UNIVERSITY OF CALICUT
G & A - IV - J

No. 67485/GA - IV - J1/2015/Admn

Calicut University.P.O
Dated: 20.06.2025

From

The Registrar

To

The Principal,
Sacred Heart College, Chalakudy

Madam,

Sub:- Syllabus of B.Sc Botany Hons programme w.e.f 2024 admission - Approval by the Board of Studies in Botany (UG) - Intimating of - Reg.

Ref:- 1. Your letter dated: 20.02.2025 forwarding the Syllabus of various FYUG & PG Programmes.
2. Minutes of the meeting of Board of Studies in Botany (UG) held on 02.06.2025
3. Orders of the Vice-chancellor in the file, on 08.06.2025

With reference to the above, I am to inform you that, the Board of Studies in Botany (UG) has approved the syllabus of **B.Sc Botany Hons.** programme w.e.f 2024 admission, submitted by your college.

Yours faithfully

Arsad M
Deputy Registrar
(For The Registrar)

SACRED HEART COLLEGE
CHALAKUDY

B. Sc. BOTANY HONOURS
(MINOR AND GENERAL FOUNDATION COURSES)

SYLLABUS & MODEL QUESTION PAPERS
w.e.f. 2024 admission onwards

(SHFYUGP Regulations 2024)

INDEX

PREFACE

The educational landscape in Kerala is undergoing a significant transformation with the introduction of the Four-Year Undergraduate Programme (FYUGP). This initiative is aligned with global educational standards and aims to provide students with an extensive and in-depth learning experience.

In conjunction with the introduction of the FYUGP, the syllabus for the Botany program is being meticulously restructured. This restructuring aims to align the curriculum with contemporary scientific advancements and societal needs. The revised syllabus is designed to provide a deep understanding of plant sciences, combining traditional knowledge with modern research and technology.

The curriculum begins with fundamental concepts and advances to complex topics. Students will explore various plant groups; explore their evolutionary significance, structural complexities, and ecological roles.

Practical skills are emphasized through laboratory exercises on all topics, reinforcing theoretical knowledge, developing critical thinking and problem-solving skills to meet industrial needs.

In conclusion the syllabus aims to cultivate a thorough understanding of plant biology, integrating conventional knowledge with contemporary scientific advancements. These updates are expected to enhance academic standards and equip students with the skills needed to excel in their future endeavours, whether as professionals or entrepreneurs, contributing positively to the scientific community and society at large.

SYLLABUS INDEX

MINOR COURSES

VOCATIONAL MINOR COURSES

GENERAL FOUNDATION COURSES

PROGRAMME OUTCOMES (POs)

At the end of the graduate programme at Sacred Heart College, Chalakudy a student would:

PO1	**Knowledge Acquisition:** Demonstrate a profound understanding of knowledge trends and their impact on the chosen discipline of study.
PO2	**Communication, Collaboration, Inclusiveness, and Leadership:** Become a team player who drives positive change through effective communication, collaborative acumen, transformative leadership, and a dedication to inclusivity.
PO3	**Professional Skills:** Demonstrate professional skills to navigate diverse career paths with confidence and adaptability.
PO4	**Digital Intelligence:** Demonstrate proficiency in varied digital and technological tools to understand and interact with the digital world, thus effectively processing complex information.
PO5	**Scientific Awareness and Critical Thinking:** Emerge as an innovative problem-solver and impactful mediator, applying scientific understanding and critical thinking to address challenges and advance sustainable solutions.
PO6	**Human Values, Professional Ethics, and Societal and Environmental Responsibility:** Become a responsible leader, characterized by an unwavering commitment to human values, ethical conduct, and a fervent dedication to the well-being of society and the environment.
PO7	**Research, Innovation, and Entrepreneurship:** Emerge as a researcher and entrepreneurial leader, forging collaborative partnerships with industry, academia, and communities to contribute enduring solutions for local, regional, and global development.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

At the end of the B. Sc. Botany Honours programme at Sacred Heart College, Chalakudy, a student would

PSO1	Understand and articulate fundamental concepts in botany, the role of plants in aesthetics, the range of plant diversity, biosafety, and intellectual property rights, thereby establishing a foundational knowledge of plant science conducive to subsequent study and research.
PSO2	Appreciate nature, and become socially responsible citizens by using the acquired knowledge to help conserve environment
PSO3	Critically Analyse and Apply botanical knowledge to address real-world issues, employing practical skills in Plant Sciences for personal, professional, environmental, and societal benefits, while developing a research-oriented mindset in related fields.
PSO4	Evaluate the validity and reliability of scientific evidence in botany, critically assessing research methods and conclusions in plant science studies, and effectively communicate botany-related concepts, research findings, and scientific information.
PSO5	Design, Conduct, and Analyse experiments using appropriate techniques and tools in the field of botany, while integrating information from various disciplines within and related to botany, such as bioinformatics, nanoscience, biotechnology, forensic botany, and artificial intelligence.
PSO6	Develop innovative solutions for conservation and sustainable plant resource management, bioprospecting, and sustainable agriculture using principles of plant science, while demonstrating creativity and entrepreneurial skills through project design and implementation.

MINIMUM CREDIT REQUIREMENTS OF THE DIFFERENT PATHWAYS
IN THE THREE-YEAR PROGRAMME IN SHFYUGP

Sl. No	Academic Pathway	Major	Minor/ Other Disciplines	Foundation Courses AEC: 4 MDC: 3 SEC: 3 VAC: 3	Intern-ship	Total Credits	Example
		Each course has 4 credits		Each course has 3 credits			
1	Single Major (A)	68 (17 courses)	24 (6 courses)	39 (13 courses)	2	133	Major: Botany + six courses in different disciplines in different combinations
2	Major (A) with Multiple Disciplines (B, C)	68 (17 courses)	12 + 12 (3 + 3 = 6 courses)	39 (13 courses)	2	133	Major: Botany + Chemistry and Zoology
3	Major (A) with Minor (B)	68 (17 courses)	24 (6 courses)	39 (13 courses)	2	133	Major: Botany Minor: Chemistry
4	Major (A) with Vocational Minor (B)	68 (17 courses)	24 (6 courses)	39 (13 courses)	2	133	Major: Botany Minor: Computational Biology
5	Double Major (A, B)	A: 48 (12 courses) B: 44 (11 courses)	- The 24 credits in the Minor stream are distributed between the two Majors. 2 MDC, 2 SEC, 2 VAC and the Internship should be in Major A. Total credits in Major A should be 48 + 20 = 68 (50% of 133) 1 MDC, 1 SEC and 1 VAC should be in Major B. Total credits in Major B should be 44 + 9 = 53 (40% of 133)	12 + 18 + 9	2	133	Botany and Zoology double major
Exit with UG Degree / Proceed to Fourth Year with 133 Credits							

B.Sc. BOTANY HONOURS PROGRAMME

COURSE STRUCTURE FOR PATHWAYS 1 – 4

1. Single Major
2. Major with Multiple Disciplines
3. Major with Minor
4. Major with Vocational Minor

Semester	Course Code	Course Title	Total Hours	Hours/ Week	Credits	Marks		
						Internal	External	Total
1	BOT1CJ 101/ BOT1MN100	Core Course 1 in Major **Aesthetic Botany**	75	5	4	30	70	100
		Minor Course 1	60/ 75	4/ 5	4	30	70	100
		Minor Course 2	60/ 75	4/ 5	4	30	70	100
	ENG1FA 101(2)	Ability Enhancement Course 1 English	60	4	3	25	50	75
		Ability Enhancement Course 2 Additional Language	45	3	3	25	50	75
		Multi-Disciplinary Course 1 Other than Major	45	3	3	25	50	75
		Total		**23/ 25**	**21**			**525**
2	BOT2CJ 101/ BOT2MN100	Core Course 2 in Major **Microbial Diversity & Phyto -Pathology**	75	5	4	30	70	100
		Minor Course 3	60/ 75	4/ 5	4	30	70	100
		Minor Course 4	60/ 75	4/ 5	4	30	70	100
	ENG2FA 103(2)	Ability Enhancement Course 3 English	60	4	3	25	50	75
		Ability Enhancement Course 4 Additional Language	45	3	3	25	50	75
		Multi-Disciplinary Course 2 Other than Major	45	3	3	25	50	75
		Total		**23/ 25**	**21**			**525**
3	BOT3CJ 201	Core Course 3 in Major **Plant Embryology, Palynology & Evolution**	60	4	4	30	70	100
	BOT3CJ 202/ BOT3MN200	Core Course 4 in Major **Plant Anatomy & Analytical techniques**	75	5	4	30	70	100

		Minor Course 5	60/ 75	4/ 5	4	30	70	100
		Minor Course 6	60/ 75	4/ 5	4	30	70	100
		Multi-Disciplinary Course 3 Kerala Knowledge System	45	3	3	25	50	75
	ENG3FV 108(2)	Value-Added Course 1 English	45	3	3	25	50	75
		Total		**23/ 25**	**22**			**550**
4	BOT4CJ 203	Core Course 5 in Major **Plant Diversity I**	75	5	4	30	70	100
	BOT4CJ 204	Core Course 6 in Major **Phytochemistry & Pharmacognosy**	75	5	4	30	70	100
	BOT4CJ 205	Core Course 7 in Major **Cell & Molecular Biology**	75	5	4	30	70	100
	ENG4FV 109(2)	Value - Added Course 2 English	45	3	3	25	50	75
		Value-Added Course 3 Additional Language	45	3	3	25	50	75
	ENG4FS 111(2)	Skill Enhancement Course 1 English	60	4	3	25	50	75
		Total		**25**	**21**			**525**
5	BOT5CJ 301	Core Course 8 in Major **Plant Diversity II**	75	5	4	30	70	100
	BOT5CJ 302	Core Course 9 in Major **Angiosperm Morphology, Systematics & Plant Resources**	75	5	4	30	70	100
	BOT5CJ 303	Core Course 10 in Major **Genetics, Plant Breeding & Palaeobotany**	60	4	4	30	70	100
		Elective Course 1 in Major	60	4	4	30	70	100
		Elective Course 2 in Major	60	4	4	30	70	100
		Skill Enhancement Course 2	45	3	3	25	50	75
		Total		**25**	**23**			**575**
6	BOT6CJ 304/ BOT8M N304	Core Course 11 in Major **Plant Physiology & Metabolism**	75	5	4	30	70	100
	BOT6CJ 305/ BOT8M N305	Core Course 12 in Major **Plant Biotechnology, Nanotechnology & Bioinformatics**	75	5	4	30	70	100

	BOT6CJ 306/ BOT8M N306	Core Course 13 in Major **Environmental Science & Phytogeography**		60	4	4	30	70	100
		Elective Course 3 in Major		60	4	4	30	70	100
		Elective Course 4 in Major		60	4	4	30	70	100
	BOT6FS 113 (1)	Skill Enhancement Course 3 - **Phytochemical Techniques**	Any one	45	3	3	25	50	75
	BOT6FS 113 (2)	**Essential Oils & Perfumery**							
	BOT6FS 113 (3)	**Seaweed Farming**							
	BOT6CJ 349	Internship in Major (Credit for internship to be awarded only at the end of Semester 6)		60		2	50	-	50
		Total			**25**	**25**			**625**
Total Credits for Three Years						**133**			**3325**
7	BOT7CJ 401	Core Course 14 in Major **Advances in Microbiology & Thallophytes**		75	5	4	30	70	100
	BOT7CJ 402	Core Course 15 in Major **Advances in Archegoniates**		75	5	4	30	70	100
	BOT7CJ 403	Core Course 16 in Major **Advanced Plant Systematics**		75	5	4	30	70	100
	BOT7CJ 404	Core Course 17 in Major **Advanced Cell & Molecular Biology**		75	5	4	30	70	100
	BOT7CJ 405	Core Course 18 in Major **Multi-omics Approach in Biology**		75	5	4	30	70	100
		Total			**25**	**20**			**500**
8	BOT8CJ 406 / BOT8M N406	Core Course 19 in Major **Geobotanical Mapping & Sustainable Development**		75	5	4	30	70	100
	BOT8CJ 407 / BOT8M N407/	Core Course 20 in Major- **Crop Improvement & Plant Pathology**		60	4	4	30	70	100

	BOT8CJ 408 / BOT8MN408/ BOT8VN302	Core Course 21 in Major- **Smart Farming**	60	4	4	30	70	100
	OR (instead of Core Courses 19-21 in Major)							
	BOT8CJ 449	Project (in Honours programme)	360	13	12	90	210	300
	BOT8CJ 499	Project (in Honours with Research programme)	360	13	12	90	210	300
		Elective Course 5 in Major / Minor Course 7	60	4	4	30	70	100
		Elective Course 6 in Major / Minor Course 8	60	4	4	30	70	100
		Elective Course 7 in Major / Minor Course 9 / Major Course in any Other Discipline	60	4	4	30	70	100
	OR (instead of Elective Course 7 in Major, in the case of Honours with Research Programme)							
	BOT8CJ 489	**Research Methodology in Botany**	60	4	4	30	70	100
		Total		**25**	**24**			**600**
Total Credits for Four Years					**177**			**4425**

The teacher should have 13hrs/week of engagement (the hours corresponding to the three core courses) in the guidance of the Project(s) in Honours programme and Honours with Research programme, while each student should have 24 hrs/week of engagement in the Project work. Total hours are given based on the student‘s engagement.

CREDIT DISTRIBUTION FOR PATHWAYS 1 – 4

1. Single Major
2. Major with Multiple Disciplines
3. Major with Minor
4. Major with Vocational Minor

Semester	Major Courses	Minor Courses	General Foundation Courses	Internship/ Project	Total
1	4	4 + 4	3 + 3 + 3	-	21
2	4	4 + 4	3 + 3 + 3	-	21
3	4 + 4	4 + 4	3 + 3	-	22
4	4 + 4 + 4	-	3 + 3 + 3	-	21
5	4 + 4 + 4 + 4 + 4	-	3	-	23
6	4 + 4 + 4 + 4 + 4	-	3	2	25
Total for Three Years	**68**	**24**	**39**	**2**	**133**
7	4 + 4 + 4 + 4 + 4	-	-	-	20
8	4 + 4 + 4	4 + 4 + 4	-	12*	24
*Instead of three Major courses					
Total for Four Years	**88 + 12 = 100**	**36**	**39**	**2**	**177**

DISTRIBUTION OF MAJOR COURSES IN BOTANY FOR PATHWAYS 1 – 4

1. Single Major
2. Major with Multiple Disciplines
3. Major with Minor
4. Major with Vocational Minor

Semester	Course Code	Course Title	Hours/ Week	Credits
1	BOT1CJ101 / BOT1MN100	Core Course 1 in Major - **Aesthetic Botany**	5	4
2	BOT2CJ101 / BOT2MN100	Core Course 2 in Major - **Microbial Diversity & Phyto Pathology**	5	4
3	BOT3CJ201	Core Course 3 in Major - **Plant Embryology, Palynology & Evolution**	4	4

	BOT3CJ202 / BOT3MN200	Core Course 4 in Major - **Plant Anatomy & Analytical Techniques**	5	4
4	BOT4CJ203	Core Course 5 in Major – **Plant Diversity I**	5	4
	BOT4CJ204	Core Course 6 in Major - **Phytochemistry & Pharmacognosy**	5	4
	BOT4CJ205	Core Course 7 in Major - **Cell & Molecular Biology**	5	4
5	BOT5CJ301	Core Course 8 in Major - **Plant Diversity II**	5	4
	BOT5CJ302	Core Course 9 in Major - **Angiosperm Morphology, Systematics & Plant Resources**	5	4
	BOT5CJ303	Core Course 10 in Major - **Genetics, Plant Breeding & Palaeobotany**	4	4
		Elective Course 1 in Major	4	4
		Elective Course 2 in Major	4	4
6	BOT6CJ304 / BOT8MN304	Core Course 11 in Major - **Plant Physiology & Metabolism**	5	4
	BOT6CJ305 / BOT8MN305	Core Course 12 in Major - **Plant Biotechnology, Nanotechnology & Bioinformatics**	5	4
	BOT6CJ306 / BOT8MN306	Core Course 13 in Major- **Environmental Science & Phytogeography**	4	4
		Elective Course 3 in Major	4	4
		Elective Course 4 in Major	4	4
	BOT6CJ349	Internship in Major	-	2
Total for the Three Years				**70**
7	BOT7CJ401	Core Course 14 in Major- **Advances in Microbiology & Thallophytes**	5	4
	BOT7CJ402	Core Course 15 in Major- **Advances in Archegoniates**	5	4
	BOT7CJ403	Core Course 16 in Major-	5	4

		Advanced Plant Systematics		
	BOT7CJ404	Core Course 17 in Major- **Advanced Cell & Molecular Biology**	5	4
	BOT7CJ405	Core Course 18 in Major- **Multi-omics Approach in Biology**	5	4
8	BOT8CJ406 / BOT8MN406	Core Course 19 in Major- **Geobotanical Mapping & Sustainable Development**	5	4
	BOT8CJ407 / BOT8MN407	Core Course 20 in Major- **Crop Improvement & Plant Pathology**	4	4
	BOT8CJ408 / BOT8MN408/ BOT8VN302/	Core Course 21 in Major- **Smart Farming**	4	4
	OR (instead of Core Courses 19-21 in Major)			
	BOT8CJ449	Project (Honours programme)	13	12
	BOT8CJ499	Project (Honours with Research programme)	13	12
		Elective Course 5 in Major	4	4
		Elective Course 6 in Major	4	4
		Elective Course 7 in Major	4	4
	OR (instead of Elective course 7 in Major, in Honours with Research programme)			
	BOT8CJ489	**Research Methodology in Botany**	4	4
Total for the Four Years				**114**

GROUPING OF MINOR COURSES IN BOTANY

(Title of the Minor: **GENERAL BOTANY)**

Group No.	Sl. No	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
								Internal	External	Total
1	**BOTANICAL DIVERSITY**									
	1	BOT1MN101	**Plant Ecology, Conservation & Plant Interactions**	1	75	5	4	30	70	100
	2	BOT2MN101	**Plant Morphology, Physiology & Plant Resources**	2	75	5	4	30	70	100
	3	BOT3MN201	**Plant Diversity & Angiosperm Taxonomy**	3	75	5	4	30	70	100
2	**INDUSTRIAL BOTANY**									
	1	BOT1MN102	**Phytochemistry**	1	75	5	4	30	70	100
	2	BOT2MN102	**Secondary Metabolites & Biofuels**	2	75	5	4	30	70	100
	3	BOT3MN202	**Essential oils of Aromatic Plants**	3	75	5	4	30	70	100
3	**PLANTS IN HUMAN WELLNESS**									
	1	BOT1MN103	**Economic Botany**	1	75	5	4	30	70	100
	2	BOT2MN103	**Plant Nutraceuticals**	2	75	5	4	30	70	100
	3	BOT3MN203	**Ethnobotany**	3	75	5	4	30	70	100
4	**AESTHETIC BOTANY**									
	1	BOT1MN100	**Aesthetic Botany**	1	75	5	4	30	70	100
	2	BOT2MN100	**Microbial Diversity & Phyto-Pathology**	2	75	5	4	30	70	100
	3	BOT3MN200	**Plant Anatomy & Analytical Techniques**	3	75	5	4	30	70	100

GROUPING OF VOCATIONAL MINOR COURSES IN BOTANY

(Title of the Vocational Minor: **VOCATIONAL BOTANY)**

Group No.	Sl. No.	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
								Internal	External	Total
1		**COMPUTATIONAL BOTANY**								
	1	BOT1VN101	**Computational Botany**	1	75	5	4	30	70	100
	2	BOT2VN101	**Biostatistics**	2	75	5	4	30	70	100
	3	BOT3VN201	**Bioinformatics**	3	75	5	4	30	70	100
	4	BOT8VN301/ BOT8EJ401	**Artificial Intelligence in Plant Science**	8	60	4	4	30	70	100
2		**HORTICULTURE TECHNIQUES**								
	1	BOT1VN102	**Horticulture & Nursery Management**	1	75	5	4	30	70	100
	2	BOT2VN102	**Plant Propagation Techniques**	2	75	5	4	30	70	100
	3	BOT3VN202	**Biofertilizer Technology**	3	75	5	4	30	70	100
	4	BOT8VN302 /BOT8CJ408	**Smart Farming**	8	60	4	4	30	70	100

(i) Students in Single Major pathway can choose course/courses from any of the Minor/ Vocational Minor groups offered by a discipline other than their Major discipline.

(ii)Students in Major with Multiple Disciplines pathway can choose all the three courses from any one of the Minor/ Vocational Minor groups offered by any discipline, other than his Major discipline as one of the multiple disciplines.

(iii) Students in Major with Minor pathway can choose all the courses from any two Minor groups offered by any discipline.

(iv) Students in Major with Vocational Minor pathway can choose all the courses from any two Vocational Minor groups offered by any discipline. The title of the Vocational Minor will be **Vocational Botany**

DISTRIBUTION OF GENERAL FOUNDATION COURSES IN BOTANY

Semester	Course Code	Course Title		Total Hours	Hours/ Week	Credits	Marks		
							Internal	External	Total
1	BOT1FM105 (1)	Multi-Disciplinary Course 1 - **Incredible Plant Kingdom**	Any one	45	3	3	25	50	75
	BOT1FM105 (2)	**Plant Propagation**							
2	BOT2FM106 (1)	Multi-Disciplinary Course 2 - **Ecosystem Diversity in India**	Any one	45	3	3	25	50	75
	BOT2FM106 (2)	**Plants in Everyday Life**							
3	BOT3FV108	Value-Added Course 1 -**Biodiversity & Conservation**		45	3	3	25	50	75
4	BOT4FV110	Value-Added Course 2 - **Environment & Climate Change**		45	3	3	25	50	75
5	BOT5FS112 (1)	Skill Enhancement Course 2 -**Herbal Technology**	Any one	45	3	3	25	50	75
	BOT5FS112 (2)	**Landscaping and Gardening**							
6	BOT6FS113 (1)	Skill Enhancement Course 3 - **Phytochemical Techniques**	Any one	45	3	3	25	50	75
	BOT6FS113 (2)	**Essential Oils & Perfumery**							
	BOT6FS113 (3)	**Seaweed Farming**							

EVALUATION SCHEME

1. The evaluation scheme for each course contains two parts: internal evaluation (about 30%) and external evaluation (about 70%). Each of the Major and Minor courses is of 4-credits. It is evaluated for 100 marks, out of which 30 marks is from internal evaluation and 70 marks, from external evaluation. Each of the General Foundation course is of 3-credits. It is evaluated for 75 marks, out of which 25 marks is from internal evaluation and 50 marks, from external evaluation.
2. The 4-credit courses (Major and Minor courses) are of two types: (i) courses with only theory and (ii) courses with 3-credit theory and 1-credit practical.
    - In 4-credit courses with only theory component, out of the total 5 modules of the syllabus, one open-ended module with 20% content is designed by the faculty member teaching that course, and it is internally evaluated for 10 marks. The internal evaluation of the remaining 4 theory modules is for 20 marks.
    - In 4-credit courses with 3-credit theory and 1-credit practical components, out of the total 5 modules of the syllabus, 4 modules are for theory and the fifth module is for practical. The practical component is internally evaluated for 20 marks. The internal evaluation of the 4 theory modules is for 10 marks.
3. All the 3-credit courses (General Foundational Courses) in Botany are with only theory component. Out of the total 5 modules of the syllabus, one open-ended module with 20% content is designed by the faculty member teaching that course, and it is internally evaluated for 5 marks. The internal evaluation of the remaining 4 theory modules is for 20 marks.

Sl. No.	Nature of the Course		Internal Evaluation in Marks (about 30% of the total)		External Exam on 4 modules (Marks)	Total Marks
			Open-ended module / Practical	On the other 4 modules		
1	4-credit course	only theory (5 modules)	10	20	70	100
2	4-credit course	Theory (4 modules) + Practical	20	10	70	100
3	3-credit course	only theory (5 modules)	5	20	50	75

1. MAJOR AND MINOR COURSES

1.1. INTERNAL EVALUATION OF THEORY COMPONENT

Sl. No.	Components of Internal Evaluation of Theory Part of a Major / Minor Course	Internal Marks for the Theory Part of a Major / Minor Course of 4-credits			
		Theory Only		Theory + Practical	
		4 Theory Modules	Open-ended Module	4 Theory Modules	Practical
1	Test paper/ Mid-semester Exam	10	4	5	-
2	Seminar/ Viva/ Quiz	6	4	3	-
3	Assignment	4	2	2	-
Total		20	10	10	20*
		30		30	

* Refer the table in section 1.2 for the evaluation of practical component

1.2. EVALUATION OF PRACTICAL COMPONENT

The evaluation of practical component in Major and Minor courses is completely by internal evaluation.

- Continuous evaluation of practical by the teacher-in-charge shall carry a weightage of 50%.
- Lab activities are to be regularly recorded in the Practical Book/Journal. The students are required to present a duly certified Practical Book/Journal, field reports and submissions wherever applicable, for appearing at the practical examination, failing which they will not be allowed to appear for the examination.
- The end-semester practical examination and viva-voce, and the evaluation of practical records shall be conducted by the teacher in-charge and an internal examiner appointed by the Department Council.
- Practical exam may include components designed to test a range of skills. These may involve demonstrating scientific experiments, innovations, identifying specimens on the spot, solving relevant problems etc.
- The process of continuous evaluation of practical courses shall be completed before 10 days from the commencement of the end-semester examination.
- Those who passed in continuous evaluation alone will be permitted to appear for the end-semester examination and viva-voce.

The scheme of continuous evaluation and the end-semester examination and viva-voce of practical component shall be as given below:

Sl. No.	Evaluation of Practical Component of Credit-1 in a Major / Minor Course	Marks for Practical	Weightage
1	Continuous evaluation of practical/ exercise performed in practical classes by the students (Performance in Lab - 7 marks; Attendance in the Lab - 3 marks)	10	50%
2	End-semester examination and viva-voce to be conducted by teacher-in-charge along with an additional examiner arranged internally by the Department Council	7	35%
3	Evaluation of the Practical records submitted for the end semester viva–voce examination by the teacher-in-charge and additional examiner	3	15%
	Total Marks	20	

1.3. EXTERNAL EVALUATION OF THEORY COMPONENT

External evaluation carries 70% marks. Examinations will be conducted at the end of each semester. Individual questions are evaluated in marks and the total marks are converted into grades by the University based on 10-point grading system (refer section 5).

PATTERN OF QUESTION PAPER FOR MAJOR AND MINOR COURSES

Duration	Type	Total No. of Questions	No. of Questions to be Answered	Marks for Each Question	Ceiling of Marks
2 Hours	Short Answer	10	8 – 10	3	24
	Paragraph/ Problem	8	6 – 8	6	36
	Essay	2	1	10	10
Total Marks					70

2. INTERNSHIP

- All students should undergo Internship of 2-credits during the first six semesters in a firm, industry or organization, or training in labs with faculty and researchers of their own institution or other Higher Educational Institutions (HEIs) or research institutions.
- Internship can be for enhancing the employability of the student or for developing the research aptitude.
- Internship can involve short term work experience, experiential learning, hands-on training on a particular skill/ equipment/techniques. It can be a short project on a specific problem or area. Attending seminars or workshops related to an area of learning or skill can be a component of Internship.

- A faculty member/ scientist/ instructor of the respective institution, where the student does the Internship, should be the supervisor of the Internship.

2.1. GUIDELINES FOR INTERNSHIP

- Internship can be in Botany or allied disciplines.
- There should be minimum 60 hrs. of engagement from the student in the Internship.
- Summer vacations and other holidays can be used for completing the Internship.
- The students should make regular and detailed entries in to a personal log book through the period of Internship. The log book will be a record of the progress of the Internship and the time spent on the work, and it will be useful in writing the final report. It may contain details of data collection, experimental conditions and results, ideas, rough work and calculation, etc. All entries should be dated. The Internship supervisor should periodically examine and countersign the log book.
- The log book and the typed report must be submitted at the end of the Internship.
- The institution at which the Internship will be carried out should be prior-approved by the Department Council of the college where the student has enrolled for the UG Honours programme.

2.2. FORMAT OF THE INTERNSHIP REPORT

1. Title page
2. Statement of attendance forwarded by the external supervisor
3. Internship Certificate, from where the internship is done which contains Name of internship centre, the area of internship, duration, performance evaluation, and date, should be included and signed by the internship supervisor and head of the internship institution
4. Introduction - Details and Profile of the institute
5. Report of the work done.
6. Summary

2.3. EVALUATION OF INTERNSHIP

- The evaluation of Internship shall be done internally through continuous assessment mode by a committee internally constituted by the Department Council of the college where the student has enrolled for the UG Honours programme.
- The credits and marks for the Internship will be awarded only at the end of semester 6.
- The scheme of continuous evaluation and the end-semester viva-voce examination based on the submitted report shall be as given below:

Sl. No.	Components of Evaluation of Internship		Marks for Internship 2 Credits	Weightage
1	Continuous evaluation of internship through interim presentations and reports by the committee internally constituted by the Department Council	Acquisition of skill set	10	40%
2		Interim Presentation and	5	

		Viva-voce		
3		Punctuality and Log Book	5	
4	End-semester viva-voce examination to be conducted by the committee internally constituted by the Department Council	Quality of the work	8	40%
5		Presentation of the work	6	
6		Viva-voce	6	
7	Evaluation of the day-to-day records, the report of internship supervisor, and final report submitted for the end semester viva–voce examination before the committee internally constituted by the Department Council		10	20%
	Total Marks		50	

3. PROJECT

3.1. PROJECT IN HONOURS PROGRAMME

- In Honours programme, the student has the option to do a Project of 12-credits instead of three Core Courses in Major in semester 8.
- The Project can be done in the same institution or any other higher educational institution (HEI)/ research centre/training centre
- The Project in Honours programme can be a short research work or an extended internship or a skill-based training programme.
- A faculty member of the respective institution, where the student does the Project, should be the supervisor of the Project.

3.2. PROJECT IN HONOURS WITH RESEARCH PROGRAMME

- Students who secure 75% marks and above (equivalently, CGPA 7.5 and above) cumulatively in the first six semesters are eligible to get selected to Honours with Research stream in the fourth year.
- A relaxation of 5% in marks (equivalently, a relaxation of 0.5 grade in CGPA) is allowed for those belonging to SC/ ST/ OBC (non-creamy layer)/ Differently-Abled/ Economically Weaker Section (EWS)/ other categories of candidates as per the decision of the UGC from time to time.
- In Honours with Research programme, the student has to do a mandatory Research Project of 12-credits instead of three Core Courses in Major in semester 8.
- The approved research centres of University of Calicut or any other university/ HEI can offer the Honours with Research programme. The departments in the affiliated colleges under University of Calicut, which are not the approved research centres of the University, should get prior approval from the University to offer the Honours with Research programme. Such departments should have minimum two faculty members with Ph.D., and they should also have the necessary infrastructure to offer Honours with Research programme.

- A faculty member of the University/ College with a Ph.D. degree can supervise the research project of the students who have enrolled for Honours with Research. One such faculty member can supervise maximum five students in Honours with Research stream.
- The maximum intake of the department for Honours with Research programme is fixed by the department based on the number of faculty members eligible for project supervision, and other academic, research, and infrastructural facilities available.
- If a greater number of eligible students are opting for the Honours with Research programme than the number of available seats, then the allotment shall be based on the existing rules of reservations and merits.

3.3. GUIDELINES FOR THE PROJECT IN HONOURS PROGRAMME AND HONOURS WITH RESEARCH PROGRAMME

- Project can be in Botany or allied disciplines.
- Project should be done individually.
- Project work can be of experimental/ theoretical/ exploration in nature.
- There should be minimum 360 hrs. of engagement from the student in the Project work in Honours programme as well as in Honours with Research programme.
- There should be minimum 13 hrs./week of engagement (the hours corresponding to the three core courses in Major in semester 8) from the teacher in the guidance of the Project(s) in Honours programme and Honours with Research programme.
- The various steps in project works are the following:
    1. Wide review of a topic.
    2. Investigation on a problem in systematic way using appropriate techniques.
    3. Systematic recording of the work.
    4. Reporting the results with interpretation/statistical analysis in a standard documented form.
    5. Presenting the results before the examiners.
- During the Project the students should make regular and detailed entries in to a personal log book through the period of investigation. The log book will be a record of the progress of the Project and the time spent on the work, and it will be useful in writing the final report. It may contain experimental conditions and results, ideas, methodologies, rough work and calculation, etc. All entries should be dated. The Project supervisor should periodically examine and countersign the log book.
- The log book and the typed report must be submitted at the end of the Project. A copy of the report should be kept for reference at the department. A soft copy of the report too should be submitted, to be sent to the external examiner in advance.
- It is desirable, but not mandatory, to publish the results of the Project in a peer reviewed journal.
- The project report shall have an undertaking from the student and a certificate from the research supervisor for originality of the work, stating that there is no plagiarism, and that the work has not been submitted for the award of any other degree/ diploma in the same institution or any other institution.

- The project proposal, institution at which the project is being carried out, and the project supervisor should be prior-approved by the Department Council of the college where the student has enrolled for the UG Honours programme.

3.4. EVALUATION OF PROJECT

- The evaluation of Project will be conducted at the end of the eighth semester by both internal and external modes.
- The Project in Honours programme as well as that in Honours with Research programme will be evaluated for 300 marks. Out of this, 90 marks is from internal evaluation and 210 marks, from external evaluation.
- The internal evaluation of the Project work shall be done through continuous assessment mode by a committee internally constituted by the Department Council of the college where the student has enrolled for the UG Honours programme. 30% of the weightage shall be given through this mode.
- The remaining 70% shall be awarded by the external examiner appointed by the University.
- The scheme of continuous evaluation and the end-semester viva-voce of the Project shall be as given below:

Components of Evaluation of Project	Marks for the Project (Honours/ Honours with Research)	Weightage
Continuous evaluation of project work through interim presentations and reports by the committee internally constituted by the Department Council	90	30%
End-semester viva-voce examination to be conducted by the external examiner appointed by the university	150	50%
Evaluation of the day-to-day records and project report submitted for the end-semester viva–voce examination conducted by the external examiner	60	20%
Total Marks	300	

INTERNAL EVALUATION OF PROJECT

Sl. No	Components of Evaluation of Project	Marks for the Project (Honours/ Honours with Research)
1	Skill in doing project work	30
2	Interim Presentation and Viva-Voce	20
3	Punctuality and Log book	20
4	Scheme/ Organization of Project Report	20
	Total Marks	90

EXTERNAL EVALUATION OF PROJECT

Sl. No	Components of Evaluation of Project	Marks for the Project (Honours/ Honours with Research) 12 credits
1	Content and relevance of the Project, Methodology, Quality of analysis, and Innovations of Research	50
2	Presentation of the Project	50
3	Project Report (typed copy), Log Book and References	60
4	Viva-Voce	50
	Total Marks	210

4. GENERAL FOUNDATION COURSES

All the General Foundation Courses (3-credits) in Botany are with only theory component.

4.1. INTERNAL EVALUATION

Sl. No.	Components of Internal Evaluation of a General Foundation Course in Botany	Internal Marks of a General Foundation Course of 3-credits in Botany	
		4 Theory Modules	Open-ended Module
1	Test paper/ Mid-semester Exam	10	2
2	Seminar/ Viva/ Quiz	6	2
3	Assignment	4	1
		20	5
	Total	25	

4.2. EXTERNAL EVALUATION

External evaluation carries about 70% marks. Examinations will be conducted at the end of each semester. Individual questions are evaluated in marks and the total marks are converted into grades by the University based on 10-point grading system (refer section 5).

PATTERN OF QUESTION PAPER FOR GENERAL FOUNDATION COURSES

Duration	Type	Total No. of Questions	No. of Questions to be Answered	Marks for Each Question	Ceiling of Marks
1.5 Hours	Short Answer	10	8 – 10	2	16
	Paragraph/ Problem	5	4 – 5	6	24
	Essay	2	1	10	10
				Total Marks	50

5. LETTER GRADES AND GRADE POINTS

- Mark system is followed for evaluating each question.
- For each course in the semester letter grade and grade point are introduced in 10-point indirect grading system as per guidelines given below.
- The Semester Grade Point Average (SGPA) is computed from the grades as a measure of the student‘s performance in a given semester.
- The Cumulative GPA (CGPA) is based on the grades in all courses taken after joining the programme of study.
- Only the weighted grade point based on marks obtained shall be displayed on the grade card issued to the students.

LETTER GRADES AND GRADE POINTS

Sl. No.	Percentage of Marks (Internal & External Put Together)	Description	Letter Grade	Grade Point	Range of Grade Points	Class
1	95% and above	Outstanding	O	10	9.50 – 10	First Class with Distinction
2	Above 85% and below 95%	Excellent	A+	9	8.50 – 9. 49	
3	75% to below 85%	Very Good	A	8	7.50 – 8.49	
4	65% to below 75%	Good	B+	7	6.50 – 7.49	First Class
5	55% to below 65%	Above Average	B	6	5.50 – 6.49	
6	45% to below 55%	Average	C	5	4.50 – 5.49	Second Class
7	35% to below 45% aggregate (internal and external put together) with a minimum of 30% in external valuation	Pass	P	4	3.50 – 4.49	Third Class
8	Below an aggregate of 35% or below 30% in external evaluation	Fail	F	0	0 – 3.49	Fail
9	Not attending the examination	Absent	Ab	0	0	Fail

- When students take audit courses, they will be given Pass (P) or Fail (F) grade without any credits.
- The successful completion of all the courses and capstone components prescribed for the three-year or four-year programme with 'P' grade shall be the minimum requirement for the award of UG Degree or UG Degree Honours or UG Degree Honours with Research, as the case may be.

5.1. COMPUTATION OF SGPA AND CGPA

- The following method shall be used to compute the Semester Grade Point Average (SGPA):

  The SGPA equals the product of the number of credits (Ci) with the grade points (Gi) scored by a student in each course in a semester, summed over all the courses taken by a student in the semester, and then divided by the total number of credits of all the courses taken by the student in the semester,

  $$\text{i.e. SGPA (Si)} = \Sigma i\ (Ci \times Gi) / \Sigma i\ (Ci)$$

  where Ci is the number of credits of the i^{th} course and Gi is the grade point scored by the student in the i^{th} course in the given semester. Credit Point of a course is the value obtained by multiplying the credit (Ci) of the course by the grade point (Gi) of the course.

  $$\text{SGPA} = \frac{\text{Sum of the credit points of all the courses in a semester}}{\text{Total credits in that semester}}$$

ILLUSTRATION – COMPUTATION OF SGPA

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course 1	3	A	8	3 x 8 = 24
I	Course 2	4	B+	7	4 x 7 = 28
I	Course 3	3	B	6	3 x 6 = 18
I	Course 4	3	O	10	3 x 10 = 30
I	Course 5	3	C	5	3 x 5 = 15
I	Course 6	4	B	6	4 x 6 = 24
	Total	20			139
	SGPA				139/20 = 6.950

- The Cumulative Grade Point Average (CGPA) of the student shall be calculated at the end of a programme. The CGPA of a student determines the overall academic level of the student in a programme and is the criterion for ranking the students.

  CGPA for the three-year programme in SHFYUGP shall be calculated by the following formula.

  $$\text{CGPA} = \frac{\text{Sum of the credit points of all the courses in six semesters}}{\text{Total credits in six semesters (133)}}$$

  CGPA for the four-year programme in SHFYUGP shall be calculated by thefollowing formula.

  $$\text{CGPA} = \frac{\text{Sum of the credit points of all the courses in eight semesters}}{\text{Total credits in eight semesters (177)}}$$

- The SGPA and CGPA shall be rounded off to three decimal points and reported in the transcripts.
- Based on the above letter grades, grade points, SGPA and CGPA, the University shall issue the transcript for each semester and a consolidated transcript indicating the performance in all semesters.

MINOR COURSES

AESTHETIC BOTANY

Programme	B. Sc. BOTANY				
Course Title	**Aesthetic Botany**				
Type of Course	**Minor**				
Semester	**I**				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Higher secondary level biology course				
Course Summary	This course offers basic idea in gardening, horticulture, photography, illustration, and craft making using botanicals.				

Course Outcomes (CO): After completing the Course, the student should be able to:-

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Demonstrate basic principles of gardening to successfully grow and maintain plants	U	C	Practical Assignment/ Quiz
CO2	Demonstrate fundamental knowledge in plant propagation and care	U	C	Observation of Practical Skills/ Quiz
CO3	Identify the importance of floriculture and its market	U	C	Seminar Presentation
CO4	Translate the passion for plants into captivating botanical imagery	Ap	P	Home Assignments
CO5	Implement techniques to plan, plant, and nurture both indoor and outdoor gardens	Ap	P	Home Assignments
CO6	Design art pieces using plant parts	C	P	Observation of Practical Skills

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)
I	**Introduction to Aesthetic Botany**		**15**
	1	Aesthetic characteristics of plants - Shape and outline, Structure and branching pattern, Symmetry of flowers, Geometric arrangements of leaves, Size and scale, Surface texture, Pattern and veining, Colour- flower hues, foliage variations, seasonal shifts.	2
	2	Landscaping - Goals, Types, Planning and layout, Style of gardens (Formal, Informal); Types of gardens (English, Mughal and Japanese)	2
	3	Gardening - definition; Principles of garden design, site selection, Features of a garden (Trees, shrubs and shrubberies, climbers and creepers, Lawn, Garden wall, Fences and gates, Paths and walkways, Borders, Hedge, Edging, Rockery, Flower beds, Pergola, Gazebo, Garden furniture, Solar-electric lights, Sculptures, Water garden)	3
	4	Propagating structures - green house, poly house, mist chamber, net frame	1
	5	Indoor gardening - selection of indoor plants, care and maintenance of indoor plants; Vertical gardens Some Famous gardens of India	3
	6	Bonsai - principle, types, methods & tools	2
	7	Aquascaping & Terrarium – Methods	2
II	**Horticultural techniques**		**15**
	8	Soil - components of soil, types of soil Fertilizers - chemical, organic, biofertilizer, composting systems Pots and Potting - Earthen, fibre, polythene bags Potting mixture, potting, repotting, top dressing. Irrigation - Surface, sprinkle, drip	4
	9	Garden tools and implements	1
	10	Seed propagation - Seed quality, seed treatment, essential conditions for successful propagation, raising of seed beds, transplanting techniques	2
	11	Vegetative propagation: a) Cutting (stem, roots, leaves) b) Grafting (approach, side, tongue)	3

		c) Budding (T-budding, patch) d) Layering (simple, trench, air)	
	12	Protection of horticultural plants - Precautions to avoid pests and diseases, biopesticides	1
	13	Hydroponics - Principle and method	1
	14	Floriculture - Industrial importance of ornamental plants Floriculture in India Cut flower market - Scope and prospects	2
	15	Flower shows and exhibitions – Importance	1
III	**Botanical documentation**		**8**
	16	Digital documentation – Basics	2
	17	Photography - Basics of Botanical Photography, Composition, Lighting and capturing, Editing and Presentation	2
	18	Micro and Macro photography	2
	19	Botanical illustrations - Botanical illustration techniques, Sketching, Water colour, Pen and Ink. Colour theory and Mixing; Significance	2
IV	**Botanical Art and Craft**		**7**
	20	Floral arrangements - Ikebana: Types of arrangements. Contemporary floral design styles.	3
	21	Resin embedding of flowers - techniques, methods and applications.	2
	22	Botanical printing - process and techniques	2
V	**Practical (Mandatory list)**		**30**
	1. Vegetative propagation-cutting, budding, grafting, layering 2. Familiarizing gardening tools and implements 3. Fresh and dry flower arrangements 4. Preparation of potting mixture and Polybag filling 5. Visit to public/institutional/ botanical gardens/nurseries/horticulture station (A brief report may be recorded)		
	Practical (Open ended/Suggestive list)		
	1. Preparation of bottle gardens 2. Terrarium making 3. Botanical Photographs 4. Bonsai preparation 5. Visit to flower shows and exhibitions		

Suggested Readings

- Andiance and Brison. 1971. Propagation Horticultural Plants.
- Chanda, K.L. and Choudhury, B. Ornamental Horticulture in India.
- George Acquaah. 2005. Horticulture: Principles and Practices. Pearson Education, Delhi.
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- Nishi Sinha: Gardening in India, Abhinav Publications, New Delhi.
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- Sudhir P. 2018. Landscape gardening. Scientific Publishers India.
- Gavino M. 2018. Floriculture and landscaping. Scitus Academics LLC.
- Percy L. 2004. Gardening in India. Oxford & IBH publishers.
- Laeeq F. 2008. Gardens. National book trust India Publishers.
- Ekta Chaudhary 2022. Garden Up. Penguin Random House India publishers.
- Prathap Rao M. 2020. Landscape Design. Standard Publishers and Distributors Pvt.
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Online Sources

- https://www.georgeweil.com/blog/botanical-printing-an-overview/
- https://www.lostincolours.com/eco-printing-for-beginners/
- https://www.instructables.com/Techniques-to-Embed-Flowers-in-Resin/
- https://www.researchgate.net/publication/341831968_Epoxy_resin_encapsulation_technique

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	-	-	-	-	-	3	-	1	-	1	-	-
CO2	3	-	-	-	-	-	3	-	1	-	1	-	-
CO3	3	-	-	-	-	1	3	-	1	-	-	-	-
CO4	3	-	-	-	-		3	-	3	2	-	-	-
CO5	3	-	1	-	-	-	3	-	3	-	2	-	-
CO6	3	-	-	-	-	-	3	-	3	-	-	1	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly/Low
2	Moderate/ Medium
3	Substantial/ High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		
CO 5		✓		✓
CO 6		✓	✓	

Programme	B. Sc. BOTANY				
Course Title	**Microbial Diversity and Phytopathology**				
Type of Course	**Minor**				
Semester	**II**				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Higher secondary level biology course				
Course Summary	This course aims to provide students with a comprehensive understanding of the microbiome and its significance in our surroundings. Students will explore the diversity of microflora and critically analyse their impact, both beneficial and harmful, on various aspects of human life and the biosphere.				

Course Outcomes: After completing the Course, the student should be able to:-

COs	**Statement**	**Cognitive level***	**Knowledge Category#**	**Evaluation Tools used**
CO1	Explain characteristic features of microbial life and their economic importance	U	F	Instructor-created exams / Quiz
CO2	Identify plant diseases and derive control measures	Ap	C & P	Seminar Presentation/Practical
CO3	Develop general awareness on the diversity of microorganisms	U	F	Instructor-created exams / Quiz
CO4	Examine the impact of microbes on the biosphere	An	C & P	Seminar presentation
CO5	Evaluate the significance of plant diseases with respect to crop production is concerned	E	P	In-class discussions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 + 30)
I	**Introduction to Microbiology and Virology**		**8**
	1	History, diversity of microbial world	1
	2	Whittaker's five kingdom system of classification. Evolutionary significance	1
	3	General characters of Viruses with emphasis on occurrence, architecture and multiplication	3
	4	Structure of Bacteriophages (T4), Virions, Prions, Mycoplasma	2
	5	General account on viral epidemics and pandemics and its pathogens - Covid, H1N1	1
II	**Bacteriology**		**15**
	6	General outline on Eubacteria and Archaebacteria, Thermophiles, Psychrophiles, and Halophiles	1
	7	Bacterial morphology and ultrastructure	3
	8	Cell Wall - Composition and detailed structure of Gram-positive and Gram-negative cell walls Gram and acid fast staining	2
	9	Effect of antibiotics and enzymes on the bacterial cell wall (brief account only).	1
	10	Cell membrane - Structure, function and chemical composition of bacterial cell membranes, mesosomes.	2
	11	Phases of growth (S-curve), Asexual methods of reproduction	1
	12	Gene transfer mechanism in bacteria - Conjugation, Transduction, and Transformation	3
	13	Pure culture isolation - Streaking, Serial dilution and Plating methods	1
	14	Cultivation, maintenance and preservation/stocking of pure cultures	1
III	**Applied Microbiology**		**12**
	15	Microbiology in agriculture - biofertilizer, bioinsecticides, nitrogen fixation, biofuels, Plant Growth Promoting Bacteria, Soil microbes and plant health	3
	16	Microbiology in medicine - Antibiotics, Antimicrobial resistance, Probiotics and Microbial therapeutics - microbiome.	2

	17	Viruses as Tools in Genetic Engineering	2
	18	Biotechnological Applications of extremophiles Bacteria in Industrial Fermentation Bioaugmentation and Biostimulation	5
IV	**Phytopathology**		**10**
	19	Importance, Definition and concepts of diseases, Types of plant pathogens, Symptoms associated with microbial plant diseases.	1
	20	Koch's postulates, Host-parasite interaction Defense strategies in plants to pathogens- Phenolics, phytoalexin, elicitors, enzymes, toxins.	3
	21	Disease management strategies - Cultural, Botanical, Chemical, Biological and Integrated Disease Management. Environmental concern over chemical management - Residues and health hazards, fungicidal resistance in plant pathogens and its managements.	3
	22	Study of some important plant diseases giving emphasis on its etiology, symptoms, epidemiology and management i) Fungal diseases - Grey leaf spot disease of coconut, Quick wilt of pepper ii) Bacterial diseases - Citrus canker, Blast of paddy iii) Viral diseases - Tapioca mosaic disease, Bunchy top of Banana	3
V	**Practical (Mandatory list)**		**30**
	1. Gram staining - Curd, root-nodules 2. Culture and isolation of bacteria using nutrient agar medium (demonstration only) 3. Case study on microbial diseases 4. Identification of the disease, pathogen, symptoms and control measures of the plant diseases mentioned in the syllabus		
Practical (Open ended/Suggestive list)			
	5. Microbiology lab visit 6. Collections and dry preservation of diseased specimens of important crops. 7. Plant pathology lab and field visit 8. Preparation of an assignment of 10 significant plant or human pathogens with the symptoms, epidemiology, life cycle and control measures (Photographs or sketch of stages of infection)		

Suggested Readings

- Agrios, G.N. 1997. Plant Pathology (4th ed) Academic Press.

- Bilgrami K.H. & H.C. Dube. 1976. A text book of Modern Plant Pathology. International
- Book Distributing Co. Lucknow.
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Mapping of COs with PSOs and POs:

	.PSO1	PSO2	PSO3	.PSO4	PSO5	.PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	-	-	-	-	-	3	-		-	-	-	-
CO2	1	-	-	-	-	2	-	-	2	-	-	-	-
CO3	1	-	-	-	-	1	3	-		-	-	-	-
CO4	1	-	-	-	1	1	-	-	2	-	-	-	-
CO5	-	-	-	-	-	2	-	-		-	-	-	1
CO6	- .	-	-	- .	-	2	-	-	2	-	2	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Practical/Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓		✓
CO 4				✓
CO 5	✓	✓		✓

Programme	B. Sc. BOTANY				
Course Title	**Plant Anatomy & Analytical Techniques**				
Type of Course	**Minor**				
Semester	**III**				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Higher Secondary level Biology course				
Course Summary	This course explores the intricate structures and functions of plant anatomy and the organization of tissues within plants and its diversity. The course also deals with a variety of analytical techniques crucial for studying various branches in biological sciences.				

Course Outcomes (CO): After completing the Course, the student should be able to:-

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools
CO1	Explain the anatomical features and its ecological diversity in plants	U	F & P	Instructor-created exams / Observation of practical skills
CO2	Assess the principle and working procedure of various analytical techniques used in biology	U	F & P	Viva voce/ Practical Assignment
CO3	Apply the analytical skills for various lab practices	Ap	P	Observation of practical skills
CO4	Analyse and compare the normal and abnormal behaviour of cambium	An	C	Instructor-created exams
CO5	Evaluate the role of plant anatomy and analytical techniques in various fields of science.	E	C	Home assignments

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)
I	**Plant Anatomy -Basics, Scope and Applications**		**9**
	1	Introduction & Applications of plant anatomy in various fields	2
	2	Tissue systems - Simple & Complex, sclereids & fibres, Stomatal diversity	2
	3	Non-living inclusions of the cell & its applications	3
	4	Anatomical complexity in organization of shoot & root apex	2
II	**Special features in Plant Anatomy**		**12**
	5	Secondary thickening in dicot stem & root	2
	6	Anomalous secondary thickening - abnormal position and behaviour of cambium	2
	7	Anatomical diversity in major ecological groups of plants	3
	8	Wood anatomy - characteristics of wood & Types of wood	3
	9	Identification of various wood & defects in wood (shakes, knots, cross grain and stress defects)	2
III	**Analytical techniques**		**12**
	10	Solutions: representing concentrations: Molarity, Normality, Percentage and ppm	1
	11	Acids and bases, buffers and pH, measurement of pH	1
	12	Preparation and use of buffers in biological studies	1
	13	Microscopy – Introduction & Applications of Light microscopy	1
	14	Electron microscopy (SEM & TEM) - Principle, working & applications	2
	15	UV - Visible spectroscopy - Working and Applications	2
	16	IR spectroscopy – Applications	2
	17	Fluorescent spectroscopy - Principle & Applications	2
IV	**Separation techniques**		**12**
	18	Centrifugation - Basics, Principles behind various types & Applications	2
	19	Differential, density gradient and Ultracentrifugation	2
	20	Chromatography - Introduction & Types	3
	21	Thin Layer Chromatography, Gas Chromatography & Liquid Chromatography - Principle and applications	3
	22	Mass spectroscopy - Basic principle and applications in plant Science	2

V	Practical (Mandatory experiments)	30
	1. Normal secondary thickening in dicot stem and dicot root (any suitable material) 2. Anomalous secondary thickening of *Boerhaavia* and *Bignonia* 3. Special anatomical features of major ecological groups - any two plants depending on local availability (Hydrophytes, Xerophytes, Parasites) 4. Detection of different structures of plants - identification of starch grains, cystolith, raphides, any two types of sclereids and fibres 5. Stomatal types – identification	
	Practical (Open ended - Suggestive list)	
	6. Anatomical identification of commercial timber like (any two from the list - Teak, Rosewood, Artocarpus, Mahogany - Original specimen/ photographs and salient features) 7. Identification of types of wood and defects 8. Demonstration of the working of different kinds of centrifuges 9. Visit to a nearby analytical lab which facilitates the use of instruments mentioned in the syllabus and submission of report.	

Suggested Readings

- Esau, K. 1977. Anatomy of Seed Plants. John Wiley & Sons.
- Metcalfe, C. R., & Chalk, L. 1979. Anatomy of the Dicotyledons: Leaves, Stem, and Wood in Relation to Taxonomy with Notes on Economic Uses (Vol. 1). Oxford University Press.
- Raven, P. H., Evert, R. F., & Eichhorn, S. E. 2005. Biology of Plants (7th ed.). W.H. Freeman and Company.
- Mauseth, J. D. 2003. Botany: An Introduction to Plant Biology. Jones and Bartlett Publishers.
- Spectroscopic Techniques: Nakanishi, K., & Solomon, T. D. 1997. Infrared and Raman Spectra of Inorganic and Coordination Compounds. Wiley.
- Mass Spectrometry in Botany: Gross, J. H. 2011. Mass Spectrometry: A Textbook. Springer.
- Coutler E. G.1969. Plant Anatomy - Part I Cells and Tissues – Edward Arnold, London.
- Dickison, W.C. (2000). Integrative Plant Anatomy, Harcourt Academic Press, USA
- Eames A. J. Morphology of Angiosperms - Mc Graw Hill, New York.
- Evert, R.F. 2006. Esau‘s Plant Anatomy: Meristem, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc
- Fahn, A. 1992. Plant Anatomy, Pergamon Press, USA
- Ruzin S.E. 1999. Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
- Webster J. G. 2004. Bioinstrumentation, John Wiley & Sons Inc.
- Narayanan P. 2000. Essentials of Biophysics, New Age Int. Pub. New Delhi.
- Hames G. G. 2005. Spectroscopy for the Biological Sciences, John Wiley & Sons Inc.

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	3	-	-	-	-	3	-	-	-	-	-	-
CO2	2	-	-	-	3	-	3	-	-	-	-	-	1
CO3	-	-	-	-	3	-	-	-	2	-	-	-	-
CO4	-	3	-	-	-	-	-	-	2	-	-	-	-
CO5	-	3	-	-	-	-	-	-	2	-	1	-	-

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Practical/Project Evaluation	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓		✓	✓
CO 3			✓	✓
CO 4	✓			✓
CO 5		✓		

BOTANICAL DIVERSITY

Programme	B. Sc. BOTANY				
Course Title	**Plant Ecology, Conservation & Plant Interactions**				
Type of Course	**Minor**				
Semester	**I**				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	-				
Course Summary	This course offers basic knowledge related to the relationships between plants and their environment, the importance of conservation efforts and the interactions between different plant species.				

Course Outcomes (CO): After completing the Course, the student should be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools
CO1	Explain the ecological relationships between plants and the environment	U	C	Test/Assignments/Field study
CO2	Summarise the significance of conservation practices	U	F	Class Discussions
CO3	Explain various interactions that occur among plant species	U	C	Test/Field study/Group project
CO4	Develop the skills necessary to contribute to the conservation and sustainable management of plant ecosystems	Ap	C	Volunteer Projects/Reflective essays
CO5	Apply conservation strategies suitable for neighbouring ecosystems	Ap	P	Case studies/Presentations/Field reports

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (45 + 30)
I		**Plant Ecology**	**9**
	1	Ecology - Definition, Ecosystem: ecological factors - biotic and abiotic.	2
	2	Ecological adaptations - Morphological and anatomical adaptations of the following types: Hydrophyte (*Vallisnaria*), Xerophyte (*Opuntia*)	2
	3	Halophyte (*Avicennia*), Epiphytes (*Vanda*) and parasites (*Cuscuta*)	2
	4	Ecological succession - Process of succession, types of succession, Hydrosere	3
II		**Biodiversity, Loss and its Consequences**	**18**
	5	Biodiversity - Definition, types of biodiversity - habitat diversity, species diversity and genetic diversity	3
	6	Values of Biodiversity - Economic and aesthetic value, Medicinal values	2
	7	Concept of Biodiversity Hotspots, Biodiversity hot spots of India.	2
	8	Concept of endemism and endemic species. ICUN plant categories with special reference to Western Ghats.	2
	9	Estimates of extinction rates worldwide and in India, causes of extinction/changes in biodiversity	2
	10	Habitat fragmentation and destruction	3
	11	Threats to biodiversity: Overexploitation, Invasive species	2
	12	Consequences: loss of gene pool, loss of ecosystem services, livelihood	2
III		**Biodiversity Conservation**	**8**
	13	Conservation methods - *In-situ* and *ex-situ* methods.	2
	14	*In-situ* methods - Biosphere reserves, National parks, Sanctuaries, Sacred grooves	2
	15	*Ex-situ* methods - Botanical gardens, Seed bank, Gene banks, Pollen banks	2
	16	Cryopreservation	2
IV		**Plant Interactions**	**10**
	17	Plant interactions: overview, Plant - microbe interactions: Mycorrhizae	1
	18	Plant - herbivore interactions, Plant defences against herbivores	2
	19	Plant - pollinator interactions, Pollination syndromes and floral specialization	2
	20	Ant-plant interactions	1
	21	Plant-animal interactions as ecosystem services	2
	22	Conservation aspect of plant-animal interactions	2

V	**Practical (Mandatory Experiments)**	**30**
	1. Study the morphological and anatomical adaptations of the hydrophytes, xerophytes, halophytes, epiphytes and parasites mentioned in the syllabus 2. Study of a pond/forest ecosystem and recording the different biotic and abiotic components 3. Field observations of plant-animal interactions in natural environments around campus 4. Field visit: To study different types of local vegetation/ecosystems and the report to be recorded.	
	Practical (Open Ended-Suggestive list)	
	5. Case studies: Contemporary Indian wildlife and biodiversity issues 6. Group presentations in an area of conservation biology 7. Discussion on biodiversity (Man-animal conflict, human interference, climate change)	

Suggested Readings

- Rajak, A. 2020. Textbook of Biodiversity. 1st edition, Notion Press, India.
- Mahanty, S. and Srivastava, A. 2016. Biodiversity and It's Conservation. Disha International Publishing House, India.
- Singh, J.S., Singh, S.P. and Gupta, S.R. 2008. Ecology, Environment and Resource Conservation. Anamaya Publications (New Delhi).
- Krishnamurthy, K.V. 2004. An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.
- Gaston, K J. and Spicer, J. I. 1998. Biodiversity: An Introduction. Blackwell Science, London, UK.
- Primack, R. B. 2002. Essentials of Conservation Biology (3^{rd} edition). Sinauer Associates, Sunderland, USA.
- Chittka, L. and Thompson, J. D. (Eds.). 2001. Cognitive Ecology of Pollination- Animal Behaviour and Floral Evolution. Cambridge University Press.
- Herrera, C. M. and Pellmyr, O. (Eds.). 2002. Plant-Animal Interactions: An Evolutionary Approach. Blackwell Publishing.
- Schaeffer, H.M., and Ruxton, G.D. (Eds). 2011. Plant-Animal Communication. Oxford University Press.

Online Sources

- https://www.igntu.ac.in/eContent/IGNTU-eContent-313628797582-M.Sc-EnvironmentalScience-4-ManojkumarRai-MicrobialEcology-2-3.pdf
- http://www.eagri.org/eagri50/AMBE101/lec29.html
- http://eagri.org/eagri50/AMBE101/pdf/lec29.pdf
- ales.arizona.edu/classes/ento415/LECTURES/ENTO415_PlantInteractions.pdf
- https://entnemdept.ufl.edu/baldwin/webbugs/3005_5006/Docs/notes/notes10.pdf

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	-	-	-	1	2	-
CO2	2	-	-	-	1	2	-
CO3	2	-	-	-	-	2	-
CO4	2	-	-	-	-	2	-
CO5	2	-	-	-	-	2	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion
- Assignment/ Seminar
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment/Seminar	Practical/Project Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓		✓
CO 3	✓		✓	✓
CO 4	✓		✓	

Programme	B. Sc. BOTANY				
Course Title	**Plant Morphology, Physiology & Plant Resources**				
Type of Course	**Minor**				
Semester	**II**				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Higher secondary level Biology course				
Course Summary	This course covers a comprehensive study of the structure, function, and utilization of plants. Students will explore the morphology of plants, and the physiological processes that occur within plants. Furthermore, students will learn about the diverse uses of plants as valuable resources for food, medicine, and more.				

Course Outcomes (CO): After completing the Course, the student should be able to:-

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools
CO1	Explain the various morphological characteristics of a plant	U	F	Quiz/ Test/Assignments/ Practical/ Field studies
CO2	Identify the physiological processes that drive plant growth, development and responses to the environment	Ap	C	Assignments/Quiz/Test
CO3	Apply knowledge of plant morphology and physiology to analyse and solve real-world problems related to plant health and productivity	Ap	C & P	Field Work/Presentations
CO4	Evaluate the importance of plants as valuable resources for food, medicine and more	E	C	Group project/Class discussion

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 + 30)
I		**Plant Morphology**	**7**
	1	Morphology of leaf; Structure, simple, compound, venation and phyllotaxy.	2
	2	Inflorescence - Racemose, cymose, special, types with examples	2
	3	Flower - as a modified shoot, structure of flower, symmetry of flower, floral parts - their arrangement, types of aestivation, relative position of parts, cohesion and adhesion of stamens and placentation.	3
II		**Plant Physiology**	**18**
	4	Water relations: Permeability, Imbibition, Diffusion, Osmosis and water potential.	2
	5	Absorption of water: passive mechanism.	1
	6	Ascent of sap: Transpiration pull or cohesion-tension theory.	2
	7	Transpiration: Types, mechanism of stomatal movement: K^+ ion theory.	2
	8	Significance of transpiration, antitranspirants.	2
	9	Photosynthesis: Introduction, significance, Two pigment systems, red drop, Emerson enhancement effect, action and absorption spectra.	3
	10	Mechanism of photosynthesis: Light reaction, cyclic & non-cyclic photo phosphorylation, Dark reactions-Calvin cycle, C_4 cycle, photorespiration (a brief account only). Factors affecting photosynthesis.	6
III		**Plant Growth**	**10**
	11	Plant growth - Definition, phases of growth, Auxins, gibberellins, cytokinin, abscisic acid and ethylene, their physiological roles.	2
	12	Senescence and abscission.	2
	13	Photo-periodism and vernalization.	2
	14	Dormancy of seeds - Factors causing dormancy, photoblasticism, techniques to break dormancy.	2
	15	Physiology of fruit ripening.	2
IV		**Plant Resources**	**10**
	16	Brief account on the various categories of plants based on their economic importance	1
	17	Study the following plants with special reference to their binomial, family, morphology of the useful part and their uses. Cereals: Paddy, Wheat; Pulses: Black gram, Green gram; Oil: Coconut, Gingelly	3

	18	Fibre: Cotton; Latex: Rubber; Beverages: Tea, Coffee	2
	19	Spices: Pepper, Cardamom, Clove	2
	20	Medicinal plants: *Rauvolfia serpentina*, *Justicia adhatoda*, *Santalum album and Curcuma longa.*	2
V	**Practical (Mandatory experiments)**		**30**

4. Identify the types of inflorescences mentioned in the syllabus.
5. Learn the principle and working of the following apparatus/experiments
   - Thistle funnel osmoscope
   - Ganong's potometer
   - Ganong's light-screen
   - Absorbo transpirometer
   - Mohl's half-leaf experiment
   - Experiment to show evolution of O_2 during photosynthesis
6. Identify at sight the economically important plant produces and products mentioned in module IV, and learn the binomial and family of the source plants, morphology of the useful parts and uses

Practical (Open ended)

Suggested Readings

- Sporne K. R. 1974. Morphology of Angiosperms. Hutchinson.
- William G. Hopkins. 1999. Introduction to Plant Physiology, 2nd edition, John Wiley & Sons, Inc.
- Frank B. Salisbury and Cleon W. Ross. 2002. Plant Physiology 3rd edition. CBS publishers and distributers.
- G. Ray Noggle and George J. Fritz. 1983. Introductory Plant Physiology Prentice Hall.
- Pandey B. P. 1987. Economic Botany
- Verma V. 1984. Economic Botany
- Hill A.W. 1981. Economic Botany, McGraw Hill Pub
- Alam, Afroz. 2020. A Textbook of Economic Botany and Ethnobotany. IK International Publishing House.
- Atal C.K. and Kapur B. M. 1982. Cultivation and Utilization of Medicinal Plants. CSIR-RRL, Jammu.
- Sambamurty and Subrahmanyam, N. S. 2008. A Textbook of Modern Economic Botany. CBS Publishers & Distributors Pvt. Ltd.
- Bhutya, R. K. 2021. Medicinal Plants of India Vol. I & II. Scientific Publishers.

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	-	-	-	1	1	-
CO2	2	-	-	-	1	1	-
CO3	2	-	1	-	1	1	-
CO4	2	-	1	-	1	1	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion
- Assignment/ Seminar
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment/Seminar	Practical/Project Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓		✓
CO 3	✓		✓	✓
CO 4	✓			

Programme	B. Sc. BOTANY				
Course Title	**Plant Diversity & Angiosperm Taxonomy**				
Type of Course	**Minor**				
Semester	**III**				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Higher secondary level Biology course				
Course Summary	This course covers a wide range of topics related to the classification and identification of plants. Students will learn about the diversity of plant species and the characteristics that define different plant groups. The course will also cover Taxonomy of Angiosperms and the methods and techniques used in it.				

Course Outcomes (CO): After completing the Course, the student should be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools
CO1	Identify wide range of plant species based on their morphological characteristics.	U	F	Quiz/ Tests/ Lab Practical / Field Studies/ Assignments
CO2	Understand the evolutionary relationships between different plant groups.	U	C	Quiz/Test/ Assignments/ Lab Practical/ Class Discussions
CO3	Demonstrate proficiency in using various tools to identify unknown plant specimens.	U	C & P	Lab Practical/ Field Work/ Assignments/ Quiz/Tests
CO4	Apply various classification systems and taxonomic principles to categorize and organize plant species.	Ap	P	Quiz/Test/ Assignments/ Lab Practical/ Projects
CO5	Appraise plant diversity and taxonomy in ecological and conservation contexts.	E	C	Essays/ Case Studies/ Field Studies/ Presentations

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (45 + 30)
I	**Cyanobacteria, Algae and Fungi**		**15**
	1	Cyanobacteria - General Account, Ecological and Economic importance.	2
	2	*Nostoc* - Structure, life cycle and ecological significance.	2
	3	Algae - General characteristics, Thallus organization & reproduction , Ecological and economic importance.	2
	4	*Spirogya* - Structure and life cycle.	2
	5	Fungi - General characteristics, Nutrition and reproduction. Economic and ecological significance of fungi.	2
	6	Morphology, reproduction and life cycle of *Agaricus* (developmental details not required)	2
	7	Symbiotic Associations - Lichens: General features, reproduction, ecological and economic importance.	2
	8	Mycorrhiza - General account and its significance.	1
II	**Bryophytes & Pteridophytes**		**8**
	9	Bryophytes - General characteristics, Thallus diversity, Ecology and economic importance.	2
	10	Morphology, anatomy and reproduction of *Riccia.*	2
	11	Pteridophytes - General account, Ecological and economical importance of Pteridophytes.	2
	12	Morphology, Anatomy and life cycle of *Pteris.*	2
III	**Gymnosperms**		**5**
	13	Gymnosperm - General account. Ecological and economic importance.	2
	14	Morphology, anatomy and reproduction of *Cycas.*	3
IV	**Angiosperms**		**17**
	15	Angiosperms - General characters, reproduction, life cycle pattern	2
	16	Nomenclature - Binomial system of nomenclature	2
	17	Basic rules of nomenclature	1
	18	Systems of classification - Bentham & Hooker's system	2
	19	Herbarium techniques: collection, drying, poisoning, mounting & labeling	2
	20	Significance of herbaria and botanical gardens	1

	21	Important herbaria and botanical gardens in India	1
	22	Study the following families and their economic importance: Fabaceae (with sub-families), Rubiaceae, Euphorbiaceae and Poaceae	6
V	**Practical (Mandatory experiments)**		**30**
	1. Microscopic observation of vegetative and reproductive structures of *Nostoc* and *Spirogyra.* 2. Make suitable micro preparations of vegetative and reproductive structures of *Agaricus, Riccia, Pteris* and *Cycas.* 3. Study of vegetative and floral characters of the families in the syllabus. Students shall be able to describe the plants in technical terms and draw the L.S. of two plants of the families and record the same. 4. Mounting of properly dried and pressed specimen of any five wild plants of the families mentioned in the syllabus, with proper herbarium label.		
Practical (Open Ended-Suggestive list)			
	5. Observation of algal diversity in ponds. 6. Field visit, identification and documentation of common Algae, Bryophytes and Pteridophytes. 7. Determine the systematic position of local plants comes under the syllabus based on their vegetative and floral characters. 8. Campus walk to identify and record campus plants.		

Suggested Readings

- Fritsch, F.E. 1935. The structure and reproduction of the algae. Vol. 1 and II, Uni. Press. Cambridge.
- Morris, I. 1967. An Introduction to the algae. Hutchinson and Co. London.
- Papenfuss, G.F. 1955. Classification of Algae.
- B.R. Vasishta. Introduction to Algae
- Mamatha Rao. 2009. Microbes and Non-flowering plants. Impact and applications. Ane Books, New Delhi.
- Sanders, W.B. 2001. Lichen interface between mycology and plant morphology, Bioscience, 51: 1025-1035.
- B.R. Vasishta. Introduction to Fungi.
- P.C. Vasishta. Introduction to Bryophytes.
- B.P. Pandey. Introduction to Pteridophytes
- Chamberlain C.J. 1935. Gymnosperms – Structure and Evolution, Chicago University Press.
- Sreevastava H.N. 1980. A Text Book of Gymnosperms. S. Chand and Co. Ltd., New Delhi.
- Vasishta P.C. 1980. Gymnosperms. S. Chand and Co., Ltd., New Delhi.
- Radford, A.E. 1986. Fundamentals of Plant Systematics. Harpor & Row Publishers, New York.
- Sivarajan, V.V. 1991. Introduction to Principles of Plant Taxonomy. Oxford & IBH,

New Delhi.

- Jeffrey, C. 1968. An introduction to Plant Taxonomy, Cambridge University Press, London.
- Gurucharan Singh. 2001. Plant Systematics. Theory and practice. Oxford & IBH Publications New Delhi.
- Sharma O.P. 1990. Plant Taxonomy – Tata McGraw Hills. Publishing company Ltd.
- Subramanyam N.S. 1999. Modern Plant Taxonomy. Vikas Publishing House Pvt Ltd.
- Pandey & Misra. 2008. Taxonomy of Angiosperms. Ane books Pvt Ltd.

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	-	-	-	1	1	-
CO2	2	-	-	-	1	1	-
CO3	2	-	-	1	1	1	-
CO4	1	-	1	-	1	1	1
CO5	2	-	-	-	1	1	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion
- Assignment/ Seminar
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment/Seminar	Practical/Project Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5				✓

INDUSTRIAL BOTANY

Programme	B. Sc. BOTANY				
Course Title	**Phytochemistry**				
Type of Course	**Minor**				
Semester	**I**				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Higher secondary level biology course				
Course Summary	This course explores the chemical compounds produced by plants, their biosynthesis, and their significance in nature and human applications. The course covers the classification, extraction, and analysis of phytochemicals, with a focus on their pharmacological properties and uses in traditional and modern medicine.				

Course Outcomes (CO): After completing the Course, the candidate should be able to:-

CO	CO Statement	Cognitive Level*	Knowledge Category #	Evaluation Tools
CO1	Identify and classify different types of phytochemicals and their sources.	R	F	Quiz/Exams/Group presentations
CO2	Explain the biosynthetic pathways and ecological roles of phytochemicals.	U	C	Written assignments/Oral presentations
CO3	Demonstrate the extraction, isolation, and analysis of phytochemicals using laboratory techniques.	Ap	C & P	Practical exams
CO4	Compare and contrast the chemical structures and properties of various phytochemicals.	An	C	Comparative reports
CO5	Assess the therapeutic and ecological significance of major classes of secondary metabolites, in pharmaceutical and ecological contexts.	E	C & P	Group discussions/Seminars/ Literature Surveys

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)
I		**Phytochemistry – Introduction**	**12**
	1	Introduction to Phytochemistry, Primary and secondary metabolites –Overview	1
	2	Carbohydrates: Classification, and functions of monosaccharides, disaccharides and plant polysaccharides.	2
	3	Amino acids: Classification and functions	2
	4	Proteins: Classification and functions, Peptide bonds and protein folding.	2
	5	Enzymes: Classification and functions	1
	6	Lipids: basic information of fatty acids and triglycerides, phospholipids and sterols, waxes and cutins	2
	7	Nucleotides: Classification and functions of nucleotides and nucleotide derivatives.	2
II		**Secondary Metabolites**	**12**
	8	Major classes of secondary metabolites - alkaloids, flavonoids, terpenoids, phenolics, and glycosides.	2
	9	Extraction methods - Hot & Cold extraction, Maceration, Soxhlet Extraction	2
	10	Solvents used in extraction of secondary metabolites - Polarity of Solvents	2
	10	Isolation Techniques: Chromatographic methods (TLC, HPLC, GC), Electrophoresis, Precipitation and crystallization	2
	11	Purification and Characterization: Purification strategies, Structural elucidation (NMR, MS, IR), Spectroscopic techniques	2
	12	Quantification of Phytochemicals: Analytical techniques (UV-Vis spectroscopy, colorimetry), Standardization and calibration, Validation of analytical methods	2
III		**Phytochemicals and their Biological Activities**	**12**
	13	Antioxidant Properties: Mechanisms of antioxidant action, Health benefits of antioxidants	2
	14	Antimicrobial and Antiviral Activities: Phytochemicals with antimicrobial properties, Applications in medicine and Agriculture	2
	15	Anti-inflammatory and Analgesic Effects: Phytochemicals with anti-inflammatory properties, Clinical applications and Acheivements	2
	16	Anticancer Properties: Phytochemicals with anticancer activity, Acheivements	2
	17	Cardiovascular Health: Phytochemicals beneficial for cardiovascular health, examples of achievements	2
	18	Other therapeutic applications: Overview of Neuroprotective effects, Antidiabetic properties, Phytochemicals in skin care	2
IV		**Phytochemicals in Industry and Agriculture**	**9**
	19	Phytochemicals in the Pharmaceutical Industry: Drug discovery	3

		and development, examples of plant-derived drugs	
	20	Phytochemicals in the Food Industry: Natural preservatives and additives, Functional foods and nutraceuticals	2
	21	Phytochemicals in Agriculture: Biopesticides and bioherbicides, Plant growth regulators, Soil health and phytoremediation	2
	22	Economic and Environmental Impacts: Economic importance of phytochemicals, Sustainable sourcing and conservation, Environmental benefits	2
V	**Practical (Mandatory list)**		**30**
	1. Qualitative test for carbohydrate 2. Qualitative test for Protein 3. Qualitative test for alkaloids 4. Qualitative test for glycosides 5. Qualitative test for phenols		
	Practical (Open ended/Suggestive list)		

Suggested Readings

- Mukherjee, Pulok K. 2019. Quality Control of Herbal Drugs: An Approach to Evaluation of Botanicals, Business Horizons, New Delhi.
- Kokate, C.K., Purohit, A.P., and Gokhale, S.B. 2015. Pharmacognosy. Nirali Prakashan, Pune.
- Aneja, K.R. Experiments in Microbiology, Plant Pathology and Biotechnology. 2017. New Age International Publishers, New Delhi.
- Trease, G.E., and Evans, W. C. 2009.Pharmacognosy. Elsevier, New Delhi.
- Sivarajan, V.V., and Balachandran, I. 1994. Ayurvedic Drugs and Their Plant Sources. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Harborne, J.B. Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis. 1998. Springer, Dordrecht.
- Bruneton, J. Pharmacognosy, Phytochemistry, Medicinal Plants. 1999. Intercept Ltd., Andover.
- Wagner, H., and Bladt, S. Plant Drug Analysis: A Thin Layer Chromatography Atlas. 1996. Springer, Berlin.
- Gurib-Fakim, A. Medicinal Plants: Traditions of Yesterday and Drugs of Tomorrow. 2006. CRC Press, Boca Raton.
- Dewick, P.M. Medicinal Natural Products: A Biosynthetic Approach. 2009. John Wiley & Sons, Chichester
- www.ncbi.nlm.nih.gov National Center for Biotechnology Information (NCBI)
- www.pharmacognosy.us American Society of Pharmacognosy
- www.phytochemicalsociety.org Phytochemical Society of Euro

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	-	1	-	1	-	1
CO2	1	-	1	-	1	-	1
CO3	1	-	1	-	1	-	2
CO4	1	-	1	-	1	-	-
CO5	1	-	1	-	1	-	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion
- Assignment/ Seminar
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment/Seminar	Practical/Project Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5				✓

Programme	B. Sc. BOTANY				
Course Title	**Secondary Metabolites & Biofuels**				
Type of Course	**Minor**				
Semester	**II**				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Higher secondary level biology course				
Course Summary	The students will explore the diversity of secondary metabolites, their biosynthetic pathways, and how these compounds can be harnessed for biofuel production. The course emphasizes the importance of sustainable energy solutions and the role of biotechnology in developing alternative fuels. The students will gain a comprehensive understanding of the current challenges and future prospects in biofuel technology.				

Course Outcomes (CO): After completing the Course, the candidate should be able to:-

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools
CO1	Identify and describe various secondary metabolites and types of biofuels.	R	F	Quiz/Exam/ Group Presentation
CO2	Explain the biosynthetic pathways and ecological functions of secondary metabolites and the production processes of biofuels.	U	C	Written Assignments/ Presentations
CO3	Demonstrate the extraction and analysis of secondary metabolites and biofuels using appropriate techniques.	Ap	C & P	Practical exam
CO4	Compare and contrast different types of secondary metabolites and biofuels based on their chemical properties and applications.	An	C	Class discussions/Written test
CO5	Assess the potential of secondary metabolites and biofuels in various industrial and environmental applications.	E	C & P	Review articles/Case studies

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)
I		**Introduction to Secondary Metabolites**	**12**
	1	Overview of Secondary Metabolites - Definition and classification, Differences between primary and secondary metabolites, Biological significance and functions, Industrial Applications	2
	2	Types of Secondary Metabolites - Alkaloids, Terpenoids, Phenolics (Structure, examples, and functions)	2
	3	Production of secondary metabolites - Factors (physical & chemical) that influence the production, Control mechanisms - phenylpropanoid pathway, shikimate pathway.	2
	4	Extraction and Isolation Techniques - Solvent extraction methods	2
	5	Analytical Techniques for Secondary Metabolites: Chromatography and spectroscopy basics, Mass spectrometry in metabolite analysis, Bioinformatics tools for metabolite analysis	2
	6	Genetic Engineering of Secondary Metabolites - Metabolic engineering techniques, Genetic modification of plants and microbes, Transgenic plants for enhanced metabolite production	2
II		**Applications of Secondary Metabolites**	**12**
	7	Industrial Applications of Secondary Metabolites: Pharmaceuticals and nutraceuticals, Agriculture and pest management, Cosmetics and personal care products	2
	8	Role of Secondary Metabolites in Human Health - Antioxidant properties, Antimicrobial and anticancer activities, Anti-inflammatory and other therapeutic effects	2
	9	Secondary Metabolites in Agriculture - Bioherbicides and biopesticides, Growth regulators and soil conditioners, Biostimulants and plant growth promoters	2
	10	Industrial Production of Secondary Metabolites - Fermentation and bioreactor technology	2
	11	Microbial Secondary Metabolites - Antibiotics, pigments, and Mycotoxins	2
	12	Marine Secondary Metabolites - Marine natural products- Sponges, algae, and microorganisms	2
III		**Introduction to Biofuels**	**12**
	13	Introduction to Biofuels - First, second, and third-generation biofuels. Comparison with fossil fuels	2
	14	Types of Biofuels Bioethanol: Production, properties, and applications: Biodiesel: Production, properties, and applications Biogas: Production, properties, and applications	2
	15	Feedstocks for Biofuel Production Plant-based feedstocks (e.g., corn, sugarcane, algae) Waste materials (e.g., agricultural residues, food waste) Microbial feedstocks (e.g., yeast, bacteria)	2
	16	Biofuel Production Processes: Fermentation processes for	2

		bioethanol, Transesterification process for biodiesel	
	17	Biogas and Advanced Biofuels: Anaerobic digestion and biogas production, Synthetic biology in biofuels: Algal biofuels and synthetic hydrocarbons.	2
	18	Analytical Techniques for Biofuels - Gas chromatography (GC) for biofuel analysis, High-performance liquid chromatography (HPLC), Mass spectrometry (MS)	2
IV	**Environmental Impact and Sustainability of Biofuels**		**9**
	19	Life Cycle Analysis of Biofuels - Principles and methodology, Impact on greenhouse gas emissions, Carbon footprint	3
	20	Socio-economic Impacts of Biofuel Production - Impact on food security and land use.	2
	21	Biofuels and Biodiversity - Effects on land use and water resources, Conservation strategies, Sustainable biofuel certification schemes	2
	22	Potential of Secondary Metabolites in Biofuels - Role of secondary metabolites in biofuel production processes - Microbial biofuel production, Secondary metabolites as biofuel Additives	2
V	**Practical (Mandatory list)**		**30**
	1. Solvent extraction 2. Chromatographic separation 3. Anaerobic digestion for biogas production		
Practical (Open ended/Suggestive list)			
	4. Production of bioethanol from a chosen feedstock 5. Case Studies and Real-World Applications 6. Visit to biofuel industry		

Suggested Readings

- Ramasamy Vijayakumar, Raja S. S. 2020. Secondary Metabolites: Biotechnology and Applications. Springer Nature, New Delhi.
- Jain A.K. 2016. Plant Secondary Metabolites. Scientific Publishers, Jodhpur.
- Casida L. E. 2019. Industrial Microbiology. New Age International Publishers, New Delhi.
- Ashok Pandey, M.A. Kalamdhad, K. Binod, S. Khanal. Biofuels: Production and Future Perspectives. 2015. Elsevier India, New Delhi.
- Chellapan S., Pandey A., Bhaskar T. 2014. Algal Biofuels: Recent Advances and Future Prospects. CRC Press, India.
- Ramasamy Vijayakumar (Ed.). 2020. Secondary Metabolites - Sources and Applications. IntechOpen, London.
- Ana Maria Loureiro da Seca, Antoaneta Trendafilova (Eds.). 2022. Isolation and Identification of Bioactive Secondary Metabolites. MDPI, Basel.
- Mann J. 2001. Natural Products: The Secondary Metabolites. Royal Society of Chemistry, Cambridge.
- Rafael Luque, Carol Sze Ki Lin, Karen Wilson, James Clark (Eds). 2016. Handbook of Biofuels Production. Woodhead Publishing, Cambridge.
- Ashok Pandey, Thallada Bhaskar, Michael Stöcker, Rajeev Sukumaran (Eds.). 2011. Biofuels: Biochemical Conversion Processes for Liquid Fuel Production. Elsevier, Amsterdam.

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	1	-	2	1	1
CO2	2	-	1	-	2	-	2
CO3	2	-	1	-	2	-	1
CO4	2	-	1	-	2	-	1
CO5	2	-	1	-	2	-	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion
- Assignment/ Seminar
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment/Seminar	Practical/Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓		✓	✓
CO 4	✓	✓		✓
CO 5	✓	✓	✓	✓

Programme	B. Sc. BOTANY				
Course Title	**Essential Oils of Aromatic Plants**				
Type of Course	**Minor**				
Semester	**III**				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Higher secondary level biology course				
Course Summary	This course provides an in-depth study of aromatic plants and their essential oils. It provides a comprehensive understanding of the production, composition, and applications of essential oils. Students will explore the botanical sources of essential oils, methods of extraction, chemical analysis, and the therapeutic and commercial uses of these volatile compounds. The course also includes a practical module where students will gain hands-on experience in oil extraction and analysis.				

Course Outcomes (CO): After completing the Course, the candidate should be able to:-

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools
CO1	Identify and list various aromatic plants and their respective essential oils.	R	F	Test/Presentation
CO2	Explain the extraction processes and chemical properties of essential oils.	U	C	Oral presentations/Assignments
CO3	Demonstrate the extraction and analysis of essential oils using appropriate techniques.	Ap	C & P	Observation of practical skill/
CO4	Compare and contrast different essential oils based on their chemical composition and therapeutic properties.	An	C	Comparative essays/Report/Class discussion
CO5	Assess the effectiveness of essential oils in various applications.	E	C & P	Research projects/Review articles/Group discussions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)
I		**Introduction to Aromatic Plants and Essential oils**	**12**
	1	Overview of Aromatic Plants and History and Origin of Essential Oils, Introduction to aromatic plants	2
	2	Historical uses of essential oils, Traditional extraction methods, Evolution of essential oil industry	2
	3	Botanical Sources of Essential Oils - Classification of aromatic plants, Parts of plants used for oil extraction	2
	4	Extraction Methods - Steam Distillation, Solvent Extraction, Cold Press Extraction, Supercritical Fluid Extraction and CO_2 Extraction	2
	5	Quality Control and Standards - Purity and adulteration, ISO standards for essential oils	2
	6	Applications of Essential Oils - Therapeutic uses (aromatherapy, medicine), Industrial uses (cosmetics, food and beverages), Emerging applications (nanotechnology, pest control)	2
II		**Chemical and Physical Properties**	**10**
	7	Chemical Composition of Essential Oils Major chemical constituents (terpenes, alcohols, esters), Factors affecting chemical composition	2
	8	Solubility and Miscibility - Solubility in water and oils, Emulsification and formulation, Compatibility with other Ingredients	2
	9	Volatility and Stability - Factors affecting volatility, Stability and shelf life, Storage conditions	2
	10	Methods of chemical analysis - Analytical techniques (GC-MS, HPLC)	2
	11	Spectroscopy and Chromatography - UV-Vis and IR spectroscopy, Gas chromatography (GC), Liquid chromatography (HPLC)	2
III		**Therapeutic Properties and Medicinal Uses**	**12**
	12	Bioactivity of Essential Oils - Antimicrobial properties, Antioxidant activity, Anti-inflammatory effects	2
	13	Aromatherapy - Principles of aromatherapy, Methods of application (diffusion, topical)	2
	14	Toxicology and Safety - Dosage and toxicity levels, Allergic reactions and contraindications, Regulatory guidelines	2
	15	Skin and Hair Care - Essential oils in dermatology, Formulation of skincare products, Benefits for hair health	2
	16	Respiratory and Immune System - Essential oils for respiratory conditions, Immune-boosting properties, Methods of Administration	2
	17	Pain Management and Musculoskeletal System - Analgesic properties, Use in massage therapy, Treatment of muscle and joint pain	2

IV	**Sustainable Practices and Innovation**		**11**
	18	Sustainable Cultivation - Organic farming practices, Conservation of aromatic plants, Ethical sourcing	3
	19	Market and Trade of Essential Oils - Global market trends, Major producing countries, Economic impact	2
	20	Environmental Impact - Carbon footprint of essential oil production, Waste management and recycling, Eco-friendly extraction techniques	2
	21	Technological Innovations - Advances in extraction technology, Novel formulations and delivery systems, Integration with Biotechnology	2
	22	Regulatory and Certification Aspects - Certification standards (USDA Organic, Fair Trade), Legal regulations and compliance, Labelling and consumer information	2
V	**Practical (Mandatory list)**		**30**
	1. Collection and identification of 10 aromatic plants 2. Preparation of plant materials for extraction 3. Demonstrate Steam distillation process 4. Solvent extraction methods 5. Paper Chromatographic Analysis of Essential Oils		
	Practical (Open ended/Suggestive list)		
	6. Sensory evaluation of essential oils (odor, color, viscosity) 7. Demonstrate Cold pressing techniques 8. Interpretation of GC-MS of essential oil 9. Visit to essential oil extraction units/Visit to aroma oil industry & submission of report		

Suggested Readings

- Raghava T.S., Mishra R.K., and Sharma. R.K. 2017. Essential Oil Plants and Their Cultivation. Scientific Publishers, Jodhpur, India.
- Sandhya S. Amin. 2018. Aromatherapy: The Essential Blending Guide. New India Publishing Agency, New Delhi, India.
- Jain S.K. and DeFilipps A. 1991. Aromatic Plants of India. CRC Press, Boca Raton, FL, USA.
- Robert Tisserand and Rodney Young. 2014. Essential Oil Safety: A Guide for Health Care Professionals. Churchill Livingstone, London, UK.
- Valerie Ann Worwood. 2016. The Complete Book of Essential Oils and Aromatherapy. New World Library, Novato, CA, USA.
- Gabriel Mojay. 1999. Aromatherapy for Healing the Spirit: Restoring Emotional and Mental Balance with Essential Oils. Healing Arts Press, Rochester, VT, USA.
- Julia Lawless. 2013. The Encyclopedia of Essential Oils: The Complete Guide to the Use of Aromatic Oils in Aromatherapy, Herbalism, Health, and Well-Being. Conari Press, San Francisco, CA, USA.
- National Institute of Aromatherapy: www.aromatherapycouncil.org
- Aromatherapy Science: www.aromatherapyscience.com
- International Federation of Essential Oils and Aroma Trades (IFEAT): www.ifeat.org
- American Botanical Council: www.herbalgram.org
- Essential Oil Resource Consultants (EORC): www.essentialorc.com

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	-	1	-	1	1	1
CO2	2	-	2	-	1	1	1
CO3	2	-	2	-	1	1	1
CO4	2	-	1	-	1	1	1
CO5	2	-	1	-	1	1	1

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion
- Assignment/ Review
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Quiz/Test	Assignment/ Review	Practical/Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3			✓	✓
CO 4	✓	✓		✓
CO 5	✓	✓	✓	✓

PLANTS IN HUMAN WELLNESS

Programme	B. Sc. BOTANY				
Course Title	**Economic Botany**				
Type of Course	**Minor**				
Semester	**I**				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Nil				
Course Summary	Economic Botany explores the use of plants in various economic sectors. The course examines the roles of plants in agriculture, medicine, industry, and culture				

Course Outcomes (CO): After completing the Course, the candidate should be able to:-

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools
CO1	Explain various categories of economically important plants	U	F	Instructor-created exams
CO2	Identify medicinal plants, understand their therapeutic properties	U	C	Practical exams/Exam
CO3	Develop an awareness of conservation efforts to protect plant biodiversity	Ap	C & P	Group discussions
CO4	Analyse the economic impact of plant resources	An	C	Class discussions/ Debates

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 + 30)
I		**Module I**	**14**
	1	Importance of Plant Resources; Plant Genetic Resources and their conservation.	2
	2	Introduction and Origin of Cultivated Plants - Vavilov's concept for the Origin of cultivated plants;	2
	3	Centres of Origin (Primary and Secondary); Centres of diversity, Harlan's concept of gene pools.	2
	4	Cereals - Rice (Morphology Production, Parboiling, Uses) Wheat (Morphology, Production, and Importance)	3
	5	Other cereals - Economic importance of Maize, Barley, Oats, Millets (jowar, bajra, ragi) and Pseudocereals	2
	6	Legumes - General account (Nutritive Value of Pulses, Protein Malnutrition, Lathyrism, Favism, Ecological Importance); chick pea and pigeon pea (Production, Morphology and Economic Importance). Fodder legumes and Green manure Crops	3
II		**Module II**	**15**
	7	Sugars and Starches - Sugarcane (Morphology, Ratooning, Products and By- products); Potato (Morphology, Seed Tubers vs True Potato Seeds and Economic uses)	3
	8	Beverages - Types of Beverages (Alcoholic and Non-Alcoholic) with examples, Tea and coffee (Morphology, Processing and Economic Importance)	3
	9	Fruits & Nuts - Tropical & Temperate; *Citrus*, Mango, Banana, Apple, Pineapple, Papaya; Nuts: Cashew, Walnut, Almond & Pistachio (Uses, Economic importance)	3
	10	Oil - Yielding Plants - Fatty Oils and Essential Oils, Comparison between Fatty Oils and Essential Oils; Coconut (Morphology and Economic Importance); Essential Oils (General characteristics, Methods of Extraction and Economic Importance, with examples).	3
	11	Spices, Condiments & Flavourings - General Account (Spices, Condiments, Culinary Herbs and Essences, with examples), Importance of Spices. Morphology of part used and Economic Importance of Clove, Pepper, Ginger, Turmeric, Cardamom, Coriander, Nutmeg, Vanilla	3
III		**Module III**	**9**
	12	Medicinal and Drug-Yielding Plants - Brief Account of Therapeutic Drugs with Examples; Morphology, Chemical Constituents, Economic Importance of *Adhatoda, Rauwolfia*	2
	13	Rubber - Para Rubber - (Morphology, Tapping of latex, Processing, Products and Economic Importance)	2
	14	Fibres and Fibre - yielding plants - Classification of Fibres based upon their Origin (surface fibres, bast fibres, and leaf fibres, with examples); Coir, Cotton (processing and economic	3

		importance)	
	15	Petro-crops - Calotropis, Jatropha	2
IV	**Module IV**		**7**
	16	Underutilized Leafy vegetables of Kerala	2
	17	Wild edible plants of Kerala	2
	18	Techniques to cultivate and conserve underutilized plants	2
	19	Role of organisations	1
V	**Practical (Mandatory)**		**30**
	Familiarise plants given above using specimens/digital resources/products (raw or processed)		
	Practical (open ended)		

Suggested Readings

- Kochhar, S.L. 2011. Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
- Kochhar, S.L. 2016. Economic Botany: A comprehensive study, Fifth edition, Cambridge University Press, NY.
- Pandey, B.P. 1999. Economic Botany. S. Chand, New Delhi.
- Singh, H. B. and R.K. Arora. 1978. Wild edible plants of India (1st ed.). ICAR Publication, New Delhi.
- Wickens, G. E. 2004. Economic Botany: Principles and Practices, Springer
- Kochhar,S. L. 2012. Economic Botany in Tropics. New Delhi, India: MacMillan & Co.
- Wickens, G. E. 2001. Economic Botany: Principles & Practices. The Netherlands: Kluwer
  Academic Publishers.
- Chrispeels, M.J., Sadava, D. E. 1994. Plants. Genes and Agriculture. Jones & Bartlett-Publishers.
- Berg L. 2008. Introductory Botany: Plants, People, And The Environment,
- Cook F.E.M. 1995. Economic Botany: Data Collection Standard Royal Botanic
- http://www.eagri.org/eagri50/GPBR212/lec01.pdf

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	2	-	-	-	1	-	-
CO2	2	-	1	-	1	-	-
CO3	2	-	-	-	1	1	1
CO4	2	-	1	-	1	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion
- Assignment/ Review
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Discussion/ Assignment	Practical/Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓

Programme	B. Sc. BOTANY				
Course Title	**Plant Nutraceuticals**				
Type of Course	**Minor**				
Semester	**II**				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	-				
Course Summary	This course offers basic knowledge on the various plant supplements and advantages of functional foods over conventional medicine to avoid potential side-effects.				

Course Outcomes (CO): After completing the Course, the candidate should be able to:-

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools
CO1	Understand the basic concepts of nutraceuticals and functional foods.	U	F	Exam/Class discussion
CO2	Understand the source of various nutraceuticals and functional foods	U	C	Quiz/Group presentations
CO3	Apply various nutraceuticals and functional foods towards managing chronic diseases.	Ap	P	Case study/debates
CO4	Utilise personalized food with respect to genetics.	Ap	P	Group project

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 + 30)
I		**Introduction to Nutraceuticals**	**12**
	1	Introduction to Nutraceuticals, Historical perspective, classification, scope & future prospects	2
	2	Sources of Nutraceuticals.	2

	3	Nutraceuticals bridging the gap between food and drug	2
	4	Relation of Nutraceutical Science with other Sciences: Medicine, Human physiology, genetics, food technology, chemistry and nutrition	3
	5	Sources and role of Isoprenoids, Isoflavones, Flavonoids, carotenoids, Tocotrienols, polyunsaturated fatty acids, sphingolipids, lecithin, choline, lycopene and terpenoids.	3
II	**Nutraceutical remedies**		**15**
	6	Functional food and nutraceuticals for disease management	2
	7	Remedies for common disorders like Arthritis, Bronchitis, circulatory problems, hypoglycemia	3
	8	Nutraceuticals for nephrological disorders, liver disorders, osteoporosis, psoriasis and ulcers	3
	9	Role of nuts in cardiovascular disease prevention.	2
	10	Nutraceuticals for specific situations such as cancer, heart disease, diabetes, stress, osteoarthritis, hypertension.	3
	11	Role of Dietary fibres in disease prevention.	2
III	**Nutraceutical supplements**		**8**
	12	Plant Based Nutraceuticals: Glucosamine, Octacosanol, Carnitine, Melatonin and Ornithine alpha ketoglutarate, Chlorophyll, Caffeine, Green tea, Lecithin, soyabean	2
	13	Probiotic, prebiotics and symbiotic foods, and their functional role.	2
	14	Fruit based nutraceuticals: grape products, Lycopene, carotene, flaxseed oil, proanthocyanidins.	2
	15	Algae based nutraceuticals	2
IV	**Functional Foods**		**10**
	16	Functional Foods: Definition and classification. Concept of free radicals and antioxidants.	2
	17	Nutritive and Non-nutritive food components with potential health effects.	2
	18	Effects of processing, storage and interactions of various environmental factors on the potentials of such foods.	2
	19	Different foods as functional food: cereal products (oats, wheat bran, rice bran, etc.), fruits and vegetables, milk and milk products, legumes, nuts, oil seeds and sea foods, herbs, spices and medicinal plants.	2
	20	Marketing and regulatory issues for functional foods and nutraceuticals: CODEX Guidelines, EU guidelines and FSSAI guidelines	2
V	**Practical (suggestive list)**		**30**

	1. Analysis of foods: Determination of reducing and non-reducing sugar, protein, determination of ash/total protein/moisture in dietary fibres. 2. Extraction and estimation of total sugars from food products (dairy product, fruit juices, bread). 3. Industrial visit to a nutraceutical firm

Suggested Readings:

- Giuseppe Mazza; Functional Foods: Biochemical and Processing Aspects, Volume 1; CRC Press
- Robert E.C. Wildman; Handbook of Nutraceuticals and Functional Foods, Second Edition; CRC Press
- Massimo Maffei; Dietary Supplements of Plant Origin; CRC Press
- Fereidoon Sahidi, Deepthi K. Weerasinghe; Nutraceutical Beverages, Chemistry, Nutrition and Health Effects; American Chemical Society
- Ronald R. Watson; Vegetables, Fruits, and Herbs in Health Promotion; CRC Press
- Fruit and Cereal Bioactives: Sources, Chemistry and Applications; Özlem Tokusoglu; Clifford Hall III; CRC Press
- Susan Sungsoo Cho, Mark L. Dreher; Marcel; Dekker Handbook of Dietary Fibre
- John Shi, G. Mazza and Marc Le Maguer, Functional Foods, Vol.2 Biochemical and Processing Aspects CRC Press
- Aluko, Rotimi. 2012. Functional Foods and Nutraceuticals, Springer-Verlag New York Inc.
- Satinder Kaur Brar, Surinder Kaur and Gurpreet Singh Dhillon. 2014. Nutraceuticals Functional Foods,
- Robert E.C. Wildman, Robert, Wildman, Taylor C. 2002. Handbook of Nutraceuticals and Functional Foods, Third Edition, Wallace
- Pathak Y. Handbook of Nutraceuticals; Ingredient, Formulations, and Applications. CRC Press, Taylor & Francis Group, London

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	-	-	-	-	-	-
CO2	1	-	-	-	-	-	-
CO3	1	-	1	-	-	-	1
CO4	1	-	-	-	-	-	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Exam
- Assignment/ presentation
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal exam	Presentation/ Assignment	Practical/Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓		✓	✓
CO 4		✓		✓

Programme	B. Sc. BOTANY				
Course Title	**Ethnobotany**				
Type of Course	**Minor**				
Semester	**III**				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Nil				
Course Summary	This course explores the relationship between plants and people, focusing on how different cultures use plants for food, medicine, rituals, and other purposes. The course also explains the traditional knowledge and practices of indigenous communities.				

Course Outcomes (CO): After completing the Course, the candidate should be able to:-

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools
CO1	Assess the intricate relationship between plants and human cultures.	E	C	Quiz/Group presentations
CO2	Identify and analyse the traditional knowledge and practices of Indigenous communities regarding plant use.	An	C	Fieldwork report/Case study analysis/Oral presentations
CO3	Appreciate and respect the invaluable wisdom of Indigenous peoples	E	C	Reflective essays/Class discussions/Debates
CO4	Develop strategies for conserving traditional plant knowledge.	C	C & P	Group projects

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs 45 + 30
I		**Introduction**	**13**
	1	Ethno-botany - Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context	2
	2	Methods to study ethnobotany a) Field work b) Herbarium c) Ancient literature and oral traditions d) Religious and sacred places e) Archaeological findings	2
	3	Indigenous knowledge system; Documentation methods (Audio, Video recording, Photographs, Interviews, Questionnaire), Authentication of plant species using floras and herbariums; Traditional Knowledge Digital Library	2
	4	Tribal Communities in Kerala - Anthropology and Ethnobotany; Brief overview with special reference to Kurichiya, Adiyan, Paniya, Cholanaikan, Kadar, Kurumba, Kuruman, Kani, Mannan, Ulladan; Exploration of their customs, beliefs, and unique Ethnobotanical practices	3
	5	Plants used by the indigenous societies a) Food plants b) Medicinal plants c) intoxicants and beverages d) Resins and oils and miscellaneous uses (common name & uses)	3
	6	Plant used for rituals and ceremonies (common name & uses)	1
II		**Ethnobotany & Conservation**	**10**
	10	Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).	2
	11	Ethnobotany and legal aspects - Biopiracy, Intellectual Property Rights and Traditional Knowledge.	2
	12	Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India.	2
	13	Centers of Ethnobotanical Studies - The International Center for Ethnobotanical Education, Research, and Service (ICEERS) in India - AICRPE (All India Coordinated Research Project on Ethnobiology), FRLHT (Foundation for the Revitalisation of Local Health Traditions)	2
	14	Contributions (J. W. Harshberger, R. E. Schultes, E. K. Janakiammal, S. K. Jain, K. S. Manilal, V. V Sivarajan & P. Pushpangadan).	2
III		**Ethnopharmacology**	**10**
	15	Definition and Scope of Ethnopharmacology, Historical Perspective and Contributions to Modern Pharmacology	2
	16	Crude Drug: Classification and sources of crude drugs, Quality, Safety, and Efficacy of Herbal Medicines. Ensuring standards in herbal medicines/nutraceuticals	3
	17	Role of Ethnopharmacology in ensuring quality and safety. Importance of ethnopharmacological studies in drug discovery	3
	18	Ethnopharmacologic contribution to Bioprospecting natural	2

		products; emerging opportunities in ethnopharmacology	
IV	**Applied Ethnobotany**		**12**
	19	Medico-ethnobotanical sources in India; Case studies of traditional medicines leading to development of modern pharmaceutical products (use of *Trichopus zeylanicus* by kani tribe and Artemesia sp. for malaria cure)	4
	20	Significance of the following plants in ethnobotanical practices (along with their habitat and morphology) - Neem, Tulsi, Vitex, Gloriosa, Pongamia, Cassia, Indigofera	3
	21	Application of natural products to certain diseases - Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases	3
	22	Palaeo - ethnobotany, ethnoecology	2
V	**Practical (Mandatory list)**		**30**
	1. Documentation, literature survey, and collection of information on ethno-botanically useful plants from traditional healers 2. Students should be able to identify the plants mentioned above 3. Research papers from various Scientific Journals for case studies		
	Practical (Open ended- Suggestive list)		
	Field trip to tribal settlement to survey & document people-plant relationship.		

Suggested Readings:

- Jain S. K. 1989. Methods and approaches in ethnobotany. Society of Ethnobotanists, Lucknow, India.
- Jain S. K. 1990. Contributions of Indian ethnobotany. Scientific publishers, Jodhpur.
- Jain S. K. 1995. Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
- Rajiv K. Sinha 1996. Ethnobotany The Renaissance of Traditional Herbal Medicine - INA - SHREE Publishers, Jaipur.
- Rama Ro, N. and A. N. Henry 1996. The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah.
- Jain S. K. 1981. Glimpses of Indian. Ethnobotany, Oxford and I B H, New Delhi.
- Jain, S. K. 2010. Manual of Ethnobotany. Rajasthan: Scientific Publishers.
- Martin, G. J. 1995. Ethnobotany: A Methods Manual. Chapman Hall
- Cunningham A. B. 2001. Applied Ethnobotany: People, Wild Plant Use and Conservation. Earthscan, London.
- Young, K. J. 2007. Ethnobotany. Infobase Publishing, New York.
- Schmidt, B. M., Cheng, D.M.K. (Eds.) 2017. Ethnobotany: A Phytochemical Perspective. John Wiley & Sons Ltd. Chichester, UK.

Online sources

- https://www.upcollege.ac.in/Upload/econtent/135.pdf
- https://uou.ac.in/sites/default/files/slm/MSCBOT-608.pdf

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	-	-	3	3	1
CO2	3	2	-	-	3	3	1
CO3	1	2	-	-	-	2	-
CO4	2	1	-	-	2	1	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Exam
- Assignment/ presentation
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal exam	Presentation/ Assignment	Practical/Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3				
CO 4		✓	✓	✓

VOCATIONAL MINOR COURSES

COMPUTATIONAL BOTANY

Programme	FYUGP Botany				
Course Title	**Computational Botany**				
Type of Course	**Vocational Minor**				
Semester	**I**				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Higher secondary level biology course				
Course Summary	The course on Computational Botany provides students with a comprehensive understanding of the application of computational techniques in the field of botany. It covers various topics such as data analysis, modeling and simulation, genomics, metabolomics, artificial intelligence, and ethical considerations.				

Course Outcomes (CO): After completing the Course, the candidate should be able to:-

COs	Statement	Cognitive level *	Knowledge Category #	Evaluation Tools
CO1	Describe various computational techniques and their applications in the field of botany	U	C	Written Assignments/Oral presentations
CO2	Explain how computational models and simulations can be used to study plant physiology and development	U	C	Simulation projects/Interactive discussions
CO3	Apply computational tools to analyse genetic data and predict plant traits	Ap	C & P	Practical lab exercises
CO4	Analyse large datasets to identify patterns and relationships in plant ecology	An	C & P	Presentation

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 + 30)
I	**Introduction to Computational Botany**		**10**
	1	Computational Biology: Definition, History, and interdisciplinary nature.	1
	2	Introduction to computational science and its relevance to botany. Data handling and manipulation techniques	1
	3	Computational Tools for Plant Morphology Analysis Significance of computational tools in modern plant biology research. Popular software and tools: PlantCV, FIJI/ImageJ, PhenoPhyte, PhenoFront, The Plant Image Analysis Platform (PIAP). Applications of computational tools	3
	4	Plant Physiology Modelling and Simulations Plant Physiology modelling approaches (mechanistic, empirical, hybrid) Applications of Physiology Modelling and Simulations	3
	5	Significance of modelling and simulations in plant biology research.	2
II	**Data Analysis in Botany**		**12**
	6	Methods for collecting botanical data (fieldwork, experiments, databases, etc.) Quality control in botanical data analysis	2
	7	Importance of data visualization in botany research Techniques for visualizing botanical data (plots, graphs, maps, etc.)	2
	8	Tools and software for data visualization Importance of data visualization in botany. Importance of choosing appropriate tools and software for effective visualization.	3
	9	Tools and software for data analysis Importance of data analyses. Importance of choosing appropriate tools and software for analyses. Examples of softwares.	3
	10	Applications of machine learning in plant science (species identification, phenotyping, etc.)	2
III	**Modelling and Simulation in Botany**		**12**
	11	Mathematical Modelling of Plant Growth and Development Role of mathematical modelling in studying plant growth and development. Types of mathematical models.	2
	12	Simulation Techniques for Plant Ecological Models Types of Plant Ecological Models: individual-based models (IBMs), population models, community models, and ecosystem models. Examples.	2
	13	Modeling and Simulation of Plant-Environment Interactions Types of Plant-Environment Interaction Models: physiological models, process-based models, and statistical models.	3

	14	Computational Models for Plant Disease Spread Types of Plant Disease Spread Models: compartmental models, spatially explicit models, and network models. Applications of Disease Spread Models: in plant pathology, epidemiology, and disease management.	3
	15	Modeling and Simulation of Plant-Pathogen Interactions Types: used to simulate plant-pathogen interactions, including epidemiological models, mechanistic models, and molecular models.	2
IV	**Applications of Computational Botany**		**11**
	16	Computational Tools for Crop Improvement Computational Techniques in Crop Breeding and Genetics. Applications of Computational Tools in Crop Improvement	1
	17	Overview of Genome sequencing and assembly, Genome-wide association studies (GWAS)	1
	18	Computational Approaches in Plant Breeding Computational Techniques in Plant Breeding: Marker-assisted selection (MAS), Genomic selection (GS)	2
	19	Applications of Computational Approaches in Plant Breeding: Disease resistance breeding, Yield improvement, Stress tolerance enhancement, Quality traits enhancement	1
	20	Computational Methods for Conservation and Biodiversity Data Collection and Management, Computational Techniques for Biodiversity Analysis Applications of Computational Methods in Conservation	2
	21	Applications of Computational Analysis in Plant Evolution: Molecular dating of plant lineages, Comparative genomics for studying genome evolution, Evolutionary relationship inference among plant taxa	2
	22	Big Data in Botany Overview of big data challenges and opportunities in botany. Scalable computing techniques for handling big data in botany.	2
V		**Practical (Mandatory list)**	**30**
	1. Basics of programming languages: Python, R. 2. Overview of using R to perform basic statistical analysis on biological data 3. Demonstrate D3.js library		
	Practical (Open ended/Suggestive list)		
	4. Demonstrate PlantCV 5. Demonstrate FIJI/ImageJ 6. Demonstrate Plant Image Analysis Platform (PIAP) 7. Demonstrate Plotly 8. Demonstrate PlantVis		

Suggested Readings:

- Sushmita Mitra and Tinku Acharya. Computational Intelligence in Image Processing. 2018. CRC Press, Broken Sound Parkway NW, Suite 300, Boca Raton, FL 33487, USA.
- Prabir Bhattacharya and Subhrajit Bhattacharya. Computational Intelligence in Data Mining.
- 2015. Springer, New York, NY 10013, USA.
- Sowdhamini R. and N. Srinivasan. Computational Biology: A Practical Introduction to

BioData Processing and Analysis with Linux, MySQL, and R. 2019. CRC Press, Broken Sound Parkway NW, Raton, USA.
- Manju Bansal and Narinder Singh. 2019. Computational Biology and Bioinformatics: Gene Regulation. Springer, Spring Street, New York.
- Richard A. White. 2017. Plants and Their Application in Computational Botany. Wiley, River Street, Hoboken, USA.
- George A. 2006. Moulton. An Introduction to Computational Biology: Maps, Sequences and Genomes. Chapman and Hall/CRC, Broken Sound Parkway USA.

Online Sources

- Website: Computational Biology and Evolutionary Genomics
- URL: http://www.compbio.dundee.ac.uk/
- Website: Indian Journal of Computational Biology and Bioinformatics
- URL: http://www.ijcbb.com/
- Website: Computational Biology Research Center - Indian Statistical Institute
- URL: http://www.isical.ac.in/~cbr/
- Computational Biology Lab - Centre for DNA Fingerprinting and Diagnostics
- URL: https://www.cdfd.org.in/biology/

Mapping of COs with PSOs and POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	-	1	3	2	-	1
CO2	3	-	1	3	2	-	1
CO3	3	-	1	3	2	-	2
CO4	3	-	1	3	2	2	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Exam/Discussion
- Assignment/ presentation
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Presentation/ Assignment	Practical/Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓		✓	
CO 4		✓		✓

Programme	FYUGP Botany				
Course Title	**Biostatistics**				
Type of Course	**Vocational Minor**				
Semester	**II**				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	-				
Course Summary	This course gives a comprehensive understanding of Biostatistics and its application in biological research, with a special focus on computer assisted data analysis. It introduces students to the use of MS Excel, R programming, and SPSS for data analysis.				

Course Outcomes (CO): After completing the Course, the candidate should be able to:-

COs	**Statement**	**Cognitive level ***	**Knowledge Category #**	**Evaluation Tools**
CO1	Understand the benefits of computer assisted data analysis.	U	F	Reflective essays/Oral presentations/ Literature reviews
CO2	Utilize MS Excel for data organization, statistical analysis, and visualization.	Ap	C & P	Practical lab exercises/Hands-on assessments
CO3	Gain a basic understanding of R programming and use it for data manipulation, statistical analysis, and visualization.	U	F	Project-based assessments
CO4	Use SPSS for data organization, statistical analysis, and interpretation of output.	Ap	C & P	Practical lab exercises/Group projects
CO5	Apply knowledge of different software tools for data analysis in biological research.	Ap	C & P	Presentation /Peer assessments

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 + 30)
I		**Introduction to Biostatistics and Descriptive Statistics**	**10**
	1	Basic concepts and terminologies in Biostatistics	2
	2	Levels of measurement and types of data	2
	3	Measures of central tendency: mean, median, mode	2
	4	Measures of dispersion: range, variance, standard deviation	2
	5	Tabular and graphical representation of data	2
II		**Probability, Distributions, and Hypothesis Testing**	**12**
	6	Basic concepts of probability	2
	7	Common probability distributions: binomial, poisson, normal	2
	8	Concepts of null and alternative hypothesis	1
	9	Types of errors	1
	10	Commonly used tests: t-test, chi-square test, ANOVA	2
	11	Concepts of correlation and regression	2
	12	Types of correlation, Simple and multiple regression	2
III		**Post Hoc Tests**	**10**
	13	The need and applications of Post Hoc tests.	1
	14	Definition, application, procedure and interpretation of results of Tukey's Honest Significant Difference (HSD) Test	3
	15	Definition, application, procedure and interpretation of results of the following: Bonferroni Correction Scheffé's Method	3
	16	Definition, application, procedure and interpretation of results of the following: Newman-Keuls test Dunnett‘s Test	3
IV		**Computer Assisted Data Analyses & Software Tools**	**13**
	17	Importance of computer assisted data analyses	1
	18	Overview of various software tools	1
	19	Online resources for Biostatistical analysis	1
	20	Data analysis using MS Excel Introduction to Excel, Inputting and organizing data, Formulas and functions, Using Excel for statistical analysis (Descriptive statistics, correlation, regression), Creating charts and graphs	3

	21	Introduction to R Programming for Data Analysis Basics of R programming, Installing and using RStudio, Data manipulation in R, Using R for statistical analysis (Descriptive statistics, correlation, regression, Post Hoc tests), Visualizing data with ggplot2	4
	22	Introduction to SPSS Inputting and organizing data, Conducting statistical analysis in SPSS (Descriptive statistics, correlation, regression, Post Hoc tests), Interpreting output from SPSS	3
V		**Practical (Mandatory list)**	**30**
	1. Calculation of range, variance, standard deviation 2. Perform t-test 3. Perform chi-square test 4. Perform ANOVA 5. Calculation of Mean, Median and Mode in MS Excel		
	Practical (Open ended/Suggestive list)		
	6. Calculation of range, variance, standard deviation in MS Excel 7. Perform t-test in SPSS 8. Perform chi-square test in SPSS 9. Perform ANOVA in MS Excel 10. Perform ANOVA using R programme		

Suggested Readings:

- Burt Gerstman B. Basic Biostatistics. 2020. Jones & Bartlett Learning, 5 Wall St, Burlington, United States.
- Wayne W. Daniel and Chad L. Cross. Biostatistics: Basic Concepts and Methodology for the Health Sciences. 2018. Wiley, United States.
- Wayne W. Daniel. 2018. Biostatistics: A Foundation for Analysis in the Health Sciences. Wiley, 111 River St, Hoboken, United States.
- Geoffrey R. Norman and David L. Streiner. 2014. Biostatistics: The Bare Essentials. PMPH-USA, 6 Industrial Drive, Charleston, United States.
- Marc M. Triola and Mario F. Triola. 2018. Biostatistics: A Foundation for Analysis in the Health Sciences. Pearson, Hudson St, New York, NY.
- Wayne W. Daniel. 2018. Biostatistics: How to Design, Analyze, and Interpret Results of Scientific Research. Wiley, United States.
- Heather M. Bush and Marie Diener-West. 2021. Biostatistics: An Applied Introduction for the Public Health Practitioner. Springer.
- Pranab Kumar Banerjee. Introduction to Biostatistics. 2017. Wiley, 111 River St, Hoboken, United States.
- Ann G. Ryan and Bonnie L. Callen. 2015. Biostatistics: Basic Concepts and Methodology for the Health Sciences. Jones & Bartlett Learning, Burlington, United States.

- Philip Miller J. and Frank E. Harrell Jr. 2018. Biostatistics: A Foundation for Analysis in the Health Sciences. Wiley, River St, Hoboken, United States.

Online Sources

- https://www.khanacademy.org/math/statistics-probability - Khan Academy: Statistics and Probability
- https://stattrek.com/ - StatTrek: Statistics and Probability
- https://www.graphpad.com/guides/prism/latest/statistics/index.htm - GraphPad Learning Center
- https://www.rstudio.com/online-learning/ - RStudio: R for Beginners
- https://www.ibm.com/support/pages/spss-tutorials - IBM: SPSS Tutorials

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	-	1	3	1	-	-
CO2	1	-	1	3	1	-	-
CO3	1	-	1	3	1	-	-
CO4	1	-	1	3	1	-	-
CO5	1	-	1	3	1	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Exam/Discussion
- Assignment/ presentation
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Presentation/ Assignment	Practical/Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓		✓
CO 4	✓		✓	✓
CO 5		✓		✓

Programme	B. Sc. BOTANY				
Course Title	**Bioinformatics**				
Type of Course	**Vocational minor**				
Semester	**III**				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	5	-	-	75
Pre-requisites	Basic awareness in computer-based data search				
Course Summary	This course helps students in understanding the basics of molecular biology and its amalgamation with various aspects of bioinformatics including database search, sequence alignment analyses cum interpretations and application at research level in plant science.				

Course Outcomes (CO): After completing the Course, the student should be able to:-

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools
CO1	Explain the structural organisation of the two macromolecules, the DNA and Proteins.	U	C	Written test
CO2	Apply modern techniques in proteomics studies	Ap	P	Practical test/Quiz
CO3	Use various databases and obtain practical expertise in addressing research level problems.	Ap	C & P	Lab test/Group discussion

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45+30)
I		**Introductory Bioinformatics**	**7**
	1	Introduction to Bioinformatics in correlation with the molecular logic of life and diverse organisation of living Forms	2
	2	WetLab vs WebLab	1
	3	Structural Biology – DNA, Protein structure; Protein- Protein interaction, Protein- DNA interaction, Forces of interactions, DNA binding proteins; Structure visualization tools- Rasmol, Pymol, Chimera and Molmol	4

II	**Genomics and Proteomics**		**12**
	4	Genome organisation- Organellar genome with special reference to chloroplast genome in botanical research. Linkage mapping, FISH and different types, STS mapping	3
	5	Whole genome sequencing- its role in identifying mutations and establishing phylogenetic relations. Ethical and social challenges- *E. coli*, Yeast, *Arabidopsis thaliana* and Humans. IPR in genome sequencing.	3
	6	Proteomics- expression, structural and functional classifications-challenges and applications – Human proteome project (HPP). Role of motifs and domains in analysis- Role of protein families	3
	7	Technologies in proteomic studies- PAGE and its different types, Protein characterisation and identification, ESI-MS, TANDEM-MS, MALDI-TOF-MS-HPLC, Peptide mass fingerprinting (PMF).	3
III	**Biological sequences and Databases**		**18**
	8	DNA & protein sequences – analysis and interpretation of similarity between sequences- Homologous, orthologous, paralogous and analogous sequences- Symbols for representing nucleotides and aminoacids	3
	9	Sequence alignment – Pairwise and multiple alignment- Scoring matrices- TIGR, EST analytical tools. PAM, BLOSUM, BLAST, PSI- BLAST, CLUSTAL W- Phylogenetic analysis- PHYLIP, MEGA, Phylogenetic tree representations. Evolutionary studies- Bootstrapping method	4
	10	Patterns in sequences - motifs and profiles - PSI-BLAST searches- analysis and interpretation of data	2
	11	Data models - concepts Entity and relationship sets– Hierarchical data models- Database management systems, Data processing	3
	12	DNA databases – EmBL, DDBJ, GenBank, Unigene,	3
	13	Protein databases – PIR, SWISS PROT, TrEMBL, PROSITE BLOCKS, PFAM; Reactome and KEGG databases	3
IV	**Applications**		**8**
	14	Protein structure prediction and structure-based drug design (SBDD), Homology modeling	3
	15	Areas of Bioinformatics: Functional and comparative genomics, Cheminformatics, Pharmacogenomics and medical Informatics	3
	16	Research areas in Bioinformatics	2
V	**PRACTICALS**		**30**

	1. Retrieval of sequence data from the given databases 2. Pairwise and multiple alignment using prescribed programmes 3. Phylogenetic analysis using PHYLIP/MEGA 4. Retrieve any protein/enzyme structure from PDB 5. Retrieve the key metabolic pathways from Reactome and KEGG 6. Visualisation of structures using Pymol

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	-	-	-	2	-	1
CO2	1	-	-	-	2	-	1
CO3	1	-	-	3	2	-	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Exam/Discussion
- Assignment/ presentation
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Presentation/ Assignment	Practical/Project Evaluation	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓		✓	✓

HORTICULTURE TECHNIQUES

Programme	B. Sc. BOTANY				
Course Title	**Horticulture and Nursery Management**				
Type of Course	**Vocational Minor**				
Semester	**I**				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	-				
Course Summary	This course provides an introduction to the principles and practices of horticulture and nursery management. Students will gain practical experience on landscaping, nursery design, layout and management				

Course Outcomes (CO): After completing the Course, the candidate should be able to:-

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools
CO1	Recall the importance of horticulture in food production, landscaping, and environmental conservation.	R	F	Quiz/Exams/Oral Presentations/Class Discussions
CO2	Apply nursery management principles to design and layout a nursery facility considering factors like soil type, drainage, and microclimate for optimal plant growth.	Ap	P	Practical Projects/Case Studies
CO3	Analyse different propagation techniques and select the most appropriate method based on plant characteristics and environmental conditions.	An	C	Written Assignments/Practical Exams
CO4	Evaluate the financial viability of a horticultural business venture by analysing budgets, marketing strategies, and regulatory compliance requirements.	E	C	Business Plan Development/Simulations

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (45 + 30)
I	**Introduction to Horticulture and Nursery Management**		**15**
	1	Importance of horticulture in food production, landscaping, and environmental conservation	2
	2	Plant taxonomy and nomenclature: understanding botanical names, local names and trade name	2
	3	Nursery Management Basics - Nursery infrastructure and facilities: greenhouses, shade houses, polyhouses	2
	4	Nursery inventory management: tracking plant varieties, quantities, and ages	1
	5	Types of Horticultural Crops- Classification of horticultural crops based on growth habit, reproductive structures, and economic importance	2
	6	Site Selection and Nursery Layout- Factors influencing site suitability: soil type, drainage, topography, and microclimate	2
	7	Nursery layout principles: zoning for production, propagation, and storage areas.	2
	8	Utilization of space efficiency techniques: vertical gardening, raised beds, container systems	2
II	**Soil and Water Management in Horticulture**		**10**
	9	Soil Preparation and Management- Soil physical properties: texture, structure, porosity, and water-holding capacity	2
	10	Soil chemical properties: pH, nutrient availability, soil testing	2
	11	Soil Conservation Practices- Soil erosion processes and prevention methods: contour plowing, terracing;	2
	12	Sustainable soil management practices: cover cropping, crop rotation, and no-till farming	2
	13	Irrigation Methods and Techniques- Irrigation system components and design considerations: pumps, pipes, valves, and emitters. Drip irrigation, rainwater harvesting, and mulching techniques	2
III	**Pest and Disease Management**		**10**
	14	Integrated pest management (IPM) strategies: cultural, biological, and chemical control methods, Biocontrol agents	2
	15	Pesticide application principles: dosage calculation, application equipment calibration, and safety measures	2
	16	Cultural disease control practices: sanitation, crop rotation, and resistant cultivar selection	2
	17	Post-harvest Pest and Disease Management- Post-harvest physiology of horticultural crops: respiration rates, ethylene production, and senescence processes	2
	18	Storage facilities and handling protocols: temperature and humidity control, sanitation practices, and packaging materials, Integrated approaches to post-harvest pest control	2

IV	**Business and Marketing in Horticulture**		**10**
	19	Introduction to Horticultural Business- Entrepreneurial skills and traits: risk management, decision-making, and innovation	3
	20	Business legal structures and regulatory compliance: business registration, taxation, and intellectual property rights	3
	21	Marketing Strategies for Horticultural Products	2
	22	Financial Management in Horticulture- Financial planning and budgeting processes	2
V	**Practical (Mandatory Experiments)**		**30 hrs**
	1. Preparation of organic pesticide (Any one) 2. Nursery Design and layout 3. Horticulture station/ Garden/ Nursery visit and report submission		
	Practical (Open Ended-Suggestive list)		
	4. Conduct hands-on demonstrations on soil testing, soil preparation techniques, and irrigation system setup to illustrate soil and water management principles. 5. Identify common pests and diseases affecting horticultural crops using field guides and reference materials. 6. Market analysis for a selected horticultural product, including researching consumer preferences, pricing strategies, and distribution channels. 7. Guide students through the process of developing a basic business plan for a hypothetical horticultural enterprise, covering aspects such as start-up costs, production goals, and marketing strategies.		

Suggested Readings

- Richards C. M., Davies K. M., & Shaffer J. L. 2009. Principles of Horticulture. Butterworth-Heinemann.
- Chopra V. L., Verma B. S., & Raghavan S. R. 2002. Principles of Plant Propagation. Tata McGraw-Hill Education.
- Lal R. 2008. Soil Science: Methods and Applications. CRC Press.
- Follett P. A., & Duan J. J. 2000. Integrated Pest Management for Crops and Pastures. CSIRO Publishing.
- . 2004. Introduction to Horticulture. Thomson Delmar Learning.
- Hartmann H. T., Kester D. E., Davies Jr. F. T. & Geneve R. L. 2011. Plant Propagation: Principles and Practices. Prentice Hall.
- Ross E. A. 2011. Soil and Water Conservation: Principles and Practices. Pearson.
- Ruberson J. R. 2018. Handbook of Pest Management in Agriculture. CRC Press.
- Stanton J. L., Stacey S. D. & Haynes F. J. 2009. Horticulture Marketing: A Resource and Training Guide. University of Florida, Institute of Food and Agricultural Sciences.

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	-	-	-	1	1	-
CO2	3	1	3	-	1	-	1
CO3	3	1	3	-	1	-	1
CO4	3	1	3	-	1	-	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Exam/Discussion
- Assignment/ presentation/Project
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Quiz/discussion	Presentation/ Assignment/Project	Theory/Practical Internal exam	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓		✓	✓
CO 3	✓	✓	✓	✓
CO 4		✓		

Programme	B. Sc. BOTANY				
Course Title	**Plant Propagation Techniques**				
Type of Course	**Vocational Minor**				
Semester	**II**				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	-				
Course Summary	Plant Propagation Techniques is a comprehensive course covering the principles and methods of plant propagation, with hands-on learning experiences. Students will gain the skills and knowledge needed to propagate plants effectively for agricultural, horticultural, and conservation purposes.				

Course Outcomes (CO): After completing the Course, the student should be able to:-

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools
CO1	Recall the principles underlying different propagation techniques, such as seed germination, cutting propagation, and grafting.	U	F	Quiz/Exam
CO2	Analyse the advantages and disadvantages of different propagation methods in various contexts, such as commercial horticulture, conservation, and restoration.	An	C	Exam/Group discussion
CO3	Evaluate the quality of seeds and plant materials for propagation, applying criteria such as viability, vigour, and genetic purity.	E	C & P	Practical test
CO4	Design and implement propagation plans for specific plant species or projects, considering factors such as propagation goals, available resources, and environmental conditions.	C	C & P	Project

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (45 + 30)
I		**Introduction to Plant Propagation**	**8**
	1	Importance and Scope of Plant Propagation-Economic and Ecological importance	1
	2	Scope in Food Security and Biodiversity Conservation	1
	3	Historical Perspectives on Plant Propagation: Early Methods of Propagation, Contributions of Pioneers in Propagation Science	2
	4	Factors Affecting Plant Growth and Propagation: Environmental Factors (Light, Temperature, Water, Nutrients)	2
	5	Genetic Factors, Interactions with Microorganisms	2
II		**Sexual Propagation Techniques**	**8**
	6	Seed Propagation: Principles and Practices-Seed Formation and Structure, Seed Treatment and Pre-germination Techniques	2
	7	Seed Dormancy and Germination- Types of Dormancy, Factors Affecting Dormancy Breakage, Environmental Requirements	2
	8	Seed Quality Assessment and Enhancement: Seed Viability and Vigour Testing	2
	9	Seed Certification and Standards	1
	10	Seed Enhancement Techniques (Scarification, Stratification, Priming)	1
III		**Vegetative and Asexual Propagation**	**20**
	11	Vegetative Reproduction: Types, Advantages and Disadvantages, Application in Plant Breeding and Clonal Selection	2
	12	Cutting Propagation: Types and Techniques-Types of Cuttings (Softwood, Hardwood, Semi-hardwood), Rooting Hormones and Substrates	2
	13	Layering and Its Variations-Methods of Layering (Simple, Air, Tip, Compound), Factors Affecting Success, Applications in Woody Plant Propagation	3
	14	Grafting and Budding Techniques-Principles of Graft Compatibility, Types of Grafting (Cleft, Whip and Tongue, Bark, Approach), Bud Grafting Techniques (T-budding, Chip budding)	3
	15	Micropropagation - Tissue Culture Basics, Process (Initiation, Multiplication, Rooting, Acclimatization), Applications in Mass Propagation and Disease Elimination	4
	16	Natural Modes of Asexual Reproduction: Propagation Techniques for Offsets, Suckers, and Runners	2
	17	Bulb Propagation Methods-Scaling, Twin Scaling	2
	18	Rhizome and Tuber Propagation, Rhizome Cuttings, Tuber Division, Tissue Culture for Rhizome and Tuber Propagation	2
IV		**Advanced Propagation Techniques and Applications**	**9**
	19	Propagation in Specialized Environments- Hydroponics: Principles and Systems	2

	20	Aeroponics: Techniques and Benefits, Aquaponics: Integration of Aquaculture and Hydroponics	2
	21	Propagation of Endangered Species, Ecological Restoration Techniques	2
	22	Innovations and Future Trends in Plant Propagation: Sustainable Practices in Propagation Technology	2
V	**Practical (Mandatory experiments)**		**30 hrs**
	1. Budding, Grafting, Layering (with suitable plant material – any two types form each 2. Demonstration of Hydroponics cultivation in glass bottles (any one plant) 3. Seed viability testing (Any suitable method)		
	Practical (Open ended-Suggestive list)		
	4. Practice on seed enhancement techniques 5. Field Trip to a Nursery or Botanical Garden: 6. Cutting Propagation Trials: Using various plant species and types of cuttings (softwood, hardwood, semi-hardwood). Students can experiment with different rooting hormones, substrates, and environmental conditions to optimize rooting success and learn practical skills in vegetative propagation. 7. Introduce students to tissue culture techniques through a micropropagation lab. 8. Community Propagation Project: Engage students in a community propagation project aimed at propagating plants for conservation, restoration, or beautification purposes. 9. Students can collaborate with local organizations, schools, or community gardens to propagate native plants, endangered species, or ornamentals.		

Suggested Readings

- Chopra V. L., & Vashistha, B. B. 2012. Plant Propagation: Principles and Practices.
- Dhankhar O. P., & Sidhu, A. S. 2017. Principles of Seed Technology.
- Singh A. K., & Singh V. P. 2015. A Textbook of Plant Propagation and Nursery Management.
- Singh S. P. 2009. Propagation of Horticultural Crops.
- Bhojwani S. S. & Razdan M. K. 1996. Plant Tissue Culture: Theory and Practice.
- Creech J. L. & Nissen R. L. 2007. Vegetative Propagation of Horticultural Crops
- Dirr M. A. & Heuser Jr. C. W. 2019. The Reference Manual of Woody Plant Propagation: From Seed to Tissue Culture.
- Thomas P. A. 2000. Practical Plant Propagation.
- George E. F., Hall M. A. & De Klerk G.-J. 2008. Plant Propagation by Tissue Culture: Volume 1. The Background.

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	-	1	-	1	1	1
CO2	2	-	2	-	3	2	2
CO3	3	-	1	-	1	1	1
CO4	2	-	2	-	3	2	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Exam/Discussion
- Assignment/ presentation/Project
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Quiz/discussion	Presentation/ Assignment/Project	Theory/Practical Internal exam	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3			✓	✓
CO 4		✓		✓

Programme	B. Sc. BOTANY				
Course Title	**Biofertilizer Technology**				
Type of Course	**Vocational Minor**				
Semester	**III**				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	-				
Course Summary	This course covers introduction to types of biofertilizers and their microbial composition, and their importance in sustainable agriculture				

Course Outcomes (CO): After completing the Course, the student should be able to:-

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools
CO1	Identify different types of Biofertilizers	U	F	Quiz/Lab Exercise
CO2	Evaluate, and utilize biofertilizers effectively to enhance soil fertility and crop productivity.	E	C & P	Practical test/Group project
CO3	Develop skills in cultivating and utilizing biofertilizers	Ap	P	Practical test
CO4	Develop practical experience necessary to contribute to sustainable agriculture practices through the use of biofertilizers	Ap	P	Lab test/Group work

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (45 + 30)
I		**Introduction to Biofertilizers**	**10**
	1	Introduction, scope, General account about the microbes used as biofertilizer	2
	2	Cyanobacteria (blue green algae), Anabaena, Cylindrospermum, Gloeocapsa, Lyngbya, Nostoc, Plectonema. Azolla and Anabaena azollae association, nitrogen fixation,	4

		factors affecting growth, blue green algae and Azolla in rice cultivation. Cyanobacteria (BGA), Bacteria and Mycorrhizae - Cyanobacteria (BGA) as biofertilizers - and Tolypothrix. Algalization, Azolla - Anabaena as biofertilizers.	
	3	Isolation of cyanobacteria. Formation of Fogg's medium - Mass cultivation of Azolla - Cyanobacterial biofertilizers - Symbiotic association of Cyanobacteria - Field application of Cyanobacterial inoculants	4
II	**Bacterial biofertilizers**		**15**
	4	Bacterial biofertilizers - Introduction, scope. A general account of bacterial biofertilizers organisms. Azospirillum, Azotobacter, Frankia, Phosphobacteria and Rhizobium.	2
	5	Rhizobium - isolation, identification, mass multiplication, and carrier based inoculants, Actinorrhizal symbiosis.	4
	6	Azospirillum - isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms.	4
	7	Azotobacter - classification, characteristics – crop response to Azotobacter inoculum, maintenance and mass multiplication.	2
	8	Phosphate solubilizing microbes (any one) - Isolation, characterization, mass inoculum production, field Application	3
	9	Biochemistry and molecular basis of nitrogen fixation - Phosphate solubilization and mobilization.	3
III	**Mycorrhizal Association**		**10**
	10	Introduction, Introduction, scope. A general account of Ecto, Endo and Arbuscular mycorrhizae (AM)	2
	11	Methods of collection, wet sieving and decanting method and inoculum production.	2
	12	Culture of mycorrhizae in Modified Melin - Norkrans (MMN) agar medium - Cultural characteristics of Ecto mycorrhizal fungi. Techniques of Ectomycorrhizal inoculum,	3
	13	Endo mycorrhizae of orchids. Isolation and method of inoculation of Arbuscular mycorrhizae (AM), Legume - AM interactions -	3
IV	**Application Technology**		**10**
	14	Application technology for seeds, seedlings, tubers etc.	3
	15	Biofertilizers - Storage, shelf life, quality control and marketing.	3
	16	Factors influencing the efficacy of biofertilizers	2
	17	National and Regional Biofertilizers Production and Development Centres.	2
V	**Practical (Suggestive list)**		**30**
	1. Mass multiplication of BGA and *Azolla* and its application in paddy field 2. Preparation of plan of biofertilizers production unit 3. Familiarise with the Equipment, machinery and tools used for biofertilizers production. 4. Preparation of media used for biofertilizers production.		

Suggested Readings

- Dubey, R. C. 2008. A Textbook of Biotechnology. S. Chand & Co., New Delhi.

- Newton, W. E. et al. 1977. Recent Developments in Nitrogen Fixation. Academic Press, New York.
- Schwintzer, C. R. and Tjepkema, J. D. 1990. The Biology of Frankia and Actinorhizal Plants. Academic Press Inc., San Diego, USA.
- Stewart, W. D. P. and Gallon, J. R. 1980. Nitrogen Fixation. Academic Press, New York.
- Subba Rao N. S. 1982. Advances in Agricultural Microbiology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Subba Rao, N. S. 2002. Soil Microbiology. 4th ed. Soil Microorganisms and Plant Growth. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Subba Rao, N. S. and Dommergues, Y. R. 1998. Microbial Interactions in Agriculture and Forestry. Vol. I, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Verma, A. 1999. Mycorrhiza. Springer Verlag, Berlin. • Wallanda, T. et al. (1997). Mycorrhizae. Backley‘s Publishers
- https://www.openaccessgovernment.org/biofertilizers-towards-sustainable-agriculture/111024/

Mapping of COs with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	-	1	-	1	-	1
CO2	3	-	1	-	1	-	2
CO3	3	1	1	-	1	-	1
CO4	3	-	1	-	1	-	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Exam/Discussion
- Assignment/ presentation/Project
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Quiz/discussion	Presentation/ Assignment/Project	Theory/Practical Internal exam	End Semester Examinations
CO 1	✓		✓	✓
CO 2		✓	✓	✓
CO 3			✓	✓
CO 4		✓	✓	✓

MULTI DISCIPLINARY COURSES

Programme	B. Sc. BOTANY				
Course Title	**Incredible Plant Kingdom**				
Type of Course	**MDC**				
Semester	**I**				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3			45
Pre-requisites	-				
Course Summary	The course offers a fascinating journey into the diverse and extraordinary world of plant which provides students with an understanding of the plant kingdom's complexity, beauty, and importance to life on Earth.				

Course Outcomes (CO): After completing the Course, the student should be able to:-

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools
CO1	Appreciate the unique characters of the plant groups and their importance in sustaining life on Earth	U	F	Written exam/Presentation
CO2	Identify the amazing facts about different plants and appreciate the curious characters	U	F	Self-assessment
CO3	Assess the important plant adaptations & modifications according to the changing habitats.	An	C	Written test/Observation of practical skills
CO4	Explore the unique wonders of plants to inspire future generations to conserve and appreciate their biodiversity.	E	C & P	Group presentation

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (36+9)
I	**Introduction**		**15**
	1	Plant groups: Unique characters and Importance of - Algae, Fungi, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms.	4
	2	Bizarre Botanical Structures.	2
	3	Weird Plant interaction: Allelopathy, mimicry, deception, myrmecophily, hydraulic redistribution	3
	4	Natural warriors - plastic degrading plants, toxin absorbing, toxin degrading	3
	5	Intelligent networking systems in plants	3
II	**Amazing plants**		**9**
	6	Aromatic plants, fertilizing plants, camouflage plants (*Corydalis hemidicentra*), stinky plants (Titan arum)	2
	7	*Victoria regia* - special features	1
	8	Weird Plants - Dragon's blood tree, Baobab Tree, Rafflesia, Lithops, Black Bat flower, Welwitschia	2
	9	Unusual orchids - types, examples and curious	1
	10	Expensive plant derivatives: Cultivation, harvest, processing and uses - Food (White & Black truffles, Saffron, Kopi luwak Coffee, Tieguanyin Tea, Macadamia Nut), Sekai-Ichi apple, Perfumery (Oudh, Bulgarian rose, Lavender), Ornamentals (Kadupul, Juliet Rose, Shenzhen Nongke Orchid)	3
III	**Curious plants**		**6**
	10	Tallest, largest, oldest and smallest plants	1
	11	Magnitudes in size, flowers, leaves and fruits	1
	12	Pollution indicators & Mineral indicators	1
	13	Bioluminescent plants – Fluorescent algae, mushrooms, night-glowing plants, principle and significance	1
	14	Carnivorous plants - Venus' fly-trap, Pitcher plant	1
	15	Reproductive wonders - spore dispersal mechanisms, Extreme pollination mechanisms, deceptive pollination mechanisms - fig, bee orchid, Vallisneria	1
IV	**Extreme plants**		**6**
	15	Plants and their adaptations: Definition of various plant types, Morphological adaptations of Hydrophyte (*Eichhornia*), Xerophyte (*Opuntia*), Parasite (*Cuscuta*), Halophyte (*Avicennia*), Epiphytes (*Vanda*)	3
	16	Plants thriving in space (Chlorella), volcanoes (Hawaiian argyroxiphium), alpine (junipers), Tundra (Arctic lichen).	2
	17	Thermophiles – Definition, examples	1
V	**Open ended**		**9**

Suggested Readings

- Pandey B.P. 2005 College Botany: Vol I, 5th edn. S. Chand & Company LTD. New Delhi.

- Raven PH Evert RF and Eichhorn SE 2013. Biology of plants. VIII th Ed. W.H. Freeman Publishers
- Santna, S.C.Chatterjee, T.P and A.P. Das. 2004. College Botany Practical (Vol II) New Central Book Agency (P) KolKatta.
- Starr C.2007. Biology: concepts and applications. VI edn. ISBN 81-315-0284-8

Online Sources

- https://www.thehindu.com/sci-tech/science/a-tiny-plant-that-can-digest-low-density-plastic-sheets/article36794827.ece
- https://www.youtube.com/watch?v=0o7kBQ-Pl2A
- https://www.youtube.com/watch?v=TWSF3df6jUs

Assessment Rubrics:

- Quiz / Exam/Discussion
- Assignment/ Presentation/Project
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Quiz/ discussion	Presentation/ Assignment/Project	Theory/Practical Internal exam	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2				✓
CO 3	✓	✓	✓	✓
CO 4		✓		✓

Programme	B. Sc. BOTANY				
Course Title	**Plant Propagation**				
Type of Course	**MDC**				
Semester	**I**				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3			45
Pre-requisites	Nil				
Course Summary	This course covers techniques for plant propagation and the utilization of plant resources. Students will learn about various methods of plant propagation, including seed propagation, cutting propagation, and tissue culture.				

Course Outcomes (CO): After completing the Course, the student should be able to:-

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools
CO1	Explain various plant propagation structures and their utilization	U	F	Quiz/Test
CO2	Summarise various methods of plant propagation	U	C	Quiz/Written Test
CO3	Demonstrate skills related to vegetative plant propagation techniques such as cuttings, layering, grafting and budding.	U	P	Practical Test
CO4	Apply specific propagation technique for a given plant species.	Ap	P	Field work

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (36 + 9)
I	**Plant Propagation**		**9**
	1	Propagation: Definition, need and potentialities for plant multiplication	2
	2	Asexual and sexual methods of propagation - advantages and disadvantages.	2
	3	Propagation facilities: Mist chamber, humidifiers, greenhouses, glasshouses, cold frames, hot beds, poly-houses	3
	4	Nursery - tools and implements (Brief account)	2
II	**Steps of Growing Plants**		**9**
	5	Soil: Composition, Types	1
	6	Chemical fertilizers: types, application, merits and demerits,	2

		Biofertilizers	
	7	Organic manure: types, application, merits and demerits	2
	8	Need of water: Irrigation – Surface, spray, drip irrigation, Sprinklers	2
	9	Plant protection: Biological, Physical and mechanical, Chemical, biopesticide	2
III	**Propagation methods**		**9**
	10	Seed propagation – Seed dormancy, seed treatment, conditions for successful propagation, raising of seed beds	2
	11	Care of seedling, transplanting techniques	1
	12	Vegetative propagation: Cutting (stem, roots), Grafting (approach, cleft)	2
	13	Budding (T-budding, patch), Layering (simple, air)	2
	14	Micro propagation- General account	2
IV	**Botany in everyday life**		**9**
	15	Vegetable gardening	2
	16	Mushroom cultivation	2
	17	Bonsai and Terrarium preparation	3
	18	Orchid and Anthurium cultivation	2
V	**Open ended (Suggestive list)**		**9**
	1. Demonstration of vegetative propagation 2. Visit to nursery/garden 3. Hands on training- Bonsai and Terrarium preparation		

Suggested Readings

- Nishi Sinha: Gardening in India, Abhinav Publications, New Delhi.
- Andiance and Brison. 1971. Propagation Horticultural Plants.
- Chanda, K.L. and Choudhury, B. Ornamental Horticulture in India.
- Premchand, Agriculture and Forest Pest and their Management, Oxford Publication.
- George Acquaah, Horticulture: Principles and Practices. Pearson Education, Delhi.
- Kolay, A.K. Basic Concepts of Soil Science. New Age International Publishers, Delhi.
- Rodgran, M.K. Plant Tissue Culture, Oxford & IBH Publishing Ltd., New Delhi.
- Hudson, T. Hartmann, Dale K. Kester, Fred T. Davies, Robert L. Geneve, Plant Propagation, Principles and Practices.

Assessment Rubrics:

- Quiz / Exam/Discussion
- Assignment/ presentation/Project
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics:

	Quiz/ discussion	Presentation/ Assignment/Project	Theory/Practical Internal exam	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3			✓	✓
CO 4		✓		✓

Programme	B. Sc. BOTANY				
Course Title	**Ecosystem Diversity in India**				
Type of Course	**MDC**				
Semester	**II**				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3		-	45
Pre-requisites	-				
Course Summary	This course provides an in-depth exploration of ecosystem diversity in India from a multidisciplinary perspective. It covers the classification, characteristics, and importance of various terrestrial and aquatic ecosystems found in India.				

Course Outcomes (CO): After completing the Course, the student should be able to:-

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools
CO1	Define various types of ecosystems found in India	R	F	Quiz/Test
CO2	Demonstrate an understanding of interdisciplinary approaches to ecosystem management	U	C	Literature survey/Discussion
CO3	Analyse the human-induced threats to Indian ecosystems and propose appropriate conservation strategies.	An	C & P	Field report
CO4	Apply theoretical knowledge through practical activities, fieldwork, and group projects to address real-world challenges in ecosystem conservation and management.	Ap	C & P	Group project
CO5	Evaluate the importance of ecosystem diversity for biodiversity conservation and human well-being.	E	C & P	Written Test/Discussion

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (36 + 9)
I	**Introduction to Ecosystem Diversity**		**9**
	1	Understanding Ecosystems - Definition of ecosystems, Components of ecosystems: biotic and abiotic factors, Importance of ecosystem diversity	2

	2	Classification of Ecosystems - Terrestrial ecosystems: forests, grasslands, deserts, etc. Aquatic ecosystems: freshwater, marine, and estuarine ecosystems; Urban ecosystems: parks, gardens, and urban forests	4
	3	Factors Affecting Ecosystem Diversity - Natural factors: climate, topography, and geological feature, Anthropogenic factors: deforestation, pollution, and urbanization; Conservation efforts: protected areas and sustainable management	3
II	**Ecosystem Diversity in India**		**12**
	4	Overview of India's Biodiversity: Richness of flora and fauna; Biogeographic zones: Himalayas, Western Ghats, Indo-Gangetic plains, etc.; Endemic species and hotspots	3
	5	Terrestrial Ecosystems in India-Tropical rainforests: Western Ghats, Northeast India; Deciduous forests: Eastern Ghats, Central India; Desert ecosystems: Thar Desert, Cold deserts of Ladakh	3
	6	Aquatic Ecosystems in India: Rivers and lakes: Ganges, Brahmaputra, Chilka Lake; Coastal ecosystems: Mangroves, Coral reefs; Marine ecosystems: Arabian Sea, Bay of Bengal	3
	7	Human Impact on Indian Ecosystems: Deforestation and habitat loss, Pollution of water bodies, Climate change effects	3
III	**Conservation and Management of Ecosystem Diversity**		**8**
	8	Importance of Conservation: Ecosystem services: biodiversity, water purification, climate regulation; Economic value: tourism, agriculture, pharmaceuticals	2
	9	Conservation Strategies: Protected areas: National parks, wildlife sanctuaries, biosphere reserves; Sustainable resource management: community-based conservation, eco-tourism; Legal frameworks: Wildlife Protection Act, Forest Rights Act	3
	10	Case Studies of Successful Conservation Projects: Project Tiger, Western Ghats biodiversity hotspot conservation, Coral reef conservation in Lakshadweep	2
	11	Ecosystem damage: Natural and Anthropogenic – Exotic species invasion, habitat fragmentation	1
IV	**Role of Interdisciplinary Approaches in Ecosystem Diversity**		**7**
	12	Ecological Economics: Valuation of ecosystem services, Sustainable development goals and ecosystem diversity	2
	13	Socio-cultural Perspectives: Traditional ecological knowledge and conservation	1
	15	Policy and Governance: Role of government policies in conservation	1
	16	International agreements: Convention on Biological Diversity, Paris Agreement	1
	17	Future Directions and Challenges: Addressing socio-economic factors such as poverty, population growth, and resource	2

		conflicts that impact ecosystem diversity	
V	**Open ended (Suggestive list)**		**9**
	1. Field trips to different ecosystems (forests, wetlands, coastal areas) 2. Presentations on case studies of successful conservation projects 3. Hands-on activities: tree planting, habitat restoration, and water quality testing 4. Debates and discussions on contemporary issues related to ecosystem diversity and conservation 5. Participation in community-based conservation initiatives		

Suggested Readings

- Michael Begon, Colin R. Townsend, John L. Harper. 2006. Introduction to Ecosystem Diversity: Ecology: From Individuals to Ecosystem, Blackwell Publishing.
- Whittaker R. H. & Likens G. E. 1975. Ecosystem Diversity in India: Indian Ecology: Patterns and Processes, Oxford University Press
- Scott P. Carroll, Charles W. Fox. 2008. Conservation and Management of Ecosystem Diversity: Conservation Biology: Evolution in Action, 1st Edition, Oxford University Press.
- Chris Maser. 2009. Role of Interdisciplinary Approaches in Ecosystem Diversity: "Interdisciplinary Environmental Studies: A Primer, CRC Press
- Manuel C. Molles Jr. 2015. Understanding Ecosystems and Factors Affecting Ecosystem Diversity: Ecology: Concepts and Applications, McGraw-Hill Education
- Peter Kareiva, Michelle Marvier, Brian Silliman. 2011. Conservation Strategies and International Agreements: Conservation Science: Balancing the Needs of People and Nature, Roberts and Company Publishers.

Assessment Rubrics:

- Quiz / Exam/Discussion
- Assignment/ presentation/Project
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics:

	Quiz/discussion	Presentation/ Assignment/Project	Theory/Practical Internal exam	End Semester Examinations
CO 1	✓		✓	✓
CO 2				✓
CO 3				✓
CO 4	✓	✓	✓	✓
CO 5	✓		✓	✓

Programme	B. Sc. BOTANY				
Course Title	**Plants in Everyday Life**				
Type of Course	**MDC**				
Semester	**II**				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-		45
Pre -requisites	-				
Course Summary	This course is designed to give an overview of how plants are indispensable to humans. It gives a broad exposure to the various aspects of plant resources & its utilization.				

Course Outcomes (CO): After completing the Course, the student should be able to:

COs	Statement	Cognitive level*	Knowledge Category#	Evaluation Tools
CO1	Recall various economically and medicinally important plant species used in day-to-day life	R	F	Quiz/Exam
CO2	Explain the uses of economically important plants and illustrate the processing of various plant parts.	U	C	Written Assignments, Lab exam/ Quiz
CO3	Analyse the utilization of various plant resources in day-to-day life.	An	C	Discussion/Presentation
CO4	Apply theoretical knowledge in utilization, and report generation of economical and medicinal plants.	Ap	C & P	Project reports/ collaborative report writing
CO5	Evaluate the quality and content of products used in everyday life	E	P	Analytical reports

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus

Module	Unit	Content	Hrs (36+9)
I		**Role of plants**	**9**
	1	Introduction to Plant resources.	1
	2	Role of plants: Air purifier (photosynthesis); plants used in	2

		rituals/festivals; nutrient source (litter manure, organic manure).	
	3	Pollution removal (phytoremediation and its types), pollution indicator (lichens).	2
	4	Common medicinal plants around us: Tulsi, *Adhatoda*, *Phyllanthus, Aloe, Andrographis, Eclipta, Coleus aromaticus* (Botanical source, part of the plant used, and medicinal uses).	3
	5	Plants as biofertilizers – *Azolla* (method of cultivation) *Gliricidia* - Uses and benefits.	1
II	**Plant resources and utilization-I**		**9**
	5	Brief description of plants, parts used and uses. Cereals: Rice, Wheat Millets: Ragi, Jowar	2
	6	Legumes: Bengal gram, Green gram, Black gram Edible oils: Sesame, Coconut	2
	7	Cash crops: Cashew, Cocoa	1
	8	Starch and tuber crops: Tapioca, Sweet potato and Yam	2
	9	Vegetable crops: Red amaranth, Lady‘s finger	2
III	**Plant resources and utilization-II**		**9**
	10	Spices: Clove, Black pepper, Cardamom Beverages: Tea and Coffee (including processing).	2
	11	Oils: Eucalyptus, Clove, Rose and Rosemary	2
	12	Fibres: Coir, Cotton, Jute, Banana and Sisal (Methods of separation of fibre, drying and processing of any two)	4
	13	Timber: Teak, Rose wood	1
IV	**Eco-friendly products from plants**		**9**
	14	Eco friendly alternatives-Introduction and scope	1
	15	Compostable garbage bags and Tableware: Example and preparation method	2
	16	Natural cleaning products and disinfectants: (One example for each and its preparation)	2
	17	Natural fabric dye, hair dye and hair and face wash, face pack, creams and gel	4
	18	Shampoo, Conditioner - (One example for each and its preparation)	
	19	Benefits of eco-friendly lifestyle	1
V	**Open ended (Suggestive list)**		**9**
	1. Field visit in the campus to identify useful plants 2. Report on eco-friendly products used in your area 3. Demonstration on preparation of various plant-based products		

Suggested Readings

- Billings S. and Collingwood S. 2013. The Big book of home remedies. Lulu.com publisher.
- Buckley, C. 2020. Plant Magic: Herbalism in Real Life. Roost Books Publishers,

New York.

- Chrispeels, M. J. and Sadava, D. E. 1994. Plants, Genes and Agriculture. Jones & Bartlett Publishers.
- Fuller, K.W. and Gallon, J. A. 1985. Plant Products and New Technology. Clarendon Press, Oxford, New York.
- Hill, A. F. 1952. Economic Botany: A Textbook of Useful Plants and Plant Products. McGraw Hill Publishing Company Ltd., New Delhi.
- Kochhar, S. L. 2012. Economic Botany in the Tropics. MacMillan India Ltd., New Delhi.
- Purohit, S. S. and Vyas, S. P. 2008. Medicinal Plant Cultivation: A Scientific Approach. Agrobios, India.
- Rao, R. S. 1985) Everyday Ayurveda: The complete book of Ayurvedic home remedies. Notion Press, India.
- Sambamurty and Subramanyam N. S. 1989. A Textbook of Economic Botany. Wiley Eastern Ltd., New Delhi.
- Sen, S. 2009. Economic Botany. NCBA Publishers, New Delhi.
- Sharma, O. P. 1996. Economic Botany. Tata McGraw Hill Publishing Company Ltd., New Delhi.
- Simpson B. B. and Conner-Ogorzaly M. 1986. Economic Botany - Plants in Our World. McGraw Hill, New York.
- Singh V, Pande P. C. and Jain D. K. 2009. A Text Book of Economic Botany. Rastogi Publications, Uttar Pradesh.
- Trivedi, P. C. 2006. Medicinal Plants: Ethnobotanical Approach. Agrobios, India.
- Upadhyay, R. 2023. Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.

Assessment Rubrics:

- Quiz / Exam/Discussion
- Assignment/ presentation/Project
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Quiz/ discussion	Presentation/ Assignment/Project	Theory/Practical Internal exam	End Semester Examinations
CO 1	✓			✓
CO 2	✓		✓	✓
CO 3	✓	✓		
CO 4		✓		✓
CO 5		✓		

SKILL ENHANCEMENT COURSES

Programme	B. Sc BOTANY				
Course Title	**Herbal Technology**				
Type of Course	**SEC**				
Semester	**V**				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	-				
Course Summary	The skill enhancement course on herbal technology provides undergraduate students with the necessary knowledge and practical skills to explore the diverse applications of plants in various industries. Through a structured curriculum encompassing plant identification, extraction techniques, processing methods, and applications of herbal technology, students will be equipped to contribute to the growing field of herbal medicine, cosmetics, and other related sectors.				

Course Outcomes (COs) After completing the Course, the student should be able to:-

COs	Statement	Cognitive level *	Knowledge Category #	Evaluation Tools
CO1	Identify various medicinal plants and understand their botanical characteristics	U	C	Test/Lab test
CO2	Employ appropriate techniques for the collection, preservation, and sustainable harvesting of medicinal plants	Ap	C & P	Written test/Field work
CO3	Demonstrate proficiency in extraction and processing methods used in herbal technology	Ap	C & P	Practical Test/Written test
CO4	Apply quality control measures and adhere to regulatory standards in the production of herbal products	Ap	C & P	Quiz/Discussions
CO5	Utilize herbal technology for the formulation and production of herbal cosmetics, supplements, medicines, and pest control products	Ap	C & P	Group project

* - Remember I, Understand (U), Apply (Ap), Analyse (An), Evaluate I, Create I

- Factual Knowledge(F) Conceptual Knowledge I Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hours (36 + 9)
I	**Introduction to Herbal Technology**		**9**
	1	Introduction to Herbal Medicine	1
	2	Definition of herb, Classification of herbs-usage, active constituents, period of life, herbal medicine, Source of Herbs	3
	3	Selection, identification and authentication of herbal materials, Processing of herbal raw material	2
	4	Regulations and Standards in Herbal Industry, Plant based industries and institutions involved in work on medicinal and aromatic plants in India.	3
II	**Plant Identification, and Standardization of herbal products**		**9**
	5	Identification, Collection and Preservation of Medicinal Plants	2
	6	Importance of standardization, Problems involved in the standardization of herbs, Estimation of parameter limits used for standardization	3
	7	Standardization of herbal products-WHO guidelines for quality standardized herbal formulations	2
	8	Sustainable Harvesting Practices and Ethical Considerations in Plant Collection	2
III	**Extraction and Processing Methods**		**9**
	9	Extraction Techniques: Solvent Extraction, Steam Distillation, and Supercritical Fluid Extraction	2
	10	Processing of Medicinal Plants: Drying, Grinding, and Formulation	3
	11	Quality Control and Standardization of Herbal Products	2
	12	Packaging and Labelling Regulations	2
IV	**Applications of Herbal Technology**		**9**
	13	Herbal Cosmetics: Formulation and Production	3
	14	Herbal Supplements and Nutraceuticals	2
	15	Herbal Medicine: Preparation and Administration	2
	16	Entrepreneurship opportunities in Herbal Industry	2
V	**Open ended**		**9 hrs**
	1. Hands on training 2. Industry visit		

Suggested Readings

- Tyler V. E., Brady L. R., and Robber J. E. 1988. Textbook of Pharmacognosy. Lee & Febiger
- Kokate C. K., Purohit A. P. and Gokhale. 2007. Pharmacognosy. Nirali Prakashan

- Ansari S. H. Essential of Pharmacognosy
- Rangari V. D. Pharmacognosy & Phytochemistry by
- Council of Research in Indian Medicine & Homeopathy. Pharmacopeial standards for Ayurvedic Formulation
- Mukherjee, P.W. 2002. Quality Control of Herbal Drugs: An Approach to Evaluation of Botanicals. Business Horizons Publishers, New Delhi, India,
- Kokate C. K., and Gokhale A. S. Cultivation of Medicinal plants, Nirali Publication
- Kokate C. K. ‐Practical Pharmacognosy.‖ Vallabh Prakashan Delhi
- Clarke E. C. G, Isolation and Identification of drugs, The pharmaceutical Press, London
- Chaudhary R. D. Herbal Drug Industry
- Mukherjee P.V. Quality Control methods of Herbal Drugs

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	1	-	-	-	3	-	-	-	2	-	-
CO2	2	3	1	-	-	1	-	-	1	-	3	1	1
CO3	1	1	2	1	3	-	1	-	3	-	2	1	2
CO4	1	1	2	1	3	-	1	-	3	-	2	1	2
CO5	1	1	2	1	3	-	1	-	3	-	2	1	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion
- Assignment/ Seminar
- Project/Practical
- Final Exam

Mapping of Cos to Assessment Rubrics :

	Internal Exam	Assignment/ Seminar	Practical/Project Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5			✓	

Programme	B. Sc BOTANY				
Course Title	**Landscaping & Gardening**				
Type of Course	**SEC**				
Semester	**V**				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	-				
Course Summary	This course provides undergraduate students with practical skills and knowledge essential for successful landscaping and gardening. This course equips students with the necessary expertise to pursue careers in horticulture, landscaping, or agricultural extension services.				

Course Outcomes (COs) After completing the Course, the student should be able to:-

COs	**Statement**	**Cognitive level ***	**Knowledge Category #**	**Evaluation Tools**
CO1	Develop practical skills in planting, pruning, and maintaining various types of gardens and outdoor spaces	U	P	Lab Test
CO2	Identify common pests and diseases affecting plants and implement integrated pest management strategies for effective pest control in gardens and nurseries	Ap	C & P	Quiz/ Practical test/ Field work
CO3	Design and maintain gardens with an understanding of plant selection, landscape design principles, and seasonal gardening practices	C	P	Group Project
CO4	Equip with the knowledge and skills necessary to pursue a career in landscaping and gardening or to enhance their own outdoor living spaces	C	C & P	Self assessment/ Presentation

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hours (36 + 9)
I	**Fundamentals of Gardening**		**9**
	1	Introduction to Gardening: Objectives and Benefits	1
	2	Principles of Plant Selection and Landscape Design	3
	3	Soil Preparation and Management for Garden Beds	2
	4	Planting Techniques and Seasonal Gardening Practices	3
II	**Landscaping**		**9**
	5	Definition, Importance, Objectives, Factors affecting landscape planning	2
	6	Landscape design principles: Simplicity, Focal point, Balance, Proportion, Rhythm, Unity	3
	7	Xeriscaping, Streetscaping	2
	8	Urban planning, planting avenues	2
III	**Agronomy and Irrigation Techniques**		**9**
	9	Basic Agronomic Practices: Fertilization, Mulching, and Weed Control	3
	10	Principles of Irrigation Management: Watering Schedules and Techniques	2
	11	Sustainable Irrigation Practices: Drip Irrigation, Sprinkler Systems, and Rainwater Harvesting	3
	12	Soil Moisture Monitoring and Irrigation Scheduling	1
IV	**Introduction to Hydroponics**		**9**
	13	Introduction to Hydroponic Systems: Types and Components	2
	14	Nutrient Solutions and Formulations for Hydroponic Growing	1
	15	Fertigation Equipment and Application Methods	2
	16	Common Pests and Diseases in Gardens and Nurseries	2
	17	Integrated Pest Management (IPM) Strategies for Sustainable Pest Control	2
V	**Open ended (Suggestive list)**		**9 hrs**
	1. Hands on training 2. Garden visits		

Suggested Readings

- Butts E. and Stensson K. 2012. Sheridan Nurseries: One hundred years of People, and Plants. Dundurn Group Ltd.
- Russell, T. 2012. Nature Guide: Trees: The world in your hands (Nature Guides).
- Sudhir P. 2018. Landscape gardening. Scientific Publishers India.
- Gavino Merlo 2018. Floriculture and landscaping. Scitus Academics LLC.

- Percy Lancasters 2004. Gardening in India. Oxford & IBH publishers.
- Laeeq Futehally 2008. Gardens. National book trust India Publishers.
- Ekta Chaudhary 2022. Garden Up. Penguin Random House India publishers.
- Prathap Rao M 2020. Landscape Design. Standard Publishers and Distributors Pvt.
- Percy Lancasters 2008. Gardening in India. 2nd Edition, Oxford & IBH publishers
- Kumar N. 1997. Introduction to Horticulture. Rajalakshmi Publications

Online Sources

- https://plantsciences.montana.edu/horticulture/ASHS_Teaching_MethodsWG/Landscape-Design/Vendrame_Basic%20Principles%20of%20Landscape%20Design.pdf
- https://www.egyankosh.ac.in/bitstream/123456789/73049/1/Unit-1.pdf
- https://www.agrimoon.com/wp-content/uploads/Principles-of-Landscape-Gardening.pdf

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	-	-	2	1	-	3	-	-	3	-	2	-	3
CO2	-	-	2	1	-	3	-	-	3	-	2	-	3
CO3	1	3	2	-	3	1	1	2	3	-	1	2	3
CO4	1	1	-	-	2	1	-	-	3	-	1	1	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Presentation
- Assignment/ Field work
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment/ Field work	Practical/ Project Evaluation	End Semester Examinations
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓		✓
CO 4			✓	

Programme	B. Sc. BOTANY				
Course Title	**Phytochemical Techniques**				
Type of Course	**SEC**				
Semester	**VI**				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	-				
Course Summary	The skill enhancement course on Phytochemical Techniques for undergraduate students provides a basic understanding of phytochemistry's significance in drug development and natural product research. Students explore extraction techniques, fractionation, and identification methods, learning about different plant secondary metabolites and their roles in biological activities.				

Course Outcomes (COs): After completing the Course, the student should be able to:-

COs	Statement	Cognitive level *	Knowledge Category #	Evaluation Tools
CO1	Explain various extraction techniques and the principles behind each technique	U	C	Written exams/ Quiz Laboratory reports/Presentation
CO2	Demonstrate proficiency in fractionation methods, both physical and chemical, and chromatographic separation techniques	U	C & P	Practical assessments/ Presentation
CO3	Demonstrate skills in qualitative phytochemical screening	U	C & P	Laboratory practical exams
CO4	Evaluate the biological activities of phytochemicals, including antimicrobial, anti-inflammatory, anti-cancer, and toxicity	E	C & P	Research projects/Literature reviews

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (36 + 9)
I	**Introduction to Phytochemistry**		**9**
	1	Importance and applications of phytochemical analysis and Classes of plant secondary metabolites	2
	2	Role of phytochemicals in drug development and natural product research	2
	3	Extraction Techniques: Solvent selection - importance, factors to be considered	1
	4	Different extraction methods: maceration, digestion, decoction, infusion, percolation, Soxhlet extraction, superficial extraction, ultrasound-assisted, and microwave-assisted extractions	4
II	**Fractionation and Identification**		**9**
	5	Fractionation - Principle and methods (Physical and Chemical methods)	2
	6	Chromatographic separation - Mechanism and methods of Paper chromatography, Thin Layer Chromatography, and Column Chromatography	3
	7	Principle, Mechanism and applications of HPLC, HPTLC	2
	8	Identification of compounds by UV Spectrum, IR Spectrum, NMR, GC-MS, and LC-MS	2
III	**Qualitative and quantitative phytochemical analysis**		**9**
	9	Qualitative Phytochemical Screening: Detection of different classes of Phytoconstituents by test tube methods	2
	10	Quantification of primary and secondary metabolites: Principle and methods of Spectroscopic analysis (Total sugar, Total protein, Phenol)	3
	11	Extraction of essential oil - Principle and Methods	2
	12	Identification of essential oil constituents by GC-MS	2
IV	**Bioassays**		**9**
	13	Antimicrobial Studies - Principle and methods	3
	14	Anti-inflammatory studies (In vitro and in vivo) - Principle and methods	2
	15	Anti-cancer studies (In vitro and in vivo) - Principle and methods	2
	16	Toxicity studies (In vitro and in vivo) - Principle and methods	2
V	**Open ended**		**9**
	1. Hands on training 2. Phytochemistry Lab visit		

Suggested Readings

- Raaman N. 2006. Phytochemical Techniques. New India Publishing Agency
- Harborne A. J. 1998. Phytochemical Methods A Guide to Modern Techniques of Plant Analysis. Springer Dordrecht
- Fischer, Nikolaus H., Isman, Murray B., Stafford, Helen A. (Eds.). 2020. Modern Phytochemical Methods. Dattani Book Agency

- Deepa P. and Trupti P. S. 2019. Phytochemicals - Extraction, Separation & Analysis Techniques. Global Education Limited
- Egbunu C., Ifemeje J. C., Maryann C. M., Kumar S. 2018. Phytochemistry. Apple Academic Press.

Online resources

- https://www.arcjournals.org/pdfs/ijarcs/v2-i4/5.pdf
- https://ijbpas.com/pdf/2021/August/MS_IJBPAS_2021_5593.pdf
- https://www.essencejournal.com/pdf/2017/vol5issue2/PartA/5-31-491.pdf
- https://www.pharmacy.dypvp.edu.in/pharmaceutical-resonance/downloads/original-research-articles/Volume-5-Issue-1/3.pdf
- https://ijariie.com/AdminUploadPdf/A_Guide_To_Phytochemical_Analysis_ijariie9430.pdf

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	-	2	1	3	1	-	-	2	-	2	-	2
CO2	3	-	2	1	3	1	-	-	2	-	2	-	2
CO3	3	-	2	1	3	1	-	-	2	-	2	-	2
CO4	3	-	2	3	3	1	-	-	2	-	2	-	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion
- Assignment/ Seminar
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment/Seminar	Practical/Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4		✓	✓	

Programme	B. Sc BOTANY				
Course Title	**Essential Oil & Perfumery**				
Type of Course	**SEC**				
Semester	**VI**				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	-				
Course Summary	The Essential Oil and Perfumery course offers a comprehensive understanding of the principles and practices involved in creating fragrances and extracting essential oils from natural sources. Through theoretical knowledge and hands-on experience, students learn the intricate art of blending scents and harnessing the therapeutic properties of essential oils for various applications.				

Course Outcomes (COs): After completing the Course, the student should be able to:-

COs	Statement	Cognitive level *	Knowledge Category #	Evaluation Tools
CO1	Recall the names and characteristics of various fragrance families	R	F	Quiz/Written Test
CO2	Demonstrate proficiency in perfume formulation techniques and fragrance composition	U	C	Lab sessions
CO3	Apply aromatherapy principles for therapeutic purposes in perfumery	Ap	C & P	Presentation/ Assignments
CO4	Evaluate fragrance formulations for their market suitability and adherence to regulatory standards	E	C & P	Research projects analyzing market trends
CO5	Design innovative fragrance formulations tailored to specific market demands and consumer preferences	Create	C & P	Group projects

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Detailed Syllabus:

Module	Unit	Content	Hrs (36 + 9)
I	**Introduction to Perfumery and Essential Oil Technology**		**9**
	1	Introduction to perfumery and essential oils, History and	3

		evolution of perfumery	
	2	Factors Influencing Essential Oil Quality: Plant variety, Growth Conditions, and Harvesting Techniques	3
	3	Quality control and assurance in perfumery, Regulatory aspects in the fragrance industry	3
II	**Chemistry of Fragrance**		**9**
	4	Chemical composition of essential oils	1
	5	Aroma chemistry: understanding fragrance molecules	2
	6	Fragrance Families and Classification: Floral, Oriental, Woody, and Citrus	2
	7	Odour classification and sensory evaluation	2
	8	Chemical analysis techniques in perfumery	2
III	**Essential Oil Production and Processing**		**9**
	9	Principal perfume and oil plants	1
	10	Extraction techniques: steam distillation, solvent extraction, enfleurage, etc	3
	11	Carrier oils: for diluting, carrying and delivering essential oils	1
	12	Post-extraction processing and refinement	2
	13	Some major essential oils and their applications; Aromatherapy- Benefits and risks	2
IV	**Perfume Formulation and Evaluation**		**9**
	15	Basics of perfume formulation	2
	16	Blending techniques and fragrance creation	2
	17	Factors influencing scent perception, Perfume stability and shelf-life	2
	18	Packaging Design and Branding Strategies	2
	19	Market analysis and consumer preferences	1
V	**Open ended (Suggestive List)**		**9**
	1. Internship: Training at fragrance companies or essential oil distilleries to gain hands-on experience in the field. 2. Industry visits: visit perfume manufacturing facilities and essential oil production units to gain practical insights. 3. Perfume formulation workshop: to create own fragrances under the guidance of industry professionals.		

Suggested readings:

- Dove R. 2018. The Essence of Perfume. Black Dog Publishing. United Kingdom.
- Tisserand R. & Young, R. 2013. Essential Oil Safety: A Guide for Health Care Professionals. Churchill Livingstone. United Kingdom.
- Rowe D. 2005. Chemistry and Technology of Flavours and Fragrances. Blackwell

Publishing. United States.

- Sell C. S. 2006. Fragrance Chemistry: The Science of the Sense of Smell. Royal Society of Chemistry. United Kingdom.
- Rhind J. P. 2012. Essential Oils: A Comprehensive Handbook for Aromatic Therapy. Singing Dragon. United Kingdom.
- Rostagno M. A. & Prado, J. M. (Eds.). 2016. Essential Oil Extraction: Methods, Techniques, and Applications. CRC Press. United States.
- Calkin R. R. & Jellinek J. S. 1994. Perfumery: Practice and Principles. Wiley. United States.
- Sell C. S. (Ed.). 2006. The Chemistry of Fragrances: From Perfumer to Consumer. Royal Society of Chemistry. United Kingdom.

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	-	-	-	1	-	-	-	1	-	-
CO2	2	1	2	1	3	3	1	-	3	-	1	-	3
CO3	2	1	2	1	3	3	1	-	3	-	1	-	3
CO4	2	1	2	1	3	3	1	-	3	-	1	-	3
CO5	2	1	2	1	3	3	1	-	3	-	1	-	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion
- Assignment/ Seminar
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment/ Seminar	Practical/Project Evaluation	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓	✓	
CO 5			✓	

Programme	B. Sc. BOTANY				
Course Title	**Seaweed Farming**				
Type of Course	**SEC**				
Semester	**VI**				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-		45
Pre-requisites	Nil				
Course Summary	The Seaweed Farming course provides an overview of the principles and practices involved in cultivating seaweed for various purposes. The course aims to equip students with the knowledge and skills needed to contribute to the growing seaweed farming industry and promote sustainable marine resource management.				

Course Outcomes (COs) After completing the Course, the student should be able to:-

COs	Statement	Cognitive level*	Knowledge Category#	Evaluation Tools
CO1	Demonstrate the knowledge of the different types of seaweed species and their cultivation requirements	U	F	Written Test/Lab practical
CO2	Analyse the importance of physico-chemical parameters in seaweeds	An	C	Written Test
CO3	Apply various farming techniques and best practices for seaweed cultivation, such as selecting suitable cultivation sites and managing pests	Ap	C & P	Practical Test/Quiz/Group discussion
CO4	Evaluate the economic viability of seaweed farming and develop a business plan for a seaweed farming operation	C	C & P	Literature survey/Project plan
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module	Unit	Content	Hrs (36 + 9)
1	**Introduction**		**8**
	1	Seaweed morphology; Classification and distribution of seaweeds	2
	2	Life cycle of seaweeds.	2
	3	Identification of cultivable seaweeds	2
	4	Global status - Present trend and scope in India and Kerala	2
II	**Seaweed cultivation**		**12**
	5	Seaweed spore collection, Site selection - Physico - chemical parameters, site preparation	3
	6	Farming methods - Construction specifications for cultivable species	2
	7	Bamboo Raft, Monoline, Tube net methods	2
	8	Seaweed Cultivation period; Disease management, Farm management, harvesting method	3
	9	Post-harvest technology, preservation of seaweeds	2
III	**Seaweed Byproducts**		**10**
	10	Phycocolloids - Agar, agarose, carrageenan, Algin -sources and use	2
	11	Seaweed as food - Porphyra, Laminaria, Monostroma, Enteromorpha, Caulerpa etc.	3
	12	Nutritional composition of edible seaweeds	1
	13	Seaweed Compost, Seaweed liquid fertilizer, Agricultural biostimulants, Animal fodder	2
	14	Seaweeds as Pharmaceuticals and cosmetics	2
IV	**Seaweed in Blue economy**		**6**
	15	Seaweed resources of Kerala coast and its economic potential	2
	16	Seaweed based industries in India, PMSSY in seaweeds, CSMCRI - Subsidy for seaweed farming, seaweed cultivation as livelihood.	2
	17	Current trends and Prospects of Seaweed Farming in India	2
V	**Open Ended (Suggestive list)**		**9**
	Visit to a seaweed farming centre		

Suggested Readings

- John B. 2023. Seaweeds of the World: A Guide to Every Order. Princeton University Press
- Leonel P. 2016. Edible seaweeds of the world Taylor & Francis
- Leonel P., Kiril, B., and Joshi N. H. (eds) 2019. Seaweeds as Plant Fertilizer, Agricultural Biostimulants and Animal Fodder. CRC Press
- Ole G. Mouritsen, Jonas Drotner Mouritsen, Mariela Johansen 2013. Seaweeds: Edible, Available, and Sustainable 3rd edition. University Of Chicago Press 304pp.

Online Sources

- http://eprints.cmfri.org.in/7537/1/565
- http://masujournal.org/107/S.K._YADAV.pdf

- http://eprints.cmfri.org.in/10671/1/12.%20Gulshad.pdf
- https://epubs.icar.org.in/index.php/IndFarm/article/download/136580/52191/383295
- https://naas.org.in/Policy%20Papers/policy%2022.pdf
- https://nph.onlinelibrary.wiley.com/doi/epdf/10.1111/nph.13278
- https://dof.gov.in/sites/default/files/2020-07/Seaweed_Cultivation.pdf
- https://repository.oceanbestpractices.org/handle/11329/1282
- https://www.fao.org/4/y4765e/y4765e0b.htm
- https://www.fao.org/4/y4765e/y4765e0b.htm
- https://egyankosh.ac.in/bitstream/123456789/9949/1/Unit%204.pdf
- http://eprints.cmfri.org.in/7612/1/628SDMRI_Research_Publication___Kaliaperumal_2003.Pdf
- http://eprints.cmfri.org.in/17847/1/AARDO_2023_Johnson%20B.pdf

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	1	1	2	2	1	2	1	-	2	-	2	-	-
CO2	1	1	2	2	1	2	1	-	2	-	2	-	-
CO3	1	1	2	2	1	2	1	-	2	-	2	3	3
CO4	1	1	2	2	1	2	1	-	2	-	2	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion
- Assignment/ Seminar
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment/ Seminar	Practical/Project Evaluation	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓		✓
CO 3	✓	✓	✓	✓
CO 4			✓	

LIST OF ONLINE COURSES

No.	Course title	Link
1	Environmental Pollution and Sustainable Management	https://onlinecourses.swayam2.ac.in/nou24_es11/preview
2	Environmental Studies : Pollution, Climate Change and Safety Management	https://onlinecourses.swayam2.ac.in/nou24_es12/preview
3	Environmental Impact Assessment for Environmental Health	https://onlinecourses.swayam2.ac.in/nou24_es07/preview
4	Proteomics	https://nptel.ac.in/courses/102101007
5	Cell Biology	https://nptel.ac.in/courses/102103012
6	Plant Tissue Culture	https://nptel.ac.in/courses/102103016
7	Genetic engineering & Applications	https://nptel.ac.in/courses/102103013
8	Plant Physiology & Metabolism	https://onlinecourses.swayam2.ac.in/cec24_bt21/preview
9	Industrial Biotechnology	https://onlinecourses.nptel.ac.in/noc19_bt20/preview
10	Plant Groups	https://onlinecourses.swayam2.ac.in/cec20_bt11/preview
11	Plant Physiology	https://onlinecourses.swayam2.ac.in/cec19_bt09/preview
12	Post Harvest Management of Fruits and Vegetables	https://onlinecourses.swayam2.ac.in/cec23_ag11/preview
13	Biodiversity and Ecological Resources	https://onlinecourses.swayam2.ac.in/cec21_ge31/preview
14	General Microbiology	https://onlinecourses.swayam2.ac.in/cec19_bt11/preview
15	Plant Pathology & Soil Health	https://onlinecourses.swayam2.ac.in/cec19_bt04/preview
16	Ecosystem & Natural Resources	https://onlinecourses.swayam2.ac.in/nou21_ge12/preview
17	Economic Botany: Plant Resource utilization	https://onlinecourses.swayam2.ac.in/cec19_bt10/preview
18	Biochemistry of Biomolecules	https://onlinecourses.swayam2.ac.in/cec20_bt12/preview
19	Biochemistry & Molecular Biology	https://onlinecourses.swayam2.ac.in/cec19_bt02/preview
20	Principles of Genetics	https://onlinecourses.swayam2.ac.in/cec21_bt02/preview
21	Genetics and Genomics	https://onlinecourses.swayam2.ac.in/cec20_bt03/preview
22	Environmental Studies	https://onlinecourses.swayam2.ac.in/cec19_bt03/preview
23	Fundamentals of Bioinformatics	https://onlinecourses.swayam2.ac.in/cec21_bt04/preview
24	Plant Biochemistry and Plant Biotechnology	https://onlinecourses.swayam2.ac.in/cec21_bt03/preview
25	Plant Physiology and	https://onlinecourses.swayam2.ac.in/cec19_bt01/preview

	Plant Tissue Culture	
26	Food Microbiology and Food Safety	https://onlinecourses.swayam2.ac.in/cec22_ag01/preview
27	Food Microbiology	https://onlinecourses.swayam2.ac.in/cec19_ag03/preview
28	Cell Biology	https://onlinecourses.swayam2.ac.in/cec19_bt12/preview
29	Global Strategies to Sustainable Development	https://onlinecourses.swayam2.ac.in/nou23_ge32/preview
30	Post Harvest Operations and Processing of Fruits, Vegetables, Spices and Plantation Crop Products	https://onlinecourses.nptel.ac.in/noc24_ag11/preview
31	Indian Agricultural Development	https://onlinecourses.swayam2.ac.in/nou19_ag08/preview
32	Molecular Biology	https://onlinecourses.swayam2.ac.in/cec24_bt24/preview
33	Biostatistics and Mathematical Biology	https://onlinecourses.swayam2.ac.in/cec24_bt01/preview
34	Intellectual Property	https://onlinecourses.swayam2.ac.in/cec20_hs18/preview
35	Basics of Remote sensing, GIS & GNSS technology and their applications	https://onlinecourses.swayam2.ac.in/aic20_ge05/preview

MODEL QUESTION PAPERS

MINOR COURSES

I Semester B.Sc. (SHFYUGP) Degree Examinations
BOT1CJ101 /BOT1MN100: Aesthetic Botany
(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A
[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Define the term "Aesthetic Botany" and explain its significance
2. Define microphotography and macrophotography and explain their significance in botany
3. What is bio pesticides? Give two examples
4. Define potting and discuss its importance in plant care and cultivation
5. What is Aquascaping?
6. Give an account of Ikebana type floral arrangement
7. What are the key factors to consider when selecting plants for indoor gardening?
8. List out the precaution to be taken to avoid pest and diseases in plants
9. What is digital documentation of plants
10. What is bonsai, and how does it differ from traditional gardening?

Section B
[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Explain the principles of design in landscaping and how they can be applied to create aesthetically pleasing outdoor gardens.
12. Mention a few garden tools and their uses.
13. Discuss the concept of symmetry in botany. Provide examples of plants with symmetrical features and explain their significance in aesthetics
14. Explain the benefits of using hydroponic systems for indoor gardening and outline the basic components of a hydroponic setup.
15. Compare and contrast drip irrigation and sprinkler irrigation systems, including their advantages and disadvantages.
16. Discuss the role of botanical illustration in scientific research, education, and conservation
17. Explain different types of Plant propagating structures
18. Explain the process of Botanical printing

Section C
[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Explain the various elements of a garden
20. Explain various plant propagation methods

II Semester B.Sc. (SHFYUGP) Degree Examinations

BOT2CJ101 /BOT2MN100: Microbial Diversity and Phytopathology

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A

[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Explain the phases represented by the S-curve in bacterial population growth.
2. What are the distinctive features of Mycoplasma, and how does the absence of a cell wall impact its structure and function?
3. Discuss the key characteristics, spread, and global impact of viral outbreaks with special focus on COVID -19.
4. Define glycocalyx and briefly explain its role in bacterial physiology.
5. Detail three asexual methods of reproduction employed by bacteria.
6. Explain the processes involved in bacterial conjugation, emphasizing the role of plasmids.
7. Explain the importance of Plant Growth Promoting Bacteria (PGPB) in agriculture
8. Explain the concept of probiotics and their role in microbial therapeutics.
9. Discuss the key aspects of Quick Wilt disease in pepper plants, including its symptoms and effective management strategies.
10. Assess the role of viruses in Genetic Engineering.

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Explain the role of Microbiome in microbial therapeutics.
12. Write on the importance of Bacteria in industrial fermentation
13. What are the importance of Antibiotics. Give two examples with their source.
14. What is the significance of cell wall in bacteria. Explain with reference to Gram staining.
15. Write any two viral plant diseases. Its causative agent, symptoms and management.
16. What are Phytoalexins. Explain its importance
17. What are the different methods of preparation of bacterial pure culture
18. Write on Biological disease management. Give two examples

Section C

[Answer any one. Each question carries 10 marks] (1x10=10 marks)

19. Give a detailed account on morphology and structure of Bacteria with illustration. Give its medical importance.
20. Explain defense strategies in Plants to pathogens and write on host pathogen interaction.

III Semester B.Sc. (SHFYUGP) Degree Examinations October 2024

BOT3CJ202 /BOT3MN200: Plant Anatomy & Analytical Techniques

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70 Section A**

[Answer All. Each question carries 3 marks](Ceiling: 24 Marks)

1. Distinguish between diacytic and paracytic stomata
2. How does Plant Anatomy serve as valuable evidence in forensic investigations?
3. What are cystolith and raphides?
4. Differentiate ring porous and diffuse porous wood
5. Distinguish between Normality and Molarity
6. Analyze the significance of pH in biological systems
7. Enumerate applications of buffers in biological studies
8. What is the principle behind spectroscopy?
9. How Ultracentrifugation differ from normal centrifugation
10. Evaluate the applications of Gas Chromatography?

Section B

[Answer All. Each question carries 6 marks] **(Ceiling: 36 Marks)**

11. Analyze the theories in the organization of shoot apex
12. Explain the anatomical features of latex secreting tissues in plants
13. Briefly explain various defects noticed in wood
14. Enumerate the features of secondary xylem to be used as typical wood
15. Analyze how anatomy of xerophytes helps them to survive in extreme climatic conditions
16. Explain principle and working of fluorescent spectroscopy
17. Explain the principle and working of Scanning electron microscope
18. Describe various applications of Mass spectroscopy

Section C

[Answer any one. Each question carries 10 marks] **(1x10=10marks)**

19. Explain with suitable example how abnormal position of cambium leads to anomaly in secondary growth of stem
20. Explain the various chromatographic techniques and its applications in Plant Science

I Semester B.Sc. (SHFYUGP) Degree Examinations
BOT1MN101: Plant Ecology, Conservation & Plant Interactions
(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A

[Answer All. Each question carries 3 marks] **(Ceiling: 24 Marks)**

1. Define ecology and explain the difference between biotic and abiotic factors in an ecosystem.
2. What is Cryopreservation?
3. Identify an example of a halophyte and explain its adaptations to saline environments.
4. Define ecological succession and describe the process of hydrosere succession.
5. Explain the concept of biodiversity and name three types of biodiversity.
6. Discuss the economic and aesthetic values of biodiversity.
7. Define biodiversity hotspots and name one hotspot in India.
8. Explain the concept of endemism and provide examples of endemic species in the Western Ghats.
9. Discuss the causes of extinction and changes in biodiversity.
10. Describe habitat fragmentation and its impact on biodiversity.

Section B

[Answer All. Each question carries 6 marks] **(Ceiling: 36 Marks)**

11. Compare and contrast the adaptations of hydrophytes and xerophytes, highlighting their structural and physiological differences.
12. Evaluate the importance of biodiversity hotspots in conservation efforts, citing examples from India.
13. Analyze the consequences of biodiversity loss
14. Discuss the significance of in-situ and ex-situ conservation methods in preserving biodiversity.
15. Explain the roles of biosphere reserves, national parks, and sanctuaries in biodiversity conservation.
16. Critically assess the effectiveness of botanical gardens and seed banks in ex-situ conservation.
17. Discuss the various plant interactions.
18. Evaluate the conservation aspects of plant-animal interactions and their contribution to ecosystem services.

Section C

[Answer any one. Each question carries 10 marks] **(1x10=10 Marks)**

19. Briefly explain ecological succession with an example.
20. Evaluate the significance of conservation practices in maintaining plant ecosystems

II Semester B.Sc. (SHFYUGP) Degree Examinations
BOT2MN101: Plant Morphology, Physiology & Plant Resources
(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A

[Answer All. Each question carries 3 marks] **(Ceiling: 24 Marks)**

1. Describe the structure of a simple leaf and provide an example.
2. Differentiate between racemose and cymose inflorescences, giving examples of each.
3. Explain the structure of a flower and discuss the types of aestivation.
4. Define permeability and explain the process of imbibition in plants.
5. Describe the mechanism of transpiration and its significance for plant physiology.
6. Explain the significance of photosynthesis and mention the two pigment systems involved.
7. Define plant growth and discuss the role of gibberellins.
8. Explain the process of fruit ripening and its physiological changes.
9. Name three categories of plants based on their economic importance.
10. Provide examples of medicinal plants and their uses.

Section B

[Answer All. Each question carries 6 marks] **(Ceiling: 36 Marks)**

11. Compare and contrast the structure and arrangement of simple and compound leaves.
12. Analyze the types of inflorescences and their adaptive significance in plant reproduction.
13. Evaluate the roles of water potential and osmosis in water relations of plants.
14. Discuss the mechanisms of stomatal movement and the factors affecting transpiration rates.
15. Explain the process of Calvin cycle in photosynthesis and discuss factors influencing photosynthesis.
16. Discuss the physiological processes involved in seed dormancy and techniques to break dormancy.
17. Evaluate the economic importance of plant resources, citing examples from different categories.
18. Analyze the medicinal properties and uses of *Rauvolfia serpentina, Justicia adhatoda,*

Section C

[Answer any one. Each question carries 10 marks] **(1x10=10 Marks)**

19. Explain the morphological characteristics of a leaf, including its structure, venation, and phyllotaxy, and discuss the adaptations of leaves in different plant environments.
20. Critically assess the roles of plant hormones in growth and development, focusing on auxins and cytokinins.

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II Semester B.Sc. (SHFYUGP) Degree Examinations

BOT3MN201:Plant Diversity & Angiosperm Taxonomy

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A

[Answer All. Each question carries 3 marks] **(Ceiling: 24 Marks)**

1. Describe the general characteristics of cyanobacteria.
2. Explain the ecological significance of *Nostoc*.
3. Describe the structure of *Spirogyra*.
4. Explain the symbiotic associations in lichens.
5. Define mycorrhiza and discuss its significance for plant growth.
6. Describe the general characteristics of bryophytes.
7. Explain the morphology of *Riccia*.
8. Discuss the ecological and economic importance of pteridophytes.
9. Describe the microsporophyll of *Cycas*.
10. Name two economically importance plants of family Euphorbiaceae, and mention their uses

Section B

[Answer All. Each question carries 6 marks] **(Ceiling: 36 Marks)**

11. Explain the binomial system of nomenclature and its basic rules.
12. Analyze the life cycle of *Nostoc*, highlighting its reproductive strategies.
13. Evaluate the role of fungi in various industries.
14. Explain the structural and reproductive adaptations of bryophytes and their ecological significance.
15. Discuss the ecological roles and economic uses of gymnosperms.
16. Evaluate the economic significance of the families Fabaceae and Poaceae
17. Discuss the general characteristics of the family Euphorbiaceae.
18. Briefly explain the life cycle of *Agaricus*

Section C

[Answer any one. Each question carries 10 marks] **(1x10=10 Marks)**

19. Critically assess the Bentham & Hooker's system of classification and its relevance in modern taxonomy.
20. Discuss the role of botanical gardens and herbaria in plant taxonomy, research, and conservation, using examples from important institutions in India.

I Semester B.Sc. (SHFYUGP) Degree Examinations

BOT1MN102: Phytochemistry

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A

[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Define primary and secondary metabolites with examples.
2. Classify monosaccharides and provide one example of each type.
3. Explain the significance of peptide bonds in protein structure.
4. Describe the basic structure and function of triglycerides.
5. What are nucleotides and what roles do they play in the cell?
6. Name two major classes of secondary metabolites and give one example of each.
7. What is Thin Layer Chromatography (TLC) and how is it used in phytochemical analysis?
8. Explain the importance of solvent polarity in the extraction of phytochemicals.
9. Define antioxidants and mention one mechanism of their action.
10. Name a phytochemical with anticancer properties and its plant source.

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Discuss the classification and functions of disaccharides, providing examples.
12. Explain the role of amino acids in the biosynthesis of proteins and phytochemicals.
13. Discuss on natural preservatives and additives
14. Discuss the therapeutic applications of flavonoids and terpenoids, focusing on their health benefits and clinical uses.
15. Explain the process of Nuclear Magnetic Resonance (NMR) spectroscopy and its application in the structural elucidation of phytochemicals.
16. Discuss the antimicrobial properties of phytochemicals and their applications in medicine and agriculture
17. Describe the economic importance of phytochemicals in the pharmaceutical industry, providing examples of plant-derived drugs.
18. Explain the concept of biopesticides and their significance in sustainable agriculture.

Section C

[Answer any one. Each question carries 10 marks] (1x10=10 Marks)

19. Evaluate the various extraction techniques used in phytochemistry, highlighting their advantages and disadvantages.
20. Discuss the environmental and economic impacts of phytochemicals.

II Semester B.Sc. (SHFYUGP) Degree Examinations
BOT2MN102: Secondary Metabolites and Biofuels
(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A

[Answer All. Each question carries 3 marks] **(Ceiling: 24 Marks)**

1. What are secondary metabolites.
2. Name three examples of alkaloids and their sources.
3. What is the role of terpenoids in plants?
4. Describe the significance of phenolic compounds.
5. Explain the shikimate pathway briefly.
6. List two solvent extraction methods.
7. Write on an analytical technique used for biofuel analysis?
8. Define bioherbicides with an example.
9. What are first-generation biofuels?
10. How do biofuels impact greenhouse gas emissions?

Section B

[Answer All. Each question carries 6 marks] **(Ceiling: 36 Marks)**

11. Explain the differences between primary and secondary metabolites.
12. Describe the ecological roles of alkaloids in plants.
13. Discuss the steps involved in the solvent extraction of phytochemicals.
14. Compare and contrast thin-layer chromatography (TLC) and high-performance liquid chromatography (HPLC).
15. Analyze the use of secondary metabolites in human health with examples.
16. Explain the transesterification process for biodiesel production.
17. Discuss the socio-economic impacts of biofuel production.
18. Describe the potential of secondary metabolites in microbial biofuel production.

Section C

[Answer any one. Each question carries 10 marks] **(1x10=10 Marks)**

19. Evaluate the industrial applications of secondary metabolites, focusing on pharmaceuticals and agriculture.
20. Assess the sustainability of biofuel production in comparison to fossil fuels, considering environmental and socio-economic factors.

III Semester B.Sc. (SHFYUGP) Degree Examinations

BOT3MN202: Essential Oils of Aromatic Plants

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A

[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. List any five aromatic plants.
2. Explain the historical uses of essential oils.
3. Describe the traditional methods of essential oil extraction.
4. Classify aromatic plants based on their botanical sources.
5. Outline the process of steam distillation for extracting essential oils.
6. What are the major chemical constituents of essential oils? Give examples.
7. How does solubility in water and oils affect the formulation of essential oils?
8. Explain the role of GC-MS in the chemical analysis of essential oils.
9. Describe the principles of aromatherapy.
10. What are the potential allergic reactions associated with essential oil use?

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Compare and contrast solvent extraction and supercritical CO_2 extraction methods.
12. Explain the factors affecting the stability and shelf life of essential oils.
13. Describe the UV-Vis and IR spectroscopy techniques used in the analysis of essential oils.
14. Discuss the antimicrobial and antioxidant properties of essential oils.
15. Explain the methods of application in aromatherapy and their therapeutic benefits.
16. Analyze the environmental impact of essential oil production and suggest eco-friendly extraction techniques.
17. Discuss the regulatory guidelines for the safe use of essential oils in consumer products.
18. Describe the analgesic properties of essential oils and their use in pain management.

Section C

[Answer any one. Each question carries 10 marks] (1x10=10 Marks)

19. Evaluate the quality control measures and ISO standards in the essential oil industry. How do these standards ensure the purity and effectiveness of essential oils?
20. Assess the global market trends of essential oils and discuss the economic impact on major producing countries. Include an analysis of future market predictions and potential growth areas.

I Semester B.Sc. (SHFYUGP) Degree Examinations

BOT1MN103: Economic Botany

(Credits: 4)

Section A

[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Explain the concept of plant genetic resources and their importance for conservation.
2. Discuss Vavilov's concept of the origin of cultivated plants
3. Describe the morphology and uses of rice.
4. Discuss the economic importance of pseudocereals.
5. Explain the nutritive value of pulses.
6. Describe the production, morphology, and economic importance of chickpea
7. Explain the by-products of sugarcane.
8. Compare Fatty oils and essential oils.
9. Discuss the types of beverages and their examples, and describe the processing of tea.
10. Explain the economic importance of fruits such as citrus and banana.

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Compare and contrast the economic importance of cereals like rice and wheat, including their production methods and uses.
12. Analyze the economic significance of legumes as sources of protein and their role in addressing protein malnutrition.
13. Evaluate the economic impact of sugars and starches from plants like sugarcane and potatoes.
14. Discuss the economic importance and processing methods of coffee, and its global trade.
15. Explain the economic value of fruits and nuts, comparing tropical and temperate varieties and their uses.
16. Critically assess the economic significance of oil-yielding plants.
17. Analyze the role of spices in culinary and medicinal applications.
18. Discuss the processing methods and uses of rubber.

Section C

[Answer any one. Each question carries 10 marks] (1x10=10 Marks)

19. Analyze the economic potential of underutilized leafy vegetables and wild edible plants, and discuss techniques for their cultivation and conservation.
20. Evaluate the conservation efforts and techniques used to cultivate and conserve underutilized plants, highlighting the role of organizations in promoting plant diversity and sustainable utilization.

II Semester B.Sc. (SHFYUGP) Degree Examinations

BOT2MN103: Plant Nutraceuticals

(Credits: 4)

Section A

[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Define nutraceuticals and explain their role in health management.
2. Give examples of functional foods and their specific health benefits.
3. Describe the sources of omega-3 fatty acids in nutraceuticals.
4. Explain the concept of bioactive compounds in functional foods.
5. Name two nutraceuticals used for managing cardiovascular diseases.
6. Discuss the benefits of probiotics for gut health.
7. Identify a functional food rich in antioxidants and its health effects.
8. Explain the role of prebiotics in promoting gut microbiota balance.
9. Name a nutraceutical used for joint health and inflammation management.
10. Describe the source of plant sterols in for cholesterol management.

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Mention few nutraceuticals based on algae, and add a note on their benefits.
12. Analyze the impact of nutraceuticals on chronic diseases like diabetes and obesity, citing examples.
13. Suggest remedies for Arthritis, using plant nutraceuticals.
14. Discuss the role of nutraceuticals and functional foods in supporting cognitive health and brain function.
15. Explain the potential risks associated with excessive consumption of nutraceuticals or functional foods.
16. Critically assess the importance fruit based nutraceuticals.
17. Analyze the challenges in incorporating nutraceuticals and functional foods into dietary guidelines for chronic disease management.
18. Discuss the emerging trends in nutraceutical research.

Section C

[Answer any one. Each question carries 10 marks] (1x10=10 Marks)

19. Discuss the concept of personalized nutrition and its application in managing chronic diseases.
20. Evaluate the role of nutraceuticals and functional foods in promoting overall health and wellness.

III Semester B.Sc. (SHFYUGP) Degree Examinations

BOT3MN203: Ethnobotany

(Credits: 4)

Section A

[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. How do plants play a role in shaping cultural practices and traditions?
2. Name one traditional plant use practice of Indigenous communities and its significance.
3. Explain the importance of plant symbolism in different cultures.
4. What is the significance of medicinal plants in traditional healing systems?
5. Identify one traditional plant-based food preparation technique and its cultural significance.
6. Discuss the role of plants in spiritual and ritual practices of various cultures.
7. Name a plant with cultural significance in ceremonies or celebrations.
8. Describe one traditional plant preservation method used by Indigenous communities.
9. Explain how plants are integrated into traditional craftsmanship and arts.
10. Discuss the importance of plant-based dyes in cultural expressions.

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Analyze the impact of globalization on traditional plant knowledge and practices of Indigenous communities.
12. Evaluate the role of storytelling in passing down plant knowledge through generations in Indigenous cultures.
13. Compare and contrast the plant use practices of two different Indigenous communities.
14. Discuss the challenges faced in preserving and conserving traditional plant knowledge in modern times.
15. Examine the role of plants in traditional medicine systems and their relevance in modern healthcare.
16. Critically assess the ethical considerations in documenting and using traditional plant knowledge.
17. Explore the cultural significance of plant-based ceremonies and rituals in Indigenous cultures.
18. Analyze the role of plants in sustainable livelihoods of Indigenous communities.

Section C

[Answer any one. Each question carries 10 marks] (1x10=10 Marks)

19. Discuss the intricate relationship between plants and human cultures, highlighting examples from different societies around the world.
20. Evaluate the importance of respecting and preserving Indigenous traditional plant knowledge, considering its value for cultural heritage and biodiversity conservation.

VOCATIONAL MINOR

I Semester B.Sc. (SHFYUGP) Degree Examinations
BOT1VN101: Computational Botany

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A

[Answer All. Each question carries 3 marks] **(Ceiling: 24 Marks)**

1. Define computational botany and explain its interdisciplinary nature.
2. List two key historical milestones in the development of computational biology.
3. What is PlantCV, and how is it used in plant morphology analysis?
4. What are the main components of a mechanistic model in plant physiology?
5. Explain the importance of quality control in botanical data analysis.
6. Name two visualization techniques commonly used in botanical research.
7. What is the role of individual-based models (IBMs) in plant ecological modeling?
8. Describe one type of plant-pathogen interaction model.
9. How is marker-assisted selection (MAS) utilized in plant breeding?
10. Explain the importance of understanding disease spread dynamics in plant pathology and discuss different types of disease spread models.

Section B

[Answer All. Each question carries 6 marks] **(Ceiling: 36 Marks)**

11. Explain the relevance of computational science to modern botany, providing one specific example.
12. Discuss the applications of PhenoPhyte in plant morphology analysis.
13. Compare and contrast empirical and hybrid modeling approaches in plant physiology.
14. Describe the process and importance of data handling in botanical research.
15. How do process-based models aid in the simulation of plant-environment interactions?
16. Evaluate the use of network models in studying the spread of plant diseases.
17. Illustrate the importance of data visualization in botany research with an example.
18. Explain the applications of machine learning in species identification within plant science. Describe the role of genomic selection (GS) in improving crop traits.

Section C

[Answer any one. Each question carries 10 marks] **(1x10=10 Marks)**

19. Critically assess the impact of computational approaches on conservation efforts and biodiversity analysis, providing specific examples of methods and applications.
20. Evaluate the significance of mathematical modeling in studying plant growth and development, discussing different types of models and their applications in detail.

II Semester B.Sc. (SHFYUGP) Degree Examinations

BOT2VN101: Biostatistics

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A

[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Define biostatistics and explain its significance in biological research.
2. Differentiate between nominal, ordinal, interval, and ratio levels of measurement, providing examples of each.
3. Calculate the mean, median, and mode for the following dataset: [10, 15, 20, 25, 30]
4. Explain the concept of variance and standard deviation. Calculate the standard deviation for the given dataset
5. Describe the differences between the binomial, Poisson, and normal probability distributions.
6. Define null and alternative hypotheses and explain their significance in hypothesis testing.
7. Discuss the types of errors in hypothesis testing, giving examples of each.
8. Explain the applications of the t-test, chi-square test, and ANOVA in biological research.
9. Define correlation and regression, explaining the differences between simple and multiple regression.
10. Explain the uses of measuring central tendency.

Section B

[Answer All. Each question carries 6 marks] **(Ceiling: 36 Marks)**

11. Calculate the range for the following dataset: [5, 8, 10, 12, 15]. Interpret the result.
12. Explain the procedure for conducting Tukey's Honest Significant Difference (HSD) test. Provide a hypothetical example.
13. Describe the Bonferroni correction method and its application in hypothesis testing.
14. Discuss the procedure and interpretation of results of Scheffé's method. Provide an example scenario..
15. Explain the Newman-Keuls test and its significance in post hoc analysis
16. Describe Dunnett's test, its procedure, and application in biological research.
17. Discuss the benefits of computer-assisted data analysis in biological research. Provide examples of software tools used for this purpose.
18. Compare and contrast the features and capabilities of MS Excel, R programming, and SPSS for data analysis in biological research.

Section C

[Answer any one. Each question carries 10 marks] **(1x10=10 marks)**

19. Explain post hoc tests used in biology.
20. Which are the tools used in biostatistics? Explain the applications of statistical tools in Biology.

II Semester B.Sc. (SHFYUGP) Degree Examinations

BOT3VN201: Bioinformatics

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A

[Answer All. Each question carries 3 marks] **(Ceiling: 24 Marks)**

1. Briefly explain the difference between WetLab and WebLab.
2. Describe the role of structural biology in understanding DNA-protein interactions.
3. What is the significance of chloroplast genome.
4. Define homologous, orthologous, paralogous, and analogous sequences.
5. Explain the concept of scoring matrices in sequence alignment.
6. What are the main challenges and applications of proteomics in the Human Proteome Project (HPP)?
7. Outline the principles of Peptide Mass Fingerprinting (PMF).
8. Describe the basic structure and purpose of the GenBank.
9. Explain the concept of phylogenetic tree representations and their significance in evolutionary studies.
10. What are the ethical and social challenges associated with whole genome sequencing?

Section B

[Answer All. Each question carries 6 marks] **(Ceiling: 36 Marks)**

11. Compare and contrast PAGE and its different types used in proteomic studies.
12. Discuss the role of protein motifs and domains in proteomic analysis.
13. Describe the process and significance of whole genome sequencing in identifying mutations and establishing phylogenetic relationships.
14. Explain the importance of structural visualization tools in bioinformatics.
15. Describe the concepts of entity and relationship sets in hierarchical data models within database management systems.
16. Explain how PSI-BLAST is used for sequence analysis and interpretation of data.
17. Describe the significance of Reactome and KEGG databases in protein research.
18. Discuss the applications of bioinformatics in functional and comparative genomics.

Section C

[Answer any one. Each question carries 10 marks] **(1x10=10 marks)**

19. Describe the various technologies used in proteomic studies.
20. Discuss the process of protein structure prediction and structure-based drug design (SBDD).

I Semester B.Sc. (SHFYUGP) Degree Examinations
BOT1VN102: Horticulture and Nursery Management

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A

[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Define integrated pest management (IPM) and list its components.
2. Explain the importance of soil testing in horticulture.
3. Describe the principles of drip irrigation.
4. Discuss the factors influencing site suitability for nursery layout.
5. Define post-harvest physiology and its relevance in horticultural crop management.
6. List the components of a greenhouse infrastructure.
7. Explain the concept of vertical gardening.
8. Provide examples of biological control methods of pest management.
9. Describe the process of soil erosion prevention in horticultural practices.
10. Compare shade houses and polyhouses.

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Analyze the role of soil properties in soil preparation and management for horticultural crops.
12. Explain the principles of pesticide application.
13. Discuss the principles of integrated pest management (IPM) and its application in sustainable pest control.
14. Compare and contrast different nursery layout principles and their impact on plant growth.
15. Evaluate the effectiveness of cultural disease control practices in horticulture.
16. Discuss the importance of marketing strategies in promoting horticultural products.
17. Analyze the financial management processes involved in horticultural business ventures.
18. Discuss the principles of financial planning in horticultural business management.

Section C

[Answer any one. Each question carries 10 marks] (1x10=10 Marks)

19. Design a nursery layout plan considering factors such as soil type, drainage, and microclimate, and explain how it optimizes plant growth and management efficiency.
20. Briefly explain various irrigation methods and techniques.

II Semester B.Sc. (SHFYUGP) Degree Examinations

BOT2VN102: Plant Propagation Techniques

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A

[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Define seed dormancy and explain the factors that can break dormancy.
2. Differentiate between softwood, hardwood, and semi-hardwood cuttings in cutting propagation.
3. Explain the principles of graft compatibility in grafting techniques.
4. Describe the process of micropropagation.
5. Discuss the methods of layering in vegetative reproduction.
6. Explain the principles of hydroponics and its benefits.
7. Describe the process of scarification in seed enhancement techniques.
8. Explain seed certification and standards and their significance.
9. Discuss the applications of aeroponics.
10. Discuss the applications of layering in woody plant propagation

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Analyze the advantages and disadvantages of sexual propagation techniques compared to asexual propagation techniques.
12. Evaluate the factors affecting seed germination and the environmental requirements for successful germination.
13. Explain the significance of micropropagation in mass propagation.
14. Describe the factors affecting plant growth and propagation.
15. Explain bulb propagation methods.
16. Evaluate the ecological restoration techniques used in propagating endangered species.
17. Discuss the types of grafting techniques and their applications in horticulture.
18. Define seed viability and vigour testing and their importance in seed quality assessment.

Section C

[Answer any one. Each question carries 10 marks] (1x10=10 Marks)

19. Design a propagation plan for a specific endangered plant species, considering the propagation goals, available resources, and environmental conditions.
20. Discuss the innovations and future trends in plant propagation technology.

III Semester B.Sc. (SHFYUGP) Degree Examinations

BOT3VN202: Biofertilizer Technology

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A

[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Define biofertilizers and name three types commonly used in agriculture.
2. Explain the role of Azolla in nitrogen fixation and its application as a biofertilizer.
3. List two bacterial biofertilizers and their benefits in agriculture.
4. Define mycorrhizae and name two types commonly used as biofertilizers.
5. Discuss the application technology for biofertilizers in seeds, seedlings, and tubers.
6. Explain the factors that can influence the efficacy of biofertilizers in soil.
7. List the benefits of using Azospirillum as a biofertilizer in agriculture.
8. Describe the symbiotic association of Rhizobium with leguminous plants.
9. Discuss the significance of phosphate-solubilizing microbes as biofertilizers.
10. Explain the method of inoculation for arbuscular mycorrhizae in agricultural practices.

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Compare and contrast the nitrogen-fixing abilities of cyanobacteria and bacterial biofertilizers.
12. Evaluate the advantages and disadvantages of using mycorrhizal biofertilizers in agriculture.
13. Discuss the biochemistry and molecular basis of nitrogen fixation.
14. Evaluate the advantages and disadvantages of using Cyanobacteria and Azolla as biofertilizers in rice cultivation.
15. Briefly explain mass cultivation of Azolla.
16. Analyze the process of mass multiplication and application technology for mycorrhizal biofertilizers.
17. Discuss the challenges associated with storage, quality control, and marketing of biofertilizers.
18. Evaluate the role of national and regional biofertilizers production centers in promoting sustainable agriculture.

Section C

[Answer any one. Each question carries 10 marks] (1x10=10 Marks)

19. Discuss the potential impacts of biofertilizers on sustainable agriculture practices.
20. Discuss the role of national and regional biofertilizers production and development centers in promoting sustainable agriculture practices.

MULTI-DISCIPLINARY COURSES

I Semester B.Sc. (SHFYUGP) Degree Examinations

BOT1FM105 (1): Incredible Plant Kingdom

(Credits: 4)

Maximum Time: 1.5 hours **Maximum Marks: 50**

Section A

[Answer All. Each question carries 2 marks] (Ceiling: 16 Marks)

1. Define the term "allelopathy" and provide an example of a plant that exhibits this interaction.
2. Describe the unique characteristics and importance of Bryophytes.
3. Explain how plastic-degrading plants contribute to environmental sustainability.
4. What are the special features of *Victoria regia*?
5. Identify and describe the adaptation mechanisms in Xerophytes, with an example.
6. What is myrmecophily, and which plants exhibit this interaction?
7. Describe the role of bioluminescent plants and provide an example.
8. Describe the morphological adaptations of hydrophytes, using Eichhornia as an example.
9. Define thermophiles and provide two examples of such plants.
10. Explain the concept of "intelligent networking systems" in plants.

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 24 Marks)

11. Discuss the significance of bizarre botanical structures in plant survival.
12. Explain the mechanisms of spore dispersal in Pteridophytes.
13. Describe the cultivation, harvest, and processing of saffron.
14. Explain the adaptive strategies of plants thriving in volcanic regions.
15. Discuss the pollination mechanisms in fig plants.

Section C

[Answer any one. Each question carries 10 marks] (1x10=10 Marks)

16. Discuss the role and importance of various plant groups in sustaining life on Earth. Provide examples to support your answer.
17. Examine the various extreme adaptations plants have developed to thrive in harsh environments. Include specific plant examples and their adaptive strategies.

II Semester B.Sc. (SHFYUGP) Degree Examinations October 2024

BOT1FM105 (2): Plant Propagation

(Credits: 4)

Section A

[Answer All. Each question carries 2 marks] (Ceiling: 16 Marks)

1. Define plant propagation and explain its need for plant multiplication.
2. List the advantages and disadvantages of asexual propagation.
3. What are the key features of a mist chamber used in plant propagation?
4. Briefly describe the composition and types of soil.
5. Explain the merits and demerits of chemical fertilizers.
6. What is drip irrigation, and what are its advantages?
7. Name and describe one method of biological plant protection.
8. What is seed dormancy, and why is seed treatment necessary?
9. Write on terrarium preparation.
10. Define micropropagation and mention one of its applications.

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 24 Marks)

11. Describe the tools and implements used in a nursery.
12. Discuss the types and application of organic manure.
13. Describe the steps involved in raising seed beds for seed propagation.
14. What are the essential conditions for successful seed propagation?
15. Explain the methods and benefits of using biopesticides in plant protection.

Section C

[Answer any one. Each question carries 10 marks] (1x10=10 marks)

16. Discuss the various vegetative plant propagation techniques. Provide examples and explain the specific conditions suitable for each technique.
17. Explain the steps involved in mushroom cultivation and the necessary conditions for successful growth.

II Semester B.Sc. (SHFYUGP) Degree Examinations

BOT2FM106 (1): Ecosystem Diversity in India

(Credits: 3)

Maximum Time: 1.5 hours **Maximum Marks: 50**

Section A

[Answer All. Each question carries 2 marks] **(Ceiling 16 marks)**

1. Define an ecosystem and list its components.
2. Name two terrestrial ecosystems found in India.
3. What are the factors affecting ecosystem diversity?
4. Mention one human-induced threat to Indian ecosystems.
5. Give an example of a protected area in India.
6. Mention the natural and one anthropogenic factor affecting ecosystem diversity.
7. What are the key roles of protected areas in conservation?
8. Explain the concept of traditional ecological knowledge (TEK).
9. Compare and contrast urban ecosystems and natural ecosystems in terms of biodiversity and conservation challenges
10. Analyze the importance of biodiversity for ecosystem services and human well-being.

Section B

[Answer All. Each question carries 6 marks] **(Ceiling 24 marks)**

11. Discuss the importance of ecosystem diversity for biodiversity conservation and human well-being.
12. Analyze the impact of climate change on Indian ecosystems.
13. Evaluate the effectiveness of protected areas in conserving India's biodiversity.
14. Compare and contrast tropical rainforests and deciduous forests in India.
15. Discuss the impacts of deforestation on Indian ecosystems and propose conservation strategies.

Section C

[Answer any one. Each question carries 10 marks] **(1x10=10 marks)**

16. Propose conservation strategies to mitigate human-induced threats to Indian ecosystems. Include examples and discuss their potential impact.
17. Discuss the interdisciplinary approaches to ecosystem management, considering ecological economics, socio-cultural perspectives, policy, and governance.

II Semester B.Sc. (SHFYUGP) Degree Examinations
BOT2FM106 (2): Plants in Everyday Life
(Credits: 3)

Maximum Time: 1.5 hours **Maximum Marks: 50**

Section A

[Answer All. Each question carries 2 marks] (Ceiling 16 marks)

1. Name two economically important plant species used in day-to-day life.
2. Explain the role of plants as biofertilizers using the example of Azolla.
3. List two plants used in rituals/festivals and their significance.
4. Mention two plants used as air purifiers and their mechanisms.
5. Name two plants commonly used in natural cleaning products.
6. Define phytoremediation and provide an example.
7. List two common medicinal plants and their respective medicinal uses.
8. Explain the role of lichens as pollution indicators.
9. Discuss the uses and benefits of *Gliricidia* in agriculture.
10. Describe the process of photosynthesis and its importance as an air purifier.

Section B

[Answer All. Each question carries 6 marks] (Ceiling 24 marks)

11. Describe the processing methods of coconut to obtain edible oil and coir fiber.
12. Explain the medicinal uses of Tulsi and Aloe vera with reference to their botanical sources and parts used.
13. Compare the uses and benefits of different types of legumes in everyday life.
14. Discuss the economic importance of cash crops like Cashew and Cocoa.
15. Analyze the role of plants in phytoremediation and their significance in pollution removal.

Section C

[Answer any one. Each question carries 10 marks] (1x10=10 Marks)

16. Evaluate the economic and medicinal importance of a plant species of your choice, detailing its uses, processing methods, and contribution to daily life.
17. Discuss the concept of eco-friendly lifestyle and its benefits, providing examples of eco-friendly products and their preparation methods.

SKILL ENHANCEMENT COURSE

III Semester B.Sc. (SHFYUGP) Degree Examinations
BOT5FS112 (1): Herbal Technology
(Credits: 3)

Maximum Time: 1.5 hours **Maximum Marks: 50**

Section A

[Answer All. Each question carries 2 marks] **(Ceiling: 16 Marks)**

1. Define herbal medicine and mention its importance.
2. What are the primary classifications of herbs based on their usage?
3. Explain the importance of authentication in the selection of herbal materials.
4. List two plant-based industries in India involved in medicinal and aromatic plants.
5. What are the main steps involved in the collection and preservation of medicinal plants?
6. Describe one major problem involved in the standardization of herbs.
7. What are the WHO guidelines for the quality standardization of herbal formulations?
8. Define sustainable harvesting practices and explain their importance.
9. Differentiate between solvent extraction and steam distillation.
10. Why are packaging and labeling regulations important in the herbal industry?

Section B

[Answer All. Each question carries 6 marks] **(Ceiling: 24 Marks)**

11. Discuss the role of active constituents in the classification of herbs.
12. Explain the ethical considerations in the collection of medicinal plants.
13. Describe the process and significance of drying and grinding in the processing of medicinal plants.
14. Explain the key quality control measures in the production of herbal products.
15. Explain the process of supercritical fluid extraction and its advantages in herbal technology.

Section C

[Answer any one. Each question carries 10 marks] **(1x10=10 Marks)**

16. Analyze the challenges involved in the standardization of herbal products and discuss the measures that can be taken to overcome these challenges.
17. Design a sustainable harvesting plan for a medicinal plant, considering ethical practices, regulatory standards, and quality control measures.

V Semester B.Sc. (SHFYUGP) Degree Examinations

BOT5FS112 (2): Landscaping & Gardening

(Credits: 3)

Maximum Time: 1.5 hours **Maximum Marks: 50**

Section A

[Answer All. Each question carries 2 marks] (Ceiling: 16 Marks)

1. Define the term "xeriscaping" and its importance in landscaping.
2. List any two benefits of seasonal gardening practices.
3. Explain the principle of balance in landscape design.
4. What are the objectives of urban planning in landscaping?
5. Describe the role of soil preparation in gardening.
6. Name two common pests found in gardens and their impact on plants.
7. What is the significance of mulching in agronomic practices?
8. Define hydroponics and mention one advantage of using this system.
9. Explain the principle of drip irrigation.
10. Give the name of any four plants used for growing as boarders.

Section B

[Answer All. Each question carries 6 marks] **(Ceiling: 24 Marks)**

11. Discuss the principles of plant selection in landscape design.
12. Explain the objectives and factors affecting landscape planning.
13. Describe the process and benefits of rainwater harvesting in sustainable irrigation practices.
14. Outline the steps involved in soil moisture monitoring and irrigation scheduling.
15. Describe the common diseases affecting plants in gardens and nurseries, and suggest control measures.

Section C

[Answer any one. Each question carries 10 marks] **(1x10=10 Marks)**

16. Analyze the different types of sustainable irrigation practices and discuss their implementation in gardens and nurseries.
17. Discuss the integrated pest management (IPM) strategies for effective pest control in gardens and nurseries, providing examples of specific control methods.

VI Semester B.Sc. (SHFYUGP) Degree Examinations

BOT6FS113 (1): Phytochemical Techniques

(Credits: 3)

Maximum Time: 1.5 hours **Maximum Marks: 50**

Section A

[Answer All. Each question carries 2 marks] **(Ceiling: 16 Marks)**

1. Define maceration and describe its importance in phytochemical extraction.
2. What are the primary differences between Soxhlet extraction and percolation?
3. List any two applications of phytochemicals in drug development.
4. Describe the principle behind IR Spectroscopy.
5. Explain the role of solvent polarity in extraction techniques.
6. What are alkaloids? Give two examples.
7. Outline the basic steps involved in paper chromatography.
8. What is the significance of fractionation in phytochemical analysis?
9. Explain the principle of UV spectroscopy in the identification of compounds.
10. Define antimicrobial activity and give one method to evaluate it.

Section B

[Answer All. Each question carries 6 marks] **(Ceiling: 24 Marks)**

11. Compare and contrast digestion and decoction as extraction techniques.
12. Outline the steps involved in performing an in vitro anti-inflammatory study.
13. Describe the process of qualitative phytochemical screening for alkaloids.
14. Explain the principle and method of gas chromatography-mass spectrometry (GC-MS) for identifying essential oil constituents.
15. Explain the role of phytochemicals in natural product research with an example.

Section C

[Answer any one. Each question carries 10 marks] (1x10=10 marks)

16. Analyze the various chromatographic techniques and discuss their applications in the separation and identification of phytochemicals.
17. Describe the methods of toxicity studies and discuss their importance in the evaluation of phytochemicals.

VI Semester B.Sc. (SHFYUGP) Degree Examinations

BOT6FS113 (2): Essential Oil and Perfumery Technology

(Credits: 3)

Maximum Time: 1.5 hours **Maximum Marks: 50**

Section A

[Answer All. Each question carries 2 marks] **(Ceiling: 16 Marks)**

1. Name any two key fragrance families and briefly describe their characteristics.
2. What are the main factors influencing essential oil quality?
3. Define the term "aromatherapy" and mention one of its therapeutic uses.
4. What is the significance of regulatory standards in the fragrance industry?
5. Explain the difference between steam distillation and solvent extraction.
6. List two major essential oils and their common applications.
7. Describe the role of carrier oils in essential oil processing.
8. What are the benefits of using enfleurage as an extraction technique?
9. Outline the importance of sensory evaluation in perfumery.
10. Briefly explain the concept of perfume stability.

Section B

[Answer All. Each question carries 6 marks] **(Ceiling: 24 Marks)**

11. Discuss the historical evolution of perfumery and its significance in modern times.
12. Explain the chemical composition of essential oils and its importance in fragrance creation.
13. Describe the process of post-extraction processing and refinement of essential oils.
14. Explain the basics of blending techniques used in fragrance creation.
15. Outline the key aspects of quality control and assurance in the fragrance industry.

Section C

[Answer any one. Each question carries 10 marks] **(1x10=10 Marks)**

16. Evaluate the different extraction techniques for essential oils, including steam distillation, solvent extraction, and enfleurage, highlighting their advantages and disadvantages.
17. Design an innovative fragrance formulation tailored to a specific market demand, considering factors such as consumer preferences, market analysis, and regulatory standards.

VI Semester B.Sc. (SHFYUGP) Degree Examinations

BOT6FS113 (3): Seaweed Farming

(Credits: 3)

Section A

[Answer All. Each question carries 2 marks] (Ceiling: 16 Marks)

1. Name two types of cultivable seaweeds and their cultivation requirements.
2. Explain the importance of physico-chemical parameters in seaweed cultivation.
3. List two farming techniques used in seaweed cultivation and describe one best practice for managing pests.
4. What factors are considered when evaluating the economic viability of seaweed farming?
5. Define seaweed morphology and describe its importance in seaweed farming.

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 24 Marks)

11. Discuss the life cycle of seaweeds and its significance in seaweed cultivation.
12. Explain the process of seaweed spore collection and discuss the criteria for selecting suitable cultivation sites.
13. Compare and contrast three farming methods used in seaweed cultivation, including their construction specifications and advantages.
14. How can seaweed byproducts such as phycocolloids and seaweed compost be utilized in different industries? Provide examples.
15. Analyze the role of seaweed in the blue economy and its potential impact on sustainable development.

Section C

[Answer any one. Each question carries 10 marks] (1x10=10 Marks)

16. Develop a business plan for a seaweed farming operation, including site selection, farming methods, post-harvest technology, and market analysis.
17. Evaluate the current trends and prospects of seaweed farming in India, considering factors such as government initiatives, economic potential, and challenges faced by the industry.