

# **NEP SYLLABUS, B.Sc. IN BOTANY, 2023**



**DEPARTMENT OF BOTANY  
COTTON UNIVERSITY,  
GUWAHATI-781001,  
ASSAM**

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## Members Present in Proceedings of BOS meeting for FYGP syllabus

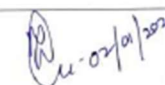

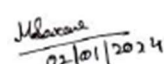

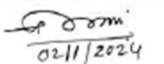

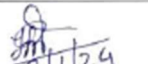
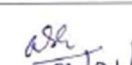
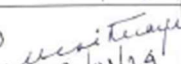
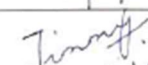
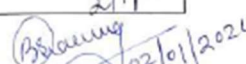


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### MEETING OF THE BOARD OF STUDIES: DEPT. OF BOTANY Dtd. 02/01/2024

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## PREAMBLE

The father of our nation, Mahatma Gandhi once said, “True education must correspond to the surrounding circumstances, or it is not a healthy growth”. Following this view, Cotton University has striven to develop various courses for the students which will not only enable them to be aware of their surroundings but contribute significantly towards the future of society. The various courses developed by the Department Botany, Cotton University on the guidelines of NEP 2020 focuses on inculcating cognitive capabilities like vital thinking, problem solving and social, ethical, and emotional abilities and qualities in the students. The NEP approach enables the university to build a student-centric syllabus and engage themselves into courses of their choices. The syllabus also focuses on employability.

Each program under NEP approach has described in detail with primary focus on three sectors viz. teaching-learning criteria, learning outcome and skill development.

The graduate program offered by the Department of Botany, Cotton University, namely, B.SC Botany envision to inculcate a holistic approach towards the plant world. The salient features of these programmes can be enlisted as-

- 1) It will offer essential knowledge on various groups of plants, ranging from lower plants to highly evolved ones and the various relationships that exist through the various core papers offered in different semesters of the course.
- 2) It will enhance the skills for studying the plants in detail by virtue of various laboratory work they will learn in the practical classes.
- 3) It will enable the students to gain knowledge on the local flora and ethno-botanical facts by the help of different elective papers in different semesters.
- 4) It will make the students aware of the economic contribution of the plants to the nation through various papers on economic botany they will study.
- 5) It will encourage the students for critical thinking and research-oriented behaviour through the dissertation work.
- 6) It will boost the confidence of the students and groom them for public speaking with the help of seminars that they will present.

With the aid of these salient features, the syllabus so developed by the department of Botany, Cotton University hopes to encourage the students to take courses in botany and make a career in this field.

## **Part I**

### **1.1. Introduction**

Northeast India is rich in floral diversity which plays a significant role in the day-to-day life of all communities residing in the region. As such, the Department of Botany, Cotton University, which is situated in Assam, a part of NE India, endeavoured to introduce programs on botany. These programs will throw light on plant life, endemic plants, and the usage of plants by various NE communities. However, as the present alarming situation necessitates transformation and/or redesigning of the system, not only by introducing innovations but developing a “learner-centric” approach, hence, the programs have been designed in accordance to the current NEP policy 2020.

The B.Sc Botany and M.Sc Botany programs have been designed to empower the students to gather essential knowledge on plants and develop technical skills to study them in detail. The syllabi, composed of a combination of core and elective papers will expose the students to current developments in the plant world. They will learn the various aspects of plant life like their metabolism, ecological interactions, and evolutions in a holistic approach. Further, these courses have endeavored to introduce the ethnic plants used by many tribes of NE India through courses on ethnobotany and economic botany.

The entire program has been designed in accordance with Bloom’s taxonomy. Thereby, the course levels have been arranged in a manner where courses of the first year (1<sup>st</sup> and 2<sup>nd</sup> semester of UG and PG) are based on levels 1, 2 and 3 of Bloom’s taxonomy. The students at these levels will get introduced to various basic concepts of Botany. He or she can recognize the various facts and factors of the plant world, understand the concept of different processes and principles involved in plant life and apply this knowledge and concepts into regular lives. The higher semesters of the PG (3<sup>rd</sup> and 4<sup>th</sup>) and UG (3<sup>rd</sup>-6<sup>th</sup>) programs have courses that enable the students analyse the different topics he or she studied and evaluate or judge the content they studied. Further, with the wholesome knowledge that they acquire through the various semesters, he or she will be able to synthesise new concepts and apply them in research studies.

### **1.2. New Education Policy (NEP) 2020**

The National Education Policy (NEP) 2020 recognizes the role of higher education in promoting human as well as societal well-being. It focuses on developing India as per its constitution into a democratic, just, socially conscious, cultured, and humane nation upholding liberty, equality, fraternity, and justice for all. It aims to develop good,

thoughtful, well-rounded, and creative individuals” and enable an individual to study one or more specialised areas of interest at a deep level and develop capabilities across a range of disciplines including sciences, social sciences, arts, humanities, languages, as well as professional, technical, and vocational subjects. The NEP 2020 visualizes the revision of the Choice Based Credit System (CBCS) for instilling innovation and flexibility. It also encourages in setting up of facilitative norms for issues, such as credit transfer, equivalence, etc., and moving towards a criterion-based grading system that moves away from high-stake examinations towards more continuous and comprehensive evaluation. The policy supports the establishment of an Academic Bank of Credit (ABC) which would digitally store the academic credits earned from various recognized HEIs so that the degrees from an HEI can be awarded considering the credits earned.

### **1.3 Aims of Bachelor’s Degree Program in Botany**

1. To gain knowledge of different life forms, plant diversity and to explore the natural genetic variation in plants.
2. To make the students familiar with economic importance of diverse plants and enable the students to explore the potential of plant resources for human welfare in a sustainable way.
3. To make the students aware of critical thinking, development of scientific attitude, improve practical skills and about ethical value system.
4. Emphasizes on critical evaluation of contemporary issues related to and nature and skill for entrepreneurship.
5. To enable the students to prepare for national and International competitive examinations for employment.

#### **1.3.1: Graduate Attributes**

The disciplinary expertise or technical knowledge that has formed the core of the university courses. They are qualities that also prepare graduates as agents for social good in the future. Some of the characteristic attributes that a graduate should demonstrate are as follows:

**Disciplinary Knowledge:** Capable of demonstrating comprehensive knowledge, understanding of theoretical and applied components of plant science and study in a multidisciplinary context.

**Communication Skills:** The graduates in Botany should have the ability to present and express thoughts and ideas effectively in writing and orally.

**Moral and ethical awareness/reasoning:** Ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work.

**Multicultural Competence:** Ability to correlate and compare recent developments in various branches of plant science and possess knowledge of the values and beliefs of multiple cultures and a global perspective.

**Information/Digital Literacy:** The graduates of Botany should have the ability to use ICT tools, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data.

**Reflective Thinking and Problem Solving:** The graduates of Botany will be able to understand the value of plant resources, need for conservation of plant resources, bio-prospecting and sustainable utilization of plant resources for human welfare.

**Critical Thinking:** The graduates of Botany should be competent for critical analysis of problems related to plant and nature, sustainable uses of biological resources and their conservation strategies.

**Self-directed learning:** Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion.

**Lifelong learning:** Ability to acquire knowledge and skills, including 'learning how to learn', that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of workplace through knowledge/skill development/reskilling.

### **1.3.2. Programme Outcomes (POs) for undergraduate programme**

1. **In-depth knowledge:** Acquire a systematic, extensive, and coherent knowledge and understanding of their academic discipline as a whole and its applications, and links to related disciplinary areas/subjects of study; demonstrate a critical understanding of the latest developments in the subject, and an ability to use established techniques of analysis and enquiry within the subject domain.
2. **Understanding Theories:** Apply, assess, and debate the major schools of thought and theories, principles and concepts, and emerging issues in the academic discipline.

3. **Analytical and critical thinking:** Demonstrate independent learning, analytical and critical thinking of a wide range of ideas and complex problems and issues.
4. **Critical assessment:** Use knowledge, understanding and skills for the critical assessment of a wide range of ideas and complex problems and issues relating to the chosen field of study.
5. **Research and Innovation:** Demonstrate comprehensive knowledge about current research and innovation, and acquire techniques and skills required for identifying problems and issues to produce a well-researched written work that engages with various sources employing a range of disciplinary techniques and scientific methods applicable.
6. **Interdisciplinary Perspective:** Commitment to intellectual openness and developing understanding beyond subject domains; answering questions, solving problems, and addressing contemporary social issues by synthesizing knowledge from multiple disciplines.
7. **Communication Competence:** Demonstrate effective oral and written communicative skills to convey disciplinary knowledge and to communicate the results of studies undertaken in an academic field accurately in a range of different contexts using the main concepts, constructs, and techniques of the subject(s) of study.
8. **Career development:** Demonstrate subject-related knowledge and skills that are relevant to academic, professional, soft skills and employability required for higher education and placements.
9. **Teamwork:** Work in teams with enhanced interpersonal skills and leadership qualities.
10. **Commitment to the society and to the Nation:** Recognise the importance of social, environmental, human and other critical issues faced by humanity at the local, national and international level; appreciate the pluralistic national culture and the importance of national integration.

### 1.3.3. Qualification Descriptors



On completion of the course, the descriptors of a graduate or undergraduate student may be listed as such-

1. He /she will have a **comprehensive and systematic knowledge on the subject** and can **apply this knowledge** on different aspects of research and teaching.
2. He/ she can **develop skills** to undertake professional teaching in universities, colleges and other institutes, government and public services, farm consultants, plant research institutes etc.
3. He/ she can **demonstrate procedural knowledge** that creates different types of professionals related to the disciplinary/subject area of study, including research and development, teaching and government and public service.
4. He/ she should be able to **use knowledge understanding and skills for critical assessment** of wide range of ideas and problems in the field of Botany.
5. He /she should be able to **apply one's disciplinary knowledge and transferable skills** to new/unfamiliar contexts and to identify and analyse problems and issues and seek solutions to real-life problems.

#### **1.3.4. Programme Specific Outcomes (PSOs) in B. Sc Botany**

Programme specific outcomes include subject-specific skills and generic skills, including transferable global skills and competencies. The students of a specific programme of study should be able to demonstrate the knowledge and skill acquired during the program and show application of this knowledge for the award of the degree.

The student after graduating with B.Sc. Botany will be able to acquire,

**PSO 1: Core competency:** Students will acquire core competency in Botany and in allied subject in terms of,

- Plant identification, systematic position, diversity, evidence based evolutionary process and phylogenetic analysis.
- Concept of Cell & tissue, Cellular organization and developmental Process in plants.
- Gene, Genome, inheritance of characters, gene expression and population dynamics.

- Microbes and Microbial diversity, plant -microbes interactions.
- Habitat of plants, ecosystem. energy flow, biotic -abiotic- interaction in ecosystem and adaptation of plants
- Plant processes, functioning and plant metabolism.

**PSO 2: Analytical ability:** Application of various scientific methods, data collection, critical analysis, practical based understanding and Students will be able to get knowledge in understanding research.

**PSO 3: Critical Thinking and problem-solving ability:** Understanding of concept of Botany and practical based knowledge on the subject is expected to facilitate critical thinking and problem-solving attitude of the students.

**PSO 4: Digital proficiency:** students will acquire digital skills and fundamental concepts with modern tools.

**PSO 5 : Independent Learner:** Will lead the students to gain knowledge and skills for further higher studies, competitive examinations , employment and to address different issues of society and environment by encouraging sustainable development and scientific temperament.

**PSO 6: Ethical and Psychological strengthening:** Will also strengthen the moral and ethical values of the students.

**PSO 7: Create teams’ workmanship:** Will enhance teams ‘workmanship of students towards institution and society .

#### **1.4. Course Level Learning Outcome Matrix or Curriculum Mapping**

Curriculum mapping is the process which helps to determine where, when, and how learning outcomes are taught and assessed within a degree program. The curriculum map clearly demonstrates in which courses learning outcomes are taught and assessed in the curriculum. It provides an effective strategy for articulating, aligning and integrating learning outcomes across a sequence of courses. The following table shows the possible linkage between the course learning outcomes and programme learning outcomes.

### 1.4.1. Core Course outcomes (Cos) and Programme Outcomes (POs) matrix for Four Year Graduate Program

Programme outcomes (POs)	BOT23C101	BOT23C 201	BOT23C301	BOT23C 302	BOT23C 401	BOT23C 402	BOT23C 403	BOT23C 501	BOT23C 502	BOT23C 503	BOT23C 504	BOT23C 601	BOT23C 602	BOT23C 603	BOT23C 604	BOT23C 701	BOT23C 702	BOT23C 703	BOT23C 704	BOT23C 801	BOT23C 802	BOT23C 803	BOT23C 804
In-depth knowledge	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Understanding theories	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Analytical and critical thinking	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Critical assessment					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Research and innovation																							

<b>Programme outcomes (POs)</b>	<b>BOT23C101</b>	<b>BOT23C 201</b>	<b>BOT23C301</b>	<b>BOT23C 302</b>	<b>BOT23C 401</b>	<b>BOT23C 402</b>	<b>BOT23C 403</b>	<b>BOT23C 501</b>	<b>BOT23C 502</b>	<b>BOT23C 503</b>	<b>BOT23C 504</b>	<b>BOT23C 601</b>	<b>BOT23C 602</b>	<b>BOT23C 603</b>	<b>BOT23C 604</b>	<b>BOT23C 701</b>	<b>BOT23C 702</b>	<b>BOT23C 703</b>	<b>BOT23C 704</b>	<b>BOT23C 801</b>	<b>BOT23C 802</b>	<b>BOT23C 803</b>	<b>BOT23C 804</b>
<b>Interdisciplinary perspective</b>																							
<b>Communication competence</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>Career development</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>Teamwork</b>																							
<b>Commitment to the society and to the Nation</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

**1.4.2 Minor, MDE and Summer internship and Dissertation Course outcomes (Cos) and Programme Outcomes (POs) matrix for Four Year Graduate Program**

<b>Programme outcomes (POs)</b>	<b>BOT23M 102</b>	<b>BOT23M DE 103</b>	<b>BOT23M 202</b>	<b>BOT23M DE 203</b>	<b>BOT23M 303</b>	<b>BOT23M DE 304</b>	<b>BOT23M 404</b>	<b>BOT23SI 406</b>	<b>BOT23M 505</b>	<b>BOT23M 605</b>	<b>BOT23M 705</b>	<b>BOT23DPW 706</b>	<b>BOT23M 805</b>	<b>BOT23DPW 806</b>
<b>In-depth knowledge</b>		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>Understanding theories</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>Analytical and critical thinking</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>Critical assessment</b>					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>Research and innovation</b>														
<b>Interdisciplinary perspective</b>					✓									
<b>Communication competence</b>	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>Career development</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>Teamwork</b>					✓									
<b>Commitment to the society and to the Nation</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

### 1.4.3. Elective Course outcomes (Cos) and Programme Outcomes (POs) matrix for Four Year Graduate Program (FYGP)

<b>Programme outcomes (POs)</b>	<b>AECC 1</b>	<b>BOT23SEC001</b>	<b>AECC 2</b>	<b>BOT23SEC002</b>	<b>AECC 3</b>	<b>SEC 3</b>	<b>MIL- II</b>
<b>In-depth knowledge</b>	✓	✓	✓	✓	✓	✓	✓
<b>Understanding theories</b>	✓	✓	✓	✓	✓	✓	✓
<b>Analytical and critical thinking</b>							
<b>Critical assessment</b>							
<b>Research and innovation</b>							
<b>Interdisciplinary perspective</b>		✓		✓		✓	
<b>Communication competence</b>	✓	✓	✓	✓	✓	✓	✓
<b>Career development</b>	✓	✓	✓	✓	✓	✓	✓
<b>Teamwork</b>							
<b>Commitment to the society and to the Nation</b>	✓	✓	✓	✓	✓	✓	✓

**1.4.4. Core Course outcomes (Cos) and Programme Specific Outcomes (PSOs) matrix for Four Year Graduate Program (FYGP)**

<b>Programme Specific outcomes (PSOs)</b>	<b>BOT23C101</b>	<b>BOT23C 201</b>	<b>BOT23C 301</b>	<b>BOT23C 302</b>	<b>BOT23C 401</b>	<b>BOT23C 402</b>	<b>BOT23C 403</b>	<b>BOT23C 501</b>	<b>BOT23C 502</b>	<b>BOT23C 503</b>	<b>BOT23C 504</b>	<b>BOT23C 601</b>	<b>BOT23C 602</b>	<b>BOT23C 603</b>	<b>BOT23C 604</b>	<b>BOT23C 701</b>	<b>BOT23C 702</b>	<b>BOT23C 703</b>	<b>BOT23C 704</b>	<b>BOT23C 801</b>	<b>BOT23C 802</b>	<b>BOT23C 803</b>	<b>BOT23C 804</b>
<b>Demonstrate</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>Analyse</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>Exhibit</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>Create</b>					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

<b>Programme Specific outcomes (PSOs)</b>	<b>BOT23C101</b>	<b>BOT23C 201</b>	<b>BOT23C 301</b>	<b>BOT23C 302</b>	<b>BOT23C 401</b>	<b>BOT23C 402</b>	<b>BOT23C 403</b>	<b>BOT23C 501</b>	<b>BOT23C 502</b>	<b>BOT23C 503</b>	<b>BOT23C 504</b>	<b>BOT23C 601</b>	<b>BOT23C 602</b>	<b>BOT23C 603</b>	<b>BOT23C 604</b>	<b>BOT23C 701</b>	<b>BOT23C 702</b>	<b>BOT23C 703</b>	<b>BOT23C 704</b>	<b>BOT23C 801</b>	<b>BOT23C 802</b>	<b>BOT23C 803</b>	<b>BOT23C 804</b>
<b>Display</b>																							
<b>Communicate</b>																							
<b>Learn</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>Show</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>Apply</b>																							



**1.4.5. Minor, MDE and Summer internship and Dissertation Course outcomes (Cos) and Programme Outcomes (POs) matrix for Four Year Graduate Program**

Programme Specific outcomes (PSOs)	BOT23M102	BOT23MDE103	BOT23M 202	BOT23M DE 203	BOT23M 303	BOT23M DE 304	BOT23M 404	BOT23MSI 406	BOT23M 505	BOT23M 605	BOT23M 705	BOT23DPW706	BOT23M 805	BOT23DPW 806
<b>Demonstrate</b>		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>Analyse</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>Exhibit</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>Create</b>					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>Display</b>														
<b>Communicate</b>					✓									
<b>Learn</b>	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>Show</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>Apply</b>					✓									

**1.4.6. Elective Course outcomes (Cos) and Programme Specific Outcomes (PSOs) matrix for Four Year Graduate Program (FYGP)**

Programme Specific outcomes (PSOs)	AECC 1	BOT23SEC001	AECC 2	BOT23SEC002	AECC 3	BOT23SEC003	MIL II
<b>Demonstrate</b>	✓	✓	✓	✓	✓	✓	✓

<b>Programme Specific outcomes (PSOs)</b>	<b>AECC 1</b>	<b>BOT23SEC001</b>	<b>AECC 2</b>	<b>BOT23SEC002</b>	<b>AECC 3</b>	<b>BOT23SEC003</b>	<b>MIL II</b>
<b>Analyse</b>							
<b>Exhibit</b>	✓	✓	✓	✓	✓	✓	✓
<b>Create</b>							
<b>Display</b>	✓	✓	✓	✓	✓	✓	✓
<b>Communicate</b>							
<b>Learn</b>	✓	✓	✓	✓	✓	✓	✓
<b>Show</b>	✓	✓	✓	✓	✓	✓	✓
<b>Apply</b>							

## **1.5. Teaching-learning process**

The programme allows to use of varied pedagogical methods and techniques.

### **A. Theory**

1. Lecture
2. Tutorial
3. Seminars
4. Assignment
5. Tests /assessments based on problem-solving.
6. Group discussion

### **B. Practical:**

1. Laboratory-based practical components and experiments.
2. Field-based learning

### **C. Project/ dissertation:**

1. Research problem discussion.
2. Technology-enabled learning.
3. Internship or summer training.
4. Encouragement for an interdisciplinary approach.

## **1.6. Scheme of Evaluation (Assessment)**

### **i) External Evaluation:**

External assessment at the University level examinations on specified times announced by the University for all the courses, theory, practical and Project. Each student should go through the evaluation process according to the University Regulations

### **ii) Continuous internal evaluation**

Internal evaluation is a continuous evaluation in all types of courses- theory/ practical / Project. The teacher has flexibility in deciding the components and their weightage in accordance with the University Regulations.

### **iii) End Semester Evaluation:**

The eligibility of students to appear in the examination will be a minimum of 80% of attendance. End semester evaluation of both theory and practical course and the time of examination will be in accordance with the academic calendar prepared by the University for each academic year. At the end of each semester, there will be an examination for theory and practical courses. The duration of examinations for all theory and practical courses in Botany will be three hours, except for the Generic Elective Course papers.

### **iv) Summer internship:**

The students will be encouraged to do an internship at respectable institutes across the country.

**v) Eligibility to appear for Practical Examination**

1. 80% Attendance (All Sem.)
2. Certified practical Record (All Sem.)
3. Herbarium and Field study report (Respective Sem.)
5. Certified Project Report (Eighth Sem.)
6. Report on Experiential Learning (Internships etc.) (Eighth Sem.)

**vi) Weightage for assessments (in percentage)**

Course	Mid-semester	End-semester
Core papers	30%	70%
Minor paper	30%	70%
MDE paper	30%	70%
SEC paper	30%	70%

**1.7. List Of Abbreviations:**

1. “C”- Core papers
2. “M”- Minor
3. “MDE”- Multidisciplinary elective
4. “SEC”- Skill enhancement course
5. “VAC”- Value added course
6. “AECC”- Ability enhancement core course

**1.8. Multiple entry and exit, type of degrees to be awarded:**

Exit level	Degree awarded	Minimum credits to be earned requirement
1st year	UG certificate	<ul style="list-style-type: none"> <li>• 40 credits from core, minor, AECC and MDE course</li> <li>• 4 credits from vocational course</li> <li>• 6 credit from skill enhancement course</li> </ul>

2 <sup>nd</sup> year	UG diploma	<ul style="list-style-type: none"> <li>• 80 credits from core, minor, AECC and MDE course</li> <li>• 6 credits from vocational course/ internship and skill enhancement course</li> </ul>
3 <sup>rd</sup> year	UG degree	<ul style="list-style-type: none"> <li>• 120 credits</li> </ul>
4 <sup>th</sup> year	UG degree (honours with research)	<ul style="list-style-type: none"> <li>• 160 credit with completion of 12 credit research project</li> </ul>
	UG degree (with honours)	<ul style="list-style-type: none"> <li>• 160 credit with completion of 12 credit of advanced level courses in lieu of research project or dissertation.</li> </ul>
<b>Entry level</b>	<b>Degree to be awarded</b>	<b>Eligibility for entry</b>
UG 1 <sup>st</sup> year	UG certification after 1 year	Completion of 10+2 year
UG 2 <sup>nd</sup> year	UG diploma after 2 year	After completion of certificate in UG course
UG 3 <sup>rd</sup> year	UG degree after 3 year	After completion of diploma in UG course
UG 4 <sup>th</sup> year	UG degree (honours) and UG degree (honours with research)	After completion of UG degree

## Part II

### COURSE STRUCTURE WITH CREDIT DISTRIBUTION FOR B.Sc. in BOTANY

<b>SEMESTER-I</b>			
<b>Course Code</b>	<b>Course Title</b>	<b>L+T+P</b>	<b>Credits</b>
<b>BOT23C101</b>	Fundamentals of Botany	3+0+1	4
<b>BOT23M 102</b>	Microbes and Lower Cryptogams	3+0+1	4
<b>BOT23 MDE 103</b>	Introduction to plant sciences	3+0+0	3
<b>AECC-1</b>	English communication <i>(To be offered by the concerned subject Department of CU )</i>	2+0+0	2
<b>BOT23 SEC001</b>	Biofertilizers, manures and composting	2+0+1	3
<b>BOT 23VAC-1</b>	Agritourism	2+0+0	2
<b>SEMESTER- II</b>			
<b>BOT23 C201</b>	Plant propagation and management	3+0+1	4
<b>BOT23M202</b>	Pteridophytes, Gymnosperms and Angiosperms	3+0+1	4
<b>BOT23MDE 203</b>	Introduction to Plant Sciences  **** The paper title and course content of the MDE paper will remain same in all semesters. Only the paper code will change as per semester. The student will opt this paper only once in any semester during the course	3+0+0	3
<b>AECC-2 MIL</b>	<i>(To be offered by the concerned subject, Department of CU )</i>	2+0+0	2
<b>BOT23 SEC002</b>	Mushroom Technology	2+0+1	3

<b>VAC-2</b>	To be offered at University Level		4
<b>SEMESTER– III</b>			
<b>BOT23C301</b>	Non-Vascular Cryptogams	3+0+1	4
<b>BOT23C302</b>	Instrumentation and laboratory techniques	3+0+1	4
<b>BOT23M303</b>	Plant Taxonomy and Ecology	3+0+1	4
<b>BOT23MDE304</b>	Introduction to Plant Sciences  **** The paper title and course content of the MDE paper will remain same in all semesters. Only the paper code will change as per semester. The student will opt this paper only once in any semester during the course	3+0+0	3
<b>AECC-3</b>	<i>(To be offered by the concerned subject, Department of CU)</i>	2+0+0	2
<b>BOT23 SEC003</b>	Techniques in plant identification and preservation	2+0+1	3
<b>SEMESTER– IV</b>			
<b>BOT23C401</b>	Vascular cryptogams and Gymnosperm	3+0+1	4
<b>BOT23C402</b>	Advanced Morphology and Plant Anatomy	3+0+1	4
<b>BOT23C403</b>	Reproductive Biology and Evolution	3+0+1	4
<b>BOT23M404</b>	Plant Physiology and Molecular Biology	3+0+1	4
<b>MIL-II</b>	University level		2
<b>BOT23 SI 406</b>	Summer Internship		2
<b>Semester V</b>			
<b>BOT23C 501</b>	Genetics and Plant Breeding	3+0+1	4
<b>BOT23C 502</b>	Angiosperm Taxonomy	3+0+1	4

<b>BOT23C 503</b>	Plant Ecology and Phytogeography	3+0+1	4
<b>BOT23C 504</b>	Plant Pathology	3+0+1	4
<b>BOT23M 505</b>	Cell Biology and Genetics	3+0+1	4
<b>Semester VI</b>			
<b>BOT23 C 601</b>	Pharmacognosy and Economic Botany	3+0+1	4
<b>BOT23C602</b>	Plant Physiology and Biochemistry	3+0+1	4
<b>BOT23C 603</b>	Microbiology	3+0+1	4
<b>BOT23C604</b>	Molecular Biology and Bioinformatics	3+0+1	4
<b>BOT23M 605</b>	Microbiology and Plant Pathology	3+0+1	4
<b>Semester VII</b>			
<b>BOT23C 701</b>	Cell Biology	3+0+1	4
<b>BOT 23C702</b>	Research Methodology and Bioethics	3+0+1	4
<b>BOT23C 703</b>	Industrial Microbiology	3+0+1	4
<b>BOT23C 704</b>	Plant Stress Biology	3+0+1	4
<b>BOT23M 705</b>	Developmental Botany and Plant Anatomy	3+0+1	4
<b>BOT23 DPW 706</b>	Dissertation Project work	0+0+4	4
<b>Remark</b>	<ul style="list-style-type: none"> <li>• Students who will opt for UG honours with research should have more than 7.5 CGPA and he or she need not take up BOT23C 704 paper.</li> <li>• Students who will opt for UG honours with degree will study BOT23C 704 with the rest of the core papers.</li> </ul>		
<b>Semester VIII</b>			
<b>BOT23C 801</b>	Traditional knowledge and IPR practices in plant science	3+0+1	4
<b>BOT23 C 802</b>	Biodiversity and Conservation Biology	3+0+1	4



<b>BOT23C 803</b>	Advanced Plant systematics	3+0+1	4
<b>BOT23C 804</b>	Biotechnology and Biostatistics	3+0+1	4
<b>BOT23M 805</b>	Economic Botany, Ethnobotany and Pharmacognosy	3+0+1	4
<b>BOT23DPW 806</b>	Dissertation Project Work	0+0+8	8
<b>Remark</b>	<ul style="list-style-type: none"> <li>• Students having dissertation or project will study Papers BOT23C 801 and BOT 23C 802 only.</li> <li>• Students who do not have dissertation or project must study Papers BOT23C 803 and BOT23C 804 along with rest of the core papers.</li> </ul>		

# UG- Semester-I

**Paper code: BOT23C-101**

**Paper title: FUNDAMENTALS OF BOTANY**

**(Credits: 04, Theory-03, Tutorial-0 Practical-01)**

**Type of paper: Theory+ Practical**

**Course outcomes:**

On completion of this course, the students will be able to:

**CO1-Understand** the distribution, characteristic features, and economic importance of different plant groups.

**CO2-Inculcate** scientific skills to study the specimens of different plant groups.

**CO3-Enhance** collaborative learning and communication skills through field study, teamwork, group discussions and home assignments.

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**A) Theory**

**(Credit:03)**

<b>Units</b>	<b>Course Content</b>	<b>Lectures</b>
<b>1</b>	<b>Algae:</b> General account, habitat, distribution and economic importance of algae as food, fodder, fertilizer and their role in fish farming.	<b>08</b>
<b>2</b>	<b>Fungi:</b> General account, habit and habitat, application of fungi as food, medicine, in agriculture (soil fertility) and in industries.	<b>08</b>
<b>3</b>	<b>Bryophytes:</b> Characteristic features, distribution, importance of bryophytes in initiating soil formation on barren terrain, in maintaining soil moisture, and in recycling nutrients in forest vegetation.	<b>08</b>
<b>4</b>	<b>Pteridophytes:</b> Characteristic features, distribution, economic importance of pteridophytes as food, biofertilizer, ornamentals and medicine.	<b>08</b>
<b>5</b>	<b>Gymnosperms:</b> Characteristic features, distribution, affinities and economic importance of gymnosperms as food, timber and medicines.	<b>08</b>
<b>6</b>	<b>Angiosperms:</b> General characteristic features, origin and Economic importance of Angiosperms as Cereals (Rice), Legumes (Black gram), Fruit (Citrus), Spices (Black pepper), Beverage (Tea), Oil seeds (Mustard), and cash crop (Rubber).	<b>08</b>

**B) Practicals:****(Credit: 01)**

- Basic concept on habit, habitat and morphology of following groups of plants-
  1. Algae
  2. Fungi
  3. Bryophytes
  4. Pteridophytes
  5. Gymnosperms
  6. Angiosperms
- Field visit to study the habit, habitat, method of collection and preservation of the following groups of plant:
  1. Algae
  2. Fungi
  3. Bryophytes
  4. Pteridophytes
  5. Gymnosperms
  6. Angiosperms
- **Relevant reports to be submitted for evaluation.**

**Suggested Readings:****a) Algae:**

- Bold, H.C. and Wayne, M.J. Introduction to Algae (2nd edition). Prentice Hall, New Jersey.
- Fritsch, F. E. (1961), Structure and reproduction in algae, Vol- I, & II Cambridge University.
- Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2<sup>nd</sup> edition.
- Sambamurty, A. A Textbook of Algae. I.K. International Pvt. Ltd., New Delhi.
- Sharma.O.P. (2011). Textbook of Algae. Tata Mc Graw Hill Education Pvt. Ltd., New
- Vashishta B.R., Sinha A. K., V. P. Singh. Botany for Degree student- Algae. S. Chand and Company

**b) Fungi:**

- Mehrotra R.S. and Aneja K.R. (1990). An Introduction to Mycology, Wiley, Eastern Limited, New Delhi.Press, London.
- Sethi, I.K. and Walia, S.K. (2011). Textbook of Fungi and Their Allies, Macmillan Publishers India Ltd.

- Sharma, O.P. (2011). Fungi and allied microbes. Tata McGraw Hill Pvt Ltd., New Delhi.
- Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
- Vashishta B.R., Revised by Sinha A. K. (2003), Botany for Degree student- Part II-Fungi. S. Chand and Company.

**c) Lichen:**

- Nash, T. H. (1996). Lichen Biology. Cambridge University Press, London
- Gupta, P and Sinha G P. (2018), The Lichen Flora of Assam, Scientific Book Publications.

**d) Bryophytes:**

- Chopra, R. N and Kumar, P. K. (1988). Biology of Bryophytes. New Age International Publishers, New Delhi.
- Goffinet B and Jonathan Shaw, A. (2009). Bryophyte Biology. Cambridge University Press, New York.
- N. S. Parihar, (2013). An Introduction to Embryophyta. Vol. I Bryophyta, Surjeet Publication, New Delhi.
- Rashid, A. (1998). An Introduction to Bryophyta. Vikas Publishing House, Pvt. Ltd., New Delhi.
- Watson, E. V. (2015). The structure and life of Bryophytes. Scientific Publication, Jodhpur, India.

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**Paper code: BOT23M-101**

**Paper title: MICROBES AND LOWER CRYPTOGAMS**

**(Credits: 04, Theory-03, Tutorial: 0, Practical-01) Type of paper: Theory+Practical,**

**Course outcomes:**

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

**CO1- Recognize** the different groups of microbes and lower cryptogams.

**CO2-Explain** the fundamental concepts and general characteristics of microbes and lower cryptogams.

**CO3- Demonstrate** the significance and utility of viruses, bacteria, fungi, and mycorrhizae.

**CO4-Develop** practical skills to identify, classify and distinguish microbes and lower cryptogams.

**A) Theory**

**(Credit: 03)**

Units	Course content	Lectures
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1	<b>Virus:</b> General characteristics, Replication – lytic and lysogenic cycles, Importance of Viruses, Bacteriophage.	08
2	<b>Bacteria:</b> Classification, Ultrastructure of a bacterial cell, Reproduction -asexual and sexual (transformation, conjugation and transduction) and Economic Importance.	08
3	<b>Algae:</b> General account, thallus organization, classification (F.E. Fritch, 1935), reproduction, Life cycle patterns of <i>Chara</i> , <i>Ectocarpus</i> and economic importance of algae.	08
4	<b>Fungi:</b> General characteristics, Classification (Ainsworth), vegetative structures, nutrition, reproduction, Life cycles of <i>Rhizopus</i> , <i>Peziza</i> , and economic importance of fungi.	08
5	<b>Lichen and Mycorrhiza:</b> General account, classification, economic importance and significance of Lichen and Mycorrhiza.	08
6	<b>Bryophytes:</b> Characteristic features, classification, reproduction, alternation of generation, origin and evolution of bryophytes, Life cycles of <i>Marchantia</i> , <i>Funaria</i> and economic importance.	08

## B) Practicals:

(Credit: 01)

- **Bacteria:** Observation of Gram-positive and Gram-negative bacteria by Gram staining.
- **Algae:** Study of vegetative and reproductive structures of the following algal types: *Chara*, *Ectocarpus*.
- **Fungi:** Study of vegetative and reproductive structures of the following taxa: *Rhizopus*, *Peziza*.
- **Lichen:** Thallus structure of different types of Lichen
- **Bryophytes:** Study of the gametophytic and sporophytic structures of the following genera: *Marchantia* and *Funaria*.
  - Practicals should be supported by practical record.

## A. Suggested Readings:

### a) Microbes:

- Dubey, R.C & D.K. Maheswari. (2022) A Textbook of Microbiology. 5<sup>th</sup> edition. S.Chand and company. New Delhi.

- Prescott, L. Harley, J. and Klein, D. (2022) Microbiology, 12th edition, Tata McGraw- Hill Co. New Delhi.

**b) Algae:**

- Pandey, B.P (2010): Botany for Degree students
- Sharma. O.P(2017): Algae
- Vasishtha, B.R. - (1974) Botany for Degree Students – Vol-I Algae.

**c) Fungi:**

- Mitra.J.N., Mitra. D., Chowdhuri, S.K.;Studies in Botany(Vol. one)(2018)Moulik Library 18-B
- Sharma, O.P., (1999) Text book of fungi. Tata McGraw Hill publishing Company Ltd. New Delhi.

**d) Lichens:** Misra, A. & R.P. Agarwal : Lichens – A Preliminary Text.

**e) Bryophyta:**

- Parihar, N.S : An Introduction to Embryophyta.
- Puri, P.: Bryophytes.
- Vasishtha, B.R. - (1974) Botany for Degree Students: Vol. III – Bryophyta

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**Paper code: BOT23MDE-103**

**Paper title: INTRODUCTION TO PLANT SCIENCES**

**(Credits:03, Theory-03, Tutorial-0, Practical-0)**

**Type of paper: Theory**

**Course outcomes:**

On completion of this course, the students will be able to:

**CO1-Understand** the diversity and general characteristics of living organisms.

**CO2- Gain** knowledge on plant life.

**CO3- Comprehend** the technologies of rDNA technologies.

**CO4- Develop** concepts on bioresources of Assam and conservation techniques.

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**A. Theory**

**(Credit-03)**

<b>Units</b>	<b>Course content</b>	<b>Lectures/Hours</b>
<b>1</b>	<b>Diversity &amp; Classification of Living Organisms</b> -Five kingdom concept with special emphasis on kingdom Plantae.	08

2	<b>Morphology and functions of different organs of flowering Plants:</b> Root, stem, leaf, and flower	08
3	<b>Plant Physiology:</b> Water relation in plants, transpiration, photosynthesis, PGR.	08
4	<b>Reproduction in flowering plants:</b> Pollination, fertilization and post-fertilization events of Angiosperms.	08
5	<b>rDNA technology:</b> Scope, basic technique, and applications of rDNA technology.	08
6	<b>Bioresources and environment:</b> Bioresources of Assam (timbers, medicine, and beverages). Environmental issues and conservation of biodiversity ( <i>Ex-situ</i> and <i>in-situ</i> conservation).	08

**Suggested readings:**

- Mitra. J.N., Mitra. D., Chowdhuri, S.K (2018). Studies in Botany (Vol. I, II, III). Moulik Library 18-B, Kolkata.
- Parihar, N.S. (2019). An Introduction to Embryophyta. Surjeet publications. Delhi.
- Singh, V., Pande, P. C. and Jain, D. K., (1997). Embryology of Angiosperms, Rastogi Publications, Meerut.
- Shukla, R.S. & Chandel P.S. (1991). Plant Ecology & Soil Science, S. Chand & Co., New Delhi.
- Verma, S.K. and Verma M (2007) A textbook of Plant Physiology and Biochemistry, S Chand, India
- Malik, C.P. (2014) Plant Physiology, Kalyani Publisher, India.
- Odum, E. P. and Barrett, G. W. (2005). Fundamentals of Ecology, 5th Edition, Cengage Learning, New Delhi, India.
- J.S. Singh, S.P. Singh and S.R. Gupta (2014). Ecology, Environmental Science and Conservation. S.Chand and Company Pvt. Ltd., New Delhi.

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**Paper code: BOT23 SEC001**

**Paper title: Biofertilizers, manures and composting**

**(Credits: 03, Theory-02, Tutorial: 0, Practical-01)**

**Type of paper: Theory + Practical,**

**Course outcomes:**

After completion of the course, students would be able to:

**CO1-Describe** the basic concepts of plant nutrition and importance of different types of fertilizers.

**CO2- Demonstrate** an understanding of the characteristics, preparation and advantages of different types of fertilizers.

**CO3- Appreciate** the benefits and importance of organic fertilizers for sustainable development.

**CO4- Think critically** on use of organic fertilizers in waste management and organic farming and entrepreneurship development.

**CO5-Prepare** organic fertilizers from domestic wastes and apply organic fertilizers for homegrown plants.

**A. Theory**

**(Credit-02)**

Unit	Course content	Lectures
1	Introduction to plant nutrition: Macro and micro nutrients. Types of fertilizers. Organic, inorganic and bio fertilizers. Advantages and disadvantages of the different types of fertilizers.	08
2	Composts: Concept, types, green leaf compost, Composting process and techniques (aerobic and anaerobic), Field application methods, benefits and issues.	08
3	Biofertilizers: Introduction, status and scope. Characteristic features of bacterial bio fertilizers – <i>Anabaena</i> , <i>Rhizobium</i> , <i>Azospirillum</i> , <i>Azotobacter</i> , Mycorrhiza, Phosphate solubilizing bacteria.	08
4	Manure: Concept, composition, types: Farm yard manure, farm slurry, compost manure, green manure, method of collection and processing, application and issues.	08

**B) Practical**

**(Credit:01)**

- Qualitative analysis of N, P and K in soil samples.
- Preparation of Compost.
- Preparation of vermicompost.
- Setting experimental pots for studying efficacy study of Biofertilizers.

**Suggested Readings**

- John Havlin, Samuel L. Tisdale, Werner L. Nelson, James D. Beaton, Pearson, (2014) Soil Fertility and Fertilizers: An Introduction to Nutrient Management



- Epstein, E. (2017) The Science of Composting, United States: CRC Press.
- The Composting Handbook: A How-to and why Manual for Farm, Municipal, Institutional and Commercial Composters. (2021). Netherlands: Elsevier Science.
- ; Kannaiyan, S. K. (2010) Biofertilizers Technology. India: Scientific Publisher (IND.
- Biofertilizers for Sustainable Agriculture and Environment. (2019). Germany: Springer International Publishing.
- Gaur, A. C., Neelakantan, S., Dargan, K. S. (1984) Organic Manures; India: Publications and Information Division, Indian Council of Agricultural Research.

**Paper code: BOT 23VAC1**

**Paper title: Agritourism**

**(Credits: 02, Theory-2, Practical-0)**

**Type of paper: Theory**

**Course Outcome:**

**CO1-** Define agritourism and food tourism and articulate the latest trends

**CO2-** Discuss interdisciplinary academic approaches, theories and success factors for Sustainable agritourism.

**CO3-** Understand the role of value-added products to both tourism and food security.

**CO4-** Link the promotion of sustainability and community resilience to agriculture and tourism and help in revenue generation.

**Theory**

**(Credit:02)**

**Unit I: Introduction:** Background and history of agritourism, introduction, importance, scope, forms of agritourism, advantages and implementation.

**Unit II: Agritourism in India:** Agritourism beyond the Farm, Case studies (at least 5) on agritourism in India, future of agritourism in India.

**Unit III: Prospect of agritourism in Assam -** Factors affecting agritourism in Assam (socioeconomic and geographical factors) on agritourism in Assam, livelihood enhancement through agritourism in Assam.

**Unit IV: Opportunities and Challenges:** Challenges and solution for effective agritourism in India, Entrepreneurship development with special reference to profitable agritourism.

### **Suggested Readings:**

- Food and Agricultural Tourism Theory and Best Practice 1st Edition: Susan L. Slocum & Kynda R. Curtis, CABI Publishing, 2021
- Agritourism: Guide for Beginners ISBN10: Priya Rajesh Parker, ISBN: 9391522432, 2021.
- Agritourism by Michal Sznajder , Lucyna Przezborska-Skobiej , Frank Scrimgeour , ISBN-10 : 1845934822 CABI Publishing,2009
- Agritourism for Sustainable Development. Reflections from Emerging African Economies. Brighton Nyagadza,; Farai Chigora,; Azizul Hassan. ISBN: 978-1-80062-368-2, 2024
- Agriculture Tourism by Jack Randall , Discovery Publishing Pvt.Ltd, ISBN-10 : 8183568912, 2012

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## **UG- SEMESTER II**

**Paper code: BOT23C 201**

**Paper title: PLANT PROPAGATION AND MANAGEMENT**

**(Credits:04, Theory-03, Tutorial-0, Practical-01) Type of paper: Theory+Practical,**

**Course outcomes:**

On completion of this course, the students will be able to

**CO1- Gain knowledge** of gardening, cultivation, multiplication and raising of seedlings of plants.

**CO2- Develop** concepts on new and modern techniques of plant propagation.

**CO3- Recognize** common diseases of nursery plants and **learn** their control measures.

**CO4- Grow** interest in nature and plant life.

**CO5- Develop** knowledge on marketing and management of economically viable plants.

**CO6 Create** opportunities for nursery establishments and **innovate** entrepreneurship ideas.

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**A. Theory**

**(Credit:03)**

<b>Unit</b>	<b>Course content</b>	<b>Lectures</b>
<b>1</b>	<b>Plantation methods:</b> Plantation methods of different types of plants (Seed and tuber propagation, cutting, layering & grafting, micropropagation).	<b>8</b>
<b>2</b>	<b>Irrigation methods ad fertilizers:</b> Pruning, irrigation methods, application of fertilizer, bio fertilizers and growth regulators for plant growth and development.	<b>8</b>
<b>3</b>	<b>Common diseases:</b> Common diseases of nursery plants and their control measures by using plant-based products.	<b>8</b>
<b>4</b>	<b>Weed management:</b> Prevention, cover crops, mowing, flaming, mulches. and soil solarization.	<b>8</b>
<b>5</b>	<b>Entrepreneurship development and business management of Nurseries.</b> Assessment of demand and supply in the market, pricing strategies, estimation of cost and benefits, availing loan, understanding marketing channels, promotion.	<b>8</b>
<b>6</b>	<b>Commercially important nursery plants of Assam</b> (Medicinal, beverage and timber plants).	<b>8</b>

**B. Practical:**

**(Credit: 01)**

- Application of fertilizers, insecticides, and pesticides on plants.
- Methods of cutting, grafting, layering.
- Seeds viability and methods to overcome seed dormancy.

**Suggested Readings:**

- V. Kumar. (2011). Nursery And Plantation Practices in Forestry. Scientific Publishers, Jodhpur.

- A. K. Singh and A. Kumar. (2020) Plant Propagation and Nursery Management. New India Publishing Agency- Nipa.
- T.R. Kumar. (2020). Plant Propagation and Nursery Management. New India Publishing Agency- Nipa.
- L.H. Bailey and R. Chamber. (2018) The Nursery Book: A Complete Guide to the Multiplication of Plants. Createspace Independent Pub.
- J.P. Barua *et al.* (2009). Barea. AICRP on agroforestry: ICAR. Horticultural research station. Assam agricultural university. Kahikuchi, Guwahati.
- O.P. Gupta. (2018). Modern Weed Management (3rd Ed.). Agrobios.

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**Paper code: BOT23M 202**

**Paper title: PTERIDOPHYTES, GYMNOSPERMS AND ANGIOSPERMS**

**(Credits:04, Theory-03, Tutorial-0, Practical-01) Type of paper: Theory+Practical**

**Course outcomes:**

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

**CO1- Demonstrate** conceptual understanding of pteridophytes, gymnosperms and angiosperms, their origin, evolution, and economic importance.

**CO2-Evaluate** conceptual understanding of the aims and objectives of plant taxonomy, ICN classification and role of herbaria.

**CO3-Develop** skills in collecting plant specimens, plant preservation, herbarium preparations and identification of pteridophytes, gymnosperms and angiosperms.

**CO4-Enhance** collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.

**A. Theory**

**(Credit: 03)**

Unit	Course content	Lectures
1	<b>Pteridophytes:</b> General characteristics, classification by Smith (1955), Economic importance, apogamy and apospory, heterospory and origin of seed habit.	08
2	<b>Pteridophytes:</b> Life cycle patterns, life history and comparative account of morphology, anatomy, and reproduction of <i>Selaginella</i> and <i>Pteris</i> .	08

3	<b>Gymnosperms:</b> General characteristics, Classification by Sporne (1975), distribution and economic importance of gymnosperm.	08
4	<b>Gymnosperms:</b> Life history and Comparative account of morphology, anatomy and of <i>Cycas</i> , <i>Pinus</i> and <i>Gnetum</i> .	08
5	<b>Introduction to Angiosperm:</b> general characteristics of dicotyledons and monocotyledons, morphology of vegetative and reproductive parts.	08
6	<b>Palaeobotany:</b> Fossil definition, types, geological time scale, one representation from fossil pteridophyte, gymnosperm and angiosperm.	08

**Practicals:**

(Credits-1)

- Pteridophytes, Study of the sporophytic structures of the following genera by preparation of temporary and permanent slides: *Selaginella* and *Pteris*.
- Gymnosperms: Study of vegetative and reproductive structures of the following taxa through specimens, temporary mounts and permanent slides or fresh material whichever is available: *Cycas*, *Pinus* and *Gnetum*.
- Palaeobotany: one specimen from each group. (from specimen/slides/photographs)
- Practical should be supported by practical record.

**Suggested Readings:**

**a) Pteridophytes:**

- Rashid, A. (1999). Introduction to Pteridophyta.
- Singh, S.K. (2008). Pteridophyta.
- Vasishtha, P.C. (2006) Botany for Degree Students: Vol.IV-Pteridophyta

**b) Gymnosperms:**

- Bhatnagar, S.P. & A. Moitra: Gymnosperms.
- Chamberlain, C.J(2009). Gymnosperm, Structure and Evolution.
- Johri B. & Biswas. (1984) Gymnosperms.
- Vasishta, P.C (2010): Botany for Degree Students :Gymnosperm.

**c) Angiosperm:**

- Mitra.J.N., Mitra. D., Chowdhuri, S.K (2018). Studies in Botany (Vol. one) Mouluk Library 18-B
- Singh G (2021), Plant Systematics - Theory and Practice(4<sup>th</sup> Edition).
- Vasishta, P.C., Taxonomy of Angiosperms.

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**Paper code: BOT 23MDE-203**

**Paper title: INTRODUCTION TO PLANT SCIENCES**

**Credits:03 ;Theory-03, Tutorial-0, Practical-0, Type of paper: THEORY**

**Course outcomes:**

On completion of this course, the students will be able to:

**CO1-Understand** the diversity and general characteristics of living organisms.

**CO2- Gain** knowledge on plant life.

**CO3- Comprehend** the technologies of rDNA technologies.

**CO4- Develop** concepts on bioresources of Assam and conservation techniques.

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**B. Theory**

Units	Course content	Lectures/Hours
1	<b>Diversity &amp; Classification of Living Organisms</b> -Five kingdom concept with special emphasis on Kingdom Plantae.	08
2	<b>Morphology and functions of different organs of flowering Plants:</b> Root, stem, leaf, and flower	08
3	<b>Plant Physiology:</b> Water relation in plants, transpiration, photosynthesis, PGR.	08
4	<b>Reproduction in flowering plants:</b> Pollination, fertilization and post-fertilization events of Angiosperms.	08
5	<b>rDNA technology:</b> Scope, basic technique, and applications of rDNA technology.	08
6	<b>Bioresources and environment:</b> Bioresources of Assam (timbers, medicine, and beverages). Environmental issues and conservation of biodiversity ( <i>Ex-situ</i> and in-situ conservation).	08

**Suggested readings:**

- Mitra. J.N., Mitra. D., Chowdhuri, S.K (2018). Studies in Botany (Vol. I, II, III). Moulik Library 18-B, Kolkata.

- Parihar, N.S. (2019). An Introduction to Embryophyta. Surjeet publications. Delhi.
- Singh, V., Pande, P. C. and Jain, D. K., (1997). Embryology of Angiosperms, Rastogi Publications, Meerut.
- Shukla, R.S. & Chandel P.S. (1991). Plant Ecology & Soil Science, S. Chand & Co., New Delhi.
- Verma, S.K. and Verma M (2007) A textbook of Plant Physiology and Biochemistry, S Chand, India
- Malik, C.P. (2014) Plant Physiology, Kalyani Publisher, India.
- Odum, E. P. and Barrett, G. W. (2005). Fundamentals of Ecology, 5th Edition, Cengage Learning, New Delhi, India.
- J.S. Singh, S.P. Singh and S.R. Gupta (2014). Ecology, Environmental Science and Conservation. S.Chand and Company Pvt. Ltd., New Delhi.

\*\*\*\* The paper title and course content of the MDE paper will remain same in all semesters. Only the paper code will change as per semester.

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**Paper code: BOT23 SEC 002**

**Paper title: MUSHROOM TECHNOLOGY**

**(Credits: 03, Theory-2, Tutorial-0, Practical-1) Type of Paper: Theory+Practical**

**Course outcomes:**

On completion of this course, the students will be able to:

**CO1-Identify** edible types of mushroom.

**CO2-Gain** the knowledge of cultivation of different types of edible mushrooms and spawn production

**CO3-Manage** the diseases and pests of mushrooms.

**CO4-Develop** skills to cultivate mushroom and learn a means of self-employment and income generation.

**CO5-Enhance** collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.

**A) Theory**

**(Credit-02)**

Unit	Content	Lecture
1	<b>Introduction to mushrooms:</b> Scope of mushroom cultivation, edible and poisonous Mushrooms – vegetative characters. Study of common edible mushrooms: Button mushroom, Milky mushroom, Oyster mushroom and Paddy straw mushroom.	8
2	<b>Cultivation of mushroom:</b> Detailed process of cultivation of oyster and paddy straw mushroom. Problems in cultivation - diseases, pests and nematodes, weeds and their management strategies.	8
3	<b>Economic importance of mushrooms:</b> Nutritional, antinutritional and medicinal properties of mushrooms, role of mushroom in agriculture and environment.	8
4	<b>Post harvest technology:</b> Harvesting and preservation of mushrooms, value added products of mushrooms.	8

#### B) Practical

(Credit-1)

- To study basic layout of mushroom house, its sterilization and sanitation process.
- To study about basic instruments and substrates used in mushroom culture.
- Preparation of mother culture, media preparation, inoculation, incubation and spawn production
- Cultivation of mushroom (*Pleurotus sp* and *Agaricus bisporus*) using suitable substrate

#### Suggested readings

- Nita Bhal. (2000). Handbook on Mushrooms. 2nd ed. Vol. I and II. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
- Pandey R.K, S. K Ghosh, 1996. A Hand Book on Mushroom Cultivation. Emkey Publications.
- Tripathi, D.P. (2005) Mushroom Cultivation, Oxford & IBH Publishing Co. PVT.LTD, New Delhi.
- Anupama PP and Mundaraj GR( 1st Eds) 2022, Biotechnology of Mushroom, Bhumi Publishing.
- Arya, A., & Rusevska, K. (Eds.). (2022). Biology, Cultivation and Applications of Mushrooms. Springer.

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## UG- Semester III

Paper code: BOT23 C 301

Paper title: NON-VASCULAR CRYPTOGRAMS

(Credits: 04, Theory-3, Tutorial-0, Practical-1), Type of paper: Theory +Practical



**Course outcomes:**

On completion of this course, the students will be able to:

**CO1: Understand** the distribution, characteristic features, life cycles, and economic importance of non-vascular cryptogams.

**CO2: Inculcate** scientific skills to study the specimens of non-vascular cryptogams in laboratory.

**CO3: Enhance** collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.

**CO4: Develop** practical skills to identify, classify and distinguish non-vascular cryptogams.

**A) Theory****(Credit-03)**

Unit	Course content	Lectures
1	<b>Algae general features:</b> Range of thallus organization, reproduction, classification (Fritsch, 1956), economic importance of algae.	08
2	<b>Algae life cycle:</b> Life cycles of Cyanophyceae- <i>Anabaena</i> ; Chlorophyceae- <i>Chara</i> , Bacillariophyceae-(General account of Diatoms) Phaeophyceae- <i>Ectocarpus</i> , Rhodophyceae- <i>Polysiphonia</i> .	08
3	<b>Fungi Introduction:</b> General characteristics; Thallus organization; Cell structure; Nutrition; and heterothallism and phylogeny. Classification (Ainsworth, 1973), and Economic importance.	08
4	<b>Fungal life-cycle:</b> <i>Phytophthora</i> , <i>Saccharomyces</i> , <i>Penicillium</i> , <i>Agaricus</i> , <i>Fusarium</i> .	08
5	<b>Lichen:</b> Occurrence; General characteristics and range of thallus organization; reproduction and economic importance of lichens.	08
6	<b>Bryophytes:</b> Classification, alternation of generation, origin and evolution of sporophyte, economic importance of bryophytes. Life cycle of <i>Marchantia</i> , <i>Anthoceros</i> and <i>Funaria</i> .	08

**B) Practicals:****(Credits: 1)**

- Study of vegetative and reproductive structure through temporary preparations and permanent slides of the following available algal types- *Anabaena*, *Chara*, *Ectocarpus*, *Polysiphonia*.
- Study of vegetative and reproductive structure through temporary preparations of the following available fungal types- *Phytophthora*, *Saccharomyces*, *Penicillium*, *Agaricus*, *Fusarium*.

- Study of thallus forms of lichens.
- Study of the gametophyte and sporophytes of *Marchantia*, *Anthoceros* and *Funaria*.
- Practical should be supported by practical records/slides and specimens.

### Suggested Readings:

#### Algae:

- Bold, H.C. and Wayne, M.J. Introduction to Algae (2nd edition). Prentice Hall, New Jersey
- Delhi.
- Fritsch, F. E. (1961), Structure and reproduction in algae, Vol- I, & II. Cambridge University.
- Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
- Sambamurty, A. A Text Book of Algae. I.K. International Pvt. Ltd., New Delhi.
- Sharma. O.P. (2011). Text book of Algae. Tata Mc Graw Hill Education Pvt. Ltd., New
- Vashishta B.R., Sinha A. K., V. P. Singh .Botany for Degree student- Algae. S. Chand and Company.

#### Fungi:

- Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
- Sharma, O.P. (2011). Fungi and allied microbes. Tata McGraw Hill Pvt Ltd., New Delhi.
- Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
- Vashishta B.R., Revised by Sinha A. K., (2003), Botany for Degree student- Part II- Fungi . S. Chand and Company.

#### Lichen:

- Nash, T. H. 1996. Lichen Biology. Cambridge University Press, London Gupta, P and Sinha G P. (2018), The Lichen Flora of Assam, Scientific Book Publications.

#### Bryophytes:

- Chopra, R. N and Kumar, P. K. (1988). Biology of Bryophytes. New Age International Publishers, New Delhi.
- Goffinet B and Jonathan Shaw, A. (2009). Bryophyte Biology. Cambridge University Press, New York.
- N. S. Parihar, (2013). An Introduction to Embryophyta. Vol. I Bryophyta, Surjeet Publication, New Delhi.
- Rashid, A. (1998). An Introduction to Bryophyta. Vikas Publishing House, Pvt. Ltd., New Delhi.
- Watson, E. V. (2015). The structure and life of Bryophytes. Scientific Publication, Jodhpur, India.

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**Paper Code: BOT23C 302**

**Paper title: INSTRUMENTATION AND LABORATORY TECHNIQUES**

**(Credits: 04, Theory- 3, Tutorial-0, Practical-01) Type of paper: Theory + Practical**

**Course outcomes:**

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

**CO1: Understand** the working principles of microscopy, chromatography, spectrophotometer, pH meter and micrometry.

**CO2: Prepare** stains, standard solutions and biochemical reagents.

**CO3: Comprehend** the mechanism of action of biochemical, histochemical, and cytological stains.

**CO4: Analyse** data by descriptive and inferential statistics and to prepare graphs and tables on MS excel.

**CO5: Develop** knowledge on scientific writing, presentation and ethics.

**CO6: Enhance** collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.

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**A) Theory**

**(Credit: 03)**

<b>Unit</b>	<b>Content</b>	<b>Lecture</b>
<b>1</b>	<b>Microscopy and Imaging techniques:</b> Principles and application of microscopy (Light microscopy and Electron microscopy).	<b>8</b>
<b>2</b>	<b>Basic laboratory instruments:</b> Principles and applications of hot air oven, incubators, autoclave, and laminar air flow chamber, centrifuge, Spectrophotometry: Principle and its application in biological research.	<b>8</b>
<b>3</b>	<b>Chromatography:</b> Principles, types and applications with special emphasis on – Paper chromatography, TLC.	<b>8</b>
<b>4</b>	<b>Basic Laboratory Techniques:</b> Basic plant and microbe culture media and methods of sterilization, concept of solutions, indicators, pH and buffers. Field and herbarium techniques, preservation of museum and herbarium specimens, preservation techniques for special types of plant (bryophytes, aquatic plants, succulents and xerophytes, palm, canes and bamboos).	<b>8</b>
<b>5</b>	<b>Plant microtechniques:</b> General account of dyes and stains; Types and sources, mechanism of action, histochemical techniques.	<b>8</b>
<b>6</b>	<b>Data analysis and presentation techniques:</b> Descriptive (Measure of central tendency and dispersion) and inferential (Test of significance: t-test and $\chi^2$ test). Scientific writing and its representations: Writing references, power-point presentation, poster presentation. Scientific writing and ethics.	<b>8</b>

**B) Practical:****(Credits: 1)**

- Spore measurement by micrometry,
- Aseptic techniques
- Preparation of solutions (normal, molal, molar, ppm and percent solutions) and serial dilution.
- Preparation of reagents, fixatives, stains and indicators (atleast two each).
- Preparation of permanent slides (double staining).
- Measurement of pH using pH metre (water and soil).
- Preparation of buffers (phosphate/ acetate buffer).
- Preparations of tables and graphs using MS Excel
- Calculation of mean, mode, median, SD, SE from the supplied data.
- Practical should be supported by practical record.

**Suggested Readings**

- Harborne JB (1998). Phytochemical Methods A Guide to Modern Techniques of Plant Analysis: JB. Springer.
- Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata
- McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.
- Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford
- University Press, New York. U.S.A.
- Wilson, K. & Walkar, J (Eds) (2000) Practical Biochemistry: Principles &
- Techniques, Cambridge University Press.

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**Paper code: BOT 23M303****Paper title: PLANT TAXONOMY AND ECOLOGY****(Credits: 04, Theory- 3, Tutorial-0, Practical-1)      Type of paper: Theory +Practical****Course outcomes:**

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

**CO1: Develop** an understanding of different concepts, categories and approaches in Plant identification.

**CO2: Analyse** the role and activities of Botanical Survey of India and Identify the sources of taxonomic characters in different disciplines.

**CO3: Interpret** the rules of ICN in relevant aspects of botanical nomenclature.

**CO4: Explain** different forms of taxonomic literature

**CO5: Enhance skill** in the adopting methods and specific techniques suitable for identification of locally available different groups of plants

**CO6: Grow** conceptual understanding of interrelationships between organisms and environment.

**CO7: Understand** ecological succession and adaptations and method for studying vegetations.

**CO8: Gain** knowledge about different functions of ecosystem.

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**A) Theory**

**(Credit: 03)**

<b>Unit</b>	<b>Content</b>	<b>Lecture</b>
1	<b>Introduction to Taxonomy:</b> Aim and objectives, components of taxonomy, relevances of plant taxonomy today, approach of different classification systems, APG in plant classification, ICN- salient features.	8
2	<b>Plant Description and Identification:</b> Botanical terminology for description. General characters, distinguishing characters and economic importance of the following families- Magnoliaceae, Solanaceae, Lamiaceae, Asteraceae, Poaceae.	8
3	<b>Role of different branches in plant taxonomy-:</b> Morphology, anatomy, palynology, cytology, phyto-chemistry, numerical taxonomy, molecular biology.	8
4	<b>Plants and Environment:</b> Basic concept of ecology, ecological organization. Ecological factors – climatic factors (light and water). Ecological adaptations – Hydrophytes and Xerophytes.	8
5	<b>Population and Community Ecology:</b> Introduction to population and its characteristics (population density, natality, mortality and population growth curves). Introduction to community and its characteristics (frequency, density, abundance).	8
6	<b>Ecosystem and Ecological Succession:</b> Introduction and types of ecosystems with examples (terrestrial and aquatic, natural and artificial). Food chain, food web, energy flow, Biogeochemical cycles (Carbon and nitrogen cycle), concept of ecological	8

	pyramids. Succession definition, types - primary and secondary, causes, mechanism, stages of succession (with special reference to Hydrosere).	
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**B) PRACTICALS:**

**(Credit:01)**

- Quantitative analysis of density and frequency of herbaceous vegetation by quadrat method
- Study of ecological adaptations
  - i. Hydrophytes - *Hydrilla*, *Eichhornia* and *Nymphaea*
  - ii. Xerophytes: *Nerium*, *Aloe* and *Asparagus*.
- Herbarium techniques for common and special type of plants (hydrophytes, succulent, and xerophytes).
- Practicals should be supported by practical record, specimen and herbarium (at least ten).

**Suggested Readings:**

**Plant Taxonomy:**

- Mitra, J.N., Mitra. D., Chowdhuri, S.K (2018). Studies in Botany(Vol. one) Moulik Library 18-B
- Singh G (2021), Plant Systematics - Theory and Practice(4th Edition).
- Vasistha, P.C., Taxonomy of Angiosperms.

**Plant Ecology:**

- Ambasht, R.S. (1974) - A text book of plant ecology (3rd Edn.) Students' Friends & Co., Varanasi, India.
- Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4<sup>th</sup> edition.
- Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India

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**Paper code: BOT23MDE-304**

**Paper title: INTRODUCTION TO PLANT SCIENCES**

**Credits:03 ( Theory-03, Tutorial-0, Practical-0, Type of paper: THEORY**

**Course outcomes:**

On completion of this course, the students will be able to:

**CO1-Understand** the diversity and general characteristics of living organisms.

**CO2- Gain** knowledge on plant life.

**CO3- Comprehend** the technologies of rDNA technologies.

**CO4- Develop** concepts on bioresources of Assam and conservation techniques.

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**A) Theory**

**(Credit:03)**

Units	Course content	Lectures/Hours
1	<b>Diversity &amp; Classification of Living Organisms</b> -Five kingdom concept with special emphasis on Kingdom Plantae.	08
2	<b>Morphology and functions of different organs of flowering Plants:</b> Root, stem, leaf, and flower	08
3	<b>Plant Physiology:</b> Water relation in plants, transpiration, photosynthesis, PGR.	08
4	<b>Reproduction in flowering plants:</b> Pollination, fertilization and post-fertilization events of Angiosperms.	08
5	<b>rDNA technology:</b> Scope, Basic technique, and applications of rDNA technology.	08
6	<b>Bioresources and environment:</b> Bioresources of Assam (timbers, medicine, and beverages). Environmental issues and conservation of biodiversity (Ex-situ and in-situ conservation).	08

#### Suggested readings:

- Mitra. J.N., Mitra. D., Chowdhuri, S.K (2018). Studies in Botany (Vol. I, II, III). Moulik Library 18-B, Kolkata.
- Parihar, N.S. (2019). An Introduction to Embryophyta. Surjeet publications. Delhi.
- Singh, V., Pande, P. C. and Jain, D. K., (1997). Embryology of Angiosperms, Rastogi Publications, Meerut.
- Shukla, R.S. & Chandel P.S. (1991). Plant Ecology & Soil Science, S. Chand & Co., New Delhi.
- Verma, S.K. and Verma M (2007) A textbook of Plant Physiology and Biochemistry, S Chand, India
- Malik, C.P. (2014) Plant Physiology, Kalyani Publisher, India.
- Odum, E. P. and Barrett, G. W. (2005). Fundamentals of Ecology, 5th Edition, Cengage Learning, New Delhi, India.
- J.S. Singh, S.P. Singh and S.R. Gupta (2014). Ecology, Environmental Science and Conservation. S.Chand and Company Pvt. Ltd., New Delhi.

\*\*\*\* The paper title and course content of the MDE paper will remain same in all semesters. Only the paper code will change as per semester.

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**Paper code: BOT23 SEC 003**

**Paper title: Techniques in Plant Identification and plant Preservation**

**Credits: 03 (L+T+P); Theory-02, Tutorial: 0, Practical-01, Type of paper: Theory+Practical,**

**Course outcomes:**

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

**CO1: Develop** an understanding of different concepts, categories and approaches of plant classification.

**CO2: Identify** the sources of taxonomic characters in different disciplines

**CO3: Understand** the importance of ICN in botanical nomenclature.

**CO4: Explain** different forms of taxonomic literature

**CO5: Learning** the methods and techniques of identification of different group of plants.

**CO6: Develop** skills in adopting specific techniques suitable for identification of locally available plants of different groups.

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**A. Theory**

**credit-02**

<b>Unit</b>	<b>Course content</b>	<b>Lectures</b>
1	<b>Principles of plant Identification and ICN</b> Aim and objectives of taxonomy, Concept and approach of different classificatory systems and APG in plant classification. Plant nomenclature and ICN- salient features, Concept of taxonomic rank.	08
2	<b>Data collection and Approaches in Identification.</b> Morphology, anatomy, palynology, cytology, phyto-chemistry, numerical taxonomy, molecular biology. Algae, fungi, lichen, bryophytes, pteridophytes, gymnosperms and angiosperms	08
3	<b>Techniques in Plant preservation and their implication.</b> Field and herbarium techniques, preservation of museum and herbarium specimens, preservation techniques for lower and higher group of plants.	08
4	<b>Taxonomic literature.</b> General reference, classical literature, Illustration, Icons; Important state, regional and all India floras, journals, manual, monograph, revision, herbaria, online resources.	08

**B. Practical**

**(Credit-01)**



- Collection and preservation of different groups of locally available plants at least one in each of the following-

- |              |                  |
|--------------|------------------|
| 1. Algae     | 5. Pteridophytes |
| 2. Fungi     | 6. Gymnosperm    |
| 3. Lichen    | 7. Angiosperm    |
| 4. Bryophyte |                  |

- Study and identification (using different techniques learned in theory) of at least one specimens of locally available plants belonging to each of the following-

- |              |                  |
|--------------|------------------|
| 1. Algae     | 5. Pteridophytes |
| 2. Fungi     | 6. Gymnosperm    |
| 3. Lichen    | 7. Angiosperm    |
| 4. Bryophyte |                  |

**Practicals should be supported by Field report, practical record, specimen and herbarium (at least two).**

**Suggested reading:**

- John, D. M.,Whitton, B.A and Brook, A. J.(eds.). 2018. The Freshwater Algal Flora of the British Isles: An Identification guide to fresh water and terrestrial algae.
- Vashishta, B.R. 2010. Botany for degree students —Algae.
- Aneja, K. R. 2003. Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International(P) Limited Punlishers. New Delhi.
- Barnett, H.L. Illustrated Genera of Imperfect Fungi. Burgess Publishing CO. 426 South Sixth StreetMinneapolis 15, Minn.
- Richmond Publishing, Slough. 480 pp. The best overall field identification guide for Britain & Ireland.
- Rashid, A. 1998. An Introduction to Bryophyta. Vikas Publishing House.
- Chaudhary, B.L., Sharma, T. P. and Sukhadia, M.L. 2006. Bryophyte Flora of Gujarat (India). Himanshu Publication.
- Vasishta, P.C 2010. Gymnosperm.
- James W. Byng. 2015. The Gymnosperms Handbook: A practical guide to extant families and genera of the world. Plant Gateway Ltd.
- Singh, G. 2012. Plant Systematics: Theory and Practice. Completely revised and enlarged 3rd edition. Oxford & IBH, New Delhi..
- Simpson, M. 2018. Plant Systematics (3rd Edition). Elsevier Academic Press. Amsterdam Boston Heidelberg London, New York Oxford Paris San Diego,San Francisco Singapore Sydney Tokyo.

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# UG- Semester IV

Paper code: BOT23C401

Paper title: VASCULAR CRYPTOGRAMS and GYMNOSPERM

(Credits:04, Theory-3, Tutorial-0, Practical-1)

Type of paper: Theory+Practical

## Course outcomes:

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

**CO1: Describe** pteridophytes and gymnosperms and understand their life cycle.

**CO2: Explain** the economic importance and evolutionary trends of vascular cryptogams and gymnosperm.

**CO3: Develop** skills to identify pteridophytes and gymnosperms based on morphological and anatomical features.

**CO4: Demonstrate** an understanding of fossilisation and the fossilised members.

**CO5: Exhibit** proficiency in the experimental techniques and methods to study pteridophytes and gymnosperms.

**CO6: Enhance** collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.

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## A) Theory

credit-03

Unit	Content	Lecture
1	<b>Pteridophytes:</b> Characteristics features and life cycle of Pteridophytes; Apogamy and Apospory.	8
2	<b>Classification</b> with special reference to Wardlaw (1955), ecological significance, stelar structure, origin and evolution of pteridophytes, heterospory and origin of seed habit.	8
3	<b>Comparative account</b> of morphology, anatomy and reproduction of <i>Psilotum</i> , <i>Lycopodium</i> , <i>Selaginella</i> , <i>Equisetum</i> , <i>Marsilea</i> and <i>Pteris</i> .	8
4	<b>Gymnosperms:</b> Classification of gymnosperms with special reference to Sporne classification (1965); resemblances and differences of gymnosperms with pteridophytes and angiosperms.	8

5	<b>Comparative account</b> of morphology, anatomy and reproduction of <i>Cycas</i> , <i>Pinus</i> , <i>Ginkgo</i> and <i>Gnetum</i> .	<b>8</b>
6	<b>Fossils:</b> Definition, types, nomenclature, fossilization; geological time scale. General account of Psilophytales ( <i>Rhynia</i> ), Lepidodendrales ( <i>Lepidodendron</i> ), Sphenophyllales ( <i>Sphenophyllum</i> ) and Bennetitales ( <i>Williamsonia</i> ).	<b>8</b>

## B) PRACTICALS

(Credits-1)

1. Study of vegetative and reproductive structures of the following taxa through temporary mounts / permanent slides- *Psilotum*, *Lycopodium*, *Selaginella*, *Equisetum*, *Marsilea* and *Pteris*.
2. Study of vegetative and reproductive structures of the following taxa- *Cycas*, *Pinus*, *Ginkgo* and *Gnetum* (through temporary mounts / permanent slides).
3. Study of Fossil forms using specimen / slides / photographs - *Rhynia*, *Lepidodendron*, *Sphenophyllum* and *Williamsonia*.

### Suggested readings:

#### Pteridophyta:

- Dutta A.C. 2016. Botany for Degree Students. Oxford University Press.
- Pandey, B. P. 2006. College Botany, Vol. II: Pteridophyta,
- Gymnosperms and Paleobotany.S. Chand & Company Ltd, New Delhi.
- Rashid A., (1999). An Introduction to Pteridophyta, Vikas Publishing House Ltd.
- Vasishtha, P.C. (2006) Botany for Degree Students: Vol.IV- Pteridophyta

#### Gymnosperm:

- Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
- Chamberlain, C.J.: Gymnosperms: Structure and evolution, (CBS publishers and distributors)
- Karkar, R.K. and Karkar, R.: The Gymnosperms
- Sporne, K.R.(1961): The Morphology of Gymnosperms,(Hutchinson University Library, London)
- Stewart, W.N. & Rothwell, G.W.: Paleobotany and evolution of plants, (Cambridge University Press)
- Vashishta, P.C.(1990): Gymnosperm, (S.C. Chand).

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Paper code: BOT23C402

Paper Title: ADVANCED MORPHOLOGY AND PLANT ANATOMY

(Credits: 04, Theory- 3, Tutorial-0, Practical-1)

Type of paper: Theory+Practical

**Course outcomes:**

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

**CO1: Develop** a conceptual understanding of plant anatomy, organization of shoot and root apex and angiosperm evolution.

**CO2: Analyse** the anatomical composition of different parts of plants and their relationships.

**CO3: Identify** special types of inflorescences, fruits, secondary growth and anomalous secondary growth in plant.

**CO4: Develop** skills of section cutting and preparation of permanent slides

**CO5: Enhance** collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.

**A) Theory****(Credit:03)**

Unit	Content	Lecture
1	<b>Advanced morphology:</b> Origin and evolution of angiosperms, inflorescence and angiospermic flowers, concept of flower as modified determinate shoot , special types of fruits: Spurious fruits ( <i>Dillenia</i> ) ; Aggregate fruits ( <i>Annona</i> , <i>Michelia</i> , <i>Catharanthus</i> , <i>Polyalthia</i> ); Multiple fruits ( <i>Ananas</i> , <i>Artocarpus</i> ). Homology and analogy of plant parts.	8
2	Theories and the development of leaf, stamen and carpel (Phyllode theory, Telome theory, Carpel polymorphism, Inferior ovary), role of morphology in plant classification.	8
3	Structure and function of cell wall and plasma-membrane, extra cell wall materials - lignin, cutin, suberin, callose, wax.	8
4	<b>Tissues and tissue system:</b> Theories of structural organisation of root apex and shoot apex. Different types of tissue and tissue systems and their functions, mechanical tissue.	8
5	<b>Leaf, stem and root anatomy:</b> Leaf anatomy, anatomy of primary monocot and dicot stems/roots, anomalous structure in the primary body of stem.	8
6	<b>Secondary growth:</b> Secondary and anomalous secondary growth in monocot and dicot stems with special reference to ( <i>Bignonia</i> , <i>Amaranthus</i> , <i>Tecoma</i> and <i>Dracaena</i> .)	8

**B) Practicals :****(Credits- 1)**

1. Study of special types of inflorescences - Cyathium, Hypanthodium, Verticillaster.
2. Study of special types of fruits - *Dillenia*, *Annona*, *Michelia*, *Catharanthus*, *Polyalthia*, *Ananas*, *Artocarpus* .
3. Study of anatomical details of the following through permanent slides/temporary stain mounts/ macerations/specimens with the help of suitable examples-stomatal types, trichomes, xylem and phloem elements.
4. Study of primary structures of monocot and dicot root and stem.
5. Study of anomalous structure in the primary body of stem - *Bougainvillea*, *Nyctanthes* and *Oryza*.
6. Study of anomalous secondary growth in *Bignonia*, *Amaranthus*, *Tecoma* and *Dracaena*.
7. Practicals should be supported by practical record/slides and specimens

**Suggested readings:****Advanced morphology:**

- Mitra J.N. (1988), An introduction to systematic Botany and Ecology, The world press private Ltd., Calcutta
- Eames, A.J.(1983), Morphology of Vascular plants, Standard University press.

**Plant anatomy:**

- Abraham, F. (1982). Plant Anatomy 3 editions, Pergaon Press, Oxford.
- Roy P (2010) Plant Anatomy, New Central Book Agency.
- Pandey B.P. (2001). Plant Anatomy. S. Chand and Company Ltd., New Delhi.
- Cutter, E. G. (1971). Plant Anatomy - Part I & II, Cell and Tissues. Edward Arnold, London.
- Easu, K. (1996). Anatomy of Seed Plants. First wiley Reprint, New Delhi.
- Fahn, A. (1985). Plant anatomy, Pergaon Press, Headington Hill Hall, Oxford.

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**Paper code: BOT23C 403****Paper title: REPRODUCTIVE BIOLOGY AND EVOLUTION****(Credits: 04, Theory-3, Tutorial-0, Practical-1)      Type of paper: Theory+ Practical****Course outcomes:**

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

**CO1: Conceptualize** reproductive development in plant, pollination and fertilization process, apomixis and polyembryony in plant.

**CO2: Draw** knowledge on theories of evolution, variation, speciation and polymorphism in plant.

**CO3: Develop** experimental proficiency in study of anthers, pollen grain through slide preparation, dissection of embryo from developing seeds.

**CO4: Enhance** collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.

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**A) Theory**

**(Credit:03)**

Unit	Content	Lecture
1	<b>Introduction:</b> Structure of anther and pollen- microsporogenesis and development of male gametophyte, pollen morphology and NPC system. Structure and types of ovules, megasporogenesis and development of female gametophyte, Types of embryo sacs, organization and ultrastructure of mature embryo sac.	08
2	<b>Pollination and Fertilization:</b> Pollination - Types, mechanisms and adaptations, double fertilization.	08
3	<b>Post fertilisation events:</b> Endosperm - Types, structure, and functions. Development of dicot and monocot embryo.	08
4	<b>Apomixis and Polyembryony:</b> Definition, types and practical applications.	08
5	<b>Evolution:</b> Evidences, theories and mechanism of evolution. Hardy–Weinberg equilibrium (gene and genotype frequency, genetic drift). Micro and macroevolution. Comprehensive overview of concept of evolution, origin of life, theories of evolution (Lamarckism, Darwinism, Neo-darwinism and Modern synthetic theory), evidences of evolution, variation and phylogenetic analysis.	08
6	<b>Variation, polymorphism and speciation:</b> Variations: Causes and consequences of variations and polymorphism. Isolation mechanism and speciation.	08

**B) Practical:**

**(Credit-1)**

1. Structure of anther: young and mature, tapetum: amoeboid and secretory (slides/photographs/specimen).
2. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous; female gametophyte of *Polygonum* (monosporic type) (slides / photographs / specimens).

3. Types of pollination (anemophily, entemophily and hydrophily) and seed dispersal mechanisms (including appendages, aril, caruncle) (permanent slides /photographs /specimens).
4. Numericals on Hardy-Weinberg equation.
5. Practicals should be supported by practical record, field report, slides/specimens/ herbarium whichever is applicable.

**Suggested Readings:**

**Embryology of Angiosperm:**

- Singh, V., Pande, P. C. and Jain, D. K., (1997). Embryology of Angiosperms, Rastogi Publications, Meerut.
- Ganguly, A. K. and Kumar, N.C., (2008). Developmental and Experimental Embryology of Angiosperms. Emkay Publications, Delhi.
- Bhojwani, S. S. and Bhatnagar, S. P., (2009). The Embryology of Angiosperms, Vikas Publishing House Pvt. Ltd., New Delhi.
- Maheswari P, (1971). An Introduction to the Embryology of Angiosperms. Tata McGraw Hill Publishing Co., Ltd., New Delhi.
- Pandey, B. P., (1995). Embryology of Angiosperms. S Chand & Co. New Delhi.

**Evolution:**

- Stewart W.N. and Rothwell G.W. (2005). Paleobotany and the Evolution of Plants. 2nd Edn. Cambridge University Press.
- Verma P.S and Agarwal V.K. (2006) Cell Biology, Genetics, Molecular Biology, Evolution, Ecology. S. Chand and Company, New Delhi.

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**Paper code: BOT23M 404**

**Paper Title: Plant Physiology and Molecular Biology**

**(Credits: 04, Theory- 03, Tutorial-0, Practical-01) Type of paper: Theory+Practical**

**Course outcomes:**

On completion of this course, the students will be able to:

**CO1-Develop** a conceptual understanding of plant water relation, mineral nutrition, plant metabolism, plant growth regulators, translocation and photoperiodism in plant.

**CO2-Perform** experiments to correlate physiological processes with plant functioning.

**CO3-Grow** experimental proficiency in isolation, separation and quantification of plant pigments and estimation of amylase activity in seed.

**CO4-Enhance** collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.

**CO5- Gain** knowledge of nucleic acids and various experiments related to their discovery.

**CO6- Understand** the concept of genetic code and gene regulation.

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**A) Theory**

**(Credit-03)**

Unit	Content	Lecture
1	<b>Mineral nutrition in plants:</b> Micro and Macronutrients. Role of minerals in plants (deficiency symptoms, disease and function).	<b>08</b>
2	<b>Transport in Plants:</b> Water relations in plants; Diffusion, osmosis, plasmolysis, imbibition, ascent of sap, transpiration, Active and passive transport in plants. Various theories of translocation of phloem. Concept of Source-sink relationship.	<b>08</b>
3	<b>Plant metabolism:</b> Photosynthesis - History, significance, Light reaction and Dark reaction, Photosynthetic pigments, Factors affecting photosynthesis in plants. Respiration - Glycolysis, anaerobic respiration, TCA cycle, electron transport system. Nitrogen metabolism - Nitrate reduction and biological nitrogen fixation in legume plant.	<b>08</b>
4	<b>Growth and development:</b> Seed dormancy, Seed germinations, Fruit ripening, Physiology of flowering (Photoperiodism, Phytochrome and vernalization in plants). Plant growth regulators: Discovery and function of Auxin, Gibberellin, Cytokinin, ABA and Ethylene in plant.	<b>08</b>
5	<b>Nucleic Acid:</b> Historical perspective; DNA as the carrier of genetic information (Griffiths, Hershey & Chase, Avery, McLeod & McCarty), DNA: structure function and replication, RNA: types, structure and functions.	<b>08</b>
6	<b>Genetic code and gene regulation:</b> Properties of genetic code, Protein: structure and organization, regulation of gene expression in prokaryotes (Lac operon).	<b>08</b>

**B) Practical :**

**(Credit-1)**

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Determination of water potential of given tissue (potato tuber) by weight method.
3. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
4. Separation of photosynthetic pigments by paper chromatography.



5. Determination of photosynthetic pigments from leaf using spectrophotometer.
6. Effect of carbon dioxide on the rate of photosynthesis.
7. To compare the rate of respiration in plants.
8. DNA quantification using diphenylamine test.
9. Quantification of protein from plant sample.

**Practicals should be supported by practical record, field report, slides/specimens/ herbarium whichever is applicable.**

### **Suggested Readings**

#### **Plant Physiology:**

- Buchanan, B.B. Gruissem, W. and Jones, R.L. 2004. Biochemistry and Molecular Biology of plants. I.K. International PVT., New Delhi.
- Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U. S.A. 4th edition.
- Moore, T.C. 1989. Biochemistry and physiology of Plant Hormones. 2<sup>nd</sup> edition. Springer - Verlag, New York, USA.
- Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A (2015). Plant Physiology and Development.

#### **Molecular Biology**

- Gupta P.K. Cell and Molecular Biology (2017) Fifth edition – Rastogi Publications.
- Verma, P. S. and V. K. Agrawal (2004). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand & Company Ltd., New Delhi.

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## **UG Vth Sem**

**Paper code: BOT23C 501**

**Paper title: GENETICS AND PLANT BREEDING**

**(Credits: 04, Theory- 3, Tutorial-0, Practical-1)**

**Type of paper: Theory+Practical**

### **Course outcomes:**

After completing this course, the student's will be able to:

**CO1: Understand** the principles of inheritance.

**CO2: Comprehend** Inheritance pattern, gene interactions expression of characters.

**CO3: Know** theories of linkage and crossing over.

**CO4: Develop** skills in the study of cytological stain and cell division.

**CO5: Enhance** collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.

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**A) Theory**

**(Credit:03)**

Unit	Content	Lecture
1	<b>Principles of inheritance:</b> Mendel's law, allelic and non-allelic gene interaction, quantitative, cytoplasmic, multiple allele and sex-linked inheritance, epigenetics.	8
2	<b>Linkage and crossing over:</b> Concept and theories of Linkage; coupling and repulsion, crossing over, cytological basis of crossing over, recombination frequency and genetic map	8
3	<b>Mutation:</b> mutation and mutagens, structural chromosomal mutation gene mutation (tautomerism and base analogue) and biochemical mutation.	8
4	<b>Principles of population genetics:</b> Allele and Genotype Frequencies, Hardy-Weinberg Equilibrium, Genetic Drift, Coalescent Theory, Gene Flow and Subdivision.	8
5	<b>Plant Breeding :</b> Plant introduction domestication and selection (pure line , mass selection and inbred line selection ) , hybridization, heterosis and inbreeding depression , role of polyploidy in crop evolution.	8
6	<b>Plant Type concept:</b> Plant type concept in plant improvement, breeding methods and improved varieties of Rice, wheat, maize and legumes.	8

**B) Practical**

**(Credit-1)**

1. Interpret the Mendel's principles; and understand the monohybrid and dihybrid crosses and their ratio.
2. Studies on effect of chemical mutagens on plant (morphology and cytology)
3. Studies on Emasculation and plant hybridization technique.
4. Studies on crossover frequencies and Construction of genetic map.
5. Studies on some improved plant varieties (Rice, Maize, wheat and legumes)
6. Numerical on gene interactions.

**Practicals should be supported by practical record, field report, slides/specimens/ herbarium whichever is applicable.**

**Suggested Readings:**

- Gupta P.K. Cell and Molecular Biology (2017) Fifth edition – Rastogi Publications.
- Singh S P & B.S. Tomar (2015) Cell Biology -Rastogi Publications
- Power CB (2010). Cell Biology - Himalay Publishing House
- Elrod S. & Stansfield W. (2004) Genetics, Tata McGraw Hill.
- Strickberger M. W (2008), Genetics, PHI learning Pvt. Ltd.
- Tamarin R. H. (2006) , Principles of Genetics- Tata McGraw Hill
- Choudhury R. C.(2017) Introduction to Principles of Plant Breeding-2<sup>nd</sup> Edition, Oxford & IBH publishing
- Singh B D,(2022) Plant Breeding Principles and Methods-12<sup>nd</sup> Edition, MedTech Science Press.  
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**Paper code: BOT23C 502**

**Paper title: ANGIOSPERM TAXONOMY**

**(Credits:04, Theory- 3, Tutorial-0, Practical-1)**

**Type of paper: Theory+ Practical**

**Course outcomes:**

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

**CO1: Develop** an understanding on concepts and chief categories of Plant classification and recognize the role of herbaria and the importance of botanical garden.

**CO2: Analyse** the role and activities of Botanical Survey of India.

**CO3: Evaluate** the role of herbaria in taxonomic studies and interpret the rules of ICN in mentioned aspects of botanical nomenclature.

**CO4: Grow** knowledge on affinity, phylogeny and economic importance of mentioned dicot and monocot families of Angiosperms.

**CO5: Distinguish** the features of locally available angiosperms and identify their diagnostic features.

**CO6: Develop** Skills in herbarium techniques and identify the locally available angiosperms following Bentham & Hooker’ s system of classification.

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**A) Theory**

**(Credit:03)**

Unit	Content	Lectures
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1	Aim and objectives of plant taxonomy, history and concept of different systems of classifications with particular reference to Bentham and Hooker and Takhtajan's system of classification, brief idea on phenetic, phyletic, cladistics and APG.	8
2	Principles and rules of binomial nomenclature, ICN rules and recommendations, type concept and its applications, rules of priority and its limitations, valid and effective publication; concept of species, genus and family.	8
3	Botanical survey of India: Organization, publication and activities, herbaria collection, Preservation, documentation, filing system; and other Research Institute of Taxonomic significance. Botanical gardens – types, its role in biodiversity conservation, teaching and research. Major Botanical Gardens of India	8
4	Changing trends in taxonomy- role of anatomy, palynology, cytology, phytochemistry, numerical taxonomy, and molecular taxonomy, computers in plant taxonomy, classification; biosystematics	8
5	Affinity, phylogeny, economic importance, comparative studies of the following families- Magnoliaceae, Fabaceae, Rubiaceae, Lamiaceae, Acanthaceae, Asteraceae.	8
6	Affinity, phylogeny, economic importance, comparative studies of the following families- Arecaceae, Poaceae, Musaceae, Zingiberaceae, Orchidaceae.	8

### **B) Practicals:**

**(Credit: 1)**

1. Description and identification (upto genus) of specimens from members of locally available dicotyledonous and monocotyledonous families included in the theory syllabus.
2. Preparation of herbarium of common angiospermic plants (at least ten) and must be submitted in the examination.
3. Field study to get an idea about the flora and to prepare field report to be submitted in the examination.

**Practicals should be supported by practical record, field report, slides/specimens/ herbarium whichever is applicable.**

### **Suggested Readings:**

- George, H.M. Lawrence (2012), Taxonomy of Vascular Plants.
- Mitra, J.N., Mitra. D., Chowdhuri, S.K (2018). Studies in Botany (Vol. one) Moulik Library 18-B
- Singh Gurucharan (2010) Plant Systematics - Theory & Practice.

- Vasistha, P.C., Taxonomy of Angiosperms.

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**Paper code: BOT23C-503**

**Paper title: PLANT ECOLOGY AND PHYTOGEOGRAPHY**

**(Credits: Theory-3, Practical-1)**

**Type of paper: Theory+ Practical**

**Course outcomes:**

On completion of this course, the students will be able to:

**CO1: Understand** the key concept of ecology with different climatic and edaphic factors along with population characteristics, dynamics, and various interactions.

**CO2: Develop** empathy for various life forms and appreciate the various ecological linkages within the web of life.

**CO3-Increase** analytical ability to link cause and impact of air and water pollution on plants.

**CO4- Recognize** different phytogeographical regions of India and their vegetations.

**CO5- Grow** proficiency in using various meteorological instruments (Lux meter, Rain gauge, Secchi disc, Soil thermometer, Min-Max thermometer) and quantitative analysis of herbaceous vegetation by quadrat method.

**A) Theory**

**(Credit:03)**

Unit	Content	Lecture
1	<b>Plants and Environment:</b> Basic concepts of ecology, Ecological factors -Climatic factors (light, water or moisture), edaphic factor (soil formation and soil profile). Plant adaptations (hydric & xeric adaptations), Principles of limiting factors.	08
2	<b>Population Ecology:</b> Concept, density, natality, mortality, age distribution, environmental resistance & carrying capacity, genecology (ecads, ecotypes and ecoclines), concept of population interactions.	08
3	<b>Ecosystem Ecology:</b> Structure and function, food chain, food web, Energy flow Biogeochemical cycle (Nitrogen, Carbon & Phosphorus cycle), Ecological pyramids.	08

4	<b>Community Ecology:</b> Community characteristics and structure (analytical and synthetic characters), ecotone and edge effect. Ecological succession: types and processes, seral stages (with reference to Hydrosere and Xerosere), Habitat and Niche.	08
5	<b>Environmental Pollution:</b> Pollution and pollutants - Definition and types; Air and water pollution: sources and kinds, impact on plants, greenhouse effect; Ozone layer depletion and acid rain.	08
6	<b>Phytogeography:</b> General Principles and objectives; Phytogeographical regions of India (Chatterjee, 1960); vegetation characteristics of Eastern Himalayas, Endemism - concept & types.	08

**B) Practical:**

**(Credit-1)**

1. Study of basic meteorological instruments (Lux meter, Rain gauge, Secchi disc, Soil thermometer, Min-Max thermometer).
2. Quantitative analysis of herbaceous vegetation for abundance, density and frequency by quadrat method.
3. Study of ecological adaptation (morphological & anatomical) of hydrophytes (*Eichhornia*, *Jussiaea* and *Hydrilla*) and xerophytes (*Nerium*, *Aloe* and Cladode of *Asparagus*).
4. To prepare map of India with respect to-major climatic zones and phyto-geographical regions of India and to comment on it. (Practical should be supported by practical record)

**Practicals should be supported by practical record, field report, slides/specimens/ herbarium whichever is applicable.**

**Suggested Readings:**

**Plant Ecology:**

- Chapman, J. L. and Reiss, M.J. (1992). Ecology - Principles and Applications, Cambridge University Press, Cambridge, UK.
- Odum, E. P. and Barrett, G. W. (2005). Fundamentals of Ecology, 5th Edition, Cengage Learning, New Delhi, India.
- Sharma, P. D. (2009). Ecology and Environment, Rastogi Publications, Meerut, India.
- Shukla, R.S. & Chandel P.S. (1991). Plant Ecology & Soil Science, S. Chand & Co., New Delhi.
- Bhatia, K. N., and Sharma, K. K.(1998),(5thEdition), A Treatise on Plant Ecology, Pradeep Publications, Jalandhar.

**Plant Geography:**

- Good, R. (1997): The Geography of flowering Plants (2nd Edn.), Longmans, Green & Co., Inc., London & Allied Science Publishers, New Delhi -495pp.
- Cain, S.A. (1944): Foundations of Plant Geography, Harper & Brothers, N.Y.

**Paper code: BOT23C-504**

**Paper title: PLANT PATHOLOGY**

**(Credits: 04, Theory-3, Tutorial-0, Practical-1)**

**Type of paper: Theory+ Practical**

**Course outcomes:**

Upon completion of this course, the students will be able to–

**CO1-Understand** the basic concept of plant pathology and comprehend the disease cycle and various host and pathogen interactions.

**CO2-Identify** the common plant diseases and pathogens, isolate the pathogen and suggest control measures.

**CO3-Demonstrate** skills in laboratory and field related to plant pathology.

**CO4-Identify** the common plant diseases according to geographical location.

**CO5-Enhance** collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.

**A) Theory**

**(Credit:03)**

<b>Unit</b>	<b>Content</b>	<b>Lecture</b>
1	<b>Fundamentals of plant pathology:</b> Introduction, Concept of plant disease, history of plant pathology, common symptoms of plant diseases.	08
2	<b>Disease development:</b> Mechanism and mode of infection. Host parasite interaction, Dissemination., defence mechanisms, causes of Epidemics, Disease cycle	08
3	<b>Methods of Studying Plant Diseases:</b> Microscopic study, Macroscopic study, Koch's postulates. Culture technique, Media, Types and Preparation. Pure culture methods- streak plate, Pour plate, spread plate, Serial dilution	08
4	<b>Plant Disease management:</b> Physical, chemical and biological management of plant diseases, Plant Quarantine, IDM.	08

5	<b>Plant Diseases:</b> Study of Diseases- Club root of Crucifers, Late blight of potato, Rust of wheat, Leaf spot of cabbage, Blast of Paddy, Citrus Canker, Tobacco Mosaic Disease with reference to causal organism, symptoms and signs, disease cycle and control measures.	08
6	<b>Resistance:</b> Systemic acquired and induced systemic, Disease resistance, R-genes, gene for gene concept, immunity (PTI & ETI), hypersensitive response and cell death.	08

## B) Practical

(Credit-1)

1. Preparation of fungal media (PDA).
2. Sterilization process.
3. Isolation of pathogen from diseased material.
4. Study of plant pathogenic fungi from diseased specimens (symptoms, causal organism, and their morphological & and reproductive characters) of Club root of Crucifers, Late blight of potato.
5. Rust of wheat, Leaf spot of cabbage, Blast of Paddy, Citrus Canker, Tobacco Mosaic Disease

**Practicals should be supported by practical record, field report, slides/specimens/ herbarium whichever is applicable.**

## Suggested Readings

- Dickinson, M.2008,-Molecular Plant Pathology ,Bios Scientific Publishers, London
- Gupta, G.P.,2004, Text book of plant diseases, Discovery Publ. House ,New, Delhi
- Mehrotra, R.S. 1991, Plant Pathology, Tata McGraw Hill Co. Delhi
- Singh, R.S.2004, Plant Diseases, Oxford & IBH Publishing Co. Pvt. Ltd., Delhi.
- Trigiano, Windham and Windham, 2003, Plant pathology, Concepts and laboratory exercises CRC Press London.

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**Paper code: BOT23M-505**

**Paper title: CELL BIOLOGY AND GENETICS**

**(Credits: 04, Theory-3, Tutorial-0, Practical-1) Type of paper: Theory+Practical**

## Course outcomes:

On successful completion of this paper, students will be able to:



**CO1-Understand** the cell structure, cell growth, development and chromosome.

**CO2-Comprehend** Inheritance pattern, gene interactions expression of characters.

**CO3-Develop** skills in study of cytological stain and cell division.

**CO4-Enhance** collaborative learning and communication skills through practical sessions.

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**A) Theory**

**(Credit: 03)**

Unit	Content	Lecture
1	<b>Eukaryotic cell:</b> Structure and function of cell wall, plasma membrane, mitochondria and chloroplast.	8
2	<b>Nucleus and chromosome:</b> chromosome structure and organization, Cell division (Mitosis and Meiosis) and significance.	8
3	<b>Inheritance:</b> Mendelian inheritance, Allelic and non-allelic gene interactions (incomplete dominance, codominance, complementary factor and epistasis), Cytoplasmic inheritance.	8
4	<b>Linkage and crossing over:</b> linkage and crossing over and their significance, genetic map.	8
5	<b>Mutation:</b> Spontaneous and induced mutation, physical and chemical mutagen, point mutation, frame shift mutation, substitution.	8
6	<b>Chromosomal aberrations-</b> Deletion, duplication, inversion & translocation, Aneuploidy & Polyploidy and its role in evolution of plants.	8

**B) Practical:**

**(Credits: 1)**

1. Study of plant cell structure with the help of epidermal peel mount/tissue sections
2. Study of various stages of mitosis in plant materials.
3. Study of meiosis in plant materials.
4. Numericals on gene interaction.

**Practicals should be supported by practical record, field report, slides/specimens/ herbarium whichever is applicable.**

**Suggested Reading:**

- Sharma, A. K. and A. Sharma (1999). Plant Chromosomes: Analysis, Manipulation and Engineering. Harward Academic Publishers, Australia.

- Shukla, R. S. and P. S. Chandel (2007). Cytogenetics, Evolution, Biostatistics and Plant Breeding. S. Chand & Company Ltd., New Delhi.
- Snustad, D. P. and M. J. Simmons (2000). Principles of Genetics. John Wiley & Sons, Inc., U S A.
- Singh S P & B.S. Tomar (2015) Cell Biology -,Rastogi Publications
- Power CB (2010). Cell Biology - Himalay Publishing House
- Verma, P. S. and V. K. Agrawal (2004). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand & Company Ltd., New Delhi.

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## UG Semester-VI

**Paper code: BOT23C-601**

**Paper title: PHARMACOGNOSY AND ECONOMIC BOTANY**

**(Credits: Theory-3, Tutorial-0, Practical-1)      Type of paper: Theory+Practical**

**Course outcomes:**

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

**CO1- Develop** an understanding on identification of crude drugs and processed medicine, their quality control methods, monitoring and regulation, standard techniques for collection and processing, packaging and maintenance of herbs and herbal products.

**CO2-Evaluate** adulteration, substitution or contamination of crude drugs using microscopic, macroscopic and analytical methods.

**CO3-Grow** understanding on pharmacognosy of certain medicinal plants.

**CO4- Inculcate** practical skills on phytochemical screening (both qualitative and quantitative) of plants with special reference to Alkaloids, Flavonoids, Cardiac Glycosides, Steroids, Tannins, Volatile oils and Resins.

**CO5-Understand** core concepts of Economic Botany and realise the commercial and industrial aspects of certain economically important plants.

**A) Theory**

**(Credit: 03)**

Unit	Content	Lecture
1	<b>Introduction:</b> Definition, history and scope of pharmacognosy, different sources of drugs, organised and unorganised drugs (dried juices, gums and mucilages and oleoresins). Classification of crude drugs. Drug adulteration and contamination.	8
2	<b>Quality control of herbal drug:</b> Evaluation of Crude Drugs, Quality Control Methods for Herbal Drugs: Macroscopic and Microscopic Examination, Chromatography, Water Content and Spectroscopy.	8
3	<b>Secondary Metabolites and Pharmacognosy:</b> Definition and classification of secondary metabolites. Biosynthesis of Secondary Metabolites with special reference to phenolics. Pharmacognosy of the following plants: <i>Andrographis</i> , <i>Curcuma</i> , <i>Rauwolfia</i>	8
4	<b>Analytical pharmacognosy:</b> Phytochemical screening of plants. Phytoconstituents important to therapy: Alkaloids, Flavonoids, Tannins, Volatile oils and Resins.	8
5	<b>Economic Botany:</b> Concept of origin of cultivated plants, plant with economic and industrial importance (food plants, medicinal plants, fibre yielding plants and food adjuncts), lower plants of economic importance.	8
6	<b>Origin, Botany and economic uses of the following:</b> <ul style="list-style-type: none"> <li>• Rice, Tea and Jute (cultivation and processing)</li> <li>• Gram, Ginger, Betle leaf and Areca nut.</li> </ul>	8

**B) Practical :**

**(Credit-1)**

1. Qualitative and quantitative analysis of at least one in each class of the following phytochemicals:

- |                |                |
|----------------|----------------|
| i. Alkaloids   | iii. Phenolics |
| ii. Flavonoids | iv. Tannins    |

- v. Volatile oil.
  2. Separation of phytochemicals by TLC.
  3. Determination of anti-oxidant activity from plants.
  4. Collection and submission of economically important plant/plant products.

**Practicals should be supported by practical record, field report, slides/specimens/ herbarium whichever is applicable.**

**Suggested readings:**

**i) Pharmacognosy:**

- Bruneton, J. (1999). Pharmacognosy: Phytochemistry of Medicinal Plants. Lavoisier Publishing.
- Dewick, P.M. (2002). Medicinal natural products : a biosynthetic approach. Wiley.
- Charlwood and Banthorpe (1991). Methods in Plant Biochemistry. Academic Press.
- Trease and Evans, (2002). Pharmacognosy. W. B. Saunders Company.
- Mukherjee P. K. (2002). Quality control of Herbal Drugs - An approach to
- Evaluation of Botanicals, Business Horizons, New Delhi, 1st Edition.
- Kokate, C.K., A.P. Purohit & S.P. Gokhale, 2000. Pharmacognosy, Nirali Prakasan.
- Kar A, Pharmacognosy and Pharmacobiotechnology, 2nd Edition, New Age international publisher.

**ii) Economic Botany:**

- Pandey B P. 2015. Economic Botany. S.Chand
- Kochhar S.L. 2016. Economic Botany in the Tropics. A comprehensive study.
- Sambamurty A.V.S.S. and N.S. Subrahmanyam. Economic Botany of Crop Plants. Asiatech Publishers Inc., Delhi
- Miglani S, 2016. A Textbook of Economic Botany. ABS Books.
- Verma V, 2009. Textbook of Economic Botany. ANE Books.

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**Paper code: BOT23C 602**

**Paper title: PLANT PHYSIOLOGY AND BIOCHEMISTRY**

**(Credits: 04, Theory-3, Tutorial-0, Practical-1)**

**Type of paper: Theory+ Practical**

**Course outcomes**

On completion of this course, the students will be able to:

**CO1-Demonstrate** understanding of structure, function and classification of biomolecules.

**CO2-Interpret** the anabolic and catabolic pathways of metabolism and its energetics.

**CO3-Conceptualize** basic plant metabolism, different biochemical pathways and their regulations.

**CO4-Develop** skills in isolation and estimation of carbohydrates, protein, amino acid, enzymes and total phenolics in plants using standard methods

**CO5-Demonstrate** the quantification of proteins by Lowry's Method, and estimation of plant pigments spectrophotometer.

**CO6-Enhance** collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.

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**A) Theory**

**(Credit:03)**

Unit	Content	Lecture
1	<b>Transport &amp; Mineral nutrition:</b> <ul style="list-style-type: none"><li>• Water Potential, water absorption, aquaporins, Transpiration.</li><li>• Ascent of sap and solute transport in plants.</li><li>• Mineral nutrients- physiological effects, mineral deficiency symptoms.</li><li>• Mechanism of phloem loading and unloading; Source–sink relationship.</li></ul>	8
2	<b>Carbon and Energy metabolism:</b> <ul style="list-style-type: none"><li>• Photosynthesis: photosynthetic pigments and LHCS and photosystems, photooxidation of water, mechanism of electron transport-photophosphorylation, C3, C4 and CAM pathways, photorespiration.</li><li>• Respiration: Glycolysis, TCA cycle, electron transport and ATP synthesis and alternate oxidase system. Pentose phosphate pathway and its significance.</li></ul>	8
3	<b>Plant growth regulators and Photophysiology :</b> <ul style="list-style-type: none"><li>• Discovery, chemical nature (basic structure), bioassay and physiological roles of hormone (Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid) and their applications in agriculture and horticulture.</li><li>• Photoperiodism (SDP, LDP, Day neutral plants);</li><li>• Phytochrome: Discovery, chemical nature, mode of action, role of phytochrome</li></ul>	8

	in plant	
4	<b>Biomolecules:</b> Structure, functions and classification of- <ul style="list-style-type: none"> <li>• Carbohydrates:</li> <li>• Amino acids</li> <li>• Proteins:</li> <li>• Lipids</li> </ul>	8
5	<b>Enzymes and vitamins:</b> Classification, properties, mechanism of action, regulation of enzyme activity, application of enzymes, role of regulatory enzymes (allosteric, covalent modulation and isozymes). Vitamins: Classification and function, Vitamins as coenzyme.	8
6	<b>Nitrogen and lipid metabolism:</b> Physiology and biochemistry of biological nitrogen fixation; Nitrate and ammonia assimilation. Biosynthesis and degradation of purines and pyrimidines in plants. Synthesis of lipids in plant, $\beta$ -oxidation of fatty acid and glyoxylate cycle.	8

**B) Practical :**

**(Credit-1)**

1. To quantify plant pigments using spectrophotometer
2. Determine protein in plant sample using Lowry's methods
3. To determine total sugar in plant sample using Anthrone methods
4. Determination of amino acids by paper chromatography
5. Determination of total phenolics in plants.
6. Separation of sugar from plant using paper chromatography
7. To determine activity of enzymes using amylase.

**Practical should be supported with Practical records.**

**Suggested Readings:**

- Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons.U.S.A. 4th edition.
- Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A(2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
- Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.
- David L Nelson and Michael M. Cox (2017) (seventh edition), Leninger Principles of Biochemistry, W. H. Freeman and Company.

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**Paper code: BOT23C603**

**Paper title: MICROBIOLOGY**

**Course outcomes:**

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

**CO1-Recall** the landmark historical events in the field of microbiology.

**CO2-Summarize** the characteristics of different types of microorganisms, and the methods used to classify them.

**CO3-Describe** structure, reproduction and importance of bacteria and virus along with the principles of microbial metabolism and growth.

**CO4-Explain** the basic principles of immunology.

**CO5-Demonstrate** experimental proficiency in use of laboratory equipments and apply microbiological techniques to culture and isolate microorganisms from various sources.

**CO6- Maintain** laboratory safety and ethics.

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**A) Theory**

**(Credit:03)**

Unit	Content	Lecture
1	<b>Fundamentals of microbiology:</b> Historical Perspective, microbes and methods in microbial culture (sterilization, pure culture, enrichment culture, isolation of micro organisms).	8
2	<b>Microbial Taxonomy and Diversity:</b> Microbial taxonomy and its modern trends, Bergey's Classification of Bacteria. Distinguishing features of Actinomycetes, Archaeobacteria and Mycoplasma, Rickettsiae & Chlamydeae. Microbiology of soil, water and air.	8
3	<b>Microbial growth and metabolism:</b> <ul style="list-style-type: none"><li>• Introduction to Metabolism: Microbial nutrition, Catabolic Pathways (Glycolysis, Entner-Doudoroff pathway, Citric acid cycle) ATP generation pathways (Fermentation; Aerobic and anaerobic respiration)</li><li>• Growth and growth curve; Mathematical expression of exponential growth phase; Measurement of growth and growth yields; Synchronous growth; Continuous culture.</li></ul>	8

4	<b>Bacteriology:</b> Ultra structure of bacterial cell, Reproduction- vegetative, asexual, sexual (conjugation, transformation and transduction), Bacterial genome and plasmid. Economic importance of Bacteria.	8
5	<b>Virology:</b> Discovery of Virus, Classification of viruses. Replication, lytic (T4 phage) and Lysogenic cycle (Lambda phage); RNA virus (TMV), Retro virus (HIV); Virioids and Prions.	8
6	<b>Immunology:</b> Concept of immunology, types of immunity, antigen and antibody-structure and classes.	8

**B) Practical:**

**(Credit-1)**

- Techniques on cleaning and Sterilization of equipments.
- Preparation of media (Potato-dextrose- Agar and Rose Bengal Agar Media)
- Pure culture technique: slant, Streak-plate methods; Pour-plate method.
- Inoculation of microbes from air, soil and water by serial dilution.
- Determination of microbial population by haemocytometer.
- Study of Gram positive and Gram negative bacteria.
- Isolation and quantification of DNA by using a standard method.

**Practicals should be supported by practical record.**

**Suggested readings**

- Banerjee, A. K. & N. Banerjee: Fundamentals of Microbiology and Immunology
- Dubey, R. C & D.K. Maheswari: A Text Book of Microbiology.
- Immunology, 13th Edition Wiley-Blackwell
- Mishra, R. R. 1996. Soil Microbiology. CBS Publ.
- Pelczar, M.J. (2001) Microbiology, 5th edition, Tata Mc Graw-Hill Co, New Delhi.
- Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan Roitt M. 2017 Roitt's Essential
- Prescott, L. Harley, J. and Klein, D. (2005) Microbiology, 6th edition, Tata Mc Graw-Hill Co. New Delhi.
- Subbarao N.S. Soil Microbiology English-OXFORD & IBH Publishing co. Pvt Ltd.

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**Paper code: BOT23C-604**

**Paper title: MOLECULAR BIOLOGY AND BIOINFORMATICS**

**Credits: Theory-3, Practical-1**

**Type of paper: Theory + Practical**

**Course outcomes**



On completion of this course, the students will be able to:

**CO1-Develop** Conceptual understanding of structure and function and biosynthesis of biomolecules.

**CO2-Understand** genetic information flow and gene expression regulation and sequential flow of genetic information

**CO3-Comprehend** the changes in hereditary material and its probable impact on organisms

**CO4-Appreciate** the basics of Bioinformatics and computational Biology.

**CO5-Develop** skills in study of DNA, Protein and basics bioinformatics application.

**CO6-Enhance** collaborative learning and communication skills through practical sessions.

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**A) Theory**

**(Credit:03)**

Unit	Content	Lecture
1	<b>Nucleic acids as genetic material:</b> History, DNA as genetic material: Griffith experiment, Avery, Mcleod and Mc Carty experiment, Hershey & Chase experiment	8
2	<b>Structure and function of nucleic acid and protein:</b> Structure and function of DNA, RNA and protein, DNA replication, transcription and translation, genetic code & its properties.	8
3	<b>Gene expression:</b> Regulation of gene expression in prokaryotes, Lac Operon, Trp operon and Ara operon.	8
4	<b>Mutation:</b> Definition and concept of mutation, mutagens, mechanism of action of physical & chemical mutagens: deletion, insertion, translocation, substitution mutation, tautomerization, alkylation, deamination, base analogues.	8
5	<b>Introductory Bioinformatics:</b> Introduction to Bioinformatics, branches, aim & scope of bioinformatics (genomics, proteomics and transcriptomics), Biological databases, biological database retrieval systems,	8
6	<b>Sequencing and phylogeny:</b> DNA sequencing, Application of proteomics in drug discovery and drug design, basics of molecular phylogeny,	8

**B) Practical**

**(Credit-1)**

1. DNA extraction from plant sample.

2. DNA quantification using diphenylamine text
3. Preparation of standard curve for protein and protein quantification from plan sample
4. Separation of protein by SDS-PAGE (Only Demonstration)
5. Construction of Restriction Map from the data provided.
6. Sequence alignment, Sequence homology and Gene annotation.

**Practicals should be supported by practical record.**

**Suggested readings**

- Frailer, D. (2007) *Molecular Biology-*, Narosa Publishing House.
- David Freielder (2009) *Microbial genetics-* Narosa Publishing House.
- Harisha, S. (2007) *Fundamentals of Bioinformatics.* I.K. International Publishing House.
- Sharma, V et al., *Textbook of Bioinformatics--* Rastogi Publications.
- Xiong, J. (2006) *Essential Bioinformatics.* Cambridge University Press.

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**Paper code: BOT23M-605**

**Paper title: MICROBIOLOGY AND PLANT PATHOLOGY**

**(Credits:04, Theory-3, Tutorial-0, Practical-1)**

**Type of paper: Theory+ Practical**

**Course outcome**

On completion of this course, the students will be able to:

**CO1-Understand** the concept of plant diseases and the underlying mechanism and

**CO2-Design** strategies for sustainable plant disease management.

**CO3-Develop** experimental proficiency in identification of plant diseases and isolation of the pathogens.

**CO3-Enhance** collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.

**CO4-Perform** experiments on control of plant diseases.

**CO5-Enhance** collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.

**A) Theory****(Credit:03)**

Unit	Content	Lecture
1	<b>Basics of Microbiology:</b> Historical perspective, basic tools and techniques used in microbiology. Modern trends in microbiology.. Economic importance.	8
2	<b>Microbial diversity:</b> Microbe classification, distinguishing features of actinomycetes, archaeobacteria, eubacteria, mycoplasma, viroids and prions.	8
3	<b>Microbial Growth and metabolism:</b> Definition of growth and Growth curve , synchronous growth and continuous culture., Energy metabolism , aerobic, anaerobic and fermentation.	8
4	<b>Pathogens in plants:</b> Symptoms caused by different pathogens, host pathogen interaction – (prepenetration, penetration and post penetration ) , host defence,	8
5	<b>Introduction to plant pathology :</b> History of plant pathology, classification , disease cycle	8
6	<b>Plant Disease control and management:</b> Physical, chemical and Biological control of plant diseases, Iintegrated disease management .	8

**B) Practical:****(Credits-1)**

1. Isolation and culture of microbes from soil
2. Staining and observation of microbes.
3. Isolation and culture of microbes from diseased plant materials
4. Study of diseased plant specimen: Black rust of wheat/ Justicia and Citrus canker.

**Practical should be supported with Practical records and permanent slides.**

**Suggested readings:**

- Dickinson, M. 2003. Molecular Plant Pathology, Garland Publishing Inc, CT.
- Ingram, D.S. and Robertson, N.F. 1999. Plant Diseases, Collins Publishers, London.
- Lane, C.R., Beales P.A. and Hughes, K.J.D. 2012. Fungal Plant Pathogens, CABI Publishing, Wallingford.
- Mehrotra, R. S., 2003. Plant Pathology, 2nd edn. Tata Mc. Graw Hill Pub. Co. Ltd., New Delhi.
- Pelczar, M.J. (2001) Microbiology, 5th edition, Tata Mc Graw-Hill Co, New Delhi.
- Prescott, L. Harley, J. and Klein, D. (2005) Microbiology, 6th edition, Tata Mc Graw-Hill Co. New Delhi.

- Schumann, G. L. and D'Arcy, C. J. 2012. Hungry Planet: Stories of Plant Diseases, APS Press, USA.

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## UG Semester-VII

**Paper code: BOT23C-701**

**Paper title: CELL BIOLOGY**

**(Credits: 04, Theory-3, Tutorial-0, Practical-1)**

**Type of Paper: Theory+Practical**

**Course outcomes:**

On completion of this course, the students will be able to:

**CO1- Comprehend** the structure of cell.

**CO2-Gain** the knowledge of different cell organelles as well as cell walls and plasma membranes.

**CO3-Understand** the Cell cycle and division.

**CO4-Develop** skills to understand cell signalling.

**CO5-Enhance** collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.

**A) Theory**

**(Credit:03)**

Unit	Content	Lecture
1	<b>Overview of cell:</b> Cell as a unit of structure and function; cell theory, Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell.	8
2	<b>Cell wall and plasma membrane:</b> Structure and function of Plant cell wall; Overview of fluid mosaic model; Chemical composition of membranes; membrane function	8
3	<b>Cell organelles:</b> Nucleus; Structure-nuclear envelope, nuclear pore complex, nuclear lamina, organization of chromatin; nucleolus. Structure and function of Chloroplast, mitochondria, Endoplasmic Reticulum, Golgi and ribosome and lysosome.	8
4	<b>Cell cycle &amp; Cell division:</b> Cell division (mitosis and meiosis) and their significance, Phases of eukaryotic cell cycle, Regulation of cell cycle-checkpoints, role of protein kinases, significance.	8

5	<b>Chromosome:</b> Structure and organisation of eukaryotic chromosome, types, euchromatin and heterochromatin, special types of chromosomes and their significance	8
6	<b>Cell Signalling:</b> Signalling mechanism, signal transductions, signal protein and protein trafficking.	8

**B) Practical :**

**(Credit-01)**

- Study of plant cell structure with the help of epidermal peel mount.
- 1. Study of protoplasmic streaming in leaf of plants (*Hydrilla* leaf, *Vallisneria*.)
- 2. Cytochemical staining of: DNA- Feulgen using Periodic Schiff's (PAS) staining technique.
- 3. Study different stages of mitosis in locally available specimen (at least two).
- 4. Study different stages of meiosis in locally available specimen (at least two).

**Practicals should be supported by practical record, slides/specimens/ whichever is applicable.**

**Suggested readings**

- Gupta P.K. Cell and Molecular Biology (2017) Fifth edition – Rastogi Publications.
- Singh S P & B.S. Tomar (2015) Cell Biology –Rastogi Publications.
- Power CB (2010). Cell Biology – Himalay Publishing House.
- Verma, P. S. and V. K. Agrawal (2004). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand & Company Ltd., New Delhi.
- Sharma, A. K. and A. Sharma (1999). Plant Chromosomes: Analysis, Manipulation and Engineering. Harward Academic Publishers, Australia.
- Shukla, R. S. and P. S. Chandel (2007). Cytogenetics, Evolution, Biostatistics and Plant Breeding. S.Chand & Company Ltd., New Delhi.
- Pollard T.D, Earnshaw WC, Schwartz JL and Johnson GT (2022). Cell Biology. Elsevier publisher.

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**Paper code: BOT23C 702**

**Paper title: RESEARCH METHODOLOGY AND BIOETHICS**

**(Credits: 04, Theory-3, Practical-1)**

**Type of paper: Theory+Practical**

**Course Outcome:**

**CO1-Develop** the concept of research, sampling , data analysis and ethics.

**CO2-Grow** proficiency in solving statistical problems using MS excel and SPSS

**CO3-Develop** skills in academic writings, research design and proposal writing.

**CO4-Enhance** collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.

**A) Theory**

**(Credit:03)**

Unit	Content	Lecture
1	<b>Fundamentals of Research:</b> Introduction to research methodology, scope of research; Formulating the research problem: identification, selection, research hypothesis, research objectives; review of literature. Concept of theory: deductive and inductive theory.	8
2	<b>Biosafety and Ethics:</b> Basic concepts of ethics in science, technology and environment. Biosafety issues in scientific research; biosafety guidelines (Government of India and institutional); Ethical and Biosafety Committees. Academic misconduct and ethics. Plagiarism and Tools for detection of plagiarism. Concept and use of AI tools in research.	8
3	<b>Academic writing:</b> Importance of academic writing; Basic rules of academic writing. Literature review: Source of literature; Process of literature review.	8
4	<b>Sampling and Research Design:</b> Research design: experimental and field study; sampling design, data collection and types, data processing and analysis, data presentation and interpretation. Principles of design in biological experiments, Randomized design. Randomized block design, split plot design, Latin square design.	8
5	<b>Tools and Data analysis in research:</b> Descriptive and inferential statistics using softwares (Microsoft Excel and SPSS), Test of significance, Use of t Test, ANOVA, correlation, regression in research. Basics of Statistical packages like Excel and SPSS etc.; introduction features and functions. Data entry steps, curation and editing.	8
6	<b>Proposal writing and publication in research:</b> Basic concept on Research proposal and report writing and its guidelines. Major Research funding agencies in India: Introduction with special reference to their objectives and mandates. Layout of a Research Paper, Journals in botany, Indexing, Impact factor of Journals, when and where to publish?	8

**A) Practicals**

**(Credit-1)**

1. To study the basics steps of data analysis in MS Excel and SPSS
2. To solve problems on t Test using MS Excel and SPSS
3. To solve problems on ANOVA using MS Excel and SPSS
4. To check Plagiarism in the given document using any one plagger detector tool
5. To write a review paper and submit to any UGC care listed journal.

**Practicals should be supported by practical record.**

**Suggested readings:**

- Thesis & Assignment Writing-J Anderson, B.H. Dursten & M. Poole ,Wiley Eastern,1977
- A Hand book of Methodology of Research -P.Rajammal and P.Devadoss, R.M.M.Vidya press,1976
- The Craft of Scientific Writing by Michael Alley, (Springer).
- Research methodology by R.Panneerselvam,PHI,New Delhi2005.
- Diane O. Fleming; Debra A. Long; Biological Safety: Principles and Practices, 4<sup>th</sup> Edition, ASM Press; 2006.
- Julie Pallant, A Step by Step Guide to Data Analysis using SPSS for Windows Third Editions , 2007.Rajkumar S. Adukia, Handbook On Intellectual Property Rights In India Crawley, Michael J. *The R book*. John Wiley & Sons, 2012.
- Soumitro Banerjee(2022). Research Methodology for Natural Sciences, , IISC press
- C R Kothari, and Gaurav Garg(2019). Research Methodology( 4 th Eds). New Age international Publisher.

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**Paper code: BOT23C 703**

**Paper title: INDUSTRIAL MICROBIOLOGY**

**(Credits: 04, Theory-3, Tutorial-0, Practical-1)**

**Type of paper: Theory+Practical**

**Course outcomes:**

On successfully completing the module, the students will be able to

**CO1: Develop** skill to handle microbes and basic instrumentation used in microbiological laboratory.

**CO2: Gain** knowledge of microbes and their importance, application in day-to-day life with special reference to environmental sustainability and industry.

**CO3: Demonstrate** a knowledge and understanding of basic fermentations processes, design of various fermenters and their types and economics of fermentation.

**CO4: Exhibit** knowledge and understanding the use of microbes in production of human consumption.

**CO5: Learn** methods of microbial extraction of metals from minerals and aqueous effluents. Concept of enzymology, concept of biosurfactants and industrial waste management.

**A) Theory****(Credit:03)**

Unit	Content	Lecture
1	<b>Application of Microbiology for Sustainable Environment:</b> A general account on role of microbes in environment, agriculture and human welfare.	8
2	<b>Microbial products in Agriculture:</b> Biofertilizers- description, production, and application. Biopesticides- description, production, and their applications against different types of pathogens.	8
3	<b>Microbial Products in different industries:</b> Ethanol production, Penicillin production, General production of vaccines, vitamins and proteins.)	8
4	<b>Biofuels and Biomining:</b> Concept and application of Biofuels. General account on bioplastics. Role of microorganisms in mineral recovery.	8
5	<b>Enzyme technology:</b> Concept of enzymology, Enzymes for textile designing, enzymes for Cheese making, enzyme immobilization technology. Concept of biosurfactants, types and their applications.	
6	<b>Industrial waste management:</b> Concept of Industrial waste and their management system. Concept of bioremediation, xenobiotics and their management, Concept of environmental monitoring of air pollution and their management.	8

**B) Practical****(Credit-1)**

- Laboratory safety rules and precautions. Familiarization with Instruments used in Microbiological Lab, their principles and working: Microscope, Autoclave, Laminar Flow Bench, Hot air Oven, Incubator, BOD incubator, Centrifuge, pH meter, Spectrophotometer, Electrophoretic assembly, PCR machine etc.
  - Biochemical activity of microorganisms: Starch hydrolysis, Protein degradation casein degradation, Carbohydrate fermentation (different sugars), IMViC Tests: Indole, Methyl red, Vogus Prausker, Citrate utilization test.
  - Determination of antibiotic susceptibility against different bacterial strains.
  - Demonstration of agarose gel electrophoresis.
  - Citric acid production/acetic acid by selected fungal /bacterial strains.
  - To determine different enzymatic activity/metabolite production/activity a) Nitrate, b) Indole acetic acid c) Siderophore.
- Visit to any nearby industry associated with microbial work.
  - Practicals should be supported by practical record.

**Suggested Readings:**



- Fermentation Microbiology and Biotechnology, E. M. T. El-Mansi , Jensielsen , David Mousdale , Ross P. Carlson, 4th Edition , CRC Press, 2019.
- Microbial Technology. Vol I- Microbial processes and Vol II - Fermentation technology edited by H.J. Pepler and D. Perlman, 2nd edition. Academic Press, USA, 2009.
- Elements Of Biotechnology by Pk Gupta , Rastogi Publications, 2015.
- Molecular Biology and Biotechnology : A Guide for Students, 3rd Edition , Helen Kreuzer, Adrienne Massey ASM Press , 2014.
- Fermented Foods, Part I Biochemistry and Biotechnology Didier Montet, Ramesh C. Ray, CRC Press, 2020.
- Prescott/Harley/Klein's Microbiology 7th Edition by Joanne Willey , Linda Sherwood , Chris Woolverton, 2007,
- Environmental and Agricultural Microbiology: Applications for Sustainability Bibhuti Bhusan Mishra, Suraja Kumar Nayak, Swati Mohapatra, Deviprasad Samantaray ,2021, Wiley-Scrivener.

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**Paper code: BOT23C-704**

**Paper title: PLANT STRESS BIOLOGY**

**(Credits: 04, Theory-3, Tutorial-0, Practical-1)**

**Type of paper: THEORY+ Practical**

**Course outcomes:**

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

**CO1: Develop** fundamental understanding of plant stress physiology.

**CO2: Elaborate** physiological impact of abiotic and biotic stress in plants and develop strategies for managing abiotic stress for increasing sustainable crop production.

**CO3: Grow** experimental proficiency in study of physiological and biochemical traits in plant in response to stress.

**CO4: Enhance** collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.

**A) Theory**

**(Credit:03)**

Unit	Content	Lecture
1	<b>Fundamentals of stress physiology:</b> Stress: Concept, definition and its types; Stress avoidance, acclimatization and adaptation in plants.	8

2	<b>Stress signalling in plant:</b> Stress sensing and perception, signalling components; Calcium, MAPK Kinases, IP, Abiotic stress signalling in plant. Hormone mediated abiotic stress signalling and responses in plants.	8
3	<b>Stress responses in plants:</b> Physiological impact of abiotic stress (drought, flood, metal, temperature and salt stress); Biotic stress (allelopathic and pathogen induced stress) in plants.	8
4	<b>Defence systems in plant:</b> ROS and antioxidant: definition, types, sources, impact and methods of ROS detection in plant. Osmotic adjustment: Role of proline, glycine betain, sorbitol, mannitol.	8
5	<b>Stress responsive proteins in plants:</b> Stress responsive proteins and their functions in plants; Aquaporins, Dehydrins, HSP, Phytochelatins and metallothionins LEA, transcription factors and abiotic stress regulation in plants.	8
6	<b>Abiotic stress management in plant:</b> Role of mineral nutrition; Micro RNA; Transgenic approach for stress resistance in crop: Bt cotton, Bt Brinjal, Golden Rice.	8

## B) PRACTICAL

(Credit-1)

1. To measure relative water content in leaves of plants.
2. To study morphological changes and stress tolerance index in plants under water stress.
3. To isolate and estimate protein by Bradford in stressed plants.
4. To estimate proline content in stressed leaves.
5. To estimate ascorbate content in plants.
6. To estimate catalase activity in plants.
7. Determination of H<sub>2</sub>O<sub>2</sub> content in plants.

**Practicals should be supported by practical record.**

### Suggested readings:

- Buchanan, Gruissem, and Jones. 2000. Biochemistry and Molecular Biology of Plants. Wiley-Blackwell-ASPB, Rockville, MD.
- G R Rout & A B Das (Eds) (2013) Molecular Stress Physiology of Plants, Springer, India
- Levitt.J. 1980. Response of Plants to Environmental Stresses. Vols. I, II. Academic John Wiley & Sons.
- Sergey Shabala (2017) Plant Stress Physiology, CABI international
- Taiz and Zeiger 2010. Plant Physiology. 5th Edition. Sinauer Associates, Inc. Sunderland, MA

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**Paper code: BOT23M 705**

**Paper title: DEVELOPMENTAL BOTANY AND PLANT ANATOMY**

**(Credits:04, Theory-3, Tutorial-0, Practical-1)**

**Type of paper: Theory+ Paper**

**Course outcomes:**

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

**CO1: Conceptualize** reproductive development in plant, Pollination and Fertilization process, apomixis and polyembryony in plant.

**CO2: Develop** experimental proficiency in study of anthers, pollen grain through slide preparation, dissection of embryo from developing seeds.

**CO3:** Grow conceptual understanding of plant anatomy.

**CO4: Learn skills** in identification of secondary growth and anomalous secondary growth in stem and preparation of permanent slide.

**CO5: Enhance** collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.

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**A) Theory**

**(Credit:03)**

<b>Unit</b>	<b>Content</b>	<b>Lecture</b>
1	<b>Reproductive development:</b> Sporogenesis and gametogenesis, organization, structure and types of embryo sacs, Structure and types of ovules.	8
2	<b>Pollination and fertilization:</b> Pollination mechanisms and adaptations; Double fertilization.	8
3	<b>Endosperm &amp; Embryo:</b> Endosperm types, structure and functions; Dicot and monocot embryo, structure and development.	8
4	<b>Seed:</b> Structure and development, appendages and dispersal mechanisms.	8
5	<b>Tissue and Tissue system:</b> Types, classification, tissue system, tissue organization of root and shoot apices.	8

6	<b>Anatomy and Secondary growth:</b> Anatomy of root, stem and leaf (monocot & dicot), anomalous secondary growth in stem.	8
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**B) Practical**

**(Credit-01)**

1. Anatomy of root, stem and leaf (monocot and dicot).
2. Studies of anomalous secondary growth in *Amaranthus*, *Boerhaavia*, *Mirabilis* and *Dracaena*.
3. Structure of mature anther, tapetum (amoeboid and secretory) (Permanent slides).
4. Types of ovules (Permanent slides).

**Practicals should be supported by practical record.**

**Suggested Reading**

**Plant anatomy:**

- Roy P (2010) Plant Anatomy, New Central Book Agency.
- Pandey B.P.(2001). Plant Anatomy. S. Chand and Company Ltd., New Delhi.
- Easu, K. (1996). Anatomy of Seed Plants. First wiley Reprint, New Delhi.
- Fahn, A. (1985). Plant anatomy, Pergaon Press, Headington Hill Hall, Oxford.

**Embryology**

- Raghavan, V. Molecular Embryology of Flowering Plants, 1997, Camb. University Press.
- Maheswari, P. An Introduction to Embryology of Angiosperm, Latest Ed., Tata McGraw Hill.
- Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House.
- Delhi. 5th edition. 6. B. K. Mishra (2017). Reproductive Biology of Angiosperms Kalynai Publishers, New Delhi.

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**Paper code: BOT23DPW-706**

**Paper Title: Dissertation\_I**

**Credits:Theory-0, Practical-4**

**Type of paper: Practical**

**Course outcomes**

On completion of the project work, the students will be able to:

**CO1** : Identify research problems based on literature survey.

**CO2:** Gain knowledge on basic research methodology and ethics.

**CO3:** Develop a scientific temperament, critical thinking, time management and inculcate a methodical approach to solve the identified research problem.

**CO4:** Develop skills in data analysis, interpretation, scientific writing and presentation.

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- Students who have **more than 7.5 CGPA** and want to opt for **Honours with Research degree** can take dissertation/project work.
  - He/she need not take Core paper (**BOT23C 704**) in this semester but must take Core Papers [ **BOT23C 701, BOT23C 702 and BOTC 703**].
  - For this semester, dissertation/project will be evaluated **for 4 credits** only.
  - Students who will opt for UG Honours degree only, must study Core paper **BOT23C 704** along with **BOT23C 701, BOT23C 702 and BOT23C 703**.

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## **UG Semester-VIII**

**Paper code: BOT23C 801**

**Paper title: TRADITIONAL KNOWLEDGE AND IPR PRACTICES IN PLANT SCIENCES**

**(Credits:04, Theory-3, Tutorial-0, Practical-1)**

**Type of paper: Theory+Practical**

**Course outcomes:**

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

**CO1: Learn** about theory and practical techniques for supporting and preserving indigenous knowledge in the current era of constant cross-cultural interactions between knowledge systems.

**CO2: Acquire knowledge** about the role of oral histories, environmental knowledge, and spiritual beliefs and their role in community research, co-management, and environmental management.

**CO3: Discuss** approaches to education regarding traditional knowledge, including traditional family methods, government programs and public institutions.

**CO4: Describe** various approaches and issues regarding the recording, management, ownership and control of traditional knowledge, including research ethics, data management, and intellectual property rights.

**CO5: Demonstrate** understanding on Bioethics and their relevance to the current scenario.

**CO6: Understand** the ethical practices and concepts appropriate to the discipline.

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**A) Theory**

**(Credit:03)**

Unit	Content	Lecture
1	<b>Introduction to Traditional knowledge:</b> Definition, scope, types and importance of traditional knowledge; physical and social change on traditional knowledge systems.	8
2	<b>Protection of traditional knowledge:</b> Significance of protecting Traditional knowledge, value of TK in global economy. Role of Government to harness TK, schedule tribes and other traditional forest dwellers (Recognition of Forest Rights), 2006; Protection of Traditional Knowledge Bill, 2016.	8
3	<b>Traditional knowledge of Northeast India-</b> homestead gardens, Irrigation- Dong and Bamboo drip, Jhum cultivation, Wet rice cultivation, Sacred groves	8
4	<b>IPR:</b> Introduction, types (patent, copyrights, geographical indications, trademarks, trade secret), treaties in IPR, laws and legislations of IPR in India, IPR protection.	8
5	<b>Patent:</b> Patent filing, provisional and complete specification, patentable and non-patentable items, patent rejection.	8
6	<b>Bioethics:</b> Introduction and principles of bioethics, its relation with other branches, ethics related to agriculture, Bioethical issues in India through case studies. Protection of environment and biodiversity - biopiracy.	8

**B) Practical**

**(Credit:01)**

1. Questionnaire preparation.
  2. Data collection methods.
  3. Traditional knowledge of selected ethnic community(s) of Assam.
  4. Any case study on local heritage management (homestead gardens / Dong / Bamboo drip / Jhum cultivation / Wet rice cultivation / Sacred groves) of selected ethnic community.
- **Relevant reports to be submitted for evaluation.**

**Suggested Readings:**

- Jain S.K., 1995. A Manual of Ethnobotany. 2<sup>nd</sup> Edition.
- Jain S.K., 1995. Contribution to Indian Ethnobotany. 3<sup>rd</sup> Edition, Scientific publishers, P.B.No. 91, Jodhpur, India.
- Sinha R.K. & S. Sinha, 2001. Ethnobiology. Surabhee Publications, Jodhpur.
- Pandey N. & K. Dharni, 2014. Intellectual Property Rights. PHI learning publishers.
- Goel D. & S. Parashar, 2013. IPR Biosafety and Bioethics. 1<sup>st</sup> edition. Pearson education, India.
- Ahuja V.K., 2018. Intellectual Property Rights in India. 2<sup>nd</sup> edition. Lexis Nexis publisher, New York.

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**Paper code: BOT23C 802**

**Paper title: BIODIVERSITY AND CONSERVATION BIOLOGY**

**(Credits:04, Theory-3, Tutorial-0, Practical-1)**

**Type of paper: THEORY+Practical**

**Course outcomes:**

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

**CO1: Understand** the concept and scope of biodiversity.

**CO2: Learn** the origin of crop plants and concept of agrobiodiversity.

**CO3: Identify** the causes and implications of loss of biodiversity.

**CO4: Utilize** various strategies for the conservation of biodiversity.

**CO5: Enhance** collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.

**A) Theory**

**(Credit:03)**

Unit	Content	Lecture
1	<b>Concepts of biodiversity:</b> Definition, concept, importance, levels and value of biodiversity; Biodiversity and ecosystem services; <b>Govt Initiatives in making India a biodiversity champion – National Mission for Green India:</b> (i) Green Credit Programme, (ii) MISHTI Initiative and (iii) Amrit Dharohar scheme; <b>Measurement of Biodiversity:</b> Useful indices (Shannon-Weiner Index, Simpson Index).	8
2	<b>Biodiversity in India:</b> India as a mega-biodiversity nation, biodiversity in India with special reference to Northeastern region, hotspots in India; wealth of Indian hotspots. Endemism in Indian flora.	8
3	<b>Agrobiodiversity:</b> Agrobiodiversity hotspots in India, Endemic and threatened plant species of agrobiodiversity importance (in the different agrobiodiversity regions in India), Vavilov’s Centre of Origin of crop plants. <b>Wild relatives of cultivated plants:</b> Crop Wild Relatives (CWR) indigenous to India (categories), importance of CWR as Plant Genetic Resource (PGR) and as socio economic resource, threats and conservation measures of CWR.	8
4	<b>Threats to biodiversity:</b> Habitat degradation and loss, natural calamities, species invasions, overharvesting/overexploitation, habitat fragmentation and metapopulation dynamics.	8

5	<b>Principles of Conservation biology:</b> Definition and concept of conservation biology; Conservation strategies: IUCN threat categories, Red Data Book, RET plants of India, <i>in-situ</i> conservation (Biosphere reserves and National Parks) and <i>ex-situ</i> conservation (Botanical gardens, seed bank and germplasm bank) and ecological restoration.	8
6	<b>Application of Geospatial Technologies in Biodiversity Studies</b> General introduction; <b>Geospatial Technologies:</b> Remote sensing (RS) and Geographical Information System (GIS); <b>Application of RS and GIS in biodiversity and conservation:</b> Forest management, management of Grasslands, agricultural biodiversity, habitat mapping and monitoring, monitoring of invasive species, Biodiversity assessment – Landscape to species.	8

## B) Practical

(Credits-1)

1. To study the plant biodiversity within the University campus and to measure the following diversity indices – (Shannon-Weiner Index, Simpson Index).
2. To prepare a map of biodiversity hotspots of India with special reference to Northeastern region.
3. To prepare a map of the agrobiodiversity hotspots in India describing the location & extent of each region and the representative agrobiodiversity.
4. Study of endemic and threatened plant species of agrobiodiversity importance (from the different agrobiodiversity regions in India (at least 10).
5. Study of the following CWR of Brahmaputra valley through fresh specimens/photographs/herbariums/museum specimens: *Camellia sinensis* var. *assamica*, *Citrus assamensis*, *Curcuma amada*, *Mangifera sylvatica*, *Musa velutina*, *Oryza rufipogon*, *Piper peepuloides* and *Zingiber spectabile*.
6. To study the RET plant wealth of Assam, India through fresh specimens/photographs/herbariums/museum specimens (atleast 5).

**Practicals should be supported by practical record.**

### Suggested readings:

- J.S. Singh, S.P. Singh and S.R. Gupta (2014). Ecology, Environmental Science and Conservation. S.Chand and Company Pvt. Ltd., New Delhi.
- K. Bhattacharya, A.K. Ghosh and G. Hait (2017). A Text Book of Botany (Ecology and Environmental Biology; Economic Botany and Pharmacognosy) . Vol. IV. New Central Book Agency (P) Ltd.
- Biodiversity and Conservation. M.J. Jeffries (1997). Routledge, Taylor and Francis Group.
- Tropical Rain Forest Ecology, Diversity & Conservation. J. Ghazoul and D. Sheil (2010). Oxford Biology.



- F.V. Dyke (2003). Conservation Biology: Foundation, Concepts, Applications. Springer.

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**Paper code: BOT23C-803**

**Paper Title: Advanced Plant Systematics**

**(Credits: 04, Theory-3, Tutorial-0, Practical-1)**

**Type of paper: Theory+ Practical**

**Course outcomes:**

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

**CO1: Understand** the concepts and approaches of plant systematics.

**CO2: Identify** the sources of taxonomic characters in different disciplines.

**CO3: Understand the** Origin, evolution and phylogenetic analysis of angiosperms.

**CO4: Acquainted** with interdisciplinary approach and advanced tools in plant systematics.

**CO5: Skills** on specific techniques for plant systematics.

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**A) Theory**

**(Credit:03)**

Unit	Content	Lecture
1	<b>Principles of Plant Identification and classification:</b> Aim and objectives, Concept and approach of different classificatory systems, phyletic, cladistics and APG in plant classification and identification.	8
2	<b>Disciplines and Evidences in Systematics:</b> Concept and application of morphology, anatomy, palynology, chemotaxonomy, cytotoxonomy and molecular taxonomy in plant classification.	8
3	<b>Numerical taxonomy:</b> Concept, applications and techniques (Character selection, OTUs, Coding characters, cluster analysis and phenogram)	8
4	<b>Phylogeny of Angiosperm:</b> Concepts (homology and analogy, parallelism and convergence, monophyly, paraphyly, polyphyly and clades), methods of illustrating evolutionary relationship.	8
5	<b>DNA barcoding:</b> Concept, and application, DNA barcoding by using rapidly accumulating DNA sequence from rbcL and matK.	8
6	<b>Molecular phylogeny:</b> Goal, principle, properties and types of phylogenetic analysis.	8

## B) PRACTICAL

(Credit-1)

1. Study of phenetic variability of taxonomic significance and character analysis of selected Angiosperm taxa/taxon (one each from monocot and dicot).
2. Study of micro morphological features of both vegetative part (any one) and reproductive part (any one) of selected taxa/taxon in relation to plant systematics.
3. Phylogenetic analysis/evolutionary status of selected taxa based on morphological/chromosomal characters.
4. In silico molecular phylogeny analysis by considering chloroplast and mitochondrial genome.

**Practical should be supported by practical record, specimen and herbarium.**

### Suggested Readings:

#### Angiosperm Morphology:

- Avise, J. (2006): Evolutionary Pathways in Nature: A Phylogenetic Approach. Cambridge University Press.
- Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. and Donoghue, M.J. 2002. Plant Systematics - A Phylogenetic Approach. 2<sup>nd</sup> edition. Sinauer Associates Inc., Cary, NC.
- Lindell Bromham (2016) : An Introduction to Molecular Evolution and Phylogenetics (2<sup>nd</sup> Edn) . Oxford University Press.
- Mondal AK. 2016. Advanced plant taxonomy. 1st edition. Nee central Book Agency (NCBA) publisher

- Pamela S. Soltis, 1992. Molecular Systematics of plants. 1st edition. Springer.
  - Pandey and Misra. 2008. Taxonomy of Angiosperms. ANE books publisher.
  - Singh, G. (2012). Plant Systematics: Theory and Practice. Completely revised and enlarged 3rd edition. Oxford & IBH, New Delhi.
  - Salemi, M. and Vandamme, A. (Editors) (2003) : The Phylogenetic Handbook : A Practical Approach to DNA and Protein Phylogeny. Cambridge University Press.
  - Simpson, M. (2018). Plant Systematics (3rd Edition). Elsevier Academic Press. Amsterdam Boston Heidelberg London, New York Oxford Paris San Diego, San Francisco Singapore Sydney Tokyo.
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**Paper code: BOT23C-804**

**Paper title: BIOTECHNOLOGY & BIOSTATISTICS**

**(Credits:04, Theory-3, Tutorial-0, Practical-1)**

**Type of paper: Theory+ Practical**

**Course outcomes**

On completion of this course, the students will be able to:

**CO1: Develop** the concept of biological databases, genomics and proteomics, DNA sequencing and sequence alignment, drug designing, molecular evolution and phylogenetic analysis.

**CO2: Understand** rDNA technology, and perform experiments associated with in-vitro culture.

**CO3: Grow** skills in tabulation, representation, interpretation and analysis of biological data using the principles of biostatistics.

**CO4: Enhance** collaborative learning and communication skills through practical sessions, teamwork, group discussions and home assignments.

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**A) Theory**

**(Credit:03)**

<b>Unit</b>	<b>Content</b>	<b>Lecture</b>
<b>1</b>	<b>Introductory Biotechnology:</b> History, Scope and branches of Biotechnology, Application in Agriculture, Environment and Medicine.	<b>8</b>
<b>2</b>	<b>DNA recombinant technology:</b> Basic technique, restriction enzymes, vectors, DNA libraries, DNA fingerprinting, applications of DNA recombinant technology. Methods of gene transfer in plants. Transgenics plants.	<b>8</b>

<b>3</b>	<b>Marker gene system:</b> Selection of transformed tissues. Marker genes and reporter genes. Marker free transgenics.	<b>8</b>
<b>4</b>	<b>Plant Tissue Culture:</b> Introduction to Plant tissue culture, scope application and somaclonal variation. Culture media, Tissue culture techniques, Somatic embryogenesis, synthetic seeds. Pollen culture, Embryo culture, protoplast culture and somatic hybridization.	<b>8</b>
<b>5</b>	<b>Basic Biostatistics:</b> Collection of data, Sampling theory and methods, measures of central tendency (mean, mode, median), variation and coefficient of variation, Standard deviation and Standard error.	<b>8</b>
<b>6</b>	<b>Inferential statistics:</b> Probability, Test of significance (t-test, chi-square test), ANOVA. Correlation and regression.	<b>8</b>

**B) Practical**

**(Credit- 1)**

1. To work out mean, mode, standard deviation, standard error and coefficient of variation
2. To work out problems related to t Test, Chi-square test
3. Preparation and sterilization of nutrient medium (MS medium), slant preparation & micro propagation of some important plants.
4. Study of preparation of synthetic seeds.
5. Construction of Restriction Map from the data provided.

**Practical should be supported with practical record.**

**Suggested Readings:**

- Harisha, S. (2007) Fundamentals of Bioinformatics. I.K. International Publishing House.
- Jogdand, S.N. Gene Biotechnology --Himalay Publishing House
- Prasad S, Elements of Biostatics - Rastogi Publications
- Rana S.V. S, Biotechniques, Theory and Practice -,Rastogi Publications.
- Sharma, V et al., Textbook of Bioinformatics-- Rastogi Publications.
- Xiong, J. (2006) Essential Bioinformatics. Cambridge University Press.

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**Paper code: BOT23M-805**

**Paper title: ECONOMIC BOTANY, ETHNOBOTANY AND PHARMACOGNOSY**

**(Credits:04, Theory-3, Tutorial-0,Practical-1)**

**Type of paper: Theory+Practical**

**Course outcomes:**

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

**CO1: Develop** understanding of origin, distribution and economic importance of certain plants.

**CO2: Conceptualize** ethnobotany as an interdisciplinary science and categorise various indigenous ethnic groups of Assam and realise their role in biodiversity and conservation.

**CO3: Develop** understanding on pharmacognostic features of plants and recognise the basic medicinal plant.

**CO4: Inculcate** practical knowledge on phytochemical screening (both qualitative and quantitative) of plants.

**CO5: Evaluate** the drug adulteration and contamination through the microscopic, macroscopic and analytical methods.

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**A) Theory**

**(Credit:03)**

<b>Unit</b>	<b>Content</b>	<b>Lecture</b>
<b>1</b>	<b>Economic Botany:</b> Concept of Vavilov' s centres of origin; primary and secondary centres of diversity, plant introductions, classification of plant resources on the basis of their uses.	<b>8</b>
<b>2</b>	<b>A brief account, origin, distribution, botanical description, morphology, economically important products and uses of the following:</b>  Cereals -Rice; Beverages -Tea; Medicinal plants - <i>Taxus wallichiana</i> , <i>Cinchona</i> , <i>Rauwolfia</i> ; Fibres - cotton and jute; Forest products -teak, bamboos and rattans (of NE India), gums and resins.	<b>8</b>

3	<b>Ethnobotany:</b> Introduction, scope and objectives; Ethnobotany as an interdisciplinary science. Sacred groves and their role in conservation of biodiversity.	8
4	<b>Different ethnic groups of Assam, Plants used by different ethnic groups of Assam</b> as: a) Food, b) Intoxicants and beverages and c) Medicine.	8
5	<b>Pharmacognosy:</b> Aims and objective of pharmacognosy, pharmacopoeas: History of Indian pharmacopoeas. Pharmacognosy of some medicinal plants Eg: <i>Ginger, Turmeric, Chirata, Rauwolfia, Adhatoda, Andrographis, Cinchona, Opium.</i>	8
6	<b>Classification</b> of crude drug, adulteration, substitution and contamination of Herbal drug. Introduction to the techniques for quality control, monitoring and regulation. Quality control methods: microscopic and macroscopic, chromatography, spectroscopy. Phytoconstituent Important to therapy - Alkaloids, Flavonoids, Tanins and steroids.	8

### B) Practical

(Credit-1)

1. Study of economically important plants: Rice, Tea, *Ocimum* and Neem, Jute, Cotton.
2. Qualitative determination of phytochemicals from plants
3. Determination of curcumin in Turmeric.
4. Organographic studies of *Zingiber, Curcuma, Rauwolfia, Adhatoda, Andrographis, Cinchona*
5. Determination of alkaloids by TLC.
6. Determination of tannins in tea leaves.
7. Study of wild medicinal and edible plants used by ethnic communities of Assam.

**Practicals should be supported by practical record /slides and specimens.**

#### Suggested Readings:

Economic Botany.

- Hill, A. - (1972) Economic Botany.
- P.L. Kochar -(1981) Economic Botany.
- S.D. Sabnis and M. Daniel - (1990) A Phytochemical Approach to economic Botany.

Ethnobotany:

- Colton C.M. 1997. Ethnobotany - Principles and applications. John Wiley and sons- Chichester.

- Jain, S.K., 1989. Methods and approaches in ethnobotany. Society of ethnobotanists,
- Jain, S.K. , 1990. Contributions of Indian ethnobotny. Scientific publishers, Jodhpur.
- Jain, S.K(1995). Manual of Ethnobotany, Scientific Publishers, Jodhpur.
- Subramanyam, N.S. & Samba Murty, A.V.S. , Economic Botany. Wiley Eastern Ltd.

Pharmacognosy:

- Ali, Mohammad (2010) Text Book of Pharmacognosy (2nd Edition).CBS Publishers & Distributor Pvt .Ltd, New Delhi, India
- Raje V N (2010) Pharmacognosy, CBS Publishers & Distributor Pvt .Ltd, New Delhi, India.
- Shah, B and Seth A K(2014) A Text Book of Pharmacognosy & Phytochemistry (2nd Edition) Elsevier, India Private Limited.
- Singh, G K and A Bhandari A (2011) Text Book of Pharmacognosy, CBS Publishers & Distributor Pvt .Ltd, New Delhi, India.

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**Paper code: BOT23DPW-806**

**Paper title: Dissertation\_II**

**Credits:Theory-0, Practical-8**

**Type of paper: Practical**

**Course outcomes**

**CO1** : Identify research problems based on literature survey.

**CO2**: Gain knowledge on basic research methodology and ethics.

**CO3**: Develop a scientific temperament, critical thinking, time management and inculcate a methodical approach to solve the identified research problem.

**CO4**: Develop skills in data analysis, interpretation, scientific writing and presentation.

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- For this semester, dissertation/project will be evaluated for 8 credits.
  - Students who do not have a dissertation/ project must study Core papers BOT803C and BOT 804C along with Bot 801C and Bot 802C.

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