussions during class. Provide pre-recorded lectures and reading materials online. Use class time for discussions, case studies, and hands-on activities that reinforce and apply the pre-learned content.
3. **Collaborative Learning:** Group activities and discussions that promote peer-to-peer learning and teamwork. Organize group assignments and study groups where students can discuss course materials, solve problems collaboratively, and learn from each other's perspectives and expertise.

Evaluation Methodologies

1. **Continuous Assessment:** Regular evaluations through quizzes, assignments, and practical reports to monitor progress and understanding. Schedule frequent quizzes, homework assignments, and lab report submissions. Provide timely feedback to help students improve and stay on track.
2. **Project and Research Paper Evaluation:** Assessment based on the quality and originality of projects and research papers. Evaluate projects and research papers for scientific rigor, creativity, and relevance. Include peer reviews and oral presentations as part of the evaluation process.
3. **Examinations and Practical Tests**: Formal written and practical exams to assess comprehensive understanding and practical skills. Conduct mid-term and final exams covering theoretical knowledge and practical skills. Include practical tests where students demonstrate proficiency in lab techniques and data analysis.

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Reference/Text Books/Research Articles

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Digital Resources (Weblinks)

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2. Botanic Gardens Conservation International. (n.d.). Retrieved from https://www.bgci.org
3. Plant Metabolic Network. (n.d.). Retrieved from https://www.plantcyc.org
4. Plant Ontology Consortium. (n.d.). Retrieved from http://www.plantontology.org
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Educational Software, Databases

1. BLAST: Basic Local Alignment Search Tool. (n.d.). National Center for Biotechnology Information (NCBI). Retrieved from https://blast.ncbi.nlm.nih.gov/Blast.cgi
2. KEGG: Kyoto Encyclopedia of Genes and Genomes. (n.d.). Retrieved from https://www.genome.jp/kegg
3. Phytozome: A Comparative Genomics Database for Plants. (n.d.). Retrieved from https://phytozome-next.jgi.doe.gov
4. TAIR: The Arabidopsis Information Resource. (n.d.). Retrieved from https://www.arabidopsis.org
5. UniProt: Universal Protein Resource. (n.d.). Retrieved from https://www.uniprot.org

Model Questions:

Unit 1: Classical Botany and Modern Innovations

Long Type for 10 Marks: Discuss the advances in molecular phylogenetics and DNA barcoding and their impact on plant taxonomy and systematics. How have these technologies revolutionized the classification and identification of plants?

Long Type for 5 Marks: Explain the role of advanced imaging techniques such as confocal microscopy and MRI in modern plant anatomy. Provide examples of how these techniques have enhanced our understanding of plant structure.

Short Type for 3/4 Marks:

1. What are the key differences between traditional taxonomy and molecular systematics?
2. Describe the process and significance of in vitro fertilization in plant embryology.
3. How has digital reconstruction contributed to the study of fossil plants in paleobotany?

Unit 2: Plant Physiology and Biochemistry

Long Type for 10 Marks: Evaluate the technological advancements in artificial photosynthesis systems. How do these systems work, and what potential benefits do they offer for agricultural productivity?

Long Type for 5 Marks: Discuss the use of nanotechnology in nutrient delivery to plants. What are the advantages and potential risks associated with this technology?

Short Type for 3/4 Marks:

1. Explain the concept of genetic engineering for improved photosynthetic efficiency.
2. What are hormone biosensors, and how are they used in plant biotechnology?
3. Describe a recent biotechnological innovation that enhances plant stress tolerance.

Unit 3: Molecular Biology and Genomics

Long Type for 10 Marks: Describe the advancements in CRISPR and genome editing technologies. Discuss their applications in functional genomics and crop improvement with specific examples.

Long Type for 5 Marks: What are single-cell genomics, and how are they applied in plant research? Provide an example of a significant discovery made using this technology.

Short Type for 3/4 Marks:

1. What are the main techniques used in next-generation sequencing (NGS)?
2. Explain the importance of single-cell RNA sequencing in transcriptomics.
3. How does epigenome editing differ from traditional gene editing?

Unit 4: Emerging Technologies and Future Trends

Long Type for 10 Marks: Assess the impact of precision agriculture technologies, such as the use of drones and IoT, on modern plant science. How do these technologies improve crop management and productivity?

Long Type for 5 Marks: Discuss the potential of AI-based tools for plant disease diagnosis. What are some current applications and future prospects of AI in plant science?

Short Type for 3/4 Marks:

1. What are the applications of nanotechnology in plant protection and growth enhancement?
2. Explain the role of gene therapy in plants and its potential benefits and challenges.
3. How do high-throughput phenotyping platforms contribute to plant breeding and genetics?

DSC-I.3 Paleobotany, Evolution of Gymnosperms and Origin of Angiosperms

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.5	III	BOT301	Paleobotany, Evolution of Gymnosperms and Origin of Angiosperms	4	60	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. To understand the phylogenetic significance of Gymnosperms,
2. To illustrate the diversity of past vegetation
3. To know the distribution and economic potential of gymnosperms
4. To contribute to the ancestry of present-day dominant vegetation: Angiosperms
5. To understand the significance of past vegetation in the formation of fossil fuel

Course Outcomes:

CO 1: Understand the paleobotany, Geological Time Scale, phylogenetic significance of Gymnosperms and origin of angiosperm.
CO 2: Gain knowledge of the life cycle pattern of gymnosperm.
CO 3: Demonstrate morphological, anatomical & reproductive characterization of gymnospermic forms.
CO 4: Illustrate the phylogenetic significance of past vegetation
CO 5: Substantiate the evolutionary trends and dominance of present-day angiosperms.

Detailed Curriculum:

Unit – I: Paleobotany:

1.1 History of paleobotany, process of fossilization, types of fossils,
1.2 Techniques of study of fossils,
1.3 Geological Time Scale and Plant life through the ages.
1.4 Contributions of Indian paleobotanists like Professors Birbal Sahni, D.D.Pant and K.R.Surange.
1.5 Applied aspects of paleobotany

Unit – II: Gymnosperms:

2.1 General characters of gymnosperms. Geographic distribution and economic importance of gymnosperms
2.2 Classification of Gymnosperms: Birbal Sahani and D.D.Pant
2.3 General account of Progymnospermopsida
2.4 Morphology, anatomy, reproduction: Pteridospermales- Lyginopteridaceae (Calymmatotheca hoeninghausii),
2.5 Morphology, anatomy, reproduction Cycadeoideales – Cycadeoidea (Bennettites)

Unit – III: Gymnosperms:

Morphology, anatomy, reproduction in context of following -
3.1 Pentoxylales
3.2 Cycadales (Cycas)
3.3 Cordaitales
3.4 Ginkgoales (Ginkgo)

Unit – IV: Gymnosperms:

Morphology, anatomy, reproduction in context of following -
4.1 Coniferales (Pinus),
4.2 Taxales (Taxus),
4.3 Gnetales (Gnetum)

Unit – V: Origin of Angiosperms

5.1 Pre-cretaceous and Cretaceous fossil angiosperms, Time of origin of angiosperms; Cradle of angiosperms.
5.2 Probable ancestors of angiosperms,
5.3 Isoetes-monocotyledon theory, Coniferales- Amentiferae theory,
5.4 Gnetales- Angiosperm theory,
5.5 Bennettitalean theory,
5.6 Pteridosperm theory

Unit – VI: Origin of Angiosperms

6.1 Monophyletic verses polyphyletic origin of angiosperms
6.2 Brief account of fossil angiosperms
6.3 Basic Evolutionary trends in Angiosperms

Proposed Pedagogies:

1. **Teaching Methodologies:**

Conducting practicals mostly with freshly collected specimens.
Visit to the field to study distribution of gymnospermic forms.
Monographic and Photographic presentation of gymnospermic material.

2. **Evaluation Methodologies:**

Small Project, Seminars, Unit test

Reference/Textbooks/Research Articles

1. Stewart W.N. qne Rothwell G.W. (1993): Paleobotany and the Evolution of Plants, Cambridge University Press
3. Foster A.S. and Gifford F.M. (1967): Comparative Morphology of Vascular Plants, Freeman Publishers, San Fransisco
4. Arnold C.A. (1947): Introduction to Palaeobotany, Mc-Graw Hill Book Co.Inc.New York and London
5. Kubitzki K. (1990): The families and genera of vascular plants-Pteridophytes and Gymnosperms, Springer Verlag, New York
6. Agashe S.N. (1995): Paleobotany, Oxford and IBH, New Delhi
7. Coulter J.M. and Chamberlain C.J. (1978): Morphology of Gymnosperms, Allahabad
8. Biswas C. and Johri B.N. (2004): The Gymnosperms, Narosa Publishing House, New Delhi
9. Bierhorst D.W. (1971): Morphology of Vascular Plants, McMillan, New York
10. Bharnagar S.P. and Moitra A. (1966): Gymnosperms, New Age International Pvt. Ltd., New Delhi
11. Delevoryas T. (1962): Morphology and Evolution of Fossil Plants, New York, Londos
12. Maheshwari P and Singh H. (1960): Economic importance of Conifers, J.Univ, Gauhati 11(Sci): 1-28
13. Maheshwari P. and Singh H. (1967): The female gametophyte of Gymnosperms, Biol. Rev.42: 88-130
14. Stace C.A.(1989): Plant Taxonomy and Biosystematics, Edward Arnold Ltd. London
15. Takhtajan A.L. (1997) Diversity and Classification of Flowering Plants, Columbia University Press, New York
16. Pant D.D. (1957): The Classification of Gymnospermous plants Palaeobot. 6: 65-70
17. Pand D.D.(1973): Cycas and Cycadales, Central Book Depot, Allahabad
18. Chamberlain C.J. (1986): Gymnosperms, Structure and Evolution, CBS Publishers and Distributors, New Delhi
19. Thomas B.A. and Spicer R.A. (1987): The Evolution and Palaeobiology of Land Plamnts, Discordies Press, Fortland, U.S.A.
20. Spicer R.A. and Thomas B.A. (1986): Systematic and Taxonomic Approaches in Palaeobotany, Systematic Association special volume
21. Stewart W.N. (1983): Palaeobotany and the Evolution of Plants, University Press, Cambridge
22. Eames, A.J. (1936) Morphology of Vascular plant-lower group. Tata Mc Graw Hill, New Delhi.
23. Chamberlain, Charles Joseph, b.(1863), Gymnosperm; Structure and Evolution. Chicago, III., The University of Chicago Press
24. Chhaya Biswas and B.M.Johri. The Gymnosperm. Springer; 1997, edition (16 April 2014
25. Bhatnagar, S.P. Moitra, Alok. (1996). Gymnosperms. New Age International.
26. Pant DD. (2002), An Introduction to Gymnosperms, Cycas, and Cycadales, Birbal Sahni Institute of Palaeobotany.
27. Steward W.N., Palaeobotany and evolution of plant. Cambridge University Press, New York.405 p.(1)

28. Andrews,H.N.,jr.1974 Palaeobotany (1947-1972) Annals of the Missouri Botanical Garden 61:179-202.(8) Page 7 of 21 .Taylor.Edith L. Tailor.Michael Krings (2009) Palaeobotany: The biology and Evolution of Fossil Plants Amsterdam ; Boston, Mass. : Academic Press, c2009
29. Wilson N Stewart and Gar W. Rothwell -1993. Palaeobotany and the evolution of plants. Cambridge university press.
30. Edith L. Taylor, Thomas N. Taylor, Michael Krings – 2009. Palaeobotany: The Biology and Evolution of Fossil Plants. Academic Press

Model Questions:

Long Type for 10 Marks:

1. Describe the process of fossilization, types of fossils,
2. Explain Techniques of study of fossils,
3. Describe Geological Time Scale and Plant life through the ages.
4. Describe the General characters the economic importance of gymnosperms
   Comparative account on Birbal Sahani and D.D. Pant classification of Gymnosperms:
   Describe male and female cone in Cycas
5. Describe morphology and anatomy of Pinus needle
6. Describe Bennettitalean theory, & Pteridosperm theory for the origin of angiosperm
7. Illustrate the Basic Evolutionary trends in Angiosperms

Long Type for 05 Marks:

1. Explain types of fossils
2. Illustrate the applied aspects of paleobotany
3. Describe the reproductive organs of Cycadeoidea (Bennettites)
4. Explain morphology and internal structure of Pinus male cone
5. Explain Bennettitalean theory
6. Explain Pteridosperm theory
7. Brief account of fossil angiosperms

Short Type for 3/4Marks:

Describe-

1. Impression fossil
2. Draw Geological Time Scale
3. Calymmatotheca hoeninghausii
4. L.S. OF Male cone in Pinus
5. polyphyletic origin of angiosperms

PRACTICALS:

MAJOR EXERCISES:

1. Study of vegetative and reproductive parts of – Cycas, Cedrus, Abies, Pinus, Cupressus, Cryptomeria, Taxodium, Podocarpus, Agathis, Thuja, Gnetum, Ephedra, Juniperus, Cephalotaxus, Taxus, (Any 5)
2. Permanent micro preparations of vegetative parts

MINOR EXERCISES

3. Study of important fossil gymnosperms and angiosperms from available material and permanent slides.
4. Ginkgo: Morphology to be studied from Museum specimens & and anatomy from permanent slides.
5. Visit to palaeobotanical Institutes, localities and collection of specimens.
6. Field visits to ecologically different localities to study living gymnosperms

DSC-II.3 Systematics and Taxonomy of Angiosperms

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.5	III	BOT302	Systematics and Taxonomy of Angiosperms	4	60	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives

1. Understand the principles, practices, and historical context of botanical nomenclature and taxonomy.
2. Explore the tools of taxonomy, including floras, monographs, herbaria, and botanical gardens, and their roles in research and conservation.
3. Learn the criteria and systems used for plant classification, including artificial, natural, phylogenetic, and APG systems.
4. Study the systematic characteristics and classification of various plant families.
5. Investigate the anatomy of angiosperms, including tissues, leaf anatomy, adaptive systems, and applications of plant anatomy in different fields.

Course Outcomes:

CO 1: Explain the principles and practices of botanical nomenclature and the significance of the Shenzhen code 2018.
CO 2: Utilize various taxonomic tools for plant identification and understand the role of herbaria and botanical gardens in teaching and research.
CO 3: Differentiate between artificial, natural, and phylogenetic systems of classification and describe their historical development.
CO 4: Classify and describe the morphological and anatomical features of various plant families.
CO 5: Analyze the anatomy of dicot and monocot leaves, roots, and stems, including secondary growth and adaptive structures.
CO 6: Apply knowledge of plant anatomy in systematic classification, forensic science, and pharmacognosy.

Unit-I: Taxonomic Nomenclature, Tools, Floristics

1.1 Aims, principles and practices in taxonomy. Botanical Nomenclature: Brief history
1.2 Scientific names: ICN, Principles, typification, Principle of priority, effective and valid publication, rank of taxa. ICBN and historical review and silent features of Shenzhen code 2018.
1.3 Tools of taxonomy: Floras, monographs, revisions, websites. Herbarium and botanical gardens, their role in teaching ,research and conservation, important herbaria and botanic gardens of the World.
1.4 Floristics: Need and significance. History of botanical exploration in India and Botanical Survey of India.
1.5 Morphological features used in identification. Artificial dichotomous keys.

Unit-II: Classification and Systems

2.1 Importance and need for classification. Criteria used for classification; phases of plant classification. Overview on pre- and post-Darwinian systems of classification.
2.2 Artificial systems of classification -, Theophrastus, Linnaeus.
2.3 Natural system of classification - Bentham and Hooker
2.4 Phylogenetic systems of classification - Cronquist, Takhtajan
2.5 APG system of classification.

Unit-III: Plant Systematics

3.1 Magnoliaceae, Ranunculaceae; Papaveraceae;
3.2 Capparidaceae; Malvaceae ;Meliaceae;
3.3 Leguminoceae, Myrtaceae; Cucurbitaceae; Cactaceae.
3.4 Gentianaceae; Rubiaceae; Asteraceae; Apocynaceae;
3.5 Asclepiadaceae; Convolvulaceae, Boraginaceae

Unit-IV: Plant Systematics

4.1 Scrophulariaceae, Acanthaceae, Lamiaceae, Polygonaceae;
4.2 Nyctaginaceae; Caryophyllaceae; Loranthaceae
4.3 Podostemonaceae; Poaceae; Cyperaceae Cannaceae;
4.4 Orchidaceae, Arecaceae

Unit-V: Anatomy of Angiosperms

5.1 Introduction and scope of Plant Anatomy: Tissues: Classification of tissues; Simple and complex tissues
5.2; Cyto differentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Cell wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances.
5.3 Leaf: Anatomy of dicot and monocot leaf, Kranz anatomy
5.4 Adaptive and Protective Systems Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni-and multicellular, glandular and nonglandular: two examples of each), stomata (classification)
5.5 Applications of Plant Anatomy in systematic, forensics and pharmacognosy.

Unit-VI: Anatomy of Angiosperms

6.1Anatomy of dicot and monocot root; Endodermis, exodermis and origin of lateral root. Secondary growth in roots
6.2 Stem: Organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, continuing meristematic residue, cyto-histological zonation)
6.3 Types of vascular bundles; Anatomy of dicot and monocot stem
6.4 Anomalous Primary Structure and Secondary growth with reference to following: *Nyctanthus, Acyranthus, Boerrhavia, Leptadinia, Bignonia, Piper*

Proposed Pedagogies:

Teaching Methodologies:

Lecture and Demonstration, actual plant specimens (Plant specimens used which are abundantly available)

Learning Methodologies:

Practicals by actual plant specimens (Plant specimens used which are abundantly available),Frequent field visits

Evaluation Methodologies:

Question and answer, description, by preparing monographs, class tests

Suggested Reading:

1. APG IV. (2016). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. *Botanical Journal of the Linnean Society, 181*(1), 1–20.
2. Balfour Austin. (2016). *Plant Taxonomy*. Syrawood Publishing House.
3. Barry G. Hall. (2011). *Phylogenetic Trees Made Easy: A How-To Manual* (4th ed.). Sinauer Associates, Inc.
4. Bhatnagar, S. P., & Moitra, A. (1996). *Gymnosperm*. New Age International Pvt. Ltd.
5. Benson, L. D. (1962). *Plant Taxonomy: Methods and Principles*. Ronald Press.
6. Chapman, J. L., & Reiss, M. J. (1998). *Ecology: Principles and applications*. Cambridge University Press.
7. Chopra, G. L. (1984). *Angiosperms: Systematics and Life-Cycle*. Pradeep Publications.
8. Cole, A. J. (1969). *Numerical Taxonomy*. Academic Press.
9. Cooke, T. (1903–1908). *The Flora of the Presidency of the Bombay Vol. I, II, III* (Repr. ed.). Botanical Survey of India.
10. Cronquist, A. (1968). *The Evolution and Classification of Flowering Plants*. Thomas Nel and Sons Ltd.
11. Cronquist, A. (1981). *An Integrated System of Classification of Flowering Plants*. Columbia University Press.
12. Datta, S. C. (1988). *Systematic Botany*. New Age Publications.
13. Davis, P. H., & Heywood, V. H. (1963). *Principles of Angiosperm Taxonomy*. Oliver & Boyd.
14. Davis, P. H., & Heywood, V. H. (1973). *Principles of Angiosperm Taxonomy*. Robert E. Kreiger Publishing Company.
15. Douglas, S., Soltis, P., Endress, P., Chase, M., Manchester, S., Judd, W., Majure, L., & Mavrodiev, E. (2017). *Phylogeny and Evolution of Angiosperms* (Revised and Updated ed.). University of Chicago Press.
16. Eames, A. J. (1961). *Morphology of the Angiosperms*. McGraw-Hill.
17. Esau, K. (1977). *Anatomy of Seed Plants*. John Wiley & Sons, Inc.
18. Felsenstein, J. (2003). *Inferring Phylogenies*. Sinauer Associates, Inc.
19. Grant, V. (1971). *Plant Speciation*. Columbia University Press.
20. Grant, W. F. (1984). *Plant Biosystematics*. Academic Press.
21. Harrison, H. J. (1971). *New Concepts in Flowering Plant Taxonomy*. Heinemann.
22. Heywood, V. H. (1967). *Plant Taxonomy*. Hodder & Stoughton Educational.
23. Heywood, V. H., & Moore, D. M. (1984). *Current Concepts in Plant Taxonomy*. Academic Press.

24. Heywood, V. H. (1995). *Global Biodiversity Assessment*. Cambridge University Press.
25. Jain, S. K., & Rao, R. R. (1977). *A Handbook of Field and Herbarium Methods*. Today and Tomorrow Printers and Publishers.
26. Joesph, F. (2003). *Inferring Phylogenies*. Sinauer Associates, Inc.
27. Jones, S. B., & Luchsinger, A. E. (1987). *Plant Systematics* (2nd ed.). McGraw-Hill.
28. Judd, W. S., Campbell, C. S., Kellogg, E. A., Stevens, P. F., & Donoghue, M. J. (2008). *Plant Systematics: A Phylogenetic Approach*. Sinauer Associates.
29. Kitching, I. J., Forey, P. L., Humphries, C. J., & Williams, D. M. (1998). *Cladistics: The Theory and Practice of Parsimony Analysis* (2nd ed.). Oxford University Press.
30. Kormondy, E. (1995). *Concepts of Ecology*. Pearson.
31. Lawrence, G. H. M. (1951). *Taxonomy of Vascular Plants*. McMillan.
32. Lawrence, G. H. M. (1955). *An Introduction to Plant Taxonomy*. McMillan.
33. Michael, P. (1984). *Ecological Methods for Field and Laboratory Investigations*. TMH Co. Ltd.
34. Michael, J. M., Soltis, P. S., Bell, C. D., Burleigh, J. G., & Soltis, D. E. (2010). Phylogenetic analysis of 83 plastid genes further resolves the early diversification of eudicots.
35. Mishra, B. K. (2017). *Anatomy of Angiosperms*. Kalyani Publishers.
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38. Nei, M., & Kumar, S. (2000). *Molecular Evolution and Phylogenetics*. Oxford University Press.
39. Odum, E. P. (2004). *Fundamentals of Ecology*. Cengage Learning.
40. Pande, B. P. (1997). *Taxonomy of Angiosperms*. S. Chand.
41. Pande, B. P. (2001). *Taxonomy of Angiosperms*. S. Chand.
42. Pandey, B. P. (2017). *Plant Anatomy*. S. Chand.
43. Radford, A. E. (1986). *Fundamentals of Plant Systematics*. Harper & Row.
44. Santapau, H. (1953). *The Flora of Khandala on the Western Ghats of India*. Botanical Survey of India.
45. Sharma, O. P. (2011). *Plant Taxonomy*. Tata McGraw Hill.
46. Shivrajan, V. V., & Robson, N. K. P. (1991). *Introduction to Principles of Plant Taxonomy*. Cambridge University Press.
47. Shukla, P., & Mishra, S. (1982). *An Introduction to Taxonomy of Angiosperms*. Vikas Publishing.
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53. Singh, N. P. (2001). *Flora of Maharashtra Volume-II*. Botanical Survey of India.
54. Singh, N. P. (2003). *Flora of Maharashtra Volume-III*. Botanical Survey of India.
55. Singh, V., & Jain, D. K. (1981). *Taxonomy of Angiosperms*. Rastogi Publication.
56. Stace, C. A. (1989). *Plant Taxonomy and Biosystematics*. Edward Arnold.
57. Stevens, P. F. (2001 onwards). Angiosperm Phylogeny Website. Version 14, July 2017 [and more or less continuously updated since].
58. Stuessy, T. F. (2009). *Plant Taxonomy: The Systematic Evaluation of Comparative Data* (2nd ed.). Columbia University Press.
59. Swingle, D. B. (1946). *A Textbook of Systematic Botany*. McGraw Hill.
60. Takhtajan, A. (1969). *Flowering Plants: Origin and Disposal*.
61. Takhtajan, A. L. (1997). *Diversity and Classification of Flowering Plants*. Columbia University Press.
62. Tayal, M. S. (2012). Rajpal and Sons, New Delhi.
63. Walter, S., Soltis, P. S., Chase, M., Manchester, S., Judd, W., Majure, L., & Mavrodiev, E. (2017). *Phylogeny and Evolution of Angiosperms* (Revised and Updated ed.). University of Chicago Press.
64. Woodland, D. W. (1991). *Contemporary Plant Systematics*. Prentice Hall.

PRACTICALS:

MAJOR EXERCISES:

Major1: Technical description of plant species available locally and identification upto family (Dicot and Monocot)

Major 2: Study of species belonging to single genus and preparation of key at genus level

Major 3: Study of distribution and types of parenchyma, collenchyma and sclerenchyma

Major 4: Stem: monocot, dicot - primary and secondary growth and anomalous secondary growth
Major 5: Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular

MINOR EXERCISES:

Minor 1: Identification of local species using Floras, keys and campus field trips

Minor 2: Preparation of herbarium specimens following standard techniques.

At least 100 specimens should be presented collectively by the class of locally abundant species. Frequent field trips should be arranged to get acquainted with local flora. One tour within state and one outside the state should be arranged to study the biodiversity of Angiosperms. Field tour reports should be supported by exhaustive field notes and photographic representations of plant species (Plants should be collected which are abundantly available)

Minor 3: Construction of phylogenetic tree based on gene sequences available at NCBI database (each student may be given different gene sequences/taxa).

Minor 4: Leaf - isobilateral, dorsiventral, C4 leaves (Kranz anatomy)

Minor 5: Root - monocot, dicot, secondary growth

DSC-III.3 Diversity Conservation, Ethnobotany, Palynology and Phytogeography

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.5	III	BOT302	Diversity Conservation, Ethnobotany, Palynology and Phytogeography	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. Get a deep knowledge on biodiversity richness in global scale and biogeography of India.
2. Assess the value of biodiversity wealth of our Nation.
3. To develop skill in practical work, experiments, equipment, and laboratory use along with collection and interpretation of biological materials and data.
4. Describe ethnobotanical research methods.
5. Students acquired the skills related to scientific research in the area of Botany.

Course Outcomes:

CO 1: Apply ethnobotanical knowledge in biodiversity conservation and socio-economic development.
CO 2: Analyze various threats to our biodiversity and able to suggest measures for conservation strategies.
CO 3: Trained effectively and scientifically to convey the message of sustainable use of resources and conservation of biodiversity to the public and young generation.
CO 4: Students can execute the phytogeographical survey.
CO 5: Students will understand the dynamic mechanism of plant pollination, fertilization, pollen-pistil interaction, and pollen development.
CO 6: Students will realize the significance and applications of palynology.

Detailed Curriculum:

Unit – I: Biodiversity and Conservation

1.1: Biodiversity Definition, types of biodiversity, Species area relationship.
1.2: Patterns of Biodiversity, latitudinal gradients, Species and genetic diversity.
1.3: Importance of Species biodiversity to the ecosystem, species richness and evenness, Rivet popper hypothesis
1.4: Loss of Biodiversity: Evil Quartet of biodiversity loss, habitat loss, over exploitation, Invasion of alien species and coextinction
1.5: Conservation of Biodiversity: Ex situ and in situ conservation, sacred groves
1.6: Wildlife sanctuaries and National parks for conservation of biodiversity, Flagship species

Unit – II: Biodiversity

2.1: Ecosystem Restoration and Management Practices Global biodiversity and it's importance. Different approaches of Biodiversity Conservation and Management, registering biodiversity.
2.2: Valuing biodiversity resources and their contributions to agriculture, community health and environment. Causes of biodiversity loss.
2.3: Techniques of species reintroduction and restoration of the degraded habitat.
2.4: Biodiversity policy and legislation. Wildlife conservation and management. Status of biodiversity conservation of India.
2.5: Uses of Biodiversity: Ecosystem services, Prevention and mitigation of natural disasters, Source of economically important products, Aesthetic and cultural benefits.
2.6: Threats to Biodiversity: Habitat loss and fragmentation, Introduction of invasive species, overexploitation, Climate change and pollution

Unit – III: Ethnobotany

3.1: Introduction to Ethnobotany, history, concept, scope and objectives. Ethnobotany as an interdisciplinary science.
3.2: Major and minor ethnic groups or Tribals of India and their lifestyle. Classification, International, National and Regional Contributors of Ethnobotany- Dr. J.W. Harshberger, R.E. Schutes Dr. E. K. Janki Ammal, Dr. S.K. Jain, Dr. K. S. Manilal, Dr. P.Y. Bhogaonkar
3.3: Ethnobotanical research Methods- Ethnomedicinal practices and traditional wisdom. Case study of local traditional health practices. Centers of Ethnobotanical studies in India, AICRPE- All India

Coordinated Research Project on ethnobiology, FRLHT- Foundation for the Revitalisation of local health traditions

3.4: People Plants relationship - Plants used by tribals as: food plants, Intoxicants and beverages, resins, oils and Miscellaneous uses.

3.5: Ethnopharmacognosy- Introduction, definition, history, scope and relevance. Indian traditional medicine. Ethnobotanical contributions to modern medicines, Challenges in ethnopharmacology

3.6: Roles for Ethnobotany in conservation of plant genetic resources. Biopiracy, Intellectual property right and traditional knowledge.

Unit – IV: Palynology

4.1: **Palynology:** History, Definition, Scope and importance, Pollen Formation, Development of the Pollen Wall and Tapetum, Chemical composition of pollen.

4.2: **Pollen Morphology**– Methods for morphological studies of pollen: i). Simple staining ii). Acetolysis technique

4.3: **Pollen Characteristics:** Pollen Units, Polarity, symmetry, size and shape, apertural pattern (NPC Classification), Exine stratification and ornamentation of pollen wall. TEM and SEM studies of pollen.

4.4: **Pollen Pistil interaction:** Structure of pistil, recognition of pollen by the stigma, Pollen germination and entry of pollen tube in to stigma, style and ovary, Significance of Pollen pistil interaction.

4.5 Pollen Viability and Storage: Pollen Viability- Introduction, variations in Pollen viability, Causes for loss of pollen viability, Test for Pollen viabilty, Factor affecting pollen viability

Pollen Storage: Introduction, Short term pollen storage, long term pollen storage, Significance.

4.6: **Aeropalynology –** Survey of air borne pollen analysis of aerospore, Methods of collecting air borne particles. Identification, preparation of pollen calendar, Allergenic spores and pollen in atmosphere and types of allergic reactions, Symptoms of pollen allergy in human beings, diagnosis and clinical treatment.

Unit – V: Phytogeography

5.1: Aims Definition and principles of Phytogeography, Types of plant distribution.

5.2: Relationship of geography to plant distribution. Continuous distribution; cosmopolitan, circumpolar, circumbolear and pan tropical

5.3: Discontinuous distribution; Theory of land bridge, theory of Continental drift, theory of Polar oscillations, glaciations.

5.4: Centres of origin and diversity of plants. Theories on the distribution of plants; theory of age area, theory of tolerance.

5.5: Factors influencing plant distribution; floristic regions of the world: vegetation zones concerning latitudes and altitudes

5.6: Geographical information systems: definition, fundamental concepts and components of GIS; development and future trends in GIS

Unit – VI: Phytogeography

6.1: Phytogeography, correlation of Climate with plant distribution; types of vegetation

6.2: Phytogeographic regions of world (Forests, Grasslands, Deserts, Tundra/Alpine areas);

6.3: Divisions of Phytogeography, Static Phytogeography; Dynamic Phytogeography

6.4: Phytogeographic regions of India, Endemism; type of endemism

6.5: Biodiversity hotspots, Himalayas; Western Ghats; The Indo-Burma region; Sunderbans; Terrai-Duar Savannah grasslands; etc.

6.6: tools and methods used phytogeographical studies; Scope and importance of plant geographer.

Proposed Pedagogies:

Teaching Methodologies:

- Students should be aware about different climatic condition restricted to specific geographical area and its correlation with available plant diversity.
- Once they understand correlation of geography, climate and plant distribution it would be very easy to understand all the theoretical approaches of phytogeography.
- Practical exercises about phytogeographical surveys and censuses, Method of phytogeographical study, Use of tool kit for the study of phytogeography. Maps: Globes (Models of the Earth), Charts and Graphs, New technology: Includes GPS, Geographic Information Systems (GIS), remote sensing technologies, aerial and satellite photographs, and surveying equipment should be used for teaching.

4. Learning Methodologies:
   - Students should be promoted to visit the different geographical area through excursion tour or field visits, students should be aware about use of tools and technique use in plant geography, Students should be assigned to make survey by using different surveying equipment's.
5. Evaluation Methodologies:
   - To assessed the depth of concept of learning programs evaluation of learning methods is need. These evaluation can be done by using quiz, productive index of assigned task etc.

Bibliography:

Reference/Text Books/Research Articles

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2. Agashe, S. N. (2005). *Palynology and its applications*. Oxford and IBH Publishing Co. Pvt. Ltd.
3. Agashe, S. N. (1994). *Recent trends in aerobiology, allergy, immunology*. Oxford and IBH Publishing Co. Pvt. Ltd.
4. Bharucha, F. R. (1983). *A textbook of the plant geography of India*.
5. Bhattacharya, K., Mujumdar, S., & Bhattacharya. (2006). *A textbook of palynology: Illustration*. Himalaya Publishing House.
6. Bhogaonkar, P. Y., & Rajgure, Y. M. (2015). *Wild edibles of Vidarbha (along with medicinal uses)*. Nabh Prakashan.
7. Bhogaonkar, P. Y. (2009). *Nutraceutical evaluation of some folk food plants of Vidarbha region* (Doctoral dissertation, SGBAU Amravati University).
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9. Colton, C. M. (1997). *Ethnobotany: Principles and applications*. John Wiley and Sons.
10. Croizat, L. (2013). *Manual of phytogeography: An account of plant-dispersal throughout the world*. Springer.
11. Daubenmire, R. (2012). *Plant geography: With special reference to North America*. Elsevier.
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13. Jain, S. K. (1989). *Methods and approaches in ethnobotany*. Society of Ethnobotanists.
14. Jain, S. K. (1990). *Contributions of Indian ethnobotany*. Scientific Publishers.
15. Jain, S. K. (1995). *Manual of ethnobotany*. Scientific Publishers.
16. Krishnamoorthy, K. V. (2004). *An advanced textbook on biodiversity principles and practices*. Oxford and IBH Publishing Co. Pvt. Ltd.
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18. Moreira-Muñoz, A. (2011). *Plant geography of Chile* (Vol. 10). Springer.
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22. Pagare, P. (2010). *Applied plant geography*. Oxford Book Company.
23. Sinha, R. K. (1996). *Ethnobotany: The renaissance of traditional herbal medicine*. INA SHREE Publishers.
24. Rama Ro, N., & Henry, A. N. (1996). *The ethnobotany of Eastern Ghats in Andhra Pradesh, India*. Botanical Survey of India.
25. Shukla, J. P., Pandey, A., & Pandey, K. (2009). *Environmental biology and ecology*. Narendra Publishing.
26. Tidke, J. A., Rajurkar, A. V., & Narkhedkar, V. R. (2022). *Pollen morphology*.
27. Tilak, S. T. (1982). *Aerobiology*. Vaijayanti Prakashan.
28. Turrill, W. B. (2013). *Pioneer plant geography: The phytogeographical researches of Sir Joseph Dalton Hooker* (Vol. 4). Springer.
29. Wilkinson, D. M. (2007). *Fundamental processes in ecology: An earth system approach*. Oxford University Press.

Digital resources like weblinks, educational software, databases, etc.:

- https://learn.concord.org/
- https://learn.concord.org/eresources/1274.run_resource_html
- https://learn.concord.org/eresources/3013.run_resource_html
- https://www.google.com.in

Model Questions:

Long Type for 10 marks :

1) Explain Global Biodiversity and it's Importance.
2) Explain Forest research Institute, survey of India
3) Explain in detail Red data Book.
4) What are the phytogeographical division of India.
5) Define Pollen Morphology? Describe in details pollen morphological characteristics?
6) Describe the process of pollen development?
7) Gradient and magnitude of Biodiversity
8) Extinction of species

Long type for 5 marks :

1) Short notes on Causes of biodiversity loss.

Short types for 3/4 marks

1) Wildlife conservation and management
3) International NGOs :- UNEP
4) Describe the characteristic of Emdenism.
5) List some of the benefits provided by vegetation.
6) Explain phytogeographical principles.
7) Explain *Invivo* and*InVitro* Pollen germination?
8) Short note on Pollen storage?
9) Levels of Biodiversity

Short answer (question for ¾ marks):

1) Factors affecting pollen viabilty.
2) Explain qualitative and quantitative analysis of Honey?
3) Short note on Acetolysis technique?
4) Uses of biodiversity
5) IUCN Red List catergories
6) Threats to biodiversity.

PRACTICALS:

MAJOR EXERCISES:

1. To study major Ethnomedicinal plants and practices followed in India
2. To prepare standard proforma or questionnaire for Ethnobotanical knowledge
3. To study the threat categories for plants and survey of medicinal plants in natural habitats for biodiversity and threat assessment.
4. Case study of local traditional health practitioner
5. To study the use of different surveying equipment's used in phytogeography.
6. To prepared a map showing plant distribution in given area of garden / institute/Campus.
7. To prepare a graphical representation showing information about number of plants, types of vegetation
8. Study of Plant distribution in given by Quadrat Method Lab
9. To study the use of different surveying equipment's used in phytogeography.

MINOR EXERCISES:

1. To study the distribution of tribal/ ethenic people In India
2. To study propagation and nursery techniques of medicinal/aromatic plants
3. To study the different GPS tool to study the plant geography.
4. To identification of native plant species and GPS photography in given study area.
5. To identification of invasive plant species and GPS photography in given study area.
6. To study Remote sensing tools used to study forests like Aerial photography, Airborne laser scanning (ALS), Terrestrial laser scanning (TLS), Drones, Cameras, Smartphones

DSE-I -Angiosperm Taxonomy, Phytochemistry and Pharmacognosy-III

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.5	III	BOT104A	Angiosperm Taxonomy, Phytochemistry and Pharmacognosy-III	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. Understand the principles and practices in plant taxonomy, including the history and types of classification systems.
2. Explore pre-Darwinian and post-Darwinian classification systems, with a focus on modern systems.
3. Learn about biosystematics, numerical taxonomy, and their relationship with classical taxonomy.
4. Study the concepts of palaeoherbs, eudicots, cladistics, and the evolutionary trends in various angiosperm groups.
5. Analyze the significance of fossil angiosperms, local plant diversity, and the socio-economic importance of living fossils.

Course Outcomes:

CO 1: Recall the definitions, concepts, and importance of taxonomy and classification systems.
CO 2: Explain the developments in plant classification from pre-Darwinian to modern systems.
CO 3: Apply the principles and methods of numerical taxonomy in plant classification.
CO 4: Analyze the phylogeny and evolutionary trends of various angiosperm groups.
CO 5: Evaluate the significance of fossil angiosperms and living fossils in understanding plant evolution.
CO 6: Integrate phytochemical and molecular systematics in the study of plant taxonomy.

UNIT I:

Principles and Practices in Plant Taxonomy : Definitions and concepts, importance of taxonomy and need for classification, hierarchical classification, general and special purpose classifications .History of Angiosperm classification from herbals to the presentday. Types of classification-artificial, natural and phylogenetic

UNIT II:

Brief account of Pre-Darwinian Classification. Post-Darwinian developments in classification, Study of Modern systems –Bessey; Dahlgren, and Thorne's system of classification.

UNIT III:

Biosystematics: a)Objectives b) Concept c)Categories d) Species conceptrelationship with classical taxonomy. Numerical Taxonomy(Phenetic methods): Definition, Principles, methods, merits and demerits.

UNIT IV:

Concepts of palaeoherbs and eudicots (tricolpates). Cladistics: Abrief account: definition and application. Angiosperms diversity:Salient features, phylogeny and evolutionary trends in Magnollidae,Asteridae, Alismatidae, and Liliidae (sensuCronquist, 1981).

UNIT V

Fossil Angiosperms: Amborella, Archaefructus and itsevolutionary significance.
Phylogeny of Ranales, Rosales, Tubiflorae, Helobiales. Local Plant Diversity and its Socio-economic importance.
Living fossils of Angiosperms: Winteraceae, Degeneriaceae, Tetracentraceae, Trochodendraceae, Eupomatiaceae

UNIT VI:

Phytochemical systematics and molecular systematics.. Biosynthetic pathways important phytochemicals a) Shikimic acid b) Mevalonic acid pathway
Ethnobotany: Concept, scope and objectives
Ethnobotany as an inter-disciplinary science. The relevance of Ethnobotany in the present context. Methodology of ethnobotanical studies
a) Field work b) Herbarium c) Ancient literature d) Archaeological findings e) Temples and sacred groves

Model Questions:

Long Type Questions:

1. Discuss the importance of taxonomy and the need for classification in plant sciences. Compare and contrast artificial, natural, and phylogenetic classification systems.
2. Explain the developments in plant classification from pre-Darwinian to modern times, focusing on the systems proposed by Bessey, Dahlgren, and Thorne.
3. Describe the objectives, concepts, and categories of biosystematics. How does it relate to classical taxonomy?
4. Analyze the concepts of palaeoherbs and eudicots, and provide a brief account of cladistics and its application in plant taxonomy.
5. Discuss the evolutionary significance of fossil angiosperms such as Amborella and Archaefructus. Explain the phylogeny of Ranales, Rosales, Tubiflorae, and Helobiales.
6. Evaluate the role of ethnobotany as an interdisciplinary science. Explain the methodology of ethnobotanical studies, including fieldwork, herbarium, ancient literature, archaeological findings, and temples and sacred groves.

Short Type Questions:

1. Define the term "hierarchical classification" in plant taxonomy.
2. What are the main differences between artificial and natural classification systems?
3. Provide a brief account of Bessey's system of classification.
4. Explain the concept of numerical taxonomy and its merits and demerits.
5. What are the salient features of the angiosperm group Magnollidae?
6. Describe the evolutionary significance of the fossil angiosperm Amborella.
7. What are the key phytochemical pathways in molecular systematics?
8. Outline the scope and objectives of ethnobotany.

Suggested Readings:

1: Alston, R. E., & Turner, B. L. (1963). Biochemical systematics. Prentice Hall.
2: Bailey, L. H. (1949). Manual of cultivated plants (2nd ed.). Macmillan.
3: Beck, C. B. (Ed.). (1976). Origin and early evolution of angiosperms. Columbia University Press.
4: Beck, C. B. (Ed.). (1976). Origin and early evolution of angiosperms. Columbia University Press.
5: Benz, G., & Santesson, J. (Eds.). (1976). Chemistry in botanical classification. Nobel Symposia: Medicine and Natural Science, Academic Press.
6: Corner, E. J. H. (1976). The seeds of dicotyledons (Vols. I & II). Cambridge University Press.
7: Cotton, C. M. (1996). Ethnobotany: Principles and applications. John Wiley & Sons Ltd.
8: Cronquist, A. (1981). An integrated system of classification of flowering plants. Columbia University Press.
9: Cunningham, A. B. (2001). Applied ethnobotany. Earthscan Publishers Ltd.
10: Davis, P. H., & Heywood, V. H. (1963). Principles of angiosperm taxonomy. D. Van Nostrand.
11: Eames, A. J. (1961). Morphology of the angiosperms. McGraw-Hill.
12: Erdtman, G. (1952). Pollen morphology and plant taxonomy: Angiosperms. Almqvist & Wiksell.
13: Evans, W. C. (2009). Trease and Evans' pharmacognosy (16th ed.). Saunders.
14: Harborne, J. B., & Turner, B. L. (1984). Plant chemotaxonomy. Academic Press.
15: Heywood, V. H. (Ed.). (1971). Taxonomy and ecology. Academic Press.
16: Houghton, P. J. (2009). Traditional plant medicines as sources of new drugs. In Trease and Evans' pharmacognosy (16th ed.). Elsevier.
17: Hughes, N. F. (1976). Paleobiology of angiosperm origins. Cambridge University Press.
18: Hutchinson, J. (1959). The families of flowering plants (Vols. I & II). Oxford University Press.
19: Hutchinson, J. (1973). Evolution and phylogeny of flowering plants. Academic Press.
20: Jain, S. K. (1981). Glimpses of Indian ethnobotany. Oxford & IBH Publishing Co. Pvt. Ltd.
21: Judd, W. S., Campbell, C. S., Kellogg, E. A., & Stevens, P. F. (2008). Plant systematics: A phylogenetic approach (3rd ed.). Sinauer Associates, Inc.
22: Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2019). Pharmacognosy. Nirali Prakashan.
23: Kumar, S. (1997). Chromosome atlas of the flowering plants of the Indian subcontinent. International Book Distributors.
24: Lawrence, G. H. M. (1951). Taxonomy of vascular plants. Macmillan.
25: Moreira, M. (1992). An introduction to ethnobotany. Moredale Publishing.
26: Naik, V. N. (1984). Taxonomy of angiosperms. Tata McGraw-Hill.
27: Saldhana, C. J., & Rao, C. K. (1977). A punched card key to the dicot families of South India.

Arvind Publishers.
28: Sneath, P. H. A., & Sokal, R. R. (1973). Numerical taxonomy: The principles and practice of numerical classification. W.H. Freeman & Co.
29: Solbrig, O. T. (1970). Evolution and systematics. Macmillan.
30: Sporne, K. R. (1974). Morphology of angiosperms. Hutchinson.
31: Swain, T. (1973). Comparative phytochemistry. Academic Press.
32: Takhtajan, A. (1969). Flowering plants: Origin and dispersal. Oliver & Boyd.
33: Voss, E. G. (Ed.). (1983). International code of botanical nomenclature. Regnum Vegetabile, Utrecht.
34: Young, D. J., & Seigler, D. S. (1981). Phytochemistry and angiosperm phylogeny. Praeger.

Digital Resources:

5: https://learn.concord.org/
6: https://learn.concord.org/eresources/1274.run_resource_html
7: https://learn.concord.org/eresources/3013.run_resource_html
8: https://www.google.com.in

Additional Indian References:

4: Singh, G., & Jain, S. K. (2013). Ethnobotany: The renaissance of traditional herbal medicine. Scientific Publishers.
5: Khare, C. P. (2007). Indian medicinal plants: An illustrated dictionary. Springer.
6: Warrier, P. K., Nambiar, V. P. K., & Ramankutty, C. (1995). Indian medicinal plants: A compendium of 500 species (Vols. 1-5). Orient Longman.

PRACTICALS:

MAJOR EXERCISES:

Major 1: Angiosperms : 1) Technical description of plant species available locally and identification upto family(Dicot and Monocot)
Major 2: . Study of species belonging to single genus and preparation of key at genus level
Major 3: . Field, herbarium methods and preparation of herbarium, museum specimens.(Students are required to submit at least twenty digital specimens).
Major 4: Handling of taxonomic softwares

MINOR EXERCISES:

Minor 1: Use of floras and manuals for plant identifications
Minor 2: Field visits for taxonomic study (minimum -2)..
Minor 3: Indentification of families studied based on flowers or essential parts of flowers

DSE-I -Molecular Systematics of Plants-III

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.5	III	BOT104B	Molecular Systematics of Plants-III	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Outcomes:

This course covers state-of-the-art methods for reconstructing phylogenies. We will cover the theoretical basis for different phylogenetic analyses and learn how to use some of the software packages available for conducting these analyses. Inferences that rely heavily on phylogenetic trees (eg. analyses of character evolution, divergence time estimation, and studies of diversification rates) will also be covered.

Unit-I	1.1. Fine structure of gene, split genes, pseudogenes, non-coding genes, orthologous and paralogous genes, overlapping genes. 1.2 Multi-gene families: evolution, types and examples.
Unit-II	2.1. Genome sequencing: methods of genome sequencing; analysis of sequenced data, 2.1. Genome size: variation of genome size; associated factors and methods for assessment of variation.
Unit-III	3.1. Physical mapping of genes on chromosomes: Restriction mapping, FISH, STS, ESTs, SSLPs, and Random Genomic Sequences. Genetic Linkage Mapping. 3.2. Difference between genetic and physical map.
Unit-IV	4.1. Genetic markers: RAPD, RFLP, AFLP, SNPs. SSR, ISSR. 4.2. Examples of molecular studies, Grass genome, Tetraploid Cotton, Arabidopsis genome.
Unit-V	5.1. Herbaria and herbarium techniques: methods of plants collection; documentation; preparation and preservation of herbarium specimens. 5.2. Virtual herbarium; major herbaria of the world and India. Vouchers in molecular systematic studies.
Unit-VI	6.1. Numerical Taxonomy: Phenetic and cladistic methods, pleiomorphic and apomorphic characters, Determination of Similarity Index and Dissimilarity Index. 6.2. Concepts of Analogy, Parallelism and convergence, Monophyly, Paraphyly and polyphyly.

Suggested Reading:

1. Retrieving, viewing and printing of the specific protein sequence (by accession no. or name) using a public database site.
2. Exploring the NCBI, ExPASy, www.ebi.ac.uk/Tools etc. websites for information and tools available there.
3. Pairwise alignment of Protein and DNA sequences & data interpretation.
4. Local and global alignment of sequence data and comparing both results.
5. Retrieving DNA and/or protein sequences of a given item (by name or accession number) from GENBANK. Performing a sequence similarity search using the BLAST.
6. Retrieving this protein sequence of a given organism and downloading the structure of this protein from existing database. Short-listing protein sequences of highest similarity from the list of BLAST search result and doing a multiple sequence alignment (Using CLUSTALW). Finding out the regions of exact/good match in the protein sequences of these sequences.
7. Aligning nucleotide sequences; designing a degenerate primer of 20 bases from nucleotide alignment data, and calculate the level of degeneracy of this primer.
8. Learning about the Phylip/MEGA program and its uses for the construction of phylogenetic trees.
9. Searching and downloading protein structure data using Entrez. Viewing the structure using public domain software.
10. Protein structures: Visualizing and analysis of inter atomic distances, H-bond calculations, secondary structure analysis and salt bridge analysis of protein structures using different software. Prediction of 3D structure of protein.

11. Angiosperm Phylogeny Group (2003) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. Botanical Journal of the Linnaean Society 141: 399-436.
12. Cracknell AP, Hayes L (2009) Introduction to Remote Sensing. CRC Press, Boca Raton, USA (Special Indian Edition).
13. Crawford DJ (2003) Plant Molecular Systematics. Cambridge University Press, Cambridge, UK.
14. Cronquist A (1981). An integrated system of classification of flowering plants. Columbia Evolution. Taylor and Francis, London.
15. Jain S.K. (1995). Manual of Ethnobotany. Scientific Publisher; Second edition (1995).
16. Judd WS, Campbell CS, Kellogg EA, Stevens PA and Donoghue MJ (2002). Plant Systematics: A Phylogenetic Approach. Sinauer Associaes, Inc., Massachusetts.
17. Nei M and Kumar S (2000). Molecular Evolution and Phylogenetics. Oxford University Press, New York. 8. Raven PH, Begr LR, Hassenzahl DM (2008). Environment. 6th edition. John Wiley & Sons, Inc., New York. Semple C and Steel MA (2003). Phylogenetics. Oxford University Press, Oxford.
18. Simpson MG (2006). Plant Systematics. Elsevier, Amsterdam.

Learning Outcome:

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

1. Structure of Genes
2. Phylogenetic analysis
3. DNA Barcoding

Laboratory Exercises:

1. Isolation of genomic DNA by using CTAB method
2. PCR amplification of specific gene markers
3. Construction of genetic map using given data.
4. Construction of physical map using given data.
5. Preparation of herbarium by using locally available plant flora.
6. Prepare a short report on virtual herbaria of world and India.
7. Determination of similarity and dissimilarity index by using appropriate software's.
8. Construction of phylogenetic tree and describe with labels.

DSE-I -Plant Tissue Culture-III

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.5	III	BOT 104C	Plant Tissue Culture-III	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Outcomes:

On completion of the course, the student should be able to

1. Learn the various methods of in vitro cultures and applicability of subject in terms of employability generation.
2. Understand the various opportunities, challenges and prospective through learning

Unit-I	1.1 Somatic hybridization – methods, selection of hybrids,advantages and applications. 1.2 Role of Somatic Hybrids and Cybrids in plantimprovement; 1.3 Cybridization and production of cybrids.
Unit-II	2.1 Plant Protoplast Culture: History, Principle, types. Isolation and Purification techniques. 2.2 Protoplast fusion,regeneration of protoplast, Viability tests, 2.3 Application/s and factors affecting protoplast culture.
Unit-III	3.1 Germplasm preservation: methods, techniques and importance. Storage techniques, equipment, cryopreservation and tissue culture components used for storage 3.2 Challenges and limitations of germplasm conservation 3.3 Cryopreservation-methods, cryoprotectants, freeze preservation technology and applications
Unit-IV	4.1 Transgenic plants: Introduction, advantages and limitations 4.2 *Agrobacterium tumefaciens* mediated, *Agrobacterium rhizogenes* mediated transformation. Binary vector system, plasmid designing. 4.3 Selection of transformants: Selectable markers, reporter gene and promoter in plant vectors.
Unit-V	5.1 Virus mediated transformation, types and applications incrop biology. 5.2 Direct Gene transfer methods: Physical and Chemicalmethods. 5.3 Selection and identification of transformed cells; 5.4 Transgenic plants; its production, case studies, prospectsand problems.
Unit-VI	6.1 Phytochemistry: primary and secondary metabolites, medicinally important phytoconstituents, 6.2 Biotransformation and bioreactors: concept, andapplications. 6.3 Industrial application of plant tissue culture forproduction of Secondary metabolites.

Suggested Readings:

1. Slater, A., Scott, N. W., & Fowler, M. R. (2004). Plant biotechnology: The genetic manipulation of plants (1st ed.). New York, NY: Oxford University Press.
2. George, E. F. (2007). Plant propagation by tissue culture: Vol. 1. The background. New York, NY: Springer.
3. Vasil, I. K. (1980). Cell culture and somatic cell genetics of plants. New York, NY: Academic Press Inc.
4. Pierik, R. L. M. (1987). In vitro culture of higher plants. Boston, MA: Martinus Nijhoff Publishers.
5. De, K. (1997). An introduction to plant tissue culture. Calcutta, India: New Central Book Agency.
6. Wolfenbarger, L. L. (2003). Environmental and ecological impacts from transgenic plants: Unintended effects. Blacksburg, VA: Information Systems for Biotechnology, Virginia Tech.

7. Varshney, R. K., & Tuberosa, R. (2007). Genomics-assisted crop improvement. Dordrecht, The Netherlands: Springer.

Learning Outcome:

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

1. Acquires the In vitro culture skills and understand the applicability towards job opportunities
2. Understand the transgenic plants, techniques for development of transgenic plants, challenges and Opportunities

Laboratory Exercises

1. Aseptic culture techniques for establishment and maintenance of cultures
2. To study Somatic hybridization techniques
3. Culturing of A. tumefacians
4. Isolation of Ti Plasmid
5. Production of hybrids and cybrids
6. To study techniques of isolation of protoplast from intact leaves
7. To study the Protoplast fusion
8. Protoplast viability test
9. Physical method of gene transfer
10. Principle and working of bioreactors
11. Visit to laboratory/Industry/Assignment

DSE-I -Advanced Plant Physiology-III

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.5	III	BOT 104D	Advanced Plant Physiology-III	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. Understand the processes of mineral and nitrogen assimilation in plants, including the roles of nitrate reductase, ammonium assimilation, and transamination reactions.
2. Explore biological nitrogen fixation (BNF) in free-living and symbiotic organisms, including the role of Nod factors, Nif genes, and nitrogenase enzyme complex.
3. Investigate the biosynthesis, storage, functions, and roles of various plant secondary metabolites such as flavonoids, phenolics, and terpenoids.
4. Analyze plant responses to herbivory, including constitutive and induced defense mechanisms, and biochemical mechanisms of allelopathy.
5. Study the molecular foundations of floral diversity, including the role of MADS box genes, epigenetic modifications, and environmental impacts on flower development.

Course Outcomes:

CO 1: Explain the assimilation of nitrite, nitrate, and ammonium in plants and the roles of asparagine and glutamine in linking carbon and nitrogen metabolism.

CO 2: Describe the mechanisms and applications of biological nitrogen fixation for crop improvement and the assimilation of sulfur and phosphate.

CO 3: Analyze the biosynthesis, storage, and functions of plant secondary metabolites and their roles in plant-microbe and plant-plant interactions.

CO 4: Evaluate plant defense mechanisms against herbivory, including constitutive and induced phytochemical responses and allelopathy.

CO 5: Discuss the challenges and molecular foundations of floral diversity, including the roles of MADS box genes and hormone signaling in flower development.

CO 6: Assess the evolutionary basis of rewards for pollination, epigenetic modifications, and environmental plasticity under abiotic stresses affecting flowering and pollen development.

Unit-I	**Assimilation of Mineral and Nitrogen Fixation** Assimilation of nitrite, nitrate reductase role, ammonium assimilation; transamination reactions; asparagine and glutamine link carbon and nitrogen metabolism
Unit-II	**Assimilation of Mineral and Nitrogen Fixation** Biological Nitrogen Fixation (BNF); Free-living and symbiotic nitrogen fixation, Nodfactors, Nifgenes, symbiosis; nitrogenase enzyme complex, Carbon and nitrogen (C/N)balance signaling in plants underelevated CO2 condition. Application of BNF for crop improvement. Sulfur and phosphate Assimilation.
Unit-III	**Plant secondary metabolites:** Biosynthesis, storage, functions and role of flavonoids, phenolics, terpenoids, alkaloids, steroids, anthocyanin, Coumarins and lignin; plant- microbe interaction; plant-plant interaction; Antinutritional factors.
Unit-IV	**Plant responses:** Plant responses to herbivory; constitutive defense mechanisms; induced phytochemical responses; biochemical mechanisms of allelopathy.
Unit-V	**Flowering challenges and Molecular foundations of floral diversity** Flowering challenges, evolutionary basis of rewards for pollination, epigenetic modifications; environmental plasticity under abiotic stresses; impact on pollen development; carbohydrate metabolism; induction of hormone signaling etc.
Unit-VI	**Flowering challenges and Molecular foundations of floral diversity** Origins of floral diversity; MADSbox genes cluster; Homologs of ABCDE genes; Duplications of class Egenes; Role of MADS box genes in variations of floral morphology; Downstream targets of floral development genes; role of Nozzle/ Sporocyteless, Rabbitears(RBE), Superman(SUP) genes in flower development.

Suggested Reading:

1. Davies,P.J.(2004).Plant Hormones: Biosynthesis,SignalTransduction, Action. 3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands.
2. Jordan,B.R.(2006).The Molecular Biologyand Biotechnology of Flowering, 2nd Edition, CAB International, Oxfordshire, U.K.
3. Nelson,D.L.andCox,M.M.(2008).Lehninger Principles of Biochemistry(5thed.).New York
4. Buchanan,Gruissemand Jones.2002.Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.
5. Annual Review of Plant Biology (formerly Annual Review of Plant Physiology and Plant Molecular Biology).
6. **BASIC REFERENCES:** Alberts et al., Molecular Biology of the Cell (parts related to plants); Salisbury and Ross, Plant Physiology; Taiz and Zeiger, Plant Physiology; Hopkins and Huner, Introduction to Plant Physiology.
7. **CURRENTLITERATURE**(JOURNALARTICLES):PlantPhysiology,The Plant Cell, Journal of Plant Physiology, Physiologia Plantarum, Plant Physiology and Biochemistry, Postharvest Biology and Technology, Hortscience, Journal of the American Society for Horticultural Science, Science, Nature, Scientific American etc.
8. Many plant physiology journals can beviewed viathe net. TheURL ofoneof the sites listing these journals is: http://www.e-journals.org/botany/

List of Laboratory Experiments:

1. Bioassay of Gibberllins- Amylase release test from seeds
2. Effects of high light intensity on chloroplast activities
3. Estimation of peroxidase activity
4. Estimation of Relative Water Content (RWC)
5. Estimation of Rubisco by ELISA
6. Estimation of Sodium,Potassium & Calcium in plant material byFlame-photometry.
7. Estimation of Stomatal Index and Stomatal Frqeuency
8. Estimation of SuperOxide Dismutase,Catalase and Peroxidase
9. Isolation of plant genomic DNA, estimation by UV spectroscopy.
10. Isolation of plant total RNA,estimation byUV spectroscopy and gel electrophoresis.
11. SDS-PAGE analysis of proteins
12. Separation of esters and perioxidases by native PAGE.
13. The determination of secondary metabolites by TLC or HPTLC
14. To Demonstrate the Activity of Catalase and Study the Effect of pH and Enzyme Concentration
15. To Study the Effect of Light Intensity and Bicarbonate concentration on O2 Evolution in Photosynthesis
16. The separation of amino acids by two dimensional chromatography
17. Demonstration of phototropism, geotropism, hydrotropism& seismonasty Analysis for total nitrogen (organic nitrogen) in plant tissues
18. Measurement of leaf area Leaf area index. and leaf thickness

DSE-I -Basic and Applied Mycology-III

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.5	III	BOT 104E	Basic and Applied Mycology-III	3	45	3 Hrs	40 (Int) + 60 (Ext)

Cos:

CO 1: Understand the basic concepts, importance, and historical developments in plant pathology, including the classification of plant diseases based on their causes (Biotic and Abiotic).

CO 2: Explain the mechanisms involved in plant infection, disease development, disease physiology, and epidemiology, and describe the defense mechanisms in plants against pathogens.

CO 3: Apply principles and methods of disease management, including regulatory, cultural, biological, and chemical control practices, and understand the historical context and guidelines of plant quarantine.

CO 4: Identify and analyze fungal diseases affecting cereals, oilseeds, and seeds, including the management and control measures for diseases like rust, smuts, and blight in various crops.

CO 5: Assess the impact of fungal diseases on vegetables and fruits, and evaluate post-harvest diseases and their control measures for crops like tomato, potato, citrus, and mango.

CO 6: Evaluate bacterial, viral, and phytoplasmal diseases affecting various crops, and propose effective control measures for diseases such as blight, soft rot, mosaic, leaf curl, and little leaf of brinjal.

Unit-I: Basics in Plant Pathology

1.1: Introduction to plant pathology and its importance
1.2: Historical developments in plant pathology
1.3: Plant Pathology in India
1.4: Symptoms of plant diseases
1.5: Classification of plant diseases based on causes (Biotic and Abiotic)

Unit-II: Mechanism of Plant Infection

2.1: Infection process
2.2: Disease development
2.3: Disease physiology
2.4: Epidemiology
2.5: Defence mechanism- pre-existing (passive), induced biochemical mechanism (phenolic compounds, phytoalexins)

Unit-III: Disease management

3.1: Principles of disease management
3.2: Regulatory methods- Brief history of quarantine, international organizations, plant quarantine in India, guidelines for import of germplasm
3.3: Methods of disease management- cultural practices, biological control, chemical control

Unit-IV: Fungal diseases, control of cereals, oilseeds, and seed pathology

4.1: Diseases of cereals - Rust and smuts of wheat, blight of rice, smuts and leaf spot of Jowar, ergot, green ear of Bajra.
4.2: Important diseases of oil seed crops -Soyabean, Groundnut, Sunflower, and Mustard.
4.3: Seed pathology- seed-borne diseases in vegetables, seed diseases caused by fungi, seed management

Unit-V: Important fungal diseases, control of vegetables & fruits.

5.1: Diseases of vegetables - Tomato, Potato, Bhindi, and cucurbits.
5.2: Diseases of Fruit crops - Citrus, Banana, Mango, and grapes.
5.3: General account of post-harvest diseases of vegetables and fruits and their control.

Unit-VI: Bacterial and Viral diseases and control measures

6.1: Bacterial diseases- Blight of rice, Tundu disease of wheat, Angular leaf spot of cotton, soft rot of fruits.
6.2: Viral diseases - Mosaic and leaf curl of Papaya, Yellow vein mosaic of Bhindi, Viral diseases of Tomato
6.3: Phytoplasmal diseases - little leaf of Brinjal, Grassy shoot of sugarcane, & Sesamum Phyllody

Suggested Reading:

1. Agrios, G. N. (1980). *Plant pathology*. New York, NY: Academic Press, Inc.
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4. Alexopoulos, C. J., & Mims, C. W. (1979). *Introductory mycology* (3rd ed.). New York, NY: John Wiley & Sons, Inc.
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16. Dube, R. C., & Maheshwari, D. K. (2000). *Practical microbiology*. New Delhi, India: S. Chand & Co. Ltd.
17. Gruen, H. E. (1959). The production of IAA by Phycomyces blakesleeanus. *Mycologia*, 57, 683-694.
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19. Jha, D. K. (1993). *A textbook of seed pathology*. New Delhi, India: Vikas Publication House.
20. Rao, K. M., & Mahadevan, A. (Eds.). (1997). *Recent developments in biocontrol of plant pathogens*. New Delhi, India: Today and Tomorrow Publishers.
21. Mehrotra, R. S., & Aneja, K. R. (1990). *An introduction to mycology*. New Delhi, India: Wiley Eastern Private Limited.
22. Mehrotra, R. S. (1989). *Plant pathology*. New Delhi, India: Tata McGraw-Hill.
23. Mehrotra, R. S., & Aneja, K. R. (1998). *An introduction to mycology*. New Delhi, India: New Age Intermediate Press.
24. Mukadam, D. S. (1997). *The illustrated kingdom of fungi*. Aurangabad, India: Akshar Ganga Prakashan.
25. Mukadam, D. S., & Gangawane, L. V. (1978). (Eds.). *Experimental plant pathology*. Aurangabad, India: Marathwada University.
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52. Singh, R. P. (1997). *Plant pathology*. Allahabad, India: Central Book Depot.
53. Sambamurty, A. V. S. S. (2006). *A textbook of plant pathology*. New Delhi, India: IK International.
54. Neergaard, P. (2005). *Seed pathology* (Vols. I & II). London, UK: Palgrave Macmillan Press.

Learning Outcome:

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

1. Identify and diagnose plant diseases accurately.
2. Analyze the impact of plant diseases on agriculture and the ecosystem.
3. Develop sustainable and environmentally friendly approaches to plant disease management.
4. Students will get job opportunities in the agriculture and seed industries.

Laboratory Exercises

Major Experiments:

1. Establishment of disease and testing for resistance (Root inoculation, Stem inoculation, Leaf inoculation, Seed inoculation).
2. Preparation of different cultural media for the cultivation of Fungi and Bacteria.
3. Isolation and identification of soil-borne fungi responsible for rot, and wilt diseases (Warcup and Waksman method).
4. Study of toxicity of fungi in relation to seed germination, and seedling abnormality.
5. Detection of pathogens associated with seeds (Examination of dry seeds, Blotter Test, Agar Test, Seedling symptom test).
6. Isolation of external and internal seed-borne mycoflora by blotter and Agar Plate method (Cereals, pulses, oil seeds, fruit seeds).
7. Monographic study of locally available plant diseases caused by fungi (at least 10).
8. Study of locally available crop plant diseases caused by Bacteria (at least 5).
9. Study of locally available plant diseases caused by viruses & Phytoplasma (at least 5).
10. Demonstration of morphological & physiological changes in disease plants.
11. Demonstration of Koch's Postulate.
12. Preparation and presentation of the herbarium of pathological specimens available in the region (at least 30).
13. Preparation of Fungal spore atlas.

Minor Experiments:

1. Principles & working of tools, equipment, and other requirements in the Mycology & Plant Pathology laboratory.
2. Slide preparation, Staining, Micrometry, and measurement of organisms.
3. Sterilization Processes viz. moist heat, dry heat, flame, chemical, and radiation.
4. Drawing of Camera Lucida diagrams and knowledge of computer-based microphotography and image processing.
5. Visit to Mushroom industry, Pharmaceutical, seed industries & Pathological study center.
6. Visit to different localities for pathogenic studies (Forests, Fields, Research fields, Nurseries, Gardens).
7. Visit to Agriculture University, Plant Pathological research centers, and Seed stations.
8. Maintain field diary and photographic collection.

Model Questions:

Long Questions (10 Marks)

1. Discuss the historical developments in plant pathology and its significance in modern agriculture.
2. Describe the infection process, disease development, and defense mechanisms in plants against pathogens.
3. Explain the principles of disease management, including regulatory methods, and cultural, biological, and chemical control practices.
4. Analyze the impact and control measures of fungal diseases affecting cereals and oilseed crops, with specific examples from wheat, rice, soybean, and mustard.

Short Questions (05 Marks)

1. Describe the symptoms of plant diseases and their classification based on biotic and abiotic causes.
2. Explain the role of epidemiology in plant pathology and disease management.
3. Discuss the guidelines for plant quarantine in India and their importance in disease management.
4. Outline the post-harvest diseases of vegetables and fruits and their control measures.

Short Questions (03 Marks)

1. What is the significance of plant pathology in India?
2. Briefly describe the induced biochemical defense mechanisms in plants.
3. Identify the common bacterial diseases affecting rice and cotton.
4. List the phytoplasmal diseases affecting brinjal, sugarcane, and sesame.

DSE-I -Molecular Biology, Biotechnology & Plant Breeding-III

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.5	III	BOT104F	Molecular Biology, Biotechnology & Plant Breeding-III	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

On completion of the course, the student should be able to:

1. To learn the basic principles of molecular biology, biotechnology & plant breeding
2. To demonstrate the methods in molecular biology, biotechnology & plant breeding
3. Understand the applicability of molecular biology, biotechnology & plant breeding in relation to present-day problems.
4. To gain the Knowledge about laboratory organization for molecular biology and biotechnology.

Course Outcomes:

CO 1: Acquire theoretical knowledge in the tools, techniques, applications and safety measures in the field of genetic engineering.

CO 2: Describes and analyze the genome mapping and sequencing methods

CO 3: Describe the mechanism of action and the use of restriction enzymes in biotechnology research and recombinant protein production.

CO 4: Improvise/Create various new methods for the improvement of self and cross-pollinated crops.

Detailed Curriculum:

Unit – I: Transcription:

1.2 Prokaryotic transcription:

1.1.1 Transcription unit – (start site, upstream promoter regions, terminator).

1.1.2 Structure and function of RNA polymerases, sigma factors.

1.1.3 Mechanism of transcription-initiation, elongation and termination (Rho-dependent and independent termination).

1.1.4 Anti-termination and inhibitors of transcription.

1.2 Eukaryotic transcription

1.2.1 RNA polymerases I, II, III - structure and assembly.

1.2.2 Basal transcription apparatus for the three polymerases with specific promoters and transcription factors,

1.2.3 Transcriptional factors – general features, motifs - zinc fingers, leucine zippers, helix-turn helix, homeodomains etc.

1.2.5 Post-transcriptional Modification: Splicing and RNA editing

Unit – II: Translation:

2.1.1 Translation machinery – ribosomes; charging of tRNA molecules and formation of aminoacyl tRNA.

2.1.2 Mechanism of translation - initiation, elongation, and termination,

2.1.3 Posttranslational modifications of proteins – glycosylation, amidation, lipidation, processing of pre- proteins

2.1.4 Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation,

2.1.5 Inhibitors of protein translation.

2.1.6 Genetic code – Universality and degeneracy, Wobble hypothesis,

Unit – III: Nucleic Acid sequencing, DNA Microarray and DNA Profiling

4.1 Nucleic acid sequencing:

4.1.1 Sequencing of nucleic acids by Maxum & Gilbert method

4.1.2 Sequencing of nucleic acid by Sangers method.

4.2 DNA microarray:

4.2.1 Principle of DNA microarray technique.

4.2.2 Types of DNA microarrays (cDNA-based microarray and Oligonucleotide-based microarrays)

4.2.3 Applications of Microarrays.

4.3.1 DNA Profiling:

4.3.1 Principles of DNA Profiling

4.3.2 Methods of DNA Profiling (RFLP-based and PCR-based)

4.3.3 Applications of DNA profiling.

Unit – IV: Restriction mapping:

4.1 Construction of restriction map,
4.2 analysis of restriction fragments and their application.
4.3 cDNA synthesis: mRNA enrichment, digestion using restriction enzymes or mechanical shearing,
4.4 Selection of appropriate vector, preparation of genomic library, use of linkers and adapters,
4.5 Method of screening of library and chromosome walking and chromosome jumping strategies.
4.6 STS tagging.

Unit – V: Plant breeding for crop improvement

5.1 Plant breeding for improvement of self-pollinated Crops

5.1.1 Pire line Selection Method
5.1.2 Mass selection method
5.1.3 Hybridization (Pedigree, back cross and bulk methods)

5.2 Breeding for vegetatively propagated plants

5.2.1 Clonal Selection method
5.2.2 Distant hybridization method
5.2.3 Other in-vitro techniques

Unit – VI: Plant Breeding for Crop improvement

6.1 Plant breeding for improvement of cross-pollinated crops: Introduction
6.1.1 Mass selection method
6.1.2 Progeny selection method
6.1.3 Recurrent selection method (Simple recurrent, Recurrent selection for GCA & SCA and reciprocal recurrent selection.
6.1.4 Hybridization (Interspecific and inter-varietal hybridization)
6.1.5 Genetical and Physiological Basis of Heterosis and Inbreeding,

Proposed Pedagogies:

1. **Teaching Methodologies:** Lecture, Direct Instructions, Demonstrations and technology-based teaching.
2. **Learning Methodologies:** Reading and writing, Auditory Learning, Visual Learning, Kinesthetic and Interpersonal learning.
3. **Evaluation Methodologies:** Formative, Summative and Outcome based evaluation.

Special Instructions (If Any):

Bibliography:

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3. Kaufman, P. B., Wu, W., Kim, D., & Cseke, L. J. (1995). *Molecular and cellular methods in biology and medicine*. CRC Press, Florida.
4. Kingsman, S. M., & Kingsman, A. J. (1998). *Genetic engineering: An introduction to gene analysis and exploitation in eukaryotes*. Blackwell Scientific Publications, Oxford.
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6. Sharma, J. R. (2001). *Principles and practice of plant breeding*. Tata McGraw-Hill.
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10. Singh, S., & Pawar, I. S. (2006). *Genetic bases and methods of plant breeding*. CBS Publication, New Delhi.
11. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2015). *Molecular biology of the gene* (7th ed.). Benjamin-Cummins Publishing Co.

Model Questions:

Long Type: (For 10 Marks)

1) Discuss the mechanism of prokaryotic transcription.
2) Give details of eukaryotic transcription mechanism.
3) Give details of translation mechanism.

4) Discuss post-translational modification in detail.
5) Explain Maxim and Gilbert's method of DNA sequencing.
6) Discuss principles, techniques, and applications of DNA microarray.
7) Give details of DNA profiling.
8) Elaborate on how to construct a restriction map of a given sequence.
9) Explain various plant breeding methods used for the improvement of self-pollinated crops
10) Explain various methods of plant breeding used for improvement of cross-pollinated crops.

Long Type: (For 05 marks)

1) Give detail account of structure and function of RNA polymerase
2) Discuss the mechanism of transcription termination
3) Discuss various transcription factors in Eukaryotes
4) Explain initiation and elongation of translation
5) Explain protein turnover and degradation
6) Discuss properties of genetic code
7) Give brief account of Sangers method of DNA sequencing
8) Discuss different types of DNA microarrays
9) Discuss DNA profiling in detail
10) Explain preparation of genomic libraries
11) Give details of STS tagging
12) Discuss pure line selection and its applications.
13) Explain clonal selection and its advantages.
14) Discuss recurrent selection method.
15) Explain genetic basis of inbreeding and heterosis

Short type questions: (3/4 marks)

1) Transcription Unit
2) Sigma factor
3) Transcription inhibitor
4) Assembly of RNA polymerase III
5) Lucine zippers
6) RNA editing
7) Protein stability
8) Wobbel hypothesis
9) Molecular chaperons
10) Applications of DNA microarray
11) Principle of DNA profiling
12) Applications of DNA profiling
13) Linkers and adaptors
14) Chromosome walking
15) Chromosome jumping
16) Mass selection
17) Bulk method
18) Progeny selection
19) Interspecific hybridization
20) Intervarietal hybridization

PRACTICALS:

MAJOR EXERCISES:

Major 1: Agarose gel electrophoresis
Major 2: Sodium–dodecyl–sulfide polyacrylamide gel electrophoresis
Major 3: Restriction Digestion of Plasmid DNA
Major 4: Emasculation and hybridization in self-pollinated plants
Major 5: Emasculation and hybridization in cross-pollinated plants
Major 6: Study of germplasm of various crops
Major 7: Blotting techniques (Western/ Northern/ Southern)

MINOR EXERCISES:

Minor 1: Preparation of various buffers required for gel electrophoresis
Minor 2: Preparation of various reagents required for SDS- PAGE
Minor 3: Demonstration of prokaryotic/ eukaryotic transcription (Live model/ audio-visuals)
Minor 4: Demonstration of translation (Live model/ audio visuals)
Minor 5: Emasculation for hybridization purpose.

Lab – V: based on DSC-I.3 and DSC-II.3 (Paleobotany and Evolution of Gymnosperms and Systematics and Taxonomy of Angiosperms)

Level	Semester	Course Name	Credits	Practical Hours	Exam Duration	Max Marks
6.5	III	Paleobotany, Evolution of Gymnosperms and Origin of Angiosperms and Systematics and Taxonomy of Angiosperms	2	60	6 Hrs	50 (Int) + 50 (Ext)

Practical Question Paper

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
PRACTICAL EXAMINATION
M.Sc. II (Botany), SEMESTER – III (NEP) DSC-I.2 & II.2
PRACTICAL V:
Paleobotany, Evolution of Gymnosperms and Origin of Angiosperms and Systematics and Taxonomy of Angiosperms

Time: 6 hrs. **Marks:** 50

Q.1: Morphology and Identification of Gymnosperm. 10M
Q.2: Morphology and Identification of Angiosperm 10M
Q.3: Identify and Describe the given Fossil material 10M
Q.4. Prepare Key at Genus Level 05M
Q.5. Perform Any ONE exercise of Tissue Identification. 05M
Q.6. Spotting (Gymnosperm, Paleobotany and Angiosperm) 10M

Lab – VI: based on DSC-III.3 AND DSE Opted by Student

Level	Semester	Course Name	Credits	Practical Hours	Exam Duration	Max Marks
6.5	III	Diversity Conservation, Ethnobotany, Palynology and Phytogeography AND DSE Opted by Student	2	60	6 Hrs	50 (Int) + 50 (Ext)

Practical Question Paper

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
PRACTICAL EXAMINATION
M.Sc. II (Botany), SEMESTER – III (NEP) DSC-III.3 & DSE
PRACTICAL VI
Diversity Conservation, Ethnobotany, Palynology and Phytogeography AND DSE Opted by Student

Time: 6 hrs. **Marks:** 50

Part A
Diversity Conservation, Ethnobotany, Palynology and Phytogeography

Q1. Explore the Ethnomedicinal attribute of given plant sample 10M
Q2. Prepare the Creative Plant distribution Map 05M
Q3. Perform any one propagation technique 05M
Q4. Principle and working of Any One Remote Sensing tool 05M

Part B
DSE: _____

Q1. Question based on Major Exercises (Any Two) 20 M
Q2. Question based on Minor Exercises (Any One) 05 M

TWO YEAR POSTGRADUATE PROGRAMME

M.Sc. BOTANY

FACULTY: SCIENCE AND TECHNOLOGY

SEMESTER – IV COURSES

S. N.	Subject
1	DSC-I.4 Applied Botany
2	DSC-II.4 Plant Ecology and Environmental Dynamics
3	DSC- III.4 Plant Biotechnology and Genetic Engineering
4	DSE-III Anyone Opted by Student / MOOC (Elective Option)
4a	DSE-II -Angiosperm Taxonomy, Phytochemistry and Pharmacognosy-IV
4b	DSE-III -Molecular Systematics of Plants- IV
4c	DSE- III -Plant Tissue Culture- IV
4d	DSE-III-Advanced Plant Physiology- IV
4e	DSE-III -Basic and Applied Mycology- IV
4f	DSE-II -Molecular Biology, Biotechnology &Plant Breeding- IV
5	Lab –VII: based on DSC-I.4, DSC-II.4, DSC III.4 and DSE Opted by Student – a. Angiosperm Taxonomy, Phytochemistry and Pharmacognosy- IV b. Molecular Systematics of Plants- IV c. Plant Tissue Culture- IV d. Advanced Plant Physiology - IV e. Basic and Applied Mycology- IV f. Molecular Biology Biotechnology & Plant Breeding- IV
9	Lab – VIII: Research Project Phase-II

DSC-I.4 Applied Botany

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.5	IV	BOT401	Applied Botany	4	60	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. To create opportunities of self-employment / students startup through botany.
2. To introduce the concepts of experimental design in organic botany, commercial botany novelty in botanicals.
3. To enrich students training and knowledge that would be useful in the Plant based industries
4. To create awareness among the students regarding the scope of botany.

Course Outcomes:

CO 1: Understand the concept of organic botany, commercial botany novelty in botanicals.
CO 2: Understand the Plant Microbe Interaction & Industrial Application
CO 3: Gain knowledge on Commercial botany.
CO 4: Demonstrate different methods Organic farming.
CO 5: Understand the concepts and significance of Plant based industries and application.
CO 6: Access the latest technologies used for Novelty in botanicals.
CO 7: Analyze and compare the plant-based industries.
CO 8: Apply the applied knowledge in Entrepreneurship and startup in Botany.

Detailed Curriculum:

Unit – I: Plant Microbe Interaction & Industrial Application

1.1: Plant Immunity: Host and non-host defenses: Pre-existing and induced structural and chemical defenses
1.2: Signal transduction pathways activated during plant resistance to pathogens, and role of SA and JA signaling
1.3: Biofertilizer: Bacteria as biofertilizer -role in plant growth promotion and alleviation of biotic and abiotic stress, tritrophic interactions & Role in modern agriculture.
1.4: Mycorrhiza as biofertilizer: its role in plant growth promotion & in modern agriculture
1.5: Biopesticides: Sources, processing and value addition.
1.6: Industries, Commercialization, Supply and Marketing of Biofertilizer & Biopesticides

Unit – II: Plant based industries and application

2.1: Introduction, various plant resources, demand & supply in Plant based industries
2.2: Natural dyes: Sources, processing & utilization
2.3: Wood based industry: Sources for Sports goods, toys, pencils, musical instruments etc. manufacturing method and utilization
2.4 : Paper Industry – Plant resources and paper manufacturing
2.5 : Industries, Commercialization, Supply and Marketing in India

Unit – III: Organic Botany

3.1 : Importance, principles and advantages of organic farming
3.2: Organic farming practices: Crop rotation, diversification, composting, vermicomposting, green manuring & biofertilizers.
3.3: IKS in organic farming, biodynamic farming, agroecology & biomass utilization
3.4: Organic farming certification process, organic market trends in India, marketing organic produces, organizations and associations involved
3.5: Government policies and support for organic farming in India, incentives and subsidies & schemes
3.6: Future prospects and opportunities, success stories/case studies, organic producer companies/ farmers/ NGOs

Unit – IV: Commercial Botany

4.1: Tree-borne oilseeds (TBOs): Wild sources, Good Field Collection Practices (GFCPs), processing, value addition and uses.
4.2: Nutraceuticals and food supplements: Wild fruits and vegetables, tubers : sources and commercial utilization
4.3: Herbal medicine: Commercially important herbs, utilization and processing, industrial applications
4.4: Plant-based tourism: Agro, Eco, Health, Forest, etc.
4.5: Industries for nutraceutical, plant-based food supplements and herbal medicine in India

4.6: Future prospects and opportunities, success stories/case studies of herbal, nutraceutical & plant-based tourism.

Unit – V: Novelty in botanicals

5.1: Genomics– Genome Sequencing, Functional Genomics, Comparative Genomics, Epigenomics,

5.2: Transcriptomics and its applications in agriculture.

5.3: Proteomics- Areas of Proteomics, Structural proteomics, Functional proteomics, Expression proteomics, Strategies for protein identification: types of analytical tools, blotting techniques, protein sequencing etc.

5.4: Potentials of proteomics in biotechnology: Case studies related to plant biotechnology. Promises of proteomics

5.5: Metabolomics: Analytical methods for detecting and quantifying metabolites. General workflow and Statistical methods in metabolomics. Pathway and metabolome database, applications and its role in systems biology.

5.6: Inter-relationship between genome, transcriptome, proteome and metabolome

Unit – VI: Scope of Botany

6.1: Scope in Higher Education: Overview on scope of botany, Opportunities for Higher Studies Doctoral, Top Institutes of India and Abroad.

6.2: Scope in Research Institutes after PG – research institutes in India CSIR, ICAR, NBPGR, NEERI, ARI

6.3: Fellowship & Scholarship – Fellowships and Scholarships for Botany students, Ethical and Legal Aspects for research in various research institutes and corporate industries.

6.4: Plant products-based industries – Scope and application in Indian industries, Readiness for entry into Corporate World of Industries, Plant based industries and their skills demands

6.5: Entrepreneurship and startup in Botany: . Opportunities, Scope and Projections, Funding agencies Government and non-government organization for startup in botany, Local and international Business (Case Study - One Each)

Proposed Pedagogies:

2. Teaching Methodologies:

Classroom teaching, power point presentation, group discussions, quiz, visit to various industries, visits to research institutes etc.

3. Learning Methodologies:

Case study, Success story of any one industry person.

4. Evaluation Methodologies:

Assignment, Projects, Internship etc.

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Model Questions:

Long Type for 10 Marks:

1. Explain Signal transduction pathways activated during plant resistance to pathogens, and role of SA in signaling.
2. Describe the Sources and processing for natural dyes preparation.
3. Describe Organic farming certification process and market trends in India.
4. Explain commercially important herbs.
5. Describe the potentials of proteomics in biotechnology and promises of proteomics
6. Describe the Scope and opportunities in Research Institutes in India

Long Type for 05 Marks:

1.Explain the role of Mycorrhiza in plant growth promotion & in modern agriculture.
2.Describe the plant resources use in Paper Industry.
3.Explain the IKS in organic farming
4.Illustrate the Statistical methods in metabolomics.

Short Type for 3/4Marks:

1.Supply chain for Biofertilizer
2.Biopesticides
3.Funding agencies Government and non-government organization for startup in botany.
4.Organic market trends in India
5.Functional Genomics
6.Plant-based tourism
7.Nutraceuticals

PRACTICALS:

Major Exercises:

1. Investigate host and non-host defenses through microscopic examination and chemical assays.
2. Conduct experiments to observe the activation of SA and JA signaling pathways during plant resistance.
3. Cultivate bacteria and prepare biofertilizers; assess their impact on plant growth in controlled conditions.
4. Isolate and culture mycorrhizal fungi; examine their effect on plant growth.
5. Extract biopesticides from plant sources and evaluate their effectiveness against common plant pathogens.
6. Design a mock business plan for the commercialization and marketing of biofertilizers and biopesticides.
7. Extract natural dyes from various plant sources and test their application on different materials.
8. Analyze the properties of different woods used in manufacturing sports goods, toys, and musical instruments.
9. Explore the process of paper manufacturing from plant resources, including pulp preparation and paper formation.
10. Implement organic farming techniques like crop rotation, composting, and vermicomposting in a small-scale setup.
11. Conduct a biodynamic farming experiment, including preparation and application of biodynamic preparations.
12. Extract and analyze active compounds from commercially important herbs.
13. Formulate a nutraceutical product using wild fruits and vegetables; analyze its nutritional content.
14. Perform a basic genome sequencing experiment using model plant organisms.
15. Conduct protein extraction and analysis using techniques like SDS-PAGE and mass spectrometry.

Minor Exercises:

1. Study the structural defenses in plants through microscopic observation.
2. Measure levels of salicylic acid (SA) and jasmonic acid (JA) in plants under stress.
3. Conduct a short-term plant growth experiment using different biofertilizers.
4. Identify different types of mycorrhizal fungi using staining techniques.
5. Test the effectiveness of biopesticides on a small set of common garden pests.
6. Apply natural dyes to fabrics and analyze color fastness.
7. Test the quality and durability of paper produced from different plant sources.
8. Analyze the nutrient content of different compost samples.
9. Set up a small vermicomposting bin and observe the composting process.
10. Identify and document wild edible plants in a local area, noting their potential uses in food supplements.

DSC-II.4 Plant Ecology and Environmental Dynamics

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.5	IV	BOT402	Plant Ecology and Environmental Dynamics	4	60	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. Know about ecology and its types
2. Learn about the importance of ecology
3. Understand the earth's environment, i.e., the Biosphere, Lithosphere, Hydrosphere, and Atmosphere.
4. Know about the ecology of India
5. Know about the conservation of natural resources for sustainable development

Course Outcomes:

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

CO1. To acquire knowledge about structure, functions, and distribution of environmental components.

CO2. To understand the complex interactions between the plant and the earth's biophysical environment.

CO3. To gather information about various parameters of plant communities.

CO4. To classify the various pollutants and their impact on the world.

CO5. To apply the knowledge to resolve present-day environmental issues.

CO6. To assess how anthropogenic and natural factors modify the biophysical environment.

Detailed Curriculum:

UNIT I: Fundamentals of Plant Ecology

1.1: Concept and scope, Origin of ecology, Indian work on ecology, Divisions of ecology.

1.2: Ecological factors- Definition; Types- Temperature, Light, Water; Humidity, Rainfall, Topography.

1.3: Effect of ecological factors- on plant metabolism, growth and development, reproduction, and distribution.

1.4: Edaphic factor- Type of soils, soil formation, soil profile, soil biota, and its role.

1.5: Atmosphere- Definition; Structure, and composition; Effects on plant life.

1.6: Atmospheric interactions- Ozone formation, depletion of the ozone layer; Formation of Clouds (natural and artificial), thunderstorms, and lightning; role in nutrient cycling.

UNIT II: Fundamentals of Plant Ecology

2.1: Morphological and anatomical adaptations in hydrophytes, mesophytes, epiphytes, xerophytes and halophytes.

2.2: Ecosystem Ecology- Concept; Types of ecosystems; Structure, and functions of the ecosystem.

2.3: Food chain- Definition and types; Food web, Ecological pyramids- Definition and types.

2.3: Ecosystem Ecology- Structure of Pond, Forest, Desert, and Cropland ecosystems.

2.4: Major Biomes-distribution, characteristics, and climate; effect of climate change.

2.5: Biogeochemical cycles- Hydrological cycle, Carbon cycle, Nitrogen cycle, Phosphorus cycle, and sulfur cycle; Biochemical dynamics.

2.6: Phytosociology: Community characteristics; Structure and composition; Classification, Stratification, stability, and Evolution; Raunkiaers plant life forms; Ecotypes and Ecads; Keystone species, ecotone and edge-effects; Functional role and niche.

UNIT III: Ecological Dynamics

3.1: Energy flow in ecosystems- Universal model, Single channel energy flow model; Pyramid of energy; Significance of energy flow, Ecosystem productivity.

3.2: Energy economics in the ecosystem; Biodiversity and ecosystem stability; Ecosystem services- Concept and scope, Role of biodiversity.

3.3: Ecological succession- Concept; types and causes of succession; general process of succession.

3.4: Ecological Succession- Stages of Hydrosere and Xerosere; Climax concept, types of climax; Changes in ecosystem properties during succession.

3.5: Population ecology: Population characteristics- Natality, Mortality, Growth curve, Growth forms, Carrying capacity, Age structure; Population growth, dispersion, and regulation; Interspecific relationships of populations- Symbiosis, competition, mutualism, parasitism, allelopathy.

3.6: Plant population study: Field techniques- Monitoring, Sampling; Qualitative, and Quantitative methods, use of remote sensing techniques.

UNIT IV: Global Environmental Challenges

4.1: Pollution – Definition; Types –Air, Water, Soil, Noise, Thermal, Radioactive and Solid waste; sources of pollution;photochemical smog, Acid Rain, Eutrophication, Bioaccumulation, biomagnifications; Control measures.

4.2: Global Climate Change- Greenhouse effect; Evidence and implications of climate change; Effect on Monsoon rainfall in the Indian subcontinent- El Nino, La Nina, anthropogenic activities and climate change.

4.3: Soil erosion- Concept; types and causes of soil erosion; impacts on- ecological degradation, deforestation, loss of species diversity; Applications of remote sensing in soil resource management.

4.4: Biodiversity loss: Causes of biodiversity loss; impact on-the environment, food security, and human health; Impact of invasive species on biodiversity.

4.5: Environmental issues: Deforestation and habitat fragmentation; ice melting and global sea level rise, weather extremes, loss of marine diversity; restoration of degraded land; effects of pollution on biological systems

4.6: Legislation- Wild Life Protection Act, 1972; Water (prevention &control) Act 1974; Forest Conservation Act, 1980; Environmental Protection Act, 1986

UNIT V: Rural and Urban Ecological Advances

5.1: Waste Management- Concept and scope; management of industrial, urban, and agricultural solid waste; biogas generation- Nisargruna technology; Municipal sewage treatment, Bioremediation.

5.2: Energy resources- Hydrogen as a source of energy, energy from biomass, bioconversion technology, energy plantations, and petro-crops; exploitation of new possibilities- solar energy, solar driers.

5.3: Forest resources: As source of NTFP; green certification; community forest management; Ecotourism; Conservation of genetic resources, and landraces of crop plants;

5.4: Environmental impact assessment (EIA)- Concepts, and scope; types of impacts, Advantages & disadvantages; National Environmental Policy Act (NEPA, 1969).

5.5: Environmental auditing: Concept and scope; Procedure of environmental auditing; Benefits; Public participation in environmental decision making- Objectives, Advantages and disadvantages.

5.6: Remote Sensing- Application in wildlife habitat and natural resource management; Agricultural applications, Urban and Regional Planning application, Wetland Mapping. Geographical information system (GIS): Use in environmental management.

UNIT VI: Agroecology and Sustainable Agriculture

6.1: Agroecology: Concept; structure and functions of agroecosystem- cropland, pastures, forest gardens; interactions.

6.2: Agroecological features: recycling, efficiency, diversity, resilience and synergies, Co-creation and sharing of knowledge; human and social values; culture and food traditions; responsible governance; and circular and solidarity economy; FAO.

6.3: Agrobiodiversity: Definition; role in climate adaptation and mitigation; Ex-situ, and In-situ conservation; Conservation of agricultural production areas- Globally Important Agricultural Heritage Systems (GIAHS).

6.4: Agrodiversity Services: provisioning services- food and nutritional security; supporting services- crop diversity conservation; regulating services- pollination, pest control, carbon capture; cultural services.

6.5: Regenerative agriculture: Concept and scope; top soil regeneration; improving water cycle, supporting bio sequestration.

6.6: Sustainable agriculture- Concept and objectives; methods of sustainable agriculture: No-till farming, Organic farming, Conservation farming, Integrated pest management.

Proposed Pedagogies:

1. Teaching Methodologies:

1. Lecture-based Teaching
2. Technology based teaching
3. Project based teaching
4. Experiment based teaching

2. Learning Methodologies:

1. Visual learning
2. Reading/ Writing
3. Project-based learning
4. Experimental learning

3. Evaluation Methodologies:

1. Formative Evaluation
2. Summative evaluation

Special Instructions (If Any):

Learning Outcomes

1. Will be able to educate common people for the cause of conservation of nature and natural resources
2. Will apply scientific knowledge for sustainable development
3. Will be able to understand the consequences of environmental pollution
4. Will understand the effects of global warming on plant life

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Model Questions: (Long type for 10 marks)

UNIT I:

1) Describe the structure of the atmosphere. Add a note on atmospheric interactions.

UNIT II

1) Explain the structure and functions of the pond ecosystem

UNIT III

1) Define succession. Explain the general process of succession.

UNIT IV

1) Describe applications of remote sensing in soil resource management

UNIT V

1) What is waste management? Explain agricultural solid waste management methods.

UNIT VI

1) Describe methods of sustainable agriculture.

Model Questions: (Long Type for 05 Marks)

UNIT I:

1) General process of soil formation
2) Effects of light factor on plant life

UNIT II

1) Ecological pyramids
2) Sulphur cycle

UNIT III

1) Ecosystem productivity
2) Interspecific relationships of populations

UNIT IV

1) Sources of pollution
2) Recommendations of the Biodiversity Act (2002)

UNIT V

1) Conservation of genetic resources
2) Procedure of environmental auditing

UNIT VI

1) Supporting services of agrobiodiversity
2) Organic farming- Concept and scope

Model Questions: (Short Type for 3/4Marks)

UNIT I:

1) Food web
2) Climax concept
3) Ecotypes and ecads

UNIT II

1) Adaptations in epiphytes
2) functions of the ecosystem
3) Effects of climate change

UNIT III

1) Single-channel energy flow model
2) Causes of succession
3) Competition

UNIT IV

1) Acid Rain
2) Causes of soil erosion

3) Deforestation
UNIT V
1) Ecotourism
2) Petro Crops
3) Landraces of crop plants
UNIT VI
1) Cultural services.
2) FAO
3) No-till farming

PRACTICALS:

MAJOR EXERCISES: (Any Ten)

1. To study physical characteristics (temperature, colour and texture) of soil samples.
2. To determine the minimum size of the quadrate by species area method.
3. To study plant community characteristics (Density, frequency, and abundance) by Quadrate method.
4. To study abiotic and biotic components of an ecosystem
5. Analysis of air pollutants by High-volume sampler
6. To study hydrophytic adaptation in plants
7. To study xerophytic adaptation in plants
8. Analysis of polluted water samples
9. Determination of BOD and COD from the water sample.
10. Estimation of synthetic detergents from water resources.
11. Study of Satellite Imagery or Arial Photographs.
12. To study the toxic effect of sewage water on seed germination
13. Determination of the total hardness of the water sample
14. Determination of the D.O. of the water sample
15. To determine vegetation cover in a given area.
16. Estimation of biomass in an ecosystem
17. To determine the water-holding capacity of the soil.
18. To find out the reproductive capacity of a species.
19. To study the impacts of soil erosion
20. To study the impacts of deforestation

MINOR EXERCISES: (Any Seven)

1. To measure rainfall by using a Rain gauge
2. To measure the humidity of the air by using a Hygrometer
3. To measure the speed and direction of the wind
4. To study the turbidity of water by using Secchi Disc
5. To measure the pH of water and soil samples
6. To measure Noise pollution in public places.
7. Demonstration of non-conventional energy sources by working models: Solar panels/ Solar cookers/Windmills/ Solar Water Heaters/ solar driers.
8. Demonstration of different horizons of local soil profile.
9. Demonstration of Nisargruna Technology
10. Documentation of biodiversity along the field margins
11. To study Cropland ecosystem
12. To study pollinator diversity of crop plants
13. Demonstration of compost making
14. Study of ecotypes of the local area

DSC- III.4 Plant Biotechnology and Genetic Engineering

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.5	IV	BOT403	Plant Biotechnology and Genetic Engineering	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. Students will be able to understand the Mechanism of growth and gain laboratory skills to culture any parts of the plant to develop new Clone / plantlets.
2. Students will be familiar with the equipment's and the Instrumentation required for tissue culture lab, their principal, working and handling to maintain aseptic condition
3. Understand and can apply his knowledge for the development of transgenic plants
4. Will understand the key role-playing various Enzymes in Biotechnology
5. Able for Effective screening of vectors for specific gene insert
6. Can compare efficient gene transfer technique with maximum efficiency
7. Modern techniques of gene knockout and its superiority

Course Outcomes:

CO 1: Knowledge - Remembering information of concept of tissue culture and steps involved.

CO 2: Comprehension - Explaining the meaning of Recombinant Biotechnology and Mechanism Involved.

CO 3: Application – Used of Plant tissue Culture, Recombinant Biotechnology, Various Enzymes in Molecular Biology with techniques like Blotting Techniques, High-Throughput Sequencing Technologies, Gene Knockout Technologies

CO 4: Analysis – Most effective method of gene transfer either Vector mediated or Vector less gene transfer methods or natural methods of gene transfer by *Agrobacterium tumefaciens*

CO 5: Synthesis–By molding the knowledge of Tissue Culture, Genetic Engineering and Techniques in Molecular Biology students can develop new gene combination, differential expression of the basis of gene knockout strategies

CO 6: Evaluation – Can evaluate the best protocol either for tissue culture or for Recombinant DNA Technology or even for gene silencing of knockout strategies.

Detailed Curriculum:

Unit – I: Plant Tissue Culture:

1.1: Totipotency of Plant cells- Dedifferentiation and Re-differentiation, Selection of Ex- Plant

1.2: Laboratory organization: Instruments- Autoclave, Centrifuge, Laminar Air Flow, etc., Sterilization methods,

1.3: Cultural media- Types, Compositions and Preparation.

1.4: Callus culture: Callus induction, incubation and establishment, Subculture maintenance and transfer of regenerated plant into field,

1.5: Cell suspension culture and characteristics.

1.6: Application of Plant Tissue Culture: Production of Biomolecules and medicine, Transgenic plant, Germ-plasm conservation, Agricultural and Environment, Food processing and Beverages

Unit – II: Somatic Embryogenesis:

2.1: Somatic embryogenesis – Somatic embryo development Stages

2.2: Synthetic Seed Production and Application

2.3: Soma clonal variation: Origin, Types and Applications.

2.4: Experimental Androgenesis

2.5: Experimental Gynogenesis

2.6: Factors controlling (Physical and chemical) Androgenesis and Applications

Unit – III: Recombinant DNA:

3.1: Aims and strategies: Transgenic Plant Development.

3.2: Gene cloning vectors - Plasmids, Phages, Cosmids, Transposons,

3.3: Expression vectors: Bacterial Expression Vectors, Yeast Expression Vectors and Plant Expression Vectors

3.4: Agrobacterium mediated gene transfer: Introduction to *Agrobacterium tumefaciens*, Structure of T – DNA

3.5: T-DNA Region Genes: Virulence (vir) Genes, Helper Genes on Binary Vectors, Opine Catabolism Genes

3.6: Mechanism of Agrobacterium mediated Gene Transfer

Unit – IV: Enzymes in Genetic Engineering:

4.1: Restriction Endonucleases: EcoRI, HindIII, BamHI Role in Genetic Engineering

4.2: Restriction Exo-onucleases: Exo-nuclease I (Exo I), Exo-nuclease III (Exo III), Lambda Exo - nuclease, T7 Exo - nuclease Role in Genetic Engineering and Applications

4.3: Role of In Genetic Engineering: S 1 nucleases, DNA ligases, Reverse Transcriptase and Alkaline Phosphatase

Unit – V: Cloning Vectors and Gene Transfer:

5.1: Selection of genes and vectors: Gene libraries: Genomic and cDNA library. PCR

5.2: Gene transfer methods: Vector mediated gene transfer methods: Ti plasmid and its significance as vector, Binary vectors, Co-Integrated vectors; Vectorless gene transfer methods: Calcium phosphate, PEG, DEAE, liposomes, Microinjection, micro projectile, and Electroporation

5.3: Selection of Clones: Marker and Reporter genes in screening methods.

5.4: Plant Based Vaccines: Production, Significance and Limitations

Unit – VI: Methods and Applications of Genetic Engineering:

6.1 Blotting Techniques: Western blot, Northern blot, and Southern blot

6.2 High-Throughput Sequencing Technologies: Principles, Illumina sequencing, ThermoFisher's Ion Torrent, Pacific Biosciences (PacBio) Single Molecule, Real-Time (SMRT) sequencing and Oxford Nanopore Technology (ONT); Applications.

6.3 Human Genome Project: Aims and Applications

6.4 Gene Knockout Technologies: CRISPR-Cas9, TALENs (Transcription Activator-Like Effector Nucleases), Zinc Finger Nucleases (ZFNs), Homologous Recombination, Transposon Mutagenesis

6.5 Gene Therapy: Strategies, Mechanism and Application

6.5 Gene Silencing Techniques: RNA Interference (RNAi), Antisense Oligonucleotides (ASOs), Small Activating RNAs (saRNAs), miRNA (MicroRNA), DNA Methylation

Proposed Pedagogies:

1. **Teaching Methodologies:** Show Animated Video for the respective Mechanism or used Flow Chart or Power Point Presentation to Uplift the imaginary power regarding the deep understanding of subject.
2. **Learning Methodologies:**
   Students must Draw a Flow chart of various Mechanism, Diagram, see Videos and try to Solve online MCQs based on the learned topics
3. **Evaluation Methodologies:** MCQs Based question Answer, Long and Short answer based on Conceptual Understanding and Flow-Chart or Diagram Drawing or identifying various labeling the specific Mechanisms etc.,

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3. Callow, J. A., Ford-Lloyd, B. V., & Newbury, H. J. (1997). *Biotechnology and plant genetic resources conservation and use*. CAB International, Oxon, UK.
4. Chrispeels, M. J., & Sadava, D. E. (1994). *Plants, genes and agriculture*. Jones & Bartlett Publishers, Boston, USA.
5. Collin, H. A., & Edwards, S. (1998). *Plant cell culture*. BIOS Scientific Publishers, Oxford, UK.
6. Collins, H. A., & Edwards, S. (1998). *Plant cell culture*. BIOS Scientific Publishers, Oxford, UK.
7. Dixon, R. A. (Ed.). (1987). *Plant cell culture: A practical approach*. IRL Press, Oxford.
8. Dubey, R. C. (2014). *Advanced biotechnology*. S. Chand and Company.
9. Glick, B. R., & Thompson, J. E. (1993). *Methods in plant molecular biology and plant biotechnology*. CRC Press, Boca Raton, Florida.
10. Govil, V. M., Agrawal, A., & Sharma, J. (2017). *Plant biotechnology and genetic engineering*. PHI Learning Private Limited.
11. Hall, R. D. (Ed.). (1999). *Plant cell culture protocols*. Humana Press, Inc., New Jersey, USA.
12. Henry, R. J. (1997). *Practical applications of plant molecular biology*. Chapman & Hall, London, UK.

13. Jain, S. M., Sopory, S. K., & Veilleux, R. E. (Eds.). (1996). *In vitro haploid production in higher plants, Vols. 1-: Fundamental aspects and methods*. Kluwer Academic Publishers, Dordrecht, Netherlands.
14. Nair, A. J. (2009). *Principles of biotechnology and genetic engineering*. Laxmi Publications.
15. Patil, U. K., & Muskan, K. (2020). *Plant biotechnology*. Dreamtech Press.
16. Primrose, S. B. (1995). *Principles of genome analysis*. Blackwell Science Ltd., Oxford, UK.
17. Raghavan, V. (1997). *Molecular biology of flowering plants*. Cambridge University Press, New York, USA.
18. Rajgopal, K. (2012). *Recombinant DNA technology and genetic engineering*. McGraw Hill Education.
19. Rastogi, S., & Pathak, N. (2009). *Genetic engineering*. Oxford Higher Education, Oxford University Press.
20. Sarma, P. V. G. K. (2021). *A practical textbook of genetic engineering in bacteria*. MJP Publisher.
21. Satyanarayana, U. (2021). *Biotechnology* (15th ed.). Books and Allied Private Ltd.
22. Schweizer, M. (1997). *Methods in biotechnology*. CRC Press.
23. Shantharam, S., & Montgomery, J. F. (1999). *Biotechnology, biosafety, and biodiversity*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
24. Shaw, C. H. (Ed.). (1998). *Plant molecular biology: A practical approach*. IRL Press, Oxford.
25. Smith, R. H. (2000). *Plant tissue culture: Techniques & experiments*. Academic Press, New York.
26. Vennison, S. J. (2009). *Laboratory manual of genetic engineering*. Prentice Hall India Learning Pvt. Ltd.

E Contents (Free Available or Purchase Links):

- Blotting Techniques. https://www.slideshare.net/IndrajaDoradla/blotting-techniques-242423183
- Genome Editing with TALENs. https://www.slideshare.net/kennethr/genome-editing-with-talens
- YouTube: Blotting Techniques
- YouTube: TALENs
- YouTube: CRISPR-Cas9
- YouTube: CRISPR Technology
- YouTube: Gene Editing
- YouTube: CRISPR Explained

Model Questions:

Long Type for 10 Marks:

1. What is Plant Tissue Culture? Explain the mechanism of Callus Culture in details and give the application of Plant Tissue Culture?
2. What is Somatic embryology? Explain in detail the various steps involved with applications?
3. What are the Aims and strategies for transgenic development?
4. What are Restriction Endonucleases? Explain their types with role in Recombinant DNA Technology?
5. What are Plant Based Vaccines? Comment on its Production, Significance and Limitations.
6. What is Biotting Techniques? Explain in details Wastern Blooting with Applications.

Long Type for 05 Marks:

1. Suspension culture and characteristics?
2. What is Soma clonal Variation? Give its applications?
3. Explain in details the Mechanism of Agrobacterium mediated gene transfer.
4. Role of Restriction Exonucleases in Genetic Engineering?
5. What is Genomic Library? Gives its applications
6. Gene Knockout Technologies

Short Type for 3/4Marks:

1. Methods of Sterilization in Tissue Culture?
2. Concept of Totipotency?
3. Cultural media?
4. Explain the various factors Affecting Androgenesis?
5. Explain in detail with Applications.
6. Give application of protoplast hybridization?
7. Helper Genes on Binary Vectors for T - DNA

8. Gene cloning vectors
9. Expression vectors
10. Role of Reverse Transcriptase and Alkaline phosphatase in r – DNA.
11. S 1 nucleases
12. DNA ligases
13. Role of Marker gene in the screening of Clones
14. Micro Projectile
15. Electroporation
16. High throughput sequences and assembly
17. Gene Knockout Technologies
18. Application of Gene Therapy

PRACTICALS:

MAJOR EXERCISES:

1. Isolation and estimation of Plant DNA.
2. Alkaline Gel electrophoresis.
3. To check protoplast viability using Evan's Blue dye, Fluorescent Di-acetate and phenol safranine
4. Induction of callus and its growth measurement
5. Organogenesis via callus formation in any plant species
6. Isolation of protoplasts from various plant tissues
7. Effect of physical (e.g., temperature) and chemical (e.g., osmoticum) factors on protoplast yield
8. Demonstration of protoplast fusion employing PEG
9. Demonstration of androgenesis in any plant species
10. Embryogenesis in any plant material
11. Preparation of artificial seeds
12. Isolation and estimation of Bacterial genomic DNA
13. Isolation of Plasmid from E. coli strain DH5-a
14. Restriction enzyme digestion and analysis on Agarose Gel
15. Isolation and estimation of Plant DNA
16. RAPD Analysis
17. Electro elution of DNA from Agarose Gels
18. Total proteins detection on Blotting Membranes
19. Purification of DNA for PCR amplification
20. DNA fingerprinting of plant genomic DNA
21. ELISA
22. Immunoassay
23. PCR

MINOR EXERCISES:

1. Preparation of artificial seeds.
2. Preparation of Bacterial Cultivation media
3. Isolation of protoplasts from various plant tissues.
4. Demonstration of protoplast fusion employing PEG
5. To check protoplast viability using Evan's Blue dye, Fluorescent diacetate, and phenosafranin
6. Preparation of Bacterial Cultivation media
7. Bacterial cultivation and growth characteristics by streak and spread plate method
8. Antimicrobial sensitivity testing

DSE-I -Angiosperm Taxonomy, Phytochemistry and Pharmacognosy-IV

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.5	IV	BOT104A	Angiosperm Taxonomy, Phytochemistry and Pharmacognosy-IV	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. Understand the comparative vegetative and floral morphology, phylogeny, and distribution of various plant families according to Cronquist's system.
2. Explore the interrelationships and evolutionary trends among plant families in different subclasses.
3. Learn about the cultivation practices and benefits of medicinal plants, including their uses by ethnic groups.
4. Study the general good agricultural practices for medicinal herbs and the distillation processes for aromatic plants.
5. Analyze the classification and pharmacological action of plant drugs and the preparation of crude drugs in different systems of medicine.

Course Outcomes:

CO 1: Recall the vegetative and floral morphology, phylogeny, and distribution of plant families.
CO 2: Explain the interrelationships and evolutionary trends among plant families in different subclasses.
CO 3: Apply knowledge of cultivation practices and uses of medicinal plants by ethnic groups.
CO 4: Analyze the general good agricultural practices for medicinal herbs, including collection, harvesting, drying, packaging, storage, and preservation.
CO 5: Evaluate the principles and methods of distillation for aromatic plants, including maintenance and yields.
CO 6: Integrate the classification and pharmacological action of plant drugs with their preparation and processing in different systems of medicine.

UNIT I:

Comparative account of vegetative and floral morphology, interrelationships; phylogeny and distribution of plant families belonging to following subclasses as per Cronquist's system (As illustrated by following orders and families).

a) Magnoliidae: Ranunculales- Ranunculaceae, Berberidaceae, Menispermaceae.

b) Hamamelideae: Urticales- Ulmaceae, Moraceae, Cannabaceae,Urticaceae.

UNIT II:

c) Caryophyllidae: Caryophyllales- Nyctaginaceae, Cactaceae,Aizoaceae,Molluginaceae, Chenopodiaceae, Portulacaceae, Amaranthaceae.

d) Dillenidae- Malvales-,Tiliaceae, Sterculiaceae, Bombacaceae,Malvaceae.

e) Rosidae: Geraniales- Oxalidaceae, Geraniaceae Balsaminaceae.

UNIT III:

f) Asteridae –Solanales- Solanaceae, Asterales- Asteraceae.

g)Alismatidae-Alismatales-Butomaceae, Limnocharitaceae,Alismataceae.

h) Zingiberidae- Zinziberales-,,Heliconiaceae, Musaceae,Zingiberaceae, Costaceae, Cannaceae, Marantaceae.

i) Liliidae- Liliales- Liliaceae, Amaryllidaceae, Iridaceae, Agavaceae,Dioscoreaceae.

UNIT IV:

Medicinal plants as future source of new drugs, Cultivation Practices of
Medicinal Plants and its benefits. Plants used by ethnic groups as food, medicines (Ethnomedicine), beverages, fodder, fibre, resins, oils, fragrances and other uses. Threatened and endangered Medicinal Plants

UNIT V:

General good agriculture practices for medicinal herbs: Source, selection and authentication herbal materials. Collection, harvesting, drying, packaging, storage and preservation of herbal raw materials.

Distillation of aromatic plants: a) Description of distillation UNITs
b) Principles of distillation

c) Methods of distillation
d) Maintenance and precautions for distillation UNITs
e) Yields and recoveries of different aromatic plants,

UNIT VI:

Classification and pharmacological action of plant drugs: drugs acting on nervous system; heart, Preparation of Crude drugs in different systems of medicine.
Value addition grading and processing of plant.

Model Questions:

Long Type Questions:

1. Compare and contrast the vegetative and floral morphology, phylogeny, and distribution of plant families in the subclass Magnoliidae, focusing on Ranunculaceae, Berberidaceae, and Menispermaceae.
2. Discuss the interrelationships and evolutionary trends among plant families in the subclass Caryophyllidae, with specific reference to Nyctaginaceae, Cactaceae, and Amaranthaceae.
3. Explain the significance of medicinal plants as a future source of new drugs and the benefits of their cultivation practices. Include examples of plants used by ethnic groups for various purposes.
4. Describe the general good agricultural practices for medicinal herbs, including the processes of collection, harvesting, drying, packaging, storage, and preservation.
5. Analyze the principles, methods, and maintenance of distillation units for aromatic plants. Discuss the yields and recoveries of different aromatic plants.
6. Evaluate the classification and pharmacological action of plant drugs, particularly those acting on the nervous system and heart. Explain the preparation of crude drugs in different systems of medicine.

Short Type Questions:

1. Define the key characteristics of the plant family Ranunculaceae.
2. What are the main differences between the families Ulmaceae and Moraceae?
3. Describe the floral morphology of the family Cactaceae.
4. Explain the significance of the family Solanaceae in the subclass Asteridae.
5. What are the uses of plants in the family Zingiberaceae by ethnic groups?
6. Outline the general good agricultural practices for medicinal herbs.
7. What are the principles of distillation for aromatic plants?
8. Describe the pharmacological action of plant drugs acting on the nervous system.

Suggested Readings:

1: Alston, R. E., & Turner, B. L. (1963). Biochemical systematics. Prentice Hall.
2: Bailey, L. H. (1949). Manual of cultivated plants (2nd ed.). Macmillan.
3: Beck, C. B. (Ed.). (1976). Origin and early evolution of angiosperms. Columbia University Press.
4: Beck, C. B. (Ed.). (1976). Origin and early evolution of angiosperms. Columbia University Press.
5: Benz, G., & Santesson, J. (Eds.). (1976). Chemistry in botanical classification. Nobel Symposia: Medicine and Natural Science, Academic Press.
6: Corner, E. J. H. (1976). The seeds of dicotyledons (Vols. I & II). Cambridge University Press.
7: Cotton, C. M. (1996). Ethnobotany: Principles and applications. John Wiley & Sons Ltd.
8: Cronquist, A. (1981). An integrated system of classification of flowering plants. Columbia University Press.
9: Cunningham, A. B. (2001). Applied ethnobotany. Earthscan Publishers Ltd.
10: Davis, P. H., & Heywood, V. H. (1963). Principles of angiosperm taxonomy. D. Van Nostrand.
11: Eames, A. J. (1961). Morphology of the angiosperms. McGraw-Hill.
12: Erdtman, G. (1952). Pollen morphology and plant taxonomy: Angiosperms. Almqvist & Wiksell.
13: Evans, W. C. (2009). Trease and Evans' pharmacognosy (16th ed.). Saunders.
14: Harborne, J. B., & Turner, B. L. (1984). Plant chemotaxonomy. Academic Press.
15: Heywood, V. H. (Ed.). (1971). Taxonomy and ecology. Academic Press.
16: Houghton, P. J. (2009). Traditional plant medicines as sources of new drugs. In Trease and Evans' pharmacognosy (16th ed.). Elsevier.
17: Hughes, N. F. (1976). Paleobiology of angiosperm origins. Cambridge University Press.
18: Hutchinson, J. (1959). The families of flowering plants (Vols. I & II). Oxford University Press.
19: Hutchinson, J. (1973). Evolution and phylogeny of flowering plants. Academic Press.
20: Jain, S. K. (1981). Glimpses of Indian ethnobotany. Oxford & IBH Publishing Co. Pvt. Ltd.

21: Judd, W. S., Campbell, C. S., Kellogg, E. A., & Stevens, P. F. (2008). Plant systematics: A phylogenetic approach (3rd ed.). Sinauer Associates, Inc.
22: Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2019). Pharmacognosy. Nirali Prakashan.
23: Kumar, S. (1997). Chromosome atlas of the flowering plants of the Indian subcontinent. International Book Distributors.
24: Lawrence, G. H. M. (1951). Taxonomy of vascular plants. Macmillan.
25: Moreira, M. (1992). An introduction to ethnobotany. Moredale Publishing.
26: Naik, V. N. (1984). Taxonomy of angiosperms. Tata McGraw-Hill.
27: Saldhana, C. J., & Rao, C. K. (1977). A punched card key to the dicot families of South India. Arvind Publishers.
28: Sneath, P. H. A., & Sokal, R. R. (1973). Numerical taxonomy: The principles and practice of numerical classification. W.H. Freeman & Co.
29: Solbrig, O. T. (1970). Evolution and systematics. Macmillan.
30: Sporne, K. R. (1974). Morphology of angiosperms. Hutchinson.
31: Swain, T. (1973). Comparative phytochemistry. Academic Press.
32: Takhtajan, A. (1969). Flowering plants: Origin and dispersal. Oliver & Boyd.
33: Voss, E. G. (Ed.). (1983). International code of botanical nomenclature. Regnum Vegetabile, Utrecht.
34: Young, D. J., & Seigler, D. S. (1981). Phytochemistry and angiosperm phylogeny. Praeger.

Digital Resources:

9: https://learn.concord.org/
10: https://learn.concord.org/eresources/1274.run_resource_html
11: https://learn.concord.org/eresources/3013.run_resource_html
12: https://www.google.com.in

Additional Indian References:

1: Singh, G., & Jain, S. K. (2013). Ethnobotany: The renaissance of traditional herbal medicine. Scientific Publishers.
2: Khare, C. P. (2007). Indian medicinal plants: An illustrated dictionary. Springer.
3: Warrier, P. K., Nambiar, V. P. K., & Ramankutty, C. (1995). Indian medicinal plants: A compendium of 500 species (Vols. 1-5). Orient Longman.

PRACTICALS:

MAJOR EXERCISES:

1. Description of locally available dicot and monocot species. Identification upto species level
2. with the help of flora.
3. Use of cytological data in Taxonomic studies - Karyotype analysis. Preparation of Karyograms; and Idiograms (to be done with the help of permanent preparation / diagram / photoplate).
4. Study of different taxonomic features like stomatal types, pollen types, trichome types,
5. Detection of secondary metabolites in plant material by quick tests. Detection of flavonoids, irridoids; leucoanthogenins, anthroquinones, alkaloids, saponins, differentiating anthocyanins from bactacyanins. crystals etc

MINOR EXERCISES:

1. Pharmacognostic studies of any 7 of the locally available medicinal plants
2. Frequent field visits to study local flora are expected. **One short tour within state and one long tour to other state to study the vegetation and biodiversity of angiosperms. Students should submit atl east 80 herbarium specimens locally available and available abundantly and 10 plants of medicinal importance which are available abundantly. (collectively) prepared according to international norms. Excursion report should be supported by field diary and photographic presentation of the flora**
3. Field trip to tribal settlement to survey, document and frame hypothesis on people-plant relationship.

DSE-I -Molecular Systematics of Plants-IV

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.5	IV	BOT104F	Molecular Systematics of Plants-IV	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

This course covers state-of-the-art methods for reconstructing phylogenies. We will cover the theoretical basis for different phylogenetic analyses and learn how to use some of the software packages available for conducting these analyses. Inferences that rely heavily on phylogenetic trees (eg. analyses of character evolution, divergence time estimation, and studies of diversification rates) will also be covered.

Unit-I	1.1. Phylogeny of angiosperm: Origin of angiosperms; molecular dating, possible ancestors. 1.2. Origin of monocot, basal living angiosperms. Evolutionary trends- evolution of inferior ovary.
Unit-II	2.1. Evolutionary trends: coevolution with animals and pollination mechanisms. 2.2. Biochemical coevolution, Evolution of xylem, stamens, pollens and carpels.
Unit-III	3.1. Phylogenomics: Current trends in plant systematics, applications over traditional taxonomic methods. 3.2. Metabolomics: Identification and quantification of cellular metabolites in biological samples. Pharmacogenomics and drug designing.
Unit-IV	4.1. Plastid markers: *rbc*L, *atp*B, *mat*K, *ndh*F, 168 rRNA, *atp*B-*rbc*L, Intergenic region, noncoding chloroplast sequences, characteristics, Limitations, discriminatory potential, PCR success rate and their applications.
Unit-V	5.1. Nuclear markers: 18S rRNA, 265 rRNA, 5.8S rRNA, ITS; characteristics, Limitations, discriminatory potential, PCR success rate and their applications.
Unit-VI	6.1. DNA Barcoding: history, criteria, genes used as a barcode (*rbc*L, *mat*K, *trn*H-*psb*A, and ITS2), steps involved in DNA barcoding. Analysis of DNA barcodes. 6.2. Mini and meta barcoding; applications of barcodes in plant taxonomy.

Suggested Reading:

1. Angiosperm Phylogeny Group (2003) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. Botanical Journal of the Linnaean Society 141: 399-436.
2. Cracknell AP, Hayes L (2009) Introduction to Remote Sensing. CRC Press, Boca Raton, USA (Special Indian Edition).
3. Crawford DJ (2003) Plant Molecular Systematics. Cambridge University Press, Cambridge, UK.
4. Cronquist A (1981). An integrated system of classification of flowering plants. Columbia Evolution. Taylor and Francis, London.
5. Jain S.K. (1995). Manual of Ethnobotany. Scientific Publisher; Second edition (1995).
6. Judd WS, Campbell CS, Kellogg EA, Stevens PA and Donoghue MJ (2002). Plant Systematics: A Phylogenetic Approach. Sinauer Associaes, Inc., Massachusetts.
7. Nei M and Kumar S (2000). Molecular Evolution and Phylogenetics. Oxford University Press, New York. 8. Raven PH, Begr LR, Hassenzahl DM (2008). Environment. 6th edition. John Wiley & Sons, Inc., New York. Semple C and Steel MA (2003). Phylogenetics. Oxford University Press, Oxford.
8. Simpson MG (2006). Plant Systematics. Elsevier, Amsterdam.

Learning Outcome:

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

1. Structure of Genes
2. Phylogenetic analysis
3. DNA Barcoding

Laboratory Exercises:

1. To demonstrate the process of sequence submission on NCBI gene bank using Bankit submission tool
2. To demonstrate the process of gene editing and consensus formation.
3. To construct the phylogenetic tree by using plastid DNA markers
4. To construct the phylogenetic tree by using nuclear DNA markers
5. In silico analysis and description of DNA barcodes
6. Comparative analysis of phylogenetic tree using different methods
7. To calculate the PCR success rate of the markers
8. To demonstrate the process of drug designing by using appropriate software's

DSE-I -Plant Tissue Culture-IV

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.5	IV	BOT 104C	Plant Tissue Culture-IV	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Outcomes:

On completion of the course, the student should be able to

1. Understand the techniques for production of secondary metabolites through in vitro cultures.
2. Understand the applicability of subject with respect to Agriculture, Horticulture, Forestry, Medicines and employability enhancement.

Unit-I	1.1 Hairy root cultures - methods, Agrobacterium rizhogenous, Ri Plamids and applications. 1.2 Production of Secondary Metabolites- Introduction, types of secondary metabolites, principle, systems of culture, optimization of yield, 1.3 Elicitors use and their types, commercial aspects, applications, limitations.
Unit-II	2.1 Metabolic Engineering and Industrial Products: History and applications. 2.2 Metabolic flux analysis; 2.3 Determining the optimal genetic manipulations, manipulation of phenylpropanoid pathway, shikimate pathway; alkaloids.
Unit-III	3.1 Molecular farming: concepts, production of edible vaccines, plant bodies, medicines. 3.2 Shoot Organ culture for alkaloids, pigments, perfumes, flavors, insecticides, anticancerous agents and pharmaceutically important compounds. 3.3 Tissue Culture in Pharmaceuticals
Unit-IV	4.1 Production of therapeutic proteins, edible vaccines, purification strategies. 4.2 Intellectual Property Rights. 4.3 Improving crops through transgenic breeding Technological advances, Need, Assessment, factors affectingand prospects
Unit-V	5.1 Applications of Plant Tissue Culture in Agriculture, Horticulture and Forestry. 5.2. Achievements and current trends in improvement of cereals, vegetable crops, oil yielding plants, ornamental plants and forest trees
Unit-VI	6.1 Application, Advantages, Challenges and constraints of the industry. 6.2 Invitro cultures for Study of the cell cycle, metabolism in cells, nutritional, morphogenetical and developmental studies in plants using 6.3 Case study in plant Tissue Culture

Learning Outcome:

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

1. Demonstrate the hairy root and other cultures for secondary metabolites production.
2. Learn the multiple aspects of subjects in relation to production of important metabolites and commercial aspects in relation to entrepreneurship and employability generation

Suggested Readings:

1. Slater, A., Scott, N. W., & Fowler, M. R. (2004). Plant biotechnology: The genetic manipulation of plants (1st ed.). New York, NY: Oxford University Press.
2. George, E. F. (2007). Plant propagation by tissue culture: Vol. 1. The background. New York, NY: Springer.
3. Vasil, I. K. (1980). Cell culture and somatic cell genetics of plants. New York, NY: Academic Press Inc.
4. Pierik, R. L. M. (1987). In vitro culture of higher plants. Boston, MA: Martinus Nijhoff Publishers.
5. De, K. (1997). An introduction to plant tissue culture. Calcutta, India: New Central Book Agency.
6. Wolfenbarger, L. L. (2003). Environmental and ecological impacts from transgenic plants: Unintended effects. Blacksburg, VA: Information Systems for Biotechnology, Virginia Tech.
7. Varshney, R. K., & Tuberosa, R. (2007). Genomics-assisted crop improvement (Vol. 1). Dordrecht, The Netherlands: Springer.

Laboratory Exercises:

1. Monocot and Dicot Seed cultures for the establishment of organ cultures
2. Profiling of secondary metabolites from callus
3. In vitro study of hairy root culture.
4. Study the functions of elicitors on roots/ cells

5. Study Tissue culture of ornamental plant
6. Study Tissue culture in Horticulture
7. Experiment on Organ culture for production of bioactive compound
8. Micro propagation of important crops and hardening / acclimatization of regenerated plants
9. Documentation of success story/case study in the field of plant tissue culture
10. Demonstration of Gene transfer techniques, direct methods.
11. Demonstration of Gene transfer techniques, indirect method
12. Demonstration of Confirmation of Genetic transformation.
13. Demonstration of gel-electrophoresis techniques

DSE-I -Advanced Plant Physiology-IV

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.5	IV	BOT 104D	Advanced Plant Physiology-IV	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. Understand the processes and regulation of programmed cell death (PCD) and senescence in plants, including the role of oxidative stress and hormonal modulation.
2. Explore analytical approaches and molecular techniques for analyzing gene expression and protein modifications during different physiological phenomena and stress responses.
3. Learn the principles of enzyme activity and specificity, including reaction kinetics and enzyme inhibition.
4. Study the mechanisms of uptake and transport of water, ions, solutes, and macromolecules in plants.
5. Examine the chemistry and biosynthesis of vitamins, hormones, and alkaloids, and understand their roles as co-enzymes and in intermediary metabolism.

Course Outcomes:

CO 1: Explain the types of PCD and the environmental and genetic regulation of senescence in plants, including the roles of polyamines and transglutaminase.
CO 2: Describe the techniques for analyzing gene expression and protein modifications, such as NGS, comparative proteomics, and blotting methods.
CO 3: Analyze enzyme kinetics using Michaelis-Menten and Lineweaver-Burke plots, and distinguish between different types of enzyme inhibition.
CO 4: Evaluate the mechanisms of water, ion, solute, and macromolecule transport in plants, and the roles of ion transporters and photoassimilate loading/unloading.
CO 5: Discuss the chemistry and biosynthesis of hormones, vitamins, and alkaloids, and their roles in plant growth and metabolism.
CO 6: Assess the physiological effects and mechanisms of plant growth regulators, the causes of dormancy, and the biochemical changes during seed germination.

Unit-I	**Programmed cell death (PCD)and Senescence** Types of PCD in plants during vegetative and reproductive stages. Different environmental or internal signals for induction of senescence; Receptor like Kinases (RLKs) in Leaf Senescence. Altered metabolism during senescence and its regulation. The oxidative stress and the anti-oxidative strategies. Hormonal modulations.Environmental,genetic and molecular regulation of PCD;Role polyamines(PAs) and transglutaminase in PCD.
Unit-II	**Analytical approaches and molecular techniques**: Analysis of gene expression at RNA and protein level in plants during different physiological phenomena and stress responses, Global expression profiling by NGS and comparative proteomics analysis.Protein sequencing methods,detection of posttranslation modification of proteins.Detection of moleculesus in northern blot,western blot,immune precipitation and immune fluorescence.
Unit-III	Enzyme activity and specificity,Constitutive and Induced enzymes; Active site, Activation energy, Reaction rate, Mechanism of action, Kinetics:rate order of reactions; Derivation of Michaelis Menten equation–single substrate; Michaelis Menten plot and Lineweaver Burke plot; Enzyme inhibition: Reversible, irreversible with on example in each case.
Unit-IV	Mechanisms of uptake and transport of water, ions, solutes and macromolecules from soil to plants, Ion transporter - types, structure and function; Mechanisms of loading and unloading of photo assimilates.

Unit-V	Chemistry of vitamins, hormones and alkaloids : Vitamins as Co- enzymes : Chemistry and biosynthesis of hormones- thyroxin. Catecholamine's. steroidal hormones. Biologically important alkaloids: intermediary metabolism : integration of metabolic pathways.
Unit-VI	**Plant growth regulators:** Physiological effects and mechanism of auxins, gibberellins, cytokinins, ethylene, abscisic acid, polyamines, jasmonic acid, hormone receptors and vitamins and hormones. Causes of dormancy and methods of breaking dormancy. Biochemical changes accompanying seed germination

Suggested Reading:

1. Davies, P.J. (2004). Plant Hormones: Biosynthesis, Signal Transduction, Action.3rd Edition, Kluwer Academic Publisher, Dordrecht, The Netherlands.
2. Jordan, B.R.(2006).The Molecular Biology and Biotechnology of Flowering, 2nd Edition, CAB International, Oxfordshire, U.K.
3. Nelson,D.L.and Cox,M.M.(2008). Lehninger Principles of Biochemistry (5thed.). New York
4. Buchanan, Gruissem and Jones. 2002. Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.
5. Annual Review of Plant Biology (formerly Annual Reviewof Plant Physiology and Plant Molecular Biology).
6. **BASIC REFERENCES:** Alberts et al., Molecular Biology of the Cell (parts related to plants); Salisbury and Ross, Plant Physiology; Taiz and Zeiger, Plant Physiology; Hopkins and Huner, Introduction to Plant Physiology.
7. **CURRENT LITERATURE** (JOURNAL ARTICLES): Plant
8. Physiology, The Plant Cell, Journal of Plant Physiology, Physiologia Plantarum, Plant Physiology and Biochemistry, Post harvest Biology and Technology, Hortscience, Journal of the American Society for Horticultural Science, Science, Nature, Scientific American etc.
9. Many plant physiology journals can be viewed via the net. The URL of one of the sites listing these journals is: http://www.e-journals.org/botany/

Laboratory Exercises:

- Assay of catalase, peroxidase and ascorbic acid oxidase activity; determination of Km value of Urease.
- Complexometric assay of Calcium and Magnesium
- Colorimetric estimation of IAA.
- Qualitative tests for carbohydrates, lipids, proteins and amino acids
- Estimation of glucose, starch, protein and amino acids
- Determination of enzymes activity–effect of enzyme concentration, pH, temperature, substrate, concentration of analyze TLC separation of dyes/ pigment

DSE-I -Basic and Applied Mycology-IV

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.5	IV	BOT 104E	Basic and Applied Mycology-IV	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

1. Understand the objectives and scope of plant pathology, including major research institutes in India.
2. Learn the concepts and evolution of plant diseases, including factors involved in phytopathology.
3. Gain knowledge on disease management techniques, forecasting systems, and diseases of forest trees.
4. Explore the genetic basis of host-parasite interactions, including breeding for disease resistance.
5. Study fungal and non-parasitic diseases of various crops and understand their significance.

Course Outcomes:

CO 1: Identify and classify plant diseases based on their mode of spread and significance.
CO 2: Explain the factors involved in phytopathology and the concepts of plant disease evolution.
CO 3: Apply integrated disease management techniques and use disease forecasting systems.
CO 4: Analyze the genetic basis of plant diseases and the genetics of resistance and pathogenicity.
CO 5: Diagnose fungal and non-parasitic diseases in cereals, oil seeds, fruits, and vegetables.
CO 6: Evaluate the impact and control measures for bacterial, viral, phytoplasma, and nematode diseases.

Unit-I	**Introduction to Plant Pathology** 1.1: Objectives of plant pathology 1.2: Scope of Plant Pathology and Research Institutes in India 1.3: Classification of Plant diseases based on the mode of spread 1.4: Significance of major plant diseases (late blight of potato, black rust of wheat, leaf spot of rice, downy mildew of grapes)
Unit-II	**Concepts of Plant Diseases** 2.1: Introduction to plant disease concepts 2.2: Evolution of diseases 2.3: Factors involved in phytopathology- disease triangle, disease pyramid, disease cone, disease prism 2.4: Koch's postulate and limitations of Koch's postulates
Unit-III	**Disease management and forecasting** 3.1: Host immunization 3.2: Integrated disease management (IDM) 3.3: Disease forecasting system- criteria used for disease forecasting, forecast based on weather conditions, forecast based on initial and secondary inoculum 3.4: Diseases of forest trees and their management
Unit-IV	**Genetic basis of host-parasite interaction** 4.1: Genes and plant diseases 4.2: Genetics of resistance- Breeding for Disease Resistance 4.3: Polygenic or horizontal resistance 4.4: Genetics of pathogenicity
Unit-V	**Fungal and Non-parasitic diseases** 5.1: Diseases of cereals – Downy mildew of maize, Loose smut of barley 5.2: Diseases of oil seeds – Rust of linseed, Charcoal rot of soybean 5.3: Diseases of fruits – Anthracnose of papaya, Apple scab 5.4: Diseases of vegetables – Anthracnose of chili, Phomopsis rot of brinjal 5.5: Non-parasitic diseases – Blackheart of potato, Black-tip, or necrosis of mango
Unit-VI	**Bacterial, viral, phytoplasma, nematode diseases** 6.1: Bacterial diseases - Soft rot of carrot, bacterial blight of bean, Moko disease of banana 6.2: Viral diseases - Mosaic of cucurbits, Rice Tungro, Bunchy top of banana 6.3: Phytoplasma diseases – Witches broom of potato, Sandal spike, little leaf of Vinca 6.4: Nematode diseases - Ear Cockle of wheat, Root-knot of vegetables

Suggested Reading:

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19. Jha, D.K. (1993) A Text Book of Seed Pathology, Vikas Publication House.
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22. Mehrotra, R.S. (1989) Plant Pathology, Tata McGraw Hill.
23. Mehrotra, R.S. and K. R. Aneja (1998) An Introduction to Mycology, New Age Intermediate Press
24. Mukadam, D.S. (1997) The Illustrated Kingdom of fungi, Akshar Ganga Prakashan, Aurangabad. 25
25. Mukadam, D.S. and L. V. Gangawane (1978) Experimental Plant Pathology (edited) Marathwada University Aurangabad.
26. Pande, P.B. (1997) Plant Pathology, S. Chand & Co. New Delhi.
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28. Preece and Dickeson. Ecology of leaf surface microorganism Academic Press, New York.
29. Rangaswamy, G. and A. Mahadevan (1999) Diseases of Crop Plant in India, Prentice Hall of India
30. Raychoudhari, S.P. and Nariani, T.K. (1977) Virus and Mycoplasma Diseases of Plant in India, Oxford and IBH Publication Co.
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Learning Outcome:

After successful completion of this course, studentswill be able to:

1. Identify and diagnose plant diseases accurately.
2. Analyze the impact of plant diseases on agriculture and the ecosystem.
3. Develop sustainable and environmentally friendly approaches to plant disease management.
4. Students will get job opportunities in the agriculture and seed industries.

Laboratory Exercise:

Major Experiments

1. Establishment of disease and testing for resistance (Root inoculation, Stem inoculation, Leaf inoculation, Seed inoculation).
2. Preparation of different cultural media for the cultivation of Fungi and Bacteria.
3. Isolation and identification of soil-borne fungi responsible for rot, wilt diseases (Warcup and Waksman method).
4. Study of toxicity of fungi in relation to seed germination, and seedling abnormality.
5. Detection of pathogens associated with seeds (Examination of dry seeds, Blotter Test, Agar Test, Seedling symptom test).
6. Isolation of external and internal seed-borne mycoflora by blotter and Agar Plate method (Cereals, pulses, oil seeds, fruit seeds).
7. Monographic study of locally available plant diseases caused by fungi (at least 10).
8. Study of locally available crop plant diseases caused by Bacteria (at least 5).
4. Study of locally available plant diseases caused by viruses & Phytoplasma (at least 5).
5. Demonstration of morphological & physiological changes in disease plants.
6. Demonstration of Koch's Postulate.
7. Preparation and presentation of the herbarium of pathological specimens available in the region (at least 30).
8. Preparation of Fungal spore atlas.

Minor Experiments

1. Principles & working of tools, equipment, and other requirements in the Mycology & Plant Pathology laboratory.
2. Slide preparation, Staining, Micrometry, and measurement of organisms.
3. Sterilization Processes viz. moist heat, dry heat, flame, chemical, and radiation.
4. Drawing of Camera Lucida diagrams and knowledge of computer-based microphotography and image processing.
5. Visit to Mushroom industry, Pharmaceutical, seed industries & Pathological study center.
6. Visit to different localities for pathogenic studies (Forests, Fields, Research fields, Nurseries, Gardens).
7. Visit to Agriculture University, Plant Pathological research centers, and Seed stations.
8. Maintain field diary and photographic collection.

DSE-I -Molecular Biology, Biotechnology & Plant Breeding-IV

Level	Semester	Course Code	Course Name	Credits	Teaching Hours	Exam Duration	Max Marks
6.5	IV	BOT104F	Molecular Biology, Biotechnology & Plant Breeding-IV	3	45	3 Hrs	40 (Int) + 60 (Ext)

Course Objectives:

On completion of the course, the student should be able to:-

1. Learn, demonstrate and understand the fundamentals of gene regulation and oncogenesis.
2. Understand the techniques genome mapping and analyze genome.
3. Expertize on performing blotting techniques.
4. Understand the basics of in vitro plant biology and molecular plant breeding

Course Outcomes:

The students will be able to-

CO 1: Acquire theoretical knowledge in the tools, techniques, applications and safety measures in the field of genetic engineering.

CO 2: Get expertise on genome mapping techniques.

CO 3: Develop small start up or industry related to plant biotechnology.

CO 4: Get expertise in molecular mapping of different crop plants.

Detailed Curriculum:

Unit – I: Gene regulation and Oncogenes

1.1 Regulation of gene expression: Gene regulation in prokaryotes - operon concepts (Lac operon and trp, arabinose operon), Negative & Positive Control, Post-translational regulation.

1.2 Gene regulation in eukaryotes- Regulation at the transcriptional and translational level, regulation by gene rearrangement.

1.3 Oncogenes and tumor suppressor genes:

1.3.1 Viral and cellular oncogenes,

1.3.2 Tumor suppressor genes from humans,

1.3.3 Structure, function, and mechanism of action of RB and p53 tumor suppressor proteins.

Unit – II: Genome mapping and related techniques

1.1 **Molecular mapping of genome:**

1.1.1 Genetic and physical maps

1.1.2 Molecular physical maps (In situ hybridization- ISH: FISH & GISH and Restriction mapping)

1.1.3 Molecular genetic maps (Non- PCR based and PCR based)

1.1.4 QTL Mapping

2.2 Chromosome walking and Chromosome jumping.

2.3 Chromosome microdissection and micro cloning

2.4 Applications of molecular mapping

Unit – III: Molecular markers, Genome analysis and Blotting techniques

3.1 Molecular markers in genome analysis:

3.1.1 Preliminary concept of RFLP, RAPD, AFLP.

3.1.2 Molecular markers linked to disease-resistant genes,

3.1.3 Applications of RFLP in forensic, disease prognosis and genetic counseling,

3.2 **Genome size and analysis**,

3.2.1 Genome mapping by conjugation,

3.2.2 Organelle genome (Chloroplast and Mitochondrial genomes)

3.2.3 DNA barcoding in relation to organelle genome

3.3 Blotting techniques:

3.1.1 Western blotting

3.1.2 Southern blotting

3.1.3 Northern blotting

Unit – IV: In vitro plant biology/ biotechnology and Gene silencing

4.1 In vitro plant biology/ Biotechnology:

4.1.1 Somatic embryogenesis and synthetic seeds

4.1.2 Haploid production (Anther culture & ovary culture)
4.1.3 Micropropagation and its applications.

4.2 Gene silencing:

4.2.1 Basics of gene silencing
4.2.1 Mechanism of Gene silencing
4.2.3 Role of RNA interference
4.2.3 Antisense technology
4.2.4 Epigenetics and gene silencing
4.2.5 Applications of gene silencing

Unit – V:

5.1 Mutagenesis:

Mutation and mutagenic agents (Physical and Chemical)

5.2 Role of mutagenesis in crop improvement

(Improvement of crop yield and Abiotic/ biotic stress tolerance in crop plants)

5.3 Ethical values associated with gene therapy, GMO, diagnosis; Recombinant DNA products/applications: Insulin, hepatitis B antigen vaccine, growth hormones.

5.4 Introduction to Molecular Farming

Unit – VI: Molecular Breeding, QTL mapping, Allele mining

6.1 Molecular Breeding:

6.1.1 Mapping genes for qualitative and quantitative traits;
6.1.2 QTL mapping using structured populations;
6.1.3 AB-QTL analysis and association mapping of QTL

6.2 Fine mapping of genes/QTL; Map-based gene/ QTL isolation and development of gene based markers.

6.3 Allele mining by TILLING and Eco-TILLING; use of markers in plant breeding; Marker-assisted selection (MAS) in backcross and heterosis breeding.

Proposed Pedagogies:

1. **Teaching Methodologies:**
   - Lecture, Direct Instructions, Demonstrations and technology-based teaching.
2. **Learning Methodologies:**
   - Reading and writing, Auditory Learning, Visual Learning, Kinesthetic and Interpersonal learning.
3. **Evaluation Methodologies:**
   - Formative, Summative and Outcome based evaluation.

Special Instructions (If Any):

Bibliography:

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17. Singh, S. (2015) A Practical Mannual of Fundamentals of Plant Breeding. Jharkhand, Rai University
18. Singh, S. and Pawar, I. S. (2006). Genetic Bases and Methods of Plant Breeding. CBS Publication New Delhi.
19. Watson, J.D., Baker, T.A, Bell, S.P, Gann, A., Levine, M. and Losick, R. (2015) Molecular Biology of the Gene, 7th Edition. Benjamin-Cummins Publishing Co.
20. Xu, Y. (2010) Molecular Plant Breeding, Cabi Digital Library.

Model Questions:

Long Type: (For 10 Marks)

1) Explain the gene regulation mechanism in prokaryotes.
2) Give detailed account of eukaryotic gene regulation.
3) Describe viral and cellular oncogenes.
4) Give details of different stages of molecular mapping of the genome.
5) Describe the molecular physical map in detail.
6) Explain different types of molecular genetic maps.
7) Discuss molecular markers used in genetic analysis.
8) Discuss details of the organelle genome studied by you.
9) Explain the principle of blotting techniques and their applications.
10) Explain micropropagation and its commercial applications.
11) Discuss the mechanism of gene silencing and its applications.
12) Discuss the role of mutagenesis in crop improvement
13) Describe ethical values related to GMO and recombinant DNA products.
14) Describe QTL mapping in plant breeding.
15) Explain allele mining by tilling and eco-tilling.

Long Type: (For 05 marks)

1) Explain Lac Operon model of gene regulation
2) Explain transcriptional gene regulation
3) Explain post- transcriptional gene regulation
4) Describe translational gene regulation
5) Give an account of tumor suppressor genes in humans
6) Explain restriction mapping
7) Explain chromosome microdissection and microcloning.
8) RAPD/ RFLP and its applications
9) Explain DNA barcoding in relation to organelle genome
10) Explain northern blotting
11) Discuss somatic embryogenesis and its applications.
12) RNA interference and antisense technology
13) Discuss various types of mutagens studied by you.
14) Give brief account of molecular farming
15) AB- QTL analysis and applications.
16) Describe marker assisted selection in brief.

Short type questions: (3/4 marks)

1) Trp Operon
2) Oncogenes
3) P53 tumor suppressor protein
4) PCR based molecular genetic map

5) Chromosome walking
6) Applications of molecular mapping
7) Applications of RFLP in forensics
8) Chloroplast/ Mitochondrial genome
9) Applications of blotting techniques
10) Applications of gene silencing
11) Anther / Ovary culture
12) Synthetic seeds
13) Ethical values related to gene therapy
14) Chemical/ Physical mutagens
15) AB- QTL
16) Ecotilling

PRACTICALS:

MAJOR EXERCISES:

Major 1: Isolation of plant DNA (from any suitable plant material)
Major 2: Restriction of plant DNA (DNA isolated from any suitable plant material).
Major 3: Embryogenesis in cultured cell from different explants.
Major 4: Anther culture/ pollen culture and production of haploids.
Major 5: *Agrobacterium* culture and selection of transformants.
Major 6: Construction of saturated linkage maps and QTL mapping.
Major 7: Blong techniques (Western/ Northern/ Southern)
Major 8: Synthetic seed production.
Major 9: Construction of restriction map of plasmid DNA.

MINOR EXERCISES:

Minor 1: Preparation of various buffers required for isolation of plant DNA and its restriction.
Minor 2: Preparation of culture medium for somatic embryogenesis.
Minor 3: Preparation of culture medium for anther culture
Minor 4: Demonstration of RFLP/ RAPD/ AFLP (live model/ audio-visuals)

Lab –VII: based on DSC-I.4, DSC-II.4, DSC III.4 and DSE Opted by Student

Level	Semester	Course Name	Credits	Practical Hours	Exam Duration	Max Marks
6.5	IV	DSC-I.4, DSC-II.4, DSC III.4 and DSE	4	120	6 Hrs	50 (Int) + 50 (Ext)

Practical Question Paper

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
PRACTICAL EXAMINATION
M.Sc. II (Botany), SEMESTER – IV (NEP) DSC-I.2 & II.2
PRACTICAL VII:
DSC-I.4, DSC-II.4, DSC III.4 and DSE

Time: 6 hrs. **Marks:** 50

Part A

Q.1: Perform Any One Major Experiment from Applied Botany 08
Q2: Perform Any One Major Experiment Plant Ecology and Environmental Dynamics 08
Q3: Perform Any One Major Experiment from Plant Biotechnology and Genetic Engineering 08
Q4: Perform Any One Minor Experiment from Applied Botany / Plant Ecology and Environmental Dynamics 03
Q5: Perform Any One Minor Experiment from Plant Biotechnology and Genetic Engineering 03

Part B

DSE: _____

Q4: Question based on Major Exercises (Any One) 10 M
Q5: Question based on Minor Exercises (Any Two) 10 M

Lab – VIII: Research Project Phase II

Level	Semester	Course Name	Credits	Practical Hours	Exam Duration	Max Marks
6.5	IV	Research Project Phase II	6	60	3 Hrs	75 (Int) + 75 (Ext)

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI
PRACTICAL EXAMINATION
M.Sc. II (Botany), SEMESTER – IV (NEP)
PRACTICAL VIII: Research Project Phase II

Time: 6 hrs. **Marks:** 75

1. Application to Real-World and Local Problems 10
2. Research Quality 10
3. Project Design and Methodology 20
4. Analysis and Interpretation of Data 10
5. Innovation and Originality 10
6. Presentation and Communication Skills 10
7. External Viva 05

MOOCS Allowed for MSc Botany Students

Course ID	Course Name	Institute	Duration	Start date	Exam date	Credits	Enrollment End date	Click here to Join the course	NPTEL URL
noc24-bt72	Biomedical nanotechnology	IIT Roorkee	4 Weeks	August 19, 2024	October 26, 2024	1	August 19, 2024	https://onlinecourses.nptel.ac.in/noc24_bt72/preview	https://nptel.ac.in/courses/102107058
noc24-bt62	Drug Delivery: Principles and Engineering	IISc Bangalore	12 Weeks	July 22, 2024	October 27, 2024	3	July 29, 2024	https://onlinecourses.nptel.ac.in/noc24_bt62/preview	https://nptel.ac.in/courses/102108077
noc24-bt51	Fundamentals of Micro and Nanofabrication	IISc Bangalore	12 Weeks	July 22, 2024	October 26, 2024	3	July 29, 2024	https://onlinecourses.nptel.ac.in/noc24_bt51/preview	https://nptel.ac.in/courses/102108078
noc24-bt40	Proteins and Gel-Based Proteomics	IIT Bombay	4 Weeks	July 22, 2024	September 22, 2024	1	July 29, 2024	https://onlinecourses.nptel.ac.in/noc24_bt40/preview	https://nptel.ac.in/courses/102101049
noc24-bt63	Immunology	IIT Kharagpur	12 Weeks	July 22, 2024	October 27, 2024	3	July 29, 2024	https://onlinecourses.nptel.ac.in/noc24_bt63/preview	https://nptel.ac.in/courses/102105083
noc24-bt43	Cellular Biophysics: A Framework for Quantitative Biology	IISER Pune	8 Weeks	July 22, 2024	September 21, 2024	2	July 29, 2024	https://onlinecourses.nptel.ac.in/noc24_bt43/preview	https://nptel.ac.in/courses/102106093
noc24-bt44	Computer Aided Drug Design	IIT Madras	8 Weeks	July 22, 2024	September 21, 2024	2	July 29, 2024	https://onlinecourses.nptel.ac.in/noc24_bt44/preview	https://nptel.ac.in/courses/102106070
noc24-bt48	Plant Cell Bioprocessing	IIT Madras	8 Weeks	July 22, 2024	September 22, 2024	2	July 29, 2024	https://onlinecourses.nptel.ac.in/noc24_bt48/preview	https://nptel.ac.in/courses/102106080
noc24-bt67	Introduction to Developmental Biology	IIT Madras	12 Weeks	July 22, 2024	November 2, 2024	3	July 29, 2024	https://onlinecourses.nptel.ac.in/noc24_bt67/preview	https://nptel.ac.in/courses/102106084
noc24-bt39	Bioreactors	IIT Madras	4 Weeks	July 22, 2024	September 21, 2024	1	July 29, 2024	https://onlinecourses.nptel.ac.in/noc24_bt39/preview	https://nptel.ac.in/courses/102106053
noc24-bt75	Introduction to Cell Biology	IISER Pune	8 Weeks	August 19, 2024	October 26, 2024	2	August 19, 2024	https://onlinecourses.nptel.ac.in/noc24_bt75/preview	https://nptel.ac.in/courses/102106096
noc24-bt76	Cell Culture Technologies	IIT Kanpur	8 Weeks	August 19, 2024	November 2, 2024	2	August 19, 2024	https://onlinecourses.nptel.ac.in/noc24_bt76/preview	https://nptel.ac.in/courses/102104059

noc24-bt41	Introduction to Dynamical Models in Biology	IIT Guwahati	4 Weeks	July 22, 2024	September 22, 2024	1	July 29, 2024	https://onlinecourses.nptel.ac.in/noc24_bt41/preview	https://nptel.ac.in/courses/102103056
noc24-bt71	Genome Editing and Engineering	IIT Guwahati	12 Weeks	July 22, 2024	November 3, 2024	3	July 29, 2024	https://onlinecourses.nptel.ac.in/noc24_bt71/preview	https://nptel.ac.in/courses/102103093
noc24-bt57	Genetic Engineering: Theory and Application	IIT Guwahati	12 Weeks	July 22, 2024	October 26, 2024	3	July 29, 2024	https://onlinecourses.nptel.ac.in/noc24_bt57/preview	https://nptel.ac.in/courses/102103074
noc24-bt65	Experimental Biotechnology	IIT Guwahati	12 Weeks	July 22, 2024	October 27, 2024	3	July 29, 2024	https://onlinecourses.nptel.ac.in/noc24_bt65/preview	https://nptel.ac.in/courses/102103083
noc24-bt66	Environmental Biotechnology	IIT Kharagpur	12 Weeks	July 22, 2024	October 27, 2024	3	July 29, 2024	https://onlinecourses.nptel.ac.in/noc24_bt66/preview	https://nptel.ac.in/courses/102105088
noc24-bt77	Design for Biosecurity	IIT Kanpur	12 Weeks	July 22, 2024	October 27, 2024	3	July 29, 2024	https://onlinecourses.nptel.ac.in/noc24_bt77/preview	https://nptel.ac.in/courses/102104459
noc24-bt46	Introduction to Proteomics	IIT Bombay	8 Weeks	July 22, 2024	September 21, 2024	2	July 29, 2024	https://onlinecourses.nptel.ac.in/noc24_bt46/preview	https://nptel.ac.in/courses/102101055
noc24-bt47	Introduction to Biostatistics	IIT Bombay	8 Weeks	July 22, 2024	September 21, 2024	2	July 29, 2024	https://onlinecourses.nptel.ac.in/noc24_bt47/preview	https://nptel.ac.in/courses/102101056
noc24-bt50	Introduction to Mechanobiology	IIT Bombay	8 Weeks	July 22, 2024	September 22, 2024	2	July 29, 2024	https://onlinecourses.nptel.ac.in/noc24_bt50/preview	https://nptel.ac.in/courses/102101058
noc24-ge41	Research Methodology	IIT Madras	8 Weeks	July 22, 2024	September 21, 2024	2	July 29, 2024	https://onlinecourses.nptel.ac.in/noc24_ge41/preview	https://nptel.ac.in/courses/121106007
noc24-hs160	Environmental Science	IIT Kharagpur	12 Weeks	July 22, 2024	November 3, 2024	3	July 29, 2024	https://onlinecourses.nptel.ac.in/noc24_hs160/preview	https://nptel.ac.in/courses/109105203
noc24-ge65	Food Packaging Technology	KUFOS Panangad	8 Weeks	August 19, 2024	November 3, 2024	2	August 19, 2024	https://onlinecourses.nptel.ac.in/noc24_ge65/preview	https://nptel.ac.in/courses/127106237
noc24-ge47	Fundamentals of Artificial Intelligence	IIT Guwahati	12 Weeks	July 22, 2024	October 26, 2024	3	July 29, 2024	https://onlinecourses.nptel.ac.in/noc24_ge47/preview	https://nptel.ac.in/courses/112103280