

Annamalai University

(Accredited with 'A' Grade by NAAC)

Faculty of Science




DEPARTMENT OF BOTANY

M.Sc BOTANY

Programme Code: SBOT21



**Regulations, Curriculum and Syllabus
2019**


Annamalai University
Faculty of Science
DEPARTMENT OF BOTANY
M.Sc. BOTANY
Programme Code:SBOT21

These rules and regulations shall govern the Two year post graduate studies leading to the award of degree of **Master of Science in Botany** in the Faculty of Science. These academic Regulations shall be called "**Annamalai University, Faculty of Science Two year M.Sc. Botany Regulations 2019**". They shall come into force with effect from the academic year 2019 – 2020.

1. Definitions and Nomenclature

- 1.1 **University** refers to Annamalai University.
- 1.2 **Department** means any of the academic departments and academic centers at the University.
- 1.3 **Discipline** refers to the specialization or branch of knowledge taught and researched in higher education. For example, Botany is a discipline in the Natural Sciences, while Economics is a discipline in Social Sciences.
- 1.4 **Programme** encompasses the combination of courses and/or requirements leading to a Degree. For example, M.A., M.Sc.
- 1.5 **Course** is an individual subject in a programme. Each course may consist of Lectures/ Laboratory /Seminar/Project work/viva-voce etc. Each course has a course title and is identified by a course code.
- 1.6 **Curriculum** encompasses the totality of student experiences that occur during the educational process.
- 1.7 **Syllabus** is an academic document that contains the complete information about an academic programme and defines responsibilities and outcomes. This includes course information, course objectives, policies, evaluation, grading, learning resources and course calendar.
- 1.8 **Academic Year** refers to the annual period of sessions of the University that comprises two consecutive semesters.
- 1.9 **Semester** is a half-year term that lasts for a minimum duration of 90 days. Each academic year is divided into two semesters.
- 1.10 **Choice Based Credit System:** A mode of learning in higher education that enables a student to have the freedom to select his/her own choice of elective courses across various disciplines for completing the Degree programme.
- 1.11 **Core Course** is mandatory and an essential requirement to qualify for the Degree.
- 1.12 **Elective Course** is a course that a student can choose from a range of alternatives.
- 1.13 **Value-added Courses** are optional courses that complement the students' knowledge and skills and enhance their employability.
- 1.14 **Credit** refers to the quantum of course work in terms of number of class hours in a semester required for a programme. The credit value reflects the content and duration of a particular course in the curriculum.

- 1.15 **Credit Hour** refers to the number of class hours per week required for a course in a semester. It is used to calculate the credit value of a particular course.
- 1.16 **Programme Outcomes** (POs) are statements that describe crucial and essential knowledge, skills and attitudes that students are expected to achieve and can reliably manifest at the end of a programme.
- 1.17 **Programme Specific Outcomes** (PSOs) are statements that list what the graduate of a specific programme should be able to do at the end of the programme.
- 1.18 **Learning Objectives** are statements that define the expected goal of a course in **Course Objectives** in terms of demonstrable skills or knowledge that will be acquired by a student.
- 1.19 **Course Outcomes** (COs) are statements that describe what students should be able to achieve/demonstrate at the end of a course. They allow follow-up and measurement of learning objectives.
- 1.20 **Grade Point Average** (GPA) is the average of the grades acquired in various courses that a student has taken in a semester. The formula for computing GPA is given in section 11.3
- 1.21 **Cumulative Grade Point Average** (CGPA) is a measure of overall cumulative performance of a student over all the semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. is given in section 11.4.
- 1.22 **Letter Grade** is an index of the performance of a student in a particular course. Grades are denoted by the letters S, A, B, C, D, E, RA, and W.

2. **Programme Offered and Eligibility Criteria:**

The Department of Botany offers a Two Year M.Sc. in Botany programme. A pass in B.Sc. (Botany) or B.Sc. (Plant Biology / Plant Biotechnology) with not less than 50% of marks under Part-III.

- 2.1 In the case of SC/ST and Differently-abled candidates, a pass is the minimum qualification for the above Programme.

- 3. **Reservation Policy:** Admission to the various programmes will be strictly based on the reservation policy of the Government of Tamil Nadu.

4. **Programme Duration**

- 4.1 The Two Year Master's Programme consist of two academic years.
- 4.2 Each academic year is divided into two semesters, the first being from July to November and the second from December to April.
- 4.3 Each semester will have 90 working days (18 weeks).

5. **Programme Structure**

- 5.1 The Two Year Master's Programme consists of Core Courses, Elective Courses (Departmental & Interdepartmental), and Project.

5.2 **Core courses**

- 5.2.1 These are a set of compulsory courses essential for each programme.
- 5.2.2 The core courses include both Theory (Core Theory) and Practical (Core Practical) courses.

5.3 **Elective courses**

- 5.3.1 Departmental Electives (DEs) are the Electives that students can choose from a range of

Electives offered within the Department.

5.3.2 Interdepartmental Electives (IDEs) are Electives that students can choose from amongst the courses offered by other departments of the same faculty as well as by the departments of other faculties.

5.4 **Experiential Learning**

5.4.1 Experiential learning provides opportunities to students to connect principles of the discipline with real-life situations.

5.4.2 In-plant training/field trips/internships/industrial visits fall under this category.

5.4.3 Experiential learning is categorized as Non-Credit Compulsory Course.

5.5 **Project**

5.5.1 Each student shall undertake a Project and submit a dissertation as per guidelines in the final semester.

5.5.2 The Head of the Department shall assign a Research Supervisor to the student.

5.5.3 The Research Supervisor shall assign a topic for research and monitor the progress of the student periodically.

5.5.4 Students who wish to undertake project work in recognized institutions/industry shall obtain prior permission from the Department. The Research Supervisor will be from the host institute.

5.6 **Value added Courses (VACs)**

5.6.1 Students may also opt to take Value added Courses beyond the minimum credits required for award of the Degree. VACs are outside the normal credit paradigm.

5.6.2 These courses impart employable and life skills. VACs are listed in the University website and in the Handbook on Interdepartmental Electives and VACs.

5.6.3 Each VAC carries 2 credits with 30 hours of instruction. Classes for a VAC are conducted beyond the regular class hours and preferably in the III Semester.

5.7 **Online Courses**

5.7.1 The Heads of Departments shall facilitate enrolment of students in Massive Open Online Courses (MOOCs) platform such as SWAYAM to provide academic flexibility and enhance the academic career of students.

5.7.2 Students who successfully complete a course in the MOOCs platform shall be exempted from one elective course of the programme.

5.8 **Credit Distribution:** The credit distribution is organized as follows:

	Credits
Core Courses	72
Elective Courses	15
Project	06
Total	93

5.9 **Credit Assignment**

Each course is assigned credits and credit hours on the following basis:

1 Credit is defined as

1 Lecture period of one hour duration per week over a semester

- 1 Tutorial period of one hour duration per week over a semester
- 1 Practical/Project period of two hours duration per week over a semester.

6 Attendance

- 6.1 Each faculty handling a course shall be responsible for the maintenance of Attendance and Assessment Record for candidates who have registered for the course.
- 6.2 The Record shall contain details of the students' attendance, marks obtained in the Continuous Internal Assessment (CIA) Tests, Assignments and Seminars. In addition the Record shall also contain the organization of lesson plan of the Course teacher.
- 6.3 The record shall be submitted to the Head of the Department and Dean once a month for monitoring the attendance and syllabus coverage.
- 6.4 At the end of the semester, the record shall be placed in safe custody for any future verification.
- 6.5 The Course teacher shall intimate to the Head of the Department at least seven calendar days before the last instruction day in the semester about the attendance particulars of all students.
- 6.6 Each student shall have a minimum of 75% attendance in all the courses of the particular semester failing which he or she will not be permitted to write the End-Semester Examination. The student has to redo the semester in the next year.
- 6.7 Relaxation of attendance requirement up to 10% may be granted for valid reasons such as illness, representing the University in extracurricular activities and participation in NCC/NSS/YRC/RRC.

7 Mentor-Mentee System

- 7.1 To help the students in planning their course of study and for general advice on the academic programme, the Head of the Department will attach certain number of students to a member of the faculty who shall function as a Mentor throughout their period of study.
- 7.2 The Mentors will guide their mentees with the curriculum, monitor their progress, and provide intellectual and emotional support.
- 7.3 The Mentors shall also help their mentees to choose appropriate electives and value-added courses, apply for scholarships, undertake projects, prepare for competitive examinations such as NET/SET, GATE etc., attend campus interviews and participate in extracurricular activities.

8 Examinations

- 8.1 The examination system of the University is designed to systematically test the student's progress in class, laboratory and field work through Continuous Internal Assessment (CIA) Tests and End-Semester Examination (ESE).
- 8.2 There will be two CIA Tests and one ESE in each semester.
- 8.3 The Question Papers will be framed to test different levels of learning based on Bloom's taxonomy viz. Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation/Creativity.

9 Continuous Internal Assessment Tests

- 8.3.1 The CIA Tests shall be a combination of a variety of tools such as class tests, assignments and seminars. This requires an element of openness.
- 8.3.2 The students are to be informed in advance about the assessment procedures.
- 8.3.3 The pattern of question paper will be decided by the respective faculty.

- 8.3.4 CIA Tests will be for one or two hours duration depending on the quantum of syllabus.
- 8.3.5 A student cannot repeat the CIA Test-I and CIA Test-II. However, if for any valid reason, the student is unable to attend the test, the prerogative of arranging a special test lies with the teacher in consultation with the Head of the Department.
- 8.3.6 For the CIA Tests, the assessment will be done by the Course teacher

8.4 **End Semester Examinations (ESE)**

- 8.4.1 The ESE for the first and third semester will be conducted in November and for the second and fourth semester in May.
- 8.5 Candidates who failed in any course will be permitted to reappear in failed course in the subsequent examinations.
- 8.6 The ESE will be of three hours duration and will cover the entire syllabus of the course.

8.7 **Evaluation**

9.1 **Marks Distribution**

- 9.1.1 For each course, the Theory, Practical and project shall be evaluated for a maximum of 100 marks.
- 9.1.2 For the theory and Project courses, CIA Tests will carry 25% and the ESE 75% of the marks.
- 9.1.3 For the Practical courses, the CIA Tests will carry 40% and the ESE 60% of the marks.

9.2 **Assessment of CIA Tests**

- 9.2.1 For the CIA Tests, the assessment will be done by the Course Instructor
- 9.2.2 For the Theory Courses, the break-up of marks shall be as follows:

CIA Tests	Marks
Test-I & Test-II	15
Seminar	5
Assignment	5
Total	25

- 9.2.3 For the Practical Courses (wherever applicable), the break-up of marks shall be as follows:

CIA Tests	Marks
Test-I	15
Test-II	15
Viva-voce and Record	10
Total	40

- 9.2.4 The M.Sc., students of Botany shall undertake a Botanical Tour during third semester under the guidance of the staff members for field training and plant collection.

9.3 **Assessment of End-Semester Examinations**

- 9.3.1 Evaluation for the ESE is done by Internal examiners.

9.4 **Assessment of Project/Dissertation**

- 9.4.1 The Project Report/Dissertation shall be submitted as per the guidelines.
- 9.4.2 The Project Work/Dissertation shall carry a maximum of 100 marks.
- 9.4.3 CIA for Project will consist of a Review of literature survey, experimentation/field work,

attendance etc.

- 9.4.4 The Project Report evaluation and viva-voce will be conducted by a committee constituted by the Head of the Department.
- 9.4.5 The Project Evaluation Committee will comprise the Head of the Department, Project Supervisor, and a senior faculty.

9.4.6 The marks shall be distributed as follows:

Continuous Internal Assessment (25 Marks)		End Semester Examination (75 Marks)	
Review-I - 10	Review-II -15	Project / Dissertation Evaluation	Viva-voce
		50	25

9.5 Assessment of Value-added Courses

- 9.5.1 Assessment of VACs shall be internal. Two CIA Tests shall be conducted during the semester by the Department(s) offering VAC.
- 9.5.2 The grades obtained in VACs will not be included for calculating the GPA/CGPA.

9.6 Passing Minimum

- 9.6.1 A student is declared to have passed in each course if he/she secures not less than 50% marks in the ESE and not less than 50% marks in aggregate taking CIA and ESE marks together.
- 9.6.2 The minimum marks for the Project/Dissertation alone is 50% and passing minimum is the aggregate of Project + CIA + Viva voce is 50%.
- 9.6.3 A candidate who has not secured a minimum of 50% of marks in a course (CIA + ESE) shall reappear for the course in the next semester/year.

10. Conferment of the Master's Degree

A candidate who has secured a minimum of 50% marks in all courses prescribed in the programme and earned the minimum required credits shall be considered to have passed the Master's Programme.

11. Marks and Grading

- 11.1 The performance of students in each course is evaluated in terms Grade Point (GP).
- 11.2 The sum total performance in each semester is rated by Grade Point Average (GPA) while Cumulative Grade Point Average (CGPA) indicates the Average Grade Point obtained for all the courses completed.
- 11.3 **The GPA** is calculated by the formula

$$GPA = \frac{\sum_{G=1}^G G_G G_G}{\sum_{G=1}^G G_G}$$

where, G_G is the Credit earned for the Course G in any semester;
 G_G is the Grade Point obtained by the student for the Course G
 G is the number of Courses passed in that semester.

- 11.4 **CGPA** is the Weighted Average Grade Point of all the Courses passed starting from the first semester to the current semester.

$$GGGG = \frac{\sum_{GG}^G \sum_{GG}^G G_G G_G}{\sum_{GG}^G \sum_{GG}^G G_G}$$

Where, G_G is the Credit earned for the Course G in any semester;

G_d is the Grade Point obtained by the student for the Course G

G is the number of Courses passed in that semester.

G is the number of semesters.

11.4 **The GPA** is calculated by the formula

$$GGG = \frac{\sum_{GG}^G G_G G_G}{\sum_{GG}^G G_G}$$

where, G_G is the Credit earned for the Course G in any semester;

G_d is the Grade Point obtained by the student for the Course G

G is the number of Courses passed in that semester.

11.5 **Evaluation :**

11.5.1 **Performance of the student for each course will be rated as shown in the Table.**

Range of Marks	Grade Points	Letter Grade
90 and above	10	S
80-89	9	A
70-79	8	B
60-69	7	C
55-59	6	D
50-54	5	E
Less than 50	0	RA
Withdrawn from the examination	0	W

11.5.2 A ten point rating scale is used for evaluation of the performance of the student to provide overall grade for the Master's Programme.

CGPA	CLASSIFICATION OF FINAL RESULT
8.25 and above	First Class with Distinction
6.5 and above but below 8.25	First Class
5.0 and above but below 6.5	Second Class
0.0 and above but below 5.0	Re-appear

11.6 **Classification of Results.** The successful candidates are classified as follows:

11.6.1 **First Class with Distinction:** Candidates who have passed all the courses prescribed

in the Programme in the first attempt with a CGPA of 8.25 and above within the programme duration. Candidates who have withdrawn from the End Semester Examinations are still eligible for First Class with Distinction (See Section 12 for details).

- 11.6.2 **First Class:** Candidates who have passed all the courses with a CGPA of 6.5 and above.
- 11.6.3 **Second Class:** Candidates who have passed all the courses with a CGPA between 5.0 and less than 6.5.
- 11.6.4 Candidates who obtain overall highest CGPA in all examinations in the First Appearance itself are eligible for **University Rank**.
- 11.7 **Course-Wise Letter Grades**
 - 11.7.1 The percentage of marks obtained by a candidate in a course will be indicated in a letter grade.
 - 11.7.2 A student is considered to have completed a course successfully and earned the credits if he/she secures an overall letter grade other than RA.
 - 11.7.3 A course successfully completed cannot be repeated for the purpose of improving the Grade Point.
 - 11.7.4 A letter grade RA indicates that the candidate shall reappear for that course. The RA Grade once awarded stays in the grade card of the student and is not deleted even when he/she completes the course successfully later. The grade acquired later by the student will be indicated in the grade sheet of the Odd/Even semester in which the candidate has appeared for clearance of the arrears.
 - 11.7.5 If a student secures RA grade in the Project Work/Field Work/Practical Work/Dissertation, he/she shall improve it and resubmit if it involves only rewriting/ incorporating the clarifications suggested by the evaluators or he/she can re-register and carry out the same in the subsequent semesters for evaluation.

12. Provision for Withdrawal from the End Semester Examination

- 12.1 The letter grade W indicates that a candidate has withdrawn from the examination.
- 12.2 A candidate is permitted to withdraw from appearing in the ESE for one course or courses in ANY ONE of the semesters ONLY for exigencies deemed valid by the University authorities.
- 12.3 Permission for withdrawal from the examination shall be granted only once during the entire duration of the programme.
- 12.4 Application for withdrawal shall be considered only if the student has registered for the course(s), and fulfilled the requirements for attendance and CIA tests.
- 12.5 The application for withdrawal shall be made ten days prior to the commencement of the examination and duly approved by the Controller of Examinations. Notwithstanding the mandatory prerequisite of ten days notice, due consideration will be given under extraordinary circumstances.
- 12.6 Withdrawal will not be granted for arrear examinations of courses in previous semesters and for the final semester examinations.
- 12.7 Candidates who have been granted permission to withdraw from the examination shall reappear for the course(s) when the course(s) are offered next.
- 12.8 Withdrawal shall not be taken into account as an appearance for the examination when considering the eligibility of the candidate to qualify for First Class with Distinction.

13. **Academic misconduct:** Any action that results in an unfair academic advantage/interference with the functioning of the academic community constitutes academic misconduct. This includes but is not limited to cheating, plagiarism, altering academic documents, fabrication/falsification of data, submitting the work of another student, interfering with other students' work, removing/defacing library or computer resources, stealing other students' notes/assignments, and electronically interfering with other students'/University's intellectual property. Since many of these acts may be committed unintentionally due to lack of awareness, students shall be sensitized on issues of academic integrity and ethics.
14. **Transitory Regulations:** Wherever there has been a change of syllabi, examinations based on the existing syllabus will be conducted for two consecutive years after implementation of the new syllabus in order to enable the students to clear the arrears. Beyond that, the students will have to take up their examinations in equivalent subjects, as per the new syllabus, on the recommendation of the Head of the Department concerned.
15. Notwithstanding anything contained in the above pages as Rules and Regulations governing the Two Year Master's Programmes at Annamalai University, the Syndicate is vested with the powers to revise them from time to time on the recommendations of the Academic Council.



Department of Botany
M.Sc. Botany (Two Year) Programme
Programme Code: SBOT21
Curricula and Scheme of Examination

(For students admitted from the academic year 2019-2020)

Course Code	Course Title	Hours/Week			C	Marks		
		L	T	P		CIA	ESE	Total
Semester-I								
19BOTC101	Core 1: Plant Diversity – I(Algae and Bryophytes)	4	0		4	25	75	100
19BOTC102	Core 2: Fungi, Lichens and Plant Pathology	4	0		4	25	75	100
19BOTC103	Core 3: Microbiology	4	0		4	25	75	100
19BOTP104	Core 4: Practical – I	0	0	12	6	40	60	100
	Elective 1: Interdepartmental Elective	3	0		3	25	75	100
					21			
Semester-II								
19BOTC201	Core 5: Plant Diversity - II (Pteridophytes, Gymnosperms and Palaeobotany)	4	0		4	25	75	100
19BOTC202	Core 6: Anatomy, Embryology of Angiosperms and Morphogenesis	4	0		4	25	75	100
19BOTC203	Core 7: Cell Biology, Genetics and Plant Breeding	4	0		4	25	75	100
19BOTP204	Core 8: Practical – II	0	0	12	6	40	60	100
	Elective 2: Interdepartmental Elective	3	0		3	25	75	100
	Elective 3: Department Elective	3	0		3	25	75	100
					24			
Semester-III								
19BOTC301	Core 9: Taxonomy of Angiosperms and Economic Botany	4	0		4	25	75	100
19BOTC302	Core 10: Biochemistry and Molecular Biology	4	0		4	25	75	100
19BOTC303	Core 11: Biological Techniques and Research Methodology	4	0		4	25	75	100
19BOTC304	Core 12: Plant Bio-technology and Genetic Engineering	4	0		4	25	75	100
19BOTP305	Core 13: Practical –III	0	0	12	6	40	60	100
	Elective 4: Interdepartmental Elective	3	0		3	25	75	100
	Elective 5: Department Elective	3	0		3	25	75	100
19PSCI300	Constitution of India*	2	0		2*	25	75	100
					28			

Semester-IV								
19BOTC401	Core 14: Plant Physiology	4	0		4	25	75	100
19BOTC402	Core 15: Environmental Biology and Evolution	4	0		4	25	75	100
19BOTP403	Core 16: Practical – IV	0	0	12	6	40	60	100
19BOTD404	Project (Dissertation & Viva-voce)	0	6	0	6	25	75	100
					20			
	Total Credits				93			

L- Lectures; P- Practical; T – Tutorial; C- Credits; CIA- Continuous Internal Assessment; ESE- End-Semester Examination

***19PSCI300 = NON CREDIT COMPULSORY COURSE**

Note:

1. Students shall take both Department Electives (DEs) and Interdepartmental Electives (IDEs) from a range of choices available. The details of interdepartmental electives are given in the "**Handbook of Interdepartmental Electives-PG Programmes**" and listed in the University website.
2. Students may opt for any Value-added Courses listed in the University website. The details of Value Added Courses are given in the "**Handbook of Value Added Courses**" and listed in the University website.
3. Guidance/Discussion on course specific **experiential learning** to Students will be provided wherever feasible to apply the knowledge, skills and attitude taught in the course, either within the classroom, within the community, or within the workplace, to learn by experience which would improve their employability skills.

ELECTIVE COURSES

I. DEPARTMENT ELECTIVE COURSES (DE)

S. No.	Course Code	Course Title	Hours/week			C	Marks		
			L	T	P		CIA	ESE	Total
1.	19BOTE205	Herbarium Keeping	3	0	0	3	25	75	100
2.	19BOTE206	Forest Technology	3	0	0	3	25	75	100
3.	19BOTE305	Applied Botany	3	0	0	3	25	75	100
4.	19BOTE306	Bioprospecting of Medicinal and Aromatic Plants	3	0	0	3	25	75	100

ANNAMALAI UNIVERSITY

Department of Botany

[Question Paper Pattern - INTERNAL TESTS I & II (CIA)]

(Based on Revised Bloom's Taxonomy)

Programme: M.Sc : Two Year PG

Time: 2 Hrs

Semester: All

Max.Marks:50

Part-A (Level-K1)

(Answer ALL of the questions)

Marks: (6x2=12)

1. Define /Choose/ Relate.....
2. What / Why / How?
3. Multiple Choices a. b. c. d.
4. Multiple Choices a. b. c. d.
5. Match the following i - a ii - b iii - c iv - d v -
6. Match the following i - a ii - b iii - c iv - d v -

Part-B (Level-K2)

(Answer any THREE of the questions)

Marks: (3x5=15)

7. Explain.....
8. Describe.....
9. Select.....
10. Compare

Part-C (Level-K3/ Level-K4)

(Answer any TWO of the questions)

Marks: (2x7=14)

11. Apply....
12. Calculate....
13. Categorize...

Part-D (Level-K5/ Level-K6)

(Answer any ONE of the questions)

Marks: (1x9=9)

14. Discuss....
15. Summarize....

ANNAMALAI UNIVERSITY
Department of Botany

Pattern of question paper for END semester examinations
(Based on Revised Bloom's Taxonomy)

Year : I

Programme: M.Sc
Course Code:
Time: 3 Hrs

Two Year PG Programme

Semester: I / II
Course Name:
Max.Marks:100

Part-A (Level-K1/ Level-K2)

Marks: (10x2=20)

(Answer ALL of the questions)

1. Define.....
2. Multiple Choices a. b. c. d.
3. Multiple Choices a. b. c. d.
4. Match the following i - a ii- b iii- c iv -d v -
5. Match the following i - a ii- b iii- c iv -d v -
6. Explain.....
7. Select.....
8. Describe.....
9. Classify....
10. Elucidate....

Part-B (Level-K3/ Level-K4)

Marks: (8x5=40)

(Answer any EIGHT of the questions)

11. Prepare.....
12. Solve.....
13. Apply.....
14. Show.....
15. Categorize...
16. Analyze...
17. Distinguish....
18. Infer....
19. Compare....
20. Compute

Part-C (Level-K5)

Marks: (3x10=30)

(Answer any THREE of the questions)

21. Discuss...
22. Summarize....
23. Evaluate.....
24. Disprove....

Part-D (Level-K6)

Marks: (1x10=10)

(Answer any ONE of the questions)

25. Design....
26. Develop...

ANNAMALAI UNIVERSITY

Department of Botany

Year : II

Programme: M.Sc

Two Year PG Programme

Semester: III / IV

Course Code:

Time: 3 Hrs

Course Name:

Max.Marks:100

Part-A (Level-K1/ Level-K2)

Marks: (10x2=20)

(Answer ALL of the questions)

1. Define.....
2. Multiple Choices a. b. c. d.
3. Multiple Choices a. b. c. d.
4. Match the following i - a ii- b iii- c iv -d v -
5. Match the following i - a ii- b iii- c iv -d v -
6. Explain.....
7. Select.....
8. Describe.....
9. Classify....
10. Elucidate....

Part-B (Level-K3/ Level-K4)

Marks: (6x5=30)

(Answer any SIX of the questions)

11. Apply.....
12. Show.....
13. Prepare
14. Make use of....
15. Categorize...
16. Analyze...
17. Distinguish....
18. Simplify.....

Part-C (Level-K5)

Marks: (3x10=30)

(Answer any THREE of the questions)

19. Discuss...
20. Recommend with
21. Evaluate.....
22. Justify....
23. Optimize...

Part-D (Level-K6)

Marks: (2x10=20)

(Answer any TWO of the questions)

24. Design....
25. Formulate ...
26. Modify

M.Sc Botany(TWO YEAR) PROGRAMME							
[End Semester Examinations]							
Bloom's Taxonomy - Questions Conforming to Levels K1 to K6							
I Year (Two year PG)				II Year (Two Year PG)			
Level	Part	Questions & Marks	Total Marks	Level	Part	Questions & Marks	Total Marks
K1	A	5 x 2	10	K1	A	5 x 2	10
K2		5 x 2	10	K2		5 x 2	10
K3	B	4 x5	20	K3	B	2 x 5	10
K4		4 x5	20	K4		4 x 5	20
K5	C	3 x 10	30	K5	C	3 x10	30
K6	D	1 x 10	10	K6	D	2x 10	20
			100				100

PROGRAMME OUTCOMES (POs)

After the successful completion of the M.ScBotany (2 year) Degree Programme, the graduates will be able to:

PO1:	Domain knowledge: Demonstrate knowledge of basic concepts, principles and applications of the specific science discipline.
PO2:	Resource Utilisation. Cultivate the skills to acquire and use appropriate learning resources including library, e-learning resources, ICT tools to enhance knowledge-base and stay abreast of recent developments.
PO3:	Analytical and Technical Skills: Ability to handle/use appropriate tools/techniques/equipment with an understanding of the standard operating procedures, safety aspects/limitations.
PO4:	Critical thinking and Problem solving: Identify and critically analyse pertinent problems in the relevant discipline using appropriate tools and techniques as well as approaches to arrive at viable conclusions/solutions.
PO5:	Project Management: Demonstrate knowledge and scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyse and interpret data and provide solutions. Exhibit organisational skills and the ability to manage time and resources.
PO6:	Individual and team work: Exhibit the potential to effectively accomplish tasks independently and as a member or leader in diverse teams, and in multidisciplinary settings.
PO7:	Effective Communication: Communicate effectively in spoken and written form as well as through electronic media with the scientific community as well as with society at large. Demonstrate the ability to write dissertations, reports, make effective presentations and documentation.
PO8:	Environment and Society: Analyse the impact of scientific and technological advances on the environment and society and the need for sustainable development.
PO9:	Ethics: Commitment to professional ethics and responsibilities.
PO10:	Life-long learning: Ability to engage in life-long learning in the context of the rapid developments in the discipline.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

At the end of the programme, the student will be able to

PSO1:	Understand the basic principles of Life forms for the scientific phenomena of Plant Science
PSO2:	Understand the enumeration and description of the natural phenomena
PSO3:	Appreciate the knowledge on the various branches of Botany (Plant Morphology, Anatomy, Embryology and Physiology)
PSO4:	Comprehend the importance of conservation of plant resources
PSO5:	Understand the various applications of plants to human welfare

Semester	19BOTC101: Core 1: Plant Diversity – I (Algae and Bryophytes)	L	T	P	C
I		4	0	0	4

Learning Objective (LO):

LO1	To acquire knowledge on the structure, reproduction and life cycle of algae and Bryophytes
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Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Identify, classify and describe the morphological nature of various types of algae
CO2	Understand the occurrence, structure and life cycle of algae and bryophytes
CO3	Appreciate the phylogeny and evolutionary relationship in non-flowering plants
CO4	Gain adequate knowledge on comparative account of various algae and bryophytes and economic importance of algae and bryophytes
CO5	Comprehend the economic importance of Algae and Bryophytes

Algae

Unit – 1

Introduction, General Characteristic features, Classification(Fritsch,1949), range of structure, reproduction and evolutionary trends of; Chlorophyceae (*Chlamydomonas*, *Volvox*, *Chlorella*, *Hydrodictyon*, *Ulothrix*, *Ulva*, *Draparnaldia*, *Oedogonium*, *Caulerpa*, *Acetabularia*, *Halimeda*, *Codium*, *Valonia*, *Chara*, *Nitella*. *Desmids*), Xanthophyceae (*Voucheria*) Bacillariophyceae(*Diatom*).

Unit – 2

Range of structure, reproduction and evolutionary trends of Phaeophyceae(*Ectocarpus*, *Padina*, *Stoechospermum*, *Sargassum*, *Turbinaria*), Rhodophyceae(*Batrochospermum*, *Polysiphonia*, *Gracilaria*and Cyanophyceae(*Microcystis*, *Lyngbya*, *Spirulina*, *Nostoc*, *Anabaena*, *Scytonema*and*Stigonema*).

Unit – 3

Origin and evolution of sex in algae – Ecology of algae - Distribution of algae in soil, fresh water and marine environment- Role of Algae in soil fertility. Culture and cultivation of algae - Algal pigments and their uses,Algae and Environment, Algal blooms and Toxins, Economic importance of algae, Fossil algae.

Bryophytes

Unit- 4

Introduction, general characters, classification, origin and evolution of Bryophytes. Alternation of generation in Bryophytes and inter relationship of Bryophytes.

Unit- 5

Range of structure of gametophyte and Sporophyte of Bryophytes (*Riccia*, *Targionia*, *Marchantia*, *Reboulia*, *Dumortiera*, *Pallavicinia*, *Riccardia*, *Porella*, *Anthoceros*, *Sphagnum* and *Bryum*). Reproduction in Bryophytes. Fossil Bryophytes and Economic importance of Bryophytes.

Text Books :

1. Sharma O.P, (2015), *Text book of Algae*, Tata McGraw – Hill Publications Pvt – New Delhi
2. Sureshkumar and KhalingMikawlawng, (2014). *Textbook of Bryophyta*. Sonali Publications, New Delhi
3. VauDeuHock,C., D.G. Mann and H.M. Johns. (2019). *Algae- An Introduction to Phycology*. Cambridge University Press., New Delhi
4. Vashishta. B.R., A.K. Sinha and Adarsh Kumar. (2016). *Botany for Degree students- Bryophyta*. S. Chand and Company Ltd., New Delhi.
5. Vashishta. B.R., A.K. Sinha and Adarsh Kumar. (2015). *Botany for Degree students - Algae*. S. Chand and Company Ltd., New Delhi.

Reference Books / Supplementary reading:

1. Fritsch,F,E.(1972). *Structure and Reproduction of Algae I & II*, Cambridge University Press.
2. Rashid.A. (2007). *An Introduction to Bryophyta* – Vikas Publications, New Delhi.
3. Watson,E.V.(2015). *The Structure and Life of Bryophytes*. United Book Prints, New Delhi

Outcome Mapping

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3								3	3	3	3		
CO2	3	3								3	3	3	3		
CO3	3	3								3	3	3	3		
CO4	3	3								3	3	3	3	2	
CO5	3	3								3	3	3			2

Semester	19BOTC102:Core 2: Fungi, Lichens and Plant Pathology	L	T	P	C
I		4	0	0	4

Learning Objective (LO):

LO1	To study the classification, structure and reproductive features of fungi and lichens
LO2	To study the basic principles of plant pathology

Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Gain adequate knowledge on comparative account of various fungi, lichens and plant pathogens
CO2	Appreciate the salient features of Fungi and lichens
CO3	Appreciate the disease of various crop plants
CO4	Understand the host parasite interaction process
CO5	Appreciate the economic importance of fungi and lichens

Fungi

Unit – 1

Introduction to Fungi, Position of Fungi among living organisms – criteria and evidences
 - Recent trends in the classification of Fungi with special reference to Alexopoulos and Mims.
 Structure, Nutrition of fungi - Myxomycotina : *Stemonitis*, *Physarum*. Eumycotina : *Olpidium*. Mastigomycotina : *Phytophthora*, *Perenospora*. Plasmodiophoromycetes : *Plasmodiophora*. Zygomycotina : *Pilobolus*.

Unit – 2

Classification and diversity of Fungi Ascomycotina : *Aspergillus*, *Xylaria*, *Claviceps*. *Peziza*, *Morchella*. Basidiomycotina : *Lycoperdon*, *Ustilago*, *Polyporus*. Deuteromycotina : *Alternaria*, *Fusarium*. Spore dispersal and factors affecting spore germination, reproduction, life history, phylogeny and affinities of the major groups of Fungi. Heterothallism, Parasexual cycle, Degeneration of sexuality. Economic importance, Fungi as bio-control agents. Ecology of Fungi - Soil Fungi – Sugar Fungi – Cellulose and lignin degrading Fungi. Role of fungi in Industry- Medicine and food. Mycorrhiza: Structure and types- uses in Agriculture

Lichens

Unit – 3

General account of structure and life cycle of Lichens-broad outline of classification. Structure, reproduction and lifecycle of the following types: a) *Parmelia*; b) *Usnea*. Ecological role and economic importance of lichens.

Plant Pathology

Unit – 4

History of Plant Pathology–Diagnosis of Plant diseases - Koch's Postulates – Symptoms and signs. Classification of Plant Diseases – Host-pathogen interaction –Disease resistance - Histological and biochemical aspects - Metabolic changes during disease development.

Unit - 5

Etiology, Symptoms-Causative agents and Control of the following diseases: Tobacco Mosaic , Bunchy top of Banana- Leaf spot in Cotton- Sheath Blight of Paddy- Citrus canker- Soft rot in vegetables. Little leaf of Brinjal; Blast of Paddy, Red rot of Sugar cane, Leaf spot diseases of groundnut and Damping-off of vegetable seedlings. Plant disease management - Principles and methods of disease control – Chemical, Biological and Agronomical Practices - Legislation and quarantine practices in India.

Text Books :

1. Dubey,H.C. (2018). *An Introduction to Fungi*. Scientific Publishers, Jodhpur.
2. MannajkumarKalita.(2017). *Fundamentals of Plant Physiology*. Kalyani Publishers, New Delhi
3. Sambamurthy A.V. S.S. (2006). *A Textbook of Plant Pathology*. I.K. International Pvt.Ltd., New Delhi.
4. Sharma,O.P. (2005). *The Text book of Fungi*. Tata McGraw Hill publishing company Ltd, New Delhi.
5. Sharma,P.D. (2009). *The Fungi*. Rastogi publications, Meerut.
6. Singh. R.S. (2015). *Plant Diseases*. Oxford & IBH publishing Co.Pvt Ltd. New Delhi

Reference Books / Supplementary reading:

1. Alexopoulos, C.J., C.W. Mims and M. Blackwell. (2007). *Introductory Mycology*. IV Edition. Wiley India (P) Ltd., Daryaganj, New Delhi.
2. Aneja, K.R and R.S Mehrotra. (2018). *An Introduction to Mycology*. New Age International Publishers, New Delhi
3. Bhupendra Singh Kharayat.(2017). *Foundations in Plant Pathology*. Kalyani Publishers, New Delhi
4. Dasgupta, M.K.(2004). *Principles of Plant Pathology*. Allied publishers Ltd. New Delhi.
5. Rangaswami,G and A.Mahadeven. (2006). *Diseases of crop plants in India*. Prentice Hall Pvt.Ltd. New Delhi.

Outcome Mapping

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3								3	3	3	3		
CO2	3	3								3	3	3	3		
CO3	3	3								3	3	3	3		

CO4	3	3								3	3	3	3		
CO5	3	3								3	3	3	3		2

Semester	19BOTC103: Core 3: Microbiology										L	T	P	C
I											4	0	0	4

Learning Objective (LO):

LO1	To study the classification, structure and reproductive features of bacteria and viruses
LO2	To understand the basic concepts of Biofertilizers and Microbial Ecology of Soil

Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Analyze the classification and structure of microorganisms
CO2	Understand the various microbial culture techniques
CO3	Learn about the advantages of microorganisms to the society
CO4	Comprehend the importance of Biofertilizers

Microbiology

Unit – 1

General account of Bacteria, Nutrition and growth curve of Bacteria, Methods of culturing bacteria, kinds of media and preparation techniques, – Isolation: serial dilution technique - pure culture – maintenance and preservation- inoculation of bacteria- Bacterial staining methods – Stains and dyes, Gram's, flagellar and other types of staining.

Unit – 2

Morphology of viruses – classification of viruses – Virus-Vector relationships – replication of virus. Satellite virus. Bacteriophages - Viroids and Prions – isolation and purification of viruses. Uses of virus in Biotechnology.

Unit – 3

Role of microbes in cycling of nitrogen, carbon and phosphorus. Microbial control-methods of physical control (heat, cold, desiccation, radiation and sound waves). Microbial leaching of minerals. Sterilization by filtration, chemical agents – disinfectants, antiseptics and antibiotics. Role of Microbes in waste water treatment, General design and application of

biofermentor. Microbes in food spoilage and food poisoning. Food preservation - Micro organisms as food – Probiotics.

Unit – 4

Microbes used as Biofertilizer: Importance of biofertilizer; Role of Biofertilizer; Different types of Biofertilizers; *Rhizobium*; *Azospirillum*; *Azotobacter*, *Azolla* and Blue –Green algae; Advantages and disadvantages of biofertilizers.

Unit – 5

Microbial Ecology of Soil: Soil as habitat: Types of Soil; Chemical involved in Soil habitats; Role of Microorganisms on the environment; Microorganisms inhibiting soil; Microbiology of decomposition; Factors affecting decomposition; Ecological significance of soil microorganisms.

Books for study:

1. Ananthanarayan, Panikers. (2020). *Microbiology* -11th Edition. University Press (India) Pvt Ltd, Hyderabad.
2. Textbook of Prescott's Microbiology– 10th Edition . . (2020). WCB Mc Graw Hill, Boston
3. Bhattacharjee, R.N, (2015). *Fundamentals of Microbiology*. Kalyani Publishers, Ludhiyana.
4. Dubey, R.C. and D.K. Maheswari, (2016). *A Textbook of Microbiology*, S. Chand & Company, New Delhi
5. Kanungo, R, Ananthanarayan and Panikers. (2017). *Textbook of Microbiology* (10th Ed). University Press, Hyderabad, India
6. Pommervi,J.C. (2018). *Fundamentals of Microbiology* (11th Ed). Jones & Bartlett Learning, USA
7. Sharma, P.D. (2017). *Microbiology*. Rastogi Publications, Meerut.

Reference Books / Supplementary reading:

1. Brain D.Robertson and Brendan W.Wren.(2012). *Systems Microbiology: Current topic and Applications*. ISBN. 978-1-908230.
2. John P.Harley.(2007). *Microbiology Lab Manual*. 7th Edition. McGraw Hill Medical Publication division
3. Mathews K.R., Montville, T.J and K.E.Kniel. (2017). *Food Microbiology: An Introduction*. ASM Press, Washington.
4. Murugalatha,N et.al. (2017). *Microbial Techniques*. MJP Publishers, New Delhi

Outcome Mapping

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3								3	3	3	3		
CO2	3	3						2		3	3	3	3		
CO3	3	3						2	2	3	3		3		2

CO4	3	3						2		3	3	2	3		2
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Semester	19BOTP104: Core 4: Practical – I (covering Plant Diversity –I, Fungi, Lichens, Plant Pathology and Microbiology)	L	T	P	C
I		0	0	12	6

Learning Objective (LO):

LO1	To observe the structure of Algae, Bryophytes, Fungi and Lichens
LO2	To observe the staining methods of Microorganism
LO3	To find out the blood group

Course Outcomes (CO)

CO1	Identify the given algae, Bryophytes, fungi and Lichens
CO2	Analyze the various microorganisms
CO3	Identify the type of Blood Group

Algae:

Chlamydomonas, Volvox, Chlorella, Hydrodictyon, Ulothrix, Ulva, Draparnaldia, Oedogonium, Caulerpa, Acetabularia, Halimeda, Chara, Nitella. Desmids, Voucheria, Diatom, Ectocarpus, Padina, Stoechospermum, Sargassum, Turbinaria.,Batrochospermum, Polysiphonia, Gracilaria, Microcystis, Lyngbya, Spirulina, Nostoc, Anabaena, Scytonema , and Stigonema

Bryophytes:

Riccia, Targionia, Marchantia, Reboulia. Dumortiera, Pallavicinia, Riccardia, Porella, Anthoceros, Sphagnum and Bryum.

Fungi:

Structure, reproduction and diagnostic features of *Stemonitis, Physarum, Olpidium, Phytophthora, Peronospora, Pilobolus, Saccharomyces, Aspergillus, Xylaria, Claviceps, Peziza, Morchella, Lycoperdon, Ustilago, Polyporus, Alternaria, Fusarium*

Lichens:

Collection and identification of lichen specimens and make labelled sketches of specimens. Study the external and internal structures of the types mentioned.

Plant Pathology:

Verification of Koch's postulates. Identification of plant diseases included in theory syllabus.

Microbiology:

Staining of microorganisms: Simple staining. Gram staining – spore and acid fast staining, preparation of culture media – Synthetic and Non-synthetic. Isolation of microorganisms. Aerobic and anaerobic forms and soil microbes, purification technique of microorganisms. Serial dilution technique. Hanging Drop method.

Outcome Mapping

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3	PS O4	PS O5
CO1	3		3		3	2					3	3	3		
CO2	3		3		2	3					3	3	3		
CO3	3		3		3	3					3	3	3		

Semester	19BOTC201:Core 5: Plant Diversity – II	L	T	P	C
II	(Pteridophytes, Gymnosperms and Palaeobotany)	4	0	0	4

Learning Objective (LO):

LO1	To acquire knowledge on living and fossils forms of Pteridophytes and Gymnosperms
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Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Gain adequate knowledge on comparative account of Pteridophytes
CO2	Comprehend the structure of Gymnosperms
CO3	Understand the palaeobotany to trace the evolution of plants
CO4	Appreciate the economic importance of Pteridology and Gymnosperms
CO5	Understand the types of fossil fuels and their conservation

Pteridophytes

Unit – 1

Introduction- General characteristic features and classifications (Reimer's) of Pteridophytes. Origin and evolution of Pteridophytes. Stelar evolution in Pteridophytes. Range of structure and reproduction in fossil forms: *Rhynia*, *Horneophyton*, *Asteroxylon*, *Lepidodendron*, *Lepidocarpon*, *Sphenophyllum* and *Calamites*.

Unit - 2

Range of structure and reproduction of Living forms: *Psilotum*, *Selaginella*, *Equisetum*, *Angiopteris*, *Osmunda*, *Adiantum*, *Pteris*, *Marsilea* and *Salvinia*. Sporangial Development and Soral evolution- Spore germination. Gametophyte development – Types and structure. Heterospory and seed habit – Economic importance of Pteridophytes

Gymnosperms

Unit – 3

Classification of Gymnosperms (Sporne, 1965). A general account of distribution, morphology, anatomy, reproduction, phylogeny and relationship of the following orders with special reference to the genera mentioned against each order.

Cycadopsida

1. Pteridospermales

Lyginopteridaceae : *Lyginopteris*, *Heterangium*, *Lagenostoma*.

Medullosaceae : *Medullosa*, *Trigonocarpus*

Glossopteridaceae : *Glossopteris*

Caytoniaceae : *Caytonia*.

2. Bennettitales

Cycadeoideaceae : *Cycadeoidea*.

3. Pentoxylales

Pentoxylaceae : *Pentoxylon*

4. Cycadales

Cycadaceae : *Cycas*

Unit – 4

Coniferopsida

1. Cordaitales.

Cordaitaceae : *Cordaites*.

2. Coniferales.

Cupressaceae : *Cupressus*

Podocarpaceae : *Podocarpus*.

Araucariaceae : *Araucaria*

3. Taxales

Taxaceae : *Taxus*.

4. Ginkgoales

Ginkgoaceae : *Ginkgo*

Gnetopsida

Gnetaceae : *Gnetum*

Evolution of Gymnosperms. Economic importance of Gymnosperms.

Palaeobotany

Unit – 5

Contributions of Birbal Sahani to Palaeobotany – Study of fossils in understanding evolution – Fossilization and fossil types. Economic importance of fossils – fossil fuels and Industrial raw materials. Geological time scale- Radio carbon dating, Fossils and fossilization. Kinds of fossils: Impressions, compressions, casts, molds, petrifications and coal balls. Importance of the study of Palaeobotany

Books for study:

1. Bhatnagar, S.P. and Alok Moitra, (2003). *Gymnosperms*, New age International Pub., New Delhi.
2. Parihar, N.S. (2005). *An Introduction to Embryophyta – Pteridophytes* – Central Book Dep, Allahabad.
3. Shripad N. Agashe. (1995). *Palaeobotany*. Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.

Reference Books / Supplementary reading:

1. Johri, R.M. (2012). *A Textbook of Gymnosperms*. Dominant publishers and Distributors pvt., Ltd, New Delhi.
2. Rashid, A. (2007). *An Introduction to Pteridophyta* – Vikas Publications, New Delhi.
3. Arnold C.R. (2000). *Introduction to Palaeobotany*. TMH publishing Co. Ltd., Bombay

Outcome Mapping

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3								3	3	3	3		
CO2	3	3								3	3	3	3		
CO3	3	3								3	3	3	3		
CO4	3	3						2		3	3		3		2
CO5	3	3						2		3	3		2	2	3

Semester	19BOTC202: Core 6: Anatomy, Embryology of Angiosperms and Morphogenesis	L	T	P	C
II		4	0	0	4

Learning Objective (LO):

LO1	To acquire the knowledge on anatomy and embryology of vascular plants
LO2	To apply knowledge on the organ development in plants

Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Analyze the various tissues in plants, their structure and functions
CO2	Understand the secondary growth in dicot and monocot plants
CO3	Comprehend the embryo and endosperm development in plants
CO4	Appreciate the development of various organs in plants

Plant Anatomy

Unit – 1

Cell Structure, Cell wall ultrastructure and their chemical nature. Tissue- Permanent tissue- Simple tissue: Parenchyma, Collenchyma and Sclerenchyma. Complex Tissue: Xylem and Phloem . Meristem - concept of apical organization of shoot and root apexes. Dermal, secretory tissues and transfer cells

Unit – 2

Structure and location of tissue system- primary and secondary structure of root and stem of dicot and monocot, vascular cambium, cork cambium, periderm formation lenticels, anomalous secondary thickening , wood anatomy-physical chemical properties of wood compression and tension wood, nodal and leaf anatomy. Vascular skeleton of flower and fruit. Ecological anatomy.

Embryology

Unit - 3

Flower structure and development- Microsporogenesis and male gametophyte development – Megasporogenesis and female gametophyte development. Pollination, fertilization, embryo development – dicot , monocot endosperms and their types

Unit - 4

Pollen pistil interaction – self incompatibility – barrier of fertilization –control of fertilization and current concept of fertilization - polyembryony – apomixis- parthenocarpy and practical applications – experimental embryology

Morphogenesis

Unit - 5

Polarity, symmetry and totipotency. Morphogenic centres of origin and organization, differentiation, dedifferentiation, redifferentiation of cells and organs. Morphogenetic factors shoot, root, leaf development and phyllotaxy. Transition to floral meristem and floral development in *Arabidopsis* and *Antirrhinum*

Books for study:

1. Bhojwani,S.S., S.P. Bhatnagar and P.K.Dantu. (2015). *The embryology of Angiosperms*. Vikas publishing House pvt.,Ltd, Noida.

2. Gulam Ahmad Sique. (2014). *Plant Anatomy*, Agrotech Press, Jaipur
3. Tayal, M.S. (2008). *Plant Anatomy*. Rastogi publications, Meerut.
4. Pandey, S.N and A.Chadha. (2005). *Plant Anatomy and Embryology*. Vikas Publishing House Pvt Ltd., New Delhi.

Reference Books / Supplementary reading:

1. Edmend W. Sinnott.(1960). *Plant Morphogenesis*. McGraw Hill Book Company, Inc- USA
2. Katherine Esau. (2006). *Anatomy of seed plants*. John willey &sons publications, New Jersey.
3. Maheshwari, P. (1982). *An Introduction to Embryology of Angiosperms*. Tata Mc Grow Hill. New York.
4. Shivanna.K.R. (2003). *Pollen Biology and Biotechnology*. Oxford IBH, New Delhi.

Outcome Mapping

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3								3	3	3	3		
CO2	3	3								3	3	3	3		
CO3	3	3								3	3	3	2		
CO4	3	3								3	3	3	2		

Semester	19BOTC203: Core 7: Cell Biology , Genetics and Plant Breeding	L	T	P	C
II		4	0	0	4

Learning Objective (LO):

LO1	To acquire the knowledge on Plant cell and cell organelles
LO2	To understand the genetics and breeding of plants

Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Understand the structure of cell and cell organelles
CO2	Appreciate the cell division
CO3	Comprehend the Mendelian principles of Genetics
CO4	Understand the mutational changes in plants
CO5	Appreciate the Principles of Plant breeding

Cell Biology

Unit – 1

Structural organization and functions of intracellular organelles: Cell wall, Nucleus, Mitochondria, Golgi body, Lysosome, Endoplasmic reticulum, Ribosome, Peroxisome, Plasmid, Vacuole, Chloroplast, structure & function of cytoskeleton and its role in motility. Cell Membrane, Structure and membrane transport. Cell signaling: signaling through G-protein coupled receptors - signal transduction pathways - second messengers - regulation of signaling pathways. Hormone receptors - signal transduction and gene expression.

Unit – 2

Cell division: Types of cell divisions, Events of cell division, Differences between mitosis and meiosis - Molecular basis of cell cycle. Synapsis, synaptonemal complex, mechanism of crossing over and formation of chiasma. Chromosomes: Types, fine structure of eukaryotic chromosome – kinetochore, chromomeres, satellite, Euchromatin and Heterochromatin- special types of chromosomes - Chromosome banding and chromosome painting. Chromosomal variation and aberration, Karyotype analysis

Genetics

Unit – 3

Mendelian Inheritance – Introduction, basic concepts and outputs. Non-Mendelian Inheritance- Types of Interaction of Genes. Sex determination in plants and sex linked inheritance, Chromosome mapping –reverse genetics and epigenetics and their biological importance. Extra-nuclear inheritance: cytoplasmic inheritance – chloroplast and Mitochondrial genome in higher plants. Transposable elements, Jumping genes- Population genetics- Genetic Map

Unit – 4

Classification of Mutation – Gene and chromosomal mutation: spontaneous and induced mutation – physical and chemical mutagens. Molecular basis of gene mutation, point, frame shift and suppressor mutation. Gene regulatory mechanisms.

Plant Breeding

Unit - 5

Introduction- floral biology and its significance of crop plants in relation to their breeding systems. Breeding methods: Methods of plant breeding in self and cross pollinated crops. Selection techniques: Types of selection – Pure line selection – Mass selection – Simple recurrent selection and Clonal selection. Plant Hybridization – Types and process of Hybridization and Heterosis. Modern methods of Plant breeding- Mutation breeding and polyploidy breeding. National and International organizations for crop improvement.

Books for study:

1. Inbasekar.(2013). *Cell Biology and Genetics*. Panima Book Distributors, Bangalore.
2. Rastogi,S.I.(2016). *Cell Biology*. New Age International Publishers, New Delhi.

- Ramachandra R.K. (2014). *Principles of Plant Breeding*. Narendra Publishing House, New Delhi
- Singh B.D., and Gurpreet Singh Bhatia, (2017). *Principles of Genetics and Plant Breeding*. Kalyani Publishers, New Delhi
- Verma, P.S and V.K. Agarwal. (2016). *Genetics*. S.Chand Company pvt ltd., New Delhi

Reference Books / Supplementary reading:

- Basu.S.B. and M.Hossain, (2004). *Principles of Genetics*. Books and Allied (P). Ltd, Kolkatta.
- Gardner, Simmons, Snustad, (2018). *Principles of Genetics*; Wiley student edition.
- Phundan Singh, (2019). *Essential of Plant Breeding*. Kalyani Publishers, New Delhi
- Pragya Khanna, (2008). *Cell and Molecular Biology*. I.K. International Publications- New Delhi.
- Sanjay Kumar Singh, (2005). *Plant Breeding*. Campus book international, New Delhi.

Outcome Mapping

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3								3	3	3	3		
CO2	3	3								3	3	3	3		
CO3	3	3	2							3	3	3	3		
CO4	3	3						2		3	3	3	3		
CO5	3	3						2		3	3	3	3		

Semester	19BOTP204: Core 8: Practical – II (covering Plant Diversity – II, Anatomy, Embryology of Angiosperms, Morphogenesis, Cell Biology, Genetics and Plant Breeding)	L	T	P	C
II		0	0	12	6

Learning Objective (LO):

LO1	To find out the cell structure and cell organelles
LO2	To know about the Mendalian inheritance
LO3	To gain knowledge on various propagation methods

Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Analyze the structure of cell division
CO2	Analyze the chromosome types
CO3	Understand the Mendalian inheritance

Pteridology:

Fossil forms: *Rhynia*, *Horneophyton*, *Asteroxylon*, *Lepidodendron*, *Lepidocarpon*, *Sphenophyllum* and *Calamites*.

Living forms: *Psilotum*, *Selaginella*, *Equisetum*, *Angiopteris*, *Osmunda*, *Adiantum*, *Pteris*, *Marsilea* and *Salvinia*.

Gymnosperms:

Identification and characteristic features of *Lyginopteris*, *Heterangium*, *Lagenostoma*, *Trignocarpus*, *Cycas*, *Cupressus*, *Podocarpus*, *Araucaria*, *Ginkgo*, and *Gnetum*.

Palaeobotany:

Compression, Impression, Petrified Fossils, Cast and mold, Amber and coal ball

Anatomy:

Examination of root and shoot apices ; maceration , clearing and peeling techniques; primary and secondary structure of dicot, monocot stem; anomalous secondary thickening in *Bougainvillea*, *Boerhaavia*, *Nyctanthes*, *Bignonia*, *Aristolochia*, *Strychnos* and *Dracaena*. nodal anatomy – different types of nodes. Different types of stomata.

Embryology:

Different stages of anther, embryo sac, endosperm and embryo development

Pollen germination and viability test

Dissection of embryo – *Tridax*, *Crotalaria* and *Cleome*

Endosperm and endosperm haustoria – Cucurbitaceae members

Morphogenesis:

Wounding of young stem and study of the wound healing response

Effect of removal of leaf primordium and axillary buds

Cell Biology:

1. Squash and smear techniques
2. Study of cell division – mitosis (*Allium cepa*, *Rhoeo*, *Urgenia*, *Scilla*)
3. Study of meiosis - (*Allium cepa*, *Helianthus*, *Tredescantia* flower buds)
4. Study of chromosomal aberrations and polyploidy
5. Karyotype analysis – Idiogram preparation
6. Study of special types of chromosomes

Genetics:

1. Genetics problems in Mendelian inheritance, gene interaction, quantitative inheritance , multiple alleles, sex linkage and genetic maps

Plant Breeding

1. Methods of vegetative propagation – Layering, Budding and Grafting
2. Hybridization techniques

Outcome Mapping

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3		2		3	3					3	3	3		
CO2	3		2		3	3					3	3	3		
CO3	3		3		2	3					3	3	3	2	
CO4	3		3		2	3					3	3	3		

Semester	19BOTC301: Core 9: Taxonomy of Angiosperms and Economic Botany	L	T	P	C
III		4	0	0	4

Learning Objective (LO):

LO1	To acquire knowledge on morphology, taxonomy and the economic importance of Angiosperms
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Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Understand the classification and nomenclature of plants
CO2	Appreciate the application of computers in plant taxonomy
CO3	Comprehend the characteristic features of various families of angiosperms
CO4	Understand the economic importance of Angiospermic plants

Taxonomy of Angiosperms

Unit – 1

Essentials of taxonomy. Historical account on classification of angiosperms. A detailed account of the systems of classification of Linnaeus, Bentham and Hooker, Engler and Prantl and a general account on the system of classification of Takhtajan . Chemotaxonomy and Numerical taxonomy. APG IV System and its significance.

Nomenclature and taxonomical techniques. Plant Nomenclature – Brief history on the origin and development of nomenclature; Detailed study of the major provisions of the International Code of Nomenclature(ICN) for algae, fungi and plants– Effective and valid publications , Role of priority and its limitation, typification, different kinds of types, author citation, rejection and retention of names and conserved names.

Unit- 2

Methods of Plant exploration ; Management of herbaria, major herbaria in India and the World, Specimen preparation for herbarium, Role of herbaria in taxonomy. Botanical Survey of India (BSI).

Different kinds of identification keys, Construction of dichotomous keys- Indented and bracketed keys. Various kinds of taxonomic literature: Floras, Revisions, Manuals, Monographs, Periodicals. Computational taxonomy, Information systems- data banking and use of computers in taxonomy, computer constructed keys. Uses of molecular tools in taxonomy: ITS, RFLP, RAPD and AFLP. DNA Bar-coding.

Unit – 3

A detailed study of the following families with their interrelationship and phylogeny

Annonaceae
Portulacaceae
Sterculiaceae
Zygophyllaceae
Rhamnaceae
Sapindaceae
Fabaceae
Combretaceae
Myrtaceae
Lythraceae
Passifloraceae
Cucurbitaceae
Apiaceae

Unit – 4

A detailed study of the following families with their interrelationship and phylogeny

Rubiaceae
Apocyanaceae
Gentianaceae
Boraginaceae
Scrophulariaceae
Acanthaceae
Lamiaceae
Nyctaginaceae
Verbenaceae
Euphorbiaceae
Casuarinaceae
Liliaceae

Poaceae

Economic Botany

Unit – 5

A brief account of botany, cultivation and utilization of cereals, pulses, nuts, vegetables and fruits - spices and condiments- fats and oils-essential oils- commercial crops- wheat, cotton and sugarcane, fibres, timbers- tannins, resins, alkaloids- Drug yielding plants- Plants as a source of renewable energy – Ethnobotany and its importance.

Books for study:

1. Gurucharan Singh, (2019). *Plant Systematics- Theory and Practice*. Oxford & IBH Publishing company (P) Ltd, New Delhi
2. Pandey.B.P. (2009). *Taxonomy of Angiosperms*.S.Chand& Co. Ltd. New Delhi.
3. Pandey,S.N and S.P. Mishra. (2014). *Taxonomy of Angiosperms*. Ane Books Pvt Ltd, New Delhi
4. Pandey,B.P. (2016). *Economic Botany*.S.Chand& Co. Ltd., New Delhi
5. Singh,S.K and Seema Srivastava. (2009). *Economic Botany*. Campus Book International, New Delhi.

Reference Books / Supplementary reading:

1. Jain, S.K.andR,R,Rao, (1977). *A Handbook of field and herbarium methods*. Today and Tomorrow's Printers and Publishers, New Delhi.
2. Lawrence, G.H.M. (1964). *Taxonomy of Vascular Plants*, Oxford & IBH Publishing company (P) Ltd, New Delhi.
3. Judd, Campbell, Kellogg, Stevens, Donoghue.(2008). *Plant systematics: A phylogenetic approach*.Third edition-Sinauer Associates, Inc publishers
4. Prasad,R.L.(2016). *Essentials of Economic Botany*. Scientific International Publishers and Distributors, New Delhi
5. Nautiyal,B.P,(2018). *Textbook of Systematic Botany*. Scientific International Pvt Ltd., New Delhi
6. Simpson M.G, (2018). *Plant Systematics*.3rd edition. Academic Press Inc., San Diego, USA

Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3								3	3	3	3		
CO2	3	3								3	3	2	3		
CO3	3	3	2							3	3	2	3		
CO4	3	3						2		3	3	3	3		2

Semester	19BOTC302: Core 10: Biochemistry and Molecular Biology	L	T	P	C
III		4	0	0	4

Learning Objective (LO):

LO1	To acquire the knowledge on biochemistry and Molecular biology of plants
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Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Understand the structural features of carbohydrates, proteins and lipids
CO2	Appreciate the properties of enzymes
CO3	Understand the structure of DNA
CO4	Appreciate the protein synthesis

Biochemistry

Unit – 1

Carbohydrates: Classification of carbohydrates; Structure and properties of monosaccharides, Oligosaccharides, Polysaccharides – Glycoproteins. Protein and Amino acids: Structure, Classification and properties; Peptides - Structure: Primary, secondary, Ramachandran plot, tertiary and quaternary structures. Classification of Lipids: Structure and properties of fatty acids, phospholipids, glycolipids, lipoproteins, cholesterol - structure and functions. Nucleic acid (DNA and RNA) – Chemical composition, properties, Watson and Crick structure of DNA, types and functions of RNA

Unit – 2

Enzymes- Classification and nomenclature chemical nature of enzymes – factors affecting enzyme action – Michaelis – Menten constant, MM equation, – Lineweaver Burk plot, enzyme inhibition, co enzymes- mechanism of enzyme action, isoenzymes. Secondary metabolites: structure, classification and properties of alkaloids, steroids, terpenoids, flavonoids. glycosides - their chemical nature and role.

Molecular Biology

Unit – 3

A, B and Z forms of DNA– Structure of prokaryotic gene – Regulatory structures – Promoter, Enhancer, Attenuator and Terminator - Structure of Eukaryotic gene -Introns and Exons, Unique and repetitive DNA- SINEs and LINEs, Satellite DNA- DNA Replication – Semiconservative mode of DNA Replication - Enzymology of DNA replication- Mechanism of DNA replication- RNA primers- - origin of replication - Replication fork - Okazaki fragments- Continuous and discontinuous synthesis of DNA – DNA damage and repair mechanism: Excision repair -mismatch repair.

Unit - 4

Transcription– definition– initiation, elongation and termination in prokaryotes and eukaryotes –promoters – pribnow box – TATA binding proteins – Complementary palindromes - Prokaryotic and Eukaryotic RNA polymerases - Post transcriptional modifications in prokaryotes and eukaryotes - capping- polyadenylation. RNA splicing, Sn RNPs, Spliceosome machinery, Exon shuffling, RNA editing.

Unit – 5

Genetic code –types of codons – codon usage – universal codon– Components of protein synthesis – structure of ribosome – polysomes – ribosome entry sites – selenocysteine insertion sequence - Protein synthesis in Prokaryotes – Initiation, Elongation, Termination, Translation and post-translational modifications in Eukaryotes, Inhibitors of translation, protein folding and targeting (brief account only). Gene regulation: prokaryotes – Lac operon, Catabolite repression. Eukaryotes – transcription factors. Alternative splicing regulated by activators and repressors, RNA interference.

Books for study:

1. Allison.A. (2007). *Fundamental Molecular Biology*. Blackwell Publishing, UK.
2. Bonner,J and W.H. Warner, (1961).*Plant Biochemistry*. Academic press. Inv.Ny.
3. Keshav Trehau, (2019). *Biochemistry*. New Age International Publishers, New Delhi
4. Rastogi,S.C, (2016). *Cell and Molecular Biology*. New Age International Publishers(p) limited, New Delhi.
5. Sambamurty A.V.S.S, (2008). *Molecular Biology*; Narosa Publishers- New Delhi

Reference Books / Supplementary reading:

1. Benjamin, Levin, (2006). *Genes VIII*. Pearson Education International, USA.
2. De Robertis and De Robertis, (2014). *Cell and Molecular Biology*. Lippincott. Williams and Wilkins. USA.
3. Nelson,D.L&M.M.Cox. (2017). *Lehninger's principles of Biochemistry*, Prentice hall, International N.J, 7th Edition

Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3								3	3	3	3		
CO2	3	3								3	3	3	3		
CO3	3	3						2		3	3	3	3		
CO4	3	3						2		3	3	3	3		

Semester	19BOTC303: Core 11: Biological Techniques and Research Methodology	L	T	P	C
III		4	0	0	4

Learning Objective (LO):

LO1	To know the principles of various biological techniques and their applications
LO2	To acquire basic knowledge on Research methodology and computer application

Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Understand the basic working principles of various microscopes
CO2	Analyze the working principles of Calorimeter, Spectrophotometer, Electrophoresis
CO3	Understand the art of scientific writing
CO4	Appreciate various patents
CO5	Comprehend the computer applications in scientific research

Unit – 1

Principles, image formation and applications of Light, Confocal, Polarizing, Transmission and Scanning electron microscopes - Material preparation for Electron microscopy. Microscopic measurements: Micrometers – Ocular, Stage, Haemocytometer and Camera Lucida - Fixatives, Dehydrating agents, Stains and their uses.

Unit – 2

Calorimeter-Principles and Applications – Spectrophotometry –UV-visible –Infrared-Atomic absorption Spectrophotometer – Chromatography – TLC, Column, GC, HPLC and Affinity.

Electrophoresis – General principles –Native PAGE and SDS- PAGE– Agarose gel. Blotting techniques- Southern, Northern and Western.

ELISA, RIA, Polymerase Chain Reaction, RAPD, RFLP, SSR, DNA finger printing and FISH techniques

Research Methodology

Unit – 3

Scientific writing – Characteristics, Logical format for writing thesis and papers

Essential features of abstracts - components of thesis writing-

Introduction –Review of literature – Primary, secondary references

Materials and methods- Effective illustration- Tables and figures- Discussions, Reference styles – Harvard and Van couver system

Unit – 4

IPR Patents - Patent procedures– Patenting information systems and services in India - Trade secrets - Copy rights and Trade marks - Patenting biological materials - Higher plants and transgenic organisms.

Plant variety protection - Plant breeder’s rights - Farmer’s rights - WTO – GATT, TRIPS.

Bioethics – Biosafety regulations, IBSC, Good Laboratory practices.

Unit – 5

Computer in Biological science, scope and prospects.

Operation system – Definition- classification- input and output devices.

Introduction to windows operating system- MS windows – MS-Word-folders, files, MS Excel – MS Power point - creating slides – templates – animation and transitions - Data storage – Data analysis - On line publications: Electronic journals - Internet-World Wide Web-search engines – their functions- Email-e-access data base concepts and implication.

Biostatistics packages- Data base preparation- Graphic applications in biology.

Books for study:

1. Marimuthu,R.(2010). *Microscopy and Microtechnique*, MJP publishers, Chennai
2. Kothari, C.R, (1991). *Research Methodology—Methods and Techniques*. Wiley Eastern Ltd, New Delhi.
3. Krishnamurthy, K.V, (1988). *Methods in Plant Histochemistry*. Viswanathan printers and publishers, Chennai.
4. SreeRamalu, V.S, (1988). *Thesis writing*. Oxford & IBH publications, New Delhi.
5. Kumar,R.(2014). *Research Methodology: A Step by Step guide for beginners*. SAGE publications India Pvt., Ltd., New Delhi

Reference Books / Supplementary reading:

1. Singh, R. (2006). *Research Methodology in Plant Science*. M.J.P. Publications, New Delhi.
2. Connor and Peter Woodford, (1979). *Writing scientific paper in English*. Pitman Publ. Co, U.K.
3. Wilson, K and John Walker. (2000). *Principles and Techniques of practical Biochemistry*, Cambridge University Press.
4. Kothari,C.R and G. Garf,(2018).*Research Methodology- Methods and Techniques*. New Age International Publishers, Kochi

Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3		3						3	3	3	3		
CO2	3	3	2	3	2	2				3	3	3	3		
CO3	3	3		3			2			3	3	3	2		

CO4	3	3		3				3		3	3	3	3		
CO5	3	3		3				3		3	3	3	3		2

Semester	19BOTC304: Core 12: Plant Bio-technology and Genetic Engineering	L	T	P	C
III		4	0	0	4

Learning Objective (LO):

LO1	To understand different biotechnological methods
LO2	To develop skills on genetic engineering of plants

Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Understand the methods of gene transfer
CO2	Appreciate the recombinant DNA technology
CO3	Understand the applications of Biotechnology in Transgenic crop plants

Plant Biotechnology

Unit – 1

Historical Background- Principle- Organization of Plant tissue culture laboratory – Aseptic techniques- Culture media –components – Steps of tissue culture – Leaf culture – Meristem culture – Protoplast isolation and culture – somatic hybridization techniques - anther and pollen culture – Haploids and their significance. Somaclonal variation.

Unit - 2

Cryopreservation technique- production of secondary metabolites through cell culture- Artificial seeds- Micropropagation of banana, sugarcane and eucalyptus.Plants as bioreactors: Edible vaccines - Plant neutraceuticals: Introduction, scope and applications. Molecular farming. Transgenic crops – GM plants: Cotton and Brinjal - Issues on GM crops.

Genetic Engineering

Unit – 3

Basic principles: Restriction endonucleases– Methods of gene transfer - Particle Gun method – Electroporation- Microinjection – Liposome - Calcium phosphate Co-precipitator - Cloning vectors – plasmids - phages - cosmids -viral vectors. Control of transgene expression in plants.

Unit - 4

DNA Sequencing Methods: Maxam and Gilbert – Sanger method and Pyro-sequencing method – Shot gun sequencing. c-DNA libraries - Genomics for evolutionary studies, Choice of host organisms for cloning- bacteria, yeast and plants- Preparation of molecular genetic maps in cereals, legumes, cotton and forest trees.

Unit – 5

Genetic engineering of *nif* genes in non leguminous plants – marker gene enzymes, vector, organization, transformation and integration. Transgenic plants – methods, selective marker genes and detection of gene transformation. Fungicide and herbicide resistance markers – Biocontrol methods of pest and diseases.

Books for study:

1. Dubey R.C,(2018). *A Textbook of Biotechnology*; Chand & Company LTD. New Delhi.
2. Phudan Singh, (2019). *Principles of Biotechnology*. Kalyani Publishers, New Delhi
3. Smith Rastogi and Neelam Pathak, (2009). *Genetic Engineering*. Oxford Univ.press.
4. Mishra, S.P, (2016). *Plant Tissue Culture*. Ane Books Pvt ltd.

Reference Books / Supplementary reading:

1. Ignacimuthu, S, (1997). *Biotechnology: An Introduction*. 2nd Edition, Narosa Publishing House, New Delhi.
2. Rastogi, S.C,(2007). *Biotechnology- Principles and Applications*. Narosa Publishing House, New Delhi.
3. Razdan,M.K, (2018). *Introduction to Plant Tissue Culture*.CBS Publishers & Distributors Pvt Ltd, New Delhi

Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3	3	-	-	-	2	-	3	3	3	3	-	3
CO2	3	3	3	3	-	-	-	2	-	3	3	3	3	-	3
CO3	3	3	3	3	-	-	-	2	2	3	3	3	3	2	3

Semester	19BOTP305: Core 13: Practical – III (covering Taxonomy of Angiosperms, Economic Botany, Biochemistry , Molecular Biology, Biological Techniques, Research Methodology, Plant Bio-technology and Genetic Engineering)	L	T	P	C
III		0	0	12	6

Learning Objective (LO):

LO1	To identify the families of angiosperms
LO2	To know about the various biochemical experiments

LO3	To gain knowledge on the various experiments on Biotechnology and Genetic Engineering
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Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Identify the given plant family
CO2	Analyze the given instrument
CO3	Analyze the experiments related to Biotechnology and Genetic engineering

Taxonomy of Angiosperms:

Detailed study of the families mentioned in the theory with two representative species from the local area.

Familiarity of the binomial nomenclature of the available species from the local flora using Gamble's flora.

Solving the taxonomical problems

Economic Botany:

Identification of family, genus, species and morphology of the useful parts of plants mentioned in the theory.

Biochemistry:

1. Estimation of total phenols
2. Estimation of aminoacids by ninhydrin method
3. Estimation of protein
4. Extraction and estimation of lipids
5. Assay of the enzyme catalase
6. Assay of the enzyme peroxidase
7. Extraction and separation of known and unknown amino acids by using paper chromatography method
8. Estimation of reducing sugar content
9. Estimation of starch content

Molecular Biology:

1. Isolation of high molecular weight genomic DNA from rice
2. Isolation of DNA from tender coconut
3. Separation of plant genomic DNA by electrophoresis
4. Qualification of Plant Genomic DNA by Spectrophotometric method
5. Quality checking of DNA by Electrophoresis
6. RAPD Techniques
7. Isolation of plasmid DNA
8. Southern blotting (Demonstration)
9. Western blot - detection of proteins (Demonstration)

Biological Techniques & Research Methodology:

1. Principles, identification and components of Light , Polarizing , TEM , SEM, ELISA and PCR

2. Electrophoretic separation of proteins by native and SDS-PAGE
3. Separation of DNA with agarose gel
4. RAPD
5. Acquiring of basic skills in Internet browsing
6. Familiarization of web browsers and search engines

Plant Biotechnology & Genetic Engineering:

1. Isolation of single cell protein
2. PCR – Technique with known primers
3. Bio control of plant insects using *Bacillus thuringiensis*
4. Bio control of plant insects using PHV.
5. Preparation of explants
6. Establishment and maintenance of carrot callus
7. Initiation and establishment of cell suspension culture of carrot
8. Embryogenesis in cultured cells of carrot
9. Microspore culture- preparation of artificial seeds

Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3		3		2	3				3	3	3	3		3
CO2	3		3		2	2				3			3		3
CO3	3		3		2	3				3			3	2	2

Semester	19PSCI300: Constitution of India	L	T	P	C
III		2	0	0	2*

Learning Objective (LO):

LO1	To understand the basic features of Indian Constitution
LO2	To grasp about the basic Rights & duties of Indian Citizenry
LO3	To ponder over the form of Indian Political System
LO4	To have broad understanding about the pivotal provisions related with liberty, Equality and fraternity

Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Imbibe about the basic features of Indian Political System
CO2	Enlighten with the rights & duties of Indian Citizens
CO3	Understand the significance of rule of law

Unit I : Introduction

Meaning of the Constitutional law and Constitutionalism – Historical Perspective of the Constitution of India – Salient features Characteristics of the Constitution of India

Unit II : Rights and Duties

Scheme of the Fundamental Rights – The scheme of the Fundamental Duties and its legal status – The Directive Principles of State Policy-Its importance and implementation

Unit III : Centre State Relationship

Federal Structure and distribution of legislative and financial powers between the union and the states- Parliamentary form of Government in India – The Constitution powers and status of the president of India.

Unit IV : Amendments and Provisions

The Historical perspectives of the constitutional amendments in India – Emergency Provision: National Emergency, President Rule. Financial Emergency

Unit V: Institutions

Judiciary –Judiciary Activism – Amending Procedures- Recent Trends –Rights to Information- Lokpal and LokAyukta

Books for study:

1. Bipan Chandra, Mridula Mukherjee, AdityaMakherjee. (2016).*India after Independence 1947-2000*, Penguin Publishers, New Delhi.
2. Durga Das Basu, (2018).*Introduction to the Constitution of India*.Prentice Hall, New Delhi.
3. Jogendra Yadav, (2000).*Transforming India: Dynamics of Democracy*, Oxford University Press New Delhi

Reference Books / Supplementary reading:

1. *The Constitution of India*.(1950) (Bare Act), Government Publications.
2. B.S.P. Ambedkar B.R.,(2015).*Framing of Indian Constitution*
3. Jain M.P.,(2014).*Indian Constitution Law*.Lexis Nexis
4. Paul R.Brass. (1999).*The politics of India Since Independence*. Cambridge University Press
5. Granville Austin,(2006).*The Indian Constitution: Cornerstone of a Nation*. Oxford University Press, New Delhi

Semester	19BOTC401:Core 14: Plant Physiology	L	T	P	C
IV		4	0	0	4

Learning Objective (LO):

LO1	To acquire knowledge on physiological aspects of plants
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Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Understand the process of photosynthesis, respiration and nitrogen metabolism
CO2	Comprehend plant growth hormones
CO3	Understand the responses of plants to biotic and abiotic stresses
CO4	Comprehend the relationship between water and plants

Unit – 1

Water and Plant Relations: Physical and chemical properties of water – Imbibition, diffusion, osmosis, components of water potential - plasmolysis - Water absorption by roots – apoplast and symplast concept - water transport through the xylem – SPAC concept – Transpiration and evapotranspiration- stomatal structure and function – mechanism of stomatal opening and closing – mineral nutrition – essential nutrients – macro and micro nutrients – deficiencies and plant disorders – absorption of solutes – translocation of solutes – pathways and mechanisms. phloem loading and unloading - translocation of photosynthates – source-sink relationship – partitioning of assimilates and harvest index.

Unit – 2

Photosynthesis: The physical nature of light – the absorption and fate of light energy – absorption and action spectra- photoreceptors- Ultra structure and biochemical compartmentation of chloroplast; Photosynthetic electron transport and Photophosphorylation (cyclic and non-cyclic): Photosystems and reaction centres - Light harvesting complexes - Photo System I & II and Oxidation of water; carbon metabolism: C₃, C₄ and CAM pathways and their distinguishing features - photorespiration and its significance .

Unit – 3

An overview of plant respiration – Glycolysis – TCA cycle– Electron transport – oxidative phosphorylation and ATP synthesis – Chemiosmotic theory - Pentose phosphate pathway– Respiration and its significance in crop improvement. Cyanide resistant respiration;

Nitrogen fixation (biological - symbiotic and non-symbiotic), physiology and biochemistry of nitrogen fixation

Unit – 4

Growth and development – phases of plant growth – growth types- Growth substances- auxin, gibberellins, cytokinins, abscisic acid and ethylene - biosynthesis, physiological effect and mechanism of action in agricultural and horticultural crops - Photoperiodism – classification of plants and mechanism of flowering – Phytochrome and their action on flowering – Vernalization- mechanism and its practical application

Unit – 5

Plant senescence –types and mechanism of senescence- Abscission: Morphological and biochemical changes – significance. Fruit ripening- Biochemical, physiological changes and control of fruit ripening. Plant response to environmental stress: Biotic and abiotic stress –water, temperature, light and salinity- adaptive mechanism to various stresses (avoidance, escape, tolerance)–stress responsive proteins - antioxidative mechanism.

Books for study:

1. Jain, V.K, (2017). *Fundamentals of Plant Physiology*, S.Chand& Company Ltd., New Delhi
2. Devlin, R.M,(1996). *Plant Physiology*, PWS publisher, Boston.
3. Pandey, N.S and P.Pandey, (2016). *A Textbook of plant Physiology*. Daya Publishing house, New Delhi
4. Verma,S.K and Mohit Verma, (2018). *A Textbook of Plant Physiology*, Biochemistry and Biotechnology. S.Chand& Company Ltd., New Delhi
5. William G. Hopkins, (1999). *Introduction to Plant Physiology*, John Wiley and sons, INC, New York.

Reference Books / Supplementary reading:

1. Moore,T.C. (1989).*Biochemistry and Physiology of Plant Hormones* (2nd Edition). Springer-verlag, New York, USA.
2. Lincoln Taiz and Eduardo Zeiger, (2006). *Plant Physiology*.Sinauer Associates Inc. Publishers, Sunderland, Massachusetts
3. Salisbury, F.B and Cleon Ross, (2007). *Plant Physiology*, Wadsworth Publishing Company, Belimont.
4. Sinha.R.K, (2018). *Modern Plant Physiology*. Narosa Publishing House, New Delhi

Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3	2	-	-	-	-	-	3	3	3	3	-	-
CO2	3	3	3	2	-	-	-	-	-	3	3	3	3	-	-
CO3	3	3	3	2	-	-	-	-	-	3	3	3	3	-	-
CO4	3	3	3	2	-	-	-	-	-	3	3	3	3	-	-

Semester	19BOTC402: Core 15: Environmental Biology and Evolution	L	T	P	C
IV		4	0	0	4

Learning Objective (LO):

LO1	To acquire knowledge on the components of environment
LO2	To know about Biodiversity and its conservation

Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Understand the ecosystem structure and functions
CO2	Comprehend the vegetation types of India
CO3	Appreciate the biodiversity conservation through <i>In-situ</i> and <i>Ex-situ</i>
CO4	Analyze the origin and evolution of life
CO5	Understand the study of vegetation

Environmental Biology

Unit – 1

The Environment: Physical environment, biotic environment, biotic and abiotic interactions. Autecology and Synecology. Ecological life cycle. Population ecology: population characteristics, population dynamics. Ecosystem ecology: Ecosystem structure and function. Ecological succession: types. Remote sensing – study of vegetation with remote sensing. Environmental pollution: causes, effects and control of air, water, soil, noise, marine, thermal and radioactive pollution. Green house effect, Ozone layer depletion and Acid rain.

Biomagnification: Eutrophication. Disaster Management: Earthquake, Volcanoes, Landslides and Tsunami.

Unit - 2

Biodiversity: Concepts, types, measures and distribution of diversity, Major Biomes of the world – Biogeographical zones of India- Vegetational types of India: Forest types, Grassland types.

Economic values of biodiversity, Loss of biodiversity. Endemism, Hotspots, Red data book, endangered plants and animals of India

Unit - 3

Conservation of Biodiversity and wild life (*Ex situ* and *In situ* methods) – Forests: Afforestation –Social forestry, Agro forestry, Extension forestry and Urban forestry. Sustainable development, Public awareness - Environmental protection Act. (Air, Water, Wildlife and Forest) Rio-summit agenda, Chipko movement. Importance of Environmental Impact Assessment (EIA) studies.

Unit - 4

Principles of Conservation: Conservation of natural resources. National and international conservation agencies (UNEP, MAB, WWF, CITES, RAMSAR and Biodiversity convention), Conservation strategy in India (Project Tiger, Biodiversity Heritage sites, Biosphere Reserves). Biodiversity act - 2002.

Evolution

Unit – 5

Origin of life: Chemosynthetic theory on the origin of life. Evolutionary theories of - Lamarck, Darwin and DeVries. Synthetic theory of evolution. Variation in Nature: Analysis of variation , Sources of variation (Mutation, recombination adaptation and selection)

Books for study:

1. Purohit, S.S., Shammi, K.J and A.K. Agarwal. (2019). *A Text book of Environmental Sciences*. Students Edition. Jodhpur
2. Singh, H.R. (2014). *Environmental Biology*. S.Chand & Company pvt.ltd, New Delhi
3. Sudha Gay. (2018). *Environmental Biology and Biotechnology*. RBSA Publishers, Jaipur
4. Sharma, P.D. (2017). *Ecology and Environment*. 13th edition, Rastogi Publishers, Meerut.
5. Subramaniam N.S, A.V.S.Sambamurthy, (2008). *Ecology*. Narosha Publications, New Delhi.
6. Verma, P.S. & Agarwal, V.K, (2016). *Cell Biology, Genetics, Molecular biology, Evolution and Ecology*. S.Chand & Company pvt ltd., New Delhi..

Reference Books / Supplementary reading:

1. Joshi, P.C. Namita Joshi, (2004). *Biodiversity and Conservation*, APH publishing company, New Delhi
2. Krishnamurthy, K.V, (2017). *An advanced text book of Biodiversity*. Oxford & IBH, New Delhi.
3. Odum, E.P. Gary W. Barrellt, (2005). *Fundamentals of Ecology-* Brooks/Cole Cenage learning, UK.
4. Manoj Tiwari, KabilKhubhe and Archaria Tiwari, (2019). *Environmental Studies*. I.K. International Publishing House Pvt Ltd, New Delhi.
5. Monika Jain, (2014). *Environmental Biotechnology*. Narosa Publishing House, New Delhi

Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3						3		3	3	3	3		
CO2	3	3						3		3	3	3	3	2	
CO3	3	3						2	2	3	3	3	3	3	
CO4	3	3						2		3	3	3	3		
CO5	3	3						2		3	3	3	3	3	

Semester	19BOTP403: Core 16: Practical – IV (covering Plant Physiology, Environmental Biology and Evolution)	L	T	P	C
IV		0	0	12	6

Learning Objective (LO):

LO1	To know about the various Plant Physiological experiments
LO2	To gain knowledge on the various methods of vegetational study

Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Understand the physiological process of plants
CO2	Analyze the various experiments related to environmental biology
CO3	Analyze the various evidences of evolution

Plant Physiology:

1. Determination of osmotic potential by plasmolytic method.
2. Determination of water potential using gravimetric method.
3. Determination of water potential using dye method (Chardakov's method).
4. Effect of Monochromatic light on apparent photosynthesis.
5. Effect of CO₂ concentration on apparent photosynthesis.
6. Effect of temperature on protoplasmic membrane.
7. Separation of chloroplast pigments using paper chromatographic technique.
8. Estimation of chlorophyll content using Arnon's method.
9. Determination of rate of photosynthesis using O₂ electrode.
10. Experiment to study the rate of Hill activity of isolated chloroplast by dye-reduction.
11. Rice coleoptile growth test for Indole Acetic Acid.
12. Effect of Auxin on root initiation
13. Experiments to show the herbicidal action of Auxin (2-4D).
14. Effect of synthetic cytokinin on the destruction of chlorophyll.
15. Estimation of Proline content
16. Estimation of Glycinebetaine content
17. Determination of Relative water content
18. Estimation of Ascorbic Acid

Methods of studying vegetation:

1. Quadrat method : List quadrat, count-quadrat, minimum size of the quadrat for a given vegetation. Abundance, relative frequency, relative density and relative dominance. Important value index and polygraph charting
2. Transect method : Line transect, belt transect and bisect method.

Pollution studies:

Effect of industrial effluents on seed germination, - Estimation of dust pollution on plants. - Ecological Instruments- Ecological adaptation of plants.

Water analysis:

Estimation of EC,pH, turbidity and TDS.
Estimation of sulphate and nitrate
Analysis of Na, K, Ca and Cl in pond water

Soil analysis:

Estimation of EC,pH
Soil moisture content
Soil N,P,K, Ca, Mg

Evolution:

Charts – Evidences of evolution, Lamarckism, Darwin and DeVries,

Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3		2	3					3	3	3		
CO2	3	3	3		2	3					3	3	3		
CO3	3	3	3		3	2					3	3	3		

DEPARTMENT ELECTIVE COURSES (DE)

Semester	19BOTE205: Herbarium Keeping	L	T	P	C
II		3	0	0	3

Learning Objective (LO):

LO1	To acquire knowledge and skills in herbarium keeping
LO2	To understand the principles of herbarium management

Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Understand the herbarium and its types
CO2	Appreciate the process of Herbarium specimen preparation
CO3	Comprehend the physical and scientific curing of herbarium specimen
CO4	Gain adequate knowledge on E-herbarium
CO5	Understand the process involved in starting a new herbarium

Unit -1: Herbarium and Specimen Collection

Herbarium- Different types, functions. Collection of specimens, types, specialized collections, need, sample collections. Ancillary collections (spirit, carpological, seed and wood). Preparation of field note book and tags. Laws and ethics of collecting samples. Important herbarium centres in the world.

Unit -2: Drying, Mounting, Preserving and Labelling of Specimens

Pressing -standard and special pressing methods. Drying and drying methods of specimens. Mounting-equipment, procedure and special preservation and storage methods for algae, fungi, lichen, bryophytes, succulents and aquatic plants. Labelling-arranging and attaching specimens, annotation slips.

Unit -3: Physical and Scientific Curation

Storing specimens, guidelines for handling specimens, labelling specimens, filling specimens, Quick guide. Scientific curation- Taxonomy and nomenclature, identifying specimens, library and literature. Collectors, itineraries, maps and gazetteers. Centralized accessioning, recording and dispatch procedures. Preventing from insect damage. Special curation (eg succulents, palms).

Unit - 4: Computerization, E-herbarium and arrangement

Computerization of specimens, removing samples from specimens, removing and repairing specimens, duplicates. Collections of illustrations and photographic records. Family arrangement of specimen collections. Rearranging the collection according to a new publication. Photography of herbarium sheets and plants in the field. E-herbarium making.

Unit -5: Starting a new Herbarium and Record keeping

Starting a new Herbarium-purpose, determining basic needs, registering of Index herbarium, infrastructure and functional areas. Equipment and suppliers. Handling specimens and helping visitors. Herbarium services, Herbarium management. All records and correspondence concerning exchanges, loans and agreement, gifts, and accessions. Annual report.

Books for study:

1. Singh, H.B and B. Subramaniam. (2008). *Field Manual on Herbarium techniques*. National Institute of Science Communication and Information Resources, New Delhi
2. Sivarajan, V.V. (1989). *Introduction to principles of plant Taxonomy*. Oxford and IBH, New Delhi.
3. Bhattacharyya, B. (2005). *Systematic Botany*. Narosa Publishing House, New Delhi.

Reference Books / Supplementary reading:

1. Greuter, W. et al. (1989). *International Code of Botanical Nomenclature*. International Association of Plant Taxonomy, Leiden.
2. Michael, G. Simpson, (2006). *Plant Systematics*. Elsevier Academic Press, Burlington, MA.

Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3					3	3		3	3	3	3	2	3
CO2	3	3	2				3	2		3	3	3	3		3
CO3	3	3					2	3			3	3	3	2	2
CO4	3	3	2				2	3			3	3	3	3	2
CO5	3	3	2	2						3	3	3	3	3	

Semester	19BOTE206: Forest Technology	L	T	P	C
II		3	0	0	3

Learning Objective (LO):

LO1	To know about the principles and scope of forest management
LO2	To study about the forest biotechnology

Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Understand the forest types of India
CO2	Appreciate the value of wild life conservation
CO3	Gain adequate knowledge on silviculture
CO4	Comprehend the physical, chemical and mechanical properties of wood
CO5	Understand the methods of studying the form

Unit - 1

Forestry-Definition, Classification, scope of forestry, forest utilization, major and minor forest products, commercial Timber yielding plants of South India.

Forest types of India, social forestry village forestry, farm forest, avenues.

Unit - 2

Principle and scope of forest management, elements of mensuration, sampling use of diameter (Girth) height and area spacement rotation, concept of sustained yield-conservation and conservation strategies ,sustainable development.

Wild life-Important animals of South India, preservation, sanctuaries endangered species causes for destruction and need for protection- wild life preservation act.

Unit-3

Elements of silviculture - silviculture of the following species:-

- a. *Tectona grandis*
- b. *Casuarinaequisitifolia*
- c. *Eucalyptus*
- d. *Bomboosasp*
- e. *Santalum album*

Silvicultural systems - clear felling, simple coppice and selection felling.

Unit- 4

Wood structure , physical, chemical and mechanical properties of wood. Wood preservation, wood seasoning and wood preservatives.

Unit- 5

Tree Improvement -Genetic variation, geographic variation, genotype and phenotype, Tree improvement methods -species introduction, hybridization, Individual tree selection, vegetative propagation, grafting, biotechnology for forestry.

Books for study:

1. Kamal Kishor Sood and Vishal Mahajan, (2018). *Forests: Climatic Change and Biodiversity*. Kalyani Publishers, New Delhi
2. Shrivastava, M.B., (1998). *Introduction to Forestry*. South Asia Books; 1 edition, New Delhi
3. Sudhir, M. (2000). *Applied biotechnology and plant genetics*. Dominant Publishers, New Delhi
4. Vinod Kumar, (1995). *Nursery and Plantation practices in Forestry, Jodhpur*. Scientific publishers.

Reference Books / Supplementary reading:

1. Agarwal A, (1985). *Forest of India*. as cited in P. Leelakrishnan, Environmental Law in India, Butterworths India, New Delhi
2. Champion ,H.G and Griffith, (1967). *Manual of General silviculture for India*, 3rd edition, New Delhi.
3. WWF.(2007). *Timber Identification Manual*. TRAFFIC, New Delhi.

Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3						2		3	3	3	3	2	
CO2	3	3						2		3	3	3	3		
CO3	3	3						2		3	3	3	3		2
CO4	3	3	2		2			2		3	3	3	3		
CO5	3	3	2		2			2		3	3	3	3	2	2

Semester	19BOTE305: Applied Botany	L	T	P	C
III		3	0	0	3

Learning Objective (LO):

LO1	To understand the Post harvest technology of fruits
LO2	To study about the principles of seed storage
LO3	To acquire knowledge on seed certification

Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Understand the cultivation and marketing of various fruits
CO2	Appreciate the process of cultivation of various flower crops
CO3	Comprehend the methods of seed storage and seed dormancy
CO4	Gain adequate knowledge on seed viability and seed certification
CO5	Understand the process involved in fruit harvesting and packaging

Unit – 1

Classification of fruits – Temperate and subtropical production – varieties, climate and soil requirements – propagation, planting density and cropping system- training and pruning – uses of growth regulators and nutrients to improve production. Weed management – pests, disease and their control – harvesting, post harvesting handling and storage – Marketing and export of the following.

Citrus, Banana, Guava, Mango, Grapes, Papaya, pineapple and Tamarind.

Unit – 2

Rose, Jasmine, Crossandra, Marigold, Dhalia and Anthurium, Micropropagation of orchids- Shadenet and green house cultivation.

Unit – 3

Principles and methods of seed storage. Effect of storage environment on seed longevity. Growth of seeds – seed maturation, Germination – Factors affecting germination – metabolism during germination – seed dormancy – types of dormancy.

Unit – 4

Seed production in self and cross pollinated crops. Classes of seed: Nucleus, breeder, foundation and certified seeds - Seed harvesting, seed processing, seed treatments, seed testing and seed sampling. Viability and vigour - Seed borne pathogens - Seed certification, standard inspection, legislation and seed law-enforcement.

Unit – 5

Introduction: production of fruits- quality losses of fruits, Determination of harvest maturity and handling methods - Factors affecting fruits during storage, package design, packaging types.

Books for study:

1. Agarwal, P.K and M.Dadlani, (1992). *Techniques in seed science and technology*
2. Kumar, N, (1993). *Introduction to Horticulture*. Rajalakshmi publication, Nagercoil.
3. Hartme,H.T. and Kester,D.E, (1986). *Plant propagation principles and practices*. Prentice Hall of India Ltd., New Delhi
4. Trivedi,P.C, (2005). *Applied Botany*.Aamishankar Publishers & Distributors, Jaipur.

Reference Books / Supplementary reading:

1. Janick,J.W.H, (1988). *Horticultural Science*. Freeman and Co., San Francisco.
2. Agarwal,R.L, (2008). *Seed Technology*. Oxford and IBH publishing. New Delhi.
3. Khan.A.A.Ed,(1977). *Physiology and Biochemistry of seed dormancy and germination*.

Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3			2	3				3	3	3	3	2	
CO2	3	3			2	3				3	3	3	3		
CO3	3	3			2	2				3	3	3	3		2
CO4	3	3			2	2				3	3	3	3		2
CO5	3	3			2	2				3	3	3	3	2	2

Semester	19BOTE306: Bioprospecting of Medicinal and Aromatic Plants	L	T	P	C
III		3	0	0	3

Learning Objective (LO):

LO1	To acquire knowledge on medicinal and aromatic plants
LO2	To understand antioxidant metabolism
LO3	To study about post harvest technology in medicinal plants

Course Outcomes (CO)

At the end of the course, the student will be able to

CO1	Understand the history of herbal medicine
CO2	Appreciate the quality control of medicinal plant preparation
CO3	Comprehend the bioactive compounds found in plants
CO4	Understand the plant defense mechanism
CO5	Gain adequate knowledge on post-harvest technology in medicinal plants

Unit – 1

Medicinal and Aromatic Plants – Importance and Scope – Classification of medicinal plants – based on morphology of useful parts, habit, taxonomical , pharmacological , chemical and Ayurvedic formulations – Cultivation of medicinal and aromatic plants – History of herbal medicine- Contribution of the Egyptians, Chinese, Greeks, Arabs and Indians -Different systems of herbal medicine: Ayurveda, Siddha and Unani.

Unit – 2

Quality control for medicinal and aromatic plant materials: Microscopic and Macroscopic examination – Visual examination and odour – Histochemical detection of cell walls and contents. Drug Evaluation: Methods of drug evaluation: Organoleptic, Microscopic, Physical, Chemical and Biological evaluation. Chemical nature of drugs: Crude drugs – Preparation and preservation - Chemical nature and Methods of tests for Carbohydrates, Glycosides, Tannins, Volatile oils, Lipids, Resinous substances and Proteins.

Unit – 3

General properties of Alcohols, Aldehyde, Glutaraldehyde, Halogens, Phenols, Gases, Surface active agents and Metallic salts ; Secondary Metabolites - Classification , General characters, Chemical nature, Extraction and Estimation methods for Alkaloids, Flavanoids, Terpenoids and Phenolic compounds -Separation, Identification and Characterization of the potential bioactive compounds using UV, FTIR, ¹H NMR, ¹³C NMR, 2D NMR, GC-MS and XRD. Bioactive molecules – Antibacterial, Antifungal, Antiplasmodial, Larvicidal and Antiviral drugs – mode of its action.

Unit – 4

Antioxidant metabolism: Plant defense mechanism – Antioxidants – Reactive oxygen species – Enzymatic and non enzymatic antioxidants –Role of antioxidants –Estimation of antioxidants – Ascorbic acid and alpha Tocopherol. Antioxidant enzymes – Peroxidase, SOD and Catalase. Free radicals, types of free radicals, Production of free radicals and Lipid peroxidation.

Unit – 5

Post-harvest technology in medicinal plants: scope and importance. Processing and utilization – Storage of crude drugs, Adulteration with reference to plant drugs, types of adulterants and methods of adulteration, Identification of adulterants. - Importance of herbal marketing -Future prospects and constraints of the herbal drug industry - Regulatory status of herbal medicine in India.

Books for study:

1. Ananthanarayan, R. and C.K.J. Paniker,(1996). *Text book of Microbiology*. 5thEdn., Orient Longman Ltd., Chennai
2. Farooqi, A.A. and B.S.Sreeramu, (2004). *Cultivation of medicinal and aromatic crops*. Revised edition, Universities Press (India) Private Limited, Hyderabad.
3. Jain, S.K, (2018). *Manuals of Ethnobotany*. Scientific suppliers, New Delhi
4. Joshi,S.G, (2018). *Medicinal Plants*.CBS Publishers pvt Ltd., New Delhi

Reference Books / Supplementary reading:

1. WHO, (2002).*Quality control methods for medicinal plant materials*, World Health Organization, Geneva, A.I.T.B.S., Publishers and Distributors, New Delhi.
2. Harbone, J.B,(1998). *Phytochemical Methods; A guide to modern techniques of plant analysis*. 3rdEdn., Springer (India) Private Limited , New Delhi.
3. Mc.Kane, L. and J. Kandel, (1996). *Microbiology: Essential and Applications*. 2ndEdn., McGraw – Hill, Inc, New Delhi.

Outcome Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3				2				3	3	3	3		2
CO2	3	3				2				3	3	3	3		2
CO3	3	3				2				3	3	3	3		2
CO4	3	3				2				3	3	3	3		
CO5	3	3				2				3	3	3	3		
