File Ref.No.16231/GA - IV - J1/2013/CU

**UNIVERSITY OF CALICUT**

**Abstract**

General & Academic IV - Faculty of Science - Modified Scheme and Syllabus of BSc Plant Science Honours Programme with effect from 2024 admission - in tune with the CUFYUGP Regulations 2024, Approved by the Vice Chancellor - Implemented - Orders Issued

**G & A - IV - J**

U.O.No. 4806/2025/Admn Dated, Calicut University.P.O, 22.03.2025

*Read:*-1. U.O.No. 9977/2024/Admn dated 24.06.2024

2. U.O Note No. 92616/EX-III-ASST-2/2024/PB dated: 05.10.2024
3. Minutes of the Board of Studies in Plant Science (single board) held on 14.12.2024
4. Remarks of the Dean, Faculty of Science dated: 17.03.2025
5. Orders of the Vice Chancellor in the file of even No. dated: 20.03.2025

**ORDER**

1. Vide paper read as (1), the Scheme and Syllabus of B.Sc. Plant Science Honours Programme in tune with CUFYUGP Regulations 2024, has been implemented with effect from 2024 admission.
2. Vide paper read as (2), Pareeksha Bhavan had pointed out certain discrepancies in the syllabus of BSc Plant Science Honours programme.
3. Accordingly, the Board of Studies in Plant Science (single board), vide paper read as (3), incorporated the corrections pointed out by Pareeksha Bhavan and approved the modified scheme and syllabus of B.Sc. Plant Science Honours programme with effect from 2024 admission, in tune with CUFYUGP Regulations 2024, .
4. The Dean, Faculty of Science vide paper read as (4), approved the minutes of the meeting of Board of Studies in Plant Science (single board).
5. Considering the above, the Vice Chancellor has approved the minutes of the meeting of the Board of Studies in Plant Science (single board) and accorded sanction to implement the modified scheme and syllabus of B.Sc Plant Science Honours programme with effect from 2024 admission, exercising the powers as per clause 10(13) of Calicut University Act 1975.
6. The modified Scheme and Syllabus of B.Sc Plant Science Honours programme in tune with CUFYUGP Regulations 2024, is thus implemented with effect from 2024 admission.
7. The U O vide paper read as (1) stands modified to this extent.
8. Orders are issued accordingly. (Syllabus appended)

Ajayakumar T.K

Assistant Registrar

To

Principals of all Affiliated Colleges

Copy to: Copy to: PS to VC/PA to PVC/ PA to Registrar/PA to CE/JCE I/JCE II/JCE IV/DoA/EX and EG Sections/GA I F/CHMK Library/SUVEGA/FYUGP Cell/SF/DF/FC

Forwarded / By Order

Section Officer

**UNIVERSITY OF CALICUT**

# B. Sc. PLANT SCIENCE HONOURS

(MAJOR, MINOR AND GENERAL FOUNDATION COURSES)

**SYLLABUS & MODEL QUESTION PAPERS**

w.e.f. 2024 admission onwards

(CUFYUGP Regulations 2024)

**BSc PLANT SCIENCE HONOURS**

(MAJOR, MINOR, AND GENERAL FOUNDATION COURSES)

**SYLLABUS**

# 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. Incorporating modern scientific advancements, the syllabus introduces Artificial intelligence in Plant Science, genomics, transcriptomics, proteomics, and metabolomics, equipping students to integrate multi-omics datasets, enhancing their understanding of plant biology and preparing them for research in applied Plant Science.

Critical aspects of applied Botany are covered, including plant breeding techniques, intellectual property rights in crop improvement, and integrated pest management strategies. Ecological and environmental implications of plant science are explored, including geobotanical principles, remote sensing, GIS technology, and sustainability challenges. 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.

**UNIVERSITY OF CALICUT**

**BOARD OF STUDIES IN PLANT SCIENCE (UG)**

| Sl.No. | Name | Official Address |
|---|---|---|
| 1 | Dr. Santhosh Nampy | Sr. Professor, Department of Botany, University of Calicut |
| 2 | Dr. John E. Thoppil | Sr. Professor, Department of Botany, University of Calicut |
| 3 | Dr. Jose T. Puthur | Professor, Department of Botany, University of Calicut |
| 4 | Dr. Gangaprasad A. | Professor, Department of Botany, University of Kerala |
| 5 | Dr. Seema Devi R. | Assistant Professor, Department of Botany, N.S.S. College, Manjeri |
| 6 | Dr. Sojan Jose<br>(Not attended meetings of the Syllabus Restructuring) | Assistant Professor, Department of Botany, Govt. College, Chittur |
| 7 | Dr. Sunojkumar P. | Associate Professor, Department of Botany, University of Calicut |
| 8 | Dr. Akhila H. | Assistant Professor, Department of Botany, Sri Vyasa NSS College, Wadakkanchery |
| 9 | Dr. P. Manimohan<br>(Not attended meetings of the Syllabus Restructuring) | Professor (Retd.), Department of Botany, University of Calicut |
| 10 | Dr. Kishore Kumar K. | Associate Professor,<br>Farook College (Autonomous), Kozhikode |

**PANEL OF EXPERTS IN SYLLABUS RESTRUCTURING**

**(Other than BoS)**

| Sl.No. | Name | Official Address |
|---|---|---|
| 1 | Dr. Rajesh K.P. | Associate Professor, Department of Botany, Zamorin's Guruvayurappan College, Kozhikode |
| 2 | Dr. Arun Kumar T.K. | Associate Professor, Department of Botany, Zamorin's Guruvayurappan College, Kozhikode |
| 3 | Dr. Tajo Abraham | Associate Professor, Department of Botany, Sir Syed College, Taliparamba, Kannur |
| 4 | Dr. Joby Paul | Assistant Professor, Department of Botany, St. Thomas College, Thrissur |
| 5 | Dr. Manudev K.M. | Assistant Professor, St. Joseph 's College, Devagiri (Autonomous), Kozhikode |

**SYLLABUS INDEX**

**CORE COURSES IN MAJOR**

| | | | |
|---|---|---|---|
| | | Elective Course 3 in Major | |
| | | Elective Course 4 in Major | |
| | | Internship in Major | |
| **VII** | PLA7CJ401 | CROP IMPROVEMENT AND PLANT MOLECULAR PATHOLOGY | 149 |
| | PLA7CJ402 | PLANT SYSTEMATICS AND MOLECULAR PHYLOGENY | 156 |
| | PLA7CJ403 | ADVANCES IN PLANT PHYSIOLOGY AND BIOCHEMISTRY | 164 |
| | PLA7CJ404 | RECENT ADVANCES IN CELL AND MOLECULAR BIOLOGY | 176 |
| | PLA7CJ405 | ENVIRONMENTAL TOXICOLOGY & MANGEMENT, COMPUTATIONAL BIOLOGY AND STATISTICAL ANAYLYSIS | 183 |
| **VIII** | PLA8CJ401/ PLA8MN401 | CANCER GENOMICS, PROTEOMICS AND SYSTEM BIOLOGY | 192 |
| | PLA8CJ402/ PLA8MN402 | INTELLECTUAL PROPERTY RIGHTS AND PATENTING | 200 |
| | PLA8CJ403/ PLA8MN403 | RESOURCE MAPPING AND CONSERVATION BIOLOGY | 207 |
| | PLA8CJ489 | RESEARCH METHODOLOGY | 215 |
| | | Project (Honours Programme) | |
| | | Project (Honours with Research Programme) | |
| | | Elective Course 5 in Major | |
| | | Elective Course 6 in Major | |
| | / | Elective Course 7 in Major | |

**ELECTIVE COURSES IN B. Sc PLANT SCIENCE WITH NO SPECIALISATION**

## GROUPING OF MINOR COURSES IN B. Sc. PLANT SCIENCE

## GROUPING OF VOCATIONAL MINOR COURSES IN B. Sc. PLANT SCIENCE

## DISTRIBUTION OF GENERAL FOUNDATION COURSES IN B. Sc. PLANT SCIENCE

| Semester | Course Code | Course Title | Page No. |
|---|---|---|---|
| **I** | PLA1FM105 | Multi-Disciplinary Course 1 – FOOD PROCESSING AND TECHNOLOGY | 409 |
| **II** | PLA2FM106 | Multi-Disciplinary Course 2 – BIODIVERSITY AND ENVIRONMENTAL INTERACTIONS | 417 |
| **III** | PLA3FV108 | Value-Added Course 1 – SUSTAINABLE AGRICULTURE AND FOOD SECURITY | 424 |
| **IV** | PLA4FV110 | Value-Added Course 2 – AGRI-BUSINESS MANAGEMENT | 431 |
| **V** | PLA5FS112 | Skill Enhancement Course 1 – PLANT PROPAGATION TECHNIQUES | 438 |
| **VI** | PLA6FS113 | Skill Enhancement Course 2 – MUSHROOM CULTIVATION & MARKETING | 444 |

## PROGRAMME OUTCOMES (PO):

At the end of the graduate programme at Calicut University, a student would:

| Sl. No. | Graduate Attributes | PO Statement |
|---|---|---|
| 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. |

These POs should be used for the OBE mapping of the syllabus of each course.

## PROGRAMME SPECIFIC OUTCOMES (PSO):

At the end of the BSc Plant Science Honours programme at Calicut University, a student would:

| | |
|---|---|
| PSO1 | In-depth knowledge of plant science: Graduates will gain a comprehensive understanding of various branches of botany, including plant diversity, structure, function, metabolism, genetics, ecology, and evolution. |
| PSO2 | Laboratory and field skills: The program emphasizes practical training, equipping students with laboratory and field skills in plant identification, experimentation, data analysis, and scientific communication. |
| PSO3 | Critical thinking and problem-solving abilities: Through affective interactions and research projects, students develop critical thinking and problem-solving skills applicable to various scientific and environmental challenges. |
| PSO4 | Effective communication skills: The program fosters effective communication skills, allowing graduates to present scientific information clearly and concisely in written and oral formats. |
| PSO5 | Lifelong learning, adaptability and professionalism: Equip the student to pursue higher degree, by participating in internship, research projects etc the students will develop with the skills and knowledge to stay updated and adaptable in the ever-evolving field. Also by maintaining ethical conduct, strong communication skill and collaboration will develop professionalism in the student. |
| PSO6 | Environmental awareness & value inculcation: Plant science studies foster a strong positive attitude towards the environment, encouraging graduates to become responsible stewards and potentially pursue careers in sustainable management, environmental research, and related fields. |

**MINIMUM CREDIT REQUIREMENTS OF THE DIFFERENT PATHWAYS**

**IN THE THREE-YEAR PROGRAMME IN CUFYUGP**

| 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: Plant Science + 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: Plant Science + Minor B: Students from Science stream other than Plant Science; Minor C: Students from Non-Science stream |
| 3 | Major (A) with Minor (B) | 68 (17 courses) | 24 (6 courses) | 39 (13 courses) | 2 | 133 | Major: Plant Science Minor: Zoology |
| 4 | Major (A) with Vocational Minor (B) | 68 (17 courses) | 24 (6 courses) | 39 (13 courses) | 2 | 133 | Major: Plant Science Minor: Vocational Courses in any discipline |
| Exit with UG Degree / Proceed to Fourth Year with 133 Credits | | | | | | | |

## BSc PLANT SCIENCE 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 | | Total |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Internal | External | |
| I | PLA1CJ101 | Core Course 1 in Major – BASICS OF PLANT SCIENCE: INSTRUMENTS AND TECHNIQUES | 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 | 45 | 3 | 3 | 25 | 50 | 75 |
| | | **Total** | | **23/ 25** | **21** | | | **525** |
| II | PLA2CJ101 | Core Course 2 in Major – PLANTS IN EVERYDAY LIFE AND HORTICULTURE | 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 |
| | ENG2FA103(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 | 45 | 3 | 3 | 25 | 50 | 75 |
| | | **Total** | | **23/ 25** | **21** | | | **525** |
| III | PLA3CJ201 | Core Course 3 in Major – BIODIVERSITY AND ENVIRONMENTAL STUDIES | 60 | 4 | 4 | 30 | 70 | 100 |
| | PLA3CJ202 | Core Course 4 in Major – ANATOMY, EMBRYOLOGY AND PALYNOLOGY | 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 | 45 | 3 | 3 | 25 | 50 | 75 |
| | ENG3FV108(2) | Value-Added Course 1 – English | 45 | 3 | 3 | 25 | 50 | 75 |
| | | **Total** | | **23/ 25** | **22** | | | **550** |
| IV | PLA4CJ201 | Core Course 5 in Major – VIRUSES, BACTERIA AND FUNGI | 75 | 5 | 4 | 30 | 70 | 100 |
| | PLA4CJ202 | Core Course 6 in Major – ALGAE AND BRYOPHYTES | 75 | 5 | 4 | 30 | 70 | 100 |
| | PLA4CJ203 | Core Course 7 in Major – PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY | 75 | 5 | 4 | 30 | 70 | 100 |
| | ENG4FV109(2) | Value-Added Course 2 – English | 45 | 3 | 3 | 25 | 50 | 75 |
| | | Value-Added Course 3 – Additional Language | 45 | 3 | 3 | 25 | 50 | 75 |
| | ENG4FS111(2) | Skill Enhancement Course 1 – English | 60 | 4 | 3 | 25 | 50 | 75 |
| | | **Total** | | **25** | **21** | | | **525** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| V | PLA5CJ301 | Core Course 8 in Major – ANGIOSPERM MORPHOLOGY AND TAXONOMY | 75 | 5 | 4 | 30 | 70 | 100 |
| | PLA5CJ302 | Core Course 9 in Major – PLANT PHYSIOLOGY, BIOCHEMISTRY AND BIO PHYSICS | 75 | 5 | 4 | 30 | 70 | 100 |
| | PLA5CJ303 | Core Course 10 in Major –PHYTOGEOGRAPHY, NATURAL RESOURCES AND UTILIZATION | 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 |
| | PLA1FS101 | Skill Enhancement Course 2 | 45 | 3 | 3 | 25 | 50 | 75 |
| | | **Total** | | **25** | **23** | | | **575** |
| VI | PLA6CJ301 | Core Course 11 in Major – CELL AND MOLECULAR BIOLOGY | 75 | 5 | 4 | 30 | 70 | 100 |
| | PLA6CJ302 | Core Course 12 in Major– PLANT BIOTECHNOLOGY, GENETIC ENGINEERING AND BIOINFORMATICS | 75 | 5 | 4 | 30 | 70 | 100 |
| | PLA6CJ303 | Core Course 13 in Major –GENETICS, PLANT BREEDING, EVOLUTION AND BIOSTATISTICS | 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 |
| | PLA6FS113 | Skill Enhancement Course 3 | 45 | 3 | 3 | 25 | 50 | 75 |
| | PLA6CJ349 | 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** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| VII | PLA7CJ401 | Core Course 14 in Major – CROP IMPROVEMENT AND PLANT MOLECULAR PATHOLOGY | 75 | 5 | 4 | 30 | 70 | 100 |
| | PLA7CJ402 | Core Course 15 in Major – PLANT SYSTEMATICS AND MOLECULAR PHYLOGENY | 75 | 5 | 4 | 30 | 70 | 100 |
| | PLA7CJ403 | Core Course 16 in Major – ADVANCES IN PLANT PHYSIOLOGY AND BIOCHEMISTRY | 75 | 5 | 4 | 30 | 70 | 100 |
| | PLA7CJ404 | Core Course 17 in Major – RECENT ADVANCES IN CELL AND MOLECULAR BIOLOGY | 75 | 5 | 4 | 30 | 70 | 100 |
| | PLA7CJ405 | Core Course 18 in Major – ENVIRONMENTAL TOXICOLOGY & MANGEMENT, COMPUTATIONAL BIOLOGY AND STATISTICAL ANAYLYSIS | 75 | 5 | 4 | 30 | 70 | 100 |
| | | **Total** | | **25** | **20** | | | **500** |
| VIII | PLA8CJ401/ PLA8MN401 | Core Course 19 in Major – CANCER GENOMICS, PROTEOMICS AND SYSTEM BIOLOGY | 75 | 5 | 4 | 30 | 70 | 100 |
| | PLA8CJ402/ PLA8MN402 | Core Course 20 in Major – INTELLECTUAL PROPERTY RIGHTS AND PATENTING | 60 | 4 | 4 | 30 | 70 | 100 |
| | PLA8CJ403/ PLA8MN403 | Core Course 21 in Major – RESOURCE MAPPING AND CONSERVATION BIOLOGY | 60 | 4 | 4 | 30 | 70 | 100 |
| | OR (instead of Core Courses 19 – 21 in Major) | | | | | | | |
| | PLA8CJ449 | Project (in Honours programme) | 360* | 13* | 12 | 90 | 210 | 300 |
| | PLA8CJ499 | Project (in Honours with Research programme) | 360* | 13* | 12 | 90 | 210 | 300 |
| | | Elective Course 5 in Major | 60 | 4 | 4 | 30 | 70 | 100 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Elective Course 6 in Major | 60 | 4 | 4 | 30 | 70 | 100 |
| | | Elective Course 7 in Major /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) | | | | | | | | |
| | PLA8CJ489 | RESEARCH METHODOLOGY | 60 | 4 | 4 | 30 | 70 | 100 |
| | | Total | | 25 | 24 | | | 600 |
| **Total Credits for Four Years** | | | | | **177** | | | **4425** |

* The teacher should have 13 hrs/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 DISTRIBUTIONFOR 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 PLANT SCIENCE 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 |
|---|---|---|---|---|
| I | PLA1CJ101 | Core Course 1 in Major- BASICS OF PLANT SCIENCE: INSTRUMENTS AND TECHNIQUES | 5 | 4 |
| II | PLA2CJ101 | Core Course 2 in Major – PLANTS IN EVERYDAY LIFE AND HORTICULTURE | 5 | 4 |
| III | PLA3CJ201 | Core Course 3 in Major – BIODIVERSITY AND ENVIRONMENTAL STUDIES | 4 | 4 |
| | PLA3CJ202 | Core Course 4 in Major ANATOMY, EMBRYOLOGY AND PALYNOLOGY | 5 | 4 |
| IV | PLA4CJ201 | Core Course 5 in Major – VIRUSES, BACTERIA AND FUNGI | 5 | 4 |
| | PLA4CJ202 | Core Course 6 in Major – ALGAE AND BRYOPHYTES | 5 | 4 |
| | PLA4CJ203 | Core Course 7 in Major – PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY | 5 | 4 |
| V | PLA5CJ301 | Core Course 8 in Major – ANGIOSPERM MORPHOLOGY AND TAXONOMY | 5 | 4 |
| | PLA5CJ302 | Core Course 9 in Major –PLANT PHYSIOLOGY, BIOCHEMISTRY AND BIOPHYSICS | 5 | 4 |
| | PLA5CJ303 | Core Course 10 in Major – PHYTOGEOGRAPHY, NATURAL RESOURCES AND UTILIZATION | 4 | 4 |
| | | Elective Course 1 in Major | 4 | 4 |
| | | Elective Course 2 in Major | 4 | 4 |
| VI | PLA6CJ301 | Core Course 11 in Major – CELL AND MOLECULAR BIOLOGY | 5 | 4 |
| | PLA6CJ302 | Core Course 12 in Major–PLANT BIOTECHNOLOGY, GENETIC ENGINEERING AND BIOINFORMATICS | 5 | 4 |
| | PLA6CJ303 | Core Course 13 in Major – GENETICS, PLANT | 4 | 4 |

| | | | | |
|---|---|---|---|---|
| | | BREEDING, EVOLUTION AND BIOSTATISTICS | | |
| | | Elective Course 3 in Major | 4 | 4 |
| | | Elective Course 4 in Major | 4 | 4 |
| | PLA6CJ349 | Internship in Major | - | 2 |
| **Total for the Three Years** | | | | **70** |
| VII | PLA7CJ401 | Core Course 14 in Major- CROP IMPROVEMENT AND PLANT MOLECULAR PATHOLOGY | 5 | 4 |
| | PLA7CJ402 | Core Course 15 in Major – PLANT SYSTEMATICS AND MOLECULAR PHYLOGENY | 5 | 4 |
| | PLA7CJ403 | Core Course 16 in Major – ADVANCES IN PLANT PHYSIOLOGY AND BIOCHEMISTRY | 5 | 4 |
| | PLA7CJ404 | Core Course 17 in Major – RECENT ADVANCES IN CELL AND MOLECULAR BIOLOGY | 5 | 4 |
| | PLA7CJ405 | Core Course 18 in Major –ENVIRONMENTAL TOXICOLOGY & MANGEMENT, COMPUTATIONAL BIOLOGY AND STATISTICAL ANAYLYSIS | 5 | 4 |
| VIII | PLA8CJ401/ PLA8MN401 | Core Course 19 in Major –CANCER GENOMICS, PROTEOMICS AND SYSTEM BIOLOGY | 5 | 4 |
| | PLA8CJ402/ PLA8MN402 | Core Course 20 in Major - INTELLECTUAL PROPERTY RIGHTS AND PATENTING | 4 | 4 |
| | PLA8CJ403/ PLA8MN403 | Core Course 21 in Major – RESOURCE MAPPING AND CONSERVATION BIOLOGY | 4 | 4 |
| | OR (instead of Core Courses 19 – 21 in Major) | | | |
| | PLA8CJ449 | Project (in Honours programme) | 13 | 12 |
| | PLA8CJ499 | Project (in 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) | | | |
| | PLA8CJ489 | RESEARCH METHODOLOGY | 4 | 4 |

| | | |
|---|---|---|
| **Total for the Four Years** | | **114** |

## ELECTIVE COURSES IN B. Sc PLANT SCIENCE WITH NO SPECIALISATION

| Sl. No. | Course Code | Title | Semester | Total Hrs | Hrs/ Week | Credits | Marks | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Internal | External | |
| 1 | PLA5EJ301 | MICROBIAL TECHNOLOGY | 5 | 60 | 4 | 4 | 30 | 70 | 100 |
| 2 | PLA5EJ302 | SUSTAINABLE AGRICULTURE AND MANAGEMENT | 5 | 60 | 4 | 4 | 30 | 70 | 100 |
| 3 | PLA5EJ303 | BASIC TISSUE CULTURE AND MICROPROPAGATION | 5 | 60 | 4 | 4 | 30 | 70 | 100 |
| 4 | PLA5EJ304 | ALGAL RESOURCES AND UTILIZATION | 5 | 60 | 4 | 4 | 30 | 70 | 100 |
| 5 | PLA6EJ301 | ENTREPRENEURIAL BOTANY AND ECOTOURISM | 6 | 60 | 4 | 4 | 30 | 70 | 100 |
| 6 | PLA6EJ302 | PHYTOCHEMISTRY AND PHARMACOGNOSY | 6 | 60 | 4 | 4 | 30 | 70 | 100 |
| 7 | PLA6EJ303 | BOTANICAL GARDENS AND BIOPROSPECTING | 6 | 60 | 4 | 4 | 30 | 70 | 100 |
| 8 | PLA6EJ304 | FORENSIC BOTANY PRINCIPLES & APPLICATIONS | 6 | 60 | 4 | 4 | 30 | 70 | 100 |
| 9 | PLA8EJ401 | ENZYME TECHNOLOGY | 6 | 60 | 4 | 4 | 30 | 70 | 100 |
| 10 | PLA8EJ402 | NANOTECHNOLOGY IN BIOSCIENCE | 6 | 60 | 4 | 4 | 30 | 70 | 100 |
| 11 | PLA8EJ403 | FUNGAL BIOLOGY AND TECHNOLOGY | 7 | 60 | 4 | 4 | 30 | 70 | 100 |
| 12 | PLA8EJ404 | PLANT MORPHOGENSIS AND DEVELOPMENTAL INTEGRATION | 7 | 60 | 4 | 4 | 30 | 70 | 100 |

**GROUPING OF MINOR COURSES IN B. Sc. PLANT SCIENCE**

(Title of the Minor: BASICS IN PLANT SCIENCE)

(Minor courses given below are not offered to students who have taken Plant Science as the major discipline and are offered to students from other major disciplines only)

| Group No. | Sl. No. | Course Code | Title | Semester | Total Hrs | Hrs/ Week | Credits | Marks | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Internal | External | |
| **1** | **MINOR B (Preferable for Science students) COMPLEMENTORY PLANT SCIENCE** | | | | | | | | | |
| | 1 | PLA1MN101 | BASICS OF PLANT SCIENCE, INSTRUMENTS AND TECHNIQUES | 1 | 75 | 5 | 4 | 30 | 70 | 100 |
| | 2 | PLA2MN101 | DIVERSITY OF MICROBES AND NON-FLOWERING PLANTS | 2 | 75 | 5 | 4 | 30 | 70 | 100 |
| | 3 | PLA3MN201 | DIVERSITY OF FLOWERING PLANTS, PLANT PHYSIOLOGY, PLANT BREEDING & PLANT BIOTECHNOLOGY | 3 | 75 | 5 | 4 | 30 | 70 | 100 |
| | | | | | | | | | | |
| **2** | **MINOR C (Preferable for Non-Science stream students) FUNDAMENTALS IN PLANT SCIENCE** | | | | | | | | | |
| | 1 | PLA1MN102 | BASICS OF PLANT SCIENCE, ENVIRONMENTAL STUDIES AND BOTANICAL | 1 | 75 | 5 | 4 | 30 | 70 | 100 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | ENTREPRENEURSHIP | | | | | | | |
| | 2 | PLA2MN102 | PLANT RESOURCE UTILIZATION, MICROBIOLOGY & PLANT PATHOLOGY | 2 | 75 | 5 | 4 | 30 | 70 | 100 |
| | 3 | PLA3MN202 | BIODIVERSITY, PLANT INTERACTIONS, BASIC TISSUE CULTURE | 3 | 75 | 5 | 4 | 30 | 70 | 100 |

## GROUPING OF VOCATIONAL MINOR COURSES IN B. Sc. PLANT SCIENCE

(Title of the Vocational Minor: VOCATIONAL COURSE IN PLANT SCIENCE)

| Group No. | Sl. No. | Course Code | Title | Semester | Total Hrs | Hrs/ Week | Credits | Marks | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Internal | External | |
| 1 | | | **LANDSCAPING, ORNAMENETAL GARDENINFG AND MANAGEMENT** | | | | | | | |
| | 1 | PLA1VN101 | GARDENING AND LANDSCAPE MANAGEMENT | 1 | 75 | 5 | 4 | 30 | 70 | 100 |
| | 2 | PLA2VN101 | FLORICULTURE, CUT FLOWER INDUSTRY & PRECISION FARMING | 2 | 75 | 5 | 4 | 30 | 70 | 100 |
| | 3 | PLA3VN201 | ORGANIC FARMING, INTEGRATED PEST MANAGEMENT, SUSTAINABLE AGRICULTURE & AGRI-ECONOMICS | 3 | 75 | 5 | 4 | 30 | 70 | 100 |
| 2 | | | **PROPAGATION, POST HARVEST AND PRESERVATION TECHNIQUES** | | | | | | | |
| | 1 | PLA1VN102 | MEDICINAL BOTANY | 1 | 75 | 5 | 4 | 30 | 70 | 100 |
| | 2 | PLA2VN102 | BOTANICAL SPECIMEN PREPARATION AND CURATION | 2 | 75 | 5 | 4 | 30 | 70 | 100 |
| | 3 | PLA3VN202 | HARVEST AND POST HARVEST STORAGE TECHNIQUES IN AGRICULTURE | 3 | 75 | 5 | 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 as one of the multiple disciplines, all the three courses from any one of the Minor/ Vocational Minor groups offered by any discipline, including their Major discipline. If they choose one of the Minor/ Vocational Minor groups offered by their Major discipline as the first one of the multiple disciplines, then their choice as the second one of the multiple disciplines should be any one of the Minor/ Vocational Minor groups offered by a discipline other than the Major discipline. If the students choose any one of the Minor/ Vocational Minor groups in Plant science as given above, then the title of the group will be the title of that multiple discipline.

iii. Students in Major with Minor pathway can choose all the courses from any two Minor groups offered by any discipline. If the students choose any two Minor groups in Plant science as given above, then the title of the Minor will be Basics in Plant Science.

iv. Students in Major with Vocational Minor pathway can choose all the courses from any two Vocational Minor groups offered by any discipline. If the students choose any two Vocational Minor groups in Plant science as given above, then the title of the Vocational Minor will be Vocational Plant Science.

## DISTRIBUTION OF GENERAL FOUNDATION COURSES IN B. Sc. PLANT SCIENCE

| Semester | Course Code | Course Title | Total Hours | Hours/ Week | Credits | Marks | | Total |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Internal | External | |
| I | PLA1FM105 | Multi-Disciplinary Course 1 – FOOD PROCESSING AND TECHNOLOGY | 45 | 3 | 3 | 25 | 50 | 75 |
| II | PLA2FM106 | Multi-Disciplinary Course 2 – BIODIVERSITY AND ENVIRONMENTAL INTERACTIONS | 45 | 3 | 3 | 25 | 50 | 75 |
| III | PLA3FV108 | Value-Added Course 1 – SUSTAINABLE AGRICULTURE AND FOOD SECURITY | 45 | 3 | 3 | 25 | 50 | 75 |
| IV | PLA4FV110 | Value-Added Course 2 – AGRI-BUSINESS MANAGEMENT | 45 | 3 | 3 | 25 | 50 | 75 |
| V | PLA5FS112 | Skill Enhancement Course 1 – PLANT PROPAGATION TECHNIQUES | 45 | 3 | 3 | 25 | 50 | 75 |
| VI | PLA6FS113 | Skill Enhancement Course 2 – MUSHROOM CULTIVATION & MARKETING | 45 | 3 | 3 | 25 | 50 | 75 |

## 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.
3. 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.
4. 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 Plant Science 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. 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* |
| Total marks | | 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%.
- Students are supposed to submit reports on visit to institutes/ Botanical gardens/ herbarium industry etc for evaluation for course papers specifying the same.
- Students are supposed to submit herbarium (ten well prepared and correctly identified locally abundant wild plants from any family), fresh/dry specimens for evaluation if it is specified in the practical component.
- 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.
- 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 | 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 hands-on training on a particular skill/ equipment/ software. 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

1. Internship can be in Plant Science/ Botany or allied disciplines.
2. There should be minimum 60 hrs. of engagement from the student in the Internship.
3. Summer vacations and other holidays can be used for completing the Internship.
4. In BSc Plant Science Hnours programme, institute/ industry visit or study tour is a requirement for the completion of Internship. Visit to minimum one national research institute, research laboratory and place of scientific importance should be part of the study tour. A brief report of the institution visit has to be submitted with photos and analysis.
5. 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 experimental conditions and results, ideas, mathematical expressions, rough work and calculation, computer file names etc. All entries should be dated. The Internship supervisor should periodically examine and countersign the log book.
6. The log book and the typed report must be submitted at the end of the Internship.
7. 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. EVALUATION OF INTERNSHIP

- The evaluation of Internship shall be done internally through continuous assessment mode by a committee internally constituted by the Department Councilof 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 Viva-voce | 5 | |
| 3 | | Punctuality and Log Book | 5 | |
| 4 | Report of Institute Visit/ Study Tour | | 5 | 10% |
| 5 | End-semester viva-voce examination to be conducted by the committee internally constituted by the Department Council | Quality of the work | 6 | 35% |
| 6 | | Presentation of the work | 5 | |
| 7 | | Viva-voce | 6 | |
| 8 | 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 | | 8 | 15% |
| | 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/ 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 asper 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

1. Project can be in Plant Science or allied disciplines.
2. Project should be done individually.
3. Project work can be of experimental/ Field study/ computational in nature.
4. 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.
5. 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.
6. The various steps in project works are the following:

    - Wide review of a topic.
    - Investigation on a problem in systematic way using appropriate techniques.
    - Systematic recording of the work.
    - Reporting the results with interpretation in a standard documented form.
    - Presenting the results before the examiners.

    i. 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, photographs rough work and calculation, computer file names etc. All entries should be dated. The Project supervisor should periodically examine and countersign the log book.

8. 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.
9. It is desirable, but not mandatory, to publish the results of the Project in a peer reviewed journal.
10. 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.
11. 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 Councilof 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 | 60 |
| 2 | Presentation of the Project | 50 |
| 3 | Project Report (typed copy), Log Book and References | 50 |
| 4 | Viva-Voce | 50 |
| **Total Marks** | | **210** |

### 4. GENERAL FOUNDATION COURSES

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

### 4.1. INTERNAL EVALUATION

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

## 4.3. 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,

  i.e. SGPA (Si) = Σi (Ci x Gi) / Σi (Ci)

  where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ithcourse 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.

$$\text{SGPA} = \frac{\sum \text{o fthecreditpointsofallthecourses} \in \text{asemester}}{\text{Totalcreditsinthatsemester}}$$

**ILLUSTRATION – COMPUTATION OF SGPA**

| Semester | Course | Credit | Letter Grade | Grade point | Credit Point (Credit × Grade) |
|---|---|---|---|---|---|
| I | Course 1 | 3 | A | 8 | 3 × 8 = 24 |
| I | Course 2 | 4 | B+ | 7 | 4 × 7 = 28 |
| I | Course 3 | 3 | B | 6 | 3 × 6 = 18 |
| I | Course 4 | 3 | O | 10 | 3 × 10 = 30 |
| I | Course 5 | 3 | C | 5 | 3 × 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 CUFYUGP shall be calculated by the following formula.

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

CGPA for the four-year programme in CUFYUGP shall be calculated by the following formula.

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

- 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.

**BSc PLANT SCIENCE PROGRAMME**
**COURSE STRUCTURE FOR PATHWAYS 1–4**

**UNIVERSITY OF CALICUT**

| | | | | | |
|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA1CJ101** | | | | |
| **Course Title** | **BASICS OF PLANT SCIENCE: INSTRUMENTS AND TECHNIQUES** | | | | |
| **Type of Course** | **Major** | | | | |
| **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** | Basic knowledge on fundamentals of plant science at the Higher Secondary level. | | | | |
| **Course Summary** | The course provides the basics of plant science instruments and methods, ranging from fundamental concepts in plant science to various branches of botany, essential instruments and imaging techniques, safety measures, common methods used in plant science research, and techniques for handling specific instruments and emphasizes the importance of safety in laboratory settings, including precautions for handling toxic chemicals and bio-safety measures. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the fundamental principles of plant science. | U | F | Test paper/ Assignment |
| CO2 | Operate various instruments used in plant science research. | U | P | Practical exam |
| CO3 | List various imaging techniques and its advantages | U | F | Seminar Presentation/ Test Paper |
| CO4 | Understand biosafety measures practiced in the laboratory | U | F | Test paper/ Assignment |
| CO5 | Prepare molar solutions and fixatives | Ap | P | Practical exam |
| CO6 | Develop and understand eco-friendly laboratory practices | U | F | Seminar 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) | Marks (70) |
|---|---|---|---|---|
| I | **Basics in Plant Science** | | **8** | **12** |
| | 1 | Fundamentals in Plant Science: Overview of plant biology and its importance. Evolutionary history of plants, Origin of plant science, Need of plant science study. | 2 | |
| | 2 | Relation of plants to man: Plants as a source of food: domestication, agriculture, and culinary uses, Medicinal plants: traditional remedies and modern pharmacology, Economic significance of plants: industry, trade, and commerce, Aesthetic and cultural value of plants: gardening, art, and rituals. | 2 | |
| | 3 | Relation of Botany to other sciences (Interdisciplinary Connections of Botany). Introduction to plant kingdom.Overview of plant diversity: algae, mosses, ferns, gymnosperms, and angiosperms. Plant classification: taxonomic hierarchy and systematic. | 2 | |
| | 4 | Brief description of various branches in Botany (Taxonomy of lower and higher groups of plants, Plant Anatomy, Morphology, Embryology, Physiology, Ecology, Phytogeography, Economic Botany, Cytology, Genetics, Plant breeding, Ethnobotany, Biotechnology, Molecular Biology, Biochemistry). | 2 | |
| II | **Basic Instruments** | | **10** | **18** |
| | 5 | Basic instruments: Bunsen burner, thermometer, pH meter, analytical balance, electronic balance, autoclave, oven, water bath, volumetric dispenser, distillation unit, $CO_2$ incubator, shaking incubator, hot air oven. | 3 | |
| | 6 | Other instruments needed in plant science study: Autoclave, Spectrophotometer, Electrophoresis Apparatus, Centrifuge, Gas Chromatograph, Liquid Chromatography. (Brief account only) | 2 | |
| | 7 | Basic Imaging instruments: Dissection | 3 | |

| | | | | |
|---|---|---|---|---|
| | | Microscope, Light Microscope and micrometers. | | |
| | 8 | Advanced Microscopes: Phase Contrast Microscope, Interference Microscope, Fluorescence Microscope, Confocal Microscope, Electron Microscope (TEM and SEM). | 2 | |
| **III** | **Bio-safety Measures** | | **12** | **18** |
| | 9 | Personal protective equipment (PPE) and its proper use -Safety Glasses, Respirators, Eye wash stations, First aid kit, Fire extinguisher, Laminar Air Flow Cabinet. | 2 | |
| | 10 | Overview of regulatory agencies and guidelines on biosafety. Types of biological hazards (e.g., bacteria, viruses, toxins). Decontamination methods for equipment and surfaces. | 2 | |
| | 11 | Classification of laboratory biosafety levels (BSL)- Requirements and features of BSL-1, BSL-2, BSL-3, and BSL-4 laboratories. | 2 | |
| | 12 | An overview on Good Laboratory Practices (GLP)- Procedures for reporting accidents, spills, and exposures, Immediate actions in case of a laboratory incident, Post-incident evaluation and documentation. | 3 | |
| | 13 | Ethical responsibilities of scientists and laboratory personnel; Eco-friendly lab practices | 3 | |
| **IV** | **Common Methods and Microtechnique** | | **15** | **22** |
| | 14 | Molar, molal and normal solutions, buffers, molarity and normality of common acids and bases. | 3 | |
| | 15 | Preparation of Dilutions-Percentage solutions. Molar, molal and normal solutions. | 2 | |
| | 16 | Technique of handling micropipettes; Precautions about common toxic chemicals and safety measures in their handling. | 2 | |
| | 17 | Killing and fixing agents- Carnoy's formula, FAA.<br>Preparation of specimens- Whole mounts, Cytological methods – Squash method. | 3 | |
| | 18 | Maceration technique, Sectioning- Hand | 2 | |

| | | | | |
|---|---|---|---|---|
| | | sectioning, Microtomes - rotary | | |
| | 19 | Staining techniques- common stains- safranin, acetocarmine; double staining; Mounting media- DPX and Canada balsam. | 3 | |
| **V** | **Practical** | | **30** | **20** |
| | 1. Visit to a well-established lab to understand the best practices for safety and decontamination methods practiced in laboratories.<br>2. Demonstrate the working of Autoclave, Spectrophotometer, Electrophoresis Apparatus, Centrifuge.<br>3. Imaging of plant materials using Image analyzer<br>4. Maceration technique to reveal different types of xylem elements<br>5. Prepare molar solutions | | | |

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**Mapping of COs with PSOs and POs:**

| CO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | | | | | 3 | 3 | | | | 2 |
| **CO 2** | 3 | 3 | | | | | 3 | 3 | | 2 | 2 | |
| **CO 3** | 3 | | 1 | 3 | | | 3 | 1 | 1 | | 2 | 2 |
| **CO 4** | 3 | | | 3 | 3 | | 3 | | | | 2 | |
| **CO 5** | 3 | 3 | 3 | | 3 | | 3 | 3 | 3 | | 2 | |
| **CO 6** | 3 | | | 3 | 3 | 3 | 3 | | | 2 | 2 | 3 |

**Correlation Levels:**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| CO | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | ✓ | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | ✓ | ✓ | ✓ | ✓ |
| CO 6 | ✓ | ✓ | | ✓ |

**FIRST SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**
**PLA1CJ101 – BASICS OF PLANT SCIENCE: INSTRUMENTS AND TECHNIQUES**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Differentiate molarity and molality.
2. What are the advantages and disadvantages of using a ph meter?
3. How do acids differ from bases?
4. Distinguish between squash and smear techniques.
5. What are the ethical issues in a medical laboratory?
6. Give an overview on good laboratory practices.
7. In microbiology, what are the advantages of laminar air flow cabinets?
8. Reflect on the uses of micropipettes.
9. Explain the decontamination methods for equipment and surfaces.
10. Compare ocular and stage micrometers.

## SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. Discuss on the classification of laboratory biosafety levels.
12. Give an account of various Killing and fixing fluids.
13. Reflect on the personal protective devices and equipment.
14. Distinguish between $CO_2$ incubator and shaking incubator.
15. Explore the different parts of a Light Microscope.
16. Compare rotary and sledge microtomes. Mention their applications.
17. Describe various basic and applied branches in Botany.
18. Differentiate gas and liquid chromatography.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. “Advanced microscopy encompasses both high-resolution and super-resolution imaging techniques.” Substantiate this statement.
20. “Staining techniques enhance and contrast a biological specimen at the microscopic level.” Prove this with the help of conventional staining and double staining techniques.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA2CJ101** | | | | |
| Course Title | **PLANTS IN EVERYDAY LIFE AND HORTICULTURE** | | | | |
| **Type of Course** | **Major** | | | | |
| **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** | Basic knowledge on fundamentals of plant science at the Higher Secondary level. | | | | |
| **Course Summary** | This course aims to introduce students to the fundamental role of plants in various aspects of everyday life. Students will explore the significance of plants in nutrition, medicine, industry, ecology, culture, and aesthetics. It combines theoretical knowledge with practical skills in horticulture, landscape design, and garden management, preparing students for diverse careers in plant sciences, agriculture, and environmental conservation. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the importance of plants in various aspects of human life. | U | F | Seminar/<br>Test paper |
| CO2 | List various economically important plant used in day-to-day life | An/E | F | Practical Exam/ Assignment / Test Paper |
| CO3 | List out the garden tools used in horticulture | An/E | F | Practical Eaxam |
| CO4 | Compare different propagation methods | An | M | Test paper/ Assignment |
| CO5 | Compare the effect of artificial and organic fertilizers on soil and crop yield | An | M | Seminar/ Test paper |
| CO6 | Prepare a plan for landscaping | Ap | P | Assignement/ 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) | Marks (70) |
|---|---|---|---|---|
| **I** | **Introduction to Plants in Everyday Life** | | **10** | **12** |
| | 1 | **Historical and cultural perspectives on plants:** Importance of plants in human civilization. Evolution and domestication of plants. | **2** | |
| | 2 | **The role of plants in human nutrition:** Nutritional value of different plant-based foods. Importance of staple crops and their impact on global nutrition. | **2** | |
| | **3** | **Medicinal plants:** Economic importance of plants in various industries (e.g., textile, paper, timber). | **2** | |
| | 4 | **Plants and ecology:** Plant communities and ecosystems. Plant-animal interactions. Importance of plants in carbon sequestration and climate regulation. | **2** | |
| | 5 | **Plants and Culture:** Plant-based rituals, festivals, and ceremonies involving plants. Plant-based art, literature, and architecture. Green spaces (Botanical gardens, Sacred groves) their uses. | **2** | |
| **II** | **Basics in horticulture** | | **12** | **20** |
| | 6 | **Concept, scope and importance of horticulture – as an art, science and business:** branches of horticulture; classification of horticultural plants. | **2** | |
| | 7 | **Famous gardens in the world and in India:** types of gardens based on country of origin, Basic styles of gardens: formal, informal and wild gardens. | **2** | |
| | 8 | **Botanical and ornamental gardens:** butterfly garden, herbal garden, kitchen garden, rock garden, roof garden, sensory garden, vertical garden, water garden, container garden (Brief account only). | **2** | |
| | 9 | **Indoor farming and hydroponics:** techniques - wicking, deep water culture (DWC), nutrient film technique (NFT), ebb and flow; aeroponics, and drip systems. Commercial Horticulture: Nurseries, Orchards, Herb farm (Brief account only). | **2** | |

| | | | | |
|---|---|---|---|---|
| | 10 | Floriculture: Production of cut flowers; Floral decorations, indoor plants. Arboriculture: Pruning, bracing, feeding and transplanting; | **2** | |
| | 11 | Miniature gardening: Terrarium and Bonsai: Principles. Landscape horticulture: Olericulture, pomology, viticulture. | **2** | |
| **III** | **Landscape Designing** | | **12** | **20** |
| | 12 | **Landscape:** Plan (general), components and features of landscaping – plant components (lawn, shrubbery, flower beds and borders, rockery, carpet beds, topiary, hedges; non plant components (garden adornments, arches, pergolas, trellises, garden walls, gates, garden fences, footpaths, seats, tables, and garden houses). | **5** | |
| | 13 | **Plant growing structures:** Shade house, green house, poly house, glasshouse, mist chamber/mist beds, hot beds, lath houses. | **3** | |
| | 14 | **Pre-planting, planting and post-planting cultural practices:** Cultural practices to increase productivity: thinning, training, trimming and pruning. | **4** | |
| **IV** | **Garden Tools** | | **11** | **18** |
| | 15 | **Essential cutting tools:** Different types - shears, long-handled, short-handled, lawn shears, secateurs, sickles, saw. | **2** | |
| | 16 | **Artificial Fertilizers:** Inorganic fertilizers, NPK fertilisers; natural and synthetic soil conditioners and soil ameliorants. | **3** | |
| | 17 | **Garden implements:** Hand trowel, hoe, spade, fork, shovel, rake; wheelbarrow, watering cans, lawn mower (electric and petrol mower), grass cutters, sprayers. | **3** | |
| | 18 | **Natural Fertilizers:** Organic fertilizers, biofertilizers, compost, vermicompost, agricultural waste, livestock manure, municipal sludge. | **3** | |

| | | | | |
|---|---|---|---|---|
| **V** | **Practical** | | **30** | **20** |
| | 1 | Identification of any ten economically important used in day-to-day life (Botanical Name and Family) | | |
| | 2 | Submit a landscape plan for the botanical garden with all components possible | | |
| | 3 | Field visit to agricultural fields | | |
| | 4 | Visit to various plant-based industries. | | |
| | 5 | Collection of data based on plant-based rituals, festivals, and various ceremonies involving plants. | | |
| | 6 | Identification of different types of garden tools and implements. | | |

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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | | | 3 | | 3 | 3 | | | 3 | | 2 |
| **CO 2** | 3 | 3 | | | 3 | 3 | 3 | 3 | | | | |
| **CO 3** | 3 | 3 | | | | 3 | 3 | 3 | 2 | 2 | | |
| **CO 4** | 3 | | | 2 | | 2 | 2 | | | 3 | 3 | |
| **CO 5** | 3 | | 3 | 3 | 3 | 3 | 2 | | | 3 | 3 | |
| **CO 6** | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 |

**Correlation Levels:**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)
-

**Mapping of COs to Assessment Rubrics:**

| COs | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | ✓ | ✓ |
| CO 3 | ✓ | ✓ | ✓ | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | ✓ | ✓ | | ✓ |
| CO 6 | ✓ | ✓ | | |

**SECOND SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA2CJ101 – PLANTS IN EVERYDAY LIFE AND HORTICULTURE**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Comment on urban green spaces.
2. What is carbon sequestration?
3. Add notes on vermicompost.
4. Describe the basic styles of gardens.
5. Enumerate common floral adornments.
6. Write notes on the impact of staple crops on global nutrition.
7. Expound the term topiary.
8. Reflect on the advantages of a sensory garden.
9. Explain the uses of wheelbarrows in the garden.
10. Differentiate a hoe from a spade.

## SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. Discuss the various essential cutting tools.
12. Explicate the management of terrarium and bonsai.
13. Reflect on the merits of integrated pest management.
14. Elucidate the various types of vegetative propagules.
15. Explore the advantages of various plant-based industries.
16. Compare and contrast organic and inorganic manures.
17. Analyse the common artificial methods of vegetative propagation.
18. Delineate the construction of various plant growing structures.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. “Pre-planting, planting and post-planting cultural practices helps to increase crop productivity”. Substantiate.
20. “Various hydroponics systems help soilless cultivation of plants.” Analyse the recent techniques involved.

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| | | | | | |
|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA3CJ201** | | | | |
| **Course Title** | **BIODIVERSITY AND ENVIRONMENTAL STUDIES** | | | | |
| **Type of Course** | **Major** | | | | |
| **Semester** | **III** | | | | |
| **Academic Level** | **200 - 299** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 |
| **Pre-requisites** | Basic knowledge on fundamentals of environment at the Higher Secondary level. | | | | |
| **Course Summary** | This course explores the various entrepreneurial opportunities in the field of Botany and understands the scope of ecotourism in Kerala. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO 1 | **Understand** the fundamental concepts in environmental science and the importance of ecological studies, plant interactions | U | **F** | Test Paper |
| CO 2 | **Create** awareness about the local biodiversity, conservation need, causes of extinction, global conservation efforts | C | **M** | Group discussion, Quiz |
| CO 3 | Use the various biodiversity monitoring softwares/ applications for identity confirmation | Ap | **P** | Test Paper/ Practical exam |
| CO 4 | Determine plant community | U/R | **F** | Practical exam |
| CO 5 | Assess biodiversity of an area | Ap | **P** | Test Paper/ Practical |
| CO 6 | List out the examples of plant-animal interactions int he nature | Ap | **C** | Assignment/ 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 (60) | Marks (70) |
|---|---|---|---|---|
| **I** | **Biodiversity** | | **16** | **20** |
| | 1 | **Biodiversity:** definition, levels, uses, threats and conservation issue, causes of extinction, global and Indian scenario; mega diversity nations and hotspots | 3 | |
| | 2 | **Forest types of Kerala:** classification, features and diversity, issues of deforestation. | 3 | |
| | 3 | RET, endemic, exotic, invasive and indigenous plant species – Keystone, Flagship, Umbrella and Indicator species, Red data book | 4 | |
| | 4 | **Conservation strategies:** *ex situ* and *in situ* methods, heritage sites, species conservation programmes, policy and legislation – biodiversity acts and rules, People's Biodiversity Register (PBR), biopiracy, bioprospecting, ecorestoration | 4 | |
| | 5 | **Biodiversity monitoring:** softwares/applications – eflora kerala, India Biodiversity Portal, POWO, e-bird, snakepedia, sarpa | 2 | |
| **II** | **Ecology and Environmental Science** | | **14** | **20** |
| | 1 | **Environment science and ecology:** introduction, scope and relevance; ecology sub-divisions - autecology, synecology and ecosystem ecology | 3 | |
| | 2 | **Ecosystem:** definition, components, features; major ecosystems of the biosphere: sea, estuarine ecosystem, desert, forest, grassland (brief account only). | 3 | |
| | 3 | **Plant adaptations:** Hydrophytes, Xerophytes, Halophytes, Epiphytes & Parasites | 3 | |
| | 4 | **Ecological succession:** definition – primary & secondary; mechanism – xerosere & hydrosere | 2 | |
| | 5 | **Techniques in plant community studies:** Quadrat and transect methods – importance, procedure | 3 | |
| **III** | **Environmental changes and Mitigation** | | **16** | **25** |
| | 1 | **Pollution and pollutants:** sources, types and management – air, water, soil, thermal and noise; phytotechnological methods, biomagnification; BOD, AQI, WQI | 4 | |
| | 2 | **Global environmental changes:** global warming and greenhouse gases, acid rains, *el-nino, la-nina* | 3 | |
| | 3 | **Remote sensing and GIS:** introduction, principle, applications of remote sensing and GIS in environmental studies and biodiversity conservation, | 5 | |

| | | | | |
|---|---|---|---|---|
| | | EIA, LCA (brief account). | | |
| | 4 | **Global conservation efforts:** Rio Earth summit, CBD, Agenda 21, Kyoto protocol, COP, Paris agreement, CITES, Ramsar convention. National and International organizations/ programmes: IUCN, UNEP, SSC, WCED, WWF, UNFCCC, IPCC, Greenpeace, Conservation International, BirdLife International, NBPGR, NBA, KSBB | 4 | |
| **IV** | **Plant interactions** | | **4** | **5** |
| | 1 | Competition, Predation, Parasitism, Symbiosis, Commensalism, Mutualism, Amensalism, Allelopathy | 2 | |
| | 2 | Pollination: Plant-Pollinator interactions; case studies - Orchids | 1 | |
| | 3 | Plant microbe interaction, myrmecophily, insectivory - examples | 1 | |
| **V** | **Open ended** | | **10** | **10** |
| | 1 | Visit nearby wetland/ forest ecosystems, eco-restoration areas, identify and categorize the plants occurring in the area according to their habitat and types and record them. | | |
| | 2 | Analyse the campus biodiversity – identify the RET, endemic, indigenous and exotic plants and prepare a report | | |
| | 3 | Study of plant communities: Determination of density, abundance, dominance, frequency by Quadrat method. | | |
| | 4 | Study of morphological and anatomical characteristics of plant groups: hydrophytes, xerophytes, halophytes, epiphytes, parasites. Find out the unique features of at least one species each from a group and record | | |
| | 5 | Use any biodiversity monitory software | | |

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**Mapping of COs with PSOs and POs:**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | | | | | 3 | 3 | | | | | 3 |
| **CO 2** | 3 | | 3 | | | 3 | 3 | 3 | | | 1 | 3 |
| **CO 3** | 3 | | | | | 3 | 3 | | 3 | | 3 | 3 |
| **CO 4** | 3 | 3 | 3 | | 3 | 3 | 3 | | 3 | 3 | 3 | 3 |
| **CO 5** | 3 | | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO 6** | 3 | | | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

**Correlation Levels:**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| C0 | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | ✓ | |
| CO 4 | ✓ | ✓ | ✓ | ✓ |
| CO 5 | | ✓ | ✓ | |
| CO 6 | | ✓ | ✓ | |

**THIRD SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA3CJ201 – BIODIVERSITY AND ENVIRONMENTAL STUDIES**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. What is EIA? What is its significance?
2. Describe the morphological adaptations in epiphytes.
3. Write notes on IUCN, SSC, NBPGR, WCED.
4. Comment on biodiversity hotspots. Name the hotspots present in India.
5. Differentiate between keystone, flagship and umbrella species?
6. Discuss the role of IUCN in biodiversity conservation.
7. Differentiate between Commensalism, Mutualism, Amensalism,
8. Give critical analysis of global warming and greenhouse gases
9. Define biomagnification and explain its biological significance.
10. Describe the ecological significance of the estuarine ecosystem.

## SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. Describe the applications of remote sensing and GIS in environmental studies.
12. What is the significance of quadrat and transect studies? What is IVI and how is it calculated?
13. How does *el-nino* differ from *la-nina*? What are their significance?
14. Discuss *ex situ* and *in situ* methods of conservation, citing examples
15. What is meant by the Red data book? What is its significance?
16. What is PBR? What is its significance? How is it prepared?
17. Differentiate between Predation, Parasitism, Commensalism, Mutualism and Amensalism.
18. Which are the various forest types in Kerala? What are their features?

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. Describe the various causes and control measures of air and water pollution
20. Give a detailed account of the process and mechanism of ecological succession.

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| | | | | | |
|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA3CJ202** | | | | |
| **Course Title** | **ANATOMY, EMBRYOLOGY AND PALYNOLOGY** | | | | |
| **Type of Course** | **Major** | | | | |
| **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** | Basic knowledge on plant anatomy, floral morphology, pollination and fertilization in plants at Higher Secondary Level | | | | |
| **Course Summary** | This course explores the tissue systems of plants, anatomical organization of stem, root and leaf, secondary and anomalous growth, palynology and embryology of plants | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the cell wall structure of plants and inclusions | U | F | Test Paper / Assignment |
| CO2 | Differentiate between dicot/monocot stem and root | Ap | P | Practical Exam |
| CO3 | Differentiate normal growth from anomalous secondary growth in plants | U | F | Practical Exam/ test Paper/ Presentations |
| CO4 | Understand Microsporogenesis and Megasporogenesis | U | F | Assignment/ Presentations |
| CO5 | Apply anatomical knowledge in wood identification | An | M | Practical Exam/ Test Paper/ Presentation |
| CO6 | Study pollen morphology to identify plants and pollen viability | Ap | P | Practical Exam/ 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) | Marks (70) |
|---|---|---|---|---|
| **I** | **Plant cell wall and cell inclusions** | | **10** | **12** |
| | 1 | Cell Wall - Structure and development; Middle lamella, Primary and Secondary wall thickening, Pits. Growth of Cell wall; cell wall materials. | 2 | |
| | 2 | Non-living inclusions, Reserve food materials - carbohydrates, proteins, fats & oils. | 2 | |
| | 3 | Carbohydrates - sugars & starch; Starch grains - structure, types with examples; Proteins - Aleurone grains; Fats & oils | 2 | |
| | 4 | Secretory materials: Nitrogenous - alkaloids, Non-nitrogenous gums, resins, tannins, organic acids, essential oils; | 2 | |
| | 5 | Mineral crystals - Calcium oxalate, Drusses, Raphides, Calcium carbonate - Cystoliths with examples | 2 | |
| **II** | **Tissues and organization** | | **10** | **18** |
| | 6 | **Tissues**: - Definition, Meristematic tissues, Permanent tissues: simple: Parenchyma, Collenchyma, Sclerenchyma. Complex: Xylem & Phloem - structure, origin and function | 3 | |
| | 7 | **Theories on apical organization**: Apical cell theory, Histogen theory, Tunica corpus theory. Organization of shoot apex and differentiation of tissues - (protoderm, procambium and ground meristem), organization of root apex in dicots and monocots. | 3 | |
| | 8 | **Secretory tissues**: Glands, glandular hairs, nectaries, hydathodes, schizogenous and lysogenous ducts, resin ducts, laticifers - articulated and non-articulated. | 2 | |
| | 9 | **Vascular bundles**: Origin and types - conjoint, collateral, bicollateral, open closed, radial, concentric - amphicribral and amphivasal. | 2 | |

| | | | | |
|---|---|---|---|---|
| **III** | **Structure of stem, root and leaf** | | **15** | **25** |
| | 10 | **Primary structure of root, stem & leaf**: Normal secondary growth in dicot stem and dicot root. Formation of vascular cambial ring - structure and activity of cambium - storied and non-storied, fusiform and ray initials. nodal anatomy, leaf vasculature and architecture. | 3 | |
| | 11 | Formation of secondary wood, secondary phloem, vascular rays, growth ring, heart wood, sapwood. | 3 | |
| | 12 | **Extra stelar Secondary thickening in stem and root**: Periderm formation. Structure - phellogen, phellem, phelloderm, bark, lenticels - structure & function | 2 | |
| | 13 | **Anomalous secondary thickening**: Boerhaavia, Bignonia and Draceana. | 3 | |
| | 14 | **Wood anatomy**: Microscopic properties of timber: Specific gravity, density, grain, strength, colour, durability and hardness. seasoning of wood, uses of wood, MDF and Plywood | 2 | |
| | 15 | Applications of Plant anatomy, Plant anatomy in phylogenetics, Anatomical phenotypes, Anatomics. | 2 | |
| **IV** | **Palynology and Embryology** | | **10** | **15** |
| | 16 | **Floral morphology**: Parts of a flower | 1 | |
| | 17 | **Palynology**: Pollen morphology- Structure of pollen wall, Shape of pollen grains, Apertural morphoforms, Exine ornamentation; Pollen allergy, forensic palynology, Economic and taxonomic importance of pollens | 2 | |
| | 18 | **Microsporogenesis**: Structure and function of wall layers Development of male gametophyte - dehiscence of anther. | 2 | |
| | 19 | **Megasporogenesis**: development of female gametophyte, embryosac- development and types- monosporic: Polygonum type, bisporic: Allium type, tetrasporic: Adoxa type. | 2 | |
| | 20 | Pollination, fertilization, barriers of fertilization, germination of pollen grains, double fertilization. | 1 | |

| | | | | |
|---|---|---|---|---|
| | 21 | **Structure of embryo:** Dicot, monocot and endosperm types. | 1 | |
| | 22 | Application of Palynology and embryology, Contributions of Indian embryologists. | 1 | |
| **V** | **Practical** | | **30** | **20** |
| | 1 | Identification the different types of tissues and vascular bundles | | |
| | 2 | Primary structure of stem, root and leaf of Dicots and Monocots<br>a. Dicot stem - normal - *Chromolaena*, bi-collateral - *Cephalandra*<br>b. Dicot root - Pea<br>c. Monocot stem - Bamboo<br>d. Monocot root - Musa<br>e. Dicot leaf – *Ixora*<br>f. Monocot leaf - Grass | | |
| | 3 | Secondary structure of Dicot stem and root - *Vernonia* | | |
| | 4 | Anomalous secondary thickening in *Boerhaavia*, *Bignonia* and *Dracaena* | | |
| | 5 | Identification of common woods in Kerala | | |
| | 6 | Datura anther T.S. | | |
| | 7 | Types of ovules: Orthotropous, Anatropous and Campylotropous | | |
| | 8<br>9 | Dicot and monocot embryo of Angiosperms<br>Viability test for pollen (any one method)<br>a. In vitro germination using sugar solution (Cavity slide method)<br>b. Acetocarmine test | | |

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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | | | 3 | | | | | |
| CO 2 | 3 | 3 | 2 | | | | 3 | | | | | |
| CO 3 | 3 | 3 | 1 | 3 | | | 3 | 3 | | 1 | | |
| CO 4 | 3 | | | 3 | | | 3 | 3 | | 1 | | |
| CO 5 | 3 | 3 | 3 | 3 | 3 | | 3 | 3 | 3 | 1 | | |
| CO 6 | 3 | 3 | 2 | | 2 | 2 | 3 | 3 | 2 | 1 | 2 | |

**Correlation Levels:**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics**

| CO | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | ✓ | ✓ |
| CO 3 | ✓ | ✓ | ✓ | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | ✓ | ✓ | ✓ | |
| CO 6 | ✓ | | ✓ | |

**THIRD SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA3CJ202 – ANATOMY, EMBRYOLOGY AND PALYNOLOGY**

**(Credits: 4)**

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

**Section A**

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

1. What are drusses, raphides and cystoliths?
2. What are simple tissues?
3. Explain the types of vascular bundles
4. Explain growth ring, heart wood and sapwood.
5. Elaborate the vascular cambium, fusiform and ray initials
6. Enumerate the major applications of Palynology
7. Enumerate the major contributions of Indian embryologists.
8. Elaborate the structure of Pollen grains
9. Distinguish between dicot and monocot embryos
10. Explain double fertilization

**Section B**

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

11. Elaborate the Non-living inclusions in a cell
12. Explain the formation of Vascular cambium
13. Differentiate between dicot and monocot stem with respect to their anatomy
14. Explain the formation of Periderm
15. Briefly explain the Anomalous secondary thickening in Draceana.
16. Briefly explain the Microsporogenesis with suitable diagram
17. Explain the process of Fertilization and Double fertilization
18. Enumerate the Application of Embryology

**Section C**

**Answer any one. Each question carries 10 marks (1 × 10=10 Marks)**

19. Explain the anomalous secondary growth in *Boerhavia* stem with suitable diagram
20. Explain the megasporogenesis with suitable diagrams

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA4CJ201** | | | | |
| **Course Title** | **VIRUSES, BACTERIA AND FUNGI** | | | | |
| **Type of Course** | **Major** | | | | |
| **Semester** | **IV** | | | | |
| **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** | Introduction and detailed study of viruses and microbes belonging to prokaryotic and eukaryotic kingdoms | | | | |

**Course Outcomes**

| COs | Statement | Cognitive Level * | Knowledge Category # | Tools used |
|---|---|---|---|---|
| CO1 | **Classify** microbes | U | F | Test paper/ presentation |
| CO2 | **Prepare** growth medium for fungi | Ap | P | Practical Exam |
| CO3 | **List** out the economic importance of microbes | F | F | Test Paper/ Assignments/ Presentation |
| CO4 | **Demonstrate** microbial isolations and sample preparation techniques for microscopy | Ap | P | Practical Exam |
| CO5 | **Analyze** prospects of microbial diversity | An | M | Assignment |
| CO6 | **Identify** the diverse forms of bacteria and fungi | Ap | P | Practical Exam |

* - 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) | Marks (70) |
|---|---|---|---|---|
| **I** | **Introduction to microbes** | | **3** | **5** |
| | 1 | The Three Domain Classification: Bacteria, Archaea, and Eukarya; cellular microbes: bacteria, archaea, fungi, algae and protists; acellular infectious agents: viruses, viroids, prions. | 3 | |
| **II** | **Viruses** | | **10** | **12** |
| | 2 | Characteristics of viruses: size, shape and structure of viruses. | 4 | |
| | 3 | Genetic material of viruses; classification of viruses (the Baltimore Scheme). | 2 | |
| | 4 | Virus Replication Cycle; bacteriophages: structure, shape, lytic cycle and lysogenic cycle of replication. | 3 | |
| | 5 | Significance of viruses. Major plant and human diseases caused by viruses; viral oncogenes and cellular oncogenes. | 1 | |
| **III** | **Bacteria** | | **10** | **18** |
| | 6 | Differences between bacteria and archaea; morphology and ultrastructure of bacteria; surface appendages, bacterial cell wall: structure and chemistry. | 2 | |
| | 7 | Bacterial diversity; major groups of bacteria; brief accounts of actinomycetes and mycoplasmas. | 1 | |
| | 8 | Bacterial growth; culture of bacteria in the lab; culture media; pure culture techniques. | 2 | |
| | 9 | Bacterial genetics: conjugation, transformation, transduction, plasmids. | 3 | |
| | 10 | Significance of bacteria. Major plant and human diseases caused by bacteria. | 1 | |
| | 11 | Cyanobacteria | 1 | |

| | | | | |
|---|---|---|---|---|
| **IV** | **Fungi** | | **22** | **35** |
| | 12 | Fungus-like organisms: True slime molds: plasmodium, sporulating structures and life cycle; sporulation in *Stemonitis*. | 2 | |
| | 13 | Fungus-like organisms: Oomycetes – general characters, reproduction, spores; somatic and reproductive structures of *Phytophthora* and *Pythium* and plant diseases caused by these two genera. | 3 | |
| | 14 | General characters of fungi; Distinction between true fungi and pseudofungi: An outline of the phylum-level classification of Kingdom Fungi proposed by Tedersoo *et al*. (2018). Species estimates. Anamorphs, teleomorphs and holomorphs; brief account of anamorphic fungi. | 3 | |
| | 15 | Mucoromycota: general characters, occurrence, reproduction, and life cycle; somatic and reproductive structures of *Rhizopus*. | 3 | |
| | 16 | Ascomycota: general characters, occurrence, reproduction and life cycle; somatic and reproductive structures of *Saccharomyces, Aspergillus* and *Xylaria*, | 3 | |
| | 17 | Basidiomycota: general characters, occurrence, reproduction and life cycle - somatic and reproductive structures of *Agaricus*; life cycle and spore stages of *Puccinia*. | 3 | |
| | 18 | Significance of fungi: medicinal, industrial, agricultural, food; aflatoxins. | 2 | |
| | | Detailed study of the fungal associations: Lichens, Mycorrhiza. | 3 | |
| **V** | **Practical** | | **30** | **20** |
| | | Preparation of a microbial growth medium and isolation of soil bacteria and fungi. | | |
| | | Gram staining of bacteria. Lactophenol cotton blue wet mount preparation of *Saccharomyces* | | |
| | | Observation of reproductive structures and spores of *Stemonitis, Phytophthora, Pythium*, *Rhizopus, Aspergillus, Xylaria*, *Usnea*, *Puccinia* and *Agaricus* | | |

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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 1 | - | - | - | - | - | 3 | 3 | | | | |
| CO 2 | 2 | 3 | - | - | - | - | 3 | | 3 | | | |
| CO 3 | - | - | 1 | - | - | - | 3 | 3 | | | | 2 |
| CO 4 | - | - | 2 | 3 | - | - | 3 | | 2 | | | |
| CO 5 | - | 1 | - | - | - | - | 3 | | | | 2 | |
| CO 6 | - | - | - | 3 | - | - | 3 | | 2 | | 2 | 2 |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| CO | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | | | ✓ | |
| CO 6 | | | ✓ | |

**FOURTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA4CJ201 – VIRUSES, BACTERIA AND FUNGI**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. What is a bacterial growth curve?
2. What is an anamorph?
3. Explain the spore stages of *Puccinia* on Barberry.
4. What is Gram staining?
5. What are plasmids?
6. What is a VAM fungus?
7. What are pseudo-fungi? Give an example.
8. Differentiate between viroids and virions?
9. How is a zygospore formed?
10. What are viral oncogenes?

## SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. What are the different types of plasmodia?
12. Describe the sexual reproductive bodies of Ascomycota.
13. What are the significance of viruses?
14. Describe the ultrastructure of a bacterial cell.
15. How are viruses classified?
16. Write the general characters of Basidiomycota
17. Write a note on bacterial genetics.
18. Write notes on plant diseases caused by viruses.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 x 10 = 10 Marks)**

19. Write an essay on the economic importance of fungi.
20. Explain the replication cycles in viruses.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA4CJ202** | | | | |
| **Course Title** | **ALGAE AND BRYOPHYTES** | | | | |
| **Type of Course** | **Major** | | | | |
| **Semester** | **IV** | | | | |
| **Academic Level** | **200 – 299** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75 |
| **Pre-requisites** | Basics of Algae and Bryophytes at CBSE/DHSE/ICSE senior secondary level | | | | |
| **Course Summary** | This course ensures a strong knowledge base on Algae and Bryophytes; two major plant groups of ecological and evolutionary significance; and with long geological history. The recent developments in the field are ground breaking. The course also offers an opportunity to get detailed knowledge on the diversity of this plant group. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| **CO1** | Understand the ecological significance of Algae and Bryophytes | C | U | Test paper/ Assignments |
| **CO2** | Documentation of algae herbarium | F | P | Practical exams/ Submission |
| **CO3** | Identify Algae and Bryophytes by microscopic features | Ap | P | Practical Exam |
| **CO4** | List the economic importance of Algae and Bryophytes | F | C | Assignment/ Presentation/ Test paper |
| **CO5** | Understand the adaptations and evolutionary trends of Bryophytes | U | F | Assignment/ Presentation |
| **CO6** | Classify Algae and Bryophytes based on its morphological features. | U | F | Assignment |

* - 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) | Marks (70) |
|---|---|---|---|---|
| **I** | **Algae - Introduction and Basics** | | **7** | **12** |
| | 1 | Introduction to Algae - Significance as first green plants on the earth; diversity in form and structure; cell morphology, range of thallus structure and reproduction | 1 | |
| | 2 | Ecological significance- major producers in ecosystems; pollution. Economic significance; beneficial and negative | 1 | |
| | 3 | Brief account on the diversity and distribution of Algae in the world, India, Kerala; Major contributors and key players. Algaebase. | 1 | |
| | 4 | Applied phycology; Single Cell Protein (SCP); algae for livelihood in rural India; Global scenario- Carbon sequestration; pollution. Research Centres: 1. CSIR-Central Salt & Marine Chemicals Research Institute (CSMCRI), 2. Central Marine Fisheries Research Institute (CMFRI)-their roles and contributions in algal research and utilisation; Algae based industries in India | 1 | |
| | 5 | Documentation of Algae; Herbarium and preservation techniques for Algae; Recent trends in understanding of Algae. | 1 | |
| | 6 | Classification- Robert Lee 2018 (brief account). | 2 | |
| **II** | **Algae- into details** | | **16** | **23** |
| | 7 | General features of Chlorophyta. 1. Structure and reproduction in Chlorophyceae: 1. *Spirogyra* 2. *Chara* | 4<br>4 | |
| | 8 | General features of Heterokontophyta. 1. Structure and reproduction in Bacillariophyceae (Diatoms): 1. *Pinnularia* | 2 | |
| | 9 | General characters and reproduction in Xanthophyceae: 1. *Vaucheria* | 2 | |
| | 10 | General characters and reproduction in Phaeophyceae: 1. *Sargassum* | 4 | |
| | 11 | General features of Rhodophyta. Structure and reproduction in Rhodophyceae: 1. *Polysiphonia* | 4 | |

| | | | | |
|---|---|---|---|---|
| **III** | **Bryophytes - introduction and basics** | | **9** | **17** |
| | 13 | Introduction to Bryophytes; three major lineages; Marchantiophyta, Anthocerotophyta and Bryophyta; Ecological significance - pioneers in succession; providing microhabitats for other life forms; use in gardens. | 1 | |
| | 14 | Brief account on the diversity and distribution of bryophytes in the world, India, Western Ghats, Kerala; distribution pattern along latitudinal gradient; Diversity in Southern India and Western Ghats; Endemics in Southern India; threats; needs for conservation. | 2 | |
| | 15 | Advances in understanding of this group over the period; recent trends in understanding of bryophytes; Classification schemes for three lineages; Anthocerotophyta (Renzaglia and Vaughn 2000), Marchantiophyta (Crandall-Stotler et al. 2009; Soderstrom et al., 2016) Bryophyta (Goffinet et al. 2008) (brief account). | 2 | |
| | 16 | Salient features of life cycle; adaptations; trends in evolution- changes in concepts over the ages from morphology based to molecular phylogeny; evolution of gametophyte and sporophyte. | 2 | |
| | 17 | Ecological significance; role played in ecosystems; rock crushers, rock builders. Economic importance of Bryophytes. | 2 | |
| **IV** | **Bryophytes - Detailed** | | **13** | **18** |
| | 18 | Herbarium and preservation methods for Bryophytes; Major research centres; key players; | 1 | |
| | 19 | Documentation of Bryophytes in India and South India; Centres of diversity; Distribution along microhabitats, macrohabitats and altitudinal gradients; | 2 | |
| | 20 | Study of distribution, structure (external and internal), reproduction, life cycle and affinities of following from major groups (Developmental details are not required); Marchantiophyta 1. *Riccia* (Developmental details are not required) | 3 | |
| | 21 | Anthocerotophyta 1. *Anthoceros* (Developmental details are not required) | 3 | |
| | 22 | Bryophyta 3. *Funaria* (Developmental details are not required) | 4 | |
| **V** | **Practical** | | **30** | **20** |

| | | | | |
|---|---|---|---|---|
| | 1 | Algae: Study the vegetative and reproductive structures of the following;<br>1. *Spirogyra*, 2. *Chara,* 3. *Pinnularia*, 4. *Vaucheria,* 5. *Sargassum,* 6. *Polysiphonia* | 15 | |
| | 2 | Bryophytes: Study of the external and internal features of the following;<br>1. *Riccia* – habit, internal structure of thallus, V.S. of thallus through antheridium, archegonium and sporophyte.<br>2. *Anthoceros*- habit, internal structure of thallus. V.S. of thallus through antheridium, archegonium and sporophyte.<br>3. *Funaria*- habit, structure of antheridial cluster, archegonial cluster, L.S. of sporophyte.<br>4. Familiarise the collection and preservation techniques of Bryophytes from the local habitats | 15 | |

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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | - | 3 | 3 | | | | | |
| CO 2 | 3 | 3 | | | - | - | 3 | 3 | | | | |
| CO 3 | 3 | 3 | | | 2 | - | 3 | 3 | 2 | | | |
| CO 4 | 3 | 3 | | 3 | 3 | 3 | 3 | 3 | | 2 | | |
| CO 5 | 3 | | 2 | 3 | - | 3 | 3 | | | 2 | | |
| CO 6 | 3 | | 3 | | - | - | 3 | | | | 2 | |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| CO | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | | | ✓ | |
| CO 6 | | | ✓ | |

**THIRD SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA4CJ202 – ALGAE AND BRYOPHYTES**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. What is SCP?
2. What is the importance of spirulina?
3. Differentiate elaters and pseudoelaters.
4. What are peristome teeth and what are the importance of peristome teeth?
5. Give one example for aquatic algae.
6. What is the structure of the chloroplast of spirogyra?
7. What are the different types of life cycle in algae?
8. What is a holdfast?
9. Write the common structure of a moss.
10. Describe the ecological significance of bryophytes.

## SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. What are the different vegetative reproduction in bryophytes?
12. What is haplo-diplontic life cycle? Explain one example in Algae.
13. Briefly explain the evolution of sporophyte in bryophytes?
14. Write a comparative account of Herbarium techniques for Algae and Bryophytes.
15. What are pyrenoids? Write a comparative account of pyrenoids in Algae and Bryophytes.
16. Write an account on the sporophyte of *Funaria*.
17. Write a comparative account of thallus in *Anthoceros* and *Riccia*.
18. Write an account on the diversity of Bryophytes in Kerala with respect to altitude?

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. Write an account of economic significance to Algae. Discuss the role of CSMCRI in production of seaweeds in India.
20. Give a detailed account of the structure of sporophyte in *Anthoceros*. Discuss its phylogenic significances.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA4CJ203** | | | | |
| **Course Title** | **PTERIDOPHYTES, GYMNOSPERMS AND PALAEOBOTANY** | | | | |
| **Type of Course** | **Major** | | | | |
| **Semester** | **IV** | | | | |
| **Academic Level** | **200 – 299** | | | | |
| **Course Details** | **Credit** | **Lecture per week** | **Tutorial per week** | **Practical per week** | **Total Hours** |
| | **4** | **3** | **-** | **2** | **75** |
| **Pre-requisites** | **Basics of Pteridophytes, Gymnosperms and Palaeobotany at CBSE/DHSE/ICSE senior secondary level** | | | | |
| **Course Summary** | This course ensures a strong knowledge base on Pteridophytes and Gymnosperms; two major plant groups of ecological and evolutionary significance; and with long geological history. The exposure to palaeobotany will help the student to get deep insights in the light of fossil evidence. The recent developments in the field, especially on the Pteridology and Gymnosperms, are ground breaking, shattering the old beliefs. The course also offers an opportunity to get detailed knowledge on the diversity of this plant group, especially in the context of Southern India/ Western Ghats. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category # | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Analyse the role played by primitive vascular plants, and their evolution to gymnosperms; their adaptations for survival and reproduction. | U | F | Assignments, presentations |
| CO2 | Understand the ecological importance of pteridophytes and gymnosperms | U | F | Assignments, presentations |
| CO3 | Identify locally available pteridophytes and gymnosperms | Ap | P | Practical Exam, Assignment, Presentation |
| CO4 | Compare the different groups of pteridophytes and gymnosperms to understand the evolutionary trends | An | M | Assignments, presentations, and test paper |
| CO5 | Familiarize with the researches and advances in the field of pteridophytes and gymnosperms | U | F | Assignments, presentations |
| CO6 | Document the diversity of pteridophytes and gymnosperms of an area | Ap | P | Assignments, 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) | Marks (70) |
|---|---|---|---|---|
| **I** | | **Pteridophytes - Introduction and basics** | **6** | 14 |
| | 1 | Introduction to Pteridophytes - Significance as first vascular land plants on the earth - brief history over the period- rise and fall; rich fossil history; present status- as gap fillers in ecosystems; from minute filmy ferns to the mighty tree ferns. | 1 | |
| | 2 | Ecological significance- pollution controlling - hyper accumulators, providing microhabitats for other organisms; roles in tropical forest gap dynamic. Economic significance: beneficial and negative- horticultural, biofertilizer, genetic transformation, weeds. Pteridophytes as lifesaver - water purification. | 1 | |
| | 3 | Brief account on the diversity and distribution of Pteridophytes in the world, India, Western Ghats, Kerala. | 1 | |
| | 4 | Advances in understanding of Pteridophytes over the period; major breakthroughs - transfer of *Psilotum* and *Equisetum* to ferns; vessels in Pteridophytes. | 1 | |
| | 5 | Radiation of Pteridophytes during Cretaceous period - in angiosperm dominated habitats; recent trends in understanding of lycophytes and ferns. | 1 | |
| | 6 | Classification - PPG (latest version; brief account). | 1 | |
| **II** | | **Pteridophytes - into details** | **14** | **17** |
| | 7 | Salient features of life cycle - independent gametophyte phase; merits and challenges: | 1 | |
| | 8 | Abnormalities or survival strategies of Pteridophytes: polyploidy, apogamy, apospory - boon or bane. Heterospory and its significance in the life cycle and evolution of Pteridophytes | 1 | |
| | 9 | Study of distribution, structure (external and internal) of sporophyte and gametophyte, reproduction, life cycle and affinities of 1) Lycopodiopsida - *Selaginella* (Developmental details not required). | 2 | |

| | | | | |
|---|---|---|---|---|
| | 10 | 2) Polypodiopsida- Study of distribution, structure (external and internal) of sporophyte and gametophyte, reproduction, life cycle and affinities of *Equisetum* (Developmental details not required). | 4 | |
| | 11 | Polypodiopsida- Study of distribution, structure (external and internal) of sporophyte and gametophyte, reproduction, life cycle and affinities of *Psilotum* (Developmental details not required) | 3 | |
| | 12 | Polypodiopsida- Study of distribution, structure (external and internal) of sporophyte and gametophyte, reproduction, life cycle and affinities of *Pteris* (Developmental details not required) | 3 | |
| **III** | | **Gymnosperms** | **20** | **32** |
| | 13 | Introduction to Gymnosperms - Significance - brief history over the period- rise and diminishing; present status; | 1 | |
| | 14 | Brief account on the diversity and distribution of Gymnosperms in the world, India, Western Ghats, Kerala; curious/ rarities in the world - *Welwitschia*. Wild gymnosperms in India/ Southern India. Endemics in Southern India; threats; needs for conservation; exotics and cultivated gymnosperms in Southern India (brief account). | 2 | |
| | 15 | Advances in understanding of Gymnosperms over the period; fossil history, classification (Yang *et al*., 2022). | 2 | |
| | 16 | Salient features of life cycle - first stage of protected gametophyte phase; merits; modes of transfer of pollen/ gametes; insects, wind. Polyploidy, trends in evolution. | 3 | |
| | 17 | Ecological significance; major component in alpine/ temperate ecosystem; coniferous dominated forests of the world (brief account); Himalayas. Economic significance. | 2 | |
| | 18 | Study of distribution, structure (external and internal), reproduction, life cycle and affinities of following from major groups (Developmental details are not required); 1) *Cycas* (Developmental details are not required). | 3 | |

| | | | | |
|---|---|---|---|---|
| | 19 | Study of distribution, structure (external and internal), reproduction, life cycle and affinities of 2) *Pinus*<br>(Developmental details are not required) | 3 | |
| | 20 | Study of distribution, structure (external and internal), reproduction, life cycle and affinities of 3) *Gnetum* (Developmental details are not required). | 4 | |
| **IV** | | **Palaeobotany** | **5** | **7** |
| | 21 | Cosmic calendar. Fossil formation and types of fossils. Geological time scale- sequence of plants in geological time.<br>Fossil Pteridophytes- *Rhynia, Lepidodendron, Lepidocarpon, Calamites*.<br>Fossil gymnosperms- *Williamsonia* | 3 | |
| | 22 | Fossil studies in India; Birbal Sahni Institute of Palaeosciences (BSIP); Fossil deposits in India (brief account). Major contributors; Birbal Sahni, Savitri Sahni.<br>Applied aspects of Palaeobotany- Exploration of fossil fuels. | 2 | |
| **V** | | **Practical** | **30** | **20** |
| | 1 | Pteridophytes:<br>Study the external and internal features of the following;<br>a. *Selaginella*: habit - isophyllous group, heterophyllous group; leaves (lateral, median and axillary), T.S. of stem, T.S. of rhizophore, Strobilus-isomorphic, bifarious; L.S. of strobilus, sporophylls, macrosporangium, microsporangium, macrospores, microspores.<br>b. *Equisetum*: habit, scale leaves, T.S. of stem, strobilus, sporophyll, L.S. of strobilus, sporangia, spores.<br>c. *Psilotum* (Considering its rare nature, fresh specimens may not be used. Teaching/ learning instructions may be based on slides/ images/ photographs): habit, T.S. of stem, C.S. of synangium.<br>d. *Pteris*: Habit, rhizome external, l.s., scales, T.S. of petiole, T.S. of sporophyll, sporangium, spores, gametophyte.<br>e. Familiarise the common wild Pteridophytes of Kerala. | 14 | |

| | | | | |
|---|---|---|---|---|
| | 2 | Gymnosperms:<br>Study of the external and internal features of the following;<br>a. *Cycas*: coralloid root, male cone, microsporophyll, megasporophyll.<br>*Pinus*: branch of unlimited growth, spur shoot, needle, male cone and female cone*Gnetum*: Habit, stem T.S., male and female cones | 14 | |
| | 3 | Study of the features of the following; *Rhynia*, *Lepidodendron, Lepidocarpon, Calamites*, *Williamsonia* | 2 | |

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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | 2 | | | 3 | 2 | | 1 | | |
| CO 2 | 3 | | | 2 | | 3 | 3 | 2 | | 1 | | 2 |
| CO 3 | 3 | 3 | 2 | 2 | 2 | | 3 | 2 | 2 | 1 | | |
| CO 4 | 3 | | | 2 | | | 3 | 2 | | 1 | 2 | |
| CO 5 | 3 | | | 2 | | | 3 | 2 | | 1 | | |
| CO 6 | 3 | 3 | | 2 | 2 | | 3 | 2 | 3 | 1 | | |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics**

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

**FOURTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA4CJ203 – PTERIDOPHYTES, GYMNOSPERMS AND PALAEOBOTANY**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. What is polyploidy? Discuss its significance in Ferns.
2. Describe the structure of gametophyte in *Equisetum*.
3. Write a comparative account of sporangium in Equisetum and *Pteris*.
4. Write an account on the internal features of *Selaginella*.
5. Write a brief note on the recent classification of Gymnosperms.
6. Write on the ecological and economic significance of Gymnosperms.
7. Write an account on the male gametophyte in *Pinus*.
8. Describe the salient morphological and anatomical features of the structure of *Welwitschia*.
9. Write a note on the endemic Gymnosperms in India.
10. Describe the structure of *Williamsonia*.

## SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. Write an account on PPG classification. Discuss its advantages.
12. What is heterospory? Discuss its significance in pteridophytes.
13. The gametophytes in pteridophytes are independent. Discuss its merits and challenges.
14. Write an account on the ecological significance of Pteridophytes. Cite two examples.
15. Describe the structure of female gametophyte in *Cycas*.
16. Write an account on the female gametophyte in *Pinus*.
17. Write a comparative account of the male gametophytes in *Cycas* and *Pinus*.
18. Write a note on the Cosmic Calender.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. Write on the salient morphological and anatomical features of *Psilotum*. Justify with reasons on its placement as a basal fern.
20. Give a detailed account of the reproductive structures of *Gnetum*. Discuss its salient features in support of its phylogenetic position.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA5CJ301** | | | | |
| **Course Title** | **ANGISPERM MORPHOLOGY AND TAXONOMY** | | | | |
| **Type of Course** | **Major** | | | | |
| **Semester** | **V** | | | | |
| **Academic Level** | **300 – 399** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75 |
| **Pre-requisites** | Basics of Angiosperm Morphology and Taxonomy at CBSE/DHSE/ICSE senior secondary level | | | | |
| **Course Summary** | This course explores the varying structures and functions of plant parts, and their role in maintaining the biodiversity. Also, they will get an idea about the Botanical Nomenclature, its principles and rule. Additionally, students gain proficiency in identifying plant groups based on the morphological features. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | **Analyze** and interpret the relationships between different angiosperm structures (roots, stems, leaves, inflorescences, flowers, fruits, and seeds) and their adaptations for survival and reproduction. | **An** | **F** | Practical exams, assignments & presentations |
| CO2 | **Appreciate** the importance and objectives of plant taxonomy and explain its historical development in India. | **U** | **F** | Assignments, presentations, & quizzes. |
| CO3 | **Demonstrate** knowledge of various taxonomic information resources like herbaria, botanical gardens, and online databases and Utilize plant identification keys to identify unknown plant specimens | **Ap** | **P** | Assignments and Practical exams |
| CO4 | **Compare and contrast** different classification systems used in plant taxonomy (e.g., Linnaeus, Bentham & Hooker, APG) and **explain** the rationale behind their development. | **U** | **F** | Assignments, presentations, and quizzes. |
| CO5 | **Construct and utilize** taxonomic keys for plant families and **Prepare and maintain** herbarium specimens according to standard practices and document relevant field data. | Ap | **P** | Practical Exams, assignments |
| CO6 | **Describe and analyze** the observations and learning outcomes of a field trip focused on plant identification and **Identify plants** belonging to different families based on their diagnostic features, using relevant floras. | **Ap** | **P** | Practical exams, assignments, Report |

* - 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) | Marks (70) |
|---|---|---|---|---|
| **I** | **Angiosperm Morphology** | | **8** | **15** |
| | 1 | **Vegetative Morphology**<br>A. Root: Types and modifications.<br>B. Stem: Types and modifications.<br>C. Leaf: Types and modifications. | 2 | 1 |
| | 2 | **Inflorescence**: Types (racemose, cymose and specialized). | 1 | 5 |
| | 3 | **Flower**: Flower as a modified shoot - detailed structure of flowers - floral parts – their arrangement, relative position, cohesion and adhesion - symmetry of flowers – floral diagram and floral formula. | 3 | 3 |
| | 4 | **Fruit**: Types with examples (simple, aggregate and multiple). | 1 | 5 |
| | 5 | **Seed:** Types, structure and adaptations. Dispersal of fruits and seeds. | 1 | 1 |
| **II** | **Taxonomy of Angiosperms** | | **7** | **15** |
| | 6 | Introduction, objectives and importance of taxonomy. | 1 | 2 |
| | 7 | **History of taxonomy in India:** Contributions of Hendrich van Rheede, William Roxburg, Robert Wight, J.D. Hooker, J.S. Gamble and E.K. Janakiammal. | 1 | 5 |
| | 8 | **Taxonomic information resources:** Herbaria - techniques - major herbaria in the India and world (any two). Botanic gardens – role in conservation – major botanic gardens in India and word (any two).<br>**Taxonomic literature:** – Floras; e-floras; revisions; monographs; indices; journals, online resources and databases. | 4 | 5 |
| | 9 | **Plant identification keys:** Construction and applications. | 1 | 3 |
| **III** | **Classification** | | **20** | **25** |
| | 11 | **Introduction to systems of classification:** Artificial (Linnaeus); Natural (Bentham & Hooker); Phylogenetic (Engler & Prantl); Angiosperm Phylogeny Group classification. Detailed study of Bentham and Hooker's and APG System. | 5 | 10 |

| | | | | |
|---|---|---|---|---|
| | | **Diagnostic features of plant families:** Annonaceae, Nymphaeaceae, Malvaceae, Rutaceae, Fabaceae, Myrtaceae, Cucurbitaceae, Apiaceae, Rubiaceae, Asteraceae, Apocynaceae, Solanaceae, Acanthaceae, Lamiaceae, Amaranthaceae, Euphorbiaceae, Orchidaceae, Arecaceae, Poaceae. | 15 | 15 |
| **IV** | **Taxonomic Hierarchy** | | **10** | **15** |
| | 12 | **Concepts of taxa:** Species concepts – biological, phenetic and phylogenetic; family, genus, and infraspecific taxa. | 2 | 2 |
| | 13 | **Taxonomic characters:** Concept of characters, primitive and advanced characters, sources, comparative morphology, vegetative, reproductive, macro- and micro-morphology, modern trends in taxonomy (brief). | 2 | 3 |
| | 14 | **Botanical nomenclature:** Limitations of common names; ICN, principles (introduction only); typification (holotype, isotype, syntype, paratype and lectotype); Rule of priority – merits and demerits; effective and valid publication; author citation. | 6 | 10 |
| **V** | **Practical** | | **30** | **20** |
| | 15 | Students have to identify the types mentioned in module 1, but need not draw the diagrams in the record. | | |
| | 16 | Students have to submit Geo tagged images of minimum ten different types mentioned in the following categories in module 1. | | |
| | 17 | Examination of floral morphology of the following plants: *Crotalaria/Caesalpinia, Ixora/Hamelia, Psidium/Callistemon, Allamanda/Catharanthus, Hibiscus/Urena, Solanum, Thunbergia, Hyptis, Euphorbia, Spathoglottis* | | |
| | 18 | Learning the characters of families mentioned in the theory syllabus from demonstrations in the laboratory using one or more plants from each family, making suitable diagrams, describing them in technical terms and identifying them up to species using any standard flora. | | |
| | 19 | Construction of taxonomic keys for the families studied. | | |
| | 20 | Each student shall submit a minimum of 10 properly identified herbarium specimens in the standard format along with field notes (Preferably weedy common plants from any family) | | |

| | | | | |
|---|---|---|---|---|
| | 21 | **Study Tour:** Students are expected to undertake a study tour of not less than 5 days duration under the guidance of the teachers to identify plants in the field using diagnostic characters. They are also expected to visit at least one research station/herbarium/botanical garden and should submit a duly certified study tour report along with herbarium sheets and field notes for external evaluation (Study tour is compulsory). | | |

## References


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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | 3 | | 3 | 2 | 3 | 3 | 3 | | | | |
| CO 2 | 3 | | 2 | 3 | | 2 | 3 | | | | | |
| CO 3 | | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | | 2 | 3 |
| CO 4 | 3 | | 2 | 2 | 3 | 2 | 3 | | 3 | 3 | 2 | 2 |
| CO 5 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | | 3 |
| CO 6 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | | 3 | 3 | 3 |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| CO | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | ✓ | ✓ | | ✓ |

**FIFTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA5CJ301 – ANGIOSPERM MORPHOLOGY AND TAXONOMY**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Differentiate between syngenesious and synandrous condition.
2. Name any two international herbaria with their acronyms.
3. What are monographs? How is it differing from revisions?
4. Differentiate between intended and bracketed keys.
5. What are e-floras?
6. With examples list out any three root modifications in plants.
7. Differentiate between lectotype and holotype.
8. What is a pollinium? Name any family having pollinia.
9. List out the diagnostic characters of Annonaceae.
10. Differentiate between aggregate and multiple fruit.

## SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. Discuss the role of botanical gardens in conservation.
12. Discuss the contribution of Dr. E.K. Janakiammal in Indian Botany.
13. Distinguish between monochasial and dichasial cymes.
14. Write a brief account of herbarium techniques.
15. Discuss the salient features of Apiaceae.
16. What is rule of priority and list out the limitation of priority?
17. Describe column in Orchidaceae.
18. Discuss the conditions of valid publication of a name?

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. Discuss APG IV classification. What are its major advancements over the previous versions?
20. Discuss the various species concepts studied.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA5CJ302** | | | | |
| **Course Title** | **PLANT PHYSIOLOGY, BIOCHEMISTRY AND BIOPHYSICS** | | | | |
| **Type of Course** | **Major** | | | | |
| **Semester** | V | | | | |
| **Academic Level** | **300 - 399** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75 |
| **Pre-requisites** | Fundamentals of Plant Physiology, Biochemistry and Biophysics at Higher secondary level | | | | |
| **Course Summary** | This course explores water, mineral absorption and organic substance transport, metabolism, biochemistry of plants and also different biophysical methods applied in plant science research | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand plant physiology through hands-on experiments, applying theoretical knowledge to real-world scenarios. | U | F | Practical Exam, Presentation |
| CO2 | Set up experiments to understand physiological phenomena | Ap | P | Practical Exam |
| CO3 | Estimate the presence/absence of carbrohydrate/protein in a given sample | Ap | P | Practical Exam |
| CO4 | Understand the biochemical reactions involved in metabolism | U | F | Test Paper, Assignment, Presentation |
| CO5 | Operate and compare different types of microscopes | Ap | P | Practical exam, field study |
| CO6 | Separate cholorophyll pigments using chromatographic techniques | Ap | P | Practical Exam |

* - 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) | Marks (70) |
|---|---|---|---|---|
| **I** | **Water, mineral absorption and organic substance transport** | | **9** | **15** |
| | 1 | **Plant water relationships:** Importance of water to plant life, physical properties of water, diffusion, osmosis, turgor pressure and water potential. **Ascent of Sap**: Radial and vertical transport of water | 2 | |
| | 2 | **Loss of water from plants:** Transport of water, transpiration, Physiology of stomata, Mechanism of guard cell Movement, K+ ion mechanism | 2 | |
| | 3 | **Mineral nutrition and Absorption of mineral salts:** Essential macro- and micro-elements and their role, deficiency symptoms, toxicity symptoms, absorption of mineral salt, mineral uptake | 3 | |
| | 4 | **Organic substances their Transport and Translocation:** Mechanism of Phloem transport, source-sink relationship, factors affecting translocation | 2 | |
| **II** | **Metabolism** | | **15** | **25** |
| | 5 | **Photosynthesis:** Photosynthesis in higher plants, photosynthetic apparatus, photosynthetic pigments, Photosynthetic electron transport and photophosphorylation, Calvin cycle, C4 pathway, CAM plants, photorespiration. Ecological significance of C3, C4, and CAM | 5 | |
| | 6 | **Respiration:** ATP -the biological energy currency, aerobic and anaerobic respiration, Glycolysis, Kreb's cycle, Electron transport mechanism (chemiosmotic theory), pentose phosphate pathway. Fate of pyruvate under aerobic and anaerobic conditions. Citric acid cycle | 3 | |
| | 7 | **Nitrogen metabolism:** Atmospheric nitrogen fixation, nitrogen cycle, Biological nitrogen fixation, symbiotic nitrogen fixation in leguminous plants, Assimilation of nitrate, Biosynthesis of amino acids. | 3 | |

| | | | | |
|---|---|---|---|---|
| | 8 | **Growth and Phases of development:** Seed dormancy and germination (Brief). Plant growth and development. Auxins, gibberellins, cytokinins, abscisic acid and ethylene, their physiological roles. Photoperiodism and vernalization.<br>**Photomorphogenesis:** Phytochrome: chemistry and physiological effects. | 4 | |
| **III** | | **Plant Biochemistry** | **10** | **15** |
| | | **Carbohydrates and Lipids:** Macromolecules-building block biomolecules – metabolic intermediates precursors. Classification of carbohydrates and lipids, Properties and Biological role | 3 | |
| | | **Proteins, Amino acids and Vitamins:** Classification, properties and biological role | 3 | |
| | | **Enzymology:** Discovery, Nomenclature, Characteristics of enzymes, Concept of holoenzyme, apoenzyme, Coenzyme and cofactors | 2 | |
| | | **Amphibolic pathways:** Anabolism, catabolism, amphibolic pathways and anapleurotic reactions. | 2 | |
| **IV** | **Biophysics** | | **11** | **15** |
| | | **Bioenergetics:** Concepts of free energy-Beerlamberts law, Thermodynamics in Biology, Biological energy transducers | 2 | |
| | | **Microscopy:** Light Microscope-Principles and applications; Electron Microscopy- SEM, TEM, AFM (Atomic Force Microscopy), Phase Contrast microscopy; Fluorescent Microscopy. | 4 | |
| | | **Photometry**: Principles and Applications-Spectroscopy- UV, Visible, NMR, Atomic absorption spectroscopy, Mass spectroscopy. | 2 | |
| | | **Chromatography:** Principles and Applications-Adsorption and partition chromatography- Column chromatography, Ion exchange chromatography, Affinity Chromatography, Gas chromatography, TLC, molecular sieve filtration. | 3 | |
| **V** | **Practical** | | **30** | **20** |
| | 1 | Students should familiarize experiments and details must be recorded. | | |

| | | | | |
|---|---|---|---|---|
| | | (Drawing not required) | | |
| | 2 | Determination of water potential by tissue weight change method. | | |
| | 3 | Determination of stomatal index. | | |
| | 4 | Separation of leaf pigments by paper chromatography / column chromatography / TLC. | | |
| | 5 | Physiology Experiments: | | |
| | | a. Effects of light intensity on photosynthesis by Wilmot's bubbler.<br>b. Thistle funnel osmoscope. (Demonstration)<br>c. Ganong's Potometer (Demonstration)<br>d. Ganong's respirometer (Demonstration)<br>e. Kuhne's fermentation vessel (Demonstration)<br>f. Mohl's half-leaf experiment (Demonstration) | | |
| | 7 | Qualitative tests for monosaccharides, and reducing non-reducing oligosaccharides, starch, amino acids and protein.<br>a) Molisch‟s test for all carbohydrates<br>b) Benedict‟s test for reducing sugars<br>c) Barfoed‟s test for monosaccharides<br>d) Seliwanoff‟s test for ketoses<br>e) Fearson‟s test (methyl amine test) for reducing disaccharides<br>f) Iodine test for starch<br>g) Ninhydrin test for amino acids and protein | | |
| | 8 | Demonstration of quantitative estimation of DNA and RNA by colorimetric /spectrophotometric method. | | |

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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | 3 | | | 3 | 3 | | 2 | 2 | 2 |
| CO 2 | 3 | 3 | 2 | | | | 3 | | | | | |
| CO 3 | 3 | | 2 | | | | 3 | | 3 | | 3 | |
| CO 4 | 3 | | 2 | 3 | 3 | 2 | 3 | 3 | | 2 | 2 | 2 |
| CO 5 | 3 | 1 | 2 | | | | 3 | | | | | |
| CO 6 | 3 | | 2 | | | | 3 | | 2 | | | |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| CO | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | ✓ | ✓ |
| CO 3 | | ✓ | ✓ | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | ✓ | ✓ | ✓ | ✓ |
| CO 6 | ✓ | | ✓ | ✓ |

**FIFTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA5CJ302 – PLANT PHYSIOLOGY, BIOCHEMISTRY AND BIOPHYSICS**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## Section A

**Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks**

1. Describe the structure and function of chloroplast in plant cell.
2. Describe the ultrastructure of mitochondria in plant cells.
3. What are the main differences between xylem and phloem in terms of structure and function?
4. Describe the function of Rubisco in the Calvin cycle.
5. Discuss the Ramachandran plot and its significance in understanding protein secondary structure.
6. Explain the role of mRNA, tRNA, and rRNA in the process of translation.
7. Explain the process of photoperiodism and its significance in plant development.
8. Explain the process of photophosphorylation in photosynthesis.
9. Describe the chemiosmotic theory and its role in ATP synthesis.
10. Compare the structures and functions of various forms of DNA (e.g., A-DNA, B-DNA, Z-DNA).

## Section B

**Answer all questions. Each question carries 5 marks. Ceiling: 36 Marks**

11. Compare and contrast the C4 and CAM pathways of carbon fixation.
12. Discuss the mechanism of phloem transport, focusing on the pressure-flow hypothesis.
13. Explain the roles of plant hormones, including auxins, gibberellins, cytokinins, abscisic acid, and ethylene, in regulating plant growth and development.
14. Compare and contrast phototropism and gravitropism in plants, highlighting their mechanisms and physiological significance.
15. Describe the classification, properties, and biological roles of carbohydrates and lipids in living organisms.
16. Explain the difference between anabolism and catabolism and how they are interconnected in cellular metabolism.
17. Explain the process of symbiotic nitrogen fixation in leguminous plants
18. Explain the process of fatty acid biosynthesis and the different types of fatty acid oxidation (alpha, beta, and omega), highlighting their roles in energy metabolism.

## Section C

**Answer any one. Each question carries 10 marks. 1 × 10= 10 Marks**

1. Discuss the principles and applications of adsorption and partition chromatography.
2. Explain the biochemical signaling mechanisms controlling flowering in plants, focusing on the roles of phytochrome, cryptochrome, photoperiodism, and thermoperiodism.

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|---|---|---|---|---|---|
| Programme | **B. Sc. PLANT SCIENCE** | | | | |
| Course Code | **PLA5CJ303** | | | | |
| Course Title | **PHYTOGEOGRAPHY, NATURAL RESOURCES AND UTILIZATION** | | | | |
| Type of Course | **Major** | | | | |
| Semester | **V** | | | | |
| Academic Level | **300 - 399** | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 |
| Pre-requisites | Fundamentals of geography, plant distribution, economically important plants at Higher secondary level | | | | |
| Course Summary | This course explores the various entrepreneurial opportunities in the field of Botany and understand the scope of ecotourism in Kerala. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | **Understand** the various Natural resources and their features | U | F | Test Paper, Assignment |
| CO2 | **Identify** and classify the Renewable & Non-renewable Resources; Biotic & Abiotic resources | U | F | Test Paper, Assignment |
| CO3 | **Identify** the phytogeographic zones of India and the various patterns of plant distribution. | Ap | P | Practical Exam |
| CO4 | **Identify** the economically important plants. | Ap | P | Practical Exam, Assignment |
| CO5 | **Understand** the importance of Traditional Botanical Knowledge | U | F | Assignment, Test Paper |
| CO6 | **Identify** the various ethnobotanically significant plants mentioned in the syllabus | Ap | P | Pratical Exam, Test Paper |

* - 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 (60) | Marks (70) |
|---|---|---|---|---|
| **I** | **Phytogeography** | | **15** | **25** |
| | 1 | Phytogeography - Definition, concept, scope and significance – contribution of Alexander von Humboldt | 3 | |
| | 2 | Patterns of plant distribution - continuous distribution and discontinuous distribution, vicarism, migration and extinction | 3 | |
| | 3 | Continental drift - Evidences and impacts, Theory of land bridges, Glaciation: Causes and consequences | 4 | |
| | 4 | Endemic distribution, theories on endemism, age and area hypothesis | 2 | |
| | 5 | Phytogeographical zones of India and the world | 3 | |
| **II** | **Ethnobotany** | | **10** | **10** |
| | 1 | Ethnobotany: Introduction, scope and significance | 1 | |
| | 2 | Major tribes of Kerala and their ethnobotanical knowledge | 1 | |
| | 3 | Importance of Traditional Botanical Knowledge, JNTBGRI model of Benefit Sharing, KIRTADS and tribal research | 3 | |
| | 4 | Ethnobotanical significance of the following species:<br>a. *Trichopus zeylanicus,*<br>b. *Ocimum sanctum,*<br>c. *Leucas aspera,*<br>d. *Ficus religiosa,*<br>e. *Curcuma longa,*<br>f. *Aegle marmelos,*<br>g. *Cynodon dactylon,*<br>h. *Azadirachta indica,*<br>i. *Cocos nucifera,*<br>j. *Coriandrum sativum,*<br>k. *Phyllanthus amarus,*<br>l. *Piper nigrum* | 5 | |
| **III** | **Economic Botany** | | **15** | **25** |
| | 1 | Plant and People – The science of economic botany, its development and significance, interdisciplinary nature | 1 | |
| | 2 | Study of economically important food crops; their Binomial, Family and Morphology of useful part, | 6 | |

| | | | | |
|---|---|---|---|---|
| | | products and uses.<br>*Cereals*: Rice, Wheat, Maize, Ragi, *Pulses* - Green gram, Bengal gram, Black gram; *Fruits* - Apple, Pineapple, Papaya, Banana, Mango, Guava, Jack, Grapes, Sapota;<br>*Vegetables*: Carrot, Beet Root, Tomato, Potato, Bitter gourd, Cucumber, Snake gourd, Ladies finger, Moringa, Cabbage, Amaranthus;<br>*Spices*: Pepper, Ginger, Cardamom, Clove, Nutmeg, Allspice, Cinnamon; *Oilseeds* - Coconut, Gingelly, Sunflower, Ground nut | | |
| | 3 | Study of economically important cash crops; their Binomial, Family and Morphology of useful part, products and uses.<br>*Beverages*: Coffee, Tea, Cocoa<br>*Masticatories*: Betel vine, Betel nut, Tobacco; Sugar – Sugar cane. | 2 | |
| | 4 | Study of economically important Industrial crops; their Binomial, Family and Morphology of useful part, products and uses.<br>*Latex*: Rubber; *Gums and Resins* – Dammar, Gum Arabic, Asafoetida; *Fibre*: Coir, Cotton, Jute; *Timber* – Teak, Rose wood, Jack, Ailanthus; *Biofuels*: Corn, sugarcane for ethanol; soybean, palm oil for biodiesel; *Medicinal plants*: *Adhatoda*, *Catharanthus*, *Phyllanthus*, *Rauvolfia*, *Aloe*; *Ornamentals*: Rose, Anthurium, Jasmine, Bougainvillea, Heliconia; *Foliage plants*: Aglaonema, Philodendron, Begonia, Ferns | 6 | |
| **IV** | **Natural Resources** | | **10** | **10** |
| | 1 | Natural resources: definition, classification based on origin, characteristics, and functions. Need for protecting natural resources. Renewable & Non-renewable Resources; Biotic & Abiotic resources | 5 | |
| | 2 | Types: Energy – Fossil & Renewable; Mineral – metal & non-metal; Land – soil, agriculture, mining, quarrying; Water - surface & ground, fresh & marine; Forest – timber & non-timber; Atmospheric, Biological and Genetic resources. | 5 | |
| **V** | **Open ended** | | **10** | **10** |

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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | | | 3 | 2 | | 3 | 1 | |
| CO 2 | 3 | | | | | | 3 | 2 | | 3 | 3 | |
| CO 3 | 3 | 3 | | | 2 | 2 | 3 | | | 1 | 2 | |
| CO 4 | 3 | 3 | | | | | 3 | | | 1 | 1 | |
| CO 5 | 3 | | 2 | 1 | | 3 | 3 | | | 1 | | |
| CO 6 | 3 | 3 | | | 2 | | 3 | | | 1 | | |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| CO | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | | | ✓ | |
| CO 6 | | | ✓ | |

**FIFTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA5CJ303 – PHYTOGEOGRAPHY, NATURAL RESOURCES AND UTILIZATION**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. What is mean by continental drift? Explain.
2. What are the causes and consequences of glaciation?
3. What is vicarism? Explain with the help of an example.
4. What is endemism? Explain with an example.
5. What is discontinuous distribution?
6. Name any three plants of ethnobotanical significance and their uses.
7. Explain the scope and significance of Ethnobotany.
8. Write the binomial and family of six medicinal plants
9. What are cash crops? Explain the uses of any 3 cash crops
10. Differentiate between Renewable & Non-renewable Resources, citing examples

## SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. Give an account of any 5 major tribal communities of Kerala.
12. Explain the theory of land bridges.
13. Explain the various theories on endemism.
14. Explain the ethnobotanical significance of any five plant species that you have studied.
15. What are industrial cops? Give the binomial, family and economic importance of any five species.
16. Give a brief account of phytogeographical zones of India?
17. Discuss the anatomical adaptations in hydrophytes
18. Which are the various forest types in Kerala? What are their features?

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. Explain the classification of food crops. Give the binomial, family and uses of any 10 species.
20. Give a detailed account on the Ethnobotanical significance of any 10 species.

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|---|---|---|---|---|---|
| Programme | **B. Sc. PLANT SCIENCE** | | | | |
| Course Code | **PLA6CJ301** | | | | |
| Course Title | **CELL AND MOLECULAR BIOLOGY** | | | | |
| Type of Course | **Major** | | | | |
| Semester | **VI** | | | | |
| Academic Level | **300 - 399** | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75 |
| Pre-requisites | Students should have Higher Secondary Level knowledge in Cell Biology and Molecular Biology. | | | | |
| Course Summary | Course aims to provide students with a comprehensive understanding of cell biology and molecular biology, equipping them with the knowledge and skills necessary to explore advanced topics in biological sciences and related fields. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the structure and function of cell organelles, cell membrane dynamics | U | F | Test Paper, Assignment |
| CO2 | Critically analyse cell cycle regulation | An | C | Practical Exam |
| CO3 | Evaluate chromosomal aberrations induced by mutagens and its effects | An | C | Practical Exam, Presentations |
| CO4 | Extract DNA from plant material | Ap | P | Presentation, Practical Exam |
| CO5 | Analyse central dogma of Biology and replication | An | M | Test Paper, Assignment, Presentation |
| CO6 | Evaluate the cell biology of Cancer | E | M | Test Paper, Assignment, 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) | Marks (70) |
|---|---|---|---|---|
| **I** | **Introduction to Cell Biology** | | **8** | **12** |
| | 1 | Cell: Overview of Cell Structure and Function, Cell Organelles and their Functions | 2 | |
| | 2 | Cell membrane: Fluid Mosaic Model, Membrane Proteins and Membrane Transport Mechanisms, Signal Transduction Pathways, Hormones and Receptors. | 2 | |
| | 3 | Cell cycle: G1, S, G2, M Phases and Significances, Spindle Formation and Disintegration, Cell Cycle Regulation, Checkpoints in the cell cycle. | 2 | |
| | 4 | Cell Division: Mitosis and Meiosis, Genetic Control and Consequences of Meiosis. | 2 | |
| **II** | **The Nucleus and Chromosomes** | | **12** | **20** |
| | 5 | Interphase Nucleus: Chromatin Scaffold and Organization, Nucleosomes, NPC Protein, Nuclear Import and Export. | 3 | |
| | 6 | Nucleolus: Structure, organization and functions. NOR | 2 | |
| | 7 | Chromosomes: Heterochromatin and Euchromatin, Satellite DNA, Karyotype and its Importance, Chromosome Banding and Significance, Mitochondrial and Chloroplast Genome. | 3 | |
| | 8 | Chromosome Aberrations: Structural and Numerical Chromosome aberrations, Aneuploidy and Euploidy, Effects of Aneuploidy on Phenotype. | 2 | |
| | 9 | Special Types of Chromosomes: Types and Significance in Evolution, Giant Chromosomes: Polytene and Lamp-Brush Chromosomes, B Chromosomes. | 2 | |

| | | | | |
|---|---|---|---|---|
| **III** | **Introduction to Molecular Biology** | | **13** | **20** |
| | 10 | Genetic Material, Classical Experiments, Organization of Genome, Eukaryotic and Prokaryotic Genome Structure. | 2 | |
| | 11 | Nucleic Acids. Nucleotides- Phosphodiester Bonds, Chargaff's Rule, DNA Forms: A, B, Z. RNA: Structure, Types, Function.. | 2 | |
| | 12 | DNA Replication, Replication errors and Repair Mechanisms (Mismatch repair, Nucleotide excision repair, Base excision repair). | 3 | |
| | 13 | Expression of Genetic Information: Transcription and Transcriptosomes-RNA Polymerases and Transcription Mechanism, Transcription in Bacteria and Eukaryotes, RNA Processing and Editing. | 3 | |
| | 14 | Translation- Genetic Code and Wobble Hypothesis, tRNA Structure and Function, Protein Synthesis and Ribosomes, Differences in Eukaryotic and Prokaryotic Translation, Post-Translational Modifications. | 3 | |
| **IV** | **Control of Gene Expression** | | **12** | **18** |
| | 15 | Prokaryotic and Eukaryotic Control, Operon Concept, Transcriptional Control by Sigma Factors, Eukaryotic Transcription Factors, Transcriptional Repression, RNA Processing and Transport, Translational Control, Post-Translational Control. | 3 | |
| | 16 | Epigenetics and gene regulation-Paramutation, Cosuppression, Imprinting. Mutagens and Mutagenesis: Types of Mutations: Point mutations (substitutions, insertions, deletions), Frameshift mutations, Silent, Missense, and Nonsense Mutations. | 3 | |
| | 17 | Apoptosis: Its role during development of organisms, role in eliminating mutated cells. | 2 | |
| | 18 | Cancer and Mutations: Oncogenes and tumor suppressor genes, Role of mutations in cancer development. | 2 | |
| | 19 | Chemical and Physical Mutagens. Mobile Genetic Elements: Types of Transposons, Mechanisms of | 2 | |

| | | | | |
|---|---|---|---|---|
| | | Transposition, Mutagenic Effects, Transposable Elements in plants. | | |
| **V** | **Practical** | | **30** | **20** |
| | 1 | Study of different phases of Mitosis/ meiosis using squash preparations | | |
| | 2 | Mutagenesis assays using chemical mutagens (e.g., EMS) | | |
| | 3 | Extraction of DNA from plant material | | |

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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | | | 3 | | | | | |
| CO 2 | 3 | 3 | 3 | | 2 | | 3 | | 2 | | 3 | |
| CO 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 2 |
| CO 4 | 3 | 3 | 2 | 2 | 2 | | 3 | 3 | | 3 | 3 | |
| CO 5 | 3 | | | 2 | 1 | | 3 | 3 | | | | |
| CO 6 | 3 | | | | | | 3 | | | | 1 | 1 |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| CO | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | ✓ | ✓ |
| CO 3 | ✓ | ✓ | ✓ | ✓ |
| CO 4 | | ✓ | ✓ | |
| CO 5 | ✓ | | | ✓ |
| CO 6 | ✓ | | | ✓ |

**SIXTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA6CJ301 – CELL AND MOLECULAR BIOLOGY**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Comment on semi-autonomous organelles.
2. What is a nucleoid?
3. Add notes on the term mobilome.
4. What are importins and exportins?
5. Delineate Wobble Hypothesis.
6. What is a doubled haploid?
7. Expound the term epigenetics.
8. What is the role of apoptosis during growth?
9. Explain the significance of tumor suppressor genes.
10. What are indels?

## SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. Discuss on signal transduction pathways.
12. Explicate the mitotic and meiotic behaviour of chromosomes
13. Reflect on the merits of banding techniques over karyotyping.
14. Elucidate the various forms of DNA.
15. Explore the factors involved in cell cycle regulation.
16. Compare and contrast inducible and repressible operons.
17. Analyse the common DNA repair mechanisms.
18. Evaluate the consequences of transposable elements in plants.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. “Polytene chromosomes are the sites of intense gene activity and are an out-come of endoreduplication.”- Substantiate.
20. “Transcriptosome is a holo-complex of proteins involved in the transcription of nucleic acid.” Analyse the enzymes involved in bacteria and eukaryotes.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA6CJ302** | | | | |
| **Course Title** | **PLANT BIOTECHNOLOGY, GENETIC ENGINEERING AND BIOINFORMATICS** | | | | |
| **Type of Course** | **Major** | | | | |
| **Semester** | **VI** | | | | |
| **Academic Level** | **300 - 399** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75 |
| **Pre-requisites** | A strong foundation in Plant Biotechnology, Genetic Engineering and Bioinformatics at Higher Secondary Level is needed. Proficiency in basic computer skills is also preferred. | | | | |
| **Course Summary** | The course aims to provide an in-depth exploration of plant genetic engineering and biotechnology, encompassing fundamental concepts, advanced techniques, industrial applications, and bioinformatics tools. Students will develop the knowledge and skills required to comprehend, apply, and critically evaluate diverse aspects of plant genetic engineering and biotechnology. The curriculum will equip students with a comprehensive understanding of genetic engineering, plant biotechnology, tissue culture techniques, and bioinformatics, empowering them to explore numerous applications in agriculture, industry, and molecular biology. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the principles and techniques of tissue culture | U | F | Test Paper, Group Discussion, Assignment, Presentation |
| CO2 | Prepare tissue culture medium | Ap | P | Practical Exam |
| CO3 | Compare various methods of gene transfer | An | C | Test Paper, Group discussion, Assignments |
| CO4 | Prepare flow chart of the method of preparing a GMO | U | F | Assignment, Presentation |
| CO5 | Anaylse the application of Biotechnology in different fields | An | C | Presentation, Assignment, Test Paper |
| CO6 | Analyse DNA sequences to find similarity in sequence alignment tools | An, Ap | P | Practical exam |

* - 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) | Marks (70) |
|---|---|---|---|---|
| I | **Plant Biotechnology** | | **12** | **18** |
| | 1 | Overview of plant biotechnology, Historical perspective and milestones, Branches of biotechnology: medical, agricultural, environmental, and industrial biotechnology, Plant biotechnology in agriculture and industry. | 2 | |
| | 2 | **Plant Tissue culture:** Brief history of plant tissue culture, Principles of totipotency, morphogenesis and organogenesis. Account on laboratory instructions and maintenance of sterilization, composition of media, nutrient and hormone requirement. | 2 | |
| | 3 | **Applications of Tissue culture:** Plant propagation **(**Organ culture: Anther, Pollen, Embryo and Endosperm culture, Organogenesis and Somatic embryogenesis, Genetic basis of somaclonal variations. Applications of somaclonal variation. | 2 | |
| | 4 | Protoplast Culture: Protoplast-Isolation regeneration and Viability test, Somatic hybridization and methods of protoplast fusion. Application of somatic hybridization and cybridization. | 2 | |
| | 5 | Application of tissue culture in forestry and agriculture; status of tissue and cell culture technology in India, Edible vaccines and their prospects. | 2 | |
| | 6 | Production of secondary metabolites: Culture conditions for producing secondary metabolites, selection of high yielding lines, elicitation and immobilization of cells. Hairy root culture– advantages of using hairy root culture, Hairy root culture and production of secondary metabolites. General account of plant biotechnology Institutes in India and Kerala. | 2 | |

| | | | | |
|---|---|---|---|---|
| II | **Tools and techniques in Plant Genetic engineering** | | **11** | **16** |
| | 7 | Basic concepts of Genetic Engineering. Recombinant DNA technology, Enzymes and Vectors for gene cloning. | 2 | |
| | 8 | Gene cloning and expression strategies. Preparation of insert: Genomic DNA library and cDNA library. Screening – Reporter gene, antibiotic screening. | 3 | |
| | 9 | Basics of gene amplification-Polymerase chain reaction, PCR Variants and its applications. | 2 | |
| | 10 | Transformation techniques: *Agrobacterium*-mediated, physical methods– shot gun, lipfection, checmical induced. | 2 | |
| | 11 | Transformation procedures and selection strategies. Blotting Techniques (Southern, Northern and Western) | 2 | |
| **III** | **Applications of Biotechnology** | | **12** | **20** |
| | 12 | DNA Fingerprinting techniques: Hybridization based (RFLP) and PCR based techniques – SSR, ISSR. Gene sequencing – Sanger method and automatic method | 3 | |
| | 13 | Successful examples of genetically modified crops (e.g., bt-Cotton, Golden Rice). Industrial applications – Alcohol and organic acide production. Food Biotechnology, Single Cell Proteins, Nutraceuticals, Mycoproteins. | 3 | |
| | 14 | Enzyme Biotechnology, Biosensors and biochips and Environmental Application – Bioremediation in waste management. | 2 | |
| | 15 | Reverse Genetics: Antisense RNA technology, RNAi and Application | 1 | |
| | 16 | Medical Biotechnology: Gene therapy, Stem Cell therapy, disease diagnosis, personalized medicine. Ethical and Environmental Considerations, Biosafety of GMO's. | 3 | |
| **IV** | **Bioinformatics** | | **10** | **16** |
| | 17 | Types of Biological data - Biodiversity data, Molecular data - DNA, RNA and Protein | 3 | |

| | | | | |
|---|---|---|---|---|
| | | sequences. Genomes and proteomes. Eukaryotic genome with special references to model organisms (Yeast, *Drosophila*), human and plants such as *Arabidopsis thaliana*. | | |
| | 18 | Bioinformatic Resources: NCBI, EBI, RCSB. Nucleotide sequence Databases: GenBank, EMBL, DDBJ; Protein sequences Databases: Swiss-Prot, TrEMBL; Sequence motifs Databases: Prosite. | 2 | |
| | 19 | Sequence based database search: Tools and techniques used in sequence analysis. Pairwise and Multiple Sequence Alignments. Tools for local and global alignment: BLAST and ClustalW. | 2 | |
| | 20 | Sequence patterns and Evolution: Molecular evolution, Diversity, Evolution and Concept of sequence patterns, motifs, profiles, various types of pattern representation viz. consensus, regular expression and profiles. Phylogenetic analysis by PHYLIP. Nature of data used in Taxonomy and Phylogeny, Description of phylogenetic trees and types of dendrograms. Analysis, interpretation and significance of dendrograms. | 3 | |
| **V** | **Practical** | | **30** | **20** |
| | 1 | Prepare any medium and inoculate in aseptic condition | | |
| | 2 | Sterile techniques and maintenance of plant tissue cultures. | | |
| | 3 | Practical training on using bioinformatics databases mentioned in the syllabus | | |
| | 4 | Sequence alignment using tools like BLAST and interpretation of alignment results. | | |
| | 5 | Demonstrate the phylogenetic analysis using software mentioned in the syllabus. | | |

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12. Stewart, C.N. (2012). *Plant Biotechnology and Genetics Principles, Techniques and Applications*. New York: John Wiley & Sons.

**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | 3 | | 2 | 3 | 3 | 2 | 2 | | |
| CO 2 | 3 | 3 | | | | | 3 | | | | | |
| CO 3 | 3 | | | 3 | | | 3 | 3 | | 2 | 3 | |
| CO 4 | 3 | | | 3 | | | 3 | 3 | | 2 | | |
| CO 5 | 3 | | 2 | 3 | 2 | 3 | 3 | 3 | | 2 | 2 | 3 |
| CO 6 | 3 | | 3 | 3 | | | 3 | 3 | 2 | 3 | 3 | |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| CO | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | | | ✓ | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | | ✓ | ✓ | ✓ |
| CO 5 | ✓ | ✓ | | ✓ |
| CO 6 | ✓ | ✓ | ✓ | ✓ |

**SIXTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA6CJ302 – PLANT BIOTECHNOLOGY, GENETIC ENGINEERING AND BIOINFORMATICS**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Explain the challenges associated with analyzing and interpreting large-scale genomic and proteomic datasets.
2. Describe the technique of hairy root culture and its advantages.
3. Write notes on the applications of somatic hybrids and cybrids.
4. Delineate the merits and demerits of Golden Rice.
5. How do researchers utilize the ZINC database in virtual screening and drug discovery processes?
6. Compare organogenesis and embryogenesis?
7. What are biosensors and biochips?
8. Comment on edible vaccines and their prospects.
9. Distinguish between binary and shuttle vectors.
10. Explain the role of substitution matrices and gap penalties in sequence alignment.

## SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. Expound on PCR, its variants and applications.
12. “Antisense RNA (asRNA) technology is a method used to silence genes.” Justify.
13. Reflect on Genomic DNA library and cDNA library.
14. How are dendrograms analyzed and interpreted in the context of evolutionary relationships? Discuss the significance of clustering and branch lengths in dendrograms.
15. “Blotting techniques characterize nucleic acids and/or proteins after *in situ* hybridization”. Validate.
16. Compare the non GMO techniques for crop improvement. Explain ethical and environmental considerations.
17. “DNA fingerprinting is based on DNA sequence variability and polymorphism.” Substantiate with techniques and applications.
18. Discuss the strengths and limitations of Muscle, T-Coffee, and Clustal W in sequence analysis.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. “Organ culture is the cultivation of either whole organs or parts of organs *in vitro*.”- Validate the statement revealing various types.
20. Compare and contrast the functionalities of GenBank, EMBL, and DDBJ as nucleotide sequence databases. Highlight their similarities and differences.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA6CJ303** | | | | |
| **Course Title** | **GENETICS, PLANT BREEDING, EVOLUTION AND BIOSTATISTICS** | | | | |
| **Type of Course** | **Major** | | | | |
| **Semester** | **VI** | | | | |
| **Academic Level** | **300 - 399** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 |
| **Pre-requisites** | Basic concept of classical genetics, organic evolution, statistics in higher secondary level | | | | |
| **Course Summary** | The course paper give an outline of concepts on classical genetics, population genetics, plant breeding methods and techniques, organic and molecular evolution, and statistical methods to analyse data | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | State Mendelian principles | U | F | Instructor-created exams / Quiz |
| CO2 | Solve problems based on Mendelian ratios and modified Mendelian ratios | Ap | M | Problems |
| CO3 | Map gene position on a chromosome | Ap | M | Problems |
| CO4 | Find the gene and genotype frequency of a population using Hardy Weinberg Principle | U | P | Problems |
| CO5 | Compare different selection and breeding techniques | Ap | P | One Minute Reflection Writing assignments |
| CO6 | Solve problems based on mean median mode standard deviation. Students can prepare histogram, pie diagram, | Ap | M | Problems |

* - 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 (60) | Marks (70) |
|---|---|---|---|---|
| **I** | **Genetics** | | **18** | **28** |
| | 1 | **Classical genetics**- Mendel's study of heredity Brief account on Mendelian principles - monohybrid dihybrid, test cross and backcross. Testing genetic hypothesis- chi-square test, pedigree analysis. Extension of Mendelism- Incomplete dominance – *Mirabilis* , Co-dominance - Blood groups in man. Gene action- Non-allelic interaction (genic) Epistasis – a) Dominant - Fruit colour in summer squashes b) Recessive epistasis - Coat colour in mouse; Complementary genes - Flower colour in sweet pea; Non-epistasis - Comb pattern in Fowls. Multiple alleles - Self sterility in Nicotiana. Pleiotropy | 5 | |
| | 2 | Linkage and crossing over - chromosome theory of linkage, crossing over, types of crossing over, mechanism of crossing over (Holliday model) Linkage map, 2 point and 3- point crosses, interference and coincidence. | 4 | |
| | 3 | Sex-linked inheritance: X-linked, Y-linked, Morgan's experiment eg. eye colour in Drosophila, sex limited and sex influenced inheritance, Dosage compensation | 3 | |
| | 4 | Extra-nuclear inheritance - Plastid inheritance in Mirabilis, Coiling pattern in snails | 2 | |
| | 5 | Population genetics: The Hardy Weinberg Principle, Estimation of gene frequencies, factors affecting equilibrium, natural selection, migration and genetic drift, Mutation - types - molecular mechanisms of gene mutation. Quantitative inheritance: Polygenic- Kernel colour of wheat | 4 | |

| | | | | |
|---|---|---|---|---|
| **II** | **Plant Breeding** | | **12** | **18** |
| | 6 | Definition and objectives of plant breeding - important national and international plant breeding institutes | 1 | |
| | 7 | Plant genetic resources – components of plant genetic resources, significance, | 1 | |
| | 8 | Breeding techniques- a) plant introduction; b) selection- mass selection, pure line selection and clonal selection; c) hybridisation techniques, hybrid vigour, inbreeding depression; d) mutation breeding; e) polyploidy breeding; f) Breeding for disease resistance | 6 | |
| | 9 | Applications of genetics in plant Breeding - Achievements with reference to the following crops in India: rice, coconut. Techniques of conservation of germplasm- cryopreservation, in situ ex situ, gene bank | 3 | |
| | 10 | IPR in Plant breeding - Brief account. | 1 | |
| **III** | **Evolution** | | **9** | **12** |
| | 11 | Origin of Earth – Introduction. Evidences of organic evolution – evidences from morphology, Anatomy, Embryology, Palynology, genetics and molecular biology. | 2 | |
| | 12 | Origin of Life: Origin of basic biological molecules – Condensation and Polymerisation. Proteinoid and Prions – Oparin concept, Miller's experiment, Evolution of prokaryotic and eukaryotic cells. Archaebacteria – Early fossilised cells. Anaerobic metabolism, Photosynthesis and Aerobic metabolism. | 3 | |
| | 13 | Theories on origin and evolution of species; Spontaneous generation – Lamarckism – Darwinism, Weismann and de Vries. Neo-Darwinism and its objection. The arguments and support for Darwinism. | 1 | |
| | 14 | Genetic Constancy and Creation of Variability- Cell divisions and genetic constancy, Genetic variability by | 2 | |

| | | | | |
|---|---|---|---|---|
| | | multiple allelism and recombination, Chromosomal variations, Gene mutations ( Brief account), Biomolecules – Evolutionary molecular level (brief account); evolutionary clocks, Microevolution, Molecular clock and mitochondrial Eve | | |
| | 15 | Speciation: Isolating mechanism – Modes of speciation – sympatric and allopatric. | 1 | |
| **IV** | **Biostatistics-Introduction** | | **11** | **12** |
| | 16 | Introduction – Importance and limitations of Biostatistics. Role of biostatistics in modern research<br>Collection of data-Sampling- random and non-random | 1 | |
| | 17 | Classification and tabulation of data: Tables. Diagrammatic presentation- Line diagram, bar diagram, Pie diagram; Graphical representation- Histogram, Frequency polygon, Frequency curve, Ogives (manual & s/w) | 2 | |
| | 18 | Measures of central tendency – Mean, Median and Mode | 2 | |
| | 19 | Measures of dispersion- Range, Mean deviation, Standard deviation, Standard error and Coefficient of variation | 2 | |
| | 20 | Test of Significance- t test, chi-square test, ANOVA | 2 | |
| | 21 | Experimental design- randomized block design, split plot design, Latin square | 1 | |
| | 22 | Correlation and regression (Brief account only) | 1 | |
| **V** | **Open ended** | | **10** | **10** |
| | 1 | Human phylogeny | | |
| | 2 | Evolution of crops | | |

| | | | | |
|---|---|---|---|---|
| | 3 | Animal pedigree analysis | | |
| | 4 | Familiarize with different statistical software | | |
| | 5 | Genetics and environmental interaction | | |
| | 6 | Demonstration of microtome sectioning and double staining | | |
| | 7 | Visit to a plant breeding institute and prepare report | | |

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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | | | 3 | | | | | |
| CO 2 | 3 | 3 | 3 | | 1 | | 3 | | | 1 | 3 | |
| CO 3 | 3 | 3 | 3 | | 2 | | 3 | | | 1 | 3 | |
| CO 4 | 3 | 3 | 3 | | 2 | 2 | 3 | | 2 | | 3 | 2 |
| CO 5 | 3 | | | 2 | | | 3 | | | | | |
| CO 6 | 3 | 3 | 3 | | 2 | | 3 | | 2 | 2 | 3 | |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| CO | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | ✓ | ✓ | | ✓ |
| CO 6 | ✓ | ✓ | | ✓ |

**SIXTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA6CJ303 – GENETICS, PLANT BREEDING, EVOLUTION AND BIOSTATISTICS**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Genetic drift
2. Inbreeding depression and Hybrid vigour
3. What are central tendencies? Explain with an example.
4. State the basic assumption is in ANOVA techniques
5. Contribution of Hugo de Vries in the theory of evolution
6. What is meristic quantative chartacters
7. Achievements in mutation breeding
8. Merits and demerits of mass selection
9. Linkage and crossing over
10. What is natural selection?

## SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. In a population of which 49% are homozygotes with genotype “tt”. Find out the gene frequency of allele ‘T’ and ’t’.
12. The duration of time from first exposure to HIV infection to AIDS diagnosis is called the incubation period. The incubation periods of a random sample of 10 HIV infected individuals is given below (in years):

    12.0, 10.5, 9.5, 6.3, 13.5, 12.5, 7.2, 8.5, 9.2, 10.2

    a) Calculate the sample mean.
    b) Calculate the sample median.
    c) Calculate the sample standard deviation.
    d) If the number 6.3 above were changed to 1.5, what would happen to the sample mean, median, and standard deviation? State whether each would increase, decrease, or remain the same.
13. Explain the mechanism of crossing over and demonstrate it significance with relevant examples
14. Write a brief essay on plant introduction and agencies of plant introduction in India
15. Write an essay on different breeding techniques with suitable example
16. Explain non-allelic gene interaction with suitable example? Justify how the dihybrid ratio is different from classical Mendelian ratio
17. How new species is formed in due course of time by different natural mechanism?
18. What is cryopreservation? Discuss its applications.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. Write an essay on sex linked inheritance with suitable experimental evidences.

20. Explain the organic evolution of life and justify with evidences.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA7CJ401** | | | | |
| **Course Title** | **CROP IMPROVEMENT AND PLANT MOLECULAR PATHOLOGY** | | | | |
| **Type of Course** | **Major** | | | | |
| **Semester** | **VII** | | | | |
| **Academic Level** | **400 - 499** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75 |
| **Pre-requisites** | Basic concept of plant breeding, pathogens, and plant diseases | | | | |
| **Course Summary** | The course paper give an outline of concepts on plant breeding, population genetics, plant breeding methods, principles of plant pathology, pathogens, and plant-pathogen interactions at the molecular level | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand Plant breeding and pathology principles | U | F | Test paper / Quiz |
| CO2 | Identify diseases of important crop plants | Ap | M | identify using live images and specimens |
| CO3 | Map QTL mapping using structured populations | Ap | M | solving Problems |
| CO4 | Analyze Genetic variability in crop plants and how they can be used in plant breeding | An | C | Test paper<br>Presentation<br>Group Discussions |
| CO5 | Compare different selection and breeding techniques | E | C | One Minute Reflection Assignments |
| CO6 | Comprehend Integrated plant disease management | U | C | Test paper |

* - 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) | Marks (70) |
|---|---|---|---|---|
| **I** | **Crop improvement - Introduction** | | **10** | **19** |
| | 1 | Basic principles of plant breeding – Objectives, Activities, Systems of reproduction in crops. Plant breeding institutes, traditional and modern methods of plant breeding. | 2 | |
| | 2 | Genetic variability, Genetic resources, germplasm, gene pool, centers of origin of crop plants. Gene bank: roles and procedures. Artificially created variation: mutation and transgenes. | 3 | |
| | 3 | Pedigree naming systems and symbols. Population and quantitative genetics: principals, types of populations in breeding programmes, | 3 | |
| | 4 | IPR in Plant breeding, laws and regulations, eligibility criteria for filing patents, procedure for patent filing. IPR policies associated with genome-edited crops. | 2 | |
| **II** | **Advanced crop improvement** | | **13** | **19** |
| | 5 | Marker assisted breeding: RAPD, AFLP, RFLP, SCARS, CAPS, SSR, isozymes. Concepts of mapping, Inheritance of markers, linkage analysis, construction of molecular linkage map, mapping genes for qualitative traits, QTL mapping using structured populations (Brief account only) | 3 | |
| | 6 | Principles and methods of genomic selection, development of gene based markers, tagging and mapping of genes, Marker assisted selection (MAS), linked, unlinked, recombinant, flanking, peak markers. Genetic variability and DNA fingerprinting. Molecular markers in plant variety protection (Brief account only) | 4 | |
| | 7 | Genome editing for crop improvement – principles, potential of genome editing, CRISPR, risks associated with edited crops, policies associated with genome-edited crops. | 3 | |
| | 8 | Crop biology, classification system, origin and domestication, production systems, breeding of rice, wheat, potato, black pepper, and breeding institutions working on the crop. | 3 | |

| | | | | |
|---|---|---|---|---|
| **III** | **Molecular pathology - Introduction** | | **12** | **14** |
| | 9 | Laboratory equipment, principles and methods: Laminar Air Flow chamber, Spectrophotometer, electrophoretic unit, light and electron microscopy, incubator, ELISA reader. | 2 | |
| | 10 | Plant disease measurement. Plant Disease Forecasting – Remote sensing. Detection of pathogens in plant tissues: Nucleic acid probes, Southern, Northern and Western hybridization, ELISA, ISEM and PCR (Brief account only) | 3 | |
| | 11 | Plant physiology and metabolism under biotic stress. Molecular mechanisms of pathogenesis: recognition phenomenon, penetration, invasion, primary disease determinant. | 2 | |
| | 12 | Enzymes and toxins in relation to plant disease. Phytoalexins. PR proteins. Antiviral proteins. SAR. HR and active oxygen radicals. | 2 | |
| | 13 | Management of pathogens through satellite, antisense - RNA. Ribozymes, coat protein, hypovirulence cross protection/useful genes and promoter technology | 3 | |
| **IV** | **Molecular plant pathology- tools and techniques** | | **10** | **18** |
| | 15 | Biochemistry and molecular biology of plant-pathogen relationships, horizontal and vertical pathosystems, RNA silencing as a general defense mechanism, virulence genes and their products | 3 | |
| | 16 | Molecular basis of gene-for-gene hypothesis; R-gene expression and transcription profiling, mapping and cloning of resistance genes and marker-aided selection, pyramiding of R genes. | 3 | |
| | 17 | Study of basic and advanced serological techniques; production of monoclonal and polyclonal antibodies. Instrumentation and maintenance of molecular plant pathology laboratory. Detection and diagnosis of plant pathogens by various immuno- and molecular techniques. Biotechnology and disease management; development of disease resistance plants using genetic engineering approaches, different methods of gene transfer, biosafety issues related to GM crops (Brief account only) | 4 | |

| | | | | |
|---|---|---|---|---|
| **V** | **Practical** | | **30** | **20** |
| | 1 | Use of any one molecular marker | | |
| | 2 | QTL mapping | | |
| | 3 | Floral biology of rice, wheat, potato, black pepper | | |
| | 4 | Growth and multiplication of biocontrol agents | | |
| | 5 | Study of crop disease symptoms mentioned in the syllabus | | |
| | 6 | Get acquainted with the procedure of patent filing | | |
| | 7 | Visit to a plant breeding institute and prepare report | | |

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5. Singh BD. 1993. Plant Breeding. 5th Edition, Kalyani Publishers, Ludhiana, 102-104.
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7. Suza, W., & Lamkey, K. (Eds.). 2023. Crop Improvement. Iowa State University Digital Press. DOI: 10.31274/isudp.2023.138.

**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | | | 3 | | | 2 | | |
| CO 2 | 3 | 3 | | | | | 3 | | | | | |
| CO 3 | 3 | 2 | 2 | 2 | | | 3 | | | 3 | | |
| CO 4 | 3 | | 2 | | 2 | | 3 | 3 | 2 | 3 | | |
| CO 5 | 3 | | | | | | 3 | | | | | |
| CO 6 | 3 | | 2 | | 2 | 3 | 3 | | | 3 | 2 | 1 |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)
-

**Mapping of COs to Assessment Rubrics:**

| COs | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| **CO 1** | ✓ | ✓ | | ✓ |
| **CO 2** | ✓ | ✓ | | ✓ |
| **CO 3** | ✓ | ✓ | | ✓ |
| **CO 4** | ✓ | ✓ | | ✓ |
| **CO 5** | | | ✓ | |
| **CO 6** | | | ✓ | |

**SEVENTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA7CJ401 – CROP IMPROVEMENT AND PLANT MOLECULAR PATHOLOGY**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. What is QTL mapping?
2. Differentiate between horizontal and vertical resistance.
3. What is ELISA?
4. What is CRISPR? What are its advantages?
5. What is DNA fingerprinting in crop improvement?
6. What is RNA slicing?
7. What are the important plant virus disease symptoms?
8. What is SAR?
9. What is pyramiding of R genes?.
10. What are the advantages of promoter technology in plant pathology?.

## SECTION B

**(Answer all questions. Each question carries 5 marks. Ceiling: 36 Marks)**

11. Explain the principle of spectrophotometer.
12. Give a few examples of genome editing used in controlling plant diseases.
13. Briefly explain the gene transfer mechanisms used in crop improvement.
14. Explain the role of enzymes and toxins in pathogenesis.
15. How is remote sensing used in plant disease management?
16. Explain the role and mechanisms of biocontrol and PGPR.
17. What is MAS? What are the different MAS systems used in plant breeding?
18. Explain the IPR rules associated with genome-edited crops.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 x 10 = 10 Marks)**

19. Explain the potential of genome editing for agriculture, society and environment.
20. Discuss the various immuno- and molecular techniques for detection and diagnosis of plant pathogens.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA7CJ402** | | | | |
| **Course Title** | **PLANT SYSTEMATICS AND MOLECULAR PHYLOGENY** | | | | |
| **Type of Course** | **Major** | | | | |
| **Semester** | **VII** | | | | |
| **Academic Level** | **400 - 499** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75 |
| **Pre-requisites** | A strong foundation in Botany at undergraduate level | | | | |
| **Course Summary** | The course aims to provide in-depth knowledge about the classification and nomenclature of Angiosperms. This course explores the morphology, classification, and evolutionary relationships of angiosperms (flowering plants). It covers the structural diversity of angiosperms, principles of plant taxonomy, and modern molecular techniques used in systematics. Students will learn to identify major plant families, understand their evolutionary relationships, and apply molecular data to taxonomic studies. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand principles of plant systematics and how to use nomenclature rules plants | U | F | Test paper, quiz |
| CO2 | Prepare taxonomic keys based on morphological characters | Ap | P | Practical exam |
| CO3 | Analyse the application of anatomy, phytochemistry, numerical methods in plant systematics | An/C | M | Test paper<br>Assignment<br>Presentation |
| CO4 | Evaluate the molecular characters to construct phylogenetic tree | E | M | Assignment<br>Online tools to construct trees |
| CO5 | Identify and classify locally available plants to corresponding families based on morphological characters | Ap | P | Practical exam |
| CO6 | Study the flora of different localities and document | U | M | Tour report<br>Herbarium |

* - 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

| Modules | Unit | Contents | Hrs. (45+30) | Marks (70) |
|---|---|---|---|---|
| **I** | **Plant Systematics** | | 10 | **15** |
| | 1 | Current ideas about the origin of angiosperms, Concept of primitive flower, evolution of stamen, carpel, and placenta. | 2 | |
| | 2 | Plant systematics and its components; Plant nomenclature: history, salient features and major provisions of International Code of Nomenclature for Algae, Fungi and Plants (ICN). Rejection of names, Conserved names and names of hybrids. A brief account of International Code of Nomenclature of Cultivated Plants. Common technical terms used in plant nomenclature. | 5 | |
| | 3 | Plant identification: Plant description terminologies; method of describing a plant species using morphological characters; taxonomic keys-dichotomous (indented, bracketed). | 2 | |
| | 4 | Taxonomic data bases: Taxonomic Databases working Group; POWO; WFO, IPNI, Index Genericorum; Index herbariorum; Angiosperm Phylogeny Group; Digital libraries; Digital taxonomic resources | 1 | |
| **II** | **Numerical Taxonomy** | | **10** | **15** |
| | 5 | Principles, construction of taxonomic groups, OTUs, concept of characters- | | |
| | 6 | Character weighting, analytical and synthetic, good and bad, quantitative and qualitative, unit and multiple; | | |
| | 7 | Character coding, measurement of resemblances, cluster analysis and phenograms, phenons, and ranks, merits, and demerits. | | |

| | | | | |
|---|---|---|---|---|
| | 8 | Softwares used for numerical taxonomy: NtSYS, PAUP, SPSS, MEGA | | |
| **III** | **Chemotaxonomy and cytotaxonomy** | | **10** | **15** |
| | 9 | Chemotaxonomy: Origin of chemotaxonomy, classes of compounds and their biological significance, use of chemical criteria in plant taxonomy. | | |
| | 10 | Cytotaxonomy: Chromosome number and structure, basic chromosome number, polyploidy, aneuploidy, karyotype and idiogram, chromosome banding, scope, and limitations. | | |
| **IV** | **Molecular Phylogeny** | | **15** | **25** |
| | 11 | Phylogeny of Angiosperms: Cladistics: steps in cladistics, cladograms, phylogenetic terms- plesiomorphic and apomorphic characters, Homology and Analogy, Parallelism and convergence, Monophyly, paraphyly and polyphyly, plesiomorphy and apomorphy. origin & evolution of angiosperms; co-evolution of angiosperms and animals; methods of illustrating evolutionary relationship (phylogenetic tree, cladogram). | | |
| | 12 | Molecular Systematics: Introduction to molecular systematics; Molecular diagnostic tools and techniques; Polymerase chain reaction (PCR) | | |
| | 13 | Generating molecular data, types of molecular data, conserved genes for taxonomic analyses – Nuclear, Plastid, and mitochondrial genes; | | |
| | 14 | Analysis of molecular data- sequence alignment; tree building methods- Maximum likelihood and Bayesian Analysis; phylogeny reconstruction and interpretation of trees. | | |
| | 15 | Method of estimating character evolution using molecular data. | | |

| | | | | |
|---|---|---|---|---|
| | | Applications of molecular systematics in plant taxonomy. | | |
| | 16 | DNA Barcoding of plants: Introduction, DNA barcoding organizations, barcoding regions of plants, steps in DNA barcoding, applications. | | |
| **V** | **Practical** | | **30** | **20** |
| | | Examination of primitive and advanced angiosperm flowers to know the characters; Dissecting members of Nympheales to examine petal to stamen transition; Examination of different types of ovaries and placentations | | |

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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | | | 3 | | | | 1 | |
| CO 2 | 3 | 3 | 3 | | | | 3 | | | | 3 | |
| CO 3 | 3 | | 2 | 2 | 2 | | 3 | 2 | | 2 | 2 | |
| CO 4 | 3 | 3 | 3 | | 3 | | 3 | | 2 | 3 | 3 | |
| CO 5 | 3 | 3 | 3 | | 3 | | 3 | | 3 | | 3 | |
| CO 6 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 3 |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| COs | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| **CO 1** | ✓ | ✓ | | ✓ |
| **CO 2** | ✓ | ✓ | ✓ | ✓ |
| **CO 3** | ✓ | ✓ | | ✓ |
| **CO 4** | ✓ | ✓ | | ✓ |
| **CO 5** | ✓ | ✓ | ✓ | ✓ |
| **CO 6** | | | ✓ | ✓ |

**SEVENTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA7CJ402 – PLANT SYSTEMATICS AND MOLECULAR PHYLOGENY**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Differentiate between indented and bracketed keys.
2. What is a legitimate name?
3. What is convergence?
4. What is ICNCP?
5. What are good and bad characters?
6. What is Index Genericorum?
7. What are taxonomic keys?
8. What are OTUs?
9. What are phenons?
10. What is monophyly?

## SECTION B

**(Answer all questions. Each question carries 5 marks. Ceiling: 36 Marks)**

11. Explain the principles of ICN.
12. Discuss the evolution of carpel.
13. Describe the methods of describing a plant.
14. Discuss Angiosperm Phylogeny Group.
15. Discuss the rules of naming a hybrid.
16. Explain any software used in numerical taxonomy.
17. Distinguish between plesiomorphic and apomorphic characters.
18. Explain homology and analogy.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. What is chemotaxonomy? Explain the role of chemical data in solving taxonomic problems.
20. Discuss the applications of molecular data in plant taxonomy.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA7CJ403** | | | | |
| **Course Title** | **Advances in Plant Physiology and Biochemistry** | | | | |
| **Type of Course** | **Major** | | | | |
| **Semester** | **VII** | | | | |
| **Academic Level** | **400 - 499** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75 |
| **Pre-requisites** | A foundational understanding of biology, basic plant physiology and biochemistry concepts | | | | |
| **Course Summary** | This course covers the plant physiological processes, including nutrient assimilation, photosynthesis, growth regulation, and stress responses and biochemistry of essential biomolecules. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Explain the significance and biochemical properties of essential biomolecules. | R | C | Instructor-created exams / Quiz |
| CO2 | Describe the metabolic pathways of carbohydrates, lipids, proteins, and nucleic acids. | U | P | Assignment / Observation of Practical Skills |
| CO3 | Discuss the processes of nutrient assimilation and the molecular physiology of micronutrient acquisition. | Ap | C | Written Tests<br>Group discussion |
| CO4 | Analyze the physiological and environmental factors influencing photosynthesis and respiration in plants. | An, Ap | P | Instructor-created exams / Home Assignments/ Practical |
| CO5 | Evaluate the role of plant hormones and growth regulators in development and stress responses. | E | P | Seminar Presentation / Group Tutorial Work |
| CO6 | Critically evaluate the role of biomolecule in metabolism | E | M | Test, Seminar, 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

| Modules | Unit | Contents | Hrs. (45+30) | Marks (70) |
|---|---|---|---|---|
| **I** | **Plant Physiology of metabolism and development** | | **11** | **20** |
| | **1** | **Importance and Energetics of Nutrient Assimilation:** Importance of phosphorus, iron, magnesium, calcium, and potassium assimilation. Energetics of nutrient assimilation. Molecular physiology of micronutrient acquisition. | 2 | |
| | **2** | **Physiological and Environmental Considerations of Photosynthesis:** Physiological and environmental consideration of photosynthesis. Distribution of photoassimilates- export. Starch and sucrose synthesis. | 3 | |
| | **3** | **Allocation and Partitioning in Plants:** Allocation and partitioning: phloem loading and unloading. Concept of osmotically generated pressure flow. Importance of plasmodesmata in symplastic transport. | 3 | |
| | **4:** | **Unique Enzymes and Interactions in Respiration:** Unique electron transport enzymes of plant mitochondria: external NAD(P)H dehydrogenase, rotenone, and cyanide-insensitive cytochrome C oxidases. Interaction between mitochondrial and other cellular components. Metabolites and specific transporters. Lipid metabolism | 2 | |
| | **5** | **Plant Growth Analysis and Developmental Regulation:** Analysis of plant growth: production of cells, growth velocity profile. Cytological and biochemical events. Initiation and regulation of development, genes involved in the control of development, role of protein kinases. Types of development: flowering-floral induction, evocation, and morphogenesis. Floral organ identity genes. | 2 | |

| | | | | |
|---|---|---|---|---|
| **II** | **Stress Physiology and Signal Transduction** | | **12** | **18** |
| | **6** | **Biochemical Signaling and Control of Flowering:** Biochemical signaling: theories of flowering. Control of flowering: phytochrome, cryptochrome, and biological clock. Factors affecting flowering: photoperiodism and thermoperiodism. | 2 | |
| | **7** | **Plant Growth Regulators:** Abscisic acid: biosynthesis and metabolism, physiological effects, role in seed dormancy and senescence. Brassinosteroid: biosynthesis, metabolism, transport, effect on growth and development. Hormonal balance concept and mechanism. | 2 | |
| | **8** | **Senescence and Programmed Cell Death:** Apoptosis and necrosis. Programmed cell death in relation to reproductive development, and stress response. Genes associated with senescence, metabolism during senescence. | 2 | |
| | **9** | **Understanding Biotic and Abiotic Stress:** Biotic stress, water deficit, and drought resistance. Heat stress and heat shock, chilling and frost. Salinity stress, high light stress, oxygen deficiency stress, and heavy-metal pollution stress. Signaling pathways activated in response to abiotic stress. Salicylic acid and jasmonic acid mediated stress tolerance. | 2 | |
| | **10** | **Signal Transduction:** Classes of signals; receptors, signal perception. Signal amplification and transduction reactions. Role of Ca++ as second messengers, role of calmodulin. Cross regulations in signal transduction pathways. Stress-associated changes in metabolites and metabolomics, homeostasis events under stress. | 3 | |

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|---|---|---|---|---|
| **III** | **Introduction to Biochemistry** | | **10** | **14** |
| | **11** | **Importance of Biochemistry:** Origin of life, history and significance of Biochemistry and biomolecules. Indian contributors of Biochemistry: G.N. Ramachandran and P.M. Bhargava. | 2 | |
| | **12** | **pH and Buffers:** Properties of water, acids, bases, and buffers. Henderson-Hasselbalch equation, pH, pKa, Kw, proton hopping | 2 | |
| | **13** | **Structure and Diversity of Carbohydrates:** Introduction to mono-, di-, oligo-, and polysaccharides. Linear and ring structures, homo- and heteroglycans, artificial sweeteners. Structure and function of major homo- and heteropolysaccharides, glycoproteins, and proteoglycans. | 2 | |
| | **14** | **Carbohydrate Metabolism:** Metabolism of starch, cellulose, and glycogen. Glycolysis, TCA cycle, terminal oxidation, gluconeogenesis, glyoxylate pathway, PPP pathway. Biosynthesis of peptidoglycan, metabolic mill. | 2 | |
| | **15** | **Amino Acids and Proteins:** Classification, diversity, properties, optical activity of amino acids. Biosynthesis and breakdown of amino acids; unusual amino acids. Biological functions; classification and conformation of proteins. Ramachandran plot, primary, secondary, tertiary, and quaternary structure. Alpha helix, beta-pleated structure, coiled coil proteins; disulfide bonds; structure and function of hemoglobin. | 2 | |
| **IV** | **Advanced Biochemistry and Metabolism** | | **12** | **18** |
| | **16** | **Protein Synthesis:** Transcription, translation, mRNA, tRNA, rRNA, genetic code. Activation of amino acids, initiation, elongation, termination, and ribosome recycling. Folding and post-translational processing. Breakdown of proteins. | 2 | |

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|---|---|---|---|---|
| | **17** | **Enzymes and Enzyme Kinetics:** Importance and properties of enzymes. Structure, function, classification, and nomenclature of enzymes. Active sites, coenzymes, substrate specificity, regulation of enzyme activity. Michaelis-Menten constant, Lineweaver-Burk plot; multienzyme complexes. Isoenzymes, ribozyme, abzyme, detailed study of FAS and Rubisco, penicillin and magic bullet, suicidal inactivators. | 2 | |
| | **18** | **Lipids and Lipid Metabolism:** Classification of lipids. Compound and derived lipids with examples. Classification of fatty acids, omega fatty acid, functional food. Trans fatty acids and their dangers, study of coconut oil. Biosynthesis of fatty acids; alpha, beta, and omega oxidation of fatty acids. | 2 | |
| | **19** | **Structural Organization of Nucleic Acids:** Nucleotides, nucleosides, nitrogen bases, purines, and pyrimidines. Types of bonds in nucleic acids. DNA: Structure, types, and conformation, forms of DNA (A, B, Z, C, D), ssDNA, triplex DNA, quadruplex DNA, circular and superhelical DNA; DNA palindromes and mirror repeats. RNA: Structure, types, and conformation, mRNA, tRNA, rRNA. | 3 | |
| | **20** | **Vitamins and Phytohormones:** Classification, structure, function, and sources of vitamins. Vitamins as coenzymes. Classification, structure, and functions of phytohormones: auxin, cytokinin, gibberellin, abscisic acid, ethylene. | 3 | |
| **V** | **Practical** | | **30** | **20** |
| | **1** | Analysis of plant growth by different methods; fresh weight, dry weight, relative growth rate | | |
| | **2** | Protein estimation by dye binding method. | | |
| | **3** | Estimation of proline in plant tissues | | |

| | | | | |
|---|---|---|---|---|
| | | under various abiotic stresses. | | |
| | **4** | Determination of peroxidase activity in plant tissues affected by biotic/abiotic stresses | | |
| | **5** | Estimation of free amino acids in senescing leaves to understand the source to sink transformation phenomenon. | | |
| | **6** | Auxin influence on hypocotyl elongation | | |
| | **7** | Preparation of standard solutions of BSA and Glucose. | | |
| | **8** | Detection of non-reducing sugar in the presence of reducing sugar | | |
| | **9** | Quantitative estimation of reducing sugar from plant tissue by any suitable method. | | |
| | **10** | Extraction and estimation of starch from plant tissue by a suitable method. | | |
| | **11** | Colorimetric estimation of protein by Biuret method. | | |
| | **12** | Colorimetric estimation of protein by Lowry et al. method. | | |

## References:


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32. https://www.ctahr.hawaii.edu/oc/freepubs/pdf/pnm3.pdf
33. https://www.asps.org.au/wp-content/uploads/Chapter-11-Fruit-growth-ripening-and-post-harvest-physiology.pdf
34. https://krishi.icar.gov.in/jspui/bitstream/123456789/17925/1/Physiology%20of%20fruit%20ripening%20%28JHA%202018%29.PDF
35. https://www.uv.mx/personal/tcarmona/files/2010/08/Moglich-et-al-2010.pdf
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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | | | 3 | | | | | |
| CO 2 | 3 | 3 | | | | | 3 | | | | | |
| CO 3 | 3 | | | 3 | | | 3 | 3 | | | | |
| CO 4 | 3 | 3 | | | | 3 | 3 | | | 2 | 2 | |
| CO 5 | 3 | | | 3 | | | 3 | 3 | | 2 | | |
| CO 6 | 3 | | 3 | 3 | 3 | | 3 | 3 | | 2 | | |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| COs | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| **CO 1** | ✓ | ✓ | | ✓ |
| **CO 2** | ✓ | ✓ | | ✓ |
| **CO 3** | ✓ | ✓ | | ✓ |
| **CO 4** | ✓ | ✓ | | ✓ |
| **CO 5** | | | ✓ | |
| **CO 6** | | | ✓ | |

**SEVENTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA7CJ403 - ADVANCES IN PHYSIOLOGY AND BIOCHEMISTRY**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## Section A

**Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks**

1. Differentiate between apoptosis and necrosis in plants.
2. What is glyoxylate pathway and how it differs from TCA cycle?
3. Describe the role of cyanide insensitive cytochrome C oxidase in plant respiration.
4. Differentiate between homo and heteropolysaccharides with examples.
5. Describe the structure and function of cellulose and its role in plant cell walls.
6. Explain the dangers of trans fatty acids and their impact on human health.
7. Explain the osmolytes and its role in tolerance of specific abiotic stresses.
8. What are the effects of brassinosteroids on plant growth and development?
9. Explain the significance of cohesion and adhesion in biochemical processes.
10. What are isoenzymes and how do they contribute to metabolic regulation?

## Section B

**Answer all questions. Each question carries 5 marks. Ceiling: 36 Marks**

11. Describe the biosynthesis of peptidoglycan and its importance in maintaining bacterial cell wall integrity.
12. Explain the concept of homo and heteroglycans with examples and their role in biological systems.
13. Explain the importance of phosphorus and iron in plant metabolism.
14. Define floral induction and describe its regulation in flowering plants.
15. Differentiate between the A, B, and Z forms of DNA in terms of structure and biological significance.
16. Describe the biosynthesis of fatty acids, including the role of alpha, beta, and omega oxidation pathways.
17. Explain the concept of osmotically generated pressure flow in phloem transport.
18. Explain how salicylic acid contributes to stress tolerance in plants.

## Section C

**(Answer any one. Each question carries 10 marks) 1 × 10= 10 Marks**

19. Describe the process of protein synthesis, including transcription, translation, and the roles of mRNA, tRNA, and ribosomes. Explain the post-translational modifications that occur after protein synthesis.
20. Describe the role of photoperiodism and thermoperiodism in the regulation of flowering, emphasizing the control by phytochrome, cryptochrome.

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|---|---|---|---|---|---|
| Programme | **B. Sc. PLANT SCIENCE** | | | | |
| Course Code | **PLA7CJ404** | | | | |
| Course Title | **RECENT ADVANCES IN CELL AND MOLECULAR BIOLOGY** | | | | |
| Type of Course | **Major** | | | | |
| Semester | **VII** | | | | |
| Academic Level | **400 – 499** | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75 |
| Pre-requisites | Through knowledge in Cell and molecular biology | | | | |
| Course Summary | Introduction and detailed study of new techniques in cell and molecular biology | | | | |

**Course Outcomes:**

| COs | Statement | Knowledge Category | Cognitive level | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the principles and applications of single-cell RNA sequencing (scRNA-seq), highlighting its significance in biological and medical research | F | U | Internal Exam, Quiz, Discussion |
| CO2 | Acquire knowledge on the techniques for the isolation and purification of proteins and nucleic acids | P | An, E | Internal exam, Group work to analyse Practical skills |
| CO3 | Investigate adhesion-mediated signalling pathways and their association with various diseases | M | Ap, E | Lab visit, Discussion, Seminar |
| CO4 | Analyze the involvement of membrane dynamics in health and disease conditions | C | An | Quiz/ Exams, Seminars, Assignments |
| CO5 | Apply the concepts and techniques of cell and molecular biology in research and biotechnological advancements | P | Ap | Demonstrations, Seminars, Presentations, Lab work |
| CO6 | Understand advanced protein analysis techniques and their applications in protein research | M | U | Lab visit, Seminars, Practical skill enhancement methods |

* - 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) | Marks (70) |
|---|---|---|---|---|
| **I** | **Introduction to single cell Analysis** | | **9** | **10** |
| | 1 | Overview of single-cell RNA sequencing (scRNA-seq) and its applications. | 2 | |
| | 2 | Understanding heterogeneity in cell populations and its significance in biology and medicine. | 3 | |
| | 3 | Imaging –based single –cell analysis techniques | 2 | |
| | 4 | Data integration and analysis pipelines for single-cell data | 2 | |
| **II** | **Cell Membrane Dynamics** | | **9** | **13** |
| | 5 | Membrane protein trafficking and sorting-mechanism, regulation of membrane protein turnover and degradation | 2 | |
| | 6 | Membrane curvature generation and membrane remodelling proteins | 2 | |
| | 7 | Mechanism of membrane fusion: SNARE proteins and fusion complexes | 3 | |
| | 8 | Role of membrane fusion events in vesicle trafficking and organelle biogenesis | 1 | |
| | 9 | Membrane dynamics in health and disease | 1 | |
| **III** | **Cell Adhesion and Signal Transduction** | | **14** | **25** |
| | 10 | Introduction to cell adhesion; cell- cell interactions; cell-extracellular matrix interactions; ligand interactions | 2 | |
| | 11 | Molecules involved in cell adhesion- ICAM, NCAM, VCAM, PECAM, laminin, fibronectin, collagen; integrins, cadherins, catenins, α –actinin, selectins, cartilage-link proteins. | 3 | |
| | 12 | Junctional adhesion complexes- structure, composition and functions | 2 | |
| | 13 | Introduction to tight junctions. Adheren junctions, desmosomes and gap junctions | 2 | |
| | 14 | Overview of adhesion mediated signalling pathways- MAP kinase, JNK, ERK, P13K and TGF-β pathways and associated diseases | 2 | |
| | 15 | Overview of receptors and G-proteins, phospholipids signifying role of cyclic nucleotides, calcium calmodulin cascade | 3 | |

| | | | | |
|---|---|---|---|---|
| | 16 | Diversity in protein kinase and phosphates specific signaling mechanism, Secondary messengers. | | |
| **IV** | **Emerging Technologies** | | **13** | **22** |
| | 17 | Isolation and purification of nucleic acids, electrophoresis and quantification of nucleic acids. | 3 | |
| | 18 | DNA sequencing: Sanger's Dideoxy Method, Maxam and Gilbert method, High throughput sequencing, nuclear run-on assay, DNA synthesis, Chromatin remodelling | 4 | |
| | 19 | Isolation and purification of protein, Electrophoresis and quantification of proteins, Protein-nucleic acid interaction analysis, Protein-protein interaction analysis; ELISA, RIA. | 4 | |
| | 20 | Protein immunoprecipitation, Protein sequencing strategies, Radioactive isotope labelling, Mass spectrometry | 2 | |
| **V** | **Practical** | | **30** | **20** |
| | 1 | Demonstrate basic functionalities including data preprocessing, quality control, dimensionality reduction and clustering | | |
| | 2 | Guide students through quality control steps including filtering cells based on gene expression levels, removal of low-quality cells and detection of potential doublets | | |
| | 3 | Provide real –world examples of sc RNA-seq studies in biological and medical research | | |
| | 4 | Isolation and purification of nucleic acid / protein | | |
| | 5 | Demonstration of protein sequencing | | |
| | 6 | DNA sequencing using a suitable method | | |

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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | - | - | 2 | 1 |
| CO 2 | 1 | 3 | 2 | - | 3 | 2 | 3 | 2 | 3 | 1 | 3 | 2 |
| CO 3 | - | 3 | 1 | 2 | 3 | 2 | 3 | 3 | - | - | 2 | 3 |
| CO 4 | - | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | - | 2 | 3 |
| CO 5 | 2 | 3 | 2 | 2 | 3 | 3 | 3 | 1 | 3 | - | 3 | 2 |
| CO 6 | 3 | 2 | - | - | 3 | 2 | 3 | 2 | 1 | - | 3 | 2 |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | | | ✓ | |
| CO 6 | | | ✓ | |

**SEVENTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA7CJ404 - RECENT ADVANCES IN CELL AND MOLECULAR BIOLOGY**

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

## Section A

**(Answer All. Each question carries 3 marks. Ceiling 24 marks)**

1. Describe the importance of understanding heterogeneity in cell populations and its significance in biology and medicine.
2. Write notes on the importance of cadherins in cell adhesion.
3. Explain the concept scRNA-seq.
4. Discuss the mechanism of membrane fusion mediated by SNARE.
5. What is a NCAM.
6. What is the significance of mass spectrometry in cell and molecular biology.
7. What are G-Proteins?
8. Explain the procedure of protein isolation.
9. Discuss protein immunoprecipitation.
10. Explain ERK.

## Section B

**(Answer All. Each question carries 5 marks. Ceiling 36 marks)**

11. Discuss the mechanism of membrane fusion mediated by SNARE proteins and fusion complexes.
12. Explain the role of membrane fusion events in vesicle trafficking and organelle biogenesis.
13. Explain the data integration and analysis pipelines used for single-cell data in biological studies.
14. Describe the quantification techniques of proteins.
15. Provide an overview of adhesion-mediated signalling pathways.
16. Explain how membrane curvature is generated and the role of membrane remodelling proteins.
17. Explain different DNA sequencing methods.
18. Discuss the role of key molecules involved in cell adhesion.

## Section C

**(Answer any one. Each question carries 10 marks) (1 × 10 = 10 marks)**

19. Explain the diversity in protein kinase and phosphatase-specific signalling mechanisms involving receptors, G-proteins, and secondary messengers.
20. Describe the process of isolation and purification of nucleic acids, including electrophoresis and quantification techniques.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA7CJ405** | | | | |
| **Course Title** | **ENVIRONMENTAL TOXICOLOGY & MANAGEMENT, COMPUTATIONAL BIOLOGY AND STATISTICAL ANALYSIS** | | | | |
| **Type of Course** | **Major** | | | | |
| **Semester** | **VII** | | | | |
| **Academic Level** | **400 – 499** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75 |
| **Pre-requisites** | Through knowledge in Cell and molecular biology | | | | |
| **Course Summary** | Strong foundation on environmental studies, bioinformatics and biostatistics | | | | |

**Course Outcome:**

| COs | Statement | Cognitive level * | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Identify the effect of chemical contaminants on the functioning of life | U | F | Internal Exam, Group Discussion |
| CO2 | Experiment and analyse the toxicity induced by chemicals on plant/ animal system | Ap | P | Practical exam/ project/ Case study |
| CO3 | Analyse the relationship between environmental toxicology and carcinogenesis | An | M | Case study |
| CO4 | Learn the methods to manage environmental toxicity by monitoring through genetically microorganism, policies by Govt | U | C | Internal Exams, Seminars, Assignments<br>Case study |
| CO5 | Evaluate the role of biological data banks for protein structure prediction, drug designing, phylogenetic tree construction | E | M | Practical exam, assignment, Presentation |
| CO6 | Analyse data for goodness of fit | Ap | P | Solving problems |

* - 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) | Marks (70) |
|---|---|---|---|---|
| **I** | **Environmental Toxicology** | | **8** | **12** |
| | 1. | Environmental Toxicology-Toxic chemicals in the environment, Mode of entry of toxic substance, biotransformation of xenobiotics detoxification | 2 | |
| | 2 | Carcinogens in air, chemical carcinogenicity, mechanism of carcinogenicity, Environmental carcinogenicity testing | 2 | |
| | 3 | Insecticides, MIC effects, Concept of major, trace and Rare Earth Element (REE)- possible effects of imbalance of some trace elements | 2 | |
| | 4. | Biogeochemical factors in environmental health. Epidemiological issues goiter, fluorosis, arsenic poisoning. | 2 | |
| **II** | **Toxicology Management** | | **12** | **18** |
| | 5 | Environmental problems & Environmental monitoring through microorganism, Microbial Reactors, genetically modified microbes & their uses in Environmental toxicology management, Bioremediation, its role and significance. | 3 | |
| | 6 | Toxicological Information Sources. -The Agency for Toxic Substances and Disease Registry , U.S. Environmental Protection Agency, The Centers for Disease Control and Prevention, The Nuclear Regulatory Commission, The Food and Drug Administration, Electronic Databases | 2 | |
| | 7 | Toxicological risk assessment and management with reference to relevant case study. | 2 | |
| | 8 | Principles and significance of systematic toxicology.<br>Genotoxicology: Definition, Effects, molecular mechanisms and prevention. | 3 | |
| | 9 | Applications of toxicology anthropogenic activities and environment. Human toxicology and medicinal ethics. | 2 | |

| | | | | |
|---|---|---|---|---|
| **III** | **Computational biology** | | **15** | **25** |
| | 11 | Nature and scope of Computational Biology and Bioinformatics, Basic algorithms in Computational Biology, | 2 | |
| | 12 | Introduction to algorithms for dynamic programming approach. Genome Browsers, Bioinformatics Database search engines | 3 | |
| | 13 | Analysis of proteins: Protein classification, homology modelling, trading, prediction of protein structure (secondary and 3 dimensional), tools for structure prediction, validation and visualization. | 3 | |
| | 14 | Whole Genome Assembly and challenges, Sequencing and analysis of large genomes, Gene prediction, Functional annotation, NGS data analysis, Concept of Big data analysis | 3 | |
| | 15 | Applications -*In silico* Drug Design: Basic Concepts, importance and application, Methods of *In silico* Drug Design: Generating phylogenetic trees based on DNA sequence and evolutionary relationship . | 3 | |
| | 16 | Biopython: Introduction, important features and application of biopython in computational biology | 1 | |
| **IV** | **Statistical analysis of data** | | **10** | **15** |
| | 17 | Definition of random variable, density function, Basic concepts of binomial and normal distributions, Sampling measurement and distribution of attributes, | 3 | |
| | 18 | Mean deviations, coefficient of variance (CV), Standard deviations, skewness and kurtosis. | 2 | |
| | 19 | Test of hypothesis; Student t-test and paired t-test; chi square test; Probability distribution (normal, binominal and poison distributions), Simple Correlation and Regression, | 2 | |
| | 20 | Analysis of variance (ANOVA): one way and two-way classification | 2 | |
| | 21 | Introduction to statistical analysis softwares | 1 | |

| | | | | |
|---|---|---|---|---|
| | | SPSS, Origin | | |
| **V** | **Practical** | | **30** | **20** |
| | 1 | Any test to analyse environmental toxicity | | |
| | 2 | Visit to a plant where microbes are used for waste management and submit report | | |
| | 3 | Identification of gene characteristics using any tools and Visualization using software tools | | |
| | 4 | Demonstration of structure based drug design: Molecular docking | | |
| | 5 | Test the goodness of fit | | |
| | 6 | Hands on training on SPSS or any such software | | |

## References


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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | 3 | | 3 | 3 | 3 | | | | 3 |
| CO 2 | 3 | 3 | 3 | | 2 | 3 | 3 | 3 | | | 3 | 3 |
| CO 3 | 3 | | | 3 | 3 | 3 | 3 | 3 | 2 | | 3 | 3 |
| CO 4 | 3 | | | | 3 | 3 | 3 | 2 | 3 | | | 3 |
| CO 5 | 3 | 3 | 3 | 3 | | | 3 | 2 | 3 | 3 | 3 | |
| CO 6 | 3 | 3 | 3 | | 3 | | 3 | | 3 | 3 | 3 | |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| Cos | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| **CO 1** | ✓ | ✓ | | ✓ |
| **CO 2** | ✓ | ✓ | ✓ | ✓ |
| **CO 3** | ✓ | ✓ | | ✓ |
| **CO 4** | ✓ | ✓ | ✓ | ✓ |
| **CO 5** | ✓ | ✓ | ✓ | ✓ |
| **CO 6** | ✓ | ✓ | ✓ | ✓ |

**SEVENTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA7CJ405 – ENVIRONMENTAL TOXICOLOGY & MANAGEMENT, COMPUTATIONAL BIOLOGY AND STATISTICAL ANALYSIS**

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

**Section A**

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

1. What are the mode of entry of toxic substance?
2. Write a short note on Microbial Reactors
3. What is Monod equation of microbial growth kinetics ?
4. State the basic assumption is in ANOVA techniques
5. What is the significance of analysing standard deviation?
6. What are the important features and application of biopython?
7. What are scope of computational biology?
8. What are effects of trace elements in inducing toxic effect in organisms?
9. Methods of solid waste management
10. What are variants in experimental sampling?

**Section B**

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

11. Explain how microbial technology help in environmental protection.
12. Enumerate the role of data base in predicting protein structure.
13. Write a brief essay on biogeochemical factors in environmental health.
14. Explain the relationship between environmental toxicity and carcinogens
15. Briefly explain the challenges in whole genome sequencing and analysing large genome.
16. Write a note on basic concepts of binomial and normal distributions with suitable example
17. Discuss about simple correlation and regression.
18. Illustrate the method of testing data for goodness fitness.

**Section C**

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

19. Write an essay on the role of modelling in environmental sciences
20. Explain the applications of bioinformatics.

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| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA8CJ401/PLA8MN401** | | | | |
| **Course Title** | **CANCER GENOMICS, PROTEOMICS AND AND SYSTEM BIOLOGY** | | | | |
| **Type of Course** | **Major** | | | | |
| **Semester** | **VIII** | | | | |
| **Academic Level** | **400-499** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 3 | - | 2 | 75 |
| **Pre-requisites** | Basics of cell biology and genetics. | | | | |
| **Course Summary** | This course delves into the cellular mechanisms and types of cancer, diagnostic and treatment strategies, and cancer genomics and proteomics. Students will explore the roles of cancer suppressor genes, advanced cancer therapies, and databases. The curriculum also covers cancer immunology, emerging research trends, and personalized medicine approaches. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand different types and cellular mechanism of cancer | U | F | Test paper<br>Assignment |
| CO2 | Understand different methods of diagnosis and treatment strategies of cancer | U | F | Assignment<br>Presentation |
| CO3 | Analyse the role of cancer suppressor genes in carcinogens | An | C | Online tool |
| CO4 | Evaluate the causes and risk factors in cancer incidence | E | M | Case study/ field survey |
| CO5 | Review different cancer Genomics and Proteomics Databases | U | F | Presentation |
| CO6 | Learn advanced researches in cancer therapy | U | C | Assignment<br>test paper |

* - 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) | Marks (70+10) |
|---|---|---|---|---|
| **I** | **Introduction to Cancer Biology** | | **10** | **14** |
| | 1 | Causes and Risk Factors, Genetic basis of cancer, Environmental carcinogens, Lifestyle factors (diet, smoking, alcohol, etc.), Infectious agents (viruses, bacteria, etc.). | 1 | |
| | 2 | **Types of Cancer**: Solid Tumors-Breast cancer, Lung cancer, Colorectal cancer, Prostate cancer and Skin cancer. Hematologic Malignancies-Leukemia, Lymphoma, Multiple Myeloma. | 2 | |
| | 3 | **Cancer Staging and Grading:** TNM Staging System (T (Tumor), N (Nodes), M (Metastasis) categories). | 1 | |
| | 4 | **Cancer Prevention and Control:** Lifestyle modifications, Screening programs, Vaccination (e.g., HPV vaccine), Public health strategies. | 2 | |
| | 5 | **Cancer Diagnostic Techniques:** Liquid Biopsies and Non-Invasive Diagnostics, Circulating tumor DNA (ctDNA) and circulating tumor cells (CTCs). Methods for detecting and analyzing ctDNA. Clinical applications of liquid biopsies. | 3 | |
| | 6 | **Ethical and Societal Implications:** Healthcare disparities in cancer, Cost of cancer care, Patient rights and autonomy, Bioethical considerations. | 1 | |
| **II** | **Cancer Genomics** | | **12** | **20** |
| | 5 | Basics of Cell cycle and its regulation and Mutations (Point mutations, insertions, deletions, and copy number variations). Characteristics of cancer cells, Tumor Microenvironment. | 2 | |
| | 6 | Carcinogenesis: Initiation, promotion and progression, Genetic mutations and oncogenes, Tumor suppressor genes and their role in cancer development, Driver mutations vs. passenger mutations. DNA repair mechanisms, genomic instability and cancer progression. | 2 | |

| | | | | |
|---|---|---|---|---|
| | 7 | **Metastasis**: Mechanisms of cancer cell migration and invasion, Extravasation and establishment of metastatic lesions, Targeting metastasis for therapeutic interventions. | 2 | |
| | 8 | **Cancer Stem Cells**: Concept of cancer stem cells, Properties and markers of cancer stem cells, Implications for cancer therapy and recurrence. | 2 | |
| | 9 | **Epigenetics and Cancer**: Epigenetic modifications in cancer, Role of chromatin remodeling in gene expression, DNA methylation, histone modifications. Role of non-coding RNAs in cancer. Therapeutic targeting of epigenetic alterations. | 2 | |
| | 10 | **Apoptosis and Cancer**: Mechanisms of apoptosis, Apoptotic pathways in cancer cells, Therapeutic strategies targeting apoptosis. | 2 | |
| **III** | **Cancer Proteomics** | | **12** | **18** |
| | 11 | Introduction to Proteomics, Proteomics and its significance in cancer research. Proteomic Technologies (Mass spectrometry, Protein microarrays, Gel-based proteomics). Protein Expression Profiling, Post-Translational Modifications (PTMs) and cancer. | 2 | |
| | 12 | Protein-Protein Interactions (co-immunoprecipitation, yeast two-hybrid, and FRET.), Biomarker Discovery, Clinical Applications (Early detection and monitoring of cancer, Personalized medicine and targeted therapy). | 2 | |
| | 13 | Role of proteomics in understanding drug resistance. Single-Cell Proteomics (Techniques and Applications). Combining proteomic data with genomic, transcriptomic, and metabolomic data. | 2 | |
| | 14 | **Cancer Genomics and Proteomics Databases:** The Cancer Genome Atlas (TCGA), Catalogue of Somatic Mutations in Cancer (COSMIC), International Cancer Genome Consortium (ICGC). | 3 | |
| | 15 | CPTAC (Clinical Proteomic Tumor Analysis | 3 | |

| | | | | |
|---|---|---|---|---|
| | | Consortium), PRIDE (PRoteomics IDEntifications Database), CanProVar (Cancer Proteome Variation Database). | | |
| **IV** | **Cancer Immunology** | | **11** | **18** |
| | 16 | Innate and adaptive immune responses to cancer, Tumor antigens and immune surveillance, Mechanisms of immune evasion by tumors. Immune evasion mechanisms in cancer. Genomic features of tumor-immune interactions. | 3 | |
| | 17 | **Cancer Immunotherapy**: Immunotherapy approaches for cancer treatment, Checkpoint inhibitors, CAR-T cells, vaccines and adoptive cell therapies. | 3 | |
| | 18 | **Cancer Neoantigens**: Definition and types of neoantigens, Identification and characterization of neoantigens, Neoantigen-based personalized cancer vaccines. | 1.5 | |
| | 19 | **Emerging Trends and Research Advances:** Cell Genomics and Spatial Transcriptomics, Single-cell RNA sequencing (scRNA-seq). Applications of single-cell genomics in cancer research. | 2 | |
| | 20 | Precision medicine, Immunotherapy breakthroughs, Nanotechnology in cancer treatment. Clinical implications for personalized medicine. | 1.5 | |
| **V** | **Practical** | | **30** | **20** |
| | 1 | Visit home pages of genomics and proteomics database | | |
| | 2 | Karyotype study of cancer cells and normal cell | | |
| | 3 | Case study- field study on the causes and incidence of cancer in local community | | |

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15. Timothy Veenstra and John Yates, 2006. Proteomics for Biological Discovery. Wiley-Interscience

**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | 1 | | 1 | | 3 | | | | 1 | |
| CO 2 | 3 | | | 2 | 2 | | 3 | 2 | 1 | | 1 | |
| CO 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 2 | | 3 | 2 | 2 |
| CO 4 | 3 | 3 | | 3 | 3 | | 3 | 3 | | | 2 | |
| CO 5 | 3 | 2 | 2 | 2 | | | 3 | 2 | | 3 | | |
| CO 6 | 3 | | 2 | | 2 | | 3 | | 1 | | 2 | |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| COs | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| **CO 1** | ✓ | ✓ | | ✓ |
| **CO 2** | ✓ | ✓ | | ✓ |
| **CO 3** | ✓ | ✓ | | ✓ |
| **CO 4** | ✓ | ✓ | | ✓ |
| **CO 5** | ✓ | ✓ | ✓ | ✓ |
| **CO 6** | | | | ✓ |

**EIGHTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA8CJ401/PLA8MN401 - CANCER GENOMICS, PROTEOMICS AND IMMUNOLOGY**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

**SECTION A**

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. What lifestyle factors are associated with an increased risk of cancer??
2. How do mutations in cell cycle regulators contribute to cancer development?
3. What are the main proteomic technologies used in cancer research?
4. What are tumor-associated antigens (TAAs) and tumor-specific antigens (TSAs)? Provide examples of each.
5. What is FRET and its application in proteomics?
6. What are copy number variations (CNVs), and how do they relate to cancer?
7. How do natural killer (NK) cells recognize and kill tumor cells?
8. Explain the significance of circulating tumor DNA (ctDNA) and circulating tumor cells (CTCs) in cancer detection.
9. What is the role of nanotechnology in cancer treatment?
10. Describe the Clinical Proteomic Tumor Analysis Consortium (CPTAC).

**SECTION B**

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. What techniques are used to study protein-protein interactions in cancer research?
12. How do cancer cells establish metastatic lesions in new tissues? What are therapeutic strategies to target metastasis?
13. How do hematologic malignancies like leukemia, lymphoma, and multiple myeloma differ from solid tumors in terms of pathology and treatment?
14. How does personalized medicine differ from traditional cancer treatment approaches? Comment on the ethical considerations in the use of personalized medicine for cancer.
15. What are cancer stem cells, and how do they differ from other cancer cells? Comment on markers of cancer stem cells.
16. What are single-cell proteomics and its applications in cancer research?
17. What are epigenetic modifications, and how do they influence cancer?
18. Discuss about tumor antigens and immune surveillance.

**SECTION C**

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. Compare and contrast the different immunotherapy approaches for cancer treatment, including checkpoint inhibitors, CAR-T cell therapy, cancer vaccines, and adoptive cell transfer. What are the strengths and limitations of each approach?
20. Discuss how cancer cells evade apoptosis and the implications for cancer progression. Evaluate therapeutic strategies designed to induce apoptosis in cancer cells.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA8CJ402/PLA8MN402** | | | | |
| **Course Title** | **INTELLECTUAL PRPERTY RIGHTS AND PATENTING** | | | | |
| **Type of Course** | **Major** | | | | |
| **Semester** | **VIII** | | | | |
| **Academic Level** | **400 – 499** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | | 60 |
| **Pre-requisites** | Basic knowledge of general principles of law, especially related to property and contracts; technological innovations and processes relevant to patenting. | | | | |
| **Course Summary** | This course provides a comprehensive understanding of Intellectual Property Rights (IPR), covering various types of intellectual property, their legal frameworks, management strategies, and the impact of IPR on innovation and business. The course aims to equip students with the knowledge and skills necessary to navigate the complex landscape of intellectual property in both national and international contexts. | | | | |

**Course Outcome:**

| Cos | Statement | Cognitive level | Knowledge Category | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the fundamental concepts and types of intellectual property rights. | U | F | Internal Exam, Group Discussion |
| CO2 | Analyze the legal frameworks governing intellectual property rights at national and international levels. | An | C | Practical exam/ project/ Case study |
| CO3 | Evaluate the role and importance of intellectual property in promoting innovation and economic growth. | E | M | Case study, Internal exam |
| CO4 | Develop strategies for managing and protecting intellectual property assets. | C | P | Internal Exams, Seminars, Assignments |
| CO5 | Examine case studies on intellectual property disputes and their resolutions. | E | M | Practical exam, assignment, Presentation |
| CO6 | Apply knowledge of intellectual property rights in various professional and business scenarios. | Ap | P | Solving problems, Practical Exam, 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 (60) | Marks (70) |
|---|---|---|---|---|
| **I** | **Overview of Intellectual property Rights** | | **10** | **12** |
| | 1 | Definition and overview of intellectual property right (IPR). History and Evolution of IPR | 2 | |
| | 2 | Meaning of property, Origin, Nature, Meaning of Intellectual Property Rights | 2 | |
| | 3 | Kinds of Intellectual property rights—Copy Right, Patent, Trade Mark, Trade Secret and trade dress, Design, Layout Design, Geographical Indication, Plant Varieties and Traditional Knowledge | 3 | |
| | 4 | International Organizations and Agreements: WIPO, TRIPS, Paris Convention, Berne Convention; IPR in India – Genesis and development. Some important examples of IPR. | 3 | |
| **II** | **Patents and Copyrights** | | **15** | **18** |
| | 5 | Origin, definition of Patent, Types of patents | 3 | |
| | 6 | Registration Procedure, Rights and Duties of Patentee, Assignment and licence, Restoration of lapsed Patents, Patent document | 2 | |
| | 7 | Surrender and Revocation of Patents, Infringement, Remedies & Penalties | 2 | |
| | 8 | Type of inventions protected by a patent; Inventions which are not patentable, Macro-economic impact of the patent system in India | 3 | |
| | 9 | Origin, Definition &types of Copy Right, What is covered by copyright? How long does copyright last | 2 | |
| | 10 | Registration procedure, Assignment & licence, Terms of Copyright; Piracy, Infringement, Remedies, Copy rights with special reference to software | 3 | |
| **III** | **Trademarks & Industrial Designs** | | **15** | **25** |
| | 11 | Origin, Meaning & Nature of Trade Marks, Types | 2 | |
| | 12 | Registration of Trade Marks, Infringement & Remedies, Offences relating to Trade Marks, Passing Off, Penalties; Domain Names on cyber space. | 3 | |
| | 13 | Industrial Designs: Definition, types, Registration of Design, Cancellation of Registration | 3 | |
| | 14 | International convention on design, functions of Design.<br>Semiconductor Integrated circuits and layout design Act-2000. | | |

| | | | | |
|---|---|---|---|---|
| **IV** | **Biotechnology and IPR** | | **10** | **15** |
| | 15 | Rationale for Intellectual Property Protection in biotechnology; Concept of Novelty in Biotechnological Inventions. Concept of Inventive Step in Biotechnological Inventions. | 3 | |
| | 16 | Microorganisms as Biotechnological Inventions. Patenting biological inventions. Patenting microorganisms. | 2 | |
| | 17 | Patenting other biological processes and products. Protection of new varieties of plants. | 2 | |
| | 18 | Justification for Protection. Biotechnology and International Treaties such as Convention on Biological Diversity and TRIPs. | 2 | |
| **V** | **Open ended** | | **10** | **10** |
| | 1 | Case Study Analysis: Review and present case studies on intellectual property disputes and their outcomes. | | |
| | 2 | Conduct a mock intellectual property audit for a hypothetical business | | |
| | 3 | Patent Search and Analysis: Perform a patent search in a specific field and analyze the findings. | | |
| | 4 | Develop a strategy for protecting and managing intellectual property for a startup company. | | |
| | 5 | Prepare an application for patent, copyright or industrial design for a hypothetical business | | |
| | 6 | Visit to an institute related to patenting, copyrights and industrial design. | | |

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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | 2 | | 3 | 3 | 3 | | | | 3 |
| CO 2 | 3 | 3 | | 2 | | 3 | 3 | 3 | | | | 3 |
| CO 3 | 3 | | | | | 2 | 3 | | | | | 2 |
| CO 4 | 3 | 3 | 2 | | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 |
| CO 5 | 3 | | 3 | 3 | 3 | 3 | 3 | 2 | | 2 | 3 | 3 |
| CO 6 | 3 | 3 | 3 | | 3 | 3 | 3 | | 3 | | 3 | 3 |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| COs | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| **CO 1** | ✓ | ✓ | | ✓ |
| **CO 2** | ✓ | ✓ | ✓ | ✓ |
| **CO 3** | ✓ | ✓ | | ✓ |
| **CO 4** | ✓ | ✓ | ✓ | ✓ |
| **CO 5** | ✓ | ✓ | ✓ | ✓ |
| **CO 6** | ✓ | ✓ | ✓ | ✓ |

**EIGHTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA8CJ402/PLA8MN402 – INTELLECTUAL PRPERTY RIGHTS AND PATENTING**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## Section A

**(Answer All. Each question carries 3 marks. Ceiling 24 marks)**

1. Define intellectual property rights (IPR) and explain their importance.
2. What are the main types of intellectual property rights?
3. Briefly describe the historical evolution of IPR.
4. What is the role of the World Intellectual Property Organization (WIPO)?
5. Explain the concept of patents and their types.
6. What is copyright? How long does it last?
7. Differentiate between a trademark and a trade secret.
8. What is the Paris Convention, and why is it important in IPR?
9. Describe the process of patent registration.
10. What are geographical indications and how do they benefit local communities?

## Section B

**(Answer All. Each question carries 5 marks. Ceiling 36 marks)**

11. Discuss the rights and duties of a patentee.
12. Explain the registration procedure for trademarks and the remedies available for trademark infringement.
13. Analyze the economic impact of the patent system in India.
14. Describe the types of inventions that are not patentable.
15. Discuss the significance of the Berne Convention in the context of copyright.
16. Explain the process and importance of industrial design registration.
17. What are the challenges in protecting biotechnological inventions through patents?
18. Describe the concept of plant variety protection and its relevance in agriculture.

## Section C

**(Answer any one. Each question carries 10 marks) (1 × 10 = 10 marks)**

19. Critically evaluate the role of international agreements like TRIPS in shaping national IPR policies. Provide examples to support your argument.
20. Discuss the ethical and legal implications of biopiracy and the measures taken to prevent it, with a focus on traditional knowledge and indigenous resources.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA8CJ403/PLA8MN403** | | | | |
| **Course Title** | **RESOURCE MAPPING & CONSERVATION BIOLOGY** | | | | |
| **Type of Course** | **Major** | | | | |
| **Semester** | **VIII** | | | | |
| **Academic Level** | **400 - 499** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | | 60 |
| **Pre-requisites** | Prerequisites for this course include a basic understanding of biology, environmental science, geography, and mathematics. | | | | |
| **Course Summary** | This course offers a comprehensive idea of natural resources, remote sensing, GIS, resource mapping, and conservation biology. Through an in-depth study of remote sensing and GIS technologies, students acquire practical skills in data analysis, mapping, and spatial modeling for various applications in environmental sciences. Practical sessions and field visits complement theoretical learning, enhancing students' understanding and application of course concepts. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| **CO1** | **Describe** the classification, conservation strategies, and sustainable management of various natural resources in India. | U | F | Written assignments, Classroom discussions |
| **CO2** | **Analyze** the impact of land use practices such as agriculture, mining, and soil erosion on the environment, and propose control measures. | An | C | Case study analyses, Group projects |
| **CO3** | **Explain** the principles of remote sensing and GIS, and their applications in resource management and environmental planning. | U | C | Quizzes, Written exams |
| **CO4** | **Interpret** spatial data for various geoscience applications using software tools | Ap | P | Practical demonstrations, Laboratory exercises |
| **CO5** | **Evaluate** the role of conservation biology in preserving biodiversity through species and ecosystem conservation methods. | E | C | Research projects, Presentations |
| **CO6** | **Apply** conservation biology principles and legal frameworks to real-world scenarios, considering socioeconomic factors and indigenous knowledge. | Ap | P | Field studies, Written 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 (60) | Marks (70) |
|---|---|---|---|---|
| **I** | **Natural Resources** | | **15** | **20** |
| | 1 | Definition of Natural resources; Classification of natural resources based on utility potential. Water resources and water conservation Strategies in India - Watershed management | 3 | |
| | 2 | Land resources in India - Agriculture: Types and cropping patterns; Mining, Quarrying and their impacts; soil erosion: causes, types, impacts - Control measures. . | 4 | |
| | 3 | Energy Resources and Conservation: Definition, classification; Conventional: Fossil fuels, Nuclear energy and their impacts. Non-conventional: Solar, Wind, Tidal, Micro-hydel, Ocean, Thermal, Geothermal. | 4 | |
| | 4 | Forest Resources: Types of Forests - Impacts of Deforestation; Minor forest Products; Forest based Industries; Forest conservation: Social Forestry – Agro-forestry - Sacred Groves - Joint forest Management. | 4 | |
| **II** | **Remote Sensing & GIS** | | **15** | **20** |
| | 1 | Remote Sensing: definitions and principles; electromagnetic spectrum; interaction of EMR with Earth's surface; spectral signature; satellites and sensors; aerial photography and image interpretation. | 4 | |
| | 2 | Geographical Information Systems: definitions and components; spatial and non-spatial data; raster and vector data; database generation; database management system. | 4 | |
| | 3 | Overview of GIS software packages; GPS survey, data import, processing, and mapping. | 3 | |
| | 4 | Applications and case studies of remote sensing and GIS in geosciences, water resource management, land use planning, forest resources, agriculture, marine and atmospheric studies. | 4 | |
| **III** | **Resource Mapping** | | **10** | **15** |
| | 1 | Overview of resource mapping. Historical context and significance. Basic Concepts in Cartography. Map types and elements. Coordinate systems and projections | 3 | |

| | | | | |
|---|---|---|---|---|
| | 2 | Mapping Natural Resources. Land cover and land use mapping. Mapping water resources. | 2 | |
| | 3 | Advanced GIS Techniques - 3D mapping & visualization, Spatial modelling. Infrastructure mapping, Mapping urban areas | 3 | |
| | 4 | Applications of Resource Mapping, Environmental management. Resource planning and policy. | 2 | |
| **IV** | **Conservation Biology** | | **10** | **15** |
| | 1 | History and scope of conservation biology. Methods for measuring biodiversity. Extinction and its consequences. Species Conservation - Species recovery plans, Captive breeding and reintroduction programs. | 4 | |
| | 2 | Ecosystem and Landscape Conservation - Ecosystem services. Conservation in Practice: Protected Areas. Biodiversity and Conservation Outside Protected Areas - Community-based conservation. | 3 | |
| | 3 | Human Dimensions of Conservation - Socioeconomic factors, Indigenous knowledge and conservation. Policy and Legislation - International conservation agreements, National laws and policies. | 3 | |
| **V** | **Open ended** | | **10** | **10** |
| | 1 | Visit a laterite/granite quarry nearby and study the impact caused by it. Prepare a report. | | |
| | 2 | Visit a natural forest/ sacred grove/protected areas nearby, conduct biodiversity studies and report. | | |
| | 3 | Familiarize GIS tools such as Google Earth, QGIS, MapInfo etc | | |
| | 4 | Visit research organizations such as KFRI, IRTC, CWRDM etc to familiarize various GIS & Remote Sensing tools | | |

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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | 2 | | 2 | 3 | | | | | |
| CO 2 | 3 | 3 | 2 | 2 | | 2 | 3 | 2 | | | 2 | |
| CO 3 | 3 | | | | | 2 | 3 | | | | | |
| CO 4 | 3 | 3 | | | | 2 | 3 | | | 3 | | |
| CO 5 | 3 | | | 2 | 2 | 3 | 3 | | | | 2 | 3 |
| CO 6 | 3 | 3 | 2 | | 2 | 3 | 3 | 2 | 2 | | | |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | | | ✓ | |
| CO 6 | | | ✓ | |

**EIGHTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA8CJ403/PLA8MN403 - RESOURCE MAPPING & CONSERVATION BIOLOGY**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Define natural resources and discuss their classification based on utility potential.
2. Explain the strategies for water conservation in India with a focus on watershed management.
3. Describe the types of land resources in India.
4. Discuss the impacts of mining, quarrying, and soil erosion, along with control measures.
5. Define energy resources and conservation. Differentiate between conventional and non-conventional energy resources, citing examples.
6. Discuss the types of forests in India and the impacts of deforestation.
7. Mention minor forest products and the importance of forest conservation methods.
8. Comment on the significance of social forestry, agro-forestry, and sacred groves in forest conservation.
9. Describe the basic concepts in cartography and map types.
10. Discuss the advanced GIS techniques such as 3D mapping, spatial modeling, and infrastructure mapping.

## SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

9. Describe the interaction of electromagnetic radiation with Earth's surface in remote sensing. Explain spectral signature and the role of satellites and sensors.
10. Differentiate between raster and vector data in GIS. Discuss the process of database generation and management.
11. Provide examples of applications and case studies of remote sensing and GIS in various fields such as geosciences, water resource management, and agriculture.
12. Discuss the importance of mapping natural resources, focusing on land cover, land use, and water resources mapping.
13. Explain the applications of resource mapping in environmental management and resource planning.
14. Define conservation biology and discuss methods for measuring biodiversity.
15. Explain the concept of ecosystem services and discuss conservation practices in protected areas.
16. Describe the human dimensions of conservation, including socioeconomic factors and policy and legislation.
17. What is extinction? Describe its causes and consequences.
18. Explain the various non-conventional energy resources.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. Write an essay on the role of GIS and remote sensing in environmental conservation.
20. Discuss the challenges and opportunities in the sustainable management of natural resources in India.

**UNIVERSITY OF CALICUT**

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA8CJ489** | | | | |
| **Course Title** | **RESEARCH METHODOLOGY** | | | | |
| **Type of Course** | **Major** | | | | |
| **Semester** | **VIII** | | | | |
| **Academic Level** | **400 - 499** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | | 60 |
| **Pre-requisites** | Students should have Higher Secondary Level knowledge in Cell Biology and Molecular Biology. | | | | |
| **Course Summary** | Course aims to provide students with a comprehensive understanding of cell biology and molecular biology, equipping them with the knowledge and skills necessary to explore advanced topics in biological sciences and related fields. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO 1 | Understand the basics concept of research methodology | U/R | F | Instructor-created exams / Quiz |
| CO 2 | Understand the method of literature collection, data collection, Various research methods. | U/R | C | Practical Assignment / Observation of Practical Skills |
| CO 3 | Compare and analysis different methods of data collection and statistical analysis tools. | Ap | P | Seminar Presentation/ software demonstration |
| CO 4 | Prepare research project proposal | An/E | M | Proposal preparation |
| CO 5 | Practice computer applications Scientific search engines. PDF and Latex files. MS WORD: Test formatting, Math Type, MS Equation editor, e-journals, e-library, | Ap | M | Lab demonstration and lab exam |
| CO 6 | Understand and analyse the ethical issues and concerns in Scientific research | U/An | M | Assignment/ Seminar? 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 (60) | Marks (70) |
|---|---|---|---|---|
| I | | **Introduction to Research Methods** | **14** | **20** |
| | 1 | Definition of research, role and objectives of research, applications and types of research, research process and steps in it.conceptualization and Formulation of a research problem, identifying variables, constructing hypothesis, Synopsis | 3 | |
| | 2 | Topic selection - Planning research, Preparation of work plans. Identification of suitable methodology - Preparation of project proposal. | 3 | |
| | 3 | Research Design: need for research design, features of a good research design, different research designs (exploratory, descriptive experimental and diagnostic research). | 3 | |
| | 4 | Variables and Their Types- Definition, Continuous, Discrete Variable, Dependent and Independent Variable, Controlled, Confounding, Intervening, Extraneous and Organismic variable. | 2 | |
| | 5 | Formulation of Hypothesis: Definition and Nature of Hypothesis. Functions, importance,Forms of hypothesis.Directional Hypothesis,non –directional hypothesis (Null Hypothesis).Difficulties in the Formulation of Useful Hypothesis | 3 | |
| II | | **Collection of literatures and research methods** | **10** | **12** |
| | 6 | Design of Sample Survey: Census V/s Sample enumerations, objectives and principles of sampling, Types of Sampling Designs/Methods of Sampling Sampling and Non-sampling,errors. Designing Questionnaires and interview. | 3 | |
| | 7 | Determination of the sample size. Primary & secondary data, Validity and Reliability of data collection procedures. Collection sources of literatures-News articles – | 3 | |

| | | | | |
|---|---|---|---|---|
| | | Newsletters – Magazines – Books – Journals.Digital library and search of articles - Keywords and search - Internet – Google Scholar – PubMed – Inflibnet – Medline – Agricola – Science direct -Open access Journals - virtual sources – other sources. Short communications –review articles | | |
| | 8 | Research Methods: Characteristics and approaches of historical research methods. Collection of protocols and selection of suitable methods according to work plan. Observational, descriptive and experimental methods. | 2 | |
| | 9 | Measurement of Scaling Concepts: Scales of measurements, nominal, ordinal, internal and ratio scales, Errors in measurements. Validity and Reliability in measurement, Scale Construction Techniques. | 2 | |
| **III** | **Result analysis and conclusion** | | **14** | **20** |
| | 10 | Data Collection & Analysis: Primary & secondary data, Validity and Reliability of data collection procedures, data preparation, exploratory data analysis, parametric and nonparametric tests, correlation and regression analysis, ANOVA, Multivariate Techniques | 3 | |
| | 11 | Data analysis – Construction of tables – headings - footer - Tabulation – Presentation of results - Use of statistical software to analyze the results- SPSS, R software. Discussion of Results based on literature – Arriving at conclusions – Preparation of Summary/abstract – Arrangement of Bibliography and how to quote reference in thesis – Appendix. | 3 | |
| | 12 | Report Writing: Discussions, Conclusion, referencing and various formats for reference writing, Bibliography, Thesis Writing, Thesis writing. | 2 | |
| | 13 | Formats of publications in research journals including subject classification, Impact factor, Citation index.Oral Presentations. Poster Presentations. Writing project proposals to funding agencies. Constructing Research Questions, Methods: FINER criteria, PICOT criteria | 3 | |
| | 14 | Computer Applications: Data Communication and networks, LAN, WAN, GAN, Internet, Website, Webpage, E-mail, Search Engines, Scientific search engines. PDF | 3 | |

| | | | | |
|---|---|---|---|---|
| | | and Latex files. MS WORD: Test formatting, Math Type, MS Equation editor, e-journals, e-library, Scopus, Central blatt Math, Mathematical reviews. | | |
| **IV** | **Publications and Ethics in research** | | **12** | **18** |
| | 15 | Publishing of Articles in newspapers /newsletters - Selection of journals – ISSN Number – Peer reviewed Journals – Science citation index – impact factor and importance. Manuscripts preparation for Journals – components. | 3 | |
| | 16 | Bioethics, Scientific misconduct, Ghost writing, Ethical Guidelines for animal subjects. Media ethics in science, Ethics in reporting research: data errors & plagiarism. Checking documents for plagiarism; Conflict of Interest (COI) in academic publishing- Submission, reprints and pdf formats. | 3 | |
| | 17 | Safety in the laboratory: Biosafety level (BSL), Occupational safety and Health (OSH), General Safety and lab-safety procedures, Chemical, electrical and UVsafety, safe handling of toxic and hazardous chemicals, storage and disposal of chemicals. | 3 | |
| | 18 | Intellectual Property (IP): An overview of Intellectual property protection (IPP) and Intellectual property rights (IPR); copyright, copyleft, indigenous intellectual property, brand protection, patent, trademark, license, intellectual property infringement. IPR in biological science | 3 | |
| **V** | **Open ended** | | **10** | **10** |
| | Research report/Proposal writing<br>Software demonstration and hands on training on statistical tools<br>Lab safety case study<br>IPR- case study in Plant resources<br>Hands on training in computer applications and programmes-word, excel, Latex | | | |

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**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO 6 | PO 1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | | | 3 | | | | | |
| CO 2 | 3 | | | 3 | | | 3 | 3 | | | | |
| CO 3 | 3 | | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | |
| CO 4 | 3 | | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | |
| CO 5 | 3 | | 3 | 3 | 2 | 3 | 3 | 3 | 2 | | 3 | 2 |
| CO 6 | 3 | 3 | | | 3 | 3 | 3 | | 3 | 3 | | |

**Correlation Levels:**

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

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examina-tions |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | ✓ | ✓ |
| CO 2 | ✓ | ✓ | ✓ | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | | ✓ | ✓ | ✓ |
| CO 6 | ✓ | ✓ | ✓ | ✓ |

**EIGHTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA8CJ489 - RESEARCH METHODOLOGY**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

**SECTION A**

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Comment on INFLIBNET.
2. Wha is synopsis?
3. Add notes on thesis writing.
4. Compare and contrast FINER and PICOT criteria?
5. Delineate result analysis methods.
6. What is the implication of ISSN number of a journal?
7. Review the term bioethics.
8. Explain the purpose and importance of peer reviewing in the publication process?
9. Evaluate the significance of data communication and networking in research.
10. What do you understand by BSL measures?

**SECTION B**

**(Answer all questions. Each question carries 5 marks. Ceiling: 36 Marks)**

11. Discuss on major IPRs involved in research.
12. Explicate the formats for reference writing
13. Reflect on various parametric and nonparametric tests
14. Elucidate the various types of statistical software.
15. Explore the factors involved in the construction of a research plan.
16. Compare Medline and Agricola data base.
17. Analyse the role of discussion in research.
18. Explain the construction and components of manuscripts.

**SECTION C**

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. "'Research Design' is planning a strategy or drawing a blue print of conducting research."- Substantiate.
20. "The duty of review of literature is to note what counts and to light up what i**s** suited to the light." Analyse the sentence with considering the importance of literature review in research.

# ELECTIVE COURSES IN B. Sc PLANT SCIENCE WITH NO SPECIALISATION

**UNIVERSITY OF CALICUT**

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA5EJ301** | | | | |
| **Course Title** | **MICROBIAL TECHNOLOGY** | | | | |
| **Type of Course** | **Elective** | | | | |
| **Semester** | **V** | | | | |
| **Academic Level** | **300 - 399** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 |
| **Pre-requisites** | Higher secondary level biology course | | | | |
| **Course Summary** | Introduction to microbes. Detailed study of microbial techniques and applications | | | | |

**Course Outcomes**

| CO | CO Statement | Cognitive level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | **Define** basic concepts and processes of microbes | U | F | Assignment, Test Paper |
| CO2 | **Describe** microbial characters | U | F | Test Paper, Presentation |
| CO3 | **Explain** microbial growth and growth requirements | U | F | Test Paper, Presentation |
| CO4 | **Demonstrate** techniques of microbial culturing | Ap | P | Lab demo, presentation |
| CO5 | Discuss the applications of microbial biotechnology in environmental protection | F | C | Group discussion, presentation |
| CO6 | List the advances in industry by Microbial biotechnology | An | C | Assignment, Presentation, Test paper |

* - 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 (60) | Marks (70) |
|---|---|---|---|---|
| **I** | **Concepts in microbiology** | | **13** | **20** |
| | 1 | Prokaryotes and eukaryotes. Organization and classification of microorganisms. Viruses, structure, classification, multiplication. | 2 | |
| | 2 | Bacterial cell structure (shape, cell associated structures like flagellum, pili, cell wall structure and composition, plasma membrane, cell inclusions, capsule, endospore), bacterial reproduction. | 2 | |
| | 3 | Brief account of fungi, hyphal structure and organelles, classification). Developments in microbiology, scope of microbiology | 1 | |
| | 4 | Microbial growth, nutrition, effect of environmental conditions on growth, modern concepts of bacterial nutrition, nutritional categories. | 2 | |
| | 5 | Growth media, continuous culture, diauxic, synchronous growth cultures and anaerobic cultures. Growth regulators (chemical and physical), antibiotic sensitivity tests. | 2 | |
| | 6 | Account of microbial genetics (recombination, transformation, conjugation, transduction. concept of operon, induction, repression, catabolite repression). | 2 | |
| **II** | **Food processing and fermentation technology** | | **12** | **20** |
| | 7 | General principles of food preservation, Processing of vegetables and fruits (sauerkraut, pickles, jam, jellies, marmalades, juices, syrups, ketchups); Cereal products (Soya sauce, miso, tempeh. idli, dosa, bread, cakes); meat, egg and fish products. Processing of milk and milk products. | 3 | |
| | 8 | Food Additives: nutrients, antimicrobial agents, antioxidants, flavoring agents, sweetners, colours, emulsifiers, enzymes, polysaccharides and other miscellaneous food additives. Cleaning and disinfection methods. | 3 | |
| | 9 | History of fermentation. Introduction to fermentation | 3 | |

| | | | | |
|---|---|---|---|---|
| | | process, Gaden's Fermentation classification, Design and operation of Fermenters, Basic concepts for selection of a reactor. Types of reactors (brief account of Packed bed reactor, Fluidized bed reactor, Trickle bed reactor, Bubble column reactor) | | |
| | 10 | Microbiological and food enzymes that cause food spoilage, | 1 | |
| | 11 | Application of enzym1e in food industries: enzymes in milk and cheese industry, baking industry, alcoholic beverages (wine and beer) and fruit juices, | 1 | |
| | 12 | starch and sugar industries, antibiotic and steroid production, enzyme therapy, enzymes in biosensors | 1 | |
| **III** | **Environmental biotechnology and waste recycling** | | **15** | **20** |
| | 13 | Microbiology of cellulose and lignin degradation. Biotechnological potential of microbial lingo-cellulolytic enzymes, white-rot, brown-rot, and soft-rot type fungal degradation. Brief account of microbial degradation of pectin and hemicellulose with their potential applications. | 3 | |
| | 14 | Microbial Insecticides: *Bacillus thruingensis*. The concept of endotoxins and cry genes, Baculoviruses. Baculoviruses as potential insecticides. | 2 | |
| | 15 | Bacterial leaching from ores, recovery of copper by direct and indirect leaching, uranium leaching using microbes. | 2 | |
| | 16 | Ecological aspects of biodeterioration. Treatment of liquid waste: activated sludge process, waste stabilization ponds, anaerobic fixed film systems, anaerobic degradation of toxic and hazardous wastes. | 3 | |
| | 17 | Waste recycling in agriculture: composting, recycling of crop residues, recycling of rural and urban wastes through conventional and vermicomposting commercial scale technology for organic fertilizer from waste. | 2 | |
| | 18 | Testing for biodegradability, biomagnification, bioremediation, efficacy testing, side effect testing. | 1 | |
| | 19 | Environmental modification for bioremediation. Microbial seeding, agents used for bioremediation, bioremediation of pesticides. | 2 | |

| | | | | |
|---|---|---|---|---|
| **IV** | **Advances in industrial microbiology** | | **10** | **10** |
| | 20 | Strain development by mutagenesis, protoplast fusion and transformation of cloned genes. | 2 | |
| | 21 | Recombinant protein expression with *E. coli* and fermentation. Expression in yeast *Pichia pastoris*, production of recombinant vaccines, purification of recombinant proteins. | 3 | |
| | 22 | Important microbial products and technology for production of alcoholic beverages, microbial biomass lovastatin and related polyketides. General account of biotransformation, immobilization of enzymes and its industrial and medical applications. Treatment of industrial effluents using activated sludge and anaerobic treatment options. | 5 | |
| V | **Open ended** | | **10** | **10** |

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1. Stanier, R.Y. Adelberg, E.A., Ingraham, J.L. 1984. General Microbiology, IV edn. Mac Millan Press.
2. Pelczar, M.J., Chan, E.C.S., Krieg, N.R. 1986. Microbiology, V Ed. Mc 3. Graw Hill.
3. Prescott. L.M., Harley J.P.L., Kreig, D.A. 1990. Microbiology, WCB Publishers.
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5. Biely, J.E., Ollis D.F. 1986. Bio Chemical Engineering Fundamentals. Megraw Hills.
6. Whitaker, A. 1984. Principles of Fermentation Technology Pergamon Press.
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10. agriculture. Fertilizer development and consultation organization New Delhi, India.
11. Wesley E.W. 1989. Industrial waste pollution control. McGraw Hill Inc. U.S.A.

**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | | | 3 | | | | | |
| CO 2 | 3 | | | 3 | | | 3 | 3 | | 1 | | |
| CO 3 | 3 | | | 3 | | | 3 | 3 | | 1 | | |
| CO 4 | 3 | 2 | | 3 | 1 | | 3 | 3 | 2 | 1 | 2 | 2 |
| CO 5 | 3 | | | 3 | 2 | 3 | 3 | 3 | | 1 | | |
| CO 6 | 3 | | 2 | 3 | 2 | 2 | 3 | 3 | | 1 | | |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| CO | Internal Exam | Assignment | Practical Examination/ Project / Field Study | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | | | | ✓ |
| CO 5 | ✓ | ✓ | ✓ | |
| CO 6 | ✓ | ✓ | ✓ | |

**FIFTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA5EJ301 – MICROBIAL TECHNOLOGY**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. What is vermicomposting?
2. Differentiate between white rot and brown rot fungal degradation.
3. What is an anaerobic fixed film system?
4. What is microbial seeding?
5. What are Balucoviruses? Mention their potential uses.
6. What is a packed bed reactor?
7. What is enzyme therapy?
8. How are bacteria classified based on nutrition?
9. Differentiate between diauxic and synchronous growth cultures.
10. What are food enzymes? Give two examples

## SECTION B

**(Answer all questions. Each question carries 5 marks. Ceiling: 36 Marks)**

11. What are the cleaning and disinfection methods used in food industry?
12. What is operon concept?
13. Explain bioremediation with examples.
14. Briefly explain the importance of microbes in medicine.
15. Explain the various liquid waste treatment processes
16. Write an account on growth regulators used in microbial culturing.
17. Explain the methods currently used in processing milk and milk products.
18. Describe the cell ultrastructure of bacteria.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. Explain the concept of Fermenters. What are the different types of reactors?
20. What are the natural genetic recombination methods in bacteria?

**UNIVERSITY OF CALICUT**

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA5EJ302** | | | | |
| **Course Title** | **SUSTAINABLE AGRICULTURE & MANAGEMENT** | | | | |
| **Type of Course** | **Elective** | | | | |
| **Semester** | **V** | | | | |
| **Academic Level** | **300 - 399** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 |
| **Pre-requisites** | Basic knowledge on farming systems and organic farming techniques at Higher Secondary level | | | | |
| **Course Summary** | This course explores agronomy, crop nutrition, farming systems, plant protection, agribusiness certification, management and entrepreneurial skills | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category # | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the basic principles and practices of agronomy and crop nutrition | U | F | Test Paper, Quiz |
| CO2 | Understand the basic principles and practices of Faming systems and maintenance | U | F | Assignment, Seminar /Quiz, Presentation |
| CO3 | Evaluate the Organic Farming and Plant protection practices | E | F | Seminar Presentation, Group Work |
| CO4 | Understand the Certification and Agribusiness Management | U | F | Test Paper/Quiz, seminar |
| CO5 | Create new methods in organic farming and marketing and inculcate Entrepreneurial skills | Ap | C | Assignment, Field Study |
| CO6 | Give awareness about the advantages and need for organic farming | C | P | Field study |

* - 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 (60) | Marks (70) |
|---|---|---|---|---|
| **I** | **Agronomy and Crop nutrition** | | **10** | **15** |
| | 1 | Fundamentals of Agronomy: Agronomy and its scope, seeds and sowing, tillage and tilth, crop density and geometry, | 2 | |
| | 2 | Crop nutrition, manures and fertilizers, nutrient use efficiency, water resources, crop water requirement, irrigation. | 3 | |
| | 3 | Weeds: importance, crop weed competition, weed management: principles and methods, herbicides: classification, selectivity and resistance. Growth and development of crops, factors affecting growth and development, crop rotation, adaptation and distribution of crops, harvesting and threshing of crops. | 2 | |
| | 4 | Cultivated plants: Origin, geographical distribution, domestication, economic importance, soil and climatic requirements, varieties, cultural practices and yield of crops. | 3 | |
| **II** | **Farming systems and maintenance** | | **10** | **15** |
| | 5 | Farming System, Precision Farming and Sustainable Agriculture: Farming System: scope, concept and importance, Types of farming systems, Farming system components and their maintenance. | 3 | |
| | 6 | Cropping system and pattern, multiple cropping system, Efficient cropping system and their evaluation. | 2 | |
| | 7 | Sustainable agriculture: High External Input Agriculture (HEIA), Low external input agriculture (LEIA) and Low External Input Sustainable Agriculture (LEISA) and its techniques for sustainability. | 3 | |
| | 8 | Integrated farming system, components of IFS and its advantages, Integrated farming system and environment. | 2 | |

| | | | | |
|---|---|---|---|---|
| **III** | **Organic Farming and Plant protection** | | **15** | **20** |
| | 9 | Concept and development of organic farming. Principles of organic farming, Types of organic farming, Biodynamic farming, Benefits of organic farming. Conventional farming vs organic farming. | 3 | |
| | 10 | Organic farming: Soil tillage, Land preparation and mulching, Choice of varieties, Propagation-seed, planting materials and seed treatments. | 2 | |
| | 11 | Organic farming systems: Green manuring, Composting methods, Vermicomposting, Bulky organic manures, Concentrated organic manures, Organic preparations, Organic amendments and sludges | 4 | |
| | 12 | Bio-fertilizers. Methods of development of biofertilizers, Types of biofertilizers. Applications and advantages | 2 | |
| | 13 | Plant protection: mechanical, botanical pesticides, bio pesticide, bio control agents, Biopesticides: Introduction, Advantage, types of Biopesticides. Agrochemical management and manufacturing. Weed management. | 2 | |
| | 14 | Agencies and institutions related to organic agriculture, Requirements for organic farming, Farm components for organic farming. | 2 | |
| **IV** | **Certification and Agribusiness Management** | | **15** | **20** |
| | 15 | Organic Certification: Farm economy: Basic concept of economics: Demand, supply, Economic viability of a farm. Basic production principles: Reducing expenses, ways to increase returns, Cost of production system. Cost/ Benefit ratio. | 4 | |
| | 16 | Marketing: Imports and exports, Farm inspection and certification: Conversion to organic farming. | 2 | |
| | 17 | Agrochemical management and manufacturing. Various agrochemical brands, classification, types & uses. | 2 | |
| | 18 | Income generation activities: Terrace farming. Horticulture Nursery, Hydroponics, Aquaponics. | 2 | |
| | 19 | Agribusiness Management: Agribusiness relations with the financing, marketing, and management of | 2 | |

| | | | | |
|---|---|---|---|---|
| | | food production. Industrial career opportunities. | | |
| | 20 | Organic crop production methods: Rice, Coconut, Arecanut, Okra, Cowpea, Amaranthus, Cucurbits, Banana, Pepper, Ginger, Turmeric and Cardamom. | 3 | |
| **V** | **Open ended** | | **10** | **10** |
| | 1 | Visit to organic farms to study the various components recommended | | |

**References:**


1. Smita Diwase, Indian Agriculture and Agribusiness Management (3rd Edition)
2. De, G.C.1989. Fundamentals of Agronomy. Oxford & IBH Publishing Co., New Delhi.
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10. Broadway, A. C., Arif A. Broadway, A Textbook of Agri-Business Management
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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | | 1 | 3 | | | | | |
| CO 2 | 3 | | | 3 | | 1 | 3 | 3 | | 1 | | |
| CO 3 | 3 | | | 3 | | 2 | 3 | 3 | | 1 | | |
| CO 4 | 3 | | | | 2 | 2 | 3 | 2 | 2 | | | |
| CO 5 | 3 | 2 | 2 | | 3 | 2 | 3 | | 3 | | 3 | 3 |
| CO 6 | 3 | 3 | 2 | | 3 | 3 | 3 | | 3 | | | 3 |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Practical Examination/ Project / Field Study | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | | ✓ | ✓ | |
| CO 6 | | | ✓ | |

**FIFTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA5EJ302 - SUSTAINABLE AGRICULTURE & MANAGEMENT**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## Section A

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

1. What are Tillage and Tilth?
2. What are Herbicides? Give example
3. What is High External Input Agriculture?
4. Explain Green Manuring
5. Elaborate the Multiple Cropping System
6. What is Biodynamic farming?
7. Explain Organic Certification
8. Elaborate the Hydroponics and Aquaponics
9. What are Organic Amendments and Sludges
10. Explain the Major Biocontrol Agents

## Section B

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

11. Elaborate the Origin and Geographical distribution of Cultivated plants
12. Explain the Components of IFS and its advantages
13. Explain Land preparation and Mulching
14. Explain the Marketing of Organic Agriculture
15. Elaborate the Types of Bio-fertilizers
16. Briefly explain the Farm Inspection and Certification
17. Explain the Organic crop production methods in Rice and Coconut
18. Elaborate the Agribusiness Management

## Section C

**[Answer any one. Each question carries 10 marks; 1 × 10 = 10 Marks)**

19. Explain the Methods of Plant protection in detail.
20. Explain the Organic farming systems in detail.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA5EJ303** | | | | |
| **Course Title** | **BASIC TISSUE CULTURE & MICROPROPAGATION** | | | | |
| **Type of Course** | **Elective** | | | | |
| **Semester** | **V** | | | | |
| **Academic Level** | **300 - 399** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 |
| **Pre-requisites** | Basic knowledge of plant biology, tissue culture and regeneration at the Higher Secondary Level. | | | | |
| **Course Summary** | The course introduces students to the principles, techniques, and applications of plant tissue culture and micropropagation. Students will learn the fundamentals of plant tissue culture, including the culture media preparation, sterilization techniques, and maintenance of aseptic conditions. They will also study the techniques of micropropagation for mass multiplication of plants, including organogenesis and somatic embryogenesis. The course will cover various applications of tissue culture in agriculture, horticulture, forestry, and conservation. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the principles and significance of plant tissue culture and micropropagation. | U | F | Test paper, Quiz |
| CO2 | Learn the techniques involved in establishing and maintaining plant tissue cultures. | U | C | Demonstration, Field, Lab visit |
| CO3 | Explain somatic embryogenesis and artificial seeds | U | F | Seminar Presentation, Assignments |
| CO4 | Explore the applications of plant tissue culture in agriculture, horticulture, forestry, and conservation. | An/E | M | Test paper |
| CO5 | Acquire skills for micropropagation of plants | Ap | P | Presentation, Demonstration |
| CO6 | Compare various media and its advantages | U | C | Test Paper, 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 (60) | Marks (70) |
|---|---|---|---|---|
| I | **Introduction to tissue culture** | | **10** | **12** |
| | 1 | Definition and historical development of plant tissue culture, Scope, Advantages, Applications & Limitations of Tissue Culture. | 2 | |
| | 2 | Basic requirements for plant tissue culture: explants, culture media, and growth conditions. | 3 | |
| | 3 | Various nutrient medium compositions. Types of culture media: solid vs. liquid media, basal vs. enriched media. Various Plant growth regulators and their role in nutrient media. | 3 | |
| | 4 | Formulation and preparation of culture media. Sterilization techniques: autoclaving, filtration, and chemical sterilants. | 2 | |
| II | **Aseptic techniques and culture initiation** | | **12** | **20** |
| | 5 | Aseptic techniques: laminar flow hood, flame sterilization, and personal hygiene. | 3 | |
| | 6 | Explant selection and preparation, Methods of culture initiation: direct vs. indirect organogenesis. Pathways of regeneration. | 2 | |
| | 7 | Types of organ cultures and their applications. | 3 | |
| | 8 | Definition and significance of somatic embryogenesis, Induction and maintenance of embryogenic cultures, Maturation and germination of somatic embryos. | 2 | |
| | 9 | Applications of somatic embryogenesis in plant breeding and propagation. Artificial seeds – Production and types. | 2 | |
| III | **Micropropagation techniques** | | **15** | **20** |
| | 10 | Principles of micropropagation, stages of micropropagation, shoot proliferation, nodal and shoot tip culture. | 3 | |
| | 11 | Rooting techniques: adventitious rooting and rooting hormones | 2 | |

| | | | | |
|---|---|---|---|---|
| | 12 | Meristem culture for the production of virus free plants, nucellus culture for clonal propagation and large scale multiplication. | 4 | |
| | 13 | Acclimatization of micro-propagated plants to *ex vitro* conditions. | 3 | |
| | 14 | Guidelines for establishing academic and commercial laboratories. | 3 | |
| **IV** | **Applications of Plant tissue culture** | | **13** | **18** |
| | 15 | Micropropagation for commercial plant production. Artificial seed production from microshoots and their *in vitro* germination. | 4 | |
| | 16 | Germplasm conservation and genetic resource management. Principles and methods of cryopreservation, Cryoprotectants and cryopreservation protocols. | 3 | |
| | 17 | Introduction to genetic transformation techniques in plant tissue culture. | 2 | |
| | 18 | Applications in plant breeding: haploid production, somaclonal variation, and genetic transformation. | 2 | |
| | 19 | Role of tissue culture in forestry, horticulture, and conservation biology. | 2 | |
| **V** | **Open ended** | | **10** | **10** |
| | 1 | Preparation of culture media and sterilization techniques | | |
| | 2 | Visit to a well-established tissue culture lab | | |

## References:


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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | | 1 | 3 | | | | | |
| CO 2 | 3 | 2 | | | | | 3 | | | | | |
| CO 3 | 3 | | | 2 | 2 | | 3 | 3 | | 2 | | |
| CO 4 | 3 | | 2 | | | 2 | 3 | | | | 1 | 2 |
| CO 5 | 3 | | | 2 | 3 | | 3 | 3 | 3 | 2 | | |
| CO 6 | 3 | | | 2 | | | 3 | 3 | | 2 | 1 | |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| CO | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | ✓ | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | ✓ | ✓ | | ✓ |
| CO 6 | ✓ | ✓ | | ✓ |

**FIFTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA5EJ303 – BASIC TISSUE CULTURE & MICROPROPAGATION**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Comment on the stages of micropropagation.
2. What are the common explants used in tissue culture?
3. Give an account on somatic embryos and its germination.
4. Write notes on acclimatization of micropropagated plants to *ex vitro* conditions.
5. Delineate the guidelines for establishing a tissue culture laboratory.
6. Explicate the combination of basal and enriched media.
7. Compare shooting and rooting hormones.
8. Expound on the need of personal hygiene in a tissue culture laboratory.
9. Explain artificial seed production from microshoots.
10. Mention the role of tissue culture in horticulture.

## SECTION B

**(Answer all questions. Each question carries 5 marks. Ceiling: 36 Marks)**

11. Discuss on haploid plant production strategies.
12. Differentiate somaclonal and gametoclonal variations.
13. Reflect on germplasm conservation and genetic resource management.
14. Elucidate the applications of somatic embryogenesis in plant breeding.
15. Explore how meristem culture can be used for the production of virus free plants.
16. Compare the advantages and limitations of tissue culture.
17. Distinguish between direct and indirect organogenesis.
18. Evaluate the role of sterilization techniques in tissue culture.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 ×10 = 10 Marks)**

19. "Organ culture is the cultivation of either whole organs or parts of organs *in vitro*."- Reveal the techniques involved in culturing various types of organs in this regard.
20. Analyse the genetic transformation techniques used in plant tissue culture.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA5EJ304** | | | | |
| **Course Title** | **ALGAL RESOURCES AND UTILIZATION** | | | | |
| **Type of Course** | **Elective** | | | | |
| **Semester** | **V** | | | | |
| **Academic Level** | **300 - 399** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 |
| **Pre-requisites** | A strong foundation in plant science, especially on algae in Degree level as a major course. | | | | |
| **Course Summary** | The course aims to provide an in-depth knowledge on the potentials of algae as a resource in producing various commercial products, and thereby improving quality of life. It gives the student an overview of knowledge in utilisation of algae in different parts of the world, including India. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand specific roles of algae in food and industry | U | F | Test paper, Assignments |
| CO2 | Analyze the role of algae in pollution control | An | C | Presentation, Test Paper |
| CO3 | Make a list of algae used as food supplements | F | C | Assignments, Group discussion |
| CO4 | Comprehend methods of cultivation and commercial utilization of algae | An | M | Presentation, Assignment |
| CO5 | Discuss bio-medical utilization of algae | U | F | Group discussion |
| CO6 | Analyze the challenges in algal resource utilization | An | M | Presentation, Field Study |

* - 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 (60) | Marks (70) |
|---|---|---|---|---|
| **I** | **Algal resources- Basics** | | **10** | 18 |
| | 1 | Brief introduction on diversity of algae, with special reference to utilitarian points. Major micro and macro algal groups of commercial importance and their uses. | 1 | |
| | 2 | Brief history of utilisation of algae for different purposes; products; from direct use as food or food supplements to industrial products | 1 | |
| | 3 | Major uses and potentials of algae- sources of Proteins, Vitamins, Minerals, Pigments, etc; Economic value; market share | 2 | |
| | 4 | Major stakeholders in algal resources; research institutions; farmer groups, industries, etc- the global and Indian scenario | 3 | |
| | 5 | Pollution control; Carbon sequestration; Biofertilizers, Biopesticides. | 3 | |
| **II** | **Algal resources - as food supplements** | | **10** | **14** |
| | 6 | Single-cell protein production using microalgae; *Spirulina*; *Chlorella*, advantages, prospects | 3 | |
| | 7 | Omega 3 from algae; advantages, prospects, market share | 2 | |
| | 8 | Algae for Colourants, Biofertilizers, Pharmaceuticals | 3 | |
| | 9 | Algae as Food, feed for shrimp, fishes, poultry, etc | 2 | |
| **III** | **Algae for applications** | | **20** | 25 |
| | 10 | Methods of algal cultivation: open ponds, closed systems, photobioreactors; culture medium to products; - culture, cultivation, collection, processing, preservation | 4 | |

| | | | | |
|---|---|---|---|---|
| | 11 | Marine algae (seaweed) cultivation and processing for food applications; High-value products from algae (phycocyanin, astaxanthin, etc) | 4 | |
| | 12 | Biomedical applications of algae; antioxidants, anti-inflammatory, anti-cancer properties | 3 | |
| | 13 | Algae in drug discovery | 2 | |
| | 14 | Advances in algal biotechnology | 4 | |
| | 15 | Biodegradable materials from algae; Bioplastic | 3 | |
| **IV** | **Prospects of Algal resources** | | **10** | **13** |
| | 16 | Key players - companies, organisations in algal research, utilization, marketing, etc; Large-scale algal cultivation in India: challenges and opportunities. | 3 | |
| | 17 | Challenges and future directions for algal utilization in India | 2 | |
| | 18 | Biofuels from algae; prospects, advantages | 2 | |
| | 19 | Algae for a sustainable bio-economy- global and Indian scenario | 3 | |
| **V** | **Open ended** | | **10** | **10** |
| | 1 | Visit to an institute engaged in research and commercialization of algal products | | |

**References:**


1. Preiss, M.R. and Kowalski, S.P., 2010. Algae and biodiesel: Patenting energized as green goes commercial. *Journal of Commercial Biotechnology*, *16*, pp.293-312.
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16. https://www.wipo.int/publications/en/details.jsp?id=4042&plang=EN
17. https://www.corbion.com/Products/Algae-ingredients-products
18. https://www.algenol.com/sustainable-products/?category=foods
19. https://www.algafeed.com/
20. https://zaarabiotech.com/

**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | | 1 | 3 | | | | | |
| CO 2 | 3 | | | 2 | | 1 | 3 | 2 | | 2 | | |
| CO 3 | 3 | | | 3 | | 1 | 3 | 3 | | | | |
| CO 4 | 3 | | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 2 |
| CO 5 | 3 | | 2 | 3 | 2 | 3 | 3 | 3 | | | 3 | 2 |
| CO 6 | 3 | 3 | 2 | | 2 | 2 | 3 | | 1 | 2 | 3 | 3 |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| CO | Internal Exam | Assignment | Practical Examination/ Project / Field Study | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | ✓ | ✓ | | ✓ |
| CO 6 | ✓ | ✓ | ✓ | ✓ |

**FIFTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA5EJ304 – ALGAL RESOURCES AND UTILISATION**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Write on anti-cancer products from algae. Cite examples.
2. Describe the prospects and limitations of biofuels from algae.
3. Write notes about the success story of an algae-based company from Kerala. Mention their products.
4. Comment on the achievements by two research organisations on algae-based technologies.
5. Algae may boost a bio-economy. Comment on this aspect citing examples from India.
6. Write a note on the economic value and market share of algae as feed for shrimps and fishes?
7. Discuss the state of algal cultivation in India and its role in boosting market share.
8. Give a critical analysis of global trends in utilization of algal products.
9. Describe the technique of purifying waste water using algae.
10. Describe the significance of biodegradable materials from algae.

## SECTION B

**(Answer all questions. Each question carries 5 marks. Ceiling: 36 Marks)**

11. Write a note on pollution control by algae.
12. Describe the modes of culture of *Spirulina*. Discuss its uses.
13. Write an account of the colouring materials from algae. Discuss their commercial uses.
14. What is Carbon sequestration? Discuss the role of algae in it.
15. What is Omega 3? Discuss the use of algae in its production.
16. Write a note on the ecological significance of algal cultivation. Cite an example to justify.
17. Write an account on algae as biofertilizers. Cite suitable examples.
18. Write an account on the patents on algae.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. Write an account of the major of economically significant algae, and products from them.
20. Write an essay on cultivation methods of algae.

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| | | | | | |
|---|---|---|---|---|---|
| Programme | **B. Sc. PLANT SCIENCE** | | | | |
| Course Code | **PLA6EJ301** | | | | |
| Course Title | **ENTREPRENEURIAL BOTANY & ECOTOURISM** | | | | |
| Type of Course | **Elective** | | | | |
| Semester | **VI** | | | | |
| Academic Level | **300 - 399** | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 |
| Pre-requisites | Higher secondary level | | | | |
| Course Summary | This course explores the intersection of botany, entrepreneurship, and ecotourism. Students will learn how to identify plant species, understand their ecological significance, and explore entrepreneurial opportunities in ecotourism related to botanical attractions. This course aims to provide students with a comprehensive understanding of entrepreneurship, food processing, nursery management, horticulture, and ecotourism, preparing them for careers in various sectors of the food and agricultural industry. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the entrepreneurial opportunities in the field of Botany. | F | C | Classroom discussions, presentations, Assignments |
| CO2 | Create innovative food products and processing techniques. | Ap | M | Practical demonstrations, Case study analyses |
| CO3 | Analyse the needs of society and propose sustainable solutions. | An | M | Group projects, Presentations and debates, Case study analyses |
| CO4 | Apply organic farming and composting techniques in practical settings. | Ap | C | Field trip, Demonstration, observations |
| CO5 | Evaluate the impact of ecotourism ventures on local communities and ecosystems. | An | C | Case study analyses, Field trip reports |
| CO6 | Apply principles of integrated pest management and biofertilizers in agricultural settings | Ap | C | Group projects, Presentations and debates, Field study and Case study analyses |

* - 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 (60) | Marks (70) |
|---|---|---|---|---|
| I | **Entrepreneurship, Value Added Food Products & Processing Techniques** | | **10** | **15** |
| | 1 | Types of Entrepreneurs, Financial assistance from Banks & other financial institutions, Role of institutions like Mudra Bank, Kerala Financial Corporation, MSME Training Institutes, Khadi and Village Industries Board, Self Help Groups, and Co-operative Institutions. Kudumbasree Projects and Microenterprises. | 2 | |
| | 2 | Preparation and preservation techniques. Causes of spoilage of food. Principles of preservation – asepsis, removal of microorganisms, anaerobic situation and special methods – drying, thermal processing – pasteurization, sterilization and canning – low temperature, use of chemical preservatives and food additives. | 3 | |
| | 3 | Preparation of pickles, jam, jelly, syrups, sauce, dry fruits, dairy products – (cheese, butter, yoghurt, paneer), candies, chocolates, kondattam. | 2 | |
| | 4 | Processing, storage and marketing of Cocoa, Coconut (copra, coir and tender coconut), Rice (par boiled, raw rice and rice flour), Pepper, Cardamom, Ginger, Arrowroot, Tapioca, Cashew, Mango, Jack fruit, Guava, Grapes, Lemon, Papaya, Musa, Garcinia. | 3 | |
| II | **Nursery Management, Organic Farming and Composting Techniques** | | **10** | **15** |
| | 5 | Definition and importance, management aspects of nurseries, planning, budgeting, lay out and types of nurseries, maintenance of nurseries. | 2 | |
| | 6 | Preparation of potting mixtures, polybags. Plant Growth structures – green houses, hot beds, cold frames, shade houses, poly-shed, mist chamber. Media for the propagation of nursery plants - soil, sand, peat, sphagnum moss, vermiculite, perlite, soil mixture. Preparation of nursery beds. Marketing-packaging and transporting of nursery products. | 3 | |

| | | | | |
|---|---|---|---|---|
| | 7 | Organic manures and fertilizers, Composition of fertilizers. NPK content of various fertilizers and preparation of fertilizer mixtures. Common organic manures – bone meal, cow dung, poultry waste, oil cakes, organic mixtures and compost. Methods of fertilizer applications- broadcasting, placement, foliar application and fertigation | 3 | |
| | 8 | Preparation of compost – aerobic and anaerobic- advantages and limitations. Vermicompost – preparation - Vermiwash – preparation. Biofertilizers – Definition and preparation of different types – *Trichoderma, Rhizobium*, PGPR, PSB, Mycorrhiza. | 2 | |
| **III** | **Introduction to Horticulture** | | **20** | **25** |
| | 9 | Definition, history, classification of horticultural plants, disciplines of horticulture; Garden tools and implements. | 2 | |
| | 10 | Irrigation and water management - surface, sub, drip and spray irrigations. | 2 | |
| | 11 | Propagation of horticultural plants - by seeds - Seed viability, seed dormancy, seed testing and certification, seed bed preparation, seedling transplanting, hardening of seedling; advantages and disadvantages of seed propagation. | 2 | |
| | 12 | Olericulture – Types of vegetable growing, Home gardening, Market gardening, Truck gardening, Vegetable garden for processing, gardens for seed production. | 2 | |
| | 13 | Floriculture - Problems and prospects of Floriculture in Kerala. Cultivation and scope of growing Anthurium, Orchids and Jasmine in Kerala. | 2 | |
| | 14 | Pomiculture – Study of cultural practices of the following fruit crops, with reference to soil, climate, varieties, methods of propagation, irrigation, training and pruning, post- harvest technology, storage and value-added products – Mango, Banana, Papaya, Sapota, Guava | 3 | |
| | 15 | Ornamental Garden designing - Use of different garden components. Lawn preparation by seeds, seedling and turfing. Maintenance of garden by Irrigation, Pruning, Repotting. Disease and Pest | 2 | |

| | | | | |
|---|---|---|---|---|
| | | control. | | |
| | 16 | Hydroponics - Introduction, types, commercial aspects, recent advancement to hydroponics and future prospects. | 1 | |
| | 17 | Terrariums - Introduction, relevance, materials required, plants suitable for terrarium, potting media, methods of setting up terrariums, care and maintenance. | 2 | |
| | 18 | Mushroom Cultivation: Cultivation of *Agaricus, Pleurotus*, and *Volvariella*. Spawn production, storage and marketing. Growth of Mushrooms on Paddy Straw and Saw dust by Poly bag. Pests and defects of mushrooms. Storage, Transporting and Marketing of Mushrooms. | 2 | |
| **IV** | **Ecotourism** | | **10** | **15** |
| | 19 | Ecotourism: Definition, Elements and characteristics of ecotourism. Types of ecotourism: Heritage ecotourism, Costal ecotourism, Cultural ecotourism, Festival ecotourism, Ayurvedic ecotourism. Positive and negative impacts of Ecotourism. The International Ecotourism Society | 5 | |
| | 20 | Major ecotourism centres in Kerala: Thenmala, Peppara, Gavi, Wayanad WLS, Silent Valley National Park, Aralam WLS, Parambikulam Tiger Reserve | 3 | |
| | 21 | Wildlife tourism and its opportunities with reference to Kerala: Aralam WLS, Wayanad WLS | 2 | |
| **V** | **Open ended** | | **10** | **10** |
| | | Preparation of pickles, jam, jelly, syrups, sauce, dry fruits, kondattam (any two) | | |
| | | Preparation of potting mixtures, polybags | | |
| | | Preparation of nursery beds and compost | | |
| | | Explore eco-friendly pest management techniques through the preparation of biopesticides using tobacco and neem decoction. | | |
| | | Cultivation of vegetables - Tomato, Brinjal, Chilly | | |
| | | Learn the art of Flower arrangement | | |

| | | | | |
|---|---|---|---|---|
| | | Cultivation of mushrooms | | |
| | | Hands-on training with terrarium preparation in a demonstration session, exploring miniature ecosystems within glass containers. | | |
| | | A visit to a nearby ecotourism destination | | |

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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | 3 | 2 | | 3 | 3 | | 2 | | |
| CO 2 | 3 | 3 | | | | | 3 | | 3 | | | |
| CO 3 | 3 | | 3 | 2 | 2 | 3 | 3 | 2 | | 2 | 2 | 3 |
| CO 4 | 3 | 3 | 2 | | | 3 | 3 | | 2 | | 2 | 3 |
| CO 5 | 3 | 3 | | | | 3 | 3 | | 3 | | 3 | 3 |
| CO 6 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | | | 3 |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| CO | Internal Exam | Assignment | Practical Examination/ Project / Field Study | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | | | ✓ | |
| CO 6 | | | ✓ | |

**SIXTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA6EJ301 – ENTREPRENEURIAL BOTANY & ECOTOURISM**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Differentiate between vermiculite and perlite.
2. Give an account of Spawn production.
3. What do you mean by fertigation? What are its advantages?
4. List out the principles of food preservation.
5. Explain the significance of the mist chamber.
6. What is integrated pest management?
7. Differentiate between floriculture and pomiculture.
8. What do you mean by hydroponics?
9. Write brief note on Ayurvedic Ecotourism
10. Give examples of any two biopesticides.

## SECTION B

**(Answer all questions. Each question carries 5 marks. Ceiling: 36 Marks)**

11. Discuss the problems and prospects of floriculture in Kerala.
12. What are the techniques behind the preparation of jams and sauces.
13. Describe the processing and storage methods of Ginger and Garcinia?
14. List out the roles of MSME Training Institute.
15. Give an account of the cultivation of *Agaricus* mushrooms.
16. What do you mean by a Terrarium? How a terrarium could be set up?
17. Describe the cultivation procedures of Tapioca.
18. Write an account of wildlife tourism and its opportunities with reference to Kerala.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. Describe the processing, storage and marketing of Cardamom, Coconut and Rice
20. What are biofertilizers? Describe the preparation of the various types of bio-fertilizers.

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| | | | | | |
|---|---|---|---|---|---|
| **Course Code** | **PLA6EJ302** | | | | |
| **Course Title** | **PHYTOCHEMISTRY AND PHARMACOGNOSY** | | | | |
| **Type of Course** | **Elective** | | | | |
| **Semester** | **VI** | | | | |
| **Academic Level** | **300 - 399** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 |
| **Pre-requisites** | A strong foundation in plant science, phytochemistry and medicinal uses of common plant parts at Higher Secondary Level is needed. | | | | |
| **Course Summary** | The course aims to provide an in-depth exploration of phytochemicals of medicinal interest. The curriculum will equip students with a comprehensive understanding of pharmacognostic aspects, empowering them to explore numerous applications related to plant science. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the basic knowledge about fundamentals of pharmacognosy | U | F | Test paper, Quiz |
| CO2 | Analyze various techniques for the estimation of phytoconstituents | Ap | P | Industrial Visit, Presentation, Group discussion |
| CO3 | Create awareness on the role of pharmacognosy in various systems of medicines | C | M | Seminar, Test Paper, Field Study |
| CO4 | Develop observation and learning skills through different instrumentation techniques | E | M | Industrial Visit, Presentation, Seminar |
| CO5 | Understand the method of quality control methods of drugs | U | F | Field Study-Institute Visit |
| CO6 | Analysis of crude drugs using instruments | Ap | F | Demonstrations |

* - 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 (60) | Marks (70) |
|---|---|---|---|---|
| **I** | **Basic Phytochemistry** | | **12** | **18** |
| | 1 | General introduction, Historical background, classification, composition, phytochemical aspects of various drug yielding plants and study of their secondary metabolites. | 2 | |
| | 2 | Primary metabolites: Study of sources, chemistry, therapeutic uses and commercial utility as pharmaceutical drugs: Carbohydrates-Agar and honey; Proteins- Spirulina and Soya; Lipids- Castor oil and Neem oil. | 3 | |
| | 3 | Secondary metabolites: classification, properties and test for identification of Alkaloids, Glycosides, Flavonoids, Tannins, Volatile oil, Resins and Sulphur-containing compounds | 2 | |
| | 4 | Utility of Secondary metabolites: Chemistry, therapeutic uses and commercial utility as Pharmaceutical Aids and/or Medicines – (A) Terpenoids and phenolic compounds: Terpenoids: Camphor, andrographolide; Phenols: Gingerol, phenolic acids,; Flavonoids- Luteolin and apigenin. | 3 | |
| | 5 | (B) Alkaloids, Sulphur-containing and other compounds – Alkaloid: morphine, nicotine, Caffeine; Steroids: Sitosterol, campesterol and stigmasterol; Sulphur-containing compounds: Allicin, defensin, thionin; Glycosides: Cardiac glycosides, Amygdalin, Anthraquinone. | 2 | |
| **II** | **Basics in Pharmacognosy** | | **10** | **16** |
| | 6 | Definitions, history, present status and scope and branches of Pharmacognosy. Sources of Drugs – Plants and Tissue culture.<br>Classification of Drugs: Morphological, Taxonomical, Chemical and Pharmacological basis. | 3 | |
| | 7 | Quality control of Drugs of Natural Origin: Adulteration of drugs of natural origin: Definition, causes of adulteration and different methods adopted in drug adulteration. | 2 | |

| | | | | |
|---|---|---|---|---|
| | 8 | Evaluation of drugs: Analysis by organoleptic, microscopic, physical, chemical and biological methods including quantitative microscopy. Role of pharmacognosy in the traditional system of medicine and Forensic Science. | 3 | |
| | 9 | General Methods: Extraction, isolation and purification of phytoconstituents using spectroscopy, chromatography and electrophoresis. | 2 | |
| **III** | **Analytical Pharmacognosy** | | **15** | **22** |
| | 10 | Isolation, identification and estimation methods for the following phytoconstituents from Dicotyledonous plants: a) Vasicine from *Adhatoda vasica*, b) Andrographolides from *Andrographis paniculata*, c) Hesperidin from Orange peel. | 3 | |
| | 11 | Isolation, identification and estimation methods for the following phytoconstituents from Monocotyledonous plants: a) Curcumin from *Curcumin Longa*, b) Piperine from *Piper Longum*, c) Gingerol from *Zingiber officinalis*. | 2 | |
| | 12 | Composition, source plants, therapeutic uses and commercial applications of Alkaloids: Periwinkle, Rauvolfia, Belladonna, Opium; Phenylpropanoids and Flavonoids: Coffee, Tea; Steroids, | 2 | |
| | 13 | Composition, source plants, therapeutic uses and commercial applications of Cardiac Glycosides & Triterpenoids: Liquorice, Dioscorea, Digitalis; Volatile oils: Mentha, Clove, Cinnamon; Tannins: Catechu; Resins: Asafoetida; Glycosides: Aloe. | 2 | |
| | 14 | Crude drug evaluation: Macroscopic, microscopic and chemical composition of the following drug yielding plants: Eucalyptus leaf, Neem leaf, clove bud and cinnamon bark. | 2 | |
| | 15 | Powder analysis of plant drugs from underground parts: a) Root: *Rauvolfia serpentina* (Sarpagandhi), b) Rhizome: *Curcuma longa* (Turmeric); Corm: *Colchicum autumnale* (Colchicine) | 2 | |
| | 16 | Powder analysis of plant drugs from aerial parts: a) Bark : *Cinnamomum zeylanicum* (Cinnamon); b) Wood: *Santalum album* (Sandal); c) Leaf : *Senna alexandrina* (Senna), d) Flower: *Eugenia caryophyllata* (Cloves), e) Fruit : *Carum carvi* | 2 | |

| | | | | |
|---|---|---|---|---|
| | | (Caraway), f) Seed : *Strychnos nux-vomica* (Nux vomica) | | |
| **IV** | **Applied Pharmacognosy** | | **13** | **14** |
| | 17 | Pharmacognosy in various systems of medicine: Role of Pharmacognosy in allopathy and traditional systems of medicine namely, Ayurveda, Unani, Siddha, Homeopathy and Chinese systems of medicine. | 4 | |
| | 18 | Study of Natural drugs: Biological source, chemical nature and uses of drugs of natural origin containing the following medicinal plant products: phytopharmaceutical drugs (PPD), Hallucinogens, Teratogens, Natural allergens. | 3 | |
| | 19 | Proteins and Enzymes used in Pharmacognosy and their applications: Proteins: albumins, globulins, prolamins and glutelins, gelatin, casein; Proteolytic enzymes: Papain, bromelain, serratiopeptidase, urokinase, streptokinase, pepsin. | 3 | |
| | 20 | Lipids used in pharmacognosy and their applications: Lipids: Waxes, fats, fixed oils; Lipid sources: Castor oil, coconut oil, linseed oil, olive oil, peanut oil, wool fat, beeswax. | 3 | |
| **V** | **Open ended** | | **10** | **10** |
| | 1 | Detection of Phytoconstituents such as i) Alkaloids, ii) Steroids, Triterpenoids and their glycosides and Saponins iii) Flavonoids and their glycosides iv) Anthracene Glycosides v) Coumarins vi) Tannins by Test Tube and TLC methods. | | |
| | 2 | Microscopical and histological Evaluation of Powdered Crude Drugs: a) Root: *Rauvolfia serpentina* (Sarpagandha), b) Rhizome: *Curcuma longa* (Turmeric), and *Zingiber officinale* c) Bark: *Cinnamomum zeylanicum* (Cinnamon), d) Wood: *Santalum album* (Sandal), e) Leaf: *Azadirachta indica* and *Eucalyptus* sp., f) Flower: *Eugenia caryophyllata* (Cloves), g) Fruit : *Carum carvi* (Caraway), h) Seed : *Strychnos nux-vomica* (Nux vomica) | | |
| | 3 | Determination of size of starch grains, calcium oxalate crystals by eye piece micrometer. | | |
| | 4 | Identification of crude drugs of the following: | | |

| | | | | |
|---|---|---|---|---|
| | | Fenugreek seeds, Lemon peel, Pudina and Cardamom. | | |
| | 5 | Determination of moisture content of crude drugs. | | |
| | 6 | Analysis of crude drugs by chemical tests: (i) Asafoetida (ii) Benzoin (iii) Colophony (iv) Aloes (v) Myrrh. | | |

**References:**


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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | | | 3 | | | | | |
| CO 2 | 3 | 3 | 2 | 2 | 3 | | 3 | | | 3 | | |
| CO 3 | 3 | | | | | | 3 | 3 | | | | |
| CO 4 | 3 | 3 | 3 | 2 | | | 3 | | | 3 | | |
| CO 5 | 3 | | | | 3 | | 3 | 3 | 3 | | 3 | |
| CO 6 | 3 | | | | 3 | 2 | 3 | | 3 | | 3 | 2 |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| CO | Internal Exam | Assignment | Practical Examination/ Project / Field Study | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | ✓ | ✓ |
| CO 3 | ✓ | ✓ | ✓ | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | | | ✓ | |
| CO 6 | | | ✓ | |

**SIXTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA6EJ302 – PHYTOCHEMISTRY AND PHARMACOGNOSY**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Comment on novel medicinal agents from marine sources.
2. Explain the commercial applications of cardiac glycosides.
3. Add notes on natural allergens.
4. Enumerate examples of plant-derived drugs from aerial parts.
5. Delineate the test for identification of alkaloids.
6. Write notes on adulteration of drugs of natural origin.
7. Describe the sulphur-containing compounds of commercial value.
8. What are the health benefits of flavonoids?
9. Explain the therapeutic use of andrographolide.
10. Reveal the role of hallucinogens in pharmacognosy.

## SECTION B

**(Answer all questions. Each question carries 5 marks. Ceiling: 36 Marks)**

11. Discuss on various lipids used in drug manufacturing.
12. Explicate the action of medicinal proteolytic enzymes.
13. Describe the methods of extraction, isolation and purification of phytochemicals.
14. Elucidate the techniques for the powder analysis of plant drugs from underground parts.
15. Analyse various primary metabolites used as pharmaceutical aids.
16. Analyse the techniques used for the isolation, and estimation of curcumine.
17. Classify various drugs based on various analytical parameters.
18. Expound various macroscopic and microscopic techniques used for crude drug evaluation.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. Discuss on major pathways to synthesize secondary metabolites in plants.
20. “In a nutshell, pharmacognosy plays an important role in the production of new plant and herbal drugs and is practised in all the systems of medicine in India.” Substantiate.

**UNIVERSITY OF CALICUT**

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA6EJ303** | | | | |
| **Course Title** | **BOTANICAL GARDEN AND BIO-PROSPECTING** | | | | |
| **Type of Course** | **Elective** | | | | |
| **Semester** | **VI** | | | | |
| **Academic Level** | **300 - 399** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 |
| **Pre-requisites** | A strong foundation in Biology at Higher Secondary Level. | | | | |
| **Course Summary** | The course aims to provide an in-depth knowledge on the potentials of botanical gardens in biodiversity conservation, the principles and practices of bio-prospecting, and the ethical, ecological, and economic considerations associated with these fields. The course will cover the history, functions, and management of botanical gardens, as well as the methodologies and applications of bio-prospecting in sustainable development. | | | | |

**Course Outcomes (CO):**

| COs | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Explain the history, significance, and functions of botanical gardens, both internationally and nationally. | U | F | Test paper<br>Assignment |
| CO2 | Design and layout components of botanical gardens, including lawns, landscaping, plant collections, and visitor management. | Ap | P | Assignment<br>Presentation |
| CO3 | Analyze the techniques and importance of in-situ and ex-situ conservation methods for threatened species. | An | C | Group discussion,<br>Case study analyses |
| CO4 | Evaluate the roles of national and international programs and organizations in biodiversity conservation and the impact of botanical gardens in these efforts. | E | C | Presentations, Test paper |
| CO5 | Apply the concept of bioprospecting to identify potential pharmaceutical, agricultural, and industrial applications, and analyze successful case studies. | Ap | P | Group Discussion Practical demonstrations, Case study analyses |
| CO6 | Discuss the ethical and legal aspects of bio-prospecting, including access and benefit-sharing agreements, intellectual property rights, and indigenous knowledge. | U | C | Classroom discussions, Test aper |

* - 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 (60) | Marks (70) |
|---|---|---|---|---|
| **I** | **Introduction and management of botanical gardens** | | **12** | **17** |
| | 1 | Botanical gardens: Definition, history, types, significance, and functions | 2 | |
| | 2 | General account of important international, national and regional botanical gardens: Royal Gardens, Kew (London) U.K.; Acharya Jagadish Chandra Bose Indian Botanic Garden (Shibpur), Kolkata; Calicut University Botanical Garden (CUBG), Kerala. | 3 | |
| | 3 | Design and layout, components of garden: Lawns and landscaping; principles of designing botanical gardens. | 3 | |
| | 4 | Plant collections, maintenance, visitor management, and education programs. | 2 | |
| | 5 | Future challenges and responsibilities of botanical gardens in a changing world and their role in scientific research - botanical gardens and sustainable development. | 2 | |
| **II** | **Conservation techniques for threatened species** | | **18** | **20** |
| | 6 | *In-situ* conservation: sanctuaries, biosphere reserves, national parks, nature reserves, community reserves, sacred habitats, preservation plots. | 1 | |
| | 7 | *Ex-situ* conservation: botanical gardens, zoos, aquaria, homestead garden; *In-vitro* tissue culture and cryopreservation, germplasm and gene Bank, seed and seedling banks, pollen and spore bank, DNA bank, butterfly gardening. | 3 | |
| | 8 | National and international programs for biodiversity conservation. Role of WWF, WCU, CITES, TRAFFIC. Concept of Schedule in Wildlife Protection. IUCN Red List of Threatened Species, guidelines for IUCN Red List categorization. Forest Rights Act; Indian Wildlife (Protection) Act, 1972; Indian Biodiversity Act 2002; Eco-tourism and Social Forestry. Ramsar wetland sites. Biodiversity Heritage Site (BHS). | 7 | |
| | 9 | Biodiversity of the Indian subcontinent, India as a mega diversity nation; India's National Biodiversity Action Plan, Species conservation projects in India: General account. | 4 | |
| | 10 | Concept of biodiversity hotspots and mega diversity country; Role of botanical gardens in plant breeding | 3 | |

| | | | | |
|---|---|---|---|---|
| | | and genetic conservation. | | |
| **III** | **Bio-prospecting: Concept and applications** | | **10** | **18** |
| | 11 | Definition and scope of bio-prospecting; bio-prospecting as a tool for survival: traditional and modern concepts. | 1 | |
| | 12 | Pharmaceutical, agricultural, and industrial applications; economic value of bio-prospecting; Screening and evaluation of bioactive compounds. | 3 | |
| | 13 | Facets of bio-prospecting: chemical prospecting, gene prospecting, and bionic prospecting | 2 | |
| | 14 | Biodiversity hotspots and bio-prospecting potential; role of bio-prospecting in biodiversity conservation. | 2 | |
| | 15 | Case studies of successful bio-prospecting projects. | 2 | |
| **IV** | **Ethical and legal aspects of bio-prospecting** | | **10** | 15 |
| | 16 | Access, benefit-sharing agreements, and Intellectual property rights: ethical arguments and position of opponents and proponents. | 3 | |
| | 17 | Indigenous knowledge and traditional practices; a brief description of decision 391. | 2 | |
| | 18 | Bio-piracy and its implications in bio-prospecting; impacts of bio-piracy and bio-prospecting | 3 | |
| | 19 | International and national legal frameworks regarding bio-prospecting. | 2 | |
| **V** | **Open ended** | | **10** | **10** |
| | 1 | Visit to nearby botanical gardens, sanctuaries, biosphere reserves, national parks, nature reserves, community reserves, sacred habitats. | | |
| | 2 | Hand-on training *in ex-situ* conservation strategies. | | |
| | 3 | Training in IUCN Red List categorization. | | |
| | 4 | Training in bioprospecting | | |

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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | **3** | | | | | | **3** | | | | | |
| CO 2 | **3** | | 2 | **2** | 3 | | **3** | 2 | 3 | 2 | 3 | |
| CO 3 | **3** | **3** | 1 | 3 | 2 | **3** | **3** | **3** | 2 | | 2 | **3** |
| CO 4 | **3** | | | 3 | | | **3** | **3** | | 2 | 2 | |
| CO 5 | 3 | 3 | 2 | **3** | | | **3** | **3** | | | | |
| CO 6 | **3** | | **2** | **3** | | **2** | **3** | **3** | | | | **2** |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | ✓ | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | ✓ | ✓ | ✓ | ✓ |
| CO 6 | ✓ | ✓ | | ✓ |

**SIXTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**
**PLA6EJ303 - BOTANICAL GARDEN AND BIO-PROSPECTING**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. What are the primary functions of botanical gardens?
2. Define the term "bio-piracy" and explain its implications.
3. Mention sectors where bio-prospecting is commonly applied.
4. Define *ex-situ* conservation with examples.
5. How do botanical gardens contribute to bio-prospecting efforts?
6. Describe the design elements commonly found in botanical gardens.
7. Define benefit-sharing in the context of bio-prospecting.?
8. Mention some major challenges associated with bio-prospecting.
9. Name 2 historical botanical gardens and their significance.
10. What are Ramsar sites?

## SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. Discuss the types and significance of botanical gardens
12. Provide case studies of successful bio-prospecting projects and discuss their impact on society and the environment.
13. Evaluate the effectiveness of botanical gardens in promoting genetic conservation and plant breeding.
14. Assess the role of botanical gardens in public education and engagement with plant diversity and conservation issues.
15. Discuss the transition of botanical gardens from medicinal herb gardens to modern institutions serving multiple purposes.
16. Analyze the challenges faced by botanical gardens in maintaining plant collections and preserving genetic diversity.
17. Analyze the role of indigenous peoples and local communities in bio-prospecting endeavors.
18. Discuss the scope of bioprospecting.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. Trace the historical evolution of botanical gardens and assess their contemporary significance in scientific research, conservation, education, and global biodiversity conservation.
20. Discuss the ethical, legal, and environmental implications of bio-prospecting activities, and also the strategies for ensuring responsible and sustainable practices.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA6EJ304** | | | | |
| **Course Title** | **FORENSIC BOTANY PRINCIPLES AND APPLICATIONS** | | | | |
| **Type of Course** | **Elective** | | | | |
| **Semester** | **VI** | | | | |
| **Academic Level** | **300 - 399** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 |
| **Pre-requisites** | A strong foundation in Higher Secondary Level Biology. | | | | |
| **Course Summary** | This course aims to familiarize students with the applications of fungi, algae, and plants in forensic investigations. Students should be able to identify and categorize botanical specimens for use as forensic evidence. | | | | |

**Course Outcomes (CO):**

| COs | Statement_ | Cognitive level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Describe the history and importance of forensic botany, including general plant classification and preservation methods. | U | F | Classroom discussions, Written assignments |
| CO2 | Identify and analyze useful plant parts such as pollen grains, wood, seeds, and leaves in forensic investigations. | An | C | Laboratory practicals, Case study analyses |
| CO3 | Evaluate the role of algae, fungi, and planktons in forensic science, focusing on their sampling, preservation, and identification. | E | C | Research projects, Presentations |
| CO4 | Explain the characteristics and forensic applications of common poisonous plants and their toxins, including abused drug-producing plants and toxic fungi. | U | C | Exams, Case study analyses |
| CO5 | Apply methods for the collection, preservation, and analysis of botanical evidence from outdoor crime scenes. | Ap | P | Field trip reports, Practical demonstrations |

| | | | | |
|---|---|---|---|---|
| CO6 | Utilize molecular techniques such as DNA analysis, DNA fingerprinting, gel electrophoresis, PCR, sequencing, and DNA cloning in the examination of botanical samples in forensic investigations. | Ap | P | Laboratory reports, Research 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 (60) | Marks (70) |
|---|---|---|---|---|
| **I** | **Introduction to forensic botany and its importance** | | **8** | 12 |
| | 1 | A brief history of forensic botany. | 2 | |
| | 2 | Natural system of plant classification based on morphology, cytology, embryology, anatomy etc. General characters used in plant identification, types of roots, leaf venation, parts of flower, types of inflorescence, cotyledon, phyllotaxy. | 3 | |
| | 3 | Methods to preserve plant specimens, cryopreservation, air drying, freeze drying, chemical preservatives, formalin, poly-vinyl alcohol. | 3 | |
| **II** | **Useful plant parts in forensic investigations** | | **18** | **22** |
| | 4 | Palynological characters; structure of pollen grains, pollen wall, exine, intine, shapes and textures of pollengrains, pollen aperture, colpate, porate, colporate, sporopollenin. | **4** | |
| | 5 | Isolation and identification of pollen grains; vacuum collection, cutting, drying, grinding, and sieving flower heads; wet-lyophylisation (WL) and conventionally dry-sieving (DS), pollen bank. | **5** | |
| | 6 | Various types of wood, timber varieties, soft wood, hard wood, heart wood, sap wood, growth ring/annual ring in wood, collection and detailing of fresh and decayed wood for forensic investigations. | **3** | |
| | 7 | Fruits and seeds, structure of dicot and monocot seed, seed dormancy, orthodox seed, recalcitrant seed, identification and use of seeds in forensic study. | **3** | |
| | 8 | Leaves, simple leaves, compound leaves, venation, phyllotaxy, leaf margin, shapes of leaves, petiole, stipule, leaf modifications, use of leaves in forensic study. | **3** | |

| | | | | |
|---|---|---|---|---|
| **III** | **Algae and fungi in forensic investigations** | | **16** | **22** |
| | 9 | Important algal groups and their key characters; Myxophyceae, Chlorophyceae, Phaeophyceae, Bacillariophyceae, Xanthophyceae, and Rhodophyceae. Pigments and storage food items in each algal group. Sampling/collection and preservation of algae. Identification of algae based on thallus structure, shape of chloroplast, flagella, pigments etc. | **6** | |
| | 10 | Major fungal groups and their key characters; Chytridiomycota, Zygomycota, Ascomycota, Basidiomycota, Deuteromycota. Spores produced by fungi; ascospore, basidiospore. Fungal spores as forensic evidence. Saprotrophic nature of fungi, post mortem interval (PMI) calculation using fungi. | **6** | |
| | 11 | Planktons and diatoms, their forensic importance. Extraction of diatoms from clothing for forensic comparison, significands of diatoms isolated from internal organs and bone marrow in cases of drowning/dead bodies collected from water. | **4** | |
| **IV** | **Common poisonous plants and their toxins** | | **8** | **14** |
| | 12 | Plant secondary metabolites; terpenes, phenolics, glycosides, alkaloids. Toxin-producing plants; Opium, Cannabis, Cocoa, Tobacco, Datura, Calotropis. Toxic/dangerous idoor plants; daffodil | **4** | |
| | 13 | Edible fungi; *Agaricus bisporus and Agaricus campestris*. Toxic fungi: *Psilocybin* mushroom, *Amanita phalloides.* | **2** | |
| | 14 | Applications of plant toxins in forensic investigations. | **2** | |
| **V** | **Open ended** | | **10** | **10** |
| | 1 | General collection and preservation methods of botanical samples. Picking, vacuum sweeping, scraping. Soil and vegetation sampling techniques for fungi in forensic study. | | |
| | 2 | Analysis of samples, DNA analysis. DNA fingerprinting, importance of molecular data in forensic investigations. | | |

| | | | | |
|---|---|---|---|---|
| | 3 | Tools and techniques used in molecular analysis. Gel electrophoresis, PCR, sequencing, DNA cloning, Chromatography, spectroscopy. | | |

## References


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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | **3** | | | | | | **3** | | | | | |
| CO 2 | **3** | | 2 | **2** | 3 | | **3** | 2 | 3 | 2 | 3 | |
| CO 3 | **3** | **3** | 1 | 3 | 2 | **3** | **3** | **3** | 2 | | 2 | **3** |
| CO 4 | **3** | | | 3 | | | **3** | **3** | | 2 | 2 | |
| CO 5 | 3 | 3 | 2 | **3** | | | **3** | **3** | | | | |
| CO 6 | **3** | | **2** | **3** | | **2** | **3** | **3** | | | | **2** |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | ✓ | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | ✓ | ✓ | ✓ | ✓ |
| CO 6 | ✓ | ✓ | | ✓ |

**SIXTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**
**PLA6EJ304 - FORENSIC BOTANY PRINCIPLES AND APPLICATIONS**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A
**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Give two examples of plant-derived toxins.
2. Differentiate hardwood and softwood.
3. Name two poisonous fungi.
4. What is cryopreservation?
5. Write any two applications of DNA fingerprinting.
6. Write the significance of diatoms in forensic studies.
7. Name two chemical preservatives used for the preservation of plant samples.
8. What is PCR?
9. What is the importance of sporopollenin in forensic investigations?
10. Name two fungal spores useful in forensic investigation.

## SECTION B
**(Answer all questions. Each question carries 5 marks. Ceiling: 36 Marks)**

11. Write a paragraph on the importance of fungal spores in forensic investigations.
12. Write a detailed account on general collection and preservation methods of botanical samples.
13. How plant toxins useful in forensic studies?
14. Write a short account on important algal groups and their features useful in forensic studies.
15. Write an account on types of seeds and their application in forensic studies.
16. What are the types of leaves and methods to preserve leaf samples?
17. How the water samples and planktons will be a powerful evidence foe crime detection?
18. What are the general characters used in the plant identification?

## SECTION C
**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. Write a detailed description on the importance of molecular data in forensic studies. Write the steps involved in DNA fingerprinting.
20. “Palynological evidences are highly useful in forensic investigations”. Analyse the statement with special reference on pollen morphology.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA8EJ401** | | | | |
| **Course Title** | **ENZYME TECHNOLOGY** | | | | |
| **Type of Course** | **Elective** | | | | |
| **Semester** | **VIII** | | | | |
| **Academic Level** | **400 - 499** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 |
| **Pre-requisites** | Students must have a thorough knowledge on protein structure, function, basic knowledge in enzyme action and mechanism. | | | | |
| **Course Summary** | Students get a thorough knowledge on enzyme mechanism, kinetics, Production, purification, analysis. The course also give an outline of the applications of enzymes in different fields. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand Fundamentals of Enzyme Structure and Functionincluding their historical significance, structural hierarchy, and functional roles, along with the mechanisms of substrate binding, enzyme-substrate specificity, and catalytic activity. | U/R | F | Instructor-created exams / Assignment |
| CO2 | **Understand e**nzyme kinetics, models of catalysis, the impact of various factors on enzyme activity and assay methods for enzyme characterization. | U/R | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Expertise in the methodologies for enzyme production from various sources, techniques for purification and immobilization, and strategies for enhancing enzyme stability and functionality for industrial and research applications. | Ap/An | M | Seminar Presentation/ Assignments |
| CO4 | Evaluate the applications of immobilised enzyme in various fields | E | M | Assignment/ Seminar |
| CO5 | **Analyse** advanced concepts in enzyme applications across industrial, clinical, and environmental domains, along with introducing protein engineering, metabolic pathway engineering, | An | M | Seminar/ Group Discussion/Test |
| CO6 | Evaluate the applications of artificial enzymes, and structure-activity relationships for drug design and biotechnological advancements. | E | M | Seminar/ Assignment/Test |

* - 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 60 | Marks (70) |
|---|---|---|---|---|
| I | | **Enzyme Basics and Mechanisms** | **10** | **16** |
| | 1 | **Introduction to enzymes:** Historical background, general terminology, and nomenclature. Structure and Function: Primary, secondary, tertiary, and quaternary structure of enzymes; active sites and substrate binding. | 2 | |
| | 2 | **Classification of enzymes:** IUB system, classification based on reaction types. **Enzyme purity criteria:** Specific activity, enzyme units (Katal and IU). | 2 | |
| | 3 | **Chemical nature of enzymes:** Protein and non-protein enzymes, ribozymes, DNAzymes. Metalloenzymes and metal-activated enzymes. | 2 | |
| | 4 | **Coenzymes and cofactors:** Prosthetic groups, Isozymes, abzymes, and synthetic enzymes (Synzymes). Isoenzymes and Allosteric Enzymes. | 2 | |
| | 5 | **Mechanisms of enzyme action:** Active sites, enzyme-substrate specificity, and energetic concepts. **Applications of Enzymes:** Overview of industrial, medical, and research applications. | 2 | |
| II | | **Enzyme Kinetics and Inhibition** | **10** | **14** |
| | 6 | **Enzyme catalysis**: Lock and key model, induced fit, and transition state theories. **Mechanisms of catalysis**: Acid-base catalysis, covalent catalysis, and metal-ion catalysis. | 3 | |
| | 7 | **Enzyme kinetics:** Michaelis-Menten equation, Km, Vmax, and turnover number. Lineweaver-Burk plot, factors affecting enzyme activity (pH, temperature, substrate concentration). | 3 | |
| | 8 | **Types of enzyme inhibition:** Competitive, non-competitive, uncompetitive, and allosteric inhibition. | 1 | |

| | | | | |
|---|---|---|---|---|
| | 9 | Kinetics of inhibition and specific examples (e.g., Penicillin, DIPF). Allosteric regulation and feedback mechanisms. | 1 | |
| | 10 | **Enzyme assay methods:** Continuous and discontinuous assays. | 2 | |
| **III** | **Enzyme Production, Purification, Immobilization, and Engineering** | | **15** | **20** |
| | 11 | **Microbial, Plant, and Animal Sources:** Screening and selection of enzyme-producing organisms. | 3 | |
| | 12 | **Upstream Processes:** Media optimization, fermentation techniques (submerged and solid-state). **Downstream Processes:** Methods of enzyme extraction, purification techniques (precipitation, chromatography, ultrafiltration). | 3 | |
| | 13 | **Enzyme Stability:** Factors affecting stability; stabilization techniques. Enzyme degradation and denaturation mechanisms. | 2 | |
| | 14 | **Enzyme production:** Cloning, overexpression, extraction, and purification strategies. | 2 | |
| | 15 | **Enzyme immobilization methods:** Adsorption, matrix entrapment, encapsulation, cross-linking, and covalent binding. | 2 | |
| | 16 | **Properties of Immobilized Enzymes:** Kinetics, stability, and reusability, Effects of mass transfer resistance. Advantages and limitations of immobilization techniques. | 2 | |
| | 17 | Applications in biosensors (clinical diagnostics and environmental monitoring) and ELISA. | 1 | |
| **IV** | **Applications and Structural Insights** | | **15** | **20** |
| | 18 | **Protein Engineering**: Rational design and directed evolution for improved enzyme performance. | 2 | |
| | 19 | **Metabolic Pathway Engineering**: Manipulating enzymes for synthetic metabolic pathways. | 2 | |

| | | | | |
|---|---|---|---|---|
| | 20 | **Advanced Techniques:** Use of CRISPR, site-directed mutagenesis, and computational modeling in enzyme design. | 2 | |
| | 21 | **Artificial Enzymes:** Design and applications of nanozymes and catalytic antibodies. **Industrial applications:** Amylases, lipases, proteolytic enzymes, cellulose-degrading enzymes, and fermentation processes, use in bioremediation. | 3 | |
| | 22 | **Clinical applications:** Enzymes as thrombolytic and anti-inflammatory agents, and diagnostic isoenzymes. | 2 | |
| | 23 | **Structure-activity relationships (SAR):** High-throughput screening and structure-based drug design. | 2 | |
| | 24 | **Case studies:** DHFR and combinatorial approaches in drug discovery. | 2 | |
| **V** | **Open ended** | | **10** | **10** |
| | 1. **Extraction and Preparation of Enzymes:** Extraction of enzymes from plant or microbial sources (e.g., amylase from sweet potato or bacterial culture).<br>2. **Estimation of enzyme activity using colorimetric or spectrophotometric methods:** (e.g., DNS assay for amylase, casein digestion for protease). Calculation of specific activity and enzyme units (IU and Katal).<br>3. **Characterization of Enzymes:** Study of protein nature using qualitative tests (e.g., Biuret test, Lowry method).<br>4. **Kinetic Studies:** Determination of Michaelis-Menten parameters (Km and Vmax) for enzymes like amylase or catalase. Use of Lineweaver-Burk plots for graphical analysis.<br>5. **Enzyme Production:** Microbial screening for enzyme producers (e.g., starch hydrolysis for amylase or casein digestion for protease).<br>6. **Enzyme Purification:** Precipitation methods (e.g., ammonium sulfate precipitation).<br>7. **Enzyme Immobilization:** Immobilization using adsorption (e.g., on activated carbon), entrapment (e.g., alginate beads), and covalent binding.<br>8. **Protein Engineering**: In silico design of enzymes using computational tools (e.g., PyMOL for structural visualization). | | | |

| | | |
|---|---|---|
| | **9. Projects**: Encourage students to design mini-projects combining production, purification, and application of an enzyme. | |

Books and References:


1. **Berg, J. M., Tymoczko, J. L., & Stryer, L. (2002).** Biochemistry (5th ed.). W. H. Freeman.
2. **Buchholz, K., Kasche, V., & Bornscheuer, U. T. (2012).** Biocatalysts and enzyme technology (2nd ed.). Wiley-Blackwell.
3. **Cleland, J. L., & Craik, C. S. (1996).** Protein engineering: Principles and practice. Wiley-Liss.
4. **Cook, P. F., & Cleland, W. W. (2007).** Enzyme kinetics and mechanism. Garland Science.
5. **Cornish-Bowden, A. (2012).** Fundamentals of enzyme kinetics (4th ed.). Portland Press.
6. **Nelson, D. L., & Cox, M. M. (2008).** Lehninger principles of biochemistry (5th ed.). W. H. Freeman.
7. **Palmer, T. (2004).** Enzymes: Biochemistry, biotechnology, and clinical chemistry (2nd ed.). Affiliated East-West Press.
8. **Palmer, T. (2004).** Enzymes: Biochemistry, biotechnology, clinical chemistry (2nd ed.). Affiliated East-West Press.
9. **Punekar, N. S. (2018).** Enzyme: Catalysis, kinetics, and mechanisms. Springer.
10. **Segel, I. H. (1993).** Enzyme kinetics: Behavior and analysis of rapid equilibrium and steady-state enzyme systems. Wiley.

**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO 6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | | | 3 | | | | | |
| CO 2 | 3 | | | | | | 3 | 2 | | | | |
| CO 3 | 3 | 2 | | | | | 3 | | | 2 | | |
| CO 4 | 3 | 2 | 2 | | 2 | | 3 | | | 2 | 2 | 2 |
| CO 5 | 3 | 2 | 2 | | 2 | 2 | 3 | | 2 | 2 | 2 | |
| CO 6 | | 2 | 2 | | 2 | | 3 | | 2 | 3 | 2 | |

**Correlation Levels:**

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

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**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 | ✓ | ✓ | | ✓ |

## EIGHTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS

## PLA8EJ401 - ENZYME TECHNOLOGY

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

### SECTION A
**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Comment onthe key steps in an enzyme assay?
2. Explain the naming of enzymes according to the IUB classification system?
3. Explain how the active site of an enzyme determines its specificity.
4. Enumerate Michaelis-Menten equation, and what does Km represent?
5. Differentiate between solid-state and submerged fermentation?
6. Define abzymes and their potential applications.
7. Examine the role pH in enzyme activity?
8. Relate immobilized enzymes to free enzymes in terms of stability?
9. Compare the mechanisms of acid-base catalysis and covalent catalysis.
10. Explain the significance of turnover number (kcat) in enzyme kinetics with an example?

### SECTION B
**(Answer all questions. Each question carries 5 marks. Ceiling: 36 Marks)**

11. Discuss the concept of substrate binding and the factors that influence enzyme-substrate interactions.
12. Explicate the role of enzyme inhibition in drug development? Provide examples.
13. Describe the principles and applications of enzyme-based biosensors.
14. Compare the lock-and-key model with the induced-fit model of enzyme catalysis.
15. Demonstrate how the Lineweaver-Burk plot can be used to determine enzyme kinetics parameters.
16. Summarizethe primary, secondary, tertiary, and quaternary structures of enzymes.
17. Analyze the role of enzyme catalysis in metabolic pathways and its regulation.
18. Differentiate between allosteric enzymes and isoenzymes, providing relevant examples.

### SECTION C
**(Answer any one. Each question carries 10 marks. 1 x 10 = 10 Marks)**

19. Break downthe process of enzyme production from microbial sources into key steps.
20. Discuss the ethical considerations of using CRISPR and protein engineering for enzyme modification.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA8EJ402** | | | | |
| **Course Title** | **NANOTECHNOLOGY IN BIOSCIENCE** | | | | |
| **Type of Course** | **Elective** | | | | |
| **Semester** | **VIII** | | | | |
| **Academic Level** | **400 - 499** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | | 60 |
| **Pre-requisites** | Basic knowledge of plant biology, tissue culture and regeneration at the Higher Secondary Level. | | | | |
| **Course Summary** | The course introduces students to. explores the application of nanotechnology in bioscience, including the design, synthesis, and characterization of nanomaterials for biomedical applications. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the principles of nanotechnology and its applications in bioscience. | U/R | F | Instructor-created exams / Quiz |
| CO2 | Learn the techniques involved in nanoscale engineering | U/R | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Attain knowledge in toxicity and safety measures adopted in nanotechnology | Ap | P | Seminar Presentation/ Assignments |
| CO4 | Develop critical thinking and problem-solving skills through laboratory experiments and case studies. | E/An/C | M | Laboratory experiments, Assignments, case studies |
| CO5 | Understand and Analyse the application of nanotechnology in different fields of bioscience | U/An | M | Test/ Group discussion/ seminar |
| CO6 | Understand and evaluate the emerging research trends and scopes in nanotechnology | U/E | M | Test/ Group discussion/ Assignment. |

* - 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 60 | Marks (70) |
|---|---|---|---|---|
| I | **Introduction to Nanotechnology** | | **10** | **12** |
| | 1 | Definition and history of nanotechnology. Applications of Nanotechnology. Nanobiomaterials, organic nanomaterials, magnetic nanoparticles, quantum dots. | 2 | |
| | 2 | Nanomaterials – sources, types, properties and applications, medical applications of nanowires and nanorods. | 2 | |
| | 3 | Carbon-based nanomaterials - applications in water filters, vaccine production and photodynamic therapy. | 2 | |
| | 4 | Metal-based nanomaterials **-** applications in biomedical field, agriculture, environmental remediation and food packaging. | 2 | |
| | 5 | Carbon nanotubes (CNTs) **-** applications in drug delivery, and regenerative medicine and cancer treatment. | 2 | |
| II | **Nanoscale Science and Engineering** | | **13** | **20** |
| | 6 | Nanoscale materials and their significance, applications as drug delivery systems, diagnostic devices, and biocompatible materials for implants and prosthetics. | 3 | |
| | 7 | Atomic and molecular structures, quantum mechanics and nanoscale phenomena. Surface science and nanoscale interactions. | 3 | |
| | 8 | Nanoscale engineering and nanoscale fabrication techniques – applications in tissue engineering, disease detection and optical imaging. | 2 | |
| | 9 | Nanoscale devices and systems - Nanoelectronics and nanophotonics- Nanomechanics and nanorobotics. Applications of nanodevices and systems. | 3 | |
| | 10 | Nanomaterials for wastewater management and nanomaterials for antimicrobial or anti-moth applications. | 2 | |
| III | **Nanotoxicology and Safety** | | **12** | **20** |
| | 11 | Toxicity of nanomaterials, mechanisms of toxicity, oxidative stress, cytotoxicity and genotoxicity. | 2 | |
| | 12 | Safety protocols and regulations against nanotoxicity, Per- | 2 | |

| | | | | |
|---|---|---|---|---|
| | | sonal protective equipment (PPE) and techniques for handling nanomaterials. | | |
| | 13 | Environmental impact of nanomaterials - pollution, toxicity and bioaccumulation, impact on air, soil and aquatic systems. | 2 | |
| | 14 | Nanotechnology in agriculture, Nanofertilizers, nanopesticides, nanomaterials for plant growth and for soil feature regulation. | 3 | |
| | 15 | Nanotechnology for food safety, nanomaterials for food packaging, food safety and food preservation. | 3 | |
| **IV** | **Applications of Nanotechnology** | | **15** | **18** |
| | 16 | Biomedical applications, Energy applications, Environmental applications, Consumer products and industrial applications. | 3 | |
| | 17 | Ethical, social and societal implications of nanotechnology, nanotechnology for transhumanism. | 3 | |
| | 18 | Regulatory frameworks, risk factors and safety protocols in nanotechnology. | 3 | |
| | 19 | Future directions and emerging trends in nanotechnology, nanotechnology in wound and burn care, aerogel-based nanomaterials in biomedical fields. | 3 | |
| | 20 | AI in nanotechnology, nanobots, nanomedicine, functional recognition imaging and nanomanufacturing. | 3 | |
| **V** | **Open ended** | | **10** | **10** |
| | 1. Synthesis of silver nanoparticles using chemical reduction method<br>2. Synthesis of gold nanoparticles using citrate reduction method<br>3. Development of a glucose biosensor using gold nanoparticles<br>4. Characterization of drug delivery systems using spectroscopy and microscopy<br>5. Preparation of nanoparticles for soil remediation<br>6.Handling, disposal of nanoparticles and Safety protocols for working with chemicals and biological agents | | | |
| | Sections from References: | | | |

Books and References:


- Siddiqui, M. H., Al-Whaibi, M. H., & Mohammad, F. (2015). Nanotechnology and plant sciences. *Springer International Publishing Switzerland. DOI*, *10*, 978-3.

- Tawade, P. V., & Wasewar, K. L. (2023). Nanotechnology in biological science and engineering. In *Environmental Applications of Microbial Nanotechnology* (pp. 43-64). Elsevier.
- Bagchi, M., Moriyama, H., & Shahidi, F. (2012). Bio-nanotechnology: a revolution in food, biomedical and health sciences.
- Navalakhe, R. M., & Nandedkar, T. D. (2007). Application of nanotechnology in biomedicine.
- Labhasetwar, V., & Leslie-Pelecky, D. L. (Eds.). (2007). Biomedical applications of nanotechnology
- Nasrollahzadeh, M., Sajadi, S. M., Sajjadi, M., & Issaabadi, Z. (2019). An introduction to nanotechnology. In *Interface science and technology* (Vol. 28, pp. 1-27). Elsevier.

**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO4 | PSO 5 | PSO 6 | PO 1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | | | 3 | | | | | |
| CO 2 | 3 | | | | | | 3 | 2 | | | | |
| CO 3 | 3 | 2 | | | 2 | | 3 | | | 2 | | 2 |
| CO 4 | 3 | | 2 | 2 | | | 3 | 2 | 3 | | | |
| CO 5 | 3 | 3 | 2 | | | 2 | 3 | | 2 | 2 | 2 | |
| CO 6 | 3 | 3 | 3 | | | 2 | 3 | | 2 | 3 | 3 | |

**Correlation Levels:**

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

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)
-

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examina-tions |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | | | | |
| CO 5 | ✓ | ✓ | ✓ | ✓ |
| CO 6 | ✓ | ✓ | ✓ | ✓ |

**EIGHTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**
**PLA8EJ402 - NANOTECHNOLOGY IN BIOSCIENCE**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Explain why biocompatible materials are important for implants and prosthetics.
2. Explain diagnostic procedures are enhanced by nanodevices?
3. Compare and contrast magnetic nanoparticles and quantum dots?
4. Define nanobiomaterials and Name two types of carbon-based nanomaterials.
5. List two applications of nanowires and nanorods in medicine.
6. Comprehend the effectiveness of nanomaterials in antimicrobial applications?
7. Examine the concern due to bioaccumulation of nanomaterials in environmental safety.
8. Comment on AI and nanotechnology work together in functional imaging?
9. Analyze how oxidative stress leads to cytotoxicity and genotoxicity in nanomaterials.
10. Compare the potential risks and benefits of using nanobots in medical procedures.

## SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. Analyze the effectiveness of aerogel-based nanomaterials in biomedical applications.
12. Compare the risks associated with nanopesticides and nanofertilizers in agriculture.
13. How do different nanoscale engineering techniques influence future trends in nanotechnology?
14. Why are personal protective equipment (PPE) and safety protocols crucial in handling nanomaterials?
15. Compare the challenges of integrating nanotechnology in wound care versus burn care treatments.
16. Examine the relationship between surface science and nanoscale interactions in medical applications.
17. Critique the impact of nanotechnology on global energy solutions.
18. Evaluate the risks and benefits of nanomaterials in consumer products.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. How do nanobots improve efficiency in drug delivery and disease treatment?
20. Analyze the ethical concerns surrounding nanotechnology in consumer products versus healthcare.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA8EJ403** | | | | |
| **Course Title** | **FUNGAL BIOLOGY AND TECHNOLOGY** | | | | |
| **Type of Course** | **Elective** | | | | |
| **Semester** | **VIII** | | | | |
| **Academic Level** | **400 - 499** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | | 60 |
| **Pre-requisites** | Knowledge on Fungal diversity, reproduction and growth | | | | |
| **Course Summary** | This course gives a detailed study on the fungal structure and ultra structure, metabolism, fungal genetics, interaction, industrial and agricultural applications and recent trends in mycology research. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the diversity and structure of fungi | U/R | F | Assignment, seminar group discussion |
| CO2 | Learn the developmental pattern of infectious structures | U/R | C | Test paper |
| CO3 | Analyse fungal metabolism for energy and secondary metabolite production | An | M | Seminar Presentation/ Assignments |
| CO4 | Critically evaluate the physiological mechanism of fungal cell to tolerate different kinds of stress and its ecological significance | An/E | M | Instructor-created exams /Demonstration |
| CO5 | Analyse the role of molecular studies in Fungi for human welfare | An | M | Test<br>Seminar<br>Group discussion |
| CO6 | Evaluate role of fungi in ecosystem and applications of fungal studies | E | M | Group discussion, Test<br>Assignment |

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

# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Met-acognitive Knowledge (M)

**Detailed Syllabus:**

| Mod-ule | Unit | Content | Hrs (60) | Marks (70) |
|---|---|---|---|---|
| I | **Introduction to Fungal diversity** | | **8** | **10** |
| | 1 | The Fungal Tree of Life, Characteristics and functions of fungi in ecosystem, Fungal biotechnology | 2 | |
| | 2 | Overview of fungal classification by Tedersoo *et al*. (2018) . Fungus and fungus-like organisms. | 2 | |
| | 3 | Characteristics of phyla in true Fungi and fungus-like organisms | 2 | |
| | 4 | Fungus- Structure and ultra structure: Hyphae as a part of colony, Yeast cell, fungal cell wall components, septa, nucleus, cytoskeleton and molecular motors | 2 | |
| II | **Fungal growth, development and nutrition** | | **12** | **15** |
| | 5 | Fungal growth- Apical growth of fungal hyphae, spore germination and orientation of hyphae, yeast cell-CDC genes in fission, 'landmarks' in budding, Fungal growth kinetics | 2 | |
| | 6 | Differentiation and development- mould yeast dimorphism, and its switch, infection structures and morphogenic triggers | 2 | |
| | 7 | Roles of hydrophobins in hyphae differentiation, Sexual development- mating and hormone and genetic control ( Brief account), Sporocarp formation. | 2 | |
| | 8 | Commercial mushroom: Exploitation of Differentiation | 2 | |
| | 9 | Fungal nutrition-Nutrient requirements, adaption for nutrient capture- enzymes, defence territory, mineral requirements, fungal culture-fungi that cannot be cultured | 2 | |

| | | | | |
|---|---|---|---|---|
| | 10 | Biodegradation by Fungi - commercial and ecological aspects of fungal enzymes, substrate utilisation efficiency.. | 2 | |
| **III** | **Fungal metabolism and fungal products** | | **15** | **20** |
| | 11 | Overview of central metabolism to obtain energy-coordination of metabolism and balancing of pathways | 2 | |
| | 12 | Mobilisation of energy storage compounds, secretion of organic acids as commercial products, Chitin Lysin synthesis | 3 | |
| | 13 | Secondary metabolism- Pathways and precursors; penicillins, Mycotoxins, Ergot alkaloid, aflatoxins, sporidesmin, other toxins precursor and specific role/toxicity ) | 4 | |
| | 14 | Tolerance to extreme condictions-physiological basis and ecological implications of temperature, pH, oxygen and water stress, Microbial consortium for human and gut environment | 3 | |
| | 15 | Hydrogenosomes and mitochondria, Commercial aspects of water stress tolerance | 3 | |
| **IV** | **Fungal genetics and interaction** | | **15** | **25** |
| | 16 | Overview of Fungi in genetic research- *Neurospora* and classical genetics, Structure and organisation of fungal genome, Genetic variation in fungi. | 2 | |
| | 17 | Applied molecular genetics in Fungi-genes for plant pathogenicity, yeast killer system, control of virulence. Molecular approaches to population structure (Brief account) | 3 | |
| | 18 | Whole genome sequencing- benefits- *Neurospora* genome sequencing, EST and microarray technology (Brief account) | 3 | |

| | | | | |
|---|---|---|---|---|
| | 19 | Fungal Spore dormancy and germination-Dormancy, dispersal and infectious behaviour of zoospores- 'homing and docking", Air born spores and human health | 2 | |
| | 20 | Fungal Ecology-Biochemical and molecular toolbox for fungal ecology: Saprophyte- pioneer, secondary, composts, root zone, decaying wood. Parasite-Antibiotics and role, mycoparasites, Competitive interaction with plants, Symbiots: Mycorrhizas- AM, Ectotrphic, Ericoids, Lichens, Fungus-insects mutualism | 3 | |
| | 21 | Applied Mycology- Fungi in bioremediation. Sustainable agriculture development and food production, Entrepreneurship with fungi | 2 | |
| **V** | **Open ended** | | **10** | **10** |
| | 1. Cultural methods of Fungi<br>2. *Trichoderma* and agriculture<br>3. Antifungal metabolites from bacteria<br>4. Endophytic fungi and pharmaceutical industry<br>**5.** Value added products from fungal biomass | | | |

**References**


1. Deacon, Jim W. *Fungal biology*. John Wiley & Sons, 2013.
2. Hudson, Harry J. Fungal biology. CUP Archive, 1991.
3. Kavanagh, Kevin, ed. Fungi: biology and applications. John Wiley & Sons, 2017.
4. Satyanarayana, Tulasi, Sunil K. Deshmukh, and B. N. Johri, eds. Developments in fungal biology and applied mycology. Singapore: Springer Singapore, 2017.
5. Gupta, Vijai Kumar, and Maria G. Tuohy, eds. Fungal biology. Springer, 2013.
6. Hoffmeister, Dirk, and Markus Gressler, eds. Biology of the Fungal Cell. Vol. 8. Springer, 2019.
7. Mark, Arentshorst, et al. "Fungal Biology." Cham: Springer International Publishing (2014): 263-272.
8. Gupta, Vijai Kumar, et al. Laboratory protocols in fungal biology. Springer International Publishing, 2022.
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10. Benz, J. Philipp, and Kerstin Schipper, eds. Genetics and biotechnology. Springer International Publishing, 2020.
11. Martín, Juan-Francisco, Carlos García-Estrada, and Susanne Zeilinger, eds. Biosynthesis and molecular genetics of fungal secondary metabolites. Springer, 2014.
12. Nowrousian, Minou, ed. Fungal genomics. Vol. 13. Springer Science & Business Media, 2014.

**Mapping of COs with PSOs and POs :**

| | PSO 1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | 3 | | | | | 3 | | | 2 | | |
| CO 2 | 3 | | | | | | 3 | | | | | |
| CO 3 | 3 | 2 | | | | 2 | 3 | | | 2 | | |
| CO 4 | 3 | | 2 | | 2 | | 3 | | | | 2 | 3 |
| CO 5 | 3 | 3 | | | | 2 | 3 | 2 | 2 | 2 | 2 | |
| CO 6 | 3 | 3 | 2 | | 3 | 2 | 3 | | 2 | 2 | 2 | 3 |

**Correlation Levels:**

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

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam/ quiz | Assignment | Field study/ Practicals/ Group discusion | End Semester Examina-tions |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | ✓ | ✓ | ✓ | ✓ |
| CO 6 | ✓ | ✓ | ✓ | ✓ |

**EIGHTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA8EJ403 - FUNGAL BIOLOGY**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

**SECTION A**

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Comment on the ultrastructure of fungal cell.
2. Contrast the characters of fungus and fungus like organism.
3. Generalize the metabolic balancing pathways in fungi
4. Express the findings of Neurospora whole genome sequencing
5. Explain the health hazards caused by airborne spores
6. Outline different toolbox o analyse fungal content on natural material
7. Illustrate genetic and hormonal control in sexual development in fungi
8. Justify the role of genetic study in the welfare of human
9. Examine the production of Penicillin and chitin synthesis
10. Discuss symbiotic fungi in ecosystem.

**SECTION B**

**(Answer all questions. Each question carries 5 marks. Ceiling: 36 Marks)**

11. Analyse the application of molecular genetics in Fungi.
12. Illustrate fungal growth kinetics and fungal adaptation to nutrient capture.
13. Describe fungal wall architecture and wall components
14. Examine the role of fungi as saprophyte in ecosystem
15. Outline the mechanism of fungal growth
16. Analyse the physiological basis of temperature and water stress tolerance.
17. Examine the application of fungal studies in various fields
18. Explain about Mycorrhizas and AM

**SECTION C**

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. Appraise various interactions of fungus in ecosystem.
20. Discuss the various secondary metabolite products from fungi

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| | | | | | |
|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA8EJ404** | | | | |
| **Course Title** | **PLANT MORPHOGENSIS AND DEVELOPMENTAL INTEGRATION** | | | | |
| **Type of Course** | **Elective** | | | | |
| **Semester** | **VIII** | | | | |
| **Academic Level** | **400 - 499** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 4 | 4 | - | - | 60 |
| **Pre-requisites** | A strong foundation in plant science, phytochemistry and medicinal uses of common plant parts at Higher Secondary Level is needed. | | | | |
| **Course Summary** | The course aims to provide an in-depth exploration of phytochemicals of medicinal interest. The curriculum will equip students with a comprehensive understanding of pharmacognostic aspects, empowering them to explore numerous applications related to plant science. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the basics of plant morphogenesis in general and molecular level | U | F | Instructor-created exams / Quiz |
| CO2 | Understand the gene regulation in embryogenesis and organogenesis | U | C | Test/Seminar |
| CO3 | Analyse different factors regulating floral evocation | An | M | Seminar Presentation/ Group Discussion |
| CO4 | Analyse the role of different genes involved in floral induction in plants | An | M | Instructor-created exams / group Discussion |
| | Evaluate the new techniques involved in developmental studies of plants | E | M | Test/ Seminar presentation |
| | Understand the applications of nanotechnology in plant developmental studies | U | C | Test/viva |

* - 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 (60) | Marks (70) |
|---|---|---|---|---|
| I | | **Basics of Plant morphogenesis** | **12** | **18** |
| | 1 | General introduction, Important terms in plant morphogenesis-potency (Totipotency, pleuripotency, multi potency, and unipotency), symmetry, polarity, differentiation and commitment. | 3 | |
| | 2 | Factors influencing morphogenesis: Morphogens, properties and gradients, plant morphogens, types. | 2 | |
| | 3 | Plant growth regulators as morphogen; morphogenic signaling of auxin, gibberellin, cytokinin and ethylene (two component system signaling). | 3 | |
| | 4 | Molecular basis of morphogenesis; Genes and DNA binding elements involved in morphogenesis action (Homeobox genes in plants). | 2 | |
| | 5 | Micro RNA mediated morphogenesis; small RNAs as plant morphogens their function (briefly). | 2 | |
| II | | **Embryogenesis and organogenesis in plants** | **12** | **16** |
| | 6 | General introduction of the process of embryogenesis and organogenesis in plants. meristem activity, patterning and it's types (SAM & RAM). | 3 | |
| | 7 | Cell division theories of plant development: role of the cell cycle machinery in plant development- Cellular theory, Organismal theory, Neo cell theory. | 3 | |
| | 8 | Gene regulations in development:specifying the shoot and root meristems (REV, PLT2), Meristem cells of the *Arabidopsis thaliana* embryo and beyond. | 3 | |
| | 9 | Correlation of ploidy with cell size: Endoreplication, ploidy changes during embryogenesis. Cell cycle regulation during organogenesis in Plants. | 32 | |
| III | | **Floral evocation in Plants** | **18** | **22** |
| | 10 | Floral evocation: Induction of flowering integrates external and internal cues (autonomous regulation, obligate or qualitative response, facultative or quantitative**),** phase changes in floral development (Juvenile phase, adult vegetative phase, adult reproductive phase). | 3 | |

| | | | | |
|---|---|---|---|---|
| | 11 | Regulation of phase change in Arabidopsis: Role of carbohydrate (threhalose-6-phosphate), regulation mediated by microRNAs (action of miR156 and miR172), | 2 | |
| | 12 | Photoperiodism: Monitoring Day Length, classification of plants according to their photoperiodic responses (short day, long day and day neutral plants). clock hypothesis, the coincidence model is based on oscillating light sensitivity (action of constants CO gene in LDPs) | 3 | |
| | 13 | Vernalization: Summer and winter annuals, process, effect of vernalization results in competence to flower at the shoot apical meristem, epigenetic changes during vernalization (suppression of FLC genes). | 3 | |
| | 14 | Floral induction: Long-distance Signaling Involved in Flowering, florigen hormone, and its translocation. The flower inducing protein FLOWERING LOCUS T (FT) in *Arabidopsis* and its translocation. | 3 | |
| | 15 | Genes involved in floral transition: Floral meristem identity genes (Leafy, AP1, CAL) and floral organ identity genes (AP1, AP2, AP3, PI, AG), ABC model of flowering, ABCDE model of flowering and their homeotic gene mutations. | 4 | |
| **IV** | **New trends in development of plants** | | **8** | **14** |
| | 17 | Stem cells: Overview of stem cells, Historical background and milestones in stem cell research, Mechanisms of stem cell differentiation, Types of stem cells (embryonic, adult, induced pluripotent stem cells) Stem cell properties, Stem cell niche and regulation, Induced Pluripotent Stem Cells (iPSCs), Applications in stem cell technology in plant development | 3 | |
| | 18 | Gene editing: The history and evolution of plant gene editing, Introduction to gene editing technologies (e.g., CRISPR-Cas9, TALENs, ZFNs)- briefly. | 2 | |
| | 19 | Nanotechnology in plant development: Overview of nanotechnology: Definitions, history, and scope, Fundamentals of plant growth and development at the cellular and molecular levels. Production of nano-fertilizers. | 3 | |
| **V** | **Open ended** | | **10** | **10** |
| | | | | |

**Books and References**:


1. Erdtman, G. (1952). Pollen morphology and Plant taxonomy. Amquist&Wiksell, Stockholm
2. Bhojwani, S. S. and Razdan, M. K. 2004. Plant Tissue culture: Theory and Practice. Elsevier.
3. Biochemistry_Molecular_Biology_of_Plants_by_Bob_B_BuchananWilhelm.pdf.
4. Palatnik, J. F., Allen, E., Wu, X., Schommer, C., Schwab, R., Carrington, J. C., & Weigel, D. (2003). Control of leaf morphogenesis by microRNAs. *Nature*, *425*(6955), 257-263.
5. Nodine, M. D., & Bartel, D. P. (2010). MicroRNAs prevent precocious gene expression and enable pattern formation during plant embryogenesis. *Genes & development*, *24*(23), 2678-2692.
6. Taiz, L. and Zeiger, E. (2002) Plant Physiology (Third Edition). Sinauer Associates, Inc., Publishers, Sunderland.

**Mapping of COs with PSOs and POs :**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | | | 3 | | | | | |
| CO 2 | 3 | | | | | | 3 | | | 1 | | |
| CO 3 | 3 | | | 3 | 2 | | 3 | 3 | | 1 | | |
| CO 4 | 3 | | | 3 | 2 | | 3 | 3 | | | 2 | |
| CO 5 | 3 | | 2 | 3 | 2 | | 3 | 3 | 1 | 1 | 2 | 1 |
| CO 6 | 3 | | | | | 2 | 3 | | | 3 | | |

**Correlation Levels:**

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

**Assessment Rubrics:**

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam/ quiz | Assignment | Filed study /Case study | End Semester Examina-tions |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | ✓ | ✓ | | ✓ |
| CO 6 | ✓ | ✓ | | ✓ |

**EIGHTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA8EJ404 - PLANT MORPHOGENSIS AND DEVELOPMENTAL INTEGRATION**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Comment on role of carbohydrate in flowering
2. Explain the production of nano fertilizers.
3. Add notes on Cell division theories of plant development.
4. Enumerate examples of gene editing tools.
5. Delineate the Types of stem cells.
6. Write note on coincidence model.
7. Describe the term pluripotency with example.
8. What are the salient features of two component system signaling?
9. Explain the microRNA mediated morphogenesis.
10. Reveal the role florigen in flowering.

## SECTION B

**(Answer all questions. Each question carries 5 marks. Ceiling: 36 Marks)**

11. Discuss on various genes involved in development of SAM.
12. Explicate the role of DNA binding elements involved in morphogenesis action.
13. Describe the process of vernalization focusing on its molecular mechanism.
14. Elucidate the technique CRISPR CAS9 with its significance in plant genomic editing.
15. Analyse different signaling process of plant growth regulators (PGRs)
16. Analyse the fundamentals of plant growth and development.
17. Classify various microRNAs involved in floral evocation and detail their features.
18. Expound various factors influencing morphogenesis: Morphogens, properties and gradients?

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 x 10 = 10 Marks)**

19. Discuss on major models and their mutations proposed for the mechanism of flowering.
20. “Floral induction leads to a reprogramming of the shoot apical meristem” Substantiate.

## MINOR B

## (Preferable for Science students)

## COMPLEMENTORY PLANT SCIENCE

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| | | | | | |
|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA1MN101** | | | | |
| **Course Title** | **BASICS OF PLANT SCIENCE: INSTRUMENTS AND TECHNIQUES** | | | | |
| **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** | Basic knowledge on fundamentals of plant science at the Higher Secondary level. | | | | |
| **Course Summary** | The course provides the basics of plant science instruments and methods, ranging from fundamental concepts in plant science to various branches of botany, essential instruments and imaging techniques, safety measures, common methods used in plant science research, and techniques for handling specific instruments and emphasizes the importance of safety in laboratory settings, including precautions for handling toxic chemicals and bio-safety measures. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the fundamental principles of plant science. | U | F | Test paper/ Assignment |
| CO2 | Operate various instruments used in plant science research. | U | P | Practical exam |
| CO3 | List various imaging techniques and its advantages | U | F | Seminar Presentation/ Test Paper |
| CO4 | Understand biosafety measures practiced in the laboratory | U | F | Test paper/ Assignment |
| CO5 | Prepare molar solutions and fixatives | Ap | P | Practical exam |
| CO6 | Develop and understand eco-friendly laboratory practices | U | F | Seminar 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) | Marks (70) |
|---|---|---|---|---|
| **I** | **Basics in Plant Science** | | **8** | **12** |
| | 1 | Fundamentals in Plant Science: Overview of plant biology and its importance. Evolutionary history of plants, Origin of plant science, Need of plant science study. | 2 | |
| | 2 | Relation of plants to man: Plants as a source of food: domestication, agriculture, and culinary uses, Medicinal plants: traditional remedies and modern pharmacology, Economic significance of plants: industry, trade, and commerce, Aesthetic and cultural value of plants: gardening, art, and rituals. | 2 | |
| | 3 | Relation of Botany to other sciences (Interdisciplinary Connections of Botany). Introduction to plant kingdom.Overview of plant diversity: algae, mosses, ferns, gymnosperms, and angiosperms. Plant classification: taxonomic hierarchy and systematic. | 2 | |
| | 4 | Brief description of various branches in Botany (Taxonomy of lower and higher groups of plants, Plant Anatomy, Morphology, Embryology, Physiology, Ecology, Phytogeography, Economic Botany, Cytology, Genetics, Plant breeding, Ethnobotany, Biotechnology, Molecular Biology, Biochemistry). | 2 | |
| **II** | **Basic Instruments** | | **10** | **18** |
| | 5 | Basic instruments: Bunsen burner, thermometer, pH meter, analytical balance, electronic balance, autoclave, oven, water bath, volumetric dispenser, distillation unit, $CO_2$ incubator, shaking incubator, hot air oven. | 3 | |
| | 6 | Other instruments needed in plant science study: Autoclave, Spectrophotometer, Electrophoresis Apparatus, Centrifuge, Gas Chromatograph, Liquid Chromatography. (Brief account only) | 2 | |

| | | | | |
|---|---|---|---|---|
| | 7 | Basic Imaging instruments: Dissection Microscope, Light Microscope and micrometers. | 3 | |
| | 8 | Advanced Microscopes: Phase Contrast Microscope, Interference Microscope, Fluorescence Microscope, Confocal Microscope, Electron Microscope (TEM and SEM). | 2 | |
| **III** | **Bio-safety Measures** | | **12** | **18** |
| | 9 | Personal protective equipment (PPE) and its proper use -Safety Glasses, Respirators, Eye wash stations, First aid kit, Fire extinguisher, Laminar Air Flow Cabinet. | 2 | |
| | 10 | Overview of regulatory agencies and guidelines on biosafety. Types of biological hazards (e.g., bacteria, viruses, toxins). Decontamination methods for equipment and surfaces. | 2 | |
| | 11 | Classification of laboratory biosafety levels (BSL)- Requirements and features of BSL-1, BSL-2, BSL-3, and BSL-4 laboratories. | 2 | |
| | 12 | An overview on Good Laboratory Practices (GLP)- Procedures for reporting accidents, spills, and exposures, Immediate actions in case of a laboratory incident, Post-incident evaluation and documentation. | 3 | |
| | 13 | Ethical responsibilities of scientists and laboratory personnel; Eco-friendly lab practices | 3 | |
| **Iv** | **Common Methods and Microtechnique** | | **15** | **22** |
| | 14 | Molar, molal and normal solutions, buffers, molarity and normality of common acids and bases. | 4 | |
| | 15 | Preparation of Dilutions-Percentage solutions. Molar, molal and normal solutions. | 3 | |
| | 16 | Technique of handling micropipettes; Precautions about common toxic chemicals and safety measures in their handling. | 2 | |
| | 17 | Killing and fixing agents- Carnoy's formula, FAA.<br>Preparation of specimens- Whole mounts, Cytological methods – Squash method. | 2 | |

| | | | | |
|---|---|---|---|---|
| | 18 | Maceration technique, Sectioning- Hand sectioning, Microtomes - rotary | 2 | |
| | 19 | Staining techniques- common stains- safranin, acetocarmine; double staining; Mounting media- DPX and Canada balsam. | 2 | |
| **V** | **Practical** | | **30** | **20** |
| | 1 | Visit to a well-established lab to understand the best practices for safety and decontamination methods practiced in laboratories. | | |
| | 2 | Demonstrate the working of Autoclave, Spectrophotometer, Electrophoresis Apparatus, Centrifuge. | | |
| | 3 | Imaging of plant materials using Image analyzer | | |
| | 4 | Maceration technique to reveal different types of xylem elements | | |
| | 5 | Prepare molar solutions | | |

**References**


1. Sanderson, J. (2020). *Biological microtechnique*. New York: Garland Science.
2. Zimmermann, A.H., James Ellis (2017). *Botanical microtechnique*. Norderstedt, Schleswig-Holstein, Germany: Hansebooks.
3. Chee, E. (2015). *Plant microtechniques and protocols*. Heidelberg: Springer.
4. Gary Wayne Stutte, Monje, O., Wheeler, R.M. and Johnson, L.B. (2015). *Plant science*. Houston, Texas: National Aeronautics And Space Administration, Johnson Space Center.
5. Yeung, E.C., Stasolla, C., Michael John Sumner, Bing Quan Huang and Springerlink (Online Service (2015). *Plant microtechniques and protocols*. Cham: Springer International Publishing.
6. Bisen, P.S. and Anjana Sharma (2013). *Introduction to instrumentation in life sciences*. Boca Raton: Crc Press.
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9. Fleming, D.O. and Hunt, D.L. (2006). *Biological safety: Principles and Practices.* Washington: Asm Press.
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11. Ruzin, S.E. (1999). *Plant microtechnique and microscopy*. New York: Oxford University Press.
12. John Gaylord Coulter (1994). *Fundamentals of plant science*. New Delhi, India: Discovery Publishing House.

**Mapping of COs with PSOs and POs:**

| CO | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | | | | | 3 | 3 | | | | 2 |
| **CO 2** | 3 | 3 | | | | | 3 | 3 | | 2 | 2 | |
| **CO 3** | 3 | | 1 | 3 | | | 3 | 1 | 1 | | 2 | 2 |
| **CO 4** | 3 | | | 3 | 3 | | 3 | | | | 2 | |
| **CO 5** | 3 | 3 | 3 | | 3 | | 3 | 3 | 3 | | 2 | |
| **CO 6** | 3 | | | 3 | 3 | 3 | 3 | | | 2 | 2 | 3 |

**Correlation Levels:**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| CO | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | ✓ | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | ✓ | ✓ | ✓ | ✓ |
| CO 6 | ✓ | ✓ | | ✓ |

## FIRST SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS

## PLA1MN101 – BASICS OF PLANT SCIENCE: INSTRUMENTS AND TECHNIQUES

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

### SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Differentiate molarity and molality.
2. What are the advantages and disadvantages of using a ph meter?
3. How do acids differ from bases?
4. Distinguish between squash and smear techniques.
5. What are the ethical issues in a medical laboratory?
6. Give an overview on good laboratory practices.
7. In microbiology, what are the advantages of laminar air flow cabinets?
8. Reflect on the uses of micropipettes.
9. Explain the decontamination methods for equipment and surfaces.
10. Compare ocular and stage micrometers.

### SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. Discuss on the classification of laboratory biosafety levels.
12. Give an account of various Killing and fixing fluids.
13. Reflect on the personal protective devices and equipment.
14. Distinguish between CO2 incubator and shaking incubator.
15. Explore the different parts of a Light Microscope.
16. Compare rotary and sledge microtomes. Mention their applications.
17. Describe various basic and applied branches in Botany.
18. Differentiate gas and liquid chromatography.

### SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. “Advanced microscopy encompasses both high-resolution and super-resolution imaging techniques.” Substantiate this statement.
20. “Staining techniques enhance and contrast a biological specimen at the microscopic level.” Prove this with the help of conventional staining and double staining techniques.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA2MN101** | | | | |
| **Course Title** | **DIVERSITY OF MICROBES AND NON-FLOWERING PLANTS** | | | | |
| **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** | Introduction and detailed study of viruses and microbes belonging to prokaryotic and eukaryotic kingdoms, and lower plant groups | | | | |

**Course Outcomes**

| COs | Statement | Knowledge Category | Cognitive level | Tools used |
|---|---|---|---|---|
| CO1 | **Describe** microbes and lower plants | C | U | Tests, Quizes |
| CO2 | **Identify** different plant groups | F | U | Field study |
| CO3 | **Explain** life cycles and forms of lower plant groups | C | U | Tests, Group discussions |
| CO4 | **Demonstrate microscopy sample preparation techniques** | P | Ap | Laboratory experiments |
| CO5 | **Analyze** interrelationships and significance of various plant groups | M | An | Discussions, Seminar |
| CO6 | **Identify** of microbes and lower plant groups | P | Ap | Laboratory experiments |

* - 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) | Marks (70) |
|---|---|---|---|---|
| **I** | **Viruses, Bacteria, Fungi** | | **22** | **25** |
| | 1 | Characteristics of viruses, generalized architecture of viruses, shape, symmetry and types, classification, bacteriophages viroids, prions, Multiplication, replication, transcription in viruses. Economic importance of viruses. | 7 | |
| | 2 | General characteristics of bacteria, archaebacteria, actinomycetes, mycoplasmas. Ultrastructure of bacterial cell, surface appendages, bacterial cell wall and staining (with special reference to Gram staining), Classification based on shapes and nutritional types. Bacterial genetics. Economic importance of bacteria. | 7 | |
| | 3 | Fungi - General characters, brief account of Mucoromycota, Ascomycota, Basidiomycota. Reproduction in fungi – vegetative, asexual, sexual. Nutritional modes in fungi, saprobic, parasitic/pathogenic, symbiotic, lichens, mycorrhiza. Economic and ecological importance of fungi. Life cycle of *Puccinia*. | 4 | |
| | 4 | Plant diseases and their symptoms. Study of the following plant diseases: Mosaic disease of Cassava (Tapioca), Citrus canker, Blast disease of rice. | 43 | |
| **II** | **Algae** | | **8** | **15** |
| | 5 | Phycology: General characters, classification, evolutionary trends in algae | 2 | |
| | 6 | Structure, reproduction, life history and economic importance of the following classes with suitable examples:<br>a) Chlorophyceae (*Spirogyra*)<br>b) Phaeophyceae (*Sargassum*)<br>**c)** Rhodophyceae | 6 | |

| | | | | |
|---|---|---|---|---|
| **III** | **Bryophytes and Pteridophytes** | | **10** | **15** |
| | 10 | Bryology: General account, diversity and distribution. Morphology and life history of Riccia.<br>Ecological and economic significance of Bryophytes. | 5 | |
| | 11 | Pteridology: General account, diversity and distribution. Morphology and life history of *Selaginella*.<br>Ecological and economic significance of Pteridophytes | 5 | |
| **IV** | **Gymnosperms** | | **5** | **15** |
| | 17 | Gymnosperms: General account, diversity and distribution. Morphology and life history of Cycas<br>Ecological and economic importance of Gymnosperms | 5 | |
| **V** | **Practical** | | **30** | **20** |
| | 1 | Identification of fungi and their different stages from slide preparations/samples –*Aspergillus, Puccinia, Agaricus*. | | |
| | 2 | Make suitable micro preparations of vegetative and reproductive structures of *Sargassum, Riccia, Selaginella* and *Cycas*. | | |
| | 3 | Identify and draw labelled diagrams of all the types mentioned in the syllabus. | | |

**References**


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4. Kumar, H.D. 1999. Introductory Phycology. Affiliated East-West Press.
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11. Vashishta, P.C., Sinha, A.K. and Kumar, A., 2010. Botany for Degree students - Algae. S. Chand & Co., New Delhi.

**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 1 | - | - | - | - | - | 3 | | | | | |
| CO 2 | 2 | 3 | - | - | - | - | 3 | 2 | | | | |
| CO 3 | - | - | 1 | - | - | - | 3 | | | | | |
| CO 4 | - | - | 2 | 3 | - | - | 3 | | | | | |
| CO 5 | - | 1 | - | - | - | - | 3 | | | | 2 | 2 |
| CO 6 | - | - | - | 3 | - | - | 3 | | 2 | | | |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| CO | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | | | ✓ | |
| CO 6 | | | ✓ | |

## SECOND SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS

### PLA2MN101 – DIVERSITY OF MICROBES AND NON-FLOWERING PLANTS

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

### SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. What is heterospory?
2. What is a cystocarp?
3. Differentiate between lateral and scalariform conjugation.
4. What is Gram staining?
5. What are plasmids?
6. What is a coralloid root?
7. What are conceptacles?
8. Write a note on bacterial nutrition.
9. What are the general characteristics of bryophytes?
10. Write a note on prions.

### SECTION B

**(Answer all questions. Each question carries 5 marks. Ceiling: 36 Marks)**

11. Explain the ecological importance of lichens.
12. Describe the sexual reproductive structures of *Selaginella*.
13. Describe the morphology of *Sargassum*?
14. Describe the internal structure of *Riccia*.
15. How are viruses classified?
16. Write the general characters of Basidiomycota
17. Write a note on bacterial genetics.
18. Write notes on a plant-diseases caused by a virus.

### SECTION C

**(Answer any one. Each question carries 10 marks. 1 x 10 = 10 Marks)**

19. Write an essay on the economic importance of fungi.
20. What are the disease symptoms and control measures of blast disease of paddy.

**UNIVERSITY OF CALICUT**

| | | | | | |
|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA3MN201** | | | | |
| **Course Title** | **DIVERSITY OF FLOWERING PLANTS, PLANT PHYSIOLOGY, PLANT BREEDING AND PLANT BIOTECHNOLOGY** | | | | |
| **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** | Basics of Angiosperm Morphology and Taxonomy, Physiology at CBSE/DHSE/ICSE senior secondary level | | | | |
| **Course Summary** | This course explores the varying structures and functions of plant parts, and their role in maintaining the biodiversity. Also, they will get an idea about the physiological phenomena and breeding techniques. Additionally, students gain the knowledge on basic tissue culture and biotechnology | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the morphological features of various taxa | U | P | Practical exams, Assignments |
| CO2 | Classify the plants based on morphological features | Ap | P | Submission, Practical exams |
| CO3 | Compare types of CO2 fixation by different ecological group of plants | U | F | Quiz, assignments and Presentation |
| CO4 | Demonstrate the effect of factors that affect photosynthetic rate | An | P | Practical exam |
| CO5 | Compare the different methods of selection and breeding techniques | U | F | Assignments, Presentation |
| CO6 | Understand the methods of micropropagation of plants and conservation *in situ* | U | F | Assignments, Presentation, Test paper |

* - 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) | Marks (70) |
|---|---|---|---|---|
| **I** | **Diversity of flowering Plants** | | **15** | **30** |
| | 1 | Inflorescence: Types (racemose, cymose and specialized). | 1 | |
| | 2 | Flower: Flower as a modified shoot - detailed structure of flowers - floral parts – their arrangement, relative position, cohesion and adhesion - symmetry of flowers | 2 | |
| | 3 | Introduction to systems of classification – Artificial (Linnaeus); Natural (Bentham & Hooker); Phylogenetic (Engler & Prantl); Angiosperm Phylogeny Group classification. Detailed study of Bentham and Hooker's , Introduction to APG System. | 2 | |
| | 4 | Diagnostic features of plant families: Malvaceae, Fabaceae, Rubiaceae, Asteraceae, Apocynaceae, Lamiaceae, Euphorbiaceae, Poaceae. | 8 | |
| | 5 | Taxonomic information resources: Herbaria - techniques - major herbaria in the India and world (any two). Botanic gardens – role in conservation – major botanic gardens in India and word (any two).<br>Taxonomic literature: – Floras; e-floras; revisions; monographs; indices; journals, online resources and databases. | 2 | |
| **II** | **Plant Physiology** | | **15** | **20** |
| | 6 | Plant cell and water; Water as a solvent. Cohesion and adhesion. Diffusion, osmosis, osmotic pressure, water potential, imbibition, Transpiration.The ascent of xylem water. | 3 | |
| | 7 | Photosynthesis in higher plants.— Photosynthetic apparatus, Photosynthetic electron transport and photophosphorylation. Assimilatory powers- ATP and NADPH. C3. C4, CAM & C2 pathways. Ecological significance of C4, CAM & C2 metabolism. | 7 | |

| | | | | |
|---|---|---|---|---|
| | 8 | Translocation and distribution of photo assimilates- Brief account of phloem loading and unloading, pressure flow hypothesis. | 3 | |
| | 9 | Plants and inorganic nutrients. Macro and Micro nutrients. Beneficial elements. Specific roles, deficiency and toxicity. | 2 | |
| **III** | **Plant Breeding** | | **7** | **10** |
| | 10 | Definition and objectives of plant breeding - important national and international plant breeding institutes; Plant genetic resources – components of plant genetic resources, significance | 2 | |
| | 11 | Steps in Plant Breeding- a) plant introduction; b) selection- mass selection, pure line selection and clonal selection; c) hybridization- types, hybrid vigour, inbreeding depression; d) Breeding | 3 | |
| | 12 | Breeding techniques - mutation breeding; polyploidy breeding; Breeding for disease resistance | 2 | |
| **IV** | **Biotechnology** | | **8** | **10** |
| | 12 | Definition and historical development of plant tissue culture, Scope, Advantages, Applications & Limitations of Tissue Culture. | 2 | |
| | 13 | Types of culture media: solid vs. liquid media, Various Plant growth regulators and their role in nutrient media. Sterilization techniques: autoclaving, filtration, and chemical sterilants. | 2 | |
| | 14 | Principles of micropropagation, stages of micropropagation, shoot proliferation, nodal and shoot tip culture. | 2 | |
| | 15 | Brief introduction on Genetic engineering and productionn of genetically modified plants- Bt Cotton | 2 | |
| **V** | **Practical** | | **30** | **20** |
| | 1 | Students have to submit Geo tagged images of minimum ten different types of inflorescence mentioned | | |

| | | | | |
|---|---|---|---|---|
| | | in the following categories in module 1. | | |
| | 2 | Examination of floral morphology of the following plants: *Hibiscus*, *Crotalaria, Ixora, Allamanda, Hyptis & Euphorbia* | | |
| | 3 | Physiology experiments - 4 | | |
| | 4 | Hybridization procedure | | |
| | 5 | Inoculation demonstration | | |
| | 6 | Each student shall submit a minimum of 5 properly identified herbarium specimens in the standard format along with field notes (Preferably invasive species) | | |

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2. Lawrence, G.H., 1951. Introduction to Plant Taxonomy. Mac Milan Comp. Ltd., New York.
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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | 2 | 2 | | | | 3 | 3 | 2 | 2 | | |
| CO 2 | 3 | 3 | | 2 | | | 3 | 3 | | | | |
| CO 3 | 3 | 3 | 3 | | | 2 | 3 | | | 2 | 2 | 2 |
| CO 4 | 3 | 2 | | 2 | | | 3 | 3 | 2 | | 2 | |
| CO 5 | 3 | 3 | 2 | 2 | | | 3 | 3 | | 2 | | |
| CO 6 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | | 3 | 2 | 3 |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| CO | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | ✓ | ✓ | | ✓ |
| CO 6 | ✓ | ✓ | | ✓ |

**THIRD SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**
**PLA3MN201 – DIVERSITY OF FLOWERING PLANTS, PLANT PHYSIOLOGY, PLANT BREEDING AND PLANT BIOTECHNOLOGY**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Define inflorescence and provide examples of different types mentioned in the syllabus.
2. Explain the structure of a flower and discuss the significance of floral symmetry.
3. Compare and contrast the Artificial and Natural systems of classification of plants.
4. Identify two diagnostic features of each of the following plant families: Malvaceae, Fabaceae, and Asteraceae.
5. Discuss the role of botanic gardens in plant conservation.
6. Define osmosis and explain its significance in plant physiology.
7. Describe the process of photosynthesis in higher plants, highlighting the C3, C4, and CAM pathways.
8. Explain the concept of hybrid vigor and its importance in plant breeding.
9. Define tissue culture and discuss its advantages in plant biotechnology.
10. Describe the procedure for inoculation demonstration in practical plant science.

## SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. Explain the differences between racemose and cymose inflorescences, providing examples.
12. Discuss the importance of floral morphology in plant identification, using examples from Hibiscus, Crotalaria, and Ixora.
13. Describe the process of diffusion and its role in plant physiology.
14. Explain the pressure flow hypothesis and its significance in phloem translocation.
15. Discuss the significance of mutation breeding in crop improvement, citing examples.
16. Describe the stages involved in micropropagation and its applications in plant biotechnology.
17. Explain the advantages and limitations of various types of culture media used in tissue culture.
18. Discuss the ecological significance of algae in aquatic ecosystems.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. Write an essay on the economic importance of fungi in agriculture and industry.
20. Discuss the objectives and significance of plant breeding institutes, highlighting their role in crop improvement.

**MINOR C**

**(Preferable for Non-Science stream students) FUNDAMENTALS IN PLANT SCIENCE**

UNIVERSITY OF CALICUT

| | | | | | |
|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA1MN102** | | | | |
| **Course Title** | **BASICS OF PLANT SCIENCE, ENVIRONMENTAL STUDIES AND BOTANICAL ENTREPRENEURSHIP** | | | | |
| **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** | Preliminary knowledge on plant science, its branches and environmental awareness at Higher Secondary level. | | | | |
| **Course Summary** | The course provides participants with a comprehensive understanding of fundamental principles in plant biology, environmental sustainability, and the entrepreneurial aspects of botanical industries. Through a blend of theoretical knowledge and practical applications, the course aims to equip learners with the necessary skills and insights to plant biology. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the interrelationships between different fields of botany | U | F | Assignment, Presentation |
| CO2 | Acquire knowledge on the threats and conservation of biodiversity | U | F | Field Study, Assignment, presentation |
| CO3 | Understand different methods for pollution control and waste management | U | C | Group discussion, Assignments, Test paper |
| CO4 | Study different components of ecosystem, type and its functions | U | F | Assignment, Presentation, Group discussion |
| CO5 | Prepare laboratory scale botanical products from plant materials | Ap | P | Practical exam |
| CO6 | Acquire entrepreneurial mindset understanding business opportunities and challenges | Ap | P | Industrial visit, 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) | Marks (70) |
|---|---|---|---|---|
| **I** | **Introduction to Plant Science** | | **8** | **12** |
| | 1 | Fundamentals in Plant Science: Overview of plant biology and its importance. Evolutionary history of plants, Origin of plant science, Need of plant science study. | 1 | |
| | 2 | Relation of plants to man: Plants as a source of food: domestication, agriculture, and culinary uses, Medicinal plants: traditional remedies and modern pharmacology, Economic significance of plants: industry, trade, and commerce, Aesthetic and cultural value of plants: gardening, art, and rituals. | 2 | |
| | 3 | Relation of Botany to other sciences (Interdisciplinary Connections of Botany). Introduction to the plant kingdom. Overview of plant diversity: algae, mosses, ferns, gymnosperms, and angiosperms. Plant classification: taxonomic hierarchy and systematic. | 2 | |
| | 4 | Brief description of various branches in Botany (Taxonomy of lower and higher groups of plants, Plant Anatomy, Morphology, Embryology, Physiology, Ecology, Phytogeography, Economic Botany, Cytology, Genetics, Plant breeding, Ethnobotany, Biotechnology, Molecular Biology, Biochemistry). | 2 | |
| | 5 | Contemporary Issues in Plant Biology-Genetically modified organisms (GMOs) and their impact on agriculture and the environment, Climate change and its effects on plant communities, Sustainable agriculture: organic farming, agroecology, and permaculture. | 1 | |
| **II** | **Introduction to Environmental studies** | | **12** | **20** |
| | 6 | Ecosystem: Definition, abiotic and biotic factors, trophic structure, Food chain and food web, Ecological pyramids, Energy flow, Productivity of | 3 | |

| | | | | |
|---|---|---|---|---|
| | | ecosystems. | | |
| | 7 | Plant Succession: Definition – Primary and Secondary succession; Autogenic and allogenic succession; Mechanism of plant succession– Hydrosere | 2 | |
| | 8 | Biodiversity and Conservation: Definition; Biodiversity - Global and Indian Scenario; Mega diversity nations and hotspots: Biosphere reserves; Biodiversity centres in India. | 2 | |
| | 9 | Threats to biodiversity; Endangered and endemic plant species, Red data book, Exotic and indigenous plant species, Keystone species, Flagship species, Umbrella species, Indicator species. | 3 | |
| | 10 | Conservation strategies *ex situ* and *in situ* methods. Organizations–IUCN, UNEP & WWF, NBPGR, Kerala state Biodiversity Board (KSBB). | 2 | |
| **III** | **Environmental studies** | | **12** | **20** |
| | 11 | Global environmental changes, climatic changes – global warming and greenhouse gases, acid rains, el-nino, efforts of world organizations in the regulation of greenhouse gases emission. | 3 | |
| | 12 | Management of environmental pollution, conventional and phyto-technological approaches, solid waste management including e-wastes. | 3 | |
| | 13 | Major ecosystems of Biosphere, Sea; Estuary; pond; desert; forest; grassland (brief account). | 3 | |
| | 14 | UNESCO Biosphere Reserves in India and in the world. Role of individuals and organizations (governmental and non-governmental) in natural resource conservation and management, Environmental legislations in India (Prevention and Control of Pollution act, 1981). | 3 | |
| **IV** | **Botanical Entrepreneurship** | | **13** | **18** |
| | 15 | Entrepreneurial botany, Introduction, Scope, Importance, Challenges, Botany and trade (brief account). | 3 | |
| | 16 | Agriculture based entrepreneurship, organic | 2 | |

| | | | | |
|---|---|---|---|---|
| | | farming, phyco-farming, biofertilizer, vermicompost (brief account). | | |
| | 17 | Algal-based cultivation, single cell protein production, nutraceutical and pharmaceutical products of algae (brief account). | 2 | |
| | 18 | Mushroom cultivation, types of edible mushrooms, cultivation methods and marketing (brief account). | 2 | |
| | 19 | Seaweed-based cultivation, Types of nutrient rich seaweeds, Preparation of Seaweed Liquid Fertilizer (brief account). | 2 | |
| | 20 | Cultivation of medicinal and aromatic plants, cultivation of traditional crops, Herbal, spice and condiment business, Botanical pesticide preparation (brief account). | 2 | |
| **V** | **Practical** | | **30** | **20** |
| | **1** | Field trip or virtual tour to botanical gardens or natural habitats. | | |
| | **2** | Construction of a food web from the given set of data (Representative of a natural ecosystem). | | |
| | **3** | Study of morphological and anatomical adaptations in Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites. | | |
| | **4** | Study of algae used for single cell protein production. | | |
| | **5** | Demonstration of mushroom cultivation (Lab-scale) | | |
| | **6** | Study of seaweed types used for preparation of liquid fertilizers. | | |
| | **7** | Preparation of any botanical preparations used as pesticides | | |

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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | 2 | | 2 | 3 | 2 | | 1 | | 2 |
| CO 2 | 3 | 3 | | 2 | | 2 | 3 | 2 | | 1 | | 2 |
| CO 3 | 3 | | | 2 | | 2 | 3 | 3 | | 1 | | 2 |
| CO 4 | 3 | | 2 | 2 | 2 | 3 | 3 | 3 | | 1 | | 2 |
| CO 5 | 3 | 3 | 2 | | 2 | 3 | 3 | | 3 | | 2 | 3 |
| CO 6 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 1 | 3 | 3 |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| CO | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | | | ✓ | |
| CO 6 | | | ✓ | |

**FIRST SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA1MN102 – BASICS OF PLANT SCIENCE, ENVIRONMENTAL STUDIES AND BOTANICAL ENTREPRENEURSHIP**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. What does species area curve denote in biology?
2. Compare an umbrella species with a flagship species.
3. Add notes on phycofarm.
4. Describe the adaptations of halophytes to saline environments.
5. Enumerate the trade related aspects of herbal medicine.
6. Write notes on the preparation of a botanical pesticide.
7. Expound the significance of megadiversity hotspot?.
8. Reflect on the activities of KSBB.
9. Explain the role of NGOs in natural resource conservation and management.
10. Give a short account on biogeochemical cycles.

## SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. Discuss on the intradisciplinary connections among various branches in Botany.
12. Explicate the link between global warming and greenhouse gases.
13. Reflect on the consequences of biomagnification.
14. Elucidate the UNESCO Biosphere Reserves in India.
15. Explain how climate change will affect plant communities.
16. Expound on the disparity between lentic and lotic ecosystems.
17. Analyse the steps involved in mushroom cultivation and management.
18. Delineate the mechanism and importance of plant succession.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 x 10 = 10 Marks)**

19. “Is urban development an environmental blessing or a curse?”. Give your views and add notes on solid waste management.
20. Analyse the different strategies of algal-based entrepreneurship for sustainable development.

**UNIVERSITY OF CALICUT**

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA2MN102** | | | | |
| **Course Title** | **PLANT RESOURCE UTILIZATION, MICROBIOLOGY & PLANT PATHOLOGY** | | | | |
| **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** | Basics of Bacteria, Virus, Fungi, Plant diseases at CBSE/DHSE/ICSE senior secondary level | | | | |
| **Course Summary** | This course explores various plant resources and its utilisation, and diversity of microbial world. It also gives an idea about the diseases caused by microorganisms and disease symptoms. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand basics of plant resources and its utilization | U | F | Internal exam, Quiz |
| CO2 | Analyze different types of economically important plant specimens | An | M | Field study, discussion |
| CO3 | Evaluate the economic aspects of microbes in day-to-day life | E | F | Quiz, assignments and Presentation |
| CO4 | Understand the ecological importance of Fungi | U | P | Internal exam, Assignment, presentation |
| CO5 | Develop industrial skill based on plant resources | Ap | P, M | Field work, Demonstration |
| CO6 | Understand and Identify the plant disease based on symptoms | U | C | Test Paper, Quiz, Field study |

* - 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) | Marks (70) |
|---|---|---|---|---|
| **I** | **Plant Resources** | | **10** | **20** |
| | 1 | Natural resources – definition, classification based on origin, characteristics, and functions. Need for protecting natural resources. Renewable & Non-renewable Resources; Biotic & Abiotic resources | 1 | |
| | 2 | Plant and People – The science of economic botany, its development and significance, interdisciplinary nature | 1 | |
| | 3 | Study the different category of economically important plants; their Binomial, Family and Morphology of useful part.<br>a) Food crops: *Cereals* - Rice, Wheat, *Pulses* - Green gram, Bengal gram, *Fruits* - Banana,Jack, *Vegetables*- Cucumber, Ladies finger, Spices- Pepper; *Oilseeds* - Coconut | 3 | |
| | 4 | Cash Crops: *Beverages* – Coffee, Tea, Sugar – Sugar cane. Industrial crops: *Latex* – Rubber; *Fibre* – Cotton; *Timber* – Teak, *Medicinal* – *Adhatoda; Ornamentals* – Jasmine | 3 | |
| | 5 | Ethnobotanical significance of the following species: *Trichopus zeylanicus, Ocimum sanctum, Aegle marmelos,* and *Cynodon dactylon* | 2 | |
| **II** | **Plant Resources Utilization** | | **10** | **15** |
| | 6 | Herbal based hair dyes: Role as an ingredient in preparations -Henna, Bhringaraj, Hibiscus, Amla. | 2 | |
| | 7 | Herbal cosmetics and aromatics: Types of herbal preparations-Turmeric, Aloe | 2 | |

| | | | | |
|---|---|---|---|---|
| | 8 | Plants used in cleansers- Roles as in gradient- (Neem, Cucumber, Rose), scrubs (Marigold, Neem), wash (Rose –face wash, hibiscus & amla- hair wash & oil), packs (Neem, Tulsi, Sandalwood, Turmeric) and creams (Rose, Jasmin, Marigold). | 2 | |
| | 9 | Extraction of essential oil from lemon grass / orange peel or citrus fruit peel. Preparation of Henna powder from Henna leaves and Aloe gel from Aloe vera. | 2 | |
| | 10 | **Paper making from plants:** Paper industry and paper manufacturing; Raw materials, Processing and kinds of paper | 2 | |
| **III** | **Microbiology** | | **15** | **21** |
| | 11 | Introduction to microbiology, scope and significance. The Three Domain Classification: Bacteria, Archaea, and Eukarya; cellular microbes: bacteria, archaea, fungi, algae and protists; acellular infectious agents: viruses, viroids, prions. | 3 | |
| | 12 | Characteristics of viruses: size, shape and structure of viruses. Structure and replication (infection mode) of Corona Virus and HIV. | 3 | |
| | 13 | Bacterial diversity; major groups of bacteria; brief accounts of actinomycetes and mycoplasmas. Bacterial genetics: conjugation, transformation, transduction. Economic. Beneficial and harmful effect of bacteria. | 4 | |
| | 14 | Fungi- Generally characteristics. Fungi like organisms and true fungi. Significance of fungi: medicinal, industrial, Eco-agricultural, food; aflatoxins. | 3 | |
| | 15 | Cyanobacteria, mycoplasma . Beneficial and harmful effects. | 2 | |

| | | | | |
|---|---|---|---|---|
| **IV** | **Pathology** | | **10** | **14** |
| | 16 | Plant pathology introduction. Common Disease symptoms any five), Structural & biochemical defenses of plants; chemical weapons of pathogens (Brief account). | 4 | |
| | 17 | Brief study of the following plant diseases seen in Kerala (Name of disease, pathogen, symptom and control measures need to be studied): 1. Blast of rice, 2. Bunchy top of banana 3. Abnormal leaf fall of rubber 4. Citrus canker, 5. Nematode infection in banana. | 6 | |
| **V** | **Practical** | | **30** | **20** |
| | 1 | Students are supposed to identify the plant materials mentioned in module 1 | | |
| | 2 | students are supposed to see bacteria under microscope-(gram stain or root nodule bacteria) | | |
| | 3 | Students are supposed to identify the disease mentioned in the syllabus | | |

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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | | | 3 | | | | | |
| CO 2 | 3 | 2 | | | | | 3 | 2 | | | | |
| CO 3 | 3 | | 3 | | 3 | | 3 | | 3 | | 3 | |
| CO 4 | 3 | 3 | | 3 | | 2 | 3 | 3 | | 3 | | 2 |
| CO 5 | 3 | | 3 | | | 3 | 3 | | 3 | | | 3 |
| CO 6 | 3 | 3 | | 3 | 3 | 2 | 3 | 3 | | 3 | 3 | 2 |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | ✓ | ✓ | | ✓ |
| CO 6 | ✓ | ✓ | | ✓ |

**SECOND SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA2MN102 – PLANT RESOURCE UTILIZATION, MICROBIOLOGY & PLANT PATHOLOGY**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. What are viroids, mycoplasmas and prions?
2. What is carbon sequestration?
3. What are renewable and non-renewable resources?
4. What are aflatoxins?
5. What are the symptoms of abnormal leaf fall of rubber?
6. What is bacterial conjugation?
7. Differentiate between blast and blight.
8. How are viruses classified based on genetics?
9. What are the structural defense strategies of plants against pathogens?
10. Write the families and morphology of useful parts of banana, jack and pepper.

## SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. Explain the three domain classification of life.
12. Outline the procedure for extraction of essential oils from plants.
13. What are herbal cosmetics? Give examples.
14. Describe the structure, and infection cycle of Corona viruses.
15. Explore the advantages of various plant-based industries.
16. Give an account on the pathogen symptoms, and control measures of blast disease of paddy.
17. Explain the importance of plants as cosmetics.
18. Explain the process of paper making.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. Write an essay on plants of ethnobotanical importance, with examples.
20. Write an essay on beneficial and harmful effects of bacteria.

UNIVERSITY OF CALICUT

| | | | | | |
|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA3MN202** | | | | |
| **Course Title** | **BIODIVERSITY, PLANT INTERACTIONS, AND BASIC TISSUE CULTURE** | | | | |
| **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** | Basics of biodiversity and knowledge about the tissue culture at higher secondary level | | | | |
| **Course Summary** | This course explores the basis and fundamentals of food science technology. The course provides proficiency on various technology of baking, processing, preservation and packing methods | | | | |

**Course Outcome**

| COs | Statement | Cognitive level | Knowledge Category | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the principles and significance of biodiversity, plant interactions and plant tissue culture | U | F | Quiz, Internal Exam |
| CO2 | Aquire knowledge on the techniques involved in establishing and maintaining plant tissue cultures | An, E | P | Internal exam, Group work to analyse Practical skills |
| CO3 | Apply knowledge of plant tissue culture in agriculture, horticulture, forestry, and conservation. | Ap | M | Assignment, Exams, Discussion, field study |
| CO4 | Develop critical thinking and problem-solving skills through laboratory experiments and case studies. | Ap | C | Quiz/ Exams, Practical skill enhancement methods |
| CO5 | Identify the application of various biodiversity monitoring softwares | Ap | P | Assignment, Practical work, Exam |
| CO6 | Understand basic requirements in Tissue culture | U | F | Test |

* - 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) | Marks (70) |
|---|---|---|---|---|
| **I** | **Biodiversity** | | **12** | **10** |
| | 1 | Biodiversity- definition, types | 2 | |
| | 2 | Biodiversity at global, National and local levels, Vegetational zones of India, Biodiversity centres of India | 4 | |
| | 3 | Measurement of diversity, value of biodiversity, India as a mega diversity nation | 3 | |
| | 4 | Major projected areas and their importance | 3 | |
| **II** | **Biodiversity Conservation** | | **14** | **25** |
| | 5. | Threats to biodiversity; Endangered and endemic plant species, Red data book, Keystone species, Flagship species, Umbrella species, Indicator species, Invasive plant species, RET | 4 | |
| | 6. | Strategies for the biodiversity conservation: *in situ*, *ex situ* and *in vitro* conservation. | 3 | |
| | 7. | Organizations- IUCN,UNEP, WWF, Biodiversity Board of Kerala (KSBDB) | 2 | |
| | 8. | Policy and legislation – biodiversity acts and rules, People's Biodiversity Register (PBR), bio-piracy, bioprospecting, Ecorestoration | 3 | |
| | 9. | Biodiversity monitoring softwares/applications – efloraKerala, India Biodiversity Portal, e-bird, snakepedia, sarpa | 2 | |
| **III** | **Plant Interactions** | | **5** | **10** |
| | 10 | Competition, Predation, Parasitism, Symbiosis, Commensalism, Mutualism, Amensalism, Allelopathy | 2 | |
| | 11 | Pollination: Plant-Pollinator interactions; case studies - Orchids | 1 | |
| | 12 | Plant microbe interaction, myrmecophily, insectivory - examples | 2 | |

| | | | | |
|---|---|---|---|---|
| **IV** | **Basic Plant Tissue Culture** | | **14** | **25** |
| | 13 | Definition and historical development of plant tissue culture, Scope, Advantages, Applications & Limitations of Tissue Culture. | 2 | |
| | 14 | Basic requirements for plant tissue culture: explants, culture media, and growth conditions. | 2 | |
| | 15 | Culture media: Types, Formulation and preparation of media (MS medium) | 1 | |
| | 16 | Sterilization techniques: autoclaving, filtration,chemicalsterilants, laminar flow hood, flame sterilization, and personal hygiene. | 2 | |
| | 17 | Procedure of Explant selection and preparation | 1 | |
| | 18 | Organ culture: Anther/Pollen, Embryo and Meristem culture (Brief account), Organogenesis and Somatic embryogenesis. Somaclonal Variations, Applications of somaclonal variation. | 2 | |
| | 19 | Protoplast Culture: Protoplast-Isolation regeneration and Viability test, Somatic hybridization and methods of protoplast fusion (Brief account). Application of somatic hybridization and cybridization. | 2 | |
| | 20 | Hairy root culture–advantages of using hairy root culture, Hairy root culture and production of secondary metabolites. | 2 | |
| **V** | **Practical** | | **30** | **20** |
| | 1 | Visit nearby wetland/ forest ecosystems, eco-restoration areas, identify and categorize the plants occurring in the area according to their habitat and types and record them. | | |
| | 2 | Preparation of plant tissue culture media, Sterilization and Culture initiation. | | |
| | 3 | Aseptic handling of plant materials | | |

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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | - | 1 | 1 | 2 | 2 | 3 | 2 | - | - | 1 | 2 |
| CO 2 | 1 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 2 |
| CO 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 2 |
| CO 4 | - | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 |
| CO 5 | - | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 |
| CO 6 | 3 | - | 1 | 1 | 2 | 2 | 3 | 2 | - | - | 1 | 2 |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | ✓ | ✓ | | ✓ |
| CO 6 | ✓ | ✓ | | ✓ |

**THIRD SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA3MN202 – BIODIVERSITY, PLANT INTERACTIONS AND BASIC TISSUE CULTURE**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

**Section A**

**(Answer All. Each question carries 3 marks. Ceiling 24 marks)**

1. What are the common explants used in tissue culture?
2. Write about the role of auxin in plant tissue culture.
3. Explain the advantages of using hairy root culture.
4. Discuss the role of IUCN in biodiversity conservation.
5. Define biomagnification and explain its biological significance.
6. Differentiate between flagship and umbrella species?
7. Explain Red Data Book?
8. What are the applications of tissue culture in horticulture field?
9. Differentiate between bioprospecting and biopiracy.
10. What is myrmecophily? Write an example.

**Section B**

**(Answer All. Each question carries 6 marks. Ceiling 36 marks)**

11. Write on the coevolution of plants and insect pollinators.
12. Explain *ex situ* and *in situ* methods of conservation with examples.
13. What is PBR? What is its significance? How is it prepared?
14. Write a note on the approaches of biodiversity management.
15. Explain steps related to protoplast fusion.
16. Write about the working principle and application of laminar air flow.
17. Explain the preparation of MS Medium.
18. Discuss about the major protected areas in India.

**Section C**

**(Answer any one. Each question carries 10 marks) (1 × 10= 10 marks)**

19. Discuss about different organization, polices and legislation related to biodiversity
20. Explain hairy root culture on emphasis to secondary metabolite production

## VOCATIONAL COURSE IN PLANT SCIENCE

## LANDSCAPING, ORNAMENETAL GARDENINFG AND MANAGEMENT

**UNIVERSITY OF CALICUT**

| | | | | | |
|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA1VN101** | | | | |
| **Course Title** | **GARDENING AND LANDSCAPE MANAGEMENT** | | | | |
| **Type of Course** | **Vocational** | | | | |
| **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 horticulture course covers plant cultivation basics like indoor gardening, commercial growing, and landscaping. Students learn about famous gardens, essential tools, fertilizers, and pest control. Through both theory and practice, the course prepares students for success in gardening as hobbyists or professionals. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Remember the scope, importance and branches of horticulture as well as the types of gardens. | R | C | Test Paper, Quiz, Discussion |
| CO2 | Understand about the cultural practices for management of insect pests of garden plants | U | F | Seminars, Field Study |
| CO3 | Apply the knowledge of various plant propagation practices that can be used in day-to-day life | Ap | P, M | Lab visit, Demonstration |
| CO4 | Analyse the uses of essential garden tools and implements as well as the plant growing structures. | An | P | Test Paper, Assignments, Demonstrations |
| CO5 | Evaluate the various pre-planting, planting and post-planting cultural practices as well as the usage of fertilizers, soil conditioners and ameliorants | E | P | Seminar Presentation, Group discussion |
| CO6 | Develop creative knowledge on indoor horticulture and commercial horticulture as well as landscaping. | C | P | Test Paper, Assignments, Field Study |

* - 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

| Modules | Chapters | Contents | Hrs. (45+30) | Marks (70) |
|---|---|---|---|---|
| **I** | **Gardens** | | **10** | **15** |
| | **1** | Introduction to Horticulture: Concept and Scope of Horticulture; Horticulture as an Art, Science, and Business; Branches of Horticulture; Classification of Horticultural Plants. | 2 | |
| | **2** | Gardens around the World: Famous Gardens Globally; Famous Gardens in India; Types of Gardens Based on Country of Origin | 2 | |
| | **3** | Styles of Gardens: Formal Gardens: Symmetry, Order, and Elegance; Informal Gardens: Naturalistic, Relaxing, and Organic; Wild Gardens: Embracing Natural Beauty and Wilderness | 2 | |
| | **4** | Specialized Horticultural Spaces: Botanical Gardens: Showcasing Plant Diversity; Ornamental Gardens: Focus on Aesthetic Appeal; Exploration of Butterfly, Herbal, Kitchen, Rock, Roof, Sensory, Vertical, Water, and Container Gardens | 24 | |
| | **5** | Cultivating Horticultural Harmony: Design Principles for Horticultural Spaces; Sustainable Practices in Garden Design and Maintenance; Economic Aspects of Horticulture: Profitability and Market Dynamics | 2 | |
| **II** | **Horticulture: Indoors to Commercial** | | **10** | **15** |
| | **6** | **Indoor Horticulture and Hydroponics:** Overview of Indoor Gardening; Introduction to Hydroponic Systems: Techniques: Wicking, Deep Water Culture (DWC), Nutrient Film Technique (NFT), Ebb and Flow, Aeroponics, Drip Systems | 2 | |
| | **7** | **Commercial Horticultutre:** Commercial Nursery Operations, Orchards and Fruit | 2 | |

| | | | | |
|---|---|---|---|---|
| | | Farming, Herb Farming, Floriculture: Cut Flower Production and Floral Decorations, Cultivation of Indoor Plants | | |
| | **8** | **Arboriculture and Small-scale Cultivation:** Practices in Arboriculture: Pruning, Bracing, Feeding, Transplanting; Terrarium and Bonsai: Principles and Cultivation | 2 | |
| | **9** | **Landscape Horticulture:** Design Principles for Landscape Gardens; Olericulture; Pomology; Viticulture; Post-harvest Technology in Horticulture | 2 | |
| | **10** | **Sustainable Growth and Innovation:** Sustainable Practices in Horticulture; Innovation and Technology in Horticultural Practices; Market Trends and Economic Considerations | 2 | |
| **III** | **Landscape Design and Horticultural Practices"** | | **15** | **20** |
| | **11** | **Landscape Design Fundamentals:** General Landscape Planning; Components of Landscaping; Plant Components: Lawn, Shrubbery, Flower Beds, Rockery, Carpet Beds, Topiary, Hedges; Non-Plant Components: Garden Adornments, Arches, Pergolas, Trellises, Garden Walls, Gates, Fences, Footpaths, Seats, Tables, Garden Houses | 4 | |
| | **12** | **Plant Growing Structures:** Shade House, Greenhouse, Poly House, Glasshouse, Mist Chamber/Mist Beds, Hot Beds, Lath Houses | 2 | |
| | **13** | **Cultural Practices for Plant Health:** Pre-Planting Practices, Planting Techniques, Post-Planting Cultural Practices, Practices to Increase Productivity: Thinning, Training, Trimming, Pruning | 3 | |
| | **14** | **Plant Propagation Methods:** Introduction to Plant Propagation; Seed Propagation; Vegetative Propagation: Natural and Artificial Methods; Artificial Methods of Vegetative Propagation: Cutting, Layering, | 3 | |

| | | | | |
|---|---|---|---|---|
| | | Grafting, Budding, Micropropagation | | |
| | **15** | **Integrating Design and Horticultural Techniques:** Applying Landscape Design Principles, Implementing Horticultural Practices, Balancing Aesthetic Appeal with Plant Health and Productivity | 3 | |
| **IV** | **Gardening: Tools, Techniques, and Care** | | **10** | **20** |
| | **16** | **Essential Garden Tools and Implement:** Hand Trowel, Hoe, Spade, Fork, Shovel, Rake; Different Types of Cutting Tools: Shears (long-handled, short-handled, lawn shears), Secateurs, Sickles, Saw, Wheelbarrow, Watering Cans, Lawn Mower (Electric and Petrol), Grass Cutters, Sprayers and Their Use | 2 | |
| | **17** | **Fertilizers for Garden Health:** Organic Fertilizers: Biofertilizers, Compost, Vermicompost, Agricultural Waste, Livestock Manure, Municipal Sludge; Inorganic Fertilizers: NPK Fertilizers; Natural and Synthetic Soil Conditioners and Soil Ameliorants | 2 | |
| | **18** | **Common Diseases and Pests in Gardens:** Identification of Common Garden Plant Diseases; Symptoms and Causative Agents; Introduction to Integrated Pest Management (IPM); Physical and Biological Control Methods; Push-Pull Technology for Pest Management | 2 | |
| | **19** | **Techniques for Plant Care:** Proper Watering Techniques; Pruning Methods for Different Plant Types; Soil Management and Improvement Strategies; Pest and Disease Prevention Measures; Weed Control Techniques | 2 | |
| | **20:** | **Seasonal Garden Maintenance;** Spring Preparation: Cleaning, Pruning, and Soil Preparation; Summer Care: Watering, Fertilizing, and Pest Management; Fall Maintenance: Harvesting, Cleaning, and Soil Amendment; Winter Protection: Mulching, Covering, and Sheltering | 2 | |

| | | | | |
|---|---|---|---|---|
| | | Plants; Year-Round Plant Care Calendar | | |
| **V** | **Practical** | | **30** | **20** |
| | **1.** | **Design of a garden** | | |
| | **2.** | **Maintenance of a vegetable garden** | | |

## References


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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 2 | | | 1 | | | 2 | | 2 | | | 1 |
| CO 2 | 3 | 1 | | 1 | | | 2 | 2 | | | | 1 |
| CO 3 | 2 | 3 | | | 2 | 1 | | | | | 2 | 1 |
| CO 4 | 3 | 3 | | | | | 2 | 2 | | 1 | | |
| CO 5 | 3 | 3 | 1 | | | | | 1 | | 3 | 1 | |
| CO 6 | 2 | 3 | | | | | 2 | 1 | | | | |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | | | ✓ | |
| CO 6 | | | ✓ | |

**FIRST SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA1VN101 – GARDENING AND LANDSCAPE MANAGEMENT**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## Section A

**(Answer All. Each question carries 3 marks. Ceiling 24 marks)**

1. Differentiate between T Budding and Patch Budding.
2. Name four annual flowering plants commonly grown in gardens.
3. What are the major factors to consider while selecting a lawn grass?
4. What are biopesticides? Give examples.
5. What is the purpose of a greenhouse in horticulture?
6. What are the roles of shade nets in greenhouse management?
7. What is the purpose of using Rooting hormone in plant propagation?
8. What are the non-plant components of landscaping? Give examples.
9. What are fungicides and insecticides?
10. What is Mowing?

## SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. Discuss the preparation and application methods of bio-pesticides.
12. Explain the importance of plant components in landscape design.
13. Write a note on the techniques involved in pruning and shaping of Bonsai.
14. Write a short note on different types of garden tools and equipment used in gardening.
15. Discuss the essential steps involved in establishing and maintaining a healthy lawn.
16. Explain the preparation of biopesticides and give a note on its application methods.
17. Write an account on the major features and benefits of special types of gardens.
18. Describe various vegetative propagation methods in horticultural plants.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. Write a detailed account on the common diseases and pests in gardens.
20. Explain the importance of horticulture as an art, science, and business, highlighting the diverse opportunities it offers.

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| | | | | | |
|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA2VN101** | | | | |
| **Course Title** | **FLORICULTURE, CUT FLOWER INDUSTRY AND PRECISION FARMING** | | | | |
| **Type of Course** | **Vocational** | | | | |
| **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** | Introduction to Floriculture, cultivation practices, cut flower industry and its business prospects and recent innovative techniques in growing plants termed precision farming and its applications | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the fundamental principles of plant science and its applied branches like floriculture. | U/R | F | Instructor-created exams / Quiz |
| CO2 | Acquire skill in the production of cut flower, precision farming and gardening | Ap | P | Industrial visit, Hands on Training, Demonstration |
| CO3 | Evaluate resources, tools and techniques in precision farming | E | C | Lab visit, Demonstrations, Discussion |
| CO4 | Analyse the industrial importances and business outturn | An | M | Group Discussion, Field Study |
| CO5 | Create an entrepreneurial mindset within the botanical industry, including cultivation, processing, marketing, of ornamental value-added floral products | C/Ap | M | Assignments on floriculture related aspects, visit to plant nurseries and flower shops |
| CO6 | Develop interdisciplinary intersection and techniques in floricultural science | An | C | Discussion, Test paper |

* - 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) | Marks (70) |
|---|---|---|---|---|
| **I** | **Introduction to Floriculture** | | **10** | **14** |
| | 1 | Components of Indian Floriculture, flowering plant cultivation, traditional flower cultivation, protected cultivation, speciality flower crops, flower seeds and bulb production. | 3 | |
| | 2 | Nursery management of potted flowering shrubs and herbs, indoor plants, scope and building up of infrastructure for nursery, planning and seasonal activities. | 2 | |
| | 3 | Floristry, biofertilizers in floristry and their method of use, nitrogenous, phosphatic, potassic, availability of nutrients from above sources, other nitrogen contributing plants. | 3 | |
| | 4 | Commercial Floriculture, Factors affecting flower production in potted plants, Floral pharmaceutical and nutraceutical compounds. | 2 | |
| **II** | **Applied Floriculture** | | **12** | **20** |
| | 5 | Floriculture, ornamental plants, flowering annuals, herbaceous perennials, shade and ornamental trees, ornamental bulbous and foliage plants, cacti and succulents, ornamental palms. | 3 | |
| | 6 | Cultivation of plants in pots, types of potted plants, pot plant and plug plant production, plug nursery, uses of plug plantation. | 2 | |
| | 7 | Indoor gardening and indoor farming, types of indoor plants, health benefits of indoor plants, Miniature gardening, Bonsai, terrarium, aerium, and their containment techniques. | 3 | |
| | 8 | Floriculture Crop introduction, Breeding of Flower crops and Ornamental Plants, Cultivation of various flower category plants. | 2 | |
| | 9 | Floriculture business, benefits, Social aspects of floriculture, flower markets, flower shops, aspects of export. | 2 | |
| **III** | **Cut Flower Industry** | | **14** | **24** |
| | 10 | Cultivation of Important cut flowers (Carnation, Aster, Dahlia, Gerbera, Anthuriums, Gladiolus, Marigold, Rose, Lilium), cut greens. | 2 | |
| | 11 | Production of cut flowers – water and nutrient management, fertigation techniques, weed management, rationing, training and pruning, disbudding. | 2 | |

| | | | | |
|---|---|---|---|---|
| | 12 | Dry flower industry, dry flower technology, flower arrangements, floral decorations, methods to prolong vase life of flowers. | 2 | |
| | 13 | Special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM, production for exhibition purposes. | 2 | |
| | 14 | Production and packaging of cut flowers; nutrient treatment for cut flowers, tropical cut flowers, temperate cut flowers. | 2 | |
| | 15 | Harvesting of flowers, methods of harvesting, storage of flowers, post harvest handling of cut flowers. | 2 | |
| | 16 | Flower grading and packaging, flower wraps, types of packing materials for flowers, transportation of cut flowers. | 2 | |
| **IV** | **Precision farming** | | **9** | **12** |
| | 17 | Concept, Farming resources (soil, water, nutrients), nutrient-use efficiency (NUE), water-use efficiency (WUE), geo-informatics tools in precision farming (GIS, GPS). | 5 | |
| | 18 | Technologies in precision farming – Proximate Sensors for precise crop and soil data capture, Remote Sensors for precise data capture, Auto-guidance systems. | 4 | |
| **V** | **Practicals** | | **30** | **20** |
| | 1. Field trip or virtual tour to botanical gardens or natural habitats.<br>2. Botanical description of varieties of ornamental flower plants.<br>3. Identification of flowering plant propagules.<br>4. Plant Propagation techniques, training and pruning.<br>5. Irrigation techniques - drip irrigation and fertigation techniques.<br>6. Manuring - foliar nutrition, growth regulator application.<br>7. Pre-harvest cultural practices- pinching, disbudding, staking.<br>8. Harvesting techniques, postharvest handling techniques.<br>9. Project preparation for regionally important cut flowers.<br>10. Visit to commercial cut flower units and case study. | | | |

## References:


1. Larkin, L. (2024). *Flower farming for profit*. Chelsea: Green Publishing.
2. Henderson, P. (2023). *Practical floriculture*. Legare Street Press.
3. Faust, J.E. and Dole, J.M. (2021). *Cut flowers and foliages*. Wallingford, Uk ; Boston, Ma, Usa: Cabi.
4. Qin Zhang (2021). *Precision agriculture technology for crop farming*. Boca Raton: CRC Press.
5. Nowak, J. (2011). *Postharvest handling and storage of cut flowers, florist greens, and potted plants*. Springer.
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7. Stafford, J.V. (2007). *Precision agriculture '07*. Wageningen: Wageningen Academic Publishers.
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11. Larson, R.A. (1992). *Introduction to floriculture*. San Diego: Academic Press.
12. Ford Runge, C. and Munson, R.D. (1990). *Improving fertilizer and chemical efficiency through 'high precision farming'*. St. Paul, Minn.: University Of Minnesota, Center For International Food And Agricultural Policy.

**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | 1 | 1 | | | 3 | | | | 1 | 1 |
| CO 2 | 2 | 3 | 3 | 2 | 3 | 2 | | 2 | 3 | | 1 | 1 |
| CO 3 | | 3 | 1 | 2 | 3 | 1 | 2 | 2 | 3 | 1 | 2 | |
| CO 4 | 1 | 3 | 2 | | 3 | 3 | 1 | 2 | 2 | | 1 | 3 |
| CO 5 | 2 | 3 | 1 | 2 | 3 | 3 | | 1 | 3 | | 2 | 3 |
| CO 6 | | 2 | | 3 | 1 | | 1 | 2 | 3 | | 2 | 1 |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| CO | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | ✓ | ✓ |
| CO 3 | ✓ | | ✓ | ✓ |
| CO 4 | ✓ | | | ✓ |
| CO 5 | ✓ | | ✓ | ✓ |
| CO 6 | ✓ | | ✓ | ✓ |

**SECOND SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA2VN101 – FLORICULTURE, CUT FLOWER INDUSTRY AND PRECISION FARMING**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Mention the importance of speciality flower crops.
2. Elucidate the use of foliar sprays.
3. Add notes on biofertilizers used in floristry.
4. What are floral adornments?
5. Differentiate tropical and temperate cut flowers.
6. Comment on floral pharmaceutical/nutraceutical products.
7. Expound the differences between pot plants and plug plants.
8. Describe the techniques of breeding of flower crops.
9. Explain dry flower technology.
10. What is the role of flower markets, flower shops in the floral industry?

## SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. Discuss on the various types of ornamental plants.
12. Explicate the various techniques of protected cultivation.
13. Evaluate the usage of proximate and remote sensors used for precise data capture.
14. Elucidate the methods to prolong vase life of cut flowers.
15. Discuss on the basic facilities and infrastructure needed for a plant nursery.
16. Delineate the post-harvest handling, flower grading and packaging of cut flowers.
17. Differentiate the precision farming techniques like WUE and NUE.
18. Analyse various fertigation techniques used in floriculture.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. “Cut flower industry is an international, multi-billion dollar business.” Discuss on the prerequisites and requisites of flower farming.
20. Discuss the recent advances and practices in indoor farming and miniature gardening.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA3VN201** | | | | |
| **Course Title** | **ORGANIC FARMING, INTEGRATED PEST MANAGEMENT, SUSTAINABLE AGRICULTURE AND AGRI ECONOMICS** | | | | |
| **Type of Course** | **Vocational** | | | | |
| **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** | Introduction and study of organic farming practices, sustainable agriculture, economics of agriculture, and integrated pest management. | | | | |

**Course Outcomes**

| COs | Statement | Cognitive level | Knowledge Category | Tools used |
|---|---|---|---|---|
| CO1 | **Understand** organic farming practices, sustainable agriculture, economics of agriculture, and integrated pest management | R/U | C | Test paper, Quiz |
| CO2 | **Identify** strengths and weaknesses of the different agricultural practices and systems | U | F | Seminars, Discussions |
| CO3 | **Analyze** economic growth and economic parameters in agriculture | An | C | Test paper |
| CO4 | Apply knowledge of organic and sustainable farming practices | Ap | P | Practical Exam |
| CO5 | **Analyze**, **interpret, decide** appropriate pest management practices | An | M | Case studies, Seminar |
| CO6 | **Develop** skills on agricultural economics | Ap | P | Laboratory experiments, Field trials |

* - 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) | Marks (70) |
|---|---|---|---|---|
| I | **Introduction** | | **15** | **25** |
| | 1 | Concept and development of organic farming: Principles of organic farming, Types of organic farming, Biodynamic farming, Benefits of organic farming. Conventional farming v/s organic farming. Agencies and institutions related to organic agriculture Requirements for organic farming, Farm components for an organic farming. | 5 | |
| | 2 | Organic farming systems: Green manuring, Composting Methods, Vermicomposting, Bulky organic manures, Concentrated organic manures, Organic preparations, Organic amendments and sludges | 5 | |
| | 3 | Bio-fertilizers. Methods of development of biofertilizers, Types of biofertilizers. Botanical pesticides, biological control agents, Biopesticides: introduction, advantage, types of Biopesticides. Agrochemical management and manufacturing. Weed management. | 5 | |
| **II** | **Integrated pest management** | | **10** | **15** |
| | 4 | Definition, pests, pathogens, disease symptoms and diagnosis, classification of plant diseases, disease triangle, plant disease control: exclusion, eradication, protection | 5 | |
| | 5 | Components of IPM, biological control, chemical control, physical control, genetic control, quarantine. Steps involved in IPM. Advantages and disadvantages of IPM | 5 | |
| **III** | **Sustainable agriculture** | | **10** | **15** |
| | 6 | Sustainable agriculture: High External Input Agriculture (HEIA), Low external input agriculture (LEIA) and Low External Input Sustainable Agriculture (LEISA) and its techniques for sustainability | 5 | |
| | 7 | Integrated farming system, components of IFS and its advantages, farming system and environment. | 5 | |

| | | | | |
|---|---|---|---|---|
| **IV** | **Agricultural economics** | | **10** | **15** |
| | 8 | Organic Certification: Farm economy: Basic concept of economics: Demand, supply, Economic Viability of a farm. Basic production principles: Reducing expenses, ways to increase returns, Cost of production system. Benefit/ cost ratio. | 5 | |
| | 9 | Marketing: Imports and exports, Farm inspection and certification: Conversion to organic farming. Agrochemical management and manufacturing. Various agrochemical brands, classification, types & uses. | 3 | |
| | 10 | Agribusiness Management: Agribusiness relations with the financing, marketing, and management of food production. Industrial career opportunities. | 2 | |
| **V** | **Practical** | | **30** | **20** |
| | 1 | Identification of common plant diseases | | |
| | 2 | Biofertilizer and biocontrol agent preparation | | |
| | 3 | Visit to a agribusiness establishment | | |

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10. Muller, F. 2000. Agrochemicals, Composition, production, toxicology, application. Wiley-VCH, Weinheim

**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 2 | | | 1 | | | 2 | | 2 | | | 1 |
| CO 2 | 3 | 1 | | 1 | | | 2 | 2 | | | | 1 |
| CO 3 | 2 | 3 | | | 2 | 1 | | | | | 2 | 1 |
| CO 4 | 3 | 3 | | | | | 2 | 2 | | 1 | | |
| CO 5 | 3 | 3 | 1 | | | | | 1 | | 3 | 1 | |
| CO 6 | 2 | 3 | | | | | 2 | 1 | | | | |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | | | ✓ | |
| CO 6 | | | ✓ | |

**THIRD SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA3VN201 – ORGANIC FARMING, INTEGRATED PEST MANAGEMENT, SUSTAINABLE AGRICULTURE AND AGRI ECONOMICS**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. What is biological control?
2. What is organic certification?
3. Expand and explain LEIA.
4. What are botanicals? Give two examples.
5. What do you mean by economic viability of a farm?
6. What is benefit/cost ratio?
7. Explain exclusion and eradication in pest management?
8. What is biodynamic farming?
9. What are the various organic farm components?
10. What is disease triangle?

## SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. What are the requirements of organic farming?
12. What is agricultural management and manufacturing?
13. Explain the methods of organic weed management?
14. What are the industrial scopes of biopesticide development?
15. What are the advantages and disadvantages of IPM?
16. Explain agrichemical branding
17. Compare conventional and modern farming techniques.
18. Explain concepts of demand and supply in the context of agribusiness.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. What is IPM? Explain its components.
20. What are biofertilizers? Explain the methods of developing biofertilizers.

**VOCATIONAL COURSE IN PLANT SCIENCE**

**PROPAGATION, POST HARVEST AND PRESERVATION TECHNIQUES**

UNIVERSITY OF CALICUT

| | | | | | |
|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA1VN102** | | | | |
| **Course Title** | **MEDICINAL BOTANY** | | | | |
| **Type of Course** | **Vocational** | | | | |
| **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** | Basic knowledge about medicinal plants and its use. | | | | |
| **Course Summary** | This course explores the use of locally available medicinal plants and its use in folk and ayurveda. The course aims to make the students get basic idea about various medical plant preparation which can be used in day to day life. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category # | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand different types of traditional medicinal systems in India | U | F | Test paper<br>Assignments |
| CO2 | Understand the importance of IPR relation to traditional knowledge and culture; | U | F | Presentation<br>Quiz |
| CO3 | Understand the ethno-botanical uses of plants and ingredients used in new generation medicines | U, An | F | Quiz, assignments and Presentation |
| CO4 | Identify and List important medicinal plants used in different preparations for common diseases | Ap | P | Practical exam |
| CO5 | Prepare plant preparations for common diseases | Ap | M | Practical exam |
| CO6 | Appreciate the conservation strategies to conserve endangered medicinal plants | U | F | Assignments, Presentation, Test paper |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

## DETAILED SYLLABUS

| Module | Unit | Content | Hrs (45+30) | Marks (70) |
|---|---|---|---|---|
| **I** | **General aspects of Medicinal Plants** | | **10** | **10** |
| | 1 | Definition, history, present and future needs. | 1 | |
| | 2 | Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences; Definition and Scope-Ayurveda: Panchamahabhutas, Saptadhatu and Tridosha concepts, Rasayana, plants used in ayurvedic treatments, | 2 | |
| | 3 | Siddha: Origin of Siddha medicinal systems, basis of Siddha system, plants used in Siddha medicine. Unani: Concept: Umoor-e-tabiya, polyherbal formulations. | 2 | |
| | 4 | Definition, history, present and future needs Introduction of plant parts (fruit, leaves, roots, stem, seeds and their modification). Role in human health and balanced diet | 3 | |
| | 5 | Basic idea of quality control and contribution of national research laboratories like CDRI, CIMAP, NBRI, etc. Precautions during use of herbal medicinal products. | 2 | |
| **II** | **Promotion of medicinal plant & Intellectual Property Rights** | | **10** | **18** |
| | 6 | Promotion of medicinal plant sector at national level: National Medicinal Plant Board and State Medicinal Plant Boards - objectives and functions. Other organizational initiatives for promotion of MAPs at National and International levels. | 2 | |
| | 7 | Demand and supply of medicinal plants. Herbal industries. | 2 | |
| | 8 | Intellectual property rights including patents, copyrights, trademarks, geographical indicators and trade secrets etc. Indian Patent Act, conditions for patenting, provisional and complete specifications, International and national laws with special reference to patents. | 4 | |

| | | | | |
|---|---|---|---|---|
| | 9 | IPRs in relation to traditional knowledge and culture; Bio-piracy. | 2 | |
| **III** | **Important Indian Medicinal Plants** | | **15** | **27** |
| | 10 | Plant parts used as powder: Identification and utilization of Amla (*Phyllanthus emblica*), Thanni (*Terminalia bellerica*), Kadukka (*Terminalia chebula*), Turmeric (*Curcuma longa*), Garlic (*Allium sativum*), Bitter guard (*Momordica charantia*), Njaval (*Syzygium cumini*), Fenugreek (*Trigonella foenumgraecum*), Cinnamon (*Cinnamomum verum*), Sarpgandhi (*Rauvolfia serpentina*), Black pepper (*Piper nigrum*), Ashwagandha (*Withania somnifera*) | 6 | |
| | 11 | Plant parts used as juice/ decoctation: Identification and utilization of Amla (*Phyllanthus emblica*), Ginger (*Zingiber officinalis*), Onion (*Allium cepa*), Bottle guard (*Lagenaria siceraria*),Tulsi (*Ocimum santum*), Neermaruthu (*Terminalia arjuna*), Neem (*Azadirecta indica*), kattarvazha (*Aloe vera*), Brahmi (*Bacopa monnieri*), Chitamruthu (*Tinospora cordifolia*), Vishnukranthi (*Convolvulus prostratq*), koovalam (*Aegle marmelos*) | 6 | |
| | 12 | Plant Parts Used as Oil: Clove (*Syzygium aromaticum*), Neem (*Azadirecta indica*), Coconut (*Coccus nucifera*), Nilgiri (*Eucalyptus* sp.) | 3 | |
| **IV** | **Ethnobotany** | | **10** | **15** |
| | 13 | Ethnobotany and Folk medicines; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: Ethnic communities of India. | 2 | |
| | 14 | Application of natural products to certain diseases - Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases. | 2 | |
| | 15 | B Conservation of endangered and endemic medicinal plants. Definition: endemic and endangered medicinal plants, Ethnomedicinal plant Gardens. | 2 | |
| | 16 | Propagation of Medicinal Plants: A brief account of plant drugs and their chief constituents used in indigenous and allopathic systems of medicine with regard to: Hemidesmus indicus, Garcinia | 4 | |

| | | | | |
|---|---|---|---|---|
| | | indica, Andrographis paniculata, Catharanthus roseus, Aloe vera, Boerhaavia diffusa, and Adathoda vasica. | | |
| **V** | **Practical** | | **30** | **20** |
| | 1 | Identification (botanical name & family), description and utilization of plants and/or plant parts studied in theory, under each group | | |
| | 2 | Any one plant formulation for any three common diseases | | |
| | 3 | Educational visit to herbal medicine factory/small processing unit/ medicinal agriculture field and submission of a report | | |

## References


1. Panda H., Hand Book of Ayurvedic Medicines, National Institute of Industrial Research, Delhi 7

   CSIR – Cultivation and Utilization of Medicinal Plants

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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | | | 3 | | | | | 2 |
| CO 2 | 3 | | 2 | 2 | | | 3 | | | 2 | | |
| CO 3 | 3 | | 2 | 2 | | | 3 | | | 2 | | |
| CO 4 | 3 | | | 2 | 3 | 3 | 3 | 3 | 2 | | 2 | |
| CO 5 | 3 | 2 | 3 | | 3 | 3 | 3 | 3 | 2 | | 2 | |
| CO 6 | 3 | | | | | 3 | 3 | | 2 | 3 | 2 | 3 |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | ✓ | ✓ | | ✓ |
| CO 6 | ✓ | ✓ | ✓ | ✓ |

**FIRST SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA1VN102 – MEDICINAL BOTANY**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Define Panchamahabhutas and its significance in Ayurveda.
2. What are the key differences between the Ayurvedic and Siddha medicinal systems?
3. Explain the concept of Umoor-e-tabiya in Unani medicine.
4. List the benefits of Amla (Embelica officinalis) in medicinal treatments.
5. What precautions should be taken while using herbal medicinal products?
6. Mention the objectives and functions of the National Medicinal Plant Board.
7. Describe the concept of bio-piracy.
8. Identify two plants used for their oil and discuss their uses.
9. What is ethnobotany, and why is it important?
10. Name two diseases and the natural products used in their treatment.

## SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. Discuss the role of indigenous medicinal sciences in modern healthcare.
12. Explain the importance of quality control in the medicinal plant sector and the role of national research laboratories.
13. Describe the current trends in the demand and supply of medicinal plants.
14. Outline the key aspects of the Indian Patent Act related to medicinal plants.
15. Discuss the identification and utilization of Turmeric (Curcuma longa) in traditional medicine.
16. Describe the methods used to study ethnobotany and its applications in India.
17. Explain the importance of conserving endangered and endemic medicinal plants.
18. Discuss the propagation techniques for medicinal plants and provide examples.

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. Write an essay on the scope and importance of medicinal plants in human health.
20. Discuss the applications of natural products in treating jaundice, cardiac issues, infertility, diabetes, blood pressure, and skin diseases.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA2VN102** | | | | |
| **Course Title** | **BOTANICAL SPECIMEN PREPARATION AND CURATION** | | | | |
| **Type of Course** | **Vocational** | | | | |
| **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** | Basics of taxonomy and morphology of algae, fungi, bryophytes, pteridophytes and spermatophytes | | | | |
| **Course Summary** | This course explores the various methods of collecting, preparing and preserving biological samples of algae, fungi, bryophytes, pteridophytes and spermatophytes. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the importance of botanical specimens in scientific research, including their role in taxonomy, economic botany, ecology, and conservation. | U | F | Lectures and demonstrations, Test Paper |
| CO2 | Evaluate the essential techniques and methods for collecting, preserving, and processing botanical specimens, including seed collections, pollen collections, and wood collections. | E, Ap | P | Lectures, ICT and Lab work, Field Work |
| CO3 | Understand the history and origin of Herbaria, as well as different types of Herbarium collections, both national and international. | U, An | F | Lectures, ICT, Field Visit |
| CO4 | Create proficiency in the preparation and labeling of Herbarium specimens, including mounting, poisoning, and storage techniques. | C | P | ICT and field and lab work |
| CO5 | Apply practical experience in collecting and preserving various plant groups, such as succulents, aquatic plants, fungi, lichens, bryophytes, pteridophytes, and spermatophytes. | Ap | M | Demonstrations, lectures and lab visits, Discussions |
| CO6 | Understand the importance of proper storage, pest control, and ethical practices in Herbarium management, including fire precautions, pest detection, and loan procedures. | U, An | M | Lectures and demonstrations, Exam, Seminars |

* - 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) | Marks (70) |
|---|---|---|---|---|
| **I** | **Botanical Specimens** | | **10** | **15** |
| | 1 | Botanical specimens; general collecting sites, collecting methods and equipment's, Field notes. Seed or fruit collections, Pollen collections, Cone collections, Wood and Bark collections, Leaf collections, | 2 | |
| | 2 | History and origin of Herbaria; Herbarium techniques: Basic Steps involved in collection and preservation: poisoning, mounting, labelling, storage; Record Keeping and filing of specimens. Electronic specimen catalogues, barcoding. | 3 | |
| | 3 | Types of Herbarium: National /International; Herbarium types: International- Kew (K); National-Central national herbarium (CAL), MH Coimbatore; Virtual Herbarium; Index herbariorum | 3 | |
| | 4 | The role of herbarium in Taxonomy, economic botany, Ecology and Conservation: Special collections, Ecological information's, Soil and topographic features, CITES | 2 | |
| **II** | **Collection and Preparation** | | **10** | **15** |
| | 5 | **Plant collection** (incl. legal considerations; Biodiversity Act; Wildlife Protection Act), identification, sorting, numbering the collections and label preparation. | 3 | |
| | 6 | Collecting techniques for special plant groups: succulents, floating or submerged aquatics, cauliflorous plants, tubers, palms, bulky specimens, | 3 | |
| | 7 | Collecting materials for ancillary disciplines: Morphology, Palynology, Anatomy, Cytology, Molecular studies, Phytochemistry | 2 | |
| | 8 | **Ancillary Collections:** Carpological Collections; Wood Collection, Seed Collection; Economic Botany Collection; Genetic Resources Collection; Pollen and Spore Collection; Paleobotanical Collection; Photographic Collections. | 2 | |

| | | | | |
|---|---|---|---|---|
| **III** | **Processing specimens** | | **15** | **25** |
| | 9 | **Introduction:** Equipment's, arranging and preparing the specimens; Preserving the specimens: Drying specimens in the field- Conventional method, The Schweinfurth method. | 1 | |
| | 10 | **Wet preservation of specimens:** Chemical fixatives and storage media, Handling chemical preservatives. | 2 | |
| | 11 | **The Collection and Curation of Algae:** Collecting marine algae; Preservation (Liquid preservation + Herbarium Mounts); Collection and preservation micro-algae (maintaining cultures; whole mounts). | 2 | |
| | 12 | **The Collection and Curation of Fungi & Lichens**: Fungarium, equipment for collection, preservation; Spore prints; Drying techniques; Packeting, boxing and mounting specimens. Collection and preservation of micro fungi (maintaining cultures, whole mounts). | 2 | |
| | 13 | **The Collection and Curation of Bryophytes**: Collecting techniques, envelop storage technique/ Packeting, Herbarium Sheet mounts; Bulk Dry methods; Drying and processing | 2 | |
| | 14 | **The Collection and Curation of Pteridophytes**: Collecting techniques, pressing; herbarium sheet mounts; museum storage; Spore collection and storage | 2 | |
| | 15 | **The Collection and Curation of Spermatophytes** (Gymnosperms and Angiosperms): Collecting techniques, pressing; herbarium sheet mounts; museum storage, | 1 | |
| | 16 | **Collection of Living materials:** Seed banks: aims, permission, collection size, sampling in the field, voucher specimens | 1 | |
| | 17 | **Labelling and Associated information:** Specimen data, Annotation data, Ancillary materials. | 2 | |

| | | | | |
|---|---|---|---|---|
| **IV** | **Storage, Pests and Treatments** | | **10** | **15** |
| | 18 | The herbarium building; Location, Construction, Essential facilities, Internal design, Fire precautions. | 2 | |
| | 19 | Types of pests; Insects pests, Non-insect pests; Fungal infections; Detection, exclusion, decontamination. Pest control: Temperature control, Repellents, Fumigation, Anoxic treatment | 2 | |
| | 20 | Basic Herbarium practices and ethics: Operation, Handling specimens, Arrangement and Organization; Shipping herbarium specimens, Loans-sending a loan-returning a loan. Studying and annotating specimens. Exchanges, Gifts, Requests for information, Acknowledging herbaria, herbarium visitors. | 3 | |
| | 21 | Major data bases- Algaebase, *Index fungorum*, MycoBank, AFTOL-SBD, POWO, WFO, TROPICOS | 3 | |
| **V** | **Practical** | | **30** | **20** |
| | 1 | Techniques of Herbarium preparation: Algae, bryophytes and vascular plants (Prepare 10 herbarium sheets) | | |
| | 2 | Techniques of preparing a fungarium | | |
| | 3 | Visit to an Internationally accredited herbaria | | |
| | 4 | Prepare a checklist of algae, fungi and vascular plants using major databases | | |

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2. Costa, C.M. and Roberts, R.P., 2014. Techniques for improving the quality and quantity of DNA extracted from herbarium specimens. *Phytoneuron*, *48*(1), pp.1-8.
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19. Yeung, E.C.T., Stasolla, C., Sumner, M.J. and Huang, B.Q. eds., 2015. *Plant microtechniques and protocols* (No. 11831). Cham, Switzerland: Springer International Publishing.

**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 2 | | | 1 | | | 2 | | 2 | | | 1 |
| CO 2 | 3 | 1 | | 1 | | | 2 | 2 | | | | 1 |
| CO 3 | 2 | 3 | | | 2 | 1 | | | | | 2 | 1 |
| CO 4 | 3 | 3 | | | | | 2 | 2 | | 1 | | |
| CO 5 | 3 | 3 | 1 | | | | | 1 | | 3 | 1 | |
| CO 6 | 2 | 3 | | | | | 2 | 1 | | | | |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | | | ✓ | |
| CO 6 | | | ✓ | |

**SECOND SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**
**PLA2VN102 – BOTANICAL SPECIMEN PREPARATION AND CURATION**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

**SECTION A**

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Give a short account of the techniques for collecting and preserving micro-algae.
2. Identify and briefly describe two major databases used in botanical research.
3. What is Fumigation?
4. Discuss the importance of CITES in the context of Herbarium collections.
5. Explain the Schweinfurth methods of drying botanical specimens.
6. Discuss the importance of seed banks and voucher specimens in the collection and preservation of Spermatophytes.
7. Demonstrate the techniques involved in preparing Herbarium sheets for Bryophytes.
8. Define a Herbarium and explain its significance in botanical research.
9. Give a short account of pests and insects in herbarium.
10. Comment on various fixatives used in the preservation of biological specimens.

**SECTION B**

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. Discuss specialized collecting techniques for specialized plant groups.
12. What are the techniques involved in the Collection of Living materials?
13. Describe the process of preparing a fungarium. What are the essential steps involved?
14. Discuss the essential facilities and internal design of a Herbarium building. What precautions should be taken against fire hazards?
15. Discuss the collection and curation of Fungi & Lichens.
16. Describe the wet preservation techniques for botanical specimens. What are the chemical fixatives and storage media commonly used?
17. How do ancillary disciplines like Morphology, Palynology, and Phytochemistry benefit from plant collections? Provide examples.
18. What legal considerations should be taken into account during plant collection? Explain the importance of the Biodiversity Act and Wildlife Protection Act in this regard.

**SECTION C**

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. Demonstrate the techniques involved in preparing Herbarium sheets for Algae, Bryophytes, and Vascular Plants.
20. Compare and contrast different types of Herbaria, both national and international. What role does a Herbarium play in various fields such as taxonomy, economic botany, ecology, and conservation?

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA3VN202** | | | | |
| **Course Title** | **HARVEST AND POST HARVEST STORAGE TECHNIQUES IN AGRICULTURE** | | | | |
| **Type of Course** | **Vocational** | | | | |
| **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** | Basic concepts of plant morphology, fruit physiology in higher secondary level | | | | |
| **Course Summary** | The course aims to give practical based knowledge on different stages of post-harvest techniques and process of horticultural products. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | List out the different stages of post-harvest system | U | F | Instructor-created exams / Quiz |
| CO2 | Demonstrate the preliminary processing of fruits | Ap | P | Experimentation |
| CO3 | Prepare non fermented fruit beverages | Ap | P | Experimentation |
| CO4 | Prepare of fruit jam, jelly and pickles | Ap | P | Home works |
| CO5 | Estimate sugar and acidity of fruits | Ap | P | Experimentation |
| CO6 | Practice the technique - sort and pack cut flowers based on quality standards | Ap | P | Experimentation |

* - Remember (R), Understand (U), Apply (Ap), Analyze (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) | Marks (70) |
|---|---|---|---|---|
| **I** | **Introduction to Post harvest system** | | **10** | **14** |
| | 1 | Harvesting, Harvesting maturity and Maturity indices. | 2 | |
| | 2 | Activities included in post harvest system and importance of post harvest technologies. | 3 | |
| | 3 | Stages of a post harvest system. | 2 | |
| | 4 | Types of post harvest processing. | 2 | |
| | 5 | Post harvest losses. | 1 | |
| **II** | **Harvest post-harvest in crop plants** | | **22** | **35** |
| | 6 | Crop plants - Harvest, post harvest & storage (Paddy, tapioca, Coconut). | 4 | |
| | 7 | Fruits & Vegetable - Harvest, post harvest & storage- Mango, Banana, Tomato, Cucumber. | 4 | |
| | 8 | Under-exploited and unexploited minor tropical and sub-tropical fruits - Guava, Pineapple, Aonla. | 3 | |
| | 9 | Harvest, post harvest & storage- Ornamental plants- Jasmine, anthurium, Orchids, Heliconia, Rose. | 4 | |
| | 10 | Harvesting tools , Harvesting and field containers , Post-harvest transport. | 3 | |
| | 11 | Damages suffered by packed produce Prevention of injuries to the product, Package selection, Packaging material and types of packages. | 2 | |

| | | | | |
|---|---|---|---|---|
| | 12 | Field operations , Field curing root, tuber and bulb crops. | 2 | |
| **III** | **Quality control and packing** | | **9** | **13** |
| | **13** | Standardization, quality factors, quality standards and quality controlImportant quality components, Objective quality standards, Development of grading standards, Quality control. | 3 | |
| | **14** | Package house-Needs of a packinghouse, Packinghouse operations, Receipt. | 2 | |
| | **15** | Sorting, Cleaning and washing Fungicide treatment, Quality selection and size-grading Waxing. | 2 | |
| | **16** | Packaging Special treatments after packaging. | 2 | |
| **IV** | **Storage and transport** | | **4** | 8 |
| | 17 | Storage potential, Factors affecting storage life, Storage structures | 2 | |
| | 18 | Transportation to market, Causes of losses, Mechanical damages, Overheating | 1 | |
| | 19 | Guidelines for establishing fruit and vegetable processing unit- FSSAI standards | 1 | |
| **V** | **Practical** | | **30** | **20** |
| | 1 | Preliminary processing of fruits | | |
| | 2 | Preparation of fruit beverages (squash/ syrup/ RTS beverage) | | |
| | 3 | Cashew apple processing | | |
| | 4 | Preparation of fruit jam | | |

| | | | | |
|---|---|---|---|---|
| | 5 | Preparation of guava jelly | | |
| | 6 | Grape wine preparation | | |
| | 7 | Preparation of pickle | | |
| | 8 | Tomato processing | | |
| | 9 | Determination of acidity | | |
| | 10 | Estimation of sugars | | |
| | 11 | Post-harvest treatment of cut flowers | | |
| | 12 | Commercial production of unfermented beverages-calculation | | |
| | 13 | Visit to processing units of horticultural crops, familiarization with different processed products from spices and plantation crops | | |

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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | | | 3 | 3 | | | | |
| CO 2 | 3 | 3 | 3 | | | | 3 | 3 | 2 | 2 | | 2 |
| CO 3 | 3 | 3 | 3 | | | | 3 | 3 | 2 | 2 | | 2 |
| CO 4 | 3 | 3 | 3 | | | | 3 | 3 | 2 | | | 2 |
| CO 5 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | | 2 |
| CO 6 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| CO | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | ✓ | ✓ |
| CO 3 | ✓ | | ✓ | ✓ |
| CO 4 | ✓ | | | ✓ |
| CO 5 | ✓ | | ✓ | ✓ |
| CO 6 | ✓ | | ✓ | ✓ |

**THIRD SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA3VN202 – HARVEST AND POST HARVEST STORAGE TECHNIQUES IN AGRICULTURE**

**Maximum Time: 2 Hrs** **Maximum Marks: 70**

## SECTION A

**(Answer all questions. Each question carries 3 marks. Ceiling: 24 Marks)**

1. Write down the importance of Post-harvest Technology.
2. Write maturity indices
3. Describe the method of Canning with a flow chart. Mention any two problems that occur during the storage of Canned products.
4. What is the difference between sorting and grading in post harvest handling?
5. Briefly explain climacteric and non-climateric fruits. Give two examples.
6. Sreeja, was writing record while preparing jelly and forgot to switch off the stove. After twenty minutes, Sanjana came from meeting and ended the jelly preparation. Is the finished product will be of high quality? If not, write the set-backs.What water is called a universal solvent?
7. Write in detail about wine preparation with the help of flow diagram.
8. Preservation by acid and drying
9. You just bought a dozen roses for your sweetheart. How can you help assure that the flowers open completely and that the bloom lasts as long as possible?
10. Why are berries always hand-harvested and field-packed?

## SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 36 Marks)**

11. Explain harvest, post harvest & storage of Mango,
12. Write in brief about the methods of low-cost storage? Write the advantages of fruit and Vegetable Preservation.
13. Elaborate the causes of post-harvest loss in horticultural crops.
14. What is the scope of post-harvest management and value addition of horticultural crops.
15. In detail describe the field preparation and curation for tuber crops
16. Explain the importance of establishing Guidelines for fruit and vegetable processing unit FSSAI standards
17. What is the difference between tomato sauce and tomato ketchup? Describe the preparation procedure for tomato sauce.
18. What is the major cause of deterioration in vegetables? How does it reduce quality and how can postharvest handling procedures be modified to minimize it?

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

19. What are the steps followed in the post-harvest handling of the horticultural produce? Discuss in detail.
20. Write an essay on quality control and packing of horticultural products in brief.

## GENERAL FOUNDATION COURSES IN B. Sc. PLANT SCIENCE

MULTI-DISCIPLINARY COURSES

**UNIVERSITY OF CALICUT**

| | | | | | |
|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA1FM105** | | | | |
| **Course Title** | **FOOD PROCESSING AND TECHNOLOGY** | | | | |
| **Type of Course** | **Multi-Disciplinary** | | | | |
| **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** | Higher secondary Level | | | | |
| **Course Summary** | This course explores the basis and fundamentals of food science technology. The course provides proficiency on various technology of baking, processing, preservation and packing methods | | | | |

**Course Outcome**

| COs | Statement | Cognitive level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understands the fundamentals of food science and technology | U | C | Quiz, Internal Exam |
| CO2 | Acquire knowledge about the food science and techniques of baking as well as preservation of food | U | C | Internal exam, Group work to analyse Practical skills |
| CO3 | Familiarize on the importance of food safety, food quality, food laws and regulations, marketing in food industry | U | C | Assignment, Exams |
| CO4 | Impart knowledge related with various packaging materials and field of packaging | U | C | Quiz/ Exams, Practical skill enhancement methods |
| CO5 | Analyse the marketing stratergies of various food products | An | M | Field study (case study)<br>Assignment |
| CO6 | Detect the adultrants in food products | Ap | P | Practical method |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

## DETAILED SYLLABUS

| Module | Unit Content | | Hrs (45) | Marks (50) |
|---|---|---|---|---|
| **I** | **Food Science- Introduction** | | **8** | **6** |
| | 1 | Introduction to food science, different kinds of food industries, scope of food processing and technology | 2 | |
| | 2 | Basic food groups and nutrients, micro and macronutrients. | 2 | |
| | 3 | Concept and characteristics of a balanced diet | 2 | |
| | 4 | Need and importance for developing a new product, types of new products, challenges and failure of new product | 2 | |
| **II** | **Processing and Preservation Technology** | | **10** | **20** |
| | 5. | Fruit and vegetable processing- preserves, pickles, fruit beverages, pectin products | 2 | |
| | 6. | Unit operation in food processing – cleaning, dry cleaning methods, wet cleaning methods, peeling, grading, sorting | 2 | |
| | 7. | Principles and methods of preservation | 1 | |
| | 8. | Chemical preservatives- definition, types. | 1 | |
| | 9. | New techniques in the preservation of food - High pressure processing, Ohmic heating, Pulse electric field processing, irradation. Importance of drying in the food processing | 2 | |
| | 10. | Preservation technology- objectives, steps, factors affecting - dehydration, concentration, refrigeration, freezing, canning | 2 | |
| **III** | **Baking Technology** | | **16** | **16** |
| | 11 | Baking industry and its scope in the Indian economy | 2 | |
| | 12 | Nutritional facts in bakery products | 1 | |

| | | | | |
|---|---|---|---|---|
| | 13 | Wheat grain technology- milling of wheat, types and composition of refined wheat flour and its storage | 3 | |
| | 14 | Preparation of cake, pastry, biscuit and cookies- types- ingredients, processing. | 3 | |
| | 15 | Faults and remedies in the baking process | 2 | |
| | 16 | Food packaging- importance, essential features of an ideal package- food packaging materials- recent trends in the field of packaging (active packaging, intelligent packaging, vacuum packagingRFID)- label designing and regulations, nutritional labelling. | 3 | |
| | 17 | Marketing and cost control of processed products | 2 | |
| **IV** | **Adulteration** | | **6** | **8** |
| | 18 | Adulteration, adulterants and their effects on health | 3 | |
| | 19 | Methods of detection of Adulterants (oil, sugar, milk, spices and condiments, additives and sweeting agents) | 3 | |
| **V** | **Open ended** | | **5** | **5** |
| | 1 | Terms, factors, concerns | 2 | |
| | 2 | Laws and regulations | 2 | |
| | 3 | Hygiene and Sanitation | 2 | |
| | 4 | HACCP (Hazard Analysis Critical Control Point) | 3 | |

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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | | | 3 | | | | | |
| CO 2 | 3 | 2 | | | 2 | | 3 | | 2 | | | |
| CO 3 | 3 | | | | 2 | 2 | 3 | | 2 | | | 2 |
| CO 4 | 3 | 2 | | | 2 | | 3 | | 2 | | 2 | |
| CO 5 | 3 | | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 |
| CO 6 | 3 | 2 | | 3 | 3 | | 3 | 3 | 3 | 2 | 2 | |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | | | ✓ | |
| CO 6 | | | ✓ | |

**FIRST SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA1FM105 - FOOD PROCESSING AND TECHNOLOGY**

**Maximum Time: 1.5 Hrs** **Maximum Marks: 50**

## Section A

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

1. Differentiate refrigeration and freezing
2. Why the permitted level of food additives important?
3. Write scope of food processing and technology
4. 4.Mention importance of minerals for good health
5. What is Ohmic heating technique?
6. Enumerate health hazards by various adulterants
7. Write on the nutritional facts in the bakery products
8. What are the characteristics of a balanced diet?
9. Write any two challenges and failures for introducing new product
10. What is vacuum packing?

## Section B

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

11. Expalin about methods of drying
12. Give an account of different types of chemical preservatives.
13. Write a note on the methods of detection of adulterants in spices and condiments
14. Write about preparation of cake
15. Describe the procedure for the preparation of biscuits

## Section C

**(Answer any one. Each question carries 10 marks; 1 × 10= 10 marks)**

16. Explain manufacture, processing, packaging and value addition of fruit products
17. Describe wheat grain technology with different types, composition and storage process of

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA2FM106** | | | | |
| **Course Title** | **BIODIVERSITY AND ENVIRONMENTAL INTERACTIONS** | | | | |
| **Type of Course** | **Multi-Disciplinary** | | | | |
| **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** | Knowledge in biology at Higher secondary Level | | | | |
| **Course Summary** | Course focussed on the natural resources, conservation strategies of biodiversity and interactions of biotic and abiotic components. This also give information about various organization and their activities related to biodiversity conservation | | | | |

**Course Outcome**

| COs | Statement | Cognitive level | Knowledge Category | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Gain knowledge on natural resources for the sustainability of the life | U | C | Instructor creator Exam |
| CO2 | Develop critical thinking on the conservation and protection of biodiversity | Ap | P | Group discussion, Quiz |
| CO3 | Establish knowledge on different organization and their activities | An | F | Assignment, Quiz, Exam, Presentation |
| CO4 | Acquire knowledge about the values in relation to the interactions of environment | An | F | Group Discussion, Presentation |
| CO5 | Attain practical knowledge on the assessment of natural sources | Ap | P | Field study |
| CO6 | Understand the current scenario on the environmental protection status and strategies of the country and world. | U | F | Assignment, group discussion, test Paper |

* - 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) | Marks (50) |
|---|---|---|---|---|
| **I** | **Introduction to Biodiversity** | | **6** | **10** |
| | 1 | Biodiversity- definition, types, biodiversity as a natural resource | 1 | |
| | 2 | Biodiversity at global, National and local levels, Vegetational zones of India, Biogeographical classification of India | 2 | |
| | 3 | Major projected areas and their importance | 2 | |
| | 4 | Measurement of diversity, value of biodiversity, India as a mega diversity nation | 1 | |
| **II** | **Concepts and Strategies** | | **9** | **15** |
| | 5 | Concepts and basis of Hotspots. Hotspots in India | 1 | |
| | 6 | Strategies for biodiversity conservation: *in situ*, *ex situ* and *in vitro* conservation. Threat to biodiversity-Extinct, Rare, Endangered and threatened flora and fauna. Red data book | 2 | |
| | 7 | Threat to biodiversity-Extinct, Rare, Endangered and threatened flora and fauna. Red data book | 2 | |
| | 8 | Biodiversity profiles- Estuarine ecosystem, lentic (lake ecosystem) and lotic (river ecosystem), Forest and grassland, Agrobiodiversity | 2 | |
| | 9 | Organizations- IUCN, UNEP, WWF, Biodiversity Board of Kerala (KSBDB)Biodiversity centres of India | 2 | |
| **III** | **Population and Community Ecology** | | **15** | **15** |
| | 10 | Population ecology: Characteristics of population, concept of carrying capacity, Population growth and regulations. | 2 | |
| | 11 | Population fluctuations, dispersion and metapopulation | 1 | |
| | 12 | Concept of r and k species. Keystone species, flagship species | 2 | |

| | | | | |
|---|---|---|---|---|
| | 13 | Community ecology: Definition, community concept | 2 | |
| | 14 | Co-evolution of populations- Association of flowering plants and insects. | 2 | |
| | 15 | Types of interactions- predation, herbivory, symbiosis, mutualism, commensalism, parasitism and allelopathy | 2 | |
| | 16 | Biological invasions- Invasive plants | 2 | |
| | 17 | Techniques in plant community studies- species area curve-density, frequency, abundance, dominance of populations- important value index-construction of phytographs | 2 | |
| **IV** | **Applied Ecology** | | **10** | **10** |
| | 18 | Global environmental change, major drivers of biodiversity change, biodiversity management approaches. | 2 | |
| | 19 | Current issues in India, Environmental education and awareness programmes. | 2 | |
| | 20 | Green Protocol | 2 | |
| | 21 | Biodiversity legislation and conservations, Biodiversity information management and communication | 2 | |
| | 22 | Genepool, biopiracy and bioprospecting | 2 | |
| **V** | **Open ended** | | **5** | **5** |
| | 1 | Case Studies: Phenology of species in relation to environment/ Plant -pollinator interaction | | |
| | 2 | Group assignment on a polluted area in a local area | | |
| | 3 | Waste water analysis- BOD, COD, Copper, Iron and Chromium | | |
| | 4 | Explore and assess natural resources like river/ forest/ grassland | | |

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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | | 3 | 3 | | | | | 3 |
| CO 2 | 3 | | 2 | | | 3 | 3 | 3 | | | | 3 |
| CO 3 | 3 | | | | | 3 | 3 | | | | 2 | 3 |
| CO 4 | 3 | | | 3 | | 3 | 3 | 3 | | 2 | | 3 |
| CO 5 | 3 | 3 | | | 2 | 3 | 3 | | 1 | 2 | | 3 |
| CO 6 | 3 | | 3 | 3 | 2 | 3 | 3 | 3 | | | 2 | 3 |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | ✓ | ✓ | ✓ | ✓ |
| CO 6 | ✓ | ✓ | | ✓ |

**SECOND SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA2FM106 – BIODIVERSITY AND ENVIRONMENTAL INTERACTIONS**

**Maximum Time: 1.5 Hrs** **Maximum Marks: 50**

**Section A**

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

1. Differentiate alpha and gamma diversity.
2. Define metapopulation with example.
3. Differentiate between bioprospecting and biopiracy.
4. What is BIM?
5. Explain the factors that regulate population growth.
6. Write about the Hotspots in India.
7. Explain Agrobiodiversity.
8. What is the Red Data Book?
9. Write difference between r and k selected species.
10. What are the global level actions to promote biodiversity conservation?

**Section B**

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

11. Explain about biogeographic zones of India.
12. Write on the coevolution of plants and insect pollinators.
13. Write a note on the approaches of biodiversity management.
14. Explain different organizations in relation to biodiversity conservation.
15. Describe different methods to measure biodiversity.

**Section C**

**(Answer any one. Each question carries 10 marks) (1 × 10 = 10 marks)**

16. Briefly explain different types of interaction and also emphasis on the interrelationship between living world and environment.
17. Explain different techniques used in the plant community studies.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA3FV108** | | | | |
| **Course Title** | **SUSTAINABLE AGRICULTURE AND FOOD SECURITY** | | | | |
| **Type of Course** | **Value Added** | | | | |
| **Semester** | **3** | | | | |
| **Academic Level** | **100 –199** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 3 | 3 | - | - | 45 |
| **Pre-requisites** | Basic knowledge about soil and soil types, basics of horticulture and practices | | | | |
| **Course Summary** | This course aims to give an idea of the basics of agronomy and horticulture, different types of farming, organic farming and its significance and methods of organic farming of different common crops. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand different types of soil types, farming systems | U | F | Test paper<br>Assignments |
| CO2 | Analyse the status of suitable agriculture strategies of the state and country | U | F | Presentation<br>Quiz |
| CO3 | Synthesize evidence from multiple sources to highlight the complexities and trade offs associated with efforts to improve the sustainability of agriculture and food systems. | Ap | M | Group discussion, Assignment |
| CO4 | Get first-hand professional experience in project management and problem solving in food security. | Ap | F | Case study, Project |
| CO5 | Gain awareness of the differing roles for specialists and generalists and understand the critical importance of knowledge sharing across disciplines to acquire sustainable agriculture | An | C | Group discussion<br>Assignment |
| CO6 | Attain a perspective of sustainable consumption and apply the learning toward the design of innovative solutions for a sustainable food future | Ap | M | Group project<br>Case study<br>Presentation |
| * - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)<br># - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M) | | | | |

## DETAILED SYLLABUS

| Module | Unit | Content | Hrs (45) | Marks (50) |
|---|---|---|---|---|
| **I** | **Fundamentals of Agronomy and horticulture** | | **6** | **5** |
| | 1 | Importance of horticulture in terms of economy, production, employment. Generation, environmental protection and human resource development. | 1 | |
| | 2 | Scope for horticulture in India. Nutritive value of horticultural crops, Divisions of horticulture with suitable examples and their importance. | 1 | |
| | 3 | Soil classification, soil fertility, weed control. | 1 | |
| | 4 | Farming System, Precision Fanning and Sustainable Agriculture | 1 | |
| | 5 | Types and systems of farming system and factors affecting types of farming, Farming system components and their maintenance, Cropping system and pattern, multiple cropping system, | 2 | |
| **II** | **Organic Farming for Sustainable Agriculture** | | **9** | **10** |
| | 6 | Concept of organic farming- Introduction: Farming, organic farming, concept and development of organic farming. Principles of organic farming,Types of organic farming | 2 | |
| | 7 | Biodynamic farming, benefits of organic farming., Need for organic farming ,Conventional farming v/s organic farming, Scope of organic farming; Kerala, national and international status , Agencies and institutions related to organic agriculture. | 3 | |
| | 8 | Plant protection introduction - conventional methods, Plant protection- botanical pesticides, Plant protection- botanical pesticides. Plant protection- bio control agents, Weed management | 2 | |
| | 9 | Farm economy: Basic concept of economics- Demand, supply 2. Economic Viability of a farm. 3. Basic production principles | 2 | |
| **III** | **Sustainable agriculture** | | **13** | **15** |
| | 10 | Effect of Climate Change on Agriculture and Soil | 2 | |

| | | | | |
|---|---|---|---|---|
| | | Properties-Shift in Climatic and Agriculture Zones. Impact on Agriculture Soil. Effect of Climate Change on Factors Influencing Agriculture | | |
| | 11 | Biotechnology and Sustainable Agriculture - Genetically Modified Foods -Biotechnology for Improving Nutritional Quality: Transgenic Plants for Better Human Health | 3 | |
| | 12 | Use of Microbes for Sustainable Agriculture-Plant-Associated Microbiome - Beneficial Rhizosphere Microorganisms , Beneficial Microbes in Agriculture Under Changing-Climatic Scenario | 3 | |
| | 13 | Nanotechnology for Sustainable agriculture - Applications of Nanotechnology in Sustaining Crop Production, Nanotechnology in Reducing Postharvest Loss | 2 | |
| | 14 | Sustained Agriculture through Agroecosystem | 1 | |
| | 15 | Plant breeding and sustainable agriculture. Traditional Plant-Breeding Approaches vs Newly Established Transgenic Technology | 2 | |
| **IV** | **Food security** | | **12** | **20** |
| | 16 | Environment, climate and food security-Food security concept; types of food insecurity; poverty, hunger and malnutrition.Inter-relationship between environment, climate and agricultural (arable agriculture and livestocks) and non-agricultural (marine; fresh water; forests) food production; impact on food security. | 2 | |
| | 17 | Role of arable agriculture in increasing and decreasing climate change and natural resources; how this can subsequently impact food security. | 2 | |
| | 18 | Methods and strategies for improving crop yield under climate and environment stress- plant breeding, bio-pesticides, GM crops; sustainable agriculture; traditional agriculture; agro-ecology; organic agriculture; subsistence agriculture; and, resource management systems (e.g., IWRM, INRM, IPM, etc.) | 2 | |
| | 19 | Nutritional security, balanced diet, hunger and human health; Impact of various abiotic environmental pollutants (air, water and soil) and changing climate (heat stress, drought) factors and biotic factors (pests) on quality of food crops; impact on health of farmers. | 2 | |

| | | | | |
|---|---|---|---|---|
| | 20 | Policy, economic and social aspect of food. Economics and policy of food security; role of institutions (e.g., FAO, NABARD, FCI, NAFED, RRB, APMC); agricultural planning in India (including recommendations of various committees for e.g., Bhutani committee, RB Gupta Committee, K N Raj Committee, etc.). | 2 | |
| | 21 | Economic viability of (a) small-scale agriculture, (b) regional food systems; farmers' income and livelihood; agricultural financing, credit and crop insurance, challenges ahead. | 2 | |
| **V** | **Open ended** | | **5** | **5** |
| | 1 | | | |
| | 2 | | | |
| | 3 | | | |

**References**


1. Fundamentals of Horticulture, Edmond, J.B., Sen., T.L., Andrews, F.S and Half-acre R.G, 1963. Tata McGraw Hill Publishing Co., New Delhi.
2 Introduction to Horticulture, Kumar, N. 1990. Rajyalakshmi Publications, Nagarcoil, Tamilnadu.
3 Basic Horticulture, Jitendra Sing, 2002. Kalyani Publishers, Hyderabad.
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9. Kristensen, P., Taji, A. and Reganold, J. (2006). Organic Agriculture: A Global Perspective.CSIRO Press, Victoria, Australia.
10. Organic Farming Web Sites Organisation IRL address Scottish Agricultural College (SAC) http://www.sac.ac.uk/organic-farming Scottish Organic Producers Association
11. Dhyan Singh, P.K. Chhonkar and B.S. Dwivedi. 2015. Manual On Soil, Plant And Water Analysis. Westville Publishing House. India.
12. Henry D. Foth. 1990. Fundamentals of Soil Science. 8th Edition. John Wiley& Sons. USA.
13. Soil Science-An Introduction. 2015. Indian Society of Soil Science. India.

**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | | 2 | 3 | | | | | 2 |
| CO 2 | 3 | | 3 | 2 | 3 | 2 | 3 | | | 2 | 3 | 2 |
| CO 3 | 3 | | 3 | 3 | 3 | | 3 | 3 | | | 3 | |
| CO 4 | 3 | 3 | | | 3 | 2 | 3 | 3 | 3 | | 3 | 2 |
| CO 5 | 3 | | 3 | | | | 3 | 3 | | | | |
| CO 6 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | ✓ | |
| CO 5 | ✓ | ✓ | | ✓ |
| CO 6 | ✓ | ✓ | ✓ | ✓ |

**THIRD SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA3FV108 - SUSTAINABLE AGRICULTURE AND FOOD SECURITY (VAC)**

**Maximum Time: 1.5 Hrs** **Maximum Marks: 50**

## Section A

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

1. How nutritional security, balanced diet, hunger and human health are addressed through sustainable agriculture.
2. Describe the difference between conventional farming and organic farming.
3. Explain the basic concepts on farm economy
4. What are the benefits of bio-pesticides? Name two home made bio-pesticide
5. How can you successfully increase the production by organic farming?
6. What is the Inter-relationship between environment, climate and agricultural?
7. How soil is classified?
8. What is the importance of horticulture in terms of economy, production, employment?
9. Crop rotation and its benefits.
10. Name a few beneficial rhizosphere microorganisms and their role.

## Section B

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

11. Explain the role of institutions in economics and policy of food security.
12. Write an essay on the plant protection methods.
13. Explain the status of organic farming in Kerala, national and international status and agencies and institutions related to organic agriculture.
14. Describe the policies and incentives of organic production
15. Explain the methods and strategies for improving crop yield under climate and environment stress

## Section C

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

16. Explain the methods to convert organic farming process for income generation.
17. Explain different fields in crop improvement to achieve sustainable agriculture with suitable examples.

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA4FV110** | | | | |
| **Course Title** | **AGRI-BUSINESS MANAGEMENT** | | | | |
| **Type of Course** | **Value Added** | | | | |
| **Semester** | **IV** | | | | |
| **Academic Level** | **100-199** | | | | |
| **Course Details** | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours |
| | 3 | 3 | - | - | 45 |
| **Pre-requisites** | Basic knowledge on agricultureal practices and marketing methods. | | | | |
| **Course Summary** | To equip students with the knowledge and skills needed to effectively manage agricultural businesses, understand agricultural market dynamics, and apply modern management practices to enhance productivity and sustainability in agriculture. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Understand the basics of agricultural economics | U/R | F | Instructor-created exams / Quiz |
| CO2 | Understand the basics of farm management | U/R | C | Practical Assignment / Observation of Practical Skills |
| CO3 | Understand the basics of agricultural extension and communication | U | C | Seminar Presentation/ Assignments |
| CO4 | Analyse the risk and its management in agribusiness | An/E | M | Instructor-created exams / Viva Voce |
| CO5 | Understand the concept of entreprenaurship in agribusiness | U | C | Assignment<br>Seminar<br>Field visit |
| CO6 | Evaluate the facors influencing the success or failure of agribusiness entreprenaurship | E | M | Assignment<br>Group discussion<br>Seminar<br>Case study |

* - 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) | Marks (50) |
|---|---|---|---|---|
| **I** | **Introduction to Agri-Business Management** | | **09** | **10** |
| | 1 | Overview of Agribusiness, Scope and Importance, Basic Concepts in Management. | 1 | |
| | 2 | **Introduction to Crop Science**- Basics of Crop Production, Soil and Climate Requirements, Crop Rotation and Mixed Farming. | 2 | |
| | 3 | **Introduction to Animal Science**- Livestock Production, Animal Husbandry Practices, Basic Veterinary Care. | 2 | |
| | 4 | **Principles of Agricultural Economics**- Micro and Macro Economics, Demand and Supply in Agriculture, Price Determination. | 2 | |
| | 5 | **Basic Accounting**- Fundamentals of Accounting, Financial Statements, Bookkeeping. | 2 | |
| **II** | **Farm Management** | | **11** | **15** |
| | 6 | Farm Planning and Budgeting, Resource Allocation, Risk Management in Agriculture. | 2 | |
| | 7 | **Marketing Management**-Principles of Marketing, Agricultural Marketing, Market Research and Analysis. | 2 | |
| | 8 | **Soil Science and Agronomy**- Soil Properties and Classification, Soil Fertility and Management, Agronomic Practices. | 3 | |
| | 9 | **Environmental Management and Sustainability-** Environmental Impact of Agriculture, Sustainable Agricultural Practices, Climate Change Adaptation. | 2 | |
| | 10 | **International Agri-Business**- Global Agricultural Markets, Export-Import Procedures, International Business Strategies. | 2 | |
| **III** | **Horticulture and Plantation Management** | | **10** | **12** |
| | 11 | Horticultural Crops and Practices, Plantation Management, Post-Harvest Technology, Operations Management, Production Planning. | 2 | |
| | 12 | Supply Chain Management in Agriculture, Quality Control. | 2 | |
| | 13 | **Agricultural Extension and Communication**- Extension Methods and Approaches, Communication Skills for Extension, Participatory Rural Appraisal (PRA) | 2 | |

| | | | | |
|---|---|---|---|---|
| | 14 | **Risk Management and Insurance in Agriculture**-Types of Risks in Agriculture, Risk Mitigation Strategies, Agricultural Insurance. | 2 | |
| | 15 | Agri-Business Law and Ethics-Legal Framework in Agriculture, Intellectual Property Rights, Ethical Issues in Agri-Business. | 2 | |
| **IV** | **Agri-Business Entrepreneurship** | | **10** | **13** |
| | 16 | Concept of Entrepreneurship, Business Plan Development, Start-up Ecosystem, Agricultural Finance and Microfinance, Agricultural Credit Systems, Microfinance Institutions and Models, Financing Smallholder Farms. | 3 | |
| | 17 | Agri-Business Logistics and Supply Chain Management, Logistics Planning, Cold Chain Management, Distribution Strategies. | 2 | |
| | 18 | **Human Resource Management in Agri-Business**-HR Practices, Labor Laws and Relations, Training and Development | 2 | |
| | 19 | Food Processing and Value Addition, Principles of Food Processing, Value Addition Techniques, Quality Assurance | 3 | |
| **V** | **Open ended** | | **5** | **5** |
| | 1 | Introduction to Information Technology in Agriculture: Role of IT in Agriculture, Agricultural Data Management. | | |
| | 2 | Precision Farming Technologies | | |
| | 3 | Rural Sociology and Development, Rural Social Structure, Community Development, Extension Education. | | |
| | 4 | Online trading platforms in India | | |

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2. James G. Beierlein, Kenneth C. Schneeberger, and Donald D. Osburn. 2012. Principles of Agribusiness Management, Publisher: Waveland Press
3. James Michael, C. Ed. 2017. Agribusiness Management: Challenges, Opportunities, and Strategies. Publisher: CRC Press.
4. Mahendra Dev S. and N. Chandrasekhara Rao. 2014. Indian Agribusiness Systems: Emerging Paradigms and Strategies. Publisher: Springer.
5. Sidhu K. S. Agribusiness Management in India. 2007. Publisher: Oxford University Press.

**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | | | | | | 3 | | | | | 2 |
| CO 2 | 3 | | | | | | 3 | | | | | 2 |
| CO 3 | 3 | 2 | | | 2 | | 3 | | | 2 | | 2 |
| CO 4 | 3 | | 2 | 2 | 2 | 3 | 3 | | 2 | 2 | 2 | |
| CO 5 | 3 | | 2 | | 2 | 3 | 3 | 2 | | 3 | | |
| CO 6 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)
-

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Practical Examination Field study | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | ✓ | ✓ |
| CO 5 | | | | |
| CO 6 | | | ✓ | |

**FOURTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA4FV110 - AGRI-BUSINESS MANAGEMENT**

**Maximum Time: 2 Hrs** **Maximum Marks: 50**

## SECTION A

**(Answer all questions. Each question carries 2 marks. Ceiling: 16 Marks)**

1. What are the basic concepts in agribusiness management?
2. What is the role of demand and supply in agriculture?
3. What is crop rotation, and why is it important?
4. What are the basics of veterinary care for livestock?
5. What factors influence soil fertility?
6. What are sustainable agricultural practices?
7. What is precision farming?
8. How does Participatory Rural Appraisal (PRA) facilitate better decision-making in agricultural communities?
9. How does agricultural insurance benefit farmers?
10. How does entrepreneurship drive innovation in agriculture?

## SECTION B

**(Answer all questions. Each question carries 6 marks. Ceiling: 24 Marks)**

11. How does basic accounting benefit agribusiness management?
12. How does agricultural marketing differ from traditional marketing?
13. Explain the significance of soil texture and structure in crop production.
14. Discuss the role of technology in climate change adaptation for agriculture.
15. How do extension services benefit farmers?

## SECTION C

**(Answer any one. Each question carries 10 marks. 1 × 10 = 10 Marks)**

16. What are the most popular online trading platforms for agriculture in India? How do these platforms benefit farmers and discuss the future prospects of online trading platforms in the Indian agricultural sector.
17. What are the characteristics of global agricultural markets and discuss the role of trade agreements in global agriculture. How do global market trends affect local farmers?

## GENERAL FOUNDATION COURSES IN B. Sc. PLANT SCIENCE

## SKILL ENHANCEMENT COURSES

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| | | | | | |
|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA5FS112** | | | | |
| **Course Title** | **PLANT PROPAGATION TECHNIQUES** | | | | |
| **Type of Course** | **Skill Enhancement** | | | | |
| **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** | Basic concepts of plant morphology, plant reproduction higher secondary school level | | | | |
| **Course Summary** | The course gives an outline of sexual and vegetative methods of propagation in plants and how we can use these techniques to raise new plants, protect and propagate and in a well-maintained nursery. | | | | |

**Course Outcomes (CO):**

| COs | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | List out the requirements for tissue culture | U | F | Instructor-created exams / Quiz |
| CO2 | Compare various methods of vegetative propagation | U | F | Instructor-created exams / Quiz |
| CO3 | Do budding, cutting, grafting and layering | Ap | P | Demonstration |
| CO4 | Compare different propagation structure suitable for their nursery plants | E | C | One Minute Reflection Writing assignments |
| CO5 | Identify a successful graft union | U | C | Home work |
| CO6 | Identify viable seed from a non viable seed from a test result | Ap | P | Experimentation |

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

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

## DETAILED SYLLABUS

| Module | Unit | Content | Hrs (45) | Marks (50) |
|---|---|---|---|---|
| **I** | **Seed propagation** | | **9** | **15** |
| | 1 | Seed propagation-Seed propagation: seed dormancy, | 3 | |
| | 2 | Seed viability and longevity, seed quality tests, seed treatment, | 2 | |
| | 3 | Essential conditions for successful propagation, raising of seed beds, transplanting techniques. | 2 | |
| | 4 | Advantages and disadvantages of seed propagation. Plant introduction | 1 | |
| | 5 | Good practices of fruit collection, seed extraction and storage | 1 | |
| **II** | **Vegetative propagation** | | **20** | **15** |
| | 6 | Cutting (stem- under-ground stems, modified stem, roots, leaves) | 1 | |
| | 7 | Grafting (approach and inarch grafting, whip tongue, Bark grafting) | 3 | |
| | 8 | Budding (T-budding, inverted T budding, Patch, Ring) | 3 | |
| | 9 | Layering (tip layering, simple layering, serpentine layering, air layering, mound layering, trench layering) | 3 | |
| | 10 | Micropropagation -general account on basic requirements, medium composition and preparation, sterilization techniques, | 5 | |
| | 11 | Meristem culture, micropropagation- steps, tissue culture, somatic embryogenesis, artificial seeds, advantages, soma clonal variations, chimera formation | 5 | |
| **III** | **Graft Union** | | **5** | **10** |
| | 12 | Anatomical, Studies of Graft/bud union and scion - stock relationship and their influences | 1 | |
| | 13 | Topophysis, cyclophysis, double-working by budding in fruit trees, | 2 | |

| | | | | |
|---|---|---|---|---|
| | 14 | Factors Influencing Rooting of cuttings and Layering, | 2 | |
| **IV** | **Nursery management** | | **6** | **10** |
| | 15 | Common possible errors in nursery activities, Watering, weeding and nutrient management in nursery | 2 | |
| | 16 | Propagation Structures: Mist Chamber, Humidifier, Green houses, Glass houses, Poly houses,cold frames and hot beds | 3 | |
| | 17 | Online nursery information and sales systems | 1 | |
| **V** | **Open ended** | | **5** | **5** |
| | 1 | Hands on training on cutting, grafting, budding, layering | | |
| | 2 | Make a Visit to plant breeding institute | | |
| | 3 | Seed viability test demo | | |
| | 4 | Inoculation of explant in Tissue culture medium (any plant of crop plant of interest) | | |

**References:**


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2. Kumar, U. 2012. Methods in Plant Tissue Culture. Agrobios.
3. Hartmann H.T., Kester D.E., Davies F.T., Geneve, R.L. 2015. Plant Propagation, Principles and Practices. Pearson.
4. Razdan M.K. 1995. Introduction to Plant Tissue Culture. Oxford & IBH.
5. Gupta P.K. 1996. Elements of Biotechnology; Rastogi and Company.
6. Rodgran, M.K. 2004. Plant Tissue Culture, Oxford & IBH.
7. P. Ratha Krishnan Rajwant K. Kalia J.C. Tewari M.M. Roy ., 2014. Plant Nursery Management: Principles and Practices, Central Arid Zone Research Institute (Indian Council of Agricultural Research) Jodhpur.

**Mapping of COs with PSOs and Pos**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 2 | | | 1 | | | 2 | | 2 | | | 1 |
| CO 2 | 3 | 1 | | 1 | | | 2 | 2 | | | | 1 |
| CO 3 | 2 | 3 | | | 2 | 1 | | | | | 2 | 1 |
| CO 4 | 3 | 3 | | | | | 2 | 2 | | 1 | | |
| CO 5 | 3 | 3 | 1 | | | | | 1 | | 3 | 1 | |
| CO 6 | 2 | 3 | | | | | 2 | 1 | | | | |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)
-

**Mapping of COs to Assessment Rubrics:**

| COs | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | | | ✓ | |
| CO 6 | | | ✓ | |

**FIFTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA5FS112 – PLANT PROPAGATION TECHNIQUES**

**Maximum Time: 1.5 Hrs** **Maximum Marks: 50**

**Section A**

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

1. Seed viability tests and its importance
2. Describe the difference between approach graft and inarching.
3. Show how the use of interstock can overcome incompatibility between stock and scion.
4. What is the difference between a tuber and a tuberous roots
5. How can you successfully transfer seedlings to fields
6. Reasons of somaclonal variations.
7. Define a chimera
8. Root cutting as a means of vegetative propagation
9. Differentiate between Mist Chamber and Humidifier,
10. How soil beds are prepared?

**Section B**

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

11. Distinguish the difference between bark graft and approach graft with illustrations.
12. Write an essay on the plot propagation structures used in nursery management.
13. Advantages and disadvantages of seed propagation
14. Describe, with illustration, the method of T budding and patch budding
15. Explain the composition of medium in tissue culture

**Section C**

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

16. What is layering? Explain, with illustrations, six different types of layering used in horticulture: tip layering, simple layering, serpentine layering, air layering, mound layering, trench layering.
17. Explain how you can develop seedlings in large scale by micropropagation. Give an account on basic requirements, medium composition and preparation, sterilisation techniques,

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|---|---|---|---|---|---|
| **Programme** | **B. Sc. PLANT SCIENCE** | | | | |
| **Course Code** | **PLA6FS113** | | | | |
| **Course Title** | **MUSHROOM CULTIVATION & MARKETING** | | | | |
| **Type of Course** | **Skill Enhancement** | | | | |
| **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** | Basic knowledge about fungi and its nutrition. | | | | |
| **Course Summary** | Students get knowledge about different types of edible and poisonous mushrooms, values of mushrooms, culture method of two types, mushroom production, and value- added products from mushrooms. | | | | |

**Course Outcomes (CO):**

| CO | CO Statement | Cognitive Level* | Knowledge Category# | Evaluation Tools used |
|---|---|---|---|---|
| CO1 | Identify edible and poisonous mushrooms | U | F | Specimen Identification/ written assignment |
| CO2 | List out various agro wastes for mushroom cultivation medium,as substratum for sustainable utilization of resources | U | F | Written tests |
| CO3 | Demonstrate the oyster mushroom cultivation using different containers by recycling materials | Ap | P | Demonstration / lab |
| CO4 | List out different pests and pathogen which affect mushroom production | U | F | Written assignments |
| CO5 | Compare the advantages of different methods of storage techniques | U | P | One Minute Reflection Writing assignments |
| CO6 | Cook mushroom dishes | Ap | P | Value added product and Food exhibition / Assignment |

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

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

## DETAILED SYLLABUS

| Module | Unit | Content | Hrs (45) | Marks (50) |
|---|---|---|---|---|
| **I** | **Introduction to Mycology** | | **11** | **14** |
| | 1 | Mushrooms: introduction, biodiversity, edible and poisonous species, Taxonomic position of Basidiomycota | 2 | |
| | 2 | Distribution and morphology of Fungi (Mushroom) all over the world, India and Kerala | 2 | |
| | 3 | The role of mushrooms in nature: saprobes, parasites, mycorrhiza formers. | 1 | |
| | 4 | Value of mushrooms – nutritional, medicinal, economic and environmental. | 1 | |
| | 5 | Mushroom Production: An Agribusiness Activity-opportunities in India for domestic and export market for button mushroom, oyster mushroom, shiitake, Future prospectives<br>Production and Marketing of Mushrooms: Global and National Scenario | 5 | |
| **II** | **Materials and Methods in Mushroom cultivation** | | **18** | **22** |
| | 7 | The equipment required in a spawn laboratory | 1 | |
| | 9 | Spawn ProductionTechnology -Pure Culture Preparation, Methods of spawn production: preparation of agar media (PDA, MEA), Substrate Preparation of Spawn; commercial and home-made; Spawn storage and Its Transport | 5 | |
| | 10 | Raw materials for mushroom cultivation: logs, wood chips, paper products, cereal straws, grain hulls, sugar cane bagasse, banana fronds and other agro-wastes. Supplements for high yield | 3 | |
| | 11 | Methods of Compost Preparation for White Button mushroom | 2 | |
| | 12 | Protocol for cultivating mushrooms on agricultural wastes: heat-treating the bulk substrate, submerged pasteurization, steam pasteurization, chemical treatment of straw, | 2 | |

| | | | | |
|---|---|---|---|---|
| | 13 | Culture containers- Cropping containers, tray culture and bag culture, casing, growth parameters (incubation temperature, relative humidity, duration, CO2 concentration, fresh air exchange, light requirement) | 2 | |
| | 14 | Cultivation Technology of White Button Mushroom and Oyster Mushroom; Biological efficiency of mushroom production. | 3 | |
| **III** | **Module 3- Harvest and post-harvest technique** | | **6** | **6** |
| | 15 | Harvesting- Methods, Do's and don't, Factors affecting effective harvest | 1 | |
| | 16 | Storing- Long term, short term, Advantages and disadvantages of different methods of storage | 2 | |
| | 17 | Recycling of Spent Mushroom Substrate | 1 | |
| | 18 | Mushrooms- Value Added Products, Art of Mushroom Cooking -5 recipe | 2 | |
| **IV** | **Constraints in mushroom production** | | **5** | **8** |
| | 19 | Diseases in Mushroom | 1 | |
| | 20 | Biology and Management of Insect Pests and Mites | 2 | |
| | 21 | Nematode Pests of Mushrooms and Their management | 2 | |
| **V** | **Open ended** | | **5** | **5** |
| | 1 | Specimen identification- edible and poisonous (not edible) | | |
| | 2 | Medium preparation and inoculation. | | |
| | 3 | Demonstration of spawn preparation | | |
| | 4 | Demonstration of oyster mushroom cultivation in polypropylene bags. | | |
| | 5 | Laboratory-scale cultivation of oyster and Button mushroom (farm visit)<br>Conduct Food fest | | |

## References


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**Mapping of COs with PSOs and POs**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | 3 | 2 | | | - | 3 | 1 | | 2 | | |
| CO 2 | 3 | 3 | 3 | 1 | - | 3 | 3 | | 2 | | | 3 |
| CO 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 2 | | 1 | 3 |
| CO 4 | 3 | 3 | 2 | 1 | - | - | 3 | 3 | | 3 | 2 | |
| CO 5 | 3 | 3 | 1 | | - | - | 3 | 3 | | 3 | 2 | |
| CO 6 | 1 | 3 | | | - | - | 1 | 1 | 1 | 1 | 2 | |

**Correlation Levels**

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

**Assessment Rubrics:**

- Quiz / Assignment / Quiz / Discussion / Seminar / Presentations
- Midterm Exam
- Assignments (20%)
- Final Exam (70%)

**Mapping of COs to Assessment Rubrics:**

| | Internal Exam | Assignment | Practical Examination | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | | | ✓ | |
| CO 6 | | | ✓ | |

**SIXTH SEMESTER B. Sc. PLANT SCIENCE DEGREE EXAMINATIONS**

**PLA6FS113 - MUSHROOM CULTIVATION & MARKETING**

**Maximum Time: 1.5 Hrs** **Maximum Marks: 50**

## Section A

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

1. What is edible part of a mushroom? List out the parts.
2. How can you evaluate the efficiency of mushroom?
3. Explain the methods of the mycelium is cultured on a medium?
4. How can you successfully transfer seedlings to fields
5. What is Casing and mention its importance.
8. List out the requirements essential for a mushroom laboratory and its uses.
9. Containers used in mushroom cultivation
10. How can you enhance a better harvesting of your button mushroom?

## Section B

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

11. Explain the growth parameters affect the various stages of mushroom cultivation
12. Advantages and disadvantages of different methods of storage
13. Explain the methods of Compost Preparation for White Button mushroom
14. Why we consider mushroom cultivation as an agribusiness? Justify
15. What are the roles of mushroom in nature?

## Section C

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

16. What is protocol for the cultivation of oyster mushroom on agricultural wastes? What are the supplements that can be added to enhance yield.
17. Explain the constrains in mushroom cultivation with special reference to pest and pathogen attack.