# Bharathidasan Government College for Women (Autonomous) Puducherry – 605 003

## NEP BASED

## SYLLABUS AND REGULATIONS

## FOR

## B.Sc. BOTANY (Hons.)

## [I TO VIII SEMESTERS]

## [EFFECTIVE FROM ACADEMIC YEAR 2023-2024]

**Minutes of the Meeting of Board of Studies in Botany**

The meeting of the Board of Studies of Botany, was held at 10.30 A.M. on 28th October 2024 in the Department of Botany, BGCW, Puducherry in online mode to discuss the curriculum for the B.Sc. Botany degree programme in compliance with the National Education Policy 2020. The chairman welcomed the members and the meeting started with self-introduction of the members and Board of Studies passed the following resolutions.

1. Resolved to ratify B.Sc. (Botany) course structure and syllabi of first two semesters of 2023 admitted batch students which was aligned in line with NEP 2020 & implemented on the advice of Pondicherry University in line with New Education Policy (NEP) 2020.

2. Resolved to approve B.Sc. (Botany) course structure and syllabi of semesters Three to six of 2023 admitted batch students [Three years program] which are to be implemented on the advice of Pondicherry University in line with New Education Policy (NEP) 2020.

3. For the 2023-24 batch the board gave its consent to have it as 3 years programme with 120 credits. It also agreed to have 15 major courses (including one summer internship/project), 6 minor courses, 3 skill enhancement courses, 3 multi-disciplinary courses and 1 projects which is community project.

4. Resolved to adopt the existing question paper pattern for 2023 admitted batch without any modifications.

5. Resolved to approve the duration of the course of 2023 admitted batch students as three yars (six semesters) since the NEP was implemented belatedly and admission of this batch was done with the notification mentioning the duration of the program as three years.

6. Resolved to approve B.Sc. (Botany) course structure and syllabi of 2024 admitted & onwards batch students that is to be implemented on the advice of Pondicherry University in line with New Education Policy (NEP) 2020. The program duration of this batch onwards is four years [Honours degree] with 160 credits, as mandated by NEP 2020. Accordingly, the syllabi of eight semesters are formulated within the framework of NEP 2020 and hereby approved.

7. For 4 years degree programme the board agreed to offer 20 major courses including one summer internship/project), 8 minor courses, 3 skill enhancement courses, 3 multi-disciplinary courses and 2 projects

out of which, one is on community development and the other one is in the areas of interest ( 8th semester).

8. Resolved to adopt the existing question paper pattern for 2024 admitted & onwards batch without any modifications.

9. Resolved to recommend to the academic council for adoption of the approved syllabi for B.Sc. (Botany).

| Sl.No. | Name and Designation | Position | Signature |
|---|---|---|---|
| 01 | Dr.Prasoon Shrivastava<br>Head of the Department &<br>Assistant Professor, BGCW,<br>Puducherry | Chairman | 28/10/24<br>Head of the Dept. of Botany<br>Bharathidasan Govt. College for women<br>Puducherry - 605 003. |
| 02 | Dr.S. Ramakrishnan,<br>Assistant Professor & Head<br>Department of Botany,<br>Tagore Arts College,<br>Puducherry | Member (VC Nominee) | 28/10/2024 |
| 03 | Dr.H. Syed Jahangir<br>Associate Professor<br>Department of Botany, Jamal Mohammed College, Trichy – 620620 | Member (Subject Expert) | Dr.H.SYED JAHANGIR M.Sc.,M.Phil.,Ph.D.,<br>Associate Professor and Head<br>DEPARTMENT OF BOTANY<br>JAMAL MOHAMED COLLEGE(Autonomous)<br>TRICHY |
| 04 | Dr. K.P.Sivakumar<br>Professor<br>Department of Plant Science,<br>Madurai Kamraj University,<br>Madurai | Member (Subject Expert) | DR.K. SIVAKUMAR<br>PROFESSOR OF PLANT SCIENCE<br>SCHOOL OF BIOLOGICAL SCIENCES<br>MADURAI KAMARAJ UNIVERSITY<br>MADURAI - 625 019 |
| 05 | Dr.K.Rajendiran<br>Associate Professor<br>Department of Botany,<br>BGCW, Puducherry | Member | |
| 06 | Dr. Mujahid Mohammed<br>Assistant Professor<br>Department of Botany,<br>BGCW, Puducherry | Member | ASSISTANT PROFESSOR<br>DEPARTMENT OF BOTANY<br>Bharathidasan Govt. College for women<br>Puducherry - 605 003. |
| 07. | Ms. N. Sundaramurthy<br>Managing Director<br>Aurokkiya Mushroom and Seed Farm, Koodapakkam,<br>Villianur Commune,<br>Puducherry | Member<br>(Representative from Industry) | |
| 08. | Ms.Vanjula<br>Research Scholar Depatment of Biotehnology, Pondicherry University, Puducherry | Member<br>(Meritorious Alumini) | Vanjula.G<br>28/10/24 |

# UG BOS in BOTANY

## B.Sc. Botany– 3 Yrs

## (or)

## B.Sc. Botany (Hons.)/B.Sc. Botany (Hons. with Research) – 4 Yrs (With Botany Major and Zoology Minor)

## Introduction

Botany is one of the important branches of biology that deals with the study of Plant life and it is one of the oldest natural sciences disciplines. From time immemorial to current times humanity has been greatly dependent on plants for food, fiber, medicine, and fuel. Plants have immense potential to address the pressing problems currently humanity is facing such as global climate change, food security, and environmental degradation. Plants with their vast diversity, resilience, and adaptions inhabited all ecosystems, and being producers they are the lifeline of all other life forms and play a key role in the maintenance of rich biodiversity on planet Earth. Plant ecosystem services are essential for the sustenance of life thus understanding various aspects of plant life is important from an economic and ecological point of view. Considering this very early Botany has evolved as a separate discipline from natural sciences and since then has seen tremendous development. The advent of molecular biology, computational and genomic tools revolutionized the field of biology including botany shifting from its classical to an advanced discipline. Understanding plant biology through modern scientific tools has opened new avenues in plant biology.

At this end to provide a holistic understanding of plant biology current syllabus was developed striking an adequate balance between basic and advanced aspects of botany. The Curriculum encompasses diverse subjects such as plant diversity, taxonomy, developmental biology, phytopathology, cell biology, physiology, biochemistry, Plant ecology, evolutionary biology, etc. In addition, advanced courses such as genetics molecular biology, microbiology, biotechnology, biostatistics, computer applications bioanalytical tools, intellectual property rights, and research methodology were designed to improve the overall competence of students at the undergraduate level.

This syllabus has been drafted to impart a comprehensive understanding of plant biology and encourage students to take up higher studies in the field of botany with a modern scientific outlook. The syllabus also provides adequate knowledge and equips students for national-level competitive exams that they may attempt in the future. Moreover, to strengthen their core competency in the subject, due importance is given to both theoretical and practical aspects. Several skill enhancement courses are also introduced in this syllabus to expand the employability opportunities of under graduates.

## 1. Programme Outcome (PO)

- The main objective of this programme is to impart the fundamental and advanced knowledge of Plant science to the students.
- The multifarious curriculum and its activities of the programme encourages the students to understand the basic concepts and learn skillset in Botany.
- It is designed to inspire the students to gain the essential knowledge in botany and instil various skills required for the future endeavours.
- The students are trained to understand the concepts and acquire knowledge of botany through effective theoretical teaching, hands-on practical training, and field studies.
- The periodical assessments are done in the form of tests, seminars, assignments, quizzes, etc in order to ensure the learning skills of the students and outcomes of the various courses offered.
- It aims to achieve these outcomes by assisting the students through effective teaching, good laboratory infrastructure, departmental library and congenial classroom environment.
- The programme caters to the needs of the students to appear for entrance examinations for higher studies as well as competitive examinations for securing jobs.
- The knowledge and expertise thus gained would help students to acquire jobs in various departments of agriculture and in national laboratories viz, ICAR, CSIR, BSI, DST, DBT and ICMR.
- They can become competent to face various exams like IFS, UPSC and other state services exams.
- Apart from this the students can also become entrepreneurs especially in the field of Algal Technology, Medicinal Botany, Mushroom Cultivation, Biofertilizers and Biopesticides production and Plant Nursery Management etc.

## 2. Programme Specific Outcome (PSO)

On successful completion of this programme, the student should be able to:

- **Disciplinary Knowledge:** Understand the fundamental principles, concepts, and theories related to biology. Also, exhibit proficiency in performing experiments in the laboratory.

- **Critical Thinking:** Analyse complex problems, evaluate information, synthesize information, apply theoretical concepts to practical situations, identify assumptions and biases, make informed decisions and communicate effectively
- **Problem Solving:** Employ theoretical concepts and critical reasoning ability and technical skills to solve problems, and explore new design possibilities.
- **Analytical & Scientific Reasoning:** Apply scientific methods, collect and analyse data, test hypotheses, evaluate evidence, apply statistical techniques and use computational models.
- **Research related skills:** Formulate research questions, conduct literature reviews, design and execute research studies, communicate research findings and collaborate in research projects.
- **Self-directed & Lifelong Learning:** Set learning goals, manage their own learning, reflect on their learning, adapt to new contexts, seek out new knowledge, collaborate with others and to continuously improve their skills and knowledge, through on-going learning and professional development, and contribute to the growth and development of their field.

3. **Breakup of Credits and Courses**: Every Undergraduate (UG) programme offered by a College confirm to the Structure specified by the UGC's Framework, 2023. A student of 3 year UG programme is mandated to complete a minimum of 120 credits and the student of 4 year Honors degree shall complete 160 credits. An UG student shall complete the following courses under different heads as listed below:

**Types of Courses**

1. Major Disciplinary Courses (MJD)
2. Minor Disciplinary Courses (MID)
3. Multi - Disciplinary Courses (MLD)
4. Ability Enhancement Courses (AEC)
5. Skill Enhancement Courses (SEC)
6. Value Added Common Courses (VAC)
7. Internships and Community service-based projects
8. Research Project work for 4-years Honours Degree

1) **Major Disciplinary Courses (MJD): (60/80 credits)** Major disciplinary courses are subject specific compulsory course that a student has to complete to obtain the UG/UG (Hons) Degree in the given discipline. Major disciplinary courses shall constitute 50% of the total credits. All discipline specific major courses designed for 4 credits each with one/two additional hours or guidance of teaching at Tutorials/ Practical.

2) **Minor Disciplinary Courses (MID):** Minor disciplinary courses refer to those subjects which are Allied/Specialization/ Elective subjects to the Major discipline. These allied courses are expected to provide additional understanding of the subject in a specific focused area. Minor disciplinary courses (MID) carries 4 credits and designed by the parent department or collaborated with sister departments.

**3) Multi-Disciplinary Courses (MLD)** All undergraduate students are mandated to pursue 9 credits worth of courses in such Multi-disciplinary areas and each MLD course carries 3 credits. Students study any 3 multiple disciplinary courses designed by other departments.

4) **Ability Enhancement Courses (AEC): (8 Credits)** All Undergraduate (UG) students are mandated to complete at least 8 Credits worth of Courses which focus on Communication and Linguistic skills, Critical reading, writing skills and each AEC carries 2 credits.

5) **Skill Enhancement Course (SEC): (9 Credits)** -These courses focus at imparting practical skills with hands-on Training and each course carries 3 credits. In order to enhance the employability of students, Department designed courses that deem fit for their students for better employment/entrepreneurship/career development.

6) **Value Added Common courses (VAC): (8 credits)** Under NEP, the UGC has proposed for 8 credits worth of common courses which are likely to add value to overall knowledge base of the students. Four courses include: a) Understanding India b) Environmental Sciences/Education c) Digital and Technological solutions d) Health, Wellness, Yoga Education, Sports & Fitness. Each VAC carries 2 credit and students need to complete 4 courses.

7) **Community Engagement and Service (CES) (2 credits)**: All UG students are also mandated to participate in a 15 days community engagement activity during their winter vacation between 3$^{rd}$ and 4$^{th}$ Semesters. This Community engagement activity is expected to expose the students to social problems of neighbourhood village students may prepare a report on the activities carried out for a award of 2 credits.

8) **Summer Internship (4 Credits)**: As per the UGC guidelines all UG students should be exposed to 4 to 6 week Summer Internship in an industrial organisations/Training Centres/Research Institution, etc. Such Summer Internship is to be conducted in between 4th Semester and 5th semester. A review of report and award of grade based on Work carried out by students is to be recorded during the 5th Semester.

9) **Research Project (12 Credits):** Students who secure 75% marks and above in the first six semesters and wish to undertake research at the undergraduate level can choose a research stream in the fourth year. A semester long Research work - during their 8th Semester and submit a Research Report. All these Research Reports are evaluated by a Jury of external experts. A presentation of Results and Viva may also be part of evaluation.

**TABLE**
**BREAKUP OF CREDITS AND COURSES**

| Sl. No. | Component | 3 Year Degree | 4 Year Hons Degree |
|---|---|---|---|
| 1 | Major Disciplinary Courses | 60 Credits<br>(15 Courses of 4 credits each) | 80 Credits<br>(20 Courses of 4 credits each) |
| 2 | Minor Discipline Courses | 24 Credits<br>(6 Courses of 4 Credits each) | 32 Credits<br>(8 Courses of 4 credits each) |
| 3 | Multi-Disciplinary Courses | 9 Credits<br>(3 courses of 3credits each) | 9 Credits<br>(3 courses of 3 credits each) |
| 4 | Ability Enhancement Courses | 8 Credits<br>(4 courses of 2 credits each) | 8 Credits<br>(4 courses of 2 credits each) |
| 5 | Skill Enhancement Course | 9 Credits<br>(3 courses of 3 credits each) | 9 Credits<br>(3courses of 3 credits each) |
| 6 | Common Value added courses | 8 Credits<br>(4 course of 2 credits each) | 8 Credits<br>(4 course of 2 credits each) |
| 7 | Community Science | 2 Credits<br>(1 field based course) | 2 Credits<br>(1 field based course) |
| 8 | Research Dissertation Project | - | 12 Credits<br>(Research Project report) |
| 9 | **Total credits required** | **120 Credits** | **160 Credits** |

## 4. Course guidelines

**Multi - Disciplinary Courses (MLD) – (9 Credits):**

1. Natural Sciences
2. Physical Sciences
3. Mathematics and Statistics
4. Computer Science/ Applications
5. Data Analysis
6. Social Sciences
7. Humanities
8. Commerce and Management
9. Library Science
10. Media Sciences etc.

**Ability Enhancement Courses (AEC) - (8 Credits):**

1. English Language
2. Languages (Tamil, Hindi and French)

**Skill Enhancement Courses (SEC) – (9 Credits):**

- Courses aimed at imparting practical skills, Hands-on training, soft skills etc to enhance the employability and entrepreneurship of the students.
- The course may be designed as per the students need and available Institutional resources.

**Value Added Common Courses (VAC) – (8 Credits):**

1. Understanding India
2. Environmental Sciences/Education
3. Digital and Technological Solutions
4. Health, Wellness, Yoga Education, Sports and Fitness

**Internships:**

1. Winter Internship (2 Credits) – (Community Engagement and Service)
2. Summer Internship (4 Credits) – (Internship in an Industrial organisation/Training centres/Research Institutions)

**Research Projects - (12 Credits):**

- Students may be given necessary guidance by the Faculty Members in identifying the Research Problems, Conduct of Study and preparation of a Project Report.

## 5. Degrees, Diplomas and Certificates:

NEP 2020 introduces the facility to breakdown the Programme of study at Undergraduate (UG) level after completion of every year of the study. Undergraduate degree programmes of either 3- or 4-years duration, with multiple entry and exit points and re-entry option with appropriate certifications. The students will be awarded the following:

- **UG Certificate in Basic Botany**
  Student who have completed 1 Year (2 Semesters) of study and have secured 40 credits along with additional 4 credits during the summer vacation of the first year (total of 44 credits) will be awarded UG Certificate in Basic Botany.
- **UG Diploma in Botany**
  Student who have completed 2 Year (4 Semesters) of study and have secured 80 credits along with additional 4 credits during the summer vacation of the second year (total of 84 credits) will be awarded UG Diploma in Botany.
- **Bachelor Degree in Botany**
  Student who have completed 3 Year (6 Semesters) of study and have secured 120 credits will be awarded Bachelor Degree in Botany.
- **Bachelor Degree in Botany with Honors**
  Student who have completed 4 Year (8 Semesters) of study and have secured 160 credits will be awarded Bachelor Degree in Botany (Hons.)
- **Bachelor Degree in Botany Hons. with Research**
  Student who have completed 4 Year (8 Semesters) of study along with Research Project in final semester and have secured 160 credits will be awarded Bachelor Degree in Botany(Hons. with Research)

## 6. Level of courses:

Courses are coded based on the learning outcomes, level of difficulty and academic vigor. The Coding structure is as follows:

- 0-99 – Pre-requisite course with no credits
- 100-199 – Foundation or Introductory Courses
- 200- 299 – Intermediate level Courses
- 300 – 399 – Higher level Courses
- 400- 499 – Advanced Courses

## 7. Course Distribution - Semester wise

| Semester | MJD | MID | MLD | AEC | SEC | VAC | Total |
|---|---|---|---|---|---|---|---|
| **I** | 1 | 1 | 1 | 1 | 1 | 1 & 2 | 7 |
| **II** | 1 | 1 | 1 | 1 | 1 | 3 & 4 | 7 |
| **III** | 2 | 1 | 1 | 1 | 1 | - | 6 |
| **IV** | 3 | 1 | - | 1 | Community Engagement | - | 6 |
| **V** | 3 | 1 | - | - | Internship (MJD) | - | 5 |
| **VI** | 4 | 1 | - | - | - | - | 5 |
| **VII** | 3 | 2 | - | - | - | | 5 |
| **VIII** | 2 | Research Project (or) 3 MJD Courses | | | | | 3 or 5 |

## 8. Levels and Credits for Each Semester

| Semester | Levels | UG 3 Years Degree | UG 4 Years (Hons) Degree |
|---|---|---|---|
| **I** | 100 | 20 | 20 |
| **II** | 100 | 20 | 20 |
| **III** | 200 | 20 | 20 |
| **IV** | 200 | 20 | 20 |
| **V** | 300 | 20 | 20 |
| **VI** | 300 | 20 | 20 |
| **VII** | 400 | - | 20 |
| **VIII** | 400 | - | 20 |
| **Total** | | **120** | **160** |

## 9. Pedagogical Style

| | |
|---|---|
| Lecture Classes | Internships |
| Tutorial Classes | Studio Activities |
| Experiments in Laboratory | Project Work |
| Seminar Classes | Community Engagement |

# 10.Course Structure

| SEMESTER I (100 level) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Code No** | **Nature of Course** | **Title of the Course** | **Credits** | **Hours/Week** | | | |
| | | | | **L** | **P** | **T** | **S** |
| **BOMJD-1** | Major Disciplinary courses (compulsory) | Thallophytes and Microbes | 4(3T+1P) | 3 | 2 | | |
| **BOMID-1** | Minor Disciplinary courses (choose any one) | * Structure and Reproduction of non-flowering plants | 4T | 4 | | | |
| | | Fundamentals of Zoology (for Botany students) | 4T | 4 | | | |
| **MLD-1** | Multi-Disciplinary courses (compulsory) | Commerce - Consumer Behaviour | 3T | 4 | | | |
| **AEC-1** | Ability Enhancement courses English or Indian Language | Basic Language and Literature | 2 | 4 | | | |
| **BOSEC-1** | Skill Enhancement Course | Algal Technology | 3P | | 5 | | |
| **VAC NEP Value added common courses I & II (compulsory)** | | VAC-1.Environmental Education | 2 | 4 | | | |
| | | VAC-2.Understanding India | 2 | 4 | | | |
| | | **Total Credits/ Total Hours of Work** | **20 Credit** | **30 Hours** | | | |

**Proposed course structure of B.Sc Botany as per NEP frame work 2020**

*Department offering minor courses (Allied/specialisations/elective) for students of other departments

| SEMESTER II (100 level) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Code No** | **Nature of Course** | **Title of the Course** | **Credits** | **Hours/Week** | | | |
| | | | | **L** | **P** | **T** | **S** |
| **BOMJD-2** | Major Disciplinary courses (compulsory) | Archegoniates and Paleobotany | 4(3T+1P) | 3 | 2 | | |
| **BOMID-2** | Minor Disciplinary courses (choose any one) | *Anatomy and Reproduction of Angiosperms | 4T | 4 | | | |
| | | Public Health and Hygiene (for Botany students) | 4T | 4 | | | |
| **MLD-2** | Multi-Disciplinary courses (compulsory) | Humanities - Spoken Tamil | 3 | 4 | | | |
| **AEC-2** | Ability Enhancement courses English or Indian Language | Basic Language and Literature | 2 | 4 | | | |
| **BOSEC-2** | Skill Enhancement Course | Plant Nursery Management | 3P | | 5 | | |
| VAC NEP Value added common courses I & II (compulsory) | | VAC-3 Health & Wellness/Yoga Education | 2 | 4 | | | |
| | | VAC-4 Digital Technology Education | 2 | 4 | | | |
| | | **Total Credits/ Total Hours of Work** | **20 Credit** | **30 Hours** | | | |

*Department offering minor courses (Allied/specialisations/elective) for students of other departments

Students who opt to exit after completion of the first year and have secured 40 credits will be awarded a UG certificate if, in addition, they complete one vocational course of 4 credits during the summer vacation of the first year. Student who secured total of 44 credits will be awarded

**Undergraduate Certificate Course in Basic Botany**

| SEMESTER III (200 level) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Code No** | **Nature of Course** | **Title of the Course** | **Credits** | **Hours/Week** | | | |
| | | | | **L** | **P** | **T** | **S** |
| **BOMJD-3** | Major Disciplinary courses (compulsory) | Plant Cell Biology | 4(3T+1P) | 3 | 2 | | |
| **BOMJD-4** | | Embryology of Angiosperms | 4(3T+1P) | 3 | 2 | | |
| **BOMID-3** | Minor Disciplinary courses (choose any one) | *Plant Physiology, Tissue Culture and Ecology | 4(3T+1P) | 4 | 2 | | |
| | | Economic Zoology (for Botany students) | 4(3T+1P) | 3 | 2 | | |
| **MLD-3** | Multi-Disciplinary courses (compulsory) | Physical Sciences Everyday Physics | 3T | 4 | | | |
| **AEC-3** | Ability Enhancement courses | Basic Language and Literature | 2 | 4 | | | |
| **BOSEC-3** | Skill Enhancement Course | Bio-fertilizers and Bio-pesticides | 3P | | 6 | | |
| | | **Total Credits/ Total Hours of Work** | **20 Credit** | **30 Hours** | | | |

* Department offering minor courses (Allied/specialisations/elective) for students of other departments

| SEMESTER IV (200 level) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Code No** | **Nature of Course** | **Title of the Course** | **Credits** | **Hours/Week** | | | |
| | | | | **L** | **P** | **T** | **S** |
| **BOMJD-5** | Major Disciplinary courses (compulsory) | Morphology and Taxonomy of Angiosperms | 4T | 4 | | | |
| **BOMJD-6** | | Anatomy of Angiosperms | 4T | 4 | | | |
| **BOMJD-7** | | Botany Main Practical- I | 4P | | 8 | | |
| **BOMID-4** | Minor Disciplinary courses (choose any one) | Phytopathology | 4T | 4 | | | |
| **AEC-4** | Ability Enhancement courses | Basic Language and Literature | 2 | 4 | | | |
| ***Project** | Winter Project/ Internship | Community Engagement | 2 | | 6 | | |
| | | **Total Credits/Total Hours of Work** | **20 Credit** | **30 Hours** | | | |

Students who opt to exit after completion of the second year and have secured 80 credits will be awarded the UG diploma if, in addition, they complete one vocational course of 4 credits during the summer vacation of the second year. Student who secured total of 84 credits will be awarded **Undergraduate Diploma course of in Botany.**

| SEMESTER-V (300 level) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Code No** | **Nature of Course** | **Title of the Course** | **Credits** | **Hours/Week** | | | |
| | | | | **L** | **P** | **T** | **S** |
| **BOMJD-8** | Major Disciplinary Courses (Compulsory) | Molecular Biology | 4T | 4 | | 1 | |
| **BOMJD-9** | | Plant Biochemistry | 4T | 4 | | 1 | |
| **BOMJD-10** | | Botany Main Practical - II | 4P | | 8 | | |
| **BOMID-5** | Minor Disciplinary Courses | Plant Ecology and Phytogeography | 4T | 4 | | 2 | |
| **BOMJD-11** | Major Disciplinary Courses | Summer Internship | 4 | | 6 | | |
| | | **Total Credits / Total Hours of Work** | **20 Credit** | **30 Hours** | | | |

| SEMESTER-VI (300 level) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Code No** | **Nature of Course** | **Title of the Course** | **Credits** | **Hours/Week** | | | |
| | | | | **L** | **P** | **T** | **S** |
| **BOMJD-12** | Major Disciplinary Courses (Compulsory) | Plant Physiology | 4T | 4 | | 1 | |
| **BOMJD-13** | | Genetics and Plant Breeding | 4T | 4 | | 1 | |
| **BOMJD-14** | | Plant Biotechnology | 4T | 4 | | 2 | |
| **BOMJD-15** | | Botany Main Practical- III | 4P | | 8 | | |
| **BOMID-6** | Minor Disciplinary Courses | Evolution and Plant biology | 4T | 4 | | 2 | |
| | | **Total Credits/Total Hours of Work** | **20 Credit** | **30 Hours** | | | |

Students who opt to exit after completion of the third year and have secured 120 credits will be awarded the **UG Degree in Botany.**

| SEMESTER-VII (400 level) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Code No** | **Nature of Course** | **Title of the Course** | **Credits** | **Hours/Week** | | | |
| | | | | **L** | **P** | **T** | **S** |
| **BOMJD-16** | Major Disciplinary Courses (Compulsory) | Microbiology | 4T | 4 | | 1 | |
| **BOMJD -17** | | Medicinal Botany | 4T | 4 | | 1 | |
| **BOMJD -18** | | Botany Main Practical - IV | 4P | 8 | | | |
| **BOMID -7** | Minor Disciplinary Courses | Bioanalytical Techniques | 4T | 4 | | 1 | 1 |
| **BIOMID -8** | | Plant Genetic Resources and IPR | 4T | 4 | | 1 | 1 |
| | | **Total Credits/Total Hours of Work** | **20 Credit** | **30 Hours** | | | |

| SEMESTER-VIII (400 level) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Code No** | **Nature of Course** | **Title of the Course** | **Credits** | **Hours/Week** | | | |
| | | | | **L** | **P** | **T** | **S** |
| **BOMJD-19** | Major Disciplinary Courses (Compulsory) | Economic Botany | 4T | 4 | | | 1 |
| **BOMJD-20** | | Mushroom cultivation | 4T | 4 | | | 2 |
| **RP** | Research Project Or 3 Major Disciplinary Courses | Research Project | 12 | | 15 | | |
| | | **In lieu of Project Department offers following 3 Majors courses** | | | | | |
| **BOMJD-21** | | Research Methodology in Biology | 4T | 4 | | | 2 |
| **BOMJD-22** | | Biostatistics &Computer Applications in Biology | 4T | 3 | | 1 | 1 |
| **BOMJD-23** | | Botany Main Practical - V | 4P | | 8 | | |
| | | **Total Credits/Total Hours of Work** | **20 Credit** | **30 Hours** | | | |

**L = Lecture, P = Practical, T = Tutorial, S = Seminar**

## 11. Semester-wise Botany Course Structure and Scheme For Under Graduate Students of Other Departments

### (Minor Disciplinary & Multi-Disciplinary Courses offered by Botany Dept.)

**SEMESTER – I / II / III**

**Multi-Disciplinary Course**

| S.No | Course Code | Course Title | Credits | Lecture/Tutorial Hours |
|---|---|---|---|---|
| 1 | MLD-3 | Biodiversity and Conservation | 3 | 4L |

**SEMESTER – I**

**Minor Disciplinary Course (For Zoology Department)**

| S.No | Paper Code | Course Title | Credits | Lecture/Tutorial Hours |
|---|---|---|---|---|
| 1 | MID-1 | Structure and Reproduction of Non Flowering Plants | 4 | 4L |

**SEMESTER – II**

**Minor Disciplinary Course (For Zoology Department)**

| S.No | Paper Code | Course Title | Credits | Lecture/Tutorial Hours |
|---|---|---|---|---|
| 1 | MID-2 | Anatomy and Reproduction of Angiosperms | 4 | 4L |

**SEMESTER – III**

**Minor Disciplinary Course (For Zoology Department)**

| S.No | Course Code | Course Title | Credits | Lecture/Tutorial Hours |
|---|---|---|---|---|
| 1 | MID-3 | Plant Physiology, Tissue Culture and Ecology | 4 | 4L |

## 12. Compulsory Courses for Under Graduate Students of Botany Department

### Major Disciplinary Courses

| S.No. | Course Code | Name of the Paper |
|---|---|---|
| 1 | BOMJD-1 | Thallophytes and Microbes |
| 2 | BOMJD-2 | Archegoniates and Paleobotany |
| 3 | BOMJD-3 | Plant Cell Biology |
| 4 | BOMJD-4 | Embryology of Angiosperms |
| 5 | BOMJD-5 | Morphology and Taxonomy of Angiosperms |

| | | |
|---|---|---|
| 6 | BOMJD-6 | Anatomy of Angiosperms |
| 7 | BOMJD-7 | Botany Main Practical-I |
| 8 | BOMJD-8 | Molecular Biology |
| 9 | BOMJD-9 | Plant Biochemistry |
| 10 | BOMJD-10 | Botany Main Practical –II |
| 11 | BOMJD-11 | Summer Project/ Internship |
| 12 | BOMJD-12 | Plant Physiology |
| 13 | BOMJD-13 | Genetics and Plant Breeding |
| 14 | BOMJD-14 | Plant Biotechnology |
| 15 | BOMJD-15 | Botany Main Practical-III |
| 16 | BOMJD-16 | Microbiology |
| 17 | BOMJD-17 | Medicinal Botany |
| 18 | BOMJD-18 | Botany Main Practical – IV |
| 19 | BOMJD-19 | Economic Botany |
| 20 | BOMJD-20 | Mushroom cultivation |
| | Research Project OR | |
| 21 | BOMJD-21 | Research Methodology in Biology |
| 22 | BOMJD-22 | Biostatistics & Computer Applications in Biology |
| 23 | BOMJD-23 | Botany Main Practical – V |

## Minor Disciplinary Courses

| S.No. | Course Code | Name of the Paper |
|---|---|---|
| 1 | MID-1 | Fundamentals of Zoology |
| 2 | MID-2 | Public Health and Hygiene |
| 3 | MID-3 | Economic Zoology |
| 4 | BOMID-4 | Phytopathology |
| 5 | BOMID-5 | Plant Ecology and Phytogeography |
| 6 | BOMID-6 | Evolution and Plant biology |
| 7 | BOMID-7 | Bioanalytical Techniques |
| 8 | BIOMID-8 | Plant Genetic Resources and IPR |

## Skill Enhancement Courses

| S.No. | Course Code | Name of the Paper |
|---|---|---|
| 1 | SEC-1 | Algal Technology |
| 2 | SEC-2 | Plant Nursery Management |
| 3 | SEC-3 | Bio-fertilizers and Bio pesticides |

## 13. Course Outcomes:

### (i) Foundation Courses for Zoology UG Programme

| | |
|---|---|
| **MID-1**<br>**Structure and Reproduction of non-flowering plants (Semester -I)** | These need-based courses are offered to help the students to acquire the basic concepts of Botany and be useful for competitive examinations. Studying three minor courses students will acquire 12 credits in botany and will get B.Sc. degree in zoology with minor in botany. In the first semester they will learn the evolutionary plant biology through the model systems. In the second semester they will learn the fundamentals of cell biology, anatomy and reproduction in plants. Third semester they will learn fundamental of plant physiology, tissue culture and ecology. |
| **MID-2**<br>**Anatomy and Reproduction of Angiosperms – (Semester -II)** | |
| **MID-3**<br>**Plant Physiology, Tissue Culture and Ecology (Semester -III)** | |

### (ii) Multidisciplinary course for other UG Programmes

| | |
|---|---|
| **MLD-1**<br>**Biodiversity and Conservation**<br>**(I to III Semesters)** | On completion of course students would be able to<br>✓ Get the comprehensive understand of various biodiversity levels<br>✓ Acquire knowledge on global biodiversity distribution pattern<br>✓ Analyse major threats of biodiversity loss and reasons to protect<br>✓ Get familiar with different conservation methods and laws enacted to conserve<br>✓ Learn the impact and importance of biodiversity on human society |

### (iii) Main Courses for B.Sc. Botany Programme

| **SEMESTER I** | |
|---|---|
| **NAME OF THE COURSE** | **OUTCOME** |
| **MJD-1:**<br>**Thallophytes and Microbes** | Course helps students appreciate the biodiversity and evolutionary development of lower plants. Highlights the significance and economic prospective of algae, fungi, lichens, microbes and possibility of generating ideas for entrepreneurship. |
| **SEC-1: Algal Technology** | On the successful completion of the course, student will be able to- |

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|---|---|
| | ✓ Acquire the knowledge on Algal culturing techniques<br>✓ Learn basic laboratory skills, hands on training on various aspects of algal technology<br>✓ Understand about the structure, cultivation and value-added products of different commercial algal strains.<br>✓ Develop knowledge on applications of algae and importance of algal based economy |
| **VAC**<br>**VAC-1.Environmental Education** | Studying this course helps students in enhanced comprehension about environment and environmental issues and causes and consequences of environmental degradation. This makes them informed citizens about environment and knowledge they acquire would help them both for higher studies and job prospective. |
| **VAC-2.Understanding India** | The course "Understanding India" helps students to gain a comprehensive understanding of the history, culture, society, politics, economy, and geography of India. This course enhances students understanding about India from global, national and local perspectives. |
| **SEMESTER II** | |
| **MJD-2**<br>**Archegoniates and Paleobotany** | Course helps students to understand the biology, evolution, and economic significance of Bryophytes, Pteridophytes and Gymnosperms thereby enhance their knowledge. Paper helps the students to gain knowledge evolution, structure and reproduction of Gymnosperm, and also the fundamentals of the palaeobotany and its significance in the context of plant evolution. |
| **SEC-2:**<br>**Plant Nursery Management** | On successful completion of the course students will have a comprehensive understanding of plant nursery management.<br>Students get familiar with different types of nurseries catering the needs of customers and suitable nursery business model.<br>Students get hands on training on soil preparation, different plant propagation methods and nursery management practices. Acquired skillset and knowledge would help to students to take up nursery management as entrepreneurship opportunity. |
| **VAC-3**<br>**Health & Wellness/Yoga** | On successful completion of this course students can acquire knowledge and skills which will help in the |

| | |
|---|---|
| **Education** | development of Physical, Mental, Social and Spiritual health. Develop Values that will enhance the personality of the students and enhances emotional stability. The Course strengthens, the future development of the students in order to achieve Occupational Wellness. |
| **VAC-4**<br>**Digital Technology Education** | This course helps students on developing digital literacy, critical thinking, and problem-solving skills. On successful completion of this course, the student will be able to have a knowledge regarding<br>➢ Knowledge about digital paradigm.<br>➢ Realization of importance of digital technology, digital financial tools, e-commerce.<br>➢ Know-how of communication and networks.<br>➢ Familiarity with the e-governance and Digital India initiatives<br>➢ An understanding of use & applications of digital technology.<br>➢ Basic knowledge of all machine learning and big data. |
| **SEMESTER III** | |
| **MJD-3**<br>**Plant Cell Biology** | In this course students will learn about the fundamental unit of life the plant cell. Subject provides knowledge on how cell works, it architecture and other functional aspects and this essential knowledge is must for students of biology |
| **MJD-4**<br>**Embryology of Angiosperms** | This paper provides fundamental knowledge on how plants reproduce, complete their life cycle and their developmental aspects which adds on to their knowledge on plant biology. |
| **SEC-3**<br>**Bio fertilizers and Bio pesticides** | On successful completion of the course students will be able to<br>➢ Develop understanding on importance of biofertilizers and different sources of biofertilizers<br>➢ Get familiarize with the biofertilizer production technologies, products specifications and other aspect production line<br>➢ Acquire knowledge on various organic fertilizers and bio-controlling methods used in organic farming |
| **SEMESTER IV** | |
| **MJD-5**<br>**Morphology and Taxonomy of Angiosperms** | This course introduces diverse morphological adaptation of plants and trends in plant taxonomy. It also provides hands-on experience; herbarium preparation and field trip impart taxonomic skills to students. Plant classification systems and practice. Course provides good opportunity to learn taxonomy which an essential and highly desired skills |

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| **MJD-6**<br>**Anatomy of Angiosperms** | On completion of the course students will be able to understand the various types of cells, tissues that makes up the plant body.<br>Understand the organization of simple and complex tissues in stem, root and leaf.<br>Distinguish between primary and secondary structure of stem and root.<br>Familiarize with basic information about secondary growth and anomalous features in some plants. |
| **MJD -7**<br>**Botany Main Practical-I** | On completion of the course students will be able to<br>• Apply the acquired skills to assign the systematic position and identifying of plant specimen<br>• Prepare the herbarium and document the plants in their locality<br>• Analyze how different tissues systems organize in plant system and architecture of plant organs<br>• Understand the anatomical features and their role in in plant development<br>• Learn to identify different diseases in plants |
| **MID-4**<br>**Plant pathology** | On completion of the course students will be able to<br>✓ understand the damage caused by different organisms in crops.<br>✓ learn some of the important of bacterial, fungal, viral diseases and their control measures.<br>✓ appreciate the preventive measures of plant diseases including quarantine measures. |
| **Winter Project/ Internship Community Engagement** | Community Engagement Project/ Internship will help students in 'developing in them' following important outcomes-<br>**Analysis of Knowledge:** Connects and extends knowledge (facts, theories, etc.) from one's own academic study/ field/ discipline to community engagement and to one's own participation in community life, politics, and government.<br>**Identity/Commitment:** Provides evidence of experience in community-engagement activities and describes what one has learned about oneself as it relates to a reinforced or clarified commitment to public action.<br>**Action and Reflection:** Demonstrates independent experience, accompanied by reflective insights or analysis about the aims and accomplishments of one's actions.<br>**Effective Communication:** Tailors communication |

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| | strategies to effectively express, listen, and adapt to others to establish relationships for further community action. |
| **SEMESTER V** | |
| **MJD-8**<br>**Molecular Biology** | This course teaches the students, the how cell works at molecular level and fundamental molecular machinery that drives life. They will learn about chromosomes, genome and genomic organization. They can understand the biochemical nature of nucleic acids, the process of synthesis of proteins and their role in living systems.<br>The knowledge gained through this course will immensely help students to improve their concepts of biology and highly useful for the advanced studies. |
| **MJD-9**<br>**Plant Biochemistry** | The course introduces the key biochemical processes of the cell and building blocks of the cell. This knowledge helps the students for their advanced studies and also prepares them for facing various competitive exams related to biology. |
| **MJD-10**<br>**Botany Main Practical -II** | On completion of the course students will be able to<br>✓ Develop understanding on structural aspects of different biomolecules and their functional role<br>✓ Familiarize with the experimental process on enzyme function and learn the analysis of various biomolecules<br>✓ Acquire knowledge on the how life operates at molecular level<br>✓ Gain understanding on molecular biology experiments |
| **MJD-11 Summer Internship** | ✓ Student will be able to test the theoretical learning in practical situations by accomplishing the tasks assigned during the internship period.<br>✓ They will be able to apply various soft skills such as time management, positive attitude and communication skills during performance of the tasks assigned in internship organization.<br>Student will be able to determine the challenges and future potential for her internship organization in particular and the sector in general. |
| **MID-5**<br>**Plant Ecology and Phytogeography** | Students will be able to understand and appreciate the interdependency between plants, animal and their surroundings. They can comprehend the need of this equilibrium for food availability, maintaining clean air and water, and sustaining biodiversity across the world.<br>Understanding the characteristics of different plant communities. Knowing the structure and functions of |

| | |
|---|---|
| | ecosystems. Understand the major factors influencing the geographic distribution of plant species. Develop ecological context how plant species adapt and evolve in an ecosystem |
| **SEMESTER VI** | |
| **MJD-12**<br>**Plant Physiology** | At the end of course completion, students will be able to<br>Gain a comprehensive understanding of key physiological processes in plants such as photosynthesis, respiration, transpiration, and nutrient uptake, and their regulation.<br>Develop the ability to analyse how environment and physiological responses shapes the plant growth and development. Get an overview on how different physiological process operates and their role in plant biology. Acquire practical skills in conducting experiments and using various techniques to measure and analyze plant physiological parameters. |
| **MJD-13**<br>**Genetics and Plant Breeding** | Gain knowledge on fundamentals of genetics and various inheritance modes. Develop the conceptual understanding of genetic mutations and the inheritable diseases Understand the laws inheritance and how one can use these laws to make a better hybrid plant through the breeding programme. Acquire the basic knowledge on two essential subjects' genetics and breeding. |
| **MJD-14**<br>**Plant Biotechnology** | This paper introduces students to the different concepts of the plant Biotechnology. Students get familiarise with the techniques of plant tissue culture and applications of plant tissue culture. Students will learn the various tools and techniques of genetic engineering and cloning process. Develop understanding on biotechnology tools and their use for human welfare and commercial value. |
| **MJD-15**<br>**Botany Main Practical -III** | Upon completion of the course, students will be able to<br>• Acquire the experimental knowledge on plant physiology and taking the measurements.<br>• Learn the problem solving skills in genetics and chromosome mapping.<br>• Familiarize with the experimental aspects of plant tissue culture tools and techniques.<br>• Analyse various rDNA technology tools and their applications |
| **MID-6**<br>**Evolution and Plant Biology** | At the end of this course, the students will be able to<br>• Understand the essential theories of evolution<br>• Differentiate between micro and macro-evolution and the forces shaping the evolution<br>• Acquire knowledge on origin of photosynthesis, phototrophic organisms and evolution of plants<br>• Analyse how evolutionary forces shape the plant |

| | |
|---|---|
| | adaptations and provide survival advantage |
| **SEMESTER VII** | |
| **MJD-16**<br>**Microbiology** | Upon completion of the course, students will be able to<br>• Familiarize with diversity of microbial world and their classification<br>• Develop understanding on structural diversity of microorganism, their growth and reproductive modes<br>• Gain knowledge on different microbiological techniques, tools and their applications<br>• Analyse the role of microorganisms in ecological and economic context |
| **MJD -17: Medicinal Botany** | After the completion of the course students will be able to<br>• Gain conceptual knowledge on traditional medicinal systems and medicinal importance of plants.<br>• Develop understanding on key medicinal taxa and their cultivation process<br>• Acquire knowledge on chemically diversity of active principles and their uses<br>• Understand the various commercial plant based drugs and their sources<br>• This course is highly relevant in the current alternative plant-based medicines and students gets opportunity to learn this concepts through this course. |
| **MJD-18**<br>**Botany Main Practical -IV** | After the completion of the course students will be able to<br>✓ Develop the skills to perform the microbiological experiments and analyze the results<br>✓ Get exposure to the various techniques of microbiology<br>✓ Understand the different sources of plant based drugs their uses<br>✓ Gain knowledge on diversity of medicinal plants their active principles<br>✓ Acquire knowledge on various bioanalytical tools and their applications |
| **MID-7**<br>**Bioanalytical Techniques** | Upon completion of the course, students will be able to:<br>✓ Learn the application of various analytical tools and techniques employed in the field of biology.<br>✓ Course will impart the principles of analytical tools and their real-life applications. |

| | |
|---|---|
| | ✓ This course will improve the knowledge of students in advanced analytical tools and improves their prospects in future career<br>✓ To select an appropriate analytical method for solving a given problem in biology-related fields (e.g. biological chemistry, biomedical sciences, biomedical engineering etc). |
| **MID-8**<br>**Plant Genetic Resources and IPR** | On successful completion of the course students will be able to<br>➢ Develop overview on plant genetic resources and their role in human welfare<br>➢ Analyze various methods of conserving PGR and their advantages and limitations<br>➢ Familiarize with need for conservation of PGR and global and national efforts of conservation<br>➢ Acquire knowledge on various aspects of IPR and patenting biotechnological innovations and concerns<br>➢ Learn about Traditional Knowledge protection |
| **Semester VIII** | |
| **MJD-19**<br>**Economic Botany** | Upon completion of the course students will gain knowledge on comprehensive understanding of diverse plant resources and their role in shaping the human society. Students learn about cultivation processes, biochemical composition, nutritive values of plant products and use of plant resources in daily life. Get familiar with taxonomic affiliation of economically important plants, useful plant parts and processing methods. Gain knowledge on the role of plant resources role in global economy and food security under backdrop of climate change. |
| **MJD-20**<br>**Mushroom Cultivation** | On completion of the course students will be able to<br>✓ Develop understanding on mushroom biology and anatomy<br>✓ Acquire skills on different aspects of mushroom cultivation process<br>✓ Gain knowledge on value of mushroom as food and postharvest technology<br>✓ Analyse the different marketing strategies and familiarize with mushroom research innovations and research centres |
| **MJD-21**<br>**Research Methodology in** | On successful completion of the course students would able |

| | |
|---|---|
| **Biology** | ➢ Understand the basic concepts of research and different research types<br>➢ Gain knowledge on research design, sampling, data handling and documentation<br>➢ Develop skillset required to carry out laboratory experiments in biology<br>➢ Learn the basic aspects of scientific writing and presentation of data and ethical aspects of research |
| **MJD-22**<br>**Biostatistics & Computer Applications in Biology** | This course exposes the student to an inter-disciplinary subject integration of biology, computers and biostatistics. Here students will learn how power of computation can be used solve the issue related to biology and their application in real life. They will also be learning the basic biostatistics and applications of statistics in field of biology. Statistics has become essential in field of biology and gaining the knowledge will improve the skillset of students. In this informatics era gained knowledge in this inter disciplinary courses not only improve their skillset but also enhances their job opportunities. |
| **MJD-23**<br>**Botany Main Practical - V** | Upon completion of the course, students will be able to<br>✓ Develop the experimental understanding of diverse plant resources, useful parts and their major chemical constituents<br>✓ Acquire skillset in formulation of hypothesis, design of research and essential laboratory practices<br>✓ Gain knowledge how to write research article and research ethics<br>✓ Analyse the biological data using statistical methods and their significance<br>✓ Demonstrate application of computers in data analysis and data presentation in biology |
| **Or** | |
| **Research Project** | Research Project Students can demonstrate the following learning outcomes<br>✓ Understand the basic concepts of research and different research types<br>✓ Gain knowledge on research design, sampling, data handling and documentation<br>✓ Develop skillset required to carry out laboratory experiments in biology<br>✓ Learn the basic aspects of scientific writing and presentation of data and ethical aspects of research |

## 14. Regulations

**14.1 Eligibility for Admission:** Qualify the 12th or equivalent examination from a recognized board with Botany, Zoology, Chemistry, Physics and English.

**14.2 Duration of the Programme**

1. B.Sc Botany three academic years containing Six semesters

2. B.Sc Botany (Hons.) Four academic years containing Eight semesters.

**14.3 Medium of Instruction :** The Medium of Instruction is English.

**14.4. Scheme of Examination**

A. **In case of complete theory paper:** The End-Semester Examination (ESE) for each course carries a maximum of 75 Marks and the Internal Assessment (CIA) is for 25 Marks.

**Break up of Internal Assessment marks:**

| | |
|---|---|
| a) | Mid Semester Exam (one) - 20 Marks |
| b) | Percentage of Attendance - 5 Marks |
| | **Total - 25 Marks** |

B. **In case of Practical conducted as a part of the theory** MJD courses, there should be an end semester practical examination. For which two Internal Examiners must be there (one internal examiner will be the Course in-charge and the other will be the Head of the concerned department). The practical marks should be treated as the Mid semester marks for those courses (Practical 20 + Attendance 5= 25 marks).

C. **In case of complete practical MJD and SEC courses** there should be an end semester practical examinationn with an Internal Examiner and an External Examiner (ESE 50 + ICA 50= 100 marks).

**14.5. Internal Assessment marks for Practicals/Project work/**

Faculty member in-charge of Lab practicals shall evaluate the practical subjects for 50 marks. The break up is as follows:

| | |
|---|---|
| Observation/Field note book | 15 |
| Practical Record | 15 |
| Regular Performance in the Lab | 15 |
| Attendance | 5 |
| **Total** | **50** |

### 14.6. Attendance Scale

96% to 100% - 5
91% to 95% - 4
86% to 90% - 3
81% to 85% - 2
76% to 80% - 1
Below 75% - Admissible for the Examination with Condonation Fee.

Below 60% - Not admissible to appear for the Examination.

### 14.7 The breakup of end semester marks

| | |
|---|---|
| **Theory subjects** (Sec A, Sec B and Sec C) Question from all units of the Syllabus | 75 Marks |
| **Practical/Internship Project Work subjects** (Based on Practical Exams/Presentation/Viva) | 50 Marks |

### 14.8 Criteria for 'Pass Mark'

Minimum Pass Mark (CIA + ESE) - 40% (for all the courses)

### 14.9 Question paper pattern (Theory)

**Bharathidasan Govt. College for Women (Autonomous), Puducherry**
**Structure of Question paper (Theory)**
**B.Sc., Botany (Main)**

**Max. Marks = 75**

| No. of Questions | No. of Questions to be asked | No. of Questions to be answered | Marks for each answer | Total | Special instructions for the paper-setter |
|---|---|---|---|---|---|
| Section A (Each answer in few sentences) | 12 | 10 | 2 | 20 | A minimum of ONE question from each unit |
| Section B (Each answer in a short paragraph) | 8 | 5 | 5 | 25 | A minimum of TWO question from each unit |
| Section C (Each answer in a long paragraph) | 5 | 3 | 10 | 30 | A minimum of ONE question from each unit |

## 15. Course Upgradation

The syllabus will be updated periodically with the external and internal subject experts including an industrialist and an alumna. The recent scientific findings and their relevance in the field of botany will be included in the course.

## 16. Scope for Higher education and Research

On successful completion of B.Sc., Botany degree the students can pursue their Post graduate studies in the following subjects.

1. Botany
2. Biotechnology
3. Microbiology
4. Molecular Biology
5. Genetic
6. Environmental studies
7. Biochemistry
8. Forestry
9. Horticulture etc.,

Candidates with Botany degree can do research in different fields such as

1. Plant taxonomy
2. Plant biochemistry
3. Molecular biology
4. Plant pathology
5. Environmental research
6. Biodiversity conservation etc.

## SEMESTER – I

### MJD-1: Thallophytes and Microbes

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA (Practical) |
| MJD-1 | 4 | 3 | 1 | 5 | 75 | 25 |

**Course Objective:**

- To study and understand the salient features of Algae, Fungi, Lichens and Microbes
- To understand the structure and reproduction Thallophytes and Microbes

**Course Outcomes:** On completion of the course students will be able to

- ✓ Understand the biodiversity and evolutionary development of lower plants
- ✓ Analyse the Thallophytes diversity and reproductive systems
- ✓ Highlights the significance and economic prospective of algae, fungi and lichens
- ✓ Acquire knowledge on microbial diversity and cell structure

**Unit-1**

**Algae and Classification:** General Characters of Algae, Classification (Fritsch, 1945), Thallus diversity in algae, Life Cycle types in Algae, Economic importance of Algae.

**Unit-2**

**Type studies of Algae:** Detailed study of following genera (Systematic Position, Occurrence, Structure, Reproduction and Life Cycle): Nostoc, Oedogonium, Navicula, Sargassum, Polysiphonia.

**Unit-3**

**Fungi:** General Characters of Fungi, Classification (Ainsworth, 1973), detailed study of following genera (Systematic Position, Occurrence, Structure, Reproduction and Life Cycle): Albugo, Rhizopus, Aspergillus, Peziza and Agaricus. Economic importance of Fungi,

**Unit-4**

**Lichens:** General Characters of Lichens, Classification based on fungal partner and kinds of frutifications, Structure of Crustose, Foliose and Fruticose lichens,. Economic importance of Lichens.

**Unit-5**

**Microorganisms:** definition, occurrence and distribution; Distinction between prokaryotes and eukaryotic microorganisms General characters of Bacteria, viruses and Mycoplasma; Shape, size and Ultrastructure of Bacteria (*E.coli*); Discovery of Viruses – biochemical composition and genetic materials and Shape, size of viruses; Ultrastructure of TMV and Mycoplasma.

**Suggested Reading:**

1. Vashishta, B.R. 1990. Botany for Degree Students – Algae. S. Chand and Co. Ltd., Calcutta.
2. Sharma, O.P. 2006. Text book of Fungi. Tata McGraw-Hill Co., New Delhi.
3. Pelczar, M.J., Chan, E.C.S. and Krieg, N.R. 1993. Microbiology – Concepts and Applications, McGraw-Hill, New York.
4. Atlas, R.M. 1986. Basic and Practical Microbiology. Macmillan Publishing Company, New York.
5. Bilgrami, K.S. and Dube, H.C. 1989. A textbook of Modern Plant Pathology. Vikas Publishing House Pvt. Ltd. New Delhi.
6. Rangaswami, G. 1975. Diseased of crop plants in India. Prentice-Hall of India Pvt. Ltd., New Delhi.
7. Bold, H.C. and Wyne, M.J. 1978. Introduction to the Algae. 2nd Edition, Prentice Hall, NJ.
8. Fritsch, F.E. 1945. Structure and reproduction of Algae. Cambridge University Press, Cambridge.
9. Kumar, H.D. 1990. The Algae. Affiliated East-West Press Pvt. Ltd., New Delhi.
10. Vashishta, B.R. 1990. Botany for Degree Students – Algae. S. Chand and Co. Ltd., Calcutta
11. Ananthanarayan, R and C.K. Jayaram Paniker.1996. Text book of Microbiology. Orient Longman, Hyderabad.
12. Prescott, L.M., Harley, J.P.and Klein, D.A. 2002. Microbiology. McGraw-Hill Co., New York.
13. Aneja,K.R. 1993. Experiments in Microbiology, Plant Pathology and Tissue Culture. Wishwa Publication, New Delhi.

## SEMESTER – I

### MJD-1: Practical of Thallophytes and Microbes

Paper Code:
Credits: 1
Max. Marks: 25

**Suggested Laboratory Exercises:**

1. Study and identification of *Nostoc.*
2. Study and identification of *Oedogonium.*
3. Study and identification of *Sagrassum.*
4. Study and identification of *Polysiphonia.*
5. Study and identification of *Albugo.*
6. Study and identification of *Rhizopus.*
7. Study and identification of *Aspergillus*
8. Study and identification of *Peziza*
9. Study and identification of *Agaricus*
10. Study of Lichens: Morphology, types using specimens/pictures.
11. Study and identification of *E.coli* (Micrographs)
12. Study and identification of TMV (Micrographs)
13. Study of Mycoplasma cell

**Bharathidasan Govt. College for Women (Autonomous), Puducherry**
**NEP 2020 B.Sc. Botany (Hons)**
**Main Practical Examination, Semester – I**
(Covering the Paper of Thallophytes and Microbes)

Paper Code:
Duration – 1.30 hrs
Max Marks-25

1. Make suitable micro-preparation of A and B. Identify, draw and give salient features. Leave the slides for valuation.
   (Preparation-2, Identification-1, Diagram-1, Salient features-1) (2 x 5 = 10 Marks)

2. Identify, draw and give salient features of C & D.
   (Identification-1, Diagram-1, Salient features-2) (2 x 4 = 8 Marks)

| | | |
|---|---|---|
| **Practical** | **-** | **18** |
| **Attendance** | **-** | **05** |
| **Record** | **-** | **02** |
| **Total** | **-** | **25** |

**Key for Practical**

| Question | Experiment / Spotter |
|---|---|
| **A** | Algae specimen (sectioning) |
| **B** | Fungi specimen (sectioning) |
| **C** | Microbes – Bacteria/TMV/Mycoplasma |
| **D** | Lichen specimen/figure |

## SEMESTER – I

### MID-1: Structure and Reproduction of Non-flowering Plants
### (For B.Sc Zoology Programme)

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MID-1 | 4 | 4 | 0 | 4 | 75 | 25 |

**Course Objectives**:

- To understand the structural organization, reproduction and economic importance of various groups of microbes and non-flowering plants

**Course Outcomes:** On course completion students will be able to

- ✓ Acquire knowledge on non-flowering plants diversity and their biology
- ✓ Understand the form, structure and reproduction of lower plants
- ✓ Analyse the evolution of non-flowering plants and their economic importance

**Unit-1**

**Algae and Fungi:** General characters of algae and structure and reproduction of *Oedogonium*; Economic importance of Algae; General characters of fungi and economic importance Fungi; structure and reproduction of Aspergillus.

**Unit-2**

**Lichens:** General characters of lichens, organization of thallus and their types (Leprose, Crustose, Foliose and Fruticose with suitable examples), economic importance of Lichens.

**Unit-3**

**Microbes:** General characters of bacteria; study of structure and reproduction of *Escherichia coli*. General characters of plant viruses; Tobacco Mosaic Virus – Structure, disease cycle, host and symptoms.

**Unit-4**

**Archegoniate:** Study of structure, reproduction and life cycles of the following genera: Marchantia (Bryophyte), Selaginella (Pteridophyte) and Pinus (Gymnosperm).

**Unit-5**

**Taxonomy:** Classification (Bentham and Hooker), study of Angiosperm families: Annonaceae, Cucurbitaceae, Apocynaceae, Euphorbiaceae and Poaceae and their economic importance.

**Suggested readings:**

1. Pandey, B.P. 2009. College Botany. Vol I. S. Chand & Co. Ltd., New Delhi.
2. Vashishta, B.R. 1990. Botany for Degree Students – Algae. S. Chand and Co. Ltd., Calcutta.
3. Sharma, O.P. 2006. Text book of Fungi. Tata McGraw-Hill Co., New Delhi.
4. Bilgrami, K.S. and Dube, H.C. 1989. A textbook of Modern Plant Pathology. Vikas Publishing House Pvt. Ltd.. New Delhi.

## SEMESTER – I

### MLD-1: Biodiversity and Conservation
### (For bachelor Degree Programme of other Departments)

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MLD-1 | 4 | 4 | 0 | 4 | 75 | 25 |

**Course Objectives:**

- To understand the over view of the biodiversity and its distribution
- To impart knowledge on importance of biodiversity in human welfare
- To learn the economic, ethical and cultural significance of biodiversity

**Course Outcomes:** On completion of course students would be able to

- ✓ Understand of various biodiversity levels and biodiversity distribution patterns
- ✓ Analyse major threats of biodiversity loss and reasons to protect
- ✓ Get familiar with different conservation methods and laws enacted to conserve
- ✓ Learn the impact and importance of biodiversity on human society

**Unit-1**

**Concepts of biodiversity:** Definition of Biodiversity, Types: Genetic diversity, Species diversity, Ecosystem Diversity. Biodiversity estimates: alpha diversity, beta diversity & gamma diversity; Pattern of biodiversity distribution (Latitudinal gradients).

**Unit-2**

**Biodiversity and value:** Importance of species richness, Endemism, Mega biodiversity centres, Biodiversity Hotspots: concepts, distribution and significance; Value of biodiversity: Economic values, ecological and ecosystem services (social, aesthetic, consumptive, and ethical values of biodiversity).

**Unit-3**

**Biodiversity Loss:** Natural and anthropogenic disturbances; habitat loss, habitat degradation, and habitat fragmentation, over-exploitation; invasive species, Co-extinctions: Mass Extinction events; Consequences of biodiversity loss.

**Unit-4**

**Conservation of biodiversity:** Reasons for conserving biodiversity (Narrowly utilitarian Broadly utilitarian, Ethical), In-situ conservation (Sacred groves, Biosphere Reserves, National Parks, Wildlife Sanctuaries); Ex-situ conservation (botanical gardens, zoological gardens, gene banks, seed and, tissue culture).

**Unit -5**

**Global and National conservation efforts:** Role of IUCN in global biodiversity conservation; IUCN Red List categorization; Wildlife (Protection) Act 1972 in India. Scope of Biodiversity Act 2002; PBR; National Biodiversity Action Plan 2015 in conservation.

**Suggested Readings:**

1. Mahanty, S. and Srivastava, A. (2016). Ecological diversity and its measurements. Blackwell Publications.
2. Myneni, S.R. (2020). Biodiversity and It's Conservation. Disha International Publishing House, India. Primack, R.B. (2002). Law of Biodiversity Protection. New Era Law Publication, India.
3. Rajak, A. (2020). Essentials of Conservation Biology (3rd edition). Sinauer Associates, Sunderland, USA
4. Singh, J.S., Singh, S.P. and Gupta, S.R.. (2008). Textbook of Biodiversity. 1st edition, Notion Press, India.
5. Sodhi, N.S., Gibson, L. and Raven, P.H. (2013). Ecology, Environment and Resource Conservation. Anamaya Publications (New Delhi).

## SEMESTER – I

### SEC-1: Algal Technology

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| SEC-1 | 3 | 0 | 3 | 5 | 50 | 50 |

**Course objectives:**

- To impart the knowledge on algal technology and its methods of cultivation
- To study the fundamentals of algal cultivation and current trends of algal technology
- To teach students about current applications and future potential of algal based economy

**Course outcome:** On successful completion of the course, student will be able to-

- ✓ Acquire the knowledge on algal culturing techniques
- ✓ Learn basic laboratory skills, hands on training on various aspects of algal technology
- ✓ Understand about the structure, cultivation and value added products of different commercial algal strains
- ✓ Gain knowledge on applications of algae and importance of algal based economy

**Unit-1**

**Introduction to Algal technology:** Definition and scope. Thallus organization in various groups of algae; Algal nutrition modes: Autotrophy and Mixotrophy; Culture media: Composition and types; Algal growth and methods of measuring algal growth; commercially strains of micro and macro algae.

**Unit-2**

**Algal cultivation methods:** Laboratory vs commercial cultivation; Mass cultivation methods: Open- cultivation methods; advantages and limitations; Closed system of cultivation: Algal photo bioreactor, basic design-operation, advantages and limitations of closed systems.

**Unit-3**

**Commercial cultivation:** Mass cultivation process of micro-algae-*Spirulina*/*Chlorella*; Mass production of blue green algae; Sea weed cultivation-methods: *Gracilaria*/*Gelidium;* Algal biomass: Harvesting, storage and processing.

**Unit-4**

**Algal applications:** Algae as food and Concept of algal single cell protein; Algae as feed with examples; Algal bio fertilizers; waste water treatment; Algal biofuel, Carbon sequestration.

**Unit-5**

**Algal Commercial products:** Algal pigments; algal based pharmaceuticals, cosmetics and nutraceuticals with examples; Algae in Industry: Agar, Alginates, Carrageenin, Mucilage, Diatomaceous earth and Funori; Algal technology in India and entrepreneurial scope.

**Suggested Laboratory Exercises (Any Sixteen activities from the list)**

1. Study of thallus organization of - Unicellular algae - Non motile: *Chlorella* and Motile: *Chlamydomonas*-slides/micrographs/photographs.
2. Study of Colonial algae - Volvox; Filamentous algae : *Oedogonium/Spirogyra*; Siphonous algae:*vaucheria*;Parenchymatous algae: Sargasssum/Gracilaria. –slides/Micrographs/specimens
3. To study the methods of collection and staining of algae.
4. Study of algae from fresh water bodies- microscopic observation and drawing.
5. Preparation of culture media for fresh water algae - soil extract medium- Pringsheim's or Modified Chu-10 medium or any other (Demonstration).
6. Isolation of algae by dilution and streak culture technique (Demonstration).
7. Measurement of algal growth: direct methods-demonstration.
8. Understanding the algal growth- Batch culture- growth curve drawing-using data
9. Studying the various types of open cultivation system design- photographs/video.
10. Study of photo bioreactors of algal culture-photographs/videos.
11. Cultivation of *Spirulina/ Chlorella* (Demonstration)/commercial scale cultivation-video/tutorials.
12. Study of commercial products of *Spirulina*. –photographs.
13. Cultivation of Blue Green Algae (demonstration).
14. Studying of sea weed cultivation methods- video/photographs.
15. Algal biomass harvesting techniques- Sedimentation/centrifugation/filtration/flocculation-demonstration.
16. Study of waste water algae- microscopic observation.
17. Study of various algal based commercial products-photographs/products display.
18. Preparation of laboratory scale biodiesel/pigments from algae- demonstration.
19. Visit to nearby *Spirulina*/sea weed cultivation farm submission of visit report.

**Suggested Readings:**

1. Anderson R.A. (2005), Algal cultural Techniques, Elsievier, London.
2. Hoek, C. Van D et al (2009) Algae: An Introduction to Phycology. Cambridge University Press
3. Jeyabalan S, Devarajan. T (2024) Algal Farming Systems: From Production to Application for a Sustainable Future, Apple academic press.
4. Sahoo, D. (2000).Farming the Ocean: Seaweed Cultivation and Utilization. Aravali Book International, New Delhi.
5. Faizal Bux, Yusuf Chisti ( 2016) Algae Biotechnology: Products and Processes, Springer International Publishing, Switzerland.

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**NEP 2020 B.Sc. Botany (Hons)**
**Main Practical Examination, Semester – I**
(Covering the Paper of Algal Technology)

Paper Code:
Duration – 3 hrs
Maximum Marks -50

1. Identify the given Microalgae A. Outline the procedure of its mass cultivation and add a note on its applications. (1 x 10 = 10 Marks)
   (Identification-1, materials-1, procedure-3, diagram -2, applications -2)
2. Identify the given specimen -B and write the procedure of its mass cultivation and applications. (1 x 10 = 10 Marks)
   (Indentification-1, materials-1 procedure-3, diagram -2, applications -2)
3. Write the Procedure/comments for the given concept 'C'. (1 x 5 = 5 Marks)
   (Procedure-3, Composition/diagram -2)
4. Identify, draw and give salient features of D, E, F, G. (4 x 5 = 20 Marks)
   (Identification-1, Diagram-2, Salient features-2)

Paper 45
Viva voce-05
**Total Practical Marks – 50**

**Key for Practical**

| **Question** | **Experiment / Spotter** |
|---|---|
| **A** | Microalgae cultivation |
| **B** | BGA/Sea weed cultivation |
| **C** | Media composition and preparation/growth measurement/ biomass harvesting techniques |
| **D** | Thallus organization of algae –spotter |
| **E** | Algal Cultivation methods (open/photo-bioreactors)-spotter |
| **F** | Algal based commercial products-display of products/photographs |
| **G** | Algal growth curve/serial dilution/streaking |

## SEMESTER - II

### MJD– 2: Archegoniates and Paleobotany

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA (Practical) |
| MJD-2 | 4 | 3 | 1 | 5 | 75 | 25 |

**Course Objective:**

- To understand the structure and reproduction of various genera of Bryophytes and Pteridophytes
- To impart knowledge on structure, reproduction and life cycle of Gymnosperms
- To provide understanding on paleobotany and fossilization

**Course Outcome:** At the end of the course, students will be able to

- ✓ Learn the classification and diversity of archegoniates
- ✓ Understand the structure and reproduction of archegoniates
- ✓ Acquire knowledge on paleobotany and process of fossilization
- ✓ Familiarise with economic and ecological significances of archegoniate

**Unit-1**

**Bryophytes**: General Characters of Bryophytes, Classification (Rothmaler, 1951), Detailed study of following genera (Systematic Position, Occurrence, Structure, Reproduction and Life Cycle): *Marchantia, Anthoceros* and *Funaria*. Economic importance of Bryophytes

**Unit-2**

**Pteridophytes:** General Characters of Pteridophytes, Classification of Pteridophytes by G.M. Smith(1955),. Stelar organization in Pteridophytes, Heterospory and Seed habit. Detailed Study of Following Genera (Systematic Position, Occurrence, Structure, Reproduction and Life Cycle): *Lycopodium, Selaginella* and *Equisetum*.

**Unit-3**

**Gymnosperms:** General characters of Gymnosperms and their Classification (K.R.Sporne, 1965), Detailed study of the morphology, anatomy and reproduction of *Cycas, Pinus* and *Gnetum* (Developmental details not required).

**Unit-4**

**Fossils:** Geological time scale; General account on fossils and fossilization; types of fossilization: compressions, impressions, casts, petrifactions (mineralized plants), compactions (Mummified plants), ambers.

**Unit-5**

**Paleobotany:** A detailed study of the following fossil genera – Rhynia, Lepidodendron, and Williamsonia. Brief note on the contributions of Birbal Sahni.

**Suggested Reading:**

1. Parihar, N.S. 2012. Introduction to Embryophyta - Bryophyta Vol.I. Surjeet Publications, New Delhi.
2. Sharma, O.P. 1990. Text book of Pteridophyta. MacMillan India Ltd., New Delhi.
3. Mukerjee, S.K. 1984. College Botany Vol II. New Central Agency, Calcutta.
4. Narayanaswami, R.V., Rao, K.N. and Raman. A. 2003. Outline of Botany.S. Vishwanathan Pvt. Ltd., Chennai.
5. Pandey, B.P. 2011. College Botany Vol.II. S. Chand and Co. Ltd., New Delhi.
6. Smith, G.M. 1989. Cryptogamic Botany (Bryophytes and Pteridophytes) Vol –II. Tata MacGraw Hill Pub. Co. Ltd., New Delhi.
7. Sambamurty, A.V.S.S. 2005. A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. I.K. International Pvt. Ltd., New Delhi.
8. Agashe, S.N. 1995. Paleobotany – Plants of the past, their evolution, paleoenvironment and application of fossil fuels. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
9. Bhatnagar S.P. and Alok Moitra. 1996. Gymnosperms. New Age International Publishers, Chennai.
10. Sporne, K.R. 1965. The morphology of Gymnosperms. B.I. Publications. New Delhi.
11. Vashishta, P.C. and Sinha, A.K. 2010. Botany for Degree Students – Gymnosperms. S. Chand & Co Ltd., New Delhi.
12. Vashishta P.C., Sinha A.K. and Kumar A. 2006. Botany For Degree Students:

## SEMESTER – II

### Practical of Archegoniates and Paleobotany

Paper Code:
Credits : 1
Max. Marks: 25

**Suggested Laboratory Exercises**

1. Observation, study of morphological and anatomical features of *Marchantia.*
2. Observation, study of morphological and anatomical features of *Anthoceros.*
3. Observation, study of morphological and anatomical features of *Funaria*.
4. Observation, study of morphological and anatomical features of *Lycopodium.*
5. Observation, study of morphological and anatomical features of *Selaginella.*
6. Observation, study of morphological and anatomical features of *Equisetum.*
7. Observation, study of morphological and anatomical features of *Cycas.*
8. Observation, study of morphological and anatomical features of *Pinus.*
9. Study of fossils:Rhynia, Lepidodendron, and Willamsonia using specimens/pictures/slides

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**Main Practical Examination, Semester – II**
(Covering the Paper of Archegoniates and Paleobotany)

Paper Code:
Duration – 1.30 hrs
Maximum Marks: 25

1. Make suitable micro-preparation of A. Identify, draw and give salient features. Leave the slides for valuation.
   (Preparation-1, Identification-1, Diagram-1, Salient features-2) (1 x 5 = 5 Marks)

2. Make suitable micro-preparation of B. Identify, draw and give salient features. Leave the slides for valuation.
   (Preparation -1, Identification-1, Diagram-1, Salient features-1) (1 x 4 = 4 Marks)

3. Identify, draw and give salient features of C, D & E
   (Identification-1, Diagram-1, Salient features-1) (3 x 3 = 9 Marks)

| | | |
|---|---|---|
| **Practical** | **-** | **18** |
| **Attendance** | **-** | **05** |
| **Record** | **-** | **02** |
| **Total** | **-** | **25** |

**Key for Practical**

| Question | Experiment / Spotter |
|---|---|
| **A** | Bryophyte / Pteridophyte material (sectioning) |
| **B** | Gymnosperm material (sectioning) |
| **C** | Slide/Figure of Bryophyte |
| **D** | Slide/Figure of Pteridophyte |
| **E** | Slide/Figure of Paleobotany |

## SEMESTER – II

### MID-2: Anatomy and Reproduction of Angiosperms
### (for B.Sc Zoology Programme)

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MID-2 | 4 | 4 | 0 | 4 | 75 | 25 |

**Course Objectives:**

- To understand plant cell architecture and cellular functions
- To gain knowledge on plant tissue systems and their function and role in plant architecture
- To learn about plant reproductive system and modes of reproduction

**Course Outcomes**: On completion of the course, students will be able to

- ✓ Develop overview of plant architecture and reproduction
- ✓ Analyse various tissues systems and their functional roles
- ✓ Learn about different plant reproductive modes and their significance in plant life cycle
- ✓ Acquire knowledge on fundamental of plant developmental biology

**Unit-1**

**Plant cell and tissue systems:** Ultrastructure of plant cell, Structure and function of cell organelle, Plant tissues systems: concept of cell growth and differentiation, Meristematic and permanent tissue characteristics, types of meristems and permanent tissues (simple, complex) and their functions.

**Unit-2**

**Anatomy:** Structure of shoot and root apex, plant growth phases, Concept of Division of labour in plant system (cell, tissue and organism level), anatomy of primary organs root, stem and leaf (Dicot and Monocot). Outline of Secondary growth in dicots.

**Unit-3**

R**eproductive organs development:** Outline of Reproductive modes in plants (vegetative, asexual, and sexual reproduction) advantages and disadvantages; Flower a modified shoot, Basics of ABC model of flower development, Microsporangium structure-function, Microsprogenesis, Male gametophyte development.

**Unit-4**

F**emale gametophyte and pollination:** Megasporangium (Ovule) structure, Megasporogenesis, female gametophyte development-structure (Polygonum type), Pollination and self and cross pollination- advantages and limitations, pollinating agents their ecological and economic value.

**Unit-5**

**Fertilization:** Events of fertilization; Pollen tube growth, pollen tube discharge, double fertilization and its significances, endosperm development-types, Dicot embryo development and structure, basics of seed development. Amphimixis and apomixis in life cycle of plants-their significance.

**Suggested Readings:**

1. Cutter, J.D. 1988. Plant Anatomy. Part I &II, Edward Arnold, London.
2. Esau, K. 1977. Anatomy of Seed plants. John Wiley & Sons, U.S.A.
3. Fahn, A. 1982. Plant Anatomy. Pergamon Press U.K.
4. JohanesOn, D.A. 1940. Plant microtechnique - McGraw Hill Book Co., New Delhi.
5. Mauseth, J.D. 1988. Plant Anatomy. The Benjamin/Cumming Pub.,U.SA.
6. Dwivedi, J.N. 1986. Embryology of Angiosperms. Rastogi & Co. Meerut.
7. Fageri, K and Van der Piji 1989. The Principles of Pollination Ecology. Pergamon Press, Oxford, UK.
8. Hartman, H. T. and Kester, D.E. 1976. Plant Propagation: Principles and Practices, 3rd edition. Prentice Hall of India Pvt. Ltd., New Delhi.
9. Johri, B.M. 1984. Embryology of Angiosperms. Springler-Verlag, Berlin.

Pandey, B.P. College Botany. Vol II. S. Chand & Co., New Delhi.

## SEMESTER - II

### SEC-2: Plant Nursery Management

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| SEC-2 | 3 | 0 | 3 | 5 | 50 | 50 |

**Course Objectives:**

- To impart knowledge of plant nursery management and types of nurseries business models.
- To gain knowledge on soil treatments, preparations and different growth media.
- To provide knowledge on various plant propagation methods.
- To understand the different management practices of plant nursery.
- To encourage students to consider nursery management as employment opportunity.

**Course Outcomes:** On successful completion of the course, students will be able to

- ✓ Develop comprehensive understanding of plant nursery management.
- ✓ Get familiar with different types of nurseries catering the needs of customers and suitable nursery business model.
- ✓ Gain hands on training on soil preparation, different plant propagation methods and nursery management practices.
- ✓ Acquired skillset and knowledge would help to students to take up nursery management as entrepreneurship opportunity.

**Unit-1**

**Introduction to plant nursery:** Scope and Importance of Nursery, types of Nurseries: On the basis of plants produced, On the basis of structure and according to the Type of Sale; Garden Tools and their use. Basic nursery lay out.

**Unit-2**

**Nursery bed and growth media:** Preparation and types of nursery beds (raised, flat and sunken) and their advantages and limitations; Soil treatment: Soil –solarisation, chemical and biological treatment methods; Growing medium: Characteristics and function of good Media, Types of growing medium (natural and synthetic)

**Unit-3**

**Plant propagation through seeds:** Seed treatments (chemical and biological); Seed germination conditions; Methods of seed sowing: Broadcasting and Line sowing; Seed sowing and growing

seedling in plug-trays (pro-trays); Different Potting mixes preparation and transplantation of plants.

**Unit- 4**

**Vegetative Propagation of nursery plants:** Underground and above ground (aerial) plant propagating materials; Mother plants and maintenance; Propagation through cuttings, Layering and Grafting and their Horticultural significances; Micro-Propagation outline and applications.

**Unit-5**

**Care and management of nursery plants:** Application of manures and fertilisers, Handling of plants-misting, watering, Common diseases in nursery plants and Insect-pests controlling measures. Maintenance of mother plants.

**Suggested Laboratory Exercises: (Any sixteen activities from the list)-**

1. Studying of nurseries based on structure :Open filed, shed-net, poly tunnel and green house
2. Studying of different gardening tools and their uses
3. Demonstration of Soil solarisation method
4. Studying nursery bed preparation : raised bed, flat and sunken beds demonstration
5. Studying of different growth media: display of various growth media
6. Preparation of potting mix using different ratios of growth media -experiments
7. Demonstration of Planting material (seed/vegetative parts ) treatment for propagation
8. Studying of conditions for seed germination-experiment
9. Demonstration of seed sowing: line- broadcasting
10. Raising of any 2 seedlings in seed trays or pro-trays -experiments
11. Transplanting of seedlings in pots and bags -experiment
12. Growing plants using underground plant material- rhizome, corm, tuber and bulb
13. Demonstration of simple and air Layering techniques
14. Demonstration of grafting in ornamental plant/fruit plants
15. Demonstration of rooting in stem cuttings
16. Bud-chip methods of sugarcane mass multiplication-experiment
17. Micro-propagation outline –using photographs
18. Studying the different chemical and organic fertilizers for plant growth
19. Studying various nursery diseases- photographs/specimens
20. Studying common insect pest of nursery (photographs) and their control measures-

21. Vertical garden design by students assignment
22. Visit to local nursery and preparing the report
23. Nursery management as entrepreneurship-discussion/seminar/assignment

**Suggested Readings:**

1. P.K. Ray (2021)Essentials of Plant Nursery Management 2nd Edition Scientific Publisher, Jodpur
2. Dr. Arun Kumar Singh & Abhinav Kumar (2021)Plant Propagation and Nursery Management, Bhavya Books.
3. Hartmann, H.T., Kester D.E., Davis, F.T and R.L Geneve (2010) Plant Propagation: Principles and practices (8th Edition).
4. Sharma, R.R and Srivastav M (2004):Plant propagation and nursery management (First Edition) International Book Distributing Co.
5. Sandhu, M.K. (1989) Plant Propagation, Wile Eastern Ltd., Bengaluru.
6. Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
7. Musser E., Andres.(2005).Fundamentals of Horticulture. New Delhi, McGraw Hill Book Co. 2.

**Bharathidasan Govt. College for Women (Autonomous), Puducherry**
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**Main Practical Examination, Semester – II**
(Covering the Paper of Plant Nursery Management)

Paper Code:
Duration – 3 hrs
Maximum marks -50

1. Identify the given Setup-A and write the procedure and applications. (1 x 10 =10 Marks)
   (Indentification-1, materials-1 procedure-4, diagram -2, applications -2)
2. Identify the given Setup-B and write the procedure and applications. (1 x 10 =10 Marks)
   (Indentification-1, materials-1 procedure-4, diagram -2, applications -2)
3. Identify the given Setup-C and write the procedure and its uses in nursery.(1 x 5= 5 Marks)
   (Identification-1, procedure-2, diagram -1, advantages 1)
4. Identify, draw and give salient features of D, E, F, G. (4 x 5= 20 Marks)
   (Identification-1, Diagram-2, Salient features-2)

Paper 45
Viva voce-05
**Total Practical Marks - 50**

**Key for Practical**

| Question | Experiment / Spotter |
|---|---|
| **A** | Setup-Grafting/Layering/Rooting in Stem cutting/Micro-propagation |
| **B** | Setup- Seed germination conditions/ Seedlings in portray |
| **C** | Setup-Raised bed/soil solarisation method/Potting mix |
| **D** | Different Gardening tools |
| **E** | Different Growing media |
| **F** | Different types of nurseries/vegetative propagated materials |
| **G** | Common diseases of nursery/ insect pest of Nursery |

## SEMESTER – III

### MJD-3: Plant Cell Biology

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MJD-3 | 4 | 3 | 1 | 5 | 75 | 25 (Practical) |

**Course Objectives:**

- To understand the structure of plant cell and cell organelles and their function
- To understand the process of cell cycle

**Course Outcomes:** at the end of the practical examination students will be able to

- ✓ Here the students will learn about the fundamentals of plant cell
- ✓ Subject provides knowledge on how cell works it architecture and other functional aspects
- ✓ Get familiar with cell cycle and its importance in plant development
- ✓ Analyse the role various cell organelles in cellular functions

**Unit-1**

**Cell Structure:** Diversity of cell size and shape. Cell theory. Structure of prokaryotic and eukaryotic cells. Cell wall, Plasma membrane: chemical composition, structure-lamellar models and fluid mosaic model.

**Unit-2**

**Cell Organelles:** Ultra structure and functions of Nucleus, Strucuture and functions of Chloroplast, Endoplasmic Reticulum, Dictyosome, Mitochondria and Microbodies (Peroxisomes and Glyoxysomes), Spherosomes, Ribosomes, Microtubules and Microfilaments.

**Unit-3**

**Cell cycle:** Dividing phase, Interphase, G1phase, S phase, G2 phase. Mitosis : Mitotic phases, Cytokinesis, Karyokinesis. Meiosis : Meiotic phases - Meiosis I & Meiosis II, Significance of meiosis.

**Unit-4**

**Chromosomes:** Structure and organization - Chromonema, chromomere, chromatid, Primary constriction, secondary constriction, satellite, telomere, heterochromatin and Euchromatin, Nucleosome.

**Unit-5**

**Special type of chromosomes:** Salivary gland chromosome, Lampbrush chromosome, B-chromosomes. Chloroplast DNA and Mitochondrial DNA.

**Suggested Reading:**

1. Arumugam,N. 2012. Cell Biology. Saras Publications, Kanyakuamri.
2. Gupta, P.K. 2004. 3rd Edition. Cell and Molecular Biology. Rastogi Publications, New Delhi.
3. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th Ed. Lippincott Williams and Wilkins, Philadelphia.
4. Gerald Karp. 2002. Cell and Molecular Biology, John Wiley & Sons, New York.
5. Nath, V. 1981. Cell Biology. S. Chand, New Delhi.
6. Paul, A. 2011. Textbook of Cell and Molecular Biology. Books and Allied (P) Ltd. Kolkata.
7. Powar, C.B. 1981. Cell Biology. Himalaya Publishing House, Bangalore.
8. Sharma, A.K and Sharma, A. 1999. Plant Chromosomes: Analysis, Manipulation and Engineering, Harwood Academic Publications, Australia.
9. Verma, P.S and Agarwal, V.K. 1993. A Textbook of Cytology. S. Chand & Co., New Delhi.
10. Verma, P.S and Agarwal, V.K. 2002. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand & Co., New Delhi.

## SEMESTER – III

### Practical of Plant Cell Biology

Paper Code:
Credits: 1
Max. Marks: 25

**Suggested Laboratory Exercises**

1. Observation of plant cells in Onion peel.
2. Observation of plant cells in Hydrilla leaf.
3. Observation of staminal cells of Rhoeo.
4. Study of Electron micrograph of prokaryotic and eukaryotic cell.
5. Study of Electron micrograph Cell wall, Plasma membrane, Nucleus, Chloroplast, Endoplasmic reticulum, Dictyosomes, Mitochondria, Ribosomes and Cytoskeleton.
6. Preparation of acetocarmine squash of Root Tip.
7. Identification of stages in Meiosis: Prophase I, Metaphase I, Anaphase I, Telophase I, Dyad, Prophase II, Metaphase II, Anaphase II, Telophase II and Tetrad.
8. Preparation of acetocarmine squash of giant Chromosomes..
9. Study of Electron micrograph of special type of chromosomes : Polytene and lampbrush chromosome.
10. Observation of microslides of special type of chromosomes : Polytene and lampbrush chromosome.
11. Preparation of smear of anther.

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**Main Practical Examination, Semester – III**
(Covering the Paper of Plant Cell Biology)

Paper Code:
Credits: 1
Duration – 1.30 hrs

1. Prepare Squash / Smear of the material A. Identify any two stages giving reasons. Leave the slide for valuation. (Preparation-3, Diagram-1, Salient features-2) (1 x 6 = 6 Marks)
2. Identify, draw and give salient features of B, C, D & E.
   (Identification-1, Diagram-1, Salient features-1) (4 x 3 = 12Marks)

| | | |
|---|---|---|
| **Practical** | **-** | **18** |
| **Attendance** | **-** | **05** |
| **Record** | **-** | **02** |
| **Total** | **-** | **25** |

**Key for Practical**

| Question | Experiment / Spotter |
|---|---|
| **A** | Mitosis/meiosis (onion root tip/Tradescantia flower bud) |
| **B** | Cell Biology Slide/Figure - Cell Organelles |
| **C** | Cell Biology Slide/Figure -Polytene / Lampbrush Chromosomes |
| **D** | Cell Biology Slide/Figure - Cell Membrane / Cell Wall |
| **E** | Cell Biology Slide/Figure - Mitosis / Meiosis stages |

## SEMESTER – III

### MJD-4: Embryology of Angiosperms

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MJD-4 | 4 | 3 | 1 | 5 | 75 | 25 (Practical) |

**Course Objective:**

- To understand reproductive processes of flowering plants
- To impart the knowledge on Origin, structure and development of reproductive organs

**Course Outcomes:** Upon completion of the course, students will be able to

- ✓ Learn fundamental knowledge on how plants reproduce
- ✓ Understand the developmental aspects of reproduction in plants
- ✓ Analyse reproductive methods and role of pollination and pollinating agents
- ✓ Develop understanding of life cycle of Angiosperms

**Unit-1**

**Flower and male gametophyte development:** Flower as a modified shoot, ABC-model of flower development (brief note); Structure and development of microsporangium; Pollinium, Translator apparatus, Gynostegium. Development of male gametophyte, pollen structure.

**Unit-2**

**Ovule and Embryo sac development:** Structure and development of Megasporangium (Ovule); Types of ovules – Orthotropus, anatropus, campylotropus, amphitropous, circinotropous; Megasporogenesis: female gametophyte (embryo sac) – structure; Development of monosporic (Polygonum), bisporic (Allium), tetrasporic (Peperomia) embryo sacs.

**Unit-3**

**Pollination and Fertilization:** Autogamy, Geitonogamy, Xenogamy and their advantages and dis advantages; Adaptations for self and cross pollinations; Agents of pollination-floral adaptations: Abiotic-wind and water, Biotic-Insects, Birds and Bats; Significance of pollinators (ecological and economic); Fertilization: Pollen germination and pollen tube growth, Double fertilization.

**Unit-4**

**Endosperm and Embryo development:** Endosperm and its functions; Endosperm development from PEN, types of endosperms: Nuclear, Cellular and Helobial, Ruminate endosperm; Embryo:

structure and development of dicotyledonous embryo (Capsella) and monocotyledonous embryo (Triticum); Parthenocarpy, Apomixis and Polyembryony.

**Unit-5**

**Seed development and dispersal:** Seed structure and development; Seed appendages- Curncle, Aril, Operculam; Seed dispersal and its mechanisms; Seed dormancy: Importance and types of dormancy; Overcoming seed dormancy. Embryology in relation to Taxonomy.

**Suggested Reading:**

1. Bhojwani. S.S. and Bhatnagar, S.P. 2004. The Embryology of Angiosperms. Vikas Publishing House (P) Ltd., New Delhi.
2. Maheshwari, P. 1950. An Introduction to the Embryology of Angiosperms. McGrawHill Books Co.
1. Bendre, A.M. and Pande, P.C. 2002. Introductory Botany. Rastogi Publications, Meerut.
2. Dwivedi, J.N. 1986. Embryology of Angiosperms. Rastogi & Co. Meerut.
3. Fageri, K and Van der Piji 1989. The Principles of Pollination Ecology. Pergamon Press, Oxford, UK.
4. Hartman, H. T. and Kester, D.E. 1976. Plant Propagation: Principles and Practices, 3rd edition. Prentice Hall of India Pvt. Ltd., New Delhi.
5. Johri, B.M. 1984. Embryology of Angiosperms. Springler-Verlag, Berlin.
6. Pandey, B.P. College Botany. Vol II. S. Chand & Co., New Delhi.
7. Sadhu, M.K. 1989. Plant Propagation. New Age International Publishers.
8. Twyman, R.M. Developmental Biology. Viva Books Pvt. Ltd. New Delhi.

## SEMESTER – III

### Practical of Embryology of Angiosperms

Paper Code:
Credits,: 1
Max. Marks: 25

**Suggested Laboratory Exercises**

1. Flower and floral parts (floral dissection)
2. L.S. of Flower
3. Study of different Types of Anthers
4. Anther – T.S. of Anther
5. Observation of pollen grains of different plants
6. Study of Pollinium, Translator, Gynostegium
7. Study of Ovule types (slides / Micrographs)
8. Study of embryo sac (Mature)
9. Dicot and monocot embryo. (Mounting)
10. Study of Different types of Endosperm
11. Study of seed appendages.

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**Main Practical Examination, Semester – III**
(Covering the Paper of Embryology of Angiosperms)

Course Code:
Time– 1.30 hrs
Maximum Marks: 25

1. Make suitable micro-preparation of A. Leave the slide for valuation. Draw and identify giving reasons.
   (Preparation-2, Identification-l, Diagram-1, Salient features-1) (1 x 5=5 Marks)
2. Make suitable micro-preparation of B. Leave the slide for valuation. (1 x 4=4 Marks)
3. Draw and identify giving reasons. C, D & E
   (Identification-l, Diagram-1, Salient features-1) (3 x 3= 9 Marks)

| | | |
|---|---|---|
| **Practical** | **-** | **18** |
| **Attendance** | **-** | **05** |
| **Record** | **-** | **02** |
| **Total** | **-** | **25** |

**Key for Practical**

| Question | Experiment / Spotter |
|---|---|
| **A** | Anther (Section) |
| **B** | Embryo / Pollinia (Dissection) |
| **C** | Ovule types/ Embryosac (Slide / Specimen) |
| **D** | Endosperms types (Slide / Specimen/photogrpah) – |
| **E** | Seed appendages/Embryo (Slide / Specimen) |

## SEMESTER – III

### MID-3: Plant Physiology, Tissue Culture and Ecology
### (For the B.Sc Zoology Programme)

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA (Practical) |
| MID-3 | 4 | 4 | 0 | 6 | 75 | 25 |

**Course Objectives:**

- To understand the fundamentals of plant physiology, Tissue culture and Ecology
- To learn the concepts of tissue culture and applications of tissue culture
- To create awareness on plant ecology and its importance

**Course Outcomes:** Upon completion of the course students, will be able to

- ✓ Gain knowledge on basic concepts of plant physiology and how physiological processes drive the plant life.
- ✓ Understand the fundamentals of plant tissue culture and its application
- ✓ Acquire knowledge on plant ecology and plant interaction with biotic and abiotic factors
- ✓ Enhance their understanding of plant biology and adds to their knowledge

**Unit-1**

**Plant water relationship:** Importance of water; Definitions and significance: Osmosis, Imbibition and Water potential; Absorption of water(active and passive); Notes on Transpiration; Ascent of sap: transpiration pull theory; Mineral nutrition: Criteria of essentiality of minerals and classification(Macro and micro); Mineral uptake: Passive transport-(facilitated diffusion-carrier and channel), and Active transport(ATP- ion pumps)

**Unit-2**

**Photosynthesis and Respiration:** Pigments; chlorophyll-carotenoids; Photosystems-and their role; Light reactions (non-cyclic and cyclic photophosphorylation) and carbon fixation (Calvin cycle); Cellular Respiration: Respiratory substrates and RQ; Outline of aerobic respiration (glycolysis, TCA cycle oxidative phosphorylation).

**Unit-3**

**Growth and Development**: Phytoharmones: physiological roles of Auxins, Cytokines and gibberellic acid and ABA in plants. Photoreceptors (phytochrome) and its role in plant physiology;

Photoperiodism and flowering in plants- short day long day and day neutral plants; Physiology of senescence.

**Unit-4**

**Plant Tissue Culture:** Definition, of tissue culture, Concept of totipotency: dedifferentiation and re-differentiation; Tissue culture lab infrastructure and equipment; Components of nutrient medium; aspectic conditions; Callus formation; Organonegsis (direct, indirect)-shoot, root induction and somatic embryo genesis; basics of micro propagation and applications of tissue culture.

**Unit-5**

**Plant Ecology:** Producers: Gross Primary and net primary productivity, secondary productivity; Concept of phytogeography; Ecotypes and keystone species and their significances; Adaptions of hydrophytes and xerophytes (Morphology, anatomy and physiological); Basics of plant succession; Plant interactions: brief notes on symbiosis (Plant vs Bacteria, fungi), allelopathy.

**Suggested Readings:**

1. Jain, V.K. 1988. Fundamentals of Plant Physiology, S.Chand and Co. Ltd.,New Delhi.
2. Mukherji. S. and Ghosh, A.K. 2005. Plant physiology. New Central Book Agency Ltd., Kolkata.
3. Pandey, S.N. and Sinha, B.K. 1989. Plant Physiology, Vikas Publishing House . New Delhi.
4. Noggle G.R.and Fritz, G.J. 1986. 2nd Ed. Introduction to Plant Physiology. PrenticeHall of India Ltd., New Delhi.
5. Dubey R.C. A Textbook of Biotechnology. S. Chand & Company Ltd. New Delhi, India.
6. Purohit S.S. Plant tissue culture. Shyam Printing Press. Jodhpur, India.
7. Das H.K. 2010.Textbook of Biotechnology (4th Edition). Wiley India Pvt Ltd., New Delhi.
8. Satyanarayana, U. 2010. Biotechnology. Uppala Author Publisher interlinks, (A.P.)
9. Chawla H.C. 2003. Plant Biotechnology- Laboratory Manual for Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

## SEMESTER – III

### Practical of Plant Physiology and Tissue culture & Ecology

**Credits-1**
**Maximum Marks-25**

**Suggested laboratory Exercises**

**Plant physiology**

1. Identification of short day and long day plants- pictures
2. Identifying the types of senescence (whole-plant/top/gradual) -pictures
3. Demonstration of Imbibition through seeds- setup
4. Ultra structure of chloroplast and mitochondria –micrographs
5. Studying the Starch accumulation in leaf during photosynthesis - iodine test experiment
6. Evolution of oxygen during photosynthesis demonstration/setup- Hydrilla funnel experiment
7. Differentiating active and passive transport- pictures
8. Observation of stomata in leaf sample –microscopic study
9. Demonstration of plasmolysis using Reaho leaf –microscopic study

**Tissue culture**

10. Identification of tissue culture equipment: Autoclave, laminar flow, pH meter etc
11. Studying the Callus induction process using setup/ photographs/pictures
12. Indemnification of direct and indirect organogenesis- photographs/pictures
13. Identification of root and shoot induction through photographs
14. Studying the micro propagation techniques- photographs/pictures/setup

**Plant ecology**

15. Studying the anatomy of the hydrophyte through sectioning -Hydrilla stem T.S
16. Studying the anatomy of the xerophyte through sectioning -Nerium leaf T.S
17. Identification of major biomes-Phytogeography maps –photographs
18. Understanding the plant succession –photographs/pictures
19. Identification of Legume rhizobium -Root nodules ( picture), Lichen

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**NEP 2020 B.Sc. Botany (Hons)**
**Allied Practical Examination, Semester – III**
(Covering the Paper of Plant Physiology, Tissue Culture and Ecology)

Course Code:
Time– 1.30 hrs
Maximum Marks: 25

1. Write notes on setup A. Draw and identify giving reasons.
   (Identification-l, Diagram-1, Procedure -2) (1x4=4 Marks)
2. Make suitable micro-preparation of B. Leave the slide for valuation.
   Draw and identify giving reasons.
   (Preparation-2, Identification-l, Diagram-1, Salient features-1) (1x5=5 Marks)
3. Identify, draw and give salient features of C, D & E.
   (Identification – 1, Diagram – 1, Salient features – 1) (3 X 3= 9 Marks)

**Practical - 18**
**Attendance - 05**
**Record - 02**
**Total - 25**

**Key for Practical**

| Question | Experiment / Spotter |
|---|---|
| **A** | Plant Physiology |
| **B** | Ecology Section |
| **C** | Plant Physiology spotter |
| **D** | Tissue Culture Spotter |
| **E** | Ecology spotter |

## SEMESTER – III

### SEC-3: Bio fertilizers and Bio Pesticides

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| SEC-3 | 3 | 0 | 3 | 6 | 50 | 50 |

**Course Objectives:**

- To understand the basic concepts of bioferlizers and organic farming
- To impart the knowledge on different types of bioferilizers and organic fertilizers their production technologies
- To gain knowledge on biocontrol agents and their role in pest management
- To create awareness on organic farming as sustainable model of food production

**Course Outcomes:** On successful completion of the course, students will be able to

- ✓ Develop understanding on importance of biofertilizers and their different sources
- ✓ Familiarize with the biofertilizer production technologies and other aspects production line
- ✓ Acquire knowledge on various organic fertilizers and bio-controling methods
- ✓ Acquire skillset and training on various aspects of biofetilizers and bio-pesticides, to consider it as an entrepreneurial opportunity

**Unit-1**

**Biofertilizers and Types:** Role of fertilizers in farming and Issues with chemical fertilizers; Definition of biofertilizers and their advantages; Types of biofertilizers: Based on organism (bacterial, fungal, cyanobacterial, aquatic plants); Based on function: Nitrogen fixing(free living & symbiotic), Phosphate solubilizing, Phosphate mobilizing and plant growth promoting rhizobacteria (PGPR) –Examples and attributes.

**Unit-2**

**Biofertilzers screening and Mass production:** Carrier based and non-carrier based (liquid) biofertilzers: advantages and limitations; screening of potential biofertilizer microbes: Isolation, activity testing and preparation of mother cultures; Mass production of carrier based microbial biofertilizers (preparation, packing- storage and product specification); Mass production of liquid biofertilizers.

**Unit-3**

**Mass production and application of biofetilizers:** Mass production of cynobacterial biofertilizer-processing storage and uses; Mass production of Azolla-processing and uses; Mass production of Arbascular Mycorrhizae –processing and uses; Methods of biofertilizers Application: Seed treatment, Seedling treatment (root dip-treatment) and direct field(soil treatment) application.

**Unit-4**

**Organic fertilizers:** Definition and advantages; types of organic fertilizers: Bulk manures (compost, vermicompost, green manure, animal dung manure); Concentrated fertilizer (oil cakes, bone meal, fish emulsion); Green manure: examples, green manuring and uses; Compost: composting methods and uses; Vermicomposting-uses; Organic fertilizers application.

**Unit-5**

**Microbial Biocontrol agents:** Definition and advantages; Biopesticides: studying activity and uses Fungal (*Beauveria bassiana*, *Metarhizium anisopliae*); Bacterial (*B. thurigiensis* **var.** *kurstakii, Bacillus subtilis)* and viral **(**Granuloviruses Nuclear Polyhedrosis viruses **or** NPVs) ; Mass production of *Terichoderma,* commercial formulation and its application; *Bacillus thurengensis*(Bt): commercial formulation and application; Plant based bio-pesticides(examples and usage) and pheromone traps as pest controllers.

**Suggested Laboratory Activities** (**Any sixteen activities from the list)**

1. Study of Lab equipment used in biofretilizer production-Display/Photographs
2. Study of cyanobacteria (used in biofertilizers) from temporary mounts /permanent slides
3. Study of morphology and T.S root nodules of leguminous plants
4. Morphological and anatomic study of *Azolla* leaf to observe Anabaena
5. Observation of mycorrhizae association from permanent slides/ micrographs
6. Familiarity with different carriers used in biofertilizer formulations- display of carriers
7. Studying the screening of phosphate solubilizing and *Trichoderma*l activity microbes -- photographs
8. Understanding the design and working of fermenter –video/photographs
9. Mass production of carrier based microbial biofertilizer- video/flow chart diagram
10. Mass production of liquid biofertilizers
11. Mass production of cyanobacterial biofertilizer-experimental demonstration
12. Mass production of *Azolla* and processing- experimental demonstration

13. Study the Seed/seedling treatment method of biofertilizer application–demonstration
14. Studying different organic fertilizers and their origin and application-product display
15. Understand the green manuring process and example of green manures—video/photographs
16. Study the compost preparation methods –video/photographs/ demonstration
17. Study the different microbial biopesticides-Organism, action, and uses--photographs
18. Mass production of *Terichoderma* and its application-demonstration
19. Study *Bacillus thurengensis*(Bt): commercial formulation and application
20. Plant based pesticides: sources, commercial products and uses-product display
21. Study the different insect traps used for pest control –video/demonstration
22. Visit to the organic farm and submission of report

**Suggested Readings:**

1. Dubey R.C. 2005. A Text book of Biotechnology. S.Chand & Co. New Delhi.
2. Kumaresan V. 2005. Biotechnology. Saras Publications. New Delhi.
3. Vayas,S.C, Vayas, S., Modi, H.A. (1998). Bio-fertilizers and organic Farming. Nadiad, Gujarat: Akta Prakashan.
4. Khosla, R. (2017). Biofertilizers and Biocontrol Agents for Organic Farming Kojo Press.
5. Dhama, A.K. (2014). Organic Farming for Sustainable Agriculture (2nd edition), Agrobios (India), Jodhpur.
6. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett Publishers.
7. SubbaRao, N.S. 1993. Biofertilizers in Agriculture and Forestry. Oxford and IBH. Publ. Co., New Delhi. Vayas,S.C, Vayas, S., Modi, H.A. 1998. Bio-fertilizers and organic Farming. Nadiad, Gujarat: AktaPrakashan

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**Main Practical Examination, Semester – III**
(Covering the Papers of Bio fertilizers and Bio pesticides)

Paper Code:
Duration – 3 hrs
Maximum Marks -50

1. Outline the Mass production of carrier based microbial biofertilizer and add a note on its applications.
   (Materials-2 procedure-4, diagram -2, applications -2) (1 x 10 = 10 Marks)
2. Identify the given specimen -B and outline the Mass production of biofertilizer and its applications.
   (Identification-1, materials-2, procedure-3, diagram-2, applications-2) (1 x 10 =10 Marks)
3. Write the Procedure for biofertlizers treatment method for a given plant material 'C.
   (Material -2, Procedure-3,) (1 x 5 = 5 Marks)
4. Identify, draw and give salient features of D, E, F, G, (4x 5 = 20 Marks)
5. (Identification-1, Diagram-2, Salient features-2)

Paper Marks -45
Viva voce -5
**Total Practical Marks -50**

**Key for Practical**

| **Question** | **Experiment / Spotter** |
|---|---|
| **A** | Microbial Biofertilizer production |
| **B** | BGA/Azolla mass production |
| **C** | Seed/seedling treatment method of biofertilizer |
| **D** | Mycorrhiza / Legume Rhizobium association-spotter |
| **E** | Biofertiliser production -display tools of products/photographs/ Biofertilizer activity screening- photograph |
| **F** | Organic fertilizer display/photographs |
| **G** | Types Biopesticides, Plant based pesticides; insect traps |

## SEMESTER – IV

### MJD-5: Morphology and Taxonomy of Angiosperms

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MJD-5 | 4 | 4 | 0 | 4 | 75 | 25 |

**Course Objectives:**

- To understand the morphological characteristics of the angiosperms
- To learn the nomenclature, classification principles and techniques in taxonomy
- To familiarize the locally available plant species based on taxonomic characters

**Course Outcomes:** On completion of the course, students will be able to

- ✓ Understand the diverse morphological adaptation of plants and their function
- ✓ Gain knowledge on different classification systems and trends on plant taxonomy
- ✓ Learn hands-on experience on herbarium preparation and field trip to impart taxonomic skills to students.
- ✓ Get good opportunity to learn taxonomy which is an essential and highly desired skill

**Unit-1**

**Morphology:** Detailed study of morphology of root and stems. Types of inflorescences. Flower: Calyx shapes and modifications, Corolla- Shapes, Androecium – Cohesion and adhesion of stamens, Gynoecium – style, stigma and types of placentation.

**Unit-2**

**Classification systems**: - Artificial: An outline of Linnaeus, Natural: Bentham and Hooker Phylogenetic systems of classification: Engler and Prantl systems of classification and their merits and demerits. Introduction to APG III system of classification; Modern trends in Taxonomy - Chemotaxonomy, Numerical Taxonomy, Cytotaxonomy.

**Unit-3**

**Plant Nomenclature and herbaria:** taxonomic hierarchy, binomial and polynomial, ICBN, ICN, principles of priority, type concept, valid and effective publication, author citation. Herbarium techniques: (Collection, pressing, drying, poisoning, mounting and preserving of

plant specimens), importance of herbaria. Brief notes on keys and flora, Manual revisions and monographs. Molecular tools in Taxonomy – RFLP, RAPD.

**Unit-4**

**Study of the Angiosperm families** and their economic importance: Annonaceae, Capparidaceae, Rutaceae, Leguminosae (Faboideae, Caesalpinioideae, and Mimosaideae) Cucurbitaceae.

**Unit-5**

**Study of the Angiosperm families** and their economic importance: Rubiaceae, Asteraceae, Apocynaceae, Asclepiadaceae, Solanaceae, Lamiaceae, Amaranthaceae, Euphorbiaceae, Orchidaceae, Liliaceae and Poaceae.

**Suggested Reading:**

1. Vashista, P.C 1991. Taxonomy of Angiosperms. S. Chand & Co., New Delhi.
2. Lawrence, G.H.M. 1951. Taxonomy of Vascular Plants. The Macmillan Company. New York.
3. Davis, P. H. and Heywood, V. H. 1973. Principles of Angiosperm Taxonomy. Rebert E. Kreiger Pub. Co,. New York.
4. Dutta, A.C and T.C Dutta, 1996. Botany for Degree Students. Oxford University Press, Chennai.
5. Henry A.N, and Chandrabose, M. 1980. An aid to International code of Botanical Nomenclature. Today & Tomorrow's Printers and Publishers. New Delhi.
6. Hutchinson, J. 1973. 3rd Edition. The Families of Flowering Plants. Oxford University Press, Oxford.
7. Jain, S.K. and R.R. Rao. 1977. A Handbook of Field and Herbarium Methods. Today & Tomorrow's Printers and Publishers, New Delhi.
8. Naik, V.N. 2000. Taxonomy of Angiosperms. Tata McGraw- Hill Publishing Company. New York.
9. Singh, G. 2005. Plant Systematics – Theory and Practice. Oxford & IBH, New Delhi.
10. Verma, B.K. 2011. Introduction to Taxonomy of Angiosperms. PHI learning Pvt.Ltd., New Delhi.

## SEMESTER–IV

### MJD – 6: Anatomy of Angiosperms

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MJD-6 | 4 | 4 | 0 | 4 | 75 | 25 |

**Course Objective:**

- To understand internal structures of the different plant parts
- To impart knowledge on various plant tissue systems and their functions
- To understand the fundamental aspects of plant growth

**Course Outcomes:** after the completion of the course students will be able to

- ✓ Learn the anatomical structure of different plant organs
- ✓ Analyse the structure and role of different tissue systems
- ✓ Understand how different tissues organise to form organs and plant body
- ✓ Acquire knowledge on secondary and primary growth

**Unit-1**

**Plant Tissue systems:** Cell wall – primary and secondary structure and functions. Plasmodesmata, Thickening of the cell wall, Pits, Chemical nature. Tissues: Meristematic and Permanent tissues, Classification of permanent tissues: simple tissues - parenchyma, types of parenchyma, collenchyma, types of collenchyma, sclerenchyma and sclerenchyma fibres and sclereids; complex tissues- xylem - primary and secondary xylem, tracheids, vessels and fibers. Phloem - primary and secondary phloem, sieve cell and sieve tube element.

**Unit-2**

**Meristems**: - Classification: Development, origin, plane of division, position and function. Types: Apical, intercalary and lateral meristems. Apical meristem: Root apex - Apical Cell theory, Histogen theory, Tunica Corpus theory, Korper-kappe theory, Quiescent centre. Shoot apex: Apical Cell theory, Histogen theory, Tunica Corpus theory. Lateral meristem: Origin, Types - Vascular cambium and cork cambium, Fascicular and interfascicular.

**Unit-3**

**Anatomy of stem and root:** Primary structure in dicot and monocot stem. Primary structure in dicot and monocot root. Secondary structure in dicot and monocot stem. Secondary structure in dicot and monocot root. Periderm: Phelloderm, Phellogen and Phellem, Annual rings- Spring wood and autumn wood, Sapwood and Heartwood, Dendrochronology, Dendroclimatology.

**Unit-4**

**Anomalous secondary growth:** Dicot stem: Inverted cortical bundles - Nyctanthes, Medullary bundles - Boerhaavia. Special type of secondary growth in Monocot stem – Dracaena.

**Unit-5**

**Anatomy of Leaf:** Anatomy of dicot leaf, Anatomy of monocot leaf. Stomatal types: Anomocytic, anisocytic, paracytic and diacytic. Secretory tissue system - Laticifers, oil glands and glandular hairs. Sectioning (Cross section, longitudinal, radial and tangential), Staining (single & double), peeling & maceration.

**Suggested Readings:**

1. Pandey B.P. Plant Anatomy. S. Chand & Company Ltd. New Delhi, India.
2. Sharma O.P. Plant Anatomy. Tata McGraw-Hill Publishing Company Ltd. New Delhi,
3. Cutter, J.D. 1988. Plant Anatomy. Part I &II, Edward Arnold, London.
4. Esau, K. 1977. Anatomy of Seed plants. John Wiley & Sons, U.S.A.
5. Fahn, A. 1982. Plant Anatomy. Pergamon Press U.K.
6. JohanesOn, D.A. 1940. Plant microtechnique - McGraw Hill Book Co., New Delhi.
7. Mauseth, J.D. 1988. Plant Anatomy. The Benjamin/Cumming Pub.,U.SA.
8. Pandey, B.P. 2002. Plant Anatomy. S. Chand & Co., New Delhi.
9. Sass. J.E. 1958. Botanical Microtechnique. Ames, Iowa.

## SEMESTER – IV

### MJD -7: Botany Main Practical -I

(Covering the papers of the Morphology and Taxonomy, Anatomy and Phytopathology)

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MJD-7 | 4 | 0 | 4 | 8 | 50 | 50 |

**Course Objectives:**

- To learn the technical description and assign a systematic position of plant specimen
- To understand the processes of herbarium preparation and economic importance of plant families
- To gain knowledge on plant anatomy and various tissues systems and their role in growth
- To understand the practical knowledge on plant pathology and identification of plant diseases

**Course Outcomes:** On completion of the course, students will be able to

- ✓ Apply the acquired skills to assign the systematic position and identifying of plant specimen
- ✓ Learn the process of the herbarium preparation and document the plants in their locality
- ✓ Analyze how different tissues systems organize in plant system and architecture of plant organs
- ✓ Identify the key symptoms and plant disease and diseases cycles

**Morphology and Taxonomy**

**Unit- 1**

1. Study of inflorescence types, flower and its parts, Floral diagram and floral formula
2. Technical description of dicot families mentioned in syllabus with at least two examples for each family (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification) and identify up to species using the flora.
3. Technical description of monocot families mentioned in syllabus as above

**Unit-2**

1. Identify plants/plant products of economic importance belonging to the families mentioned in the syllabus; with binomial, family and morphology of useful parts.
2. Field visit: Local or outside area / Botanical Garden.
3. Preparation of Herbarium (Preparation of 30 properly identified herbarium specimens; mounting of a properly dried and pressed specimen of any common plants from your locality with herbarium label).
4. Submission: Record book, Tour report, Field Note book and Herbarium

**Anatomy**

**Unit-3**

1. Study of simple tissue: parenchyma, collenchyma, sclerenchyma through slides/Micrographs
2. Study of complex tissues: xylem and Phloem through slides/Micrographs
3. Study of Primary structures of dicot stem----T.S of *Tridax/Helianthus* stem
4. Study of Primary structures monocot stem ----- T.S of *Asparagus/Maize* stem
5. Study of Primary structures Dicot root.----T.S of Bengal gram/black gram roots
6. Study of Primary structures Monocot root---T.S of Canna/Lilly roots

**Unit-4**

1. Study of dicot leaf: T.S of *Mangifera indica* leaf
2. Study of monocot leaf: T.S of Bamboo / *Dracena* leaf
3. Study of Anomalous secondary growth: Nyctanthes, Boerhaavia and Dracaena stem.
4. Study of laticifers, Glandular hair, Oil ducts through slides/micrograph Study of types of stomata: Anomocytic, Anisocytic, Paracytic, Diacytic through Slides/Micrographs

**Phyotopathology**

**Unit-5**

1. Study and identification of pathogen, disease symptoms and host of the following plant diseases:
    a) Mosaic disease of tobacco.
    b) Canker on Citrus plants.
    c) Rust of Wheat
    d) Paddy Blast
    e) Tikka disease
    f) Red rot of sugarcane.

**Bharathidasan Govt. College for Women (Autonomous), Puducherry**
**NEP 2020 B.Sc. Botany (Hons)**
**Main Practical Examination, Semester – IV**
(**Covering the papers of MJD-7: Botany Main Practical-I**)

Paper code: Duration – 3 hrs
Maximum Marks – 50

1. Describe the given specimen A in technical terms. Draw L.S. of flower & CS of Ovary, Floral Diagram. Write the Floral Formula. Identify its Family by enumerating Salient features.
   (Description-2, L.S. of Flower and C.S. of Ovary 2, Floral Diagram and Formula-2, Systematic position & identification-2 marks) (1 x 8 = 8 marks)
2. Make suitable micro-preparation of B. Leave the slide for valuation. Draw and identify giving reasons.
   (Preparation -2, Identification-1, Diagram- 1, Salient features-2) (1 x 6 = 6 marks)
3. Make suitable micro-preparation of C. Leave the slide for valuation. Draw and identify giving reasons.
   (Preparation -2, Identification-1, Diagram- 1, Salient features-2) (1 x 6 = 6 marks)
4. Identify the binomial, family and morphology of the useful part and give the economic importance and uses of D.
   (Binomial-1, Family-1, morphology of useful part-1, Uses-1) (1 x 4 = 4 marks)
5. Identify, draw diagram and write salient features of E, F, G.
   (Identification-1, Diagram-1, Salient features-2) (3 x 4 = 12 marks)

Practical - 36
Herbarium and Field note - 10
Viva voce - 04
**Total 50**

**Key for Practical**

| **Question** | **Experiment / Spotter** |
|---|---|
| **A** | Plant specimen (Taxonomy) |
| **B** | Anatomy – T.S. of / Stem / Leaf |
| **C** | Phytopathology-section |
| **D** | Plant specimen (Economic botany) |
| **E** | Slide/figure: Secondary growth/Anomalous secondary growth |
| **F** | Slide / figure – Simple / Complex Tissues |
| **G** | Phytopathology-spotter |

## SEMESTER-IV

### MID-4: Phytopathology

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MJD-4 | 4 | 4 | 0 | 4 | 75 | 25 |

**Course Objective:**

- To study various symptoms of plant diseases and causative pathogens
- Top learn the host-pathogen interaction and disease resistance mechanisms
- To understand the preventive and control methods for important diseases of crop plants

**Course Outcomes:** Upon completion of the course, students will be able to

- ✓ Understand the different types of disease causing agents and identify plant diseases
- ✓ Gain knowledge on pathogen biology and diseases cycles
- ✓ Develop understanding on concepts of plant disease resistance mechanisms
- ✓ Provide knowledge on different disease controlling methods and measures

**Unit-1**

**Introduction to phytopathology:** Definition, Significance and History of Phytopathology, Brief notes on E.J. Butler and T.S. Sadasivan. Disease triangle- disease development.

**Unit-2**

**Notes on various Symptoms of Plant diseases:** Rots, Rusts, Smuts, Leaf spots, Blights (Leaf blight), Mildews, Cankers and Mosaics.

**Unit-3**

**Detailed study of the following Plant Diseases** (including Symptoms, causative organism, Disease cycle and Control): Tobacco mosaic, Citrus canker, Rust of Wheat, Blast of Rice, Tikka disease of Groundnut, Red rot of Sugarcane.

**Unit-4**

**Disease Resistance in Plants**: Horizontal and Vertical resistance, Structural and Chemical Resistance of Plants to Pathogens, Hypersensitive reaction; Systemic acquired resistance (SAR).

**Unit-5**

**Preventive and Control methods of Plant Diseases:** Quarantine Check, Breeding for Disease Resistance, Chemicals used to control Plant diseases, Biological Control of Plant Diseases. Integrated pest management. \

**Suggested Readings:**

1. Bilgrami, K.S. and Dube, H.C. 1989. A textbook of Modern Plant Pathology. Vikas Publishing House Pvt. Ltd. New Delhi.
2. Rangaswami, G. 1975. Diseased of crop plants in India. Prentice-Hall of India Pvt. Ltd., New Delhi.
3. Mehrotra, R.S. and Ashok Aggarwal. 2006. Plant Pathology. Tata McGraw Hill, New Delhi.
4. Pandey, B.P. 2012. Plant Pathology – Pathogen & Disease. S. Chand & Co.
5. Sambamurty, A.V.S.S. 2006. A Textbook of Plant Pathology. IK International Pvt., New Delhi.
6. Schumann, G.L. and Cleora J. D'Arcy. 2009. Essential Plant Pathology, 2nd Edition. APS Press, USA.
7. Singh, R.S. 2009. Plant Diseases. Oxford & IBH Publishing Company Pvt. Ltd., New Delhi.
8. Singh, R.S. 2010. Introduction to Principles of Plant Pathology. Oxford & IBH Publishing Company Pvt. Ltd., New Delhi.

## SEMESTER-V

### MJD-8: Molecular Biology

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MJD-8 | 4 | 4 | 0 | 5 | 75 | 25 |

**Course Objectives:**

- To learn the molecular processes of cells
- To study about the structure of DNA and RNA and replication of DNA
- To understand the Transcription the protein synthesis and gene regulation

**Course Outcomes:** Upon completion of the course, students will be able to

- ✓ Understand the how cell works at molecular level and fundamentals of molecular machinery that drives life
- ✓ Develop understanding on flow genetic information from DNA to protein to phenotype
- ✓ Improve their concepts of biology and highly useful for the future advanced studies

**Unit-1**

**The Genetic Material:** Nature of genetic material and fine structure of gene. Griffith experiment, transforming principle- Hershey & Chase experiment. RNA as genetic material in TMV. Physical and chemical structure of DNA and RNA- nucleoside and nucleotides. Forms of DNA (B-form, A-form & Z-form). Types of RNA (in Prokaryotes and Eukaryotes).

**Unit-2**

**Replication and Transcription:** Replication of DNA- Meselson & Stahl experiment, semi-conservative, bidirectional, semi continuous model, Transcriptional machinery and key events - RNA polymerase, promoter gene- initiation, elongation and termination. Reverse transcription. Modification and processing of mRNA in eukaryotes.

**Unit-3**

**Protein synthesis and Gene regulation:** Translation- features of genetic code- Wobble hypothesis, role of t-RNA and ribosomes. Initiation, elongation and termination- peptidyl transferase. Regulation of gene expression at transcriptional level. Lac Operon.

**Unit-4**

**Gene mutation:** Types of mutations - addition, deletion, inversion, translocation and substitution. Spontaneous and induced mutations, frame shift, tautomerization, depurination. Mutagens: Physical and chemical mutagens. Consequences of gene mutations in plants.

**Unit-5**

**Concepts on basic techniques of molecular biology**: Polymerase chain reaction (basic PCR only) and its applications. Restriction enzymes - EcoRI. Southern blotting, Northern blotting and Western blotting techniques.

**Suggested Readings:**

1. Verma, P.S. and Agarwal, V.K. 2009. Molecular Biology. S. Chand & Company Ltd., New Delhi.
2. Friefelder, D. 1987. 2nd Ed. Molecular Biology. Narosa Publishing House, New Delhi.
3. Allison, L.A. 2007. Fundamental Molecular Biology. Blackwell Publishing, USA. Brown, T.A. 2001. 4th Ed. Gene cloning and DNA analysis – An Introduction, Blackwell Science, Oxford.
4. Chawla H.C. 2003. Plant Biotechnology- Laboratory Manual for Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
5. De Robertis, E.D.P. and De Robertis (Junior). E.M.F. 1987. Cell and Molecular Biology, Lea and Febiger, Philadelphia.
6. Desmond S.T. Nicholl. 2010. An Introduction to Genetic Engineering. Cambridge University Press, New Delhi.
7. Karp, G. 1988. Cell Biology (2nd ed.). Mc Graw Hill Book Co., New York.
8. Lewin, B. 2004. Genes VIII. Pearson Education, New Jersery.
9. Primrose, S., Twyman, R and Old, B. 2001. 6th Ed. Principles of Gene Manipulation, Blackwell Science, Oxford.
10. Smith- Keatry , P. 1991. Molecular Genetics, Mac Millan Pub. Co. Ltd., London.
11. Sheeler, P. and Bianchi, D.E. 2006. 3rd Ed. Cell and Molecular Biology.Wiley India (P.) Ltd., New Delhi.
12. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. 2004. Molecular Biology of the Gene. Dorling Kindersley Publishing Inc., New Delhi.

## SEMESTER-V

### MJD-9: Plant Biochemistry

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MJD-9 | 4 | 4 | 0 | 5 | 75 | 25 |

**Course Objectives:**

- To understand the structure and properties of various biomolecules
- To study the biochemical process of cells and macromolecular organization
- To learn about the plant metabolism and enzymology

**Course Outcomes:** On completion of the course, students will be able to

- ✓ Understand the key biochemical processes and building blocks of the cell
- ✓ Gain knowledge on Plant biochemical reactions and Plant metabolism
- ✓ Develop concepts on enzyme structure and enzymatic mechanisms
- ✓ Encourage students to undertake research in plant biochemistry

**Unit-1**

**Chemical bonds and biochemical reactions:** Atomic structure and chemical bonding, types of chemical bonding -Ionic and Covalent bond, bond energy, electrostatic force, van der Waals interactions. Bioenergetics: Energy, free energy, laws of thermodynamics, entropy, chemical equilibrium, oxidation-reduction potential. Redox reactions.

.

**Unit-2**

**Carbohydrates:** Classification; Structures, properties and biological functions of monosaccharides, disaccharides and polysaccharides. Biosynthesis of Sucrose and Starch.

**Unit-3**

**Proteins:** Amino Acids – Classification. Protein structure: Primary, Secondary, Tertiary and Quaternary structures. Denaturation & renaturation of Proteins.

**Unit-4**

**Lipids:** Classifications of lipids, physical and chemical properties of fats, structure and functions of saturated and unsaturated fatty acids. Biosynthesis of Saturated fatty acids, Beta oxidation.

**Unit-5**

**Enzymes:** classification, Holoenzymes and Apoenzymes; mechanism of enzyme action, enzyme inhibition. Types of inhibition - Competitive, Non-competitive and Uncompetitive inhibition. Irreversible inhibition, Feedback inhibition, Allosteric inhibition, coenzymes.

**Suggested Reading:**

1. Jain, J.L., Jain, S and Jain, M. 2016. Fundamentals of Biochemistry. S. Chand and Co.
2. Satyanarayana, U and Chakrapani, U. 2017. Essentials of Biochemistry. Books and Allied (P) Ltd.
3. Lehninger,A.L. 1999. 2nd Ed . Biochemistry,. Kalyani Publishers., New Delhi.
4. Jayaraman,J. 1981. Laboratory Manual in Biochemistry. Wiley Eastern Limited, New Delhi.
5. Conn, E.E., Stumpf, P.K., Bryening, G and Doi, R.H. 2001. 5th Ed Outlines of Biochemistry.John Wiley & Sons, New York.
6. 5. Rodwell V.W., Bender D., Botham K.M., Kennelly P.J. and Weil P.A. 2015.Harpers Illustrated Biochemistry (30th ed.). The McGraw-Hill Education. USA.
7. 6. Salisbury F.B. and Ross C.W. 1986. Plant Physiology (3rd ed.). CBS Publishers & Distributors. New Delhi.
8. 7. Taiz L. and Zeiger E. 2010. Plant Physiology (5th ed.). Sinauer Associates Inc. U.S.A.

## SEMESTER-V

### MJD-10: Botany Main Practical -II

(Covering the papers of Molecular Biology, Plant Biochemistry and Plant ecology and Phytogeography)

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MJD-10 | 4 | 0 | 4 | 8 | 50 | 50 |

**Course Objectives:**

- To understand the various biomolecules and their structures and detect the biomolecules in the given samples
- To learn about enzyme activities experimentally and practice the TLC for separation of organic molecules
- To Gain knowledge on fundamental molecular processes of life and learn about the key experiments related to molecular biology
- To learn about plant ecology and phytogeography

**Course Outcomes:** On successful completion of the course, students will be able to

- ✓ Develop a understanding on structural aspects of different biomolecules and their functional role
- ✓ Familiarize with the experimental process on enzyme function and learn the analysis of various biomolecules
- ✓ Acquire knowledge on the how life operates at molecular level
- ✓ Gain understanding on ecological adaptations of plants

**Molecular Biology**

**Unit-1**

1. Identification of figure - DNA replication – Semi conservative method.
2. Identification of figure - Transcription in Protein synthesis.
3. Identification of figure - 70S Ribosomes association.
4. Identification of figure - Translation in Protein synthesis.

**Unit-2**

1. Identification of figure - Griffith Transformation experiment.
2. Isolation of DNA from coconut milk- SSC method (sodium chloride - sodium citrate method).
   b. Isolation of DNA from ripe banana
3. Qualitative detection of DNA by diphenylamine method

4. Extraction of RNA from yeast cells
5. Separation of DNA/RNA by Agarose gel electrophoresis.
6. Staining of nucleic acids in vivo (Geimsa stain).
7. Study of - Southern blotting technique(Photograph)
    b. Study of - Northern blotting technique (Photograph)
    c. Study of - Western blotting technique (Photograph)

**Plant Biochemistry**

**Unit-3**

1. Quantitative estimation of soluble sugars and insoluble starch.
2. Qualitative test of protein by Biuret method
3. Qualitative test of Lipid by Sudan IV or saponification method
4. Unsaturated fatty acid detection by Iodine test
5. Detection of amino acids by ninhydrine reagent
6. Study of Polysaccharides- amylose, amylopectin-Photographs
7. Study of structure of protein – Primary, Secondary: helices, sheet, Quaternary
8. Study of saturated, monounsaturated and unsaturated fatty acids- photographs

**Unit-4**

1. Separation of amino acids and sugars by paper chromatography
2. Separation of Chloroplast pigments using Paper Chromatographic technique
3. To study the Enzyme activity –Amylase,
4. To study the enzyme activity- catalase
5. Studying the Enzyme-substrate complex: Lock and key and Induced fit models-photographs
6. Identification of inhibitory actions: competitive, non-competitive and Un-competitive – using photographs or electronic sources

**Plant Ecology and Phytogeography**

**Unit-5**

1. Study of anatomical adaptions of Xerophyte: (Nerium leaf);
2. Study of anatomical adaptions of Hydrophyte: (Hydrilla stem)
3. Study of morphological adaptations of hydrophytes and xerophytes-specimens or photographs
4. Study of hydroxere and xeroxere –photographs
5. Study of Plant interactions : Root nodules and allelopathy -photographs

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**NEP 2020 B.Sc. Botany (Hons)**
**Main Practical Examination; Semester-V**
**(Covering the papers of MJD-10: Botany Main Practical-II)**

Paper code: Duration – 3 hrs
Maximum Marks - 50

1. Stain the given specimen A. List the materials required, write the procedure and leave the preparation for valuation
   (Preparation-3, Procedure-3,list of materials-1, Diagram-2, Result-2) (1 x 11 =11Marks)
2. Outline the procedure for given experiment B. List the materials required. Set the experiment and Draw the diagram, tabulate the data and report the result, Leave the setup for valuation.
   (Set up-3, Procedure-3, list of materials-1, Diagram-2, Result-2) (1 x 11 = 11 Marks)
3. Make suitable micro-preparation of C. Leave the slide for valuation. Draw and identify giving reasons.
   (Preparation -2, Identification-1, Diagram- 2, Salient features-2) (1 x 7 = 7 Marks)
4. Identify, draw diagram and write salient features of D, E, F.
   (Identification-1, Diagram-2, Salient features-2) (3 x 5 = 15 Marks)

Practical - 44
Viva Voce - 06
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**Total 50**

**Key for Practical**

| **Question** | **Experiment / Spotter** |
|---|---|
| **A** | Molecular Biology – staining DNA |
| **B** | Biochemistry Experiment |
| **C** | Ecology section |
| **D** | Molecular Biology spotter |
| **E** | Biochemistry spotter |
| **F** | Ecology spotter |

## SEMESTER-V

### MID-5: Plant Ecology and Phytogeography

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MID-5 | 4 | 4 | 0 | | 75 | 25 |

**Course objective:**

- To understand the concepts of plants ecology and distribution of plant communities
- To study the effects of environmental factors on plant and their adaptations
- To learn the interactions of plants with biotic and abiotic components in sustain ecosystems

**Course outcome:** after successful completion of the course, students will be able to

- ✓ Understanding the characteristics of different plant communities
- ✓ Knowing the structure and functions of ecosystems
- ✓ Understand the major factors influencing the geographic distribution of species
- ✓ Develop ecological context how plant species adapt and evolve in a ecosystem

**Unit-1**

**Structure of ecosystem**: Ecosystem, Ecology concept and scope; components of ecosystem-Biotic, abiotic; Biosphere-atmosphere, lithosphere and hydrosphere, and their importance, Ecological Levels of organization, types ecosystems-Autoecology, population ecology and Synecology, habitat, range and ecological niche concept and their significances

**Unit-2**

**Plant communities and ecosystem:** Autotrophy-heterotrophy, Producers: Biomass and Productivity; gross primary productivity, net primary productivity, secondary productivity, role of plants in energy and nutrient flow in ecosystem, ecological stratification, Plant community analysis: analytical and synthetic methods, ecotone and edge effect.

**Unit-3**

**Plant communities and environment:** Acclimation and adaptations, concept of phenotype: role of genes and environment, Phenotypic plasticity, Concept of ecotypes and their importance.. Adaptation to water and temperature: hydrophytes and xerophytes and their adaptations (Morpholoical, anatomical and physiological).

**Unit-4**

**Plant communities and interaction**s: Concept of Succession-fire as succession force, Primary and secondary succession; pioneer and climax community; hydroxere and xerosere; ecotypes and their significances; Ecological interactions: Competition and mutualism; Plant-plant interactions: symbiosis, commensalism, Allelopathy and parasitism; Plant–animal interactions: herbivory, pollination-pollinators and Zoochory.

**Unit-5**

**Plant communities distribution:** Concept of phytogeopgraphy, continental drift, global vegetation distribution altitude and latitude, endemism and tolerance, Major biomes of the world, Vegetation types of INDIA, Concept of hotspots- world and Indian biodevrsity hotspots and their significances, enadmic plant species.

**Suggested Readings:**

1. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
3. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A
4. Chapin FS, Matson PA, Mooney HA (2002). Principles of Terrestrial Ecosystem and Ecology. New York, Springer. pp. 362-365.
5. Gary M, Larry N, Richard K, Dennis S, eds. (2013). Ecosystem Management: Adaptive, Community-Based Conservation. Island Press. ISBN 978-1-55963-824-1.
6. Sharma PD (2011) Ecology and Environment. Rastogi publications, Meerut
7. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

## SEMESTER- VI

### MJD-12: Plant Physiology

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MJD-12 | 4 | 4 | 0 | 5 | 75 | 25 |

**Course Objectives:**

- To acquire the fundamental knowledge on various plant physiological processes
- To Understand role of physiological processes in plant functioning
- To understand the key principles of plant physiology behind the plant growth and development

**Course Outcomes**: at the end of course completion, students will be able to

- ✓ Gain a comprehensive understanding of key physiological processes in plants such as photosynthesis, respiration, transpiration, and nutrient uptake, and their regulation
- ✓ Develop the ability to analyse how environment and physiological responses shapes the plant growth and development
- ✓ Get an over view on how different physiological process operates and their role in plant biology
- ✓ Acquire practical skills in conducting experiments and using various techniques to measure and analyze plant physiological parameters

**Unit-1**

**Plant-Water relations:** Importance of water, imbibition, diffusion and osmosis - water absorption and transport – active and passive absorption; Water potential, osmotic potential and pressure potential. Ascent of Sap (Root pressure, capillary transpirational pull) evidences and limitations; Transpiration: types, transpiration significance, mechanism of stomatal movement; guttation.

**Unit-2**

**Plant Mineral Nutrition:** Mineral nutrition – Criteria of essentiality; Role of Major and Minor elements in plant nutrition - deficiency symptoms; Mineral uptake: passive transport-diffusion, facilitated diffusion-carrier based transport, ion exchange theory; Active transport- ATP-Pumps; Nitrogen metabolism: Nitrogen fixation: Symbiotic and asymbiotic fixation.

**Unit-3**

**Photosynthesis:** Photosynthetic apparatus and pigment systems; Absorption and Action spectrum; Red drop and Emerson effect; cyclic and non-cyclic photo phosphorylation. Carbon fixation: $C_3$, $C_4$ and CAM pathway, factors affecting photosynthesis, photorespiration. Source – sink relationship-brief note on phloem transport.

**Unit-4**

**Respiration:** Respiratory substrates, RQ, aerobic respiration, Glycolysis, TCA cycle, Electron transport and oxidative phosphorylation-chemiosmatic theory of ATP synthesis; Pentose phosphate pathway; factors affecting respiration; Anaerobic vs aerobic energy balance; Fermentation.

**Unit-5**

**Plant growth and development:** Phases of growth, factors affecting growth; Plant growth regulators – auxins, gibberellins, cytokinins, abscissic acid and ethylene - their physiological role. Photoperiodism; physiology of flowering; Florien concept; vernalization; Phytochrome. Physiology of senescence; fruit ripening; Physiology of seed germination.

**Suggested Reading:**

1. Jain, V.K. 1988. Fundamentals of Plant Physiology, S.Chand and Co. Ltd.,New Delhi.
2. Mukherji. S. and Ghosh, A.K. 2005. Plant physiology. New Central Book Agency Ltd., Kolkata.
3. Pandey, S.N. and Sinha, B.K. 1989. Plant Physiology, Vikas Publishing House . New Delhi.
4. Noggle G.R.and Fritz, G.J. 1986. 2nd Ed. Introduction to Plant Physiology. PrenticeHall of India Ltd., New Delhi.
5. Gupta, N.K and Gupta, S. 2005. Plant Physiology. Oxford & IBH Publishing Co. Ltd., New Delhi.
6. Sundararajan, S. 2000. Plant Physiology. Anmol Publication Ltd. New Delhi.
7. Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology. Asia Ltd. Singapore.
8. Devlin, R.M. and Witham, F.H. 1986. 4th Ed. Plant Physiology,. CBS Publishing House,. New Delhi.

## SEMESTER- VI

### MJD-13: Genetics and Plant Breeding

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MJD-13 | 4 | 4 | 0 | 5 | 75 | 25 |

**Course Objective:**

- To understand the basic theoretical concepts and techniques of Genetics and Plant breeding
- To study the fundamentals of inheritance, phenotype-genotype concept and role of genes
- To learn the gene and chromosome mutations and consequences

**Course Outcomes: On completion of the course students will be able to**

- ✓ Gain knowledge on fundamentals of genetics and various inheritance modes
- ✓ Develop the conceptual understanding of genetic mutations and the inheritable diseases
- ✓ Understand the laws of inheritance and how one can use these laws to make a better hybrid plant through the breeding programme.
- ✓ Acquire the basic knowledge on two essential subjects genetics and breeding

**Unit-1**

**Laws of inheritance:** Mendelian and Non-Mendelian inheritance – Laws of Mendel, Mendel's experiments – reciprocal cross, Monohybrid Cross, Dihybrid cross, back cross, test cross. Gene Interactions - Codominance, Incomplete dominance, Lethal genes, Complementary, Supplementary, Inhibitory and Duplicate gene interaction, pleiotropy, polygenic inheritance. Gene environment Effects – Expressivity & Penetrance. Multiple alleles in plants (self incompatibility).

**Unit-2**

**Linkage and Crossing over**: Linkage Group – complete linkage, incomplete linkage, coupling phase and repulsion phase. Crossing Over – cytological basis of crossing over. Chromosome mapping - two and three point test crosses and their significance.

**Unit-3**

**Sex determination** - Chromosomal basis of sex determination – XX-XY, XX-XO and ZZ-ZW method, Sex chromosome in Melandrium, Genetic basis of Sex determination, Sex-linked inheritance in man (haemophilia). Maternal inheritance in snails and Paramecium; cytoplasmic inheritance in Mirabilis (Plastids). Cytoplasmic male sterility in Maize.

**Unit-4**

**Mutations:** Chromosomal mutation - Variation in Chromosomal Structure – Deletion, Duplication, Inversion and Translocation – behavior of chromosome during cell division and their consequences. Variation in Chromosomal Number – Aneuploidy and Euploidy (Polyploidy) – autopolyploidy and allopolyploidy in plants. Transposable Elements of Maize and evolutionary significance. Population genetics – Genotype frequencies, Allelic frequencies, Hardy-Weinberg law and equilibrium.

**Unit-5**

**Plant Breeding** – Aims and objectives. Mode of reproduction in relation to breeding methods – vegetative (natural and artificial) and sexual. Methods of crop improvement- Selection- Mass, pure-line and clonal; hybridization in self and cross - pollinated crops; heterosis; plant introduction and acclimatization; mutation breeding.

**Suggested Reading:**

1. Gardener, J., Simmons, H.J. and Snustad, D.P. 2006. Principle of Genetics, John Wiley & Sons, New York.
2. Chaudhuri, H.K. 1994. Elementary principles of Plant Breeding. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Singh, B.D. 1990. Fundamentals of Genetics. Kalyani Publishers, New Delhi.
4. Tamarin, R.H. 2007. Principles of Genetics. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
5. Ursula Goodenough. Genetics. Saunders college Publishing Co., Philadelphia, USA
6. Sharma, J.R. 1996. Principles and Practices of Plant Breeding. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
7. Singh, B.D. 2007. Plant Breeding – Principles and Methods. Kalyani Publishers, New Delhi.
8. Shella, V.L. 2011. Horticulture. MJP Publishers, Chennai.

## SEMESTER- VI

### MJD – 14: Plant Biotechnology

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MJD-14 | 4 | 4 | 0 | 6 | 75 | 25 |

**Course Objectives:**

- To familiarize the students with the basic principles and techniques in plant tissue culture.
- To impart knowledge on the production of transgenic plants and their safe handling and maintenance.
- To study the basics of rDNA technology and tools

**Course Outcomes:**

- ✓ This paper introduces the students to the concepts of the plant Biotechnology
- ✓ Familiarise with the techniques of plant tissue culture and applications of plant tissue cultures
- ✓ Learn the various tools and techniques of genetic engineering and cloning process
- ✓ Develop understanding on biotechnology tools and their use for human welfare and commercial value.

**Unit-1**

**Introduction to tissue culture:** Significance of biotechnology. Plant tissue culture: Definition, History of Plant Tissue Culture (PTC). Sterilization procedures for tissue culture. Cellular differentiation and redifferentiation, totipotency. Outlines on PTC media- (MS medium in detail). Plant growth regulators.

**Unit-2**

**Types of PTC:** Callus culture and cell suspension culture. Direct and indirect organogenesis. Somaclonal variations and their uses in agriculture. Virus free plant production through meristem culture. Micropropagation (using axillary and apical bud cultures). Anther and pollen cultures.

**Unit-3**

**Applications of PTC:** Protoplast isolation and culture. Somatic hybridization. - selection of somatic hybrids and cybrids. Somatic embryogenesis- artificial seed production. Basics of Secondary metabolite production - Production of Shikonin from Lithospermum erythrorhizon

**Unit-4**

**Principles and tools of genetic engineering:** Restriction enzymes- Type II endonucleases. Nomenclature of type II restriction endonucleases. DNA Ligases and polymerases. Cloning Vectors - pBR322, Cosmids, Fosmid, BAC, Yeast artificial chromosome, Agrobacterium-mediated gene transfer.

**Unit-5**

**Gene delivery systems**: Plant Viruses, Particle gun bombardment, Microinjection, Electroporation. Concepts on Microarray. Introduction to molecular markers. Production of transgenic plants (insect resistant plant -Bt gene). Principles behind the production of Golden rice. Plantibodies and edible vaccines.

**Suggested Reading:**

1. Dubey R.C. A Textbook of Biotechnology. S. Chand & Company Ltd. New Delhi, India.
2. Purohit S.S. Plant tissue culture. Shyam Printing Press. Jodhpur, India.
3. Das H.K. 2010.Textbook of Biotechnology (4th Edition). Wiley India Pvt Ltd., New Delhi.
4. Satyanarayana, U. 2010. Biotechnology. Uppala Author Publisher interlinks, (A.P.)
5. Chawla H.C. 2003. Plant Biotechnology- Laboratory Manual for Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
6. Desmond S.T. Nicholl. 2010. An Introduction to Genetic Engineering. Cambridge University Press, New Delhi.
7. Gupta, P.K. 2000. Elements of Biotechnology. Rastogi Publications, Meerut.
   Ignacimuthu, S. 2003.
8. Kumaresan V. 2010. Biotechnology. Saras Publication. Nagercoil, Tamil Nadu.
9. Prakash, J. and Pierik R.L.M. 1993. Plant Biotechnology- Commercial prospects and Problems. Science Publishers, Inc., U.S.A.
10. Primrose, S., Twyman, R. and Old, B. 2001. Principles of Gene Manipulation ($6^{th}$ Ed.). Blackwell Science, Oxford.

## SEMESTER- VI

### MJD-15: Botany Main Practical-III

(Covering the papers of Plant Physiology, Genetics and Plant breeding, Tissue culture and Biotechnology and Evolution and Plant biology)

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MJD-15 | 4 | 0 | 4 | 8 | 50 | 50 |

**Course Objectives:**

- To provide experimental skills in plant physiology and studying the different physiological processes and their measurements
- To learn the solving of problems related chromosome mapping crossing over and gene frequencies
- To understand the methods of tissue culture and their applications

**Course Outcomes**: upon completion of the course students will be able to

- ✓ Acquire the experimental knowledge on plant physiology and taking the measurements
- ✓ Learn the problem solving skills in genetics and chromosome mapping
- ✓ Familiarize with the experimental aspects of plant tissue culture tools and techniques
- ✓ Analyze various rDNA technology tools and their applications

**Plant Physiology**

**Unit-1**

1. Determination of Osmotic potential by plasmolytic method.
2. Study of process of imbibition in seeds.
3. Determination of water potential by gravimetric method.
4. Microscopic Observation of stomata opening and closing
5. Study of Membrane permeability.

**Unit-2**

6. Effect of light intensity on photosynthesis
7. Effect of monochromatic light on photosynthesis
8. To determine rate of photosynthesis under variable carbon dioxide concentration.
9. Separation of Chloroplast pigments using Paper Chromatographic technique.
10. To compare the rate of respiration of various plant parts.
11. Differentiation of C3 and C4 plants by starch test.
12. Demonstration of fermentation using Kuhne's flask

**Plant Biotechnology**

**Unit-3**

1. Study of secondary metabolites production.
2. MS medium preparation and sterilization.
3. Callus culture- demonstration, Anther, Ovary culture.
4. Solving the problems related to gene manipulation (restriction enzyme recognition sites).
5. Micro propagation (axillary bud or terminal bud).
6. Protoplast isolation and culture.
7. Identification of figures/slides pertaining to chapters mentioned in the theory.

**Unit-4**

**Genetics and Plant Breeding**

1. Training in solving problems as mentioned in the syllabus
2. Study of numerical and structural variations of chromosomes from figures and charts.
3. Identification of genetic disorder from photographs.
4. Mapping of chromosomes with suggested data.
5. Demonstration of hybridization techniques—emasculation and bagging of flowers, pollinating them manually.
6. Testing of seeds for viability and germination.

**Evolution and Plant Biology**

**Unit-5**

1. Study of anoxygenic and oxygenic photosynthesis-Photographs/figures
2. Study of the origin of chloroplasts and Evolution of photosynthetic organisms (endosymbiotic theory)- Photographs
3. Study of Early vascular plants: Stelar evolution- photographs/figures
4. Study of evolution of heterospory, seed habit and evolution of seed- photographs/figures
5. Study of Coevolution of pollinator-floral characters (fig-wasp, yucca-yucca moth, hummingbird- tubular flowers)- Photographs/figures
6. Study of Antagonism: Plant defence-herbivory- Photographs/figures

**Bharathidasan Govt. College for Women (Autonomous), Puducherry**
**NEP 2020 B.Sc. Botany (Hons)**
**Main Practical Examination, Semester- VI**
(**Covering the Papers of MJD-15: Botany Main Practical-III**)

Paper code: Duration – 3 hrs
Maximum Marks - 50

1. Outline the procedure for given experiment A. List the materials required. Set the experiment and Draw the diagram, Tabulate the data and report the result. Leave the setup for valuation. (1 x 12 = 12 Marks)
   (Set up -3, Procedure -3, list of materials-1, Diagram/ Graph- 2, Tabulation – 2, Result-1)
2. Write on the procedure and application of setup B. (1 x 10 = 10 Marks)
   (Identification-1, List of materials-1, Procedure-4, Diagram-2, Applications-2)
3. Solve the problem C. (Calculation-5, Diagram / Graph-2) ( 1 x 10 = 10 Marks)
4. Identify, draw diagram and write salient features of D, E, F.
   (Identification-1, Diagram-1, Salient features-2) (3 x 4 = 12 Marks)

Practical - 44
Viva voce - 06
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**Total 50**

**Key for Practical**

| Question | Experiment / Spotter |
|---|---|
| **A** | Physiology experiment |
| **B** | Tissue culture and Biotechnology experiment |
| **C** | Genetics Problem /Genetic mapping |
| **D** | Plant Physiology spotter |
| **E** | Tissue culture and Biotechnology experiment spotter |
| **F** | Evolution and Plant Biology spotter |

## SEMESTER- VI

### MID-6: Evolution and Plant Biology

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MID-6 | 4 | 4 | 0 | | 75 | 25 |

**Course Objectives:**

- To study the fundamental of evolution and introduces the core concepts on origin of life and Evolution for life forms, and various theories of evolution.
- To Imparts knowledge on origin of plants and their evolution and role of evolutionary forces in shaping plant life.

**Course Outcomes:** At the end of this course, the students will be able to:

- ✓ Understand the essential theories of evolution
- ✓ Differentiate between micro and macroevolution and the forces shaping evolution
- ✓ Learn about origin of photosynthesis, phototrophic organisms and evolution of plants
- ✓ Analyse how evolutionary forces shape the plant adaptations and provide survival advantage

**Unit-1**

**Concepts of Evolution:** meaning; Origin of Life: pre-biotic conditions and events; Theory of biochemical evolution: origin of macro-molecules, Oparin's bubble hypothesis- Uery-Miller experiment; Biological evolution of Life: Proto-cell models (coacervates and proteinoid microspheres). Evolution of prokaryotes and eukaryotes.

**Unit-2**

**Evolutionary theories and forces:** Theories of Evolution: Lamarkism. Darwinism, and neodarwinism; Evidence of evolution: palaeontological, biogeographical, Anatomical: Convergence and divergence, (analogy and homology) vestigial and Embryological. Evolutionary forces: Concept of natural selection, variations: mutations, gene flow-genetic shuffling- role in evolution, Hardy Weinberg equilibrium; Founder effect.

**Unit-3**

**Evolution and speciation:** Concept of Micro-evolution: drug resistance; Macroevolution: Adaptive radiation in Darwin's Finches. Macroevolution and the biological diversity of plants; Concept of biological speciation; Brief mechanisms of speciation (geographical, reproductive isolation); Mode of speciation: allowpatric, sympatric and paripatric speciation.

**Unit-4**

**Origin and evolution of Plants:** The evolution of photosynthesis: (anoxygenic and oxygenic photosynthesis); the origin of chloroplasts and Evolution of photosynthetic organisms (endosymbiotic theory),. The main lines of plant evolution: from algae to angiosperms; Early vascular plants: Stelar evolution; evolution of heterospory, seed habit and evolution of seed.

**Unit -5**

**Plant Evolutionary Adaptations:** Convergent evolution in plants (Cacti and euphorbs, Carnivorous plants); Divergent evolution in plants (morphological adaptations); Co-evolution in plants- Mutualism: Legume–Rhizobium, Coevolution of pollinator-floral characters (fig-wasp, hummingbird- tubular flowers); Antagonism: Plant defence-herbivory: Evolution of mechanical and chemical defence (secondary metabolites).

**Suggested Readings:**

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1. Mark Ridley (2003) Evolution (3rd edition), Blackwell.
2. Rosenbaum, P.E. (2010). Volpe's Understanding Evolution. McGraw-Hill, New York.
3. Futuyma, Douglas and Mark, Kirkpatrick (2017) 3rd Ed. Evolutionary Biology, Oxford University Press.
4. Zimmer C. and Emlen D. J., (2013) 1stEd. Evolution: Making Sense of Life, Roberts & Co.
5. Willis, KJ & McElwain, JC 2002. The Evolution of Plants. Oxford University Press, Oxford
6. Kenrick, Paul, and Peter R. Crane. "The origin and early evolution of plants on land." Nature 389.6646 (1997): 33-39.
7. Bell, P., & Hemsley, A. R. (2000). Green Plants : Their Origin and Diversity. Cambridge, UK: Cambridge University Press.
8. Henry, R. J. (2004). Plant Diversity and Evolution : Genotypic and Phenotypic Variation in Higher Plants. Wallingford, Oxon, GBR
9. Douglas J. Futuyma (1998). Evolutionary Biology (3rd Edition), Sinauer Associates

## SEMESTER-VII

### MJD-16: Microbiology

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MJD-16 | 4 | 4 | 0 | 5 | 75 | 25 |

**Course Objectives:**

- To study the microbial diversity general characters and microbial classification
- To understand the Structure, growth, cellular function and reproduction of different microorganisms
- To learn the microbiological techniques and applications of microbiology

**Course Outcomes:** Upon completion of the course, students will be able to

- Familiarize with diversity of microbial world and their classification
- Develop understanding on structural diversity of microorganism and their reproductive modes
- Gain knowledge on different microbiological techniques, tools and their applications
- Analyse the role of microorganisms in ecological and economic context

**Unit-1**

**Introduction to microbiology:** Major advancement in the field of microbiology; Whittaker's Five Kingdom concept; three domains of life (rRNA based); General characters of bacteria and Archaea, eukaryotic microbes; Introduction to virus and classification of viruses (Baltimore); Bacterial taxonomy: Classical Taxonomy and Molecular Taxonomy, brief note on bacterial systematics (16S rRNA-based).

**Unit-2**

**Microbial cell structure:** Ultrastructure of prokaryotic cell (*E.coli and bacillus*), bacterial Cell wall: gram-positive and negative bacteria; Inclusion bodies (PHAs glycogen, polyphosphates); Fine structure of Mycoplasmas; Structure of viruses: DNA virus(T4 phage), RNA virus(TMV), Enveloped virus(Influenza A); Brief note on viroids and prions.

**Unit-3**

**Microbial growth and Reproduction: N**utritional types (based on carbon, energy, electron donor); Microbial growth factors; Reproduction of bacteria: fission, fragmentation, brief note on Endospore; Recombination in bacteria (Transformation, Conjugation and Transduction); Extra chromosomal DNA (plasmid only) and antibiotic resistance. Brief note on reproduction in virus (T4 phage): lytic and lysogenic cycles.

**Unit-4**

**Microbial culture techniques:** Growth curve (sigmoidal), growth Kinetics; Batch and continuous cultures; Microbial culture media: simple vs complex, selective vs differential media, broth and solid media; Sterilization Methods; Pure culture techniques: serial dilution, plating (spread, pour plate) and streaking; Preservation of microbial cultures; Staining: Simple staining and differential staining (Gram staining).

**Unit-5**

**Applied Microbiology:** Application of microbes in agriculture: bio fertilizer, biocontroling agents with suitable examples), Industrial microbiology: alcoholic beverages (alcohol and wine), antibiotics (Penicillin and Streptomycin), and organic acids (vinegar) production. Brief notes on microbial bioremediation and microbial spoilage of food. Microbial growth control: disinfectant, antiseptic and antibiotics (their types and mode of action)

**Suggested Reading:**

1. Pelczar, M.J., Chan, E.C.S. and Krieg, N.R. 1993. Microbiology – Concepts and Applications, McGraw-Hill, New York.
2. Atlas, R.M. 1986. Basic and Practical Microbiology. Macmillan Publishing Company, New York.
3. Ananthanarayan, R and C.K. Jayaram Paniker.1996. Text book of Microbiology. Orient Longman, Hyderabad.
4. Casida, L.E. JR. 2010. Industrial Microbiology. New Age International Publishers, New Delhi.
5. Das H.K. 2010.Textbook of Biotechnology (4th Edition). Wiley India Pvt Ltd., New Delhi.
6. Prescott, L.M., Harley, J.P.and Klein, D.A. 2002. Microbiology. McGraw-Hill Co., New York.
7. Aneja,K.R. 1993. Experiments in Microbiology, Plant Pathology and Tissue Culture. Wishwa Publication, New Delhi.
8. Dubey, R.C. and Maheswari, D.K. 2010. A Text Book of Microbiology. S. Chand Co., New Delhi.
9. Fiedler P.L and Kareiva, P.M. (1997) Conservation biology Chapman and Hall International Thompson Publishing.USA
10. Gabriel M. (2000) Biodiversity and conservation Oxford and IBH publishing company Pvt Ltd. New Delhi.

## SEMESTER-VII

### MJD-17: Medicinal Botany

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MJD-17 | 4 | 4 | 0 | 5 | 75 | 25 |

**Course Objectives:**

- To enrich the knowledge on traditional medicinal systems as well as rich herbal diversity of our region.
- To identify medicinal taxa and learn their chemical constituents
- To acquire knowledge on herbal drugs.

**Course Outcomes:** after the completion of the course students will be able to

- ✓ Gain conceptual knowledge on traditional medicinal systems and medicinal importance of plants.
- ✓ Develop understanding on key medicinal taxa and their cultivation process
- ✓ Acquire knowledge on chemically diversity of active principles and their uses
- ✓ Understand the various commercial plant based drugs and their sources
- ✓ This course is highly relevant in the current alternative plant-based medicines and students gets opportunity to learn this concepts through this course.

**Unit-1**

**Traditional medicinal systems:** Introduction, historical background of medicinal botany. Folk medicine, a brief outline on traditional systems of medicine – Ayurvedha, Siddha, Unani and Homeopathy. Ethnobotany. Present status of medicinal botany.

**Unit-2**

**Pharmacognosy:** crude drug classification, drug adulterations and substitutions, evaluation of drugs by morphological, microscopic and chemical methods.

**Unit-3**

**Plant products of medical importance**: source, description of the products, chemical constituents, active principles and therapeutic uses of the following.

| | | |
|---|---|---|
| i) | Carbohydrates | Ispaghula (*Plantago ovata*), Agar |
| ii) | Glycosides | Senna (*Cassia sp*), *Digitalis and Glycyrrhiza* |
| iii) | Tannins | Acacia, Myrobalan (*Terminalia chebula*) |
| iv) | Fixed oils | Ground nut oil (*Arachis hypogaea*), Castor oil (*Ricinus communis*) |
| v) | Volatile oils | Eucalyptus, Clove, Lemon and Ocimum |
| vi) | Resins | Asafoetida and Pinus |
| vii) | Alkaloids | Rauvolfia, Atropa and Opium |
| viii) | Steroids | Solanum, Dioscorea |

**Unit -4**

**Toxins of plant origin:** Allergens, Teratogens and hallucinogens from hemp. Poisonous plants (*Thevetia Peruviana and Strychnos nux-vomica*) Types of plant poison, action of poisons, treatments. Kasayam and Churnam.

**Unit-5**

**Cultivation of medicinal plants:** *Cassia senna, Coleus forskolii, Ocimum basilicum, Phyllanthus amarus and Aloe vera*. Marketing of medicinal plant products.

**Suggested Reading:**

1. Kokate, C.K, Purohit, A.P and Gokhale, S.B. 1998. A Textbook of Pharmacognosy. Nirali Prakasan, Pune.
2. Trease, G.E. 1952. A Text book of Pharmacognosy. Bailliere Tindal & Cox, London.
3. Jain, S.K. (ed) 1981 Glimpses of Indian Ethnobotany- Oxford & IBH Publishing Co., New Delhi.
4. Jain, S.K. and Mudgal, V. 1999. A Handbook of Ethnobotany. Bishen Singh Mahendra Pal Singh, Dehradun.
5. Joshi, S.G. 2000 Medicinal plants. Oxford & IBH Publishing Co., New Delhi.
6. Rastogi, R.R. and B.N. Mehrotra. 1993. Compendium of Indian Medicinal Plants. Vol. I & II. CSIR, Publication and Information Directorate, New Delhi.
7. Wallis, T.E. 1960. Text book of Pharmacognosy. J & A Churchill Ltd, London.
8. Iyengar, M.A. 1974. Pharmacognosy of Powdered Crude Drugs. Manipal.
9. Iyengar, M.A. 1975. Anatomy of Crude Drugs. Manipal.
10. Satyavati, G.V., Raina, M.K and Sharma, M. 1976. (Eds.) Medicinal Plants of India. Vols. 1 & 2, ICMR, New Delhi.
11. Bhattacharjee, S.K. 1998. Handbook of Medicinal Plants. Pointer Publishers, Jaipur.
12. Chopra, R.N., Nayar, S.L. and Chopra, I.C. 1956. Glossary of Indian Medical Plants. C.S.I.R, New Delhi.

## SEMESTER-VII

### MJD – 18: Botany Main Practical-IV

(Covering the papers of Microbiology, Medicinal Botany, Bioanalytical techniques Plant Genetic Resources and Intellectual Property Rights)

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MJD-18 | 4 | 0 | 4 | 8 | 75 | 25 |

**Course Objectives:**

- To impart experimental skills set in the field of microbiology, medicinal botany bioanalytical techniques
- To learn the experimental procedures, results observation and analysis of the results in relevant course

**Course Outcomes:** after the completion of the course students will be able to

- ✓ Develop the skills to perfume the microbiological experiments and analyze the results
- ✓ Get exposure to the various techniques of microbiology
- ✓ Understand the different sources of plant based drugs their uses
- ✓ Gain knowledge on diversity of medicinal plants their active principles
- ✓ Acquire knowledge on various bioanalytical tools and their applications

**Suggested Laboratory Exercises**

**Microbiology**

**Unit-1**

1. Study of important microbiological tools (Laminar Air Flow Chamber, Autoclave, Inoculation needle and loop, Inoculation hood, Hot air oven etc.).
2. Study of Gram staining
3. Preparation of medium
4. Study of bacterial growth
5. Serial dilution method – isolation of microbes from soil.
6. Demonstration spread plate and streaking for pure culture isolation

**Unit-2**

7. Inoculation, incubation of *E coli* /*Bacillus*/Fungi and study of cultural characteristics.
8. Anti-microbial sensitivity test-demonstration
9. Preparation of agar slants, inoculation, incubation and preservation.
10. Study of microbial products (antibiotics)
11. Study of microbial products (Organic Acids)

**Medicinal Botany**

**Unit-3**

1. Morphological studies of plant parts used as drugs (for plants included in the syllabus).
2. Anatomical studies of plant parts used as drugs (for plants included in the syllabus).
3. To visit the medicinal plant nurseries.
4. To collect locally available medicinal plants.
5. Study of harvesting, drying, grading and processing techniques.
6. Identification of crude drugs by histochemical methods
7. Identification of crude drugs by phytochemical methods.
8. Identification of drug adulterants.

**Bioanalytical Techniques**

**Unit-4**

1. To study and identify different types of Microscopes. Figures / Photos
2. To study the preparation of standard curve for estimating concentration of protein / sugar/ DNA through Calorimeter / Spectrophotometer
3. Determination of lambda max using UV Spectrophotometer
4. Demonstration of different types of Chromatographies. Videos/ Photos / Demonstration.
5. To study SDS-PAGE, Agarose Gel Electrophoresis. Videos/ Photos / Demonstration.
6. To study different types of Laminar Air flow Cabinets. Videos/ Photos / Demonstration.
7. To study and identify different types of Centrifuge. Figure / Diagrams
8. To study detection and measurement of radioactivity. Videos/ Photos .
9. To study and identify Autoradiography technique. Videos/ Photos.

**Plant Genetic Resources and IPR**

**Unit-5**

1. Study of genetic variations in crop plants: Indian Rice / Mango germplasm
2. Study of In situ Conservation: Gene sanctuaries (Garo Hills of Meghalaya), and biosphere reserves of India
3. Study of Ex situ Conservation: Seed banks of India (Indian Seed Vault, Ladakh)
4. Study of Field gene banks, Cryopreservation
5. Study plant related patents with suitable examples
6. Studying trademarks related to plants with suitable examples
7. Study of Geographical Indicators: Malabar pepper, Basmati rice, Darjeeling Tea,
8. Study of Biopiracy- classical case Neem, Turmeric

**Bharathidasan Govt. College for Women (Autonomous), Puducherry**
**NEP 2020 B.Sc. Botany (Hons)**
**Main Practical Examination, Semester – VII**
**(Covering the Papers of MJD-18: Botany Main Practical -IV)**

Paper code: Duration: 3 hrs
Maximum Marks: 50

1. Stain the specimen A with Gram stain. Identify and draw. Write the staining procedure and leave the slide for valuation.
   (Preparation-3, Procedure-3, Diagram-1, Identification- 1) (1 x 8 = 8 Marks)
2. Identify the Active principle of a given sample B. (1 x 8 = 8 Marks)
   (Preparation-2, Procedure-3, Diagram-2, Identification-1)
3. Comment on the given setup C, draw diagram and write notes.
   (Identification-2, Diagram-2, Notes-4) (1 x 8= 8 Marks)
4. Draw and write critical comments on D, E, F & G
   (Identification-1, Diagram-1, Salient features-3) (4 x 5 = 20 Marks)

Practical - 44
Viva voce - 06
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Total 50

**Key for Practical**

| Question | Experiment / Spotter |
|---|---|
| **A** | Microbiology –Gram staining |
| **B** | Medicinal Botany - phytochemical test |
| **C** | Bio analytical Techniques setup |
| **D** | Microbiology spotter |
| **E** | Medicinal Botany spotter |
| **F** | Bio analytical Techniques spotter |
| **G** | Plant Genetic Resources and IPR |

## SEMESTER-VII

### MID-7: Bio-Analytical Techniques

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MID-7 | 4 | 4 | 0 | 6 | 75 | 25 |

**Course Objective:**

- To understand the principle, working and applications of analytical tools used in biology

**Course Outcomes**

- ✓ Through this course students will learn the application of various analytical tools and techniques employed in the field of biology.
- ✓ Course will impart the principles of analytical tools and their real-life applications
- ✓ This course will improve the knowledge of students in advanced analytical tools and improves their prospects in future career.

**Unit-1**

**Microscopy:** Principle, construction and applications of simple, compound and light and dark field, Fluorescent microscopy; electron microscopes (SEM and TEM), Micrometry. Brief notes on Phase contrast microscopy.

**Unit-2**

**Spectroscopy and Chromatography:** Principle, usage and applications of spectrophotometry – UV, visible and IR; Chromatography- principle, working and applications, paper, column, TLC, HPLC. Gel electrophoresis- Protein separation – SDS-PAGE; Nucleic acid separation - Agarose gel electrophoresis. Blotting techniques.

**Unit-3**

Principles and applications of pH meter, Good buffers (Phosphate buffer). Autoclave, Laminar air flow chamber – Principles and applications.

**Unit-4**

**Centrifugation:** Ultra centrifuge, density gradient – principle, working and applications. Dialysis, Ultrafiltration, Lyophilization. Centrifugal vacum concentration.

**Unit-5**

**Radio isotopic techniques:** Radioisotopes – alpha, beta and gamma rays, half-life period. Detection and measurement of radioactivity – Geiger Muller counter, Liquid Scintillation counting, Autoradiography.

**Suggesting Readings:**

1. Bajpai, P.K. 2006. Biological Instrumentation and Methodology. S. Chank and Co. Ltd., New Delhi.
2. Chawla H.C. 2003. Plant Biotechnology- Laboratory Manual for Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Pelczar, M.J., Chan, E.C.S and Krieg, N.R. 1993. Microbiology – Concepts and Applications, McGraw-Hill, New York.
4. Skoog, D.A. 1985. Principles of instrumental analysis. Saunders College Pub., Oxford.
5. Sass, J.E. 1958. Botanical Microtechnique. State College Press, Amer, IOWA.
6. Wilson, K. and Walker, J. 2010. 7th Ed. Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press, Cambridge

## SEMESTER-VII

### MID-8: Plant Genetic Resources and Intellectual Property Rights

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MJD-18 | 4 | 4 | 0 | 6 | 75 | 25 |

**Course Objectives**:

- To understand the concepts of plant genetic resources and importance of genetic resources for human welfare
- To learn the different methods of conservation of plant genetic resources and global, national efforts on conservation
- To gain knowledge on fundamentals of intellectual property rights, types, objectives and laws on IPR.
- To familiarize with IPR protection in context of Biological innovations and moral issues on IPR

**Course Outcomes**: On successful completion of the course students will be able to

- ✓ Develop overview on plant genetic resources and their role in human welfare
- ✓ Analyze various methods of conserving PGR and their advantages and limitations
- ✓ Familiarize with need for conservation of PGR and global and national efforts of conservation
- ✓ Acquire knowledge on various aspects of IPR and patenting biotechnological innovations and concerns

**Unit-1**

**Concepts of Plant Genetic Resources :** Plant genetic resources (PGR): Definition and scope; Vavilov's concept for the Origin of cultivated plants; Major centres of origin and diversity; Primary and Secondary Centres of Origin; Harlan's concept of gene pools; Plant domestication; Concept of germplasm and its types; Genetic variability-its significance.

**Unit-2**

**Plant Genetic Resources Utilization:** Land races and wild relatives; Genetic resources role in plant breeding and crop improvement; PGR for food security and nutrition, medicinal value- ethnobotanical knowledge; PGR: bioprospecting and biotechnological applications; PGR and their ecosystem services; International Treaties and Conventions (CBD, ITPGRFA) on PGR; National and international centres of PGR (Outline).

**Unit-3**

**Plant Genetic Resource Management:** collection, maintenance, evaluation, and documentation; Reasons for conserving PGR- Genetic vulnerability, Genetic erosion; Methods for conserving PGR: In situ and Ex situ Conservation advantages and limitations; In situ Conservation: Gene sanctuaries, botanical gardens, biosphere reserves, national parks, on farm conservation; Ex situ Conservation: Seed banks, Field gene banks, *In vitro* banks, cryopreservation and DNA libraries (DNA banks);

**Unit-4**

**Concepts of IPR:** Introduction to intellectual property right (IPR): Concept and types, and importance; Patents: Objectives, Rights, Patent Act 1970 and its amendments; Procedure of obtaining patents, Working of patents and Infringement; Copyrights Introduction: Works protected under copyright law, Transfer of Copyright, and Infringement; Trademarks: Objectives, Types and Rights; Concept of Geographical Indications.

**Unit-5**

**IPR and biology:** Concept of Traditional Knowledge: its protection, Objectives, Knowledge-Holders; Issues concerning: Bio-Prospecting and Bio-Piracy; Plant Varieties Protection-Objectives, Justification, Rights of farmers, Breeders and Researchers, UPOV, DUS; Farmers' Rights Act, 2001. Patenting Biotech Inventions: Objective, Applications, Concept of Novelty; Moral Issues in patenting biotechnological inventions.

**Suggested Readings**:

1. Dr. Amit Kumar, Dr. Anubha Sharma, Dr. Upendra Kumar Balyan, Dr. Tejbir Singh Dhak (2024). Economic Botany and Plant Genetic Resources at a glance. Sharma Publisheres and D
2. B. P. Singh, Umesh Srivastava, (2004). Plant Genetic Resources in Indian Perspective: Theory and Practices. Indian Council of Agricultural Research, INDIA.
3. Binay B. Mandal (2022).Plant Genetic Resources Conservation and Management. IK International Pvt. Ltd. INDIA
4. FAO (2010). The Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture. Rome ( eBook: https://www.fao.org/4/i1500e/i1500e.pdf )

5. Salgotra, R.K.; Chauhan, B.S. (2023; Review article). Genetic Diversity, Conservation, and Utilization of Plant Genetic Resources. *Genes* 2023, *14*, 174. https://doi.org/10.3390/genes14010174
6. 1. N.K. Acharya: Textbook on intellectual property rights, Asia Law House (2001).
7. Manjula Guru & M.B. Rao, Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications (2003).
8. P. Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill (2001).
9. Arthur Raphael Miller, Micheal H.Davis; Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers (2000).
10. Jayashree Watal, Intellectual property rights in the WTO and developing countries, Oxford University Press, Oxford.

## SEMESTER-VIII

### MJD-19: Economic Botany

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MJD-19 | 4 | 4 | 0 | 5 | 75 | 25 |

**Course Objectives:**

- To understand the plant diversity catering to the various needs of human society.
- To learn the origin, evolution, morphology and cultivation of economically important plants.
- To gain knowledge on plant based products their role in human nutrition and their economic importance.
- To impart knowledge on importance of different plant resources and their role in world economy and food security and need for protecting the plant diversity

**Course Outcomes:** On completion of the course students will be able to

- ✓ Gain knowledge a comprehensive understanding of diverse plant resources and their role in shaping the human society.
- ✓ Understand the cultivation processes, biochemical composition, nutritive values of plant based products and various applications of plant resources in daily life.
- ✓ Familiarise with taxonomic affiliation of economically important plants, morphology of useful plant parts and processing methods.
- ✓ Analyse on the role of plant resources as food, fodder, Fiber, fuel and medicine and their role in global economy and food security under backdrop of climate change.

**Unit-1**

**Origin of cereal and their economy:** Domestication of plants, evolution of farming and its role in development of human civilization; Cereals: Origin, Evolution, Morphology, Production, and Economic Importance of Wheat (hexaploid) and Rice; Maize (Origin and economic importance); Millets: Origin, diversity, nutrition and their role in global food security.

**Unit-2**

**Legumes and economic importance :** General account (Nutritive Value of Pulses, Protein Malnutrition); Chick pea and Pigeon pea (Production, Morphology and Economic Importance); Other Legumes: Pea, Cowpea (Production and Economic Importance); Fodder

legumes (Production and Economic Importance); Importance of legumes in soil fertility-Green manure, cover crops and nitrogen fixation; Legumes as climate resilient food crop.

**Unit-3**

**Starch, Sugar and oil yielding plants:** Potato (Morphology, Tuber Anatomy, and Economic uses); Brief note on Cassava and sweet potato-nutrition and as climate resilient crops. Sugarcane (Morphology, Ratooning, Products and By-products); Groundnut, Musturd (Morphology and Economic Importance); Essential Oils: *Citonella* and sandalwood (General characteristics, brief note on Methods of Extraction and Economic Importance);

**Unit-4**

**Beverages (Non-Alcoholic) and spices:** Tea, Cocoa and Coffee (Morphology, Chemistry, Processing and Economic Importance); Spices & Flavourings: Spice Clove, Nutmeg, Cinnamom, and Black Pepper (Cultivation, Morphology, and Economic Importance); Cultivation, processing and economic importance of Saffron and Vanilla.

**Unit-5**

**Fibre, Rubber and Timber yielding Plants:** Classification of Fibres based upon their Origin (surface fibres, bast fibres, and leaf fibres, with examples); Jute and Cotton (morphology, processing, extraction and economic importance); Flax fibres and economic importance; Rubber Para Rubber - *Hevea brasiliensis* (Morphology, Tapping of latex, Processing, Products and Economic Importance) Brief note on important Indian timber yielding plants-agroforestry.

**Suggested readings:**

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.
3. Economic Botany. B P Pandey. S. Chand Publishing.
4. College Botany Vol. –I, II & III. - Gangulee and Kar, New Central Book Agency, Kolkata
5. A Text Book of Economic Botany A.V.S. Samba Murty, N.S. Subrahmanyam.
6. Kochhar, S.L. (2012). Economic Botany in Tropics. MacMillan & Co.
7. Kochhar, S.L. (2016). Economic Botany – A Comprehensive Study (5th Ed.). Cambridge University Press.
8. Albert F. Hill and O. P. Sharma (1996), Hill's Economic Botany, Tata Mc-Graw-Hill Publishing Company Limited, New Delhi

## SEMESTER-VIII

### MJD-20: Mushroom Cultivation

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MJD-20 | 4 | 4 | 0 | 6 | 75 | 25 |

**Course Objectives:**

- To study the morphology and anatomy of fruiting bodies and life cycle
- To learn the mushroom cultivation methods
- To understand nutritional value of mushrooms and their storage
- To acquire knowledge on mushroom research and marketing methods

**Course Outcomes**: On completion of the course students will be able to

- ✓ Develop understanding on mushroom biology and anatomy
- ✓ Acquire skills on different aspects of mushroom cultivation process
- ✓ Gain knowledge on value of mushroom as food and postharvest technology
- ✓ Analyse the different marketing strategies and familiarize with mushroom research

**Unit-1**

Introduction to fungi. General characters of Agaricales. History of mushroom cultivation. Morphology and anatomical studies of edible mushrooms (*Agaricus bisporus, Pleurotus ostreatus and Calocybe indica*). Spore print and study of basidiospores; Introduction of commercial edible mushrooms.

**Unit-2**

**Mushroom Cultivation Techniques:** Seasonal and environmentally controlled crop houses and their advantages and limitations, Infrastructure, equipment, common substrates of mushroom cultivations, substrate sterilization techniques: physical-pasteurization, autoclaving, chemical-lime and formalin and application and limitations, details of preparation of spawn.

**Unit-3**

**Cultivation of white button and oyster Mushrooms**: Preparation of compost: Long and short method, Spawning and types of spawning, Casing (Covering the spawned compost) and

cropping and crop management. Cultivation of oyster mushroom (*Pleurotus* spp.) Substrate preparation, spawning, cropping and harvesting.

**Unit-4**

**Cultivation of milky mushroom (*Calocybe indica*) and mushroom diseases:** Substrate preparation, spawning, cropping and harvesting. Bed and hanging bag methods. Major diseases of mushrooms: competitor moulds, fungal and bacterial diseases and their management. Poisonous mushrooms: types of toxins, symptoms and precautions, Medicinal mushrooms: active principles and medicinal uses with suitable examples.

**Unit-5**

**Mushroom storage, nutrition and marketing:** Short-term storage and long-term storage: Refrigeration, drying, canning, storage in salt solutions. Nutrition values of mushrooms. Mushroom as food. Mushroom Research Centres – National level. Marketing in India and abroad.

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**Suggested reading:**

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991). Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj Kapoor, S.C.(1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.
5. Dr. Anil K. Thakur , Dr. Susheel K. Bassi, Dr. N.S. Atri Vinesh Mushroom Cultivation Technology (Skill Enhancement Course) B.Sc. Classes. S Vinesh & Co.
6. Acharya-Sarkar Mushroom Cultivation Techno World.
7. J.N. Kapoor Mushroom Cultivation, Indian Council of Agricultural Research, New Delhi

## SEMESTER-VIII

### MJD-21: Research Methodology in Biology

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MJD-21 | 4 | 4 | 0 | 6 | 75 | 25 |

**Course Objectives:**

- To understand the basic concepts of research and scientific research methodology
- To learn the best practices of research and research ethics
- To familiarize with scientific writing, presentation and publication ethics

**Course Outcomes:** On successful completion of the course students would able

- ✓ Understand the basic concepts of research and different research types
- ✓ Gain knowledge on research design, sampling, data handling and documentation
- ✓ Develop skillset required to carry out laboratory experiments in biology
- ✓ Learn the basic aspects of scientific writing and presentation of data and ethical aspects of research

**Unit-1**

**Concept of research:** Definition and meaning of research; research objectives; Research methods vs. Methodology; Types of research: Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs Qualitative research; Criteria of good research; Formal Science and Empirical Science; Steps of research processes.

**Unit-2**

**Research topic and Hypothesis generation:** Defining and Formulation of research problem (topic); Importance of literature review in defining a research topic; Literature review: Primary and Secondary sources (reviews, patents, research databases); Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis.

**Unit-3**

**Design, sampling and hypothesis testing:** Research Design: Concept and Importance of design; Features of a good research design; Exploratory Research vs Descriptive Research; Basic Principles of Experimental Designs, Sampling Design: Steps in Sampling-sampling types; Concept of measurement; Data Analysis and role of statistics; Hypothesis Testing-Documentation and interpretation of data.

**Unit-4**

**Biology Laboratory skills and scientific writing:** Common calculations in laboratories: Molarity and normality of common acids and bases. Preparation of solutions: Dilutions, Percentage solutions and buffers; Model organisms in biology-attributes (*E.coli*, *Saccharomyces*, *Arabidopsis*, *Drosophila*, Mouse); Good laboratory practices; handling and storage of biological material; Layout of a Research Paper and writing; Poster presentation.

**Unit-5**

**Research and Publication Ethics:** Research Integrity, reproducibility and accountability; Scientific misconduct: Falsification, Fabrication and Plagiarism (FFP), Conflict of research, Predatory publishers and Journals; copyright infringement; citation and acknowledgement, Biosafety Regulatory issues in Biotechnology.

**Suggested readings:**

1. C R Kothari, Research Methodology: methods and techniques, New Age International Publication Ltd
2. J W Creswell, Research Design, Sage South Asia Edition D G Montgomery, Design and analysis of Experiments, John Willy India Edition
3. The Ethics of Teaching and Scientific Research by Miro Todorovich; Paul Kurtz; Sidney Hook.
4. Glenn, J. C *Handbook of research methods*. New Delhi: Oxford Book Company.(Juhu)
5. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi
6. Petter Laake, Haakon Breien Benestad, Bjorn R. Olsen (2007). Research Methodology in the Medical and Biological Sciences, Academic Press
7. What are Qualitative Research Ethics? Rose Wiles, Bloomsbury (2013).
8. Scientific Integrity and Research Ethics: An Approach from the Ethos of Science, David Koepsell, Springer (2017)

## SEMESTER-VIII

### MJD-21: Biostatistics and Computer Applications in Biology

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MJD-21 | 4 | 4 | 0 | 6 | 75 | 25 |

**Course Objectives:**

- To understand the basic theoretical concepts and to get practical knowledge in computer applications towards Biology, Bioinformatics and Biostatics.
- To know the basics of Bioinformatics and Biostatics with its applications

**Course Outcomes:** After completion of the course students will be able to

- ✓ Learn an inter-disciplinary subject integration of biology, computers and biostatistics.
- ✓ Gain knowledge on how power of computation can be used solve the issue related to biology and their application in real life.
- ✓ Understand the basic biostatistics and applications of statistics in field of biology.
- ✓ Statistics has become essential in field of biology and gaining the knowledge will improve the skillset of students.
- ✓ In this informatics era gained knowledge in this inter disciplinary courses not only improve their skillset but also enhances their job opportunities.

**Unit-1**

**Introduction to Biostatistics**: Measure of Central Tendency – Arithmetic Mean, - for Ungrouped Data, Grouped Data. Discrete Series- Direct Method, Continuous Series- Direct Method, Median - Computation of median, Discrete Series, Continuous Series; Mode - Computation of Mode, Discrete Series, Continuous Series. Measure of Dispersion –Measures based upon averages – Mean deviation & Standard deviation. Comparing Averages: The Student's t-Test for Independent Samples, Analyzing Frequencies: The Chi-Square Test, Introduction to Regression and Correlation

**Unit-2**

**Introduction to computers:** Type of computers, components of computer and its functions, input and output devices, operating systems, MS-Office (MSWord, MS-Excel and MS-Power point).

**Unit-3**

**Databases and computational tools:** Database software – MS access; Image editing software (Photoshop). Details of networks, internet & email, online and offline search. Outline of Search engines (Google); Pubmed, Scopus.

**Unit-4**

**Information systems:** Fundamentals of Geographic Information System (GIS) and Remote Sensing. GIS Softwares (Google Earth). Information systems in India – ENVIS and BTIS.

**Unit-5**

**Bioinformatics and Applications:** Introduction to Bioinformatics and its applications, History of Bioinformatics. Nucleic acid sequence databases – EMBL, GenBank, DDBJ. FASTA Format. Sequence searching and comparison software - BLAST; Pairwise sequence alignment and multiple sequence alignment, Clustal W; Phylogenetic tree (distance based, character based), Phylip.

**Suggested readings:**

1. Rajaraman, V. 2010. 5th Ed. Fundamentals of Computers. PHI Learning Pvt. Ltd., New Delhi.
2. Peter Norton. 2006. Introduction to Computers. Tata McGraw Hill (India) Ltd, New Delhi.
3. Alexis Leon and Mathews Leon. 1999. Introduction to Computers. Vikas Publishing House, New Delhi
4. Krane, D.E. and Raymer, M.L. 2009. Fundamental Concepts of Bioinformatics. Pearson Education, Inc.
5. Rastogi, S.C., Mendiratta, N. and Rastogi, P. 2004. Bioinformatics – Methods and Applications. Prentice Hall of India Pvt. Ltd., New Delhi.
6. Mani, K. and Vijayaraj, N. 2002. Bioinformatics for Beginners. Kalaikathir Achchagam, Coimbatore.
7. Genebank: http://www.ncbi.nlm.nih.gov/Genbank/
8. EMBL Nucleotide Sequence Database http://www.ebi.ac.uk/embl/
9. DDBJ: www.ddbj.nig.ac.jp/
10. Banerjee, P.K. 2012. Introduction to Biostatistics. S. Chand and Co. Ltd. New Delhi.
11. Rastogi, V.B. 2011. Fundamental of Biostatistics. Ane Books Pvt. Ltd.

## SEMESTER-VIII

### MJD-22: Botany Main Practical -V

(Covering the papers of Economic Botany, Mushroom Cultivation, Research Methodology and Biostatistics and Computer Application in Biology)

| Course Code | Credits | Credits Distribution | | Teaching (Hours/week) | Maximum Marks (100) | |
|---|---|---|---|---|---|---|
| | | Theory | Practical | | ESE | CIA |
| MJD-22 | 4 | 0 | 4 | 8 | 50 | 50 |

**Course Objectives:**

- To study the various plant resources and their uses and their chemical test
- To learn the basic concepts of research and good laboratory practices and ethics
- To understand the applications of computational power and statistics in field of biology

**Course Outcomes:** Upon completion of the course, students will be able to

- ✓ Develop the experimental understanding of diverse plant resources, useful parts and their major chemical constituents
- ✓ Acquire skillset in formulation of hypothesis, design of research and essential laboratory practices
- ✓ Gain knowledge how to write research article and research ethics
- ✓ Analyse the biological data using statistical methods and their significance
- ✓ Demonstrate application of computers in data analysis and data presentation in biology

## Suggested Laboratory Exercises:

**Economic Botany**

**Unit-1**

1. Cereals: Wheat or Rice -habit sketch, L.S/T.S. grain - Microchemical test for starch
2. Legumes: Chickpea or Pigeon pea -habit, fruit, seed structure-microchemical test for protein
3. Sugars: Sugarcane (habit sketch, products and by-products-sugars detection of sugars in samples (qualitative)
4. Microscopic observation of starch grains from different sources
5. Potato -habit sketch, tuber morphology, T.S. tuber to show localization of starch grains-staining

**Unit-2**

6. Oil-Yielding Plants: Fatty Oils: Groundnut (habit-specimen, fruit, seeds, microchemical tests for fats and lipids
7. Spices: Clove, Black pepper Saffron, vanilla, nutmeg, Cinnomom (specimen/digital resources)
8. Beverages: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans) – microchemical test for tannins
9. Cotton (specimen, W.M. seed to show lint and fuzz; W.M. fibre)
10. Essential Oils: habit sketch of citronella, Jasmine and Eucalyptus (specimens/photographs)
11. Rubber: Para Rubber-Habit, Tapping of latex (Specimen/photograph),

**Mushroom Cultivation**

**Unit-3**

1. Study of edible and medicinal Mushrooms
2. Study of spore print
3. Preparation of PDA media
4. Isolation of pure culture from fruiting body.
4. Preparation of spawn,
5. Preparation of commercial spawn.
6. Preparation of substrate for growing Mushroom
7. Study of different spawning techniques.

**Research Methodology in Biology**

**Unit-4**

1. Preparation of solutions of different concentration (Molarity/Normality /Percentage)
2. Study of preparation of Buffers
3. Study of model organism of Biological studies.
4. Study of layout of Research Paper/
5. Study of Biosafety regulations in Biological Research.

**Biostatistics and Computer Application**

**Unit-5**

1. Calculation of averages (Mean, Median and Mode), Measure of dispersion from given data.
2. Retrieval of DNA / Protein sequence from data base.
3. Calculation of test of Significance - student ‘t’ test
5. Plot a Graph from the given data.
6. Study of phylogenetic tree.
7. Study of pairwise alignment of sequences.

**Bharathidasan Govt. College for Women (Autonomous), Puducherry**
**NEP 2020 B.Sc. Botany (Hons)**
**Main Practical Examination, Semester – VIII**
**(Covering the papers of MJD-22: Botany Main Practical -IV)**

Paper code: Duration: 3 hrs
Maximum Marks: 50

1. Identify the phytochemical constituent of a given plant material A and describe it. Draw the diagram, Leave the slide / test tube for valuation. (Preparation-2, Identification- 1, Procedure-2, Diagram-2 marks) (1 x 7 = 7 Marks)
2. Identify the given set up B and Outline the Procedure. (Materials-1, Identification- 1, Procedure-3, Diagram-2 marks) (1 x 7 = 7 Marks)
3. Prepare the given concentration of solution C and Outline the procedure. (Materials-1, Calculation- 3, Procedure-3 marks) (1 x 7 = 7 Marks)
4. Calculate the Averages of given data 'D' and Plot the graph in Excel sheet and save it for valuation. (Calculation – 3, Plotting graph -4,) (1 x 7 = 7 Marks)
5. Draw and write critical comments on E, F, G and H (Identification-1, Diagram-1, Salient features-2) (4 x 4 = 16 Marks)

Practical - 44
Viva voce - 06
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Total-50 marks

**Key for Practical**

| Question | Experiment/Spotter |
|---|---|
| **A** | Economic Botany- test/setup |
| **B** | Mushroom cultivation –setup |
| **C** | Research Methodology –preparation of solutions |
| **D** | Biostatistics and Computer Applications |
| **E** | Economic Botany spotter |
| **F** | Mushroom cultivation spotter |
| **G** | Research Methodology spotter |
| **H** | Biostatistics and Computer Applications spotter |