Annamalai University

(Accredited with 'A' Grade by NAAC)

M.Sc. Botany (Two-Year) Programme

Regulations & Curriculum-2019

UGC-SAP and DST-FIST Assisted

Department of Botany

ANNAMALAI UNIVERSITY

REGULATIONS FOR THE TWO-YEAR POST GRADUATE PROGRAMMES UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

These Regulations are common to all the students admitted to the Two-Year Master's Programmes in the Faculties of Arts, Science, Indian Languages, Education, Marine Sciences, and Fine Arts from the academic year 2019-2020 onwards.

1. Definitions and Nomenclature

1.1 **University** refers to Annamalai University.

1.2 **Department** means any of the academic departments and academic centres 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/Tutorials/Laboratory work/Seminar/Project work/Experiential learning/ Report writing/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 also known as Course Objectives are statements that define the expected goal of a course in terms of demonstrable skills or knowledge that will be acquired by a student as a result of instruction.

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.

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

M.Sc. Botany	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 Programmes 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.

5.3.3 Students shall take a combination of both DEs and IDEs.

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 (as applicable) fall under this category.

5.4.3 Experiential learning is categorised as Core.

5.5 Project

5.5.1 Each student shall undertake a Project 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 recognised institutions/industry shall obtain prior permission from the University. The Research Supervisor will be from the host institute, while the Co-Supervisor shall be a faculty in the parent department.

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, of which 60% (18 hours) shall be Theory and 40% (12 hours) Practical.

5.6.4 Classes for a VAC are conducted beyond the regular class hours and preferably in the II and III Semesters.

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 organised as follows:

	Credits
Core Courses	65-75
Elective Courses	15
Project	6-8
Total (Minimum requirement for award of Degree)	**90-95***

**Each Department shall fix the minimum required credits for award of the Degree within the prescribed range of 90-95 credits.*

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 per week over a semester

1 Tutorial period of one hour per week over a semester

1 Practical/Project period of two or three hours (depending on the discipline) 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 organisation of lesson plan of the Course Instructor.

6.3 The record shall be submitted to the Head of the Department once a month for monitoring the attendance and syllabus coverage.

6.4 At the end of the semester, the record shall be duly signed by the Course Instructor and the Head of the Department and placed in safe custody for any future verification.

6.5 The Course Instructor 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.

8.4 Continuous Internal Assessment Tests

8.4.1 The CIA Tests shall be a combination of a variety of tools such as class tests, assignments, seminars, and viva-voce that would be suitable to the course. This requires an element of openness.

8.4.2 The students are to be informed in advance about the assessment procedures.

8.4.3 The pattern of question paper will be decided by the respective faculty.

8.4.4 CIA Test-I will cover the syllabus of the first two units while CIA Test-II will cover the last three units.

8.4.5 CIA Tests will be for two to three hours duration depending on the quantum of syllabus.

8.4.6 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.

8.5 End Semester Examinations (ESE)

8.5.1 The ESE for the first/third semester will be conducted in November and for the second/fourth semester in May.

8.5.2 A candidate who does not pass the examination in any course(s) of the first, second and third semesters will be permitted to reappear in such course(s) that will be held in April and November in the subsequent semester/year.

8.5.3 The ESE will be of three hours duration and will cover the entire syllabus of the course.

9 Evaluation

9.1 Marks Distribution

9.1.1. Each course, both Theory and Practical as well as Project/Internship/Field work/In-plant training shall be evaluated for a maximum of 100 marks.

9.1.2 For the theory courses, CIA Tests will carry 25% and the ESE 75% of the marks.

9.1.3 For the Practical courses, the CIA Tests will constitute 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:

	Marks
Test-I & Test-II	15
Seminar	05
Assignment	05
Total	25

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

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

9.3 Assessment of End-Semester Examinations

9.3.1 Evaluation for the ESE is done by both External and Internal examiners (Double Evaluation).

9.3.2 In case of a discrepancy of more than 10% between the two examiners in awarding marks, third evaluation will be resorted to.

9.4 Assessment of Project/Dissertation

9.4.1 The Project Report/Dissertation shall be submitted as per the guidelines laid down by the University.

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:

<table>
<tr><td colspan="2">Continuous Internal Assessment (25 Marks)</td><td colspan="2">End Semester Examination (75 Marks)</td></tr>
<tr><td rowspan="2">Review-I 10</td><td rowspan="2">Review-II: 15</td><td>Project / Dissertation Evaluation</td><td>Viva-voce</td></tr>
<tr><td>50</td><td>25</td></tr>
</table>

9.5 Assessment of Value-added Courses

9.5.1 Assessment of VACs shall be internal.

9.5.2 Two CIA Tests shall be conducted during the semester by the Department(s) offering VAC.

9.5.3 A committee consisting of the Head of the Department, faculty handling the course and a senior faculty member shall monitor the evaluation process.

9.5.4 The grades obtained in VACs will not be included for calculating the GPA.

9.6 Passing Minimum

9.6.1 A student is declared to have passed in each course if he/she secures not less than 40% marks in the ESE and not less than 50% marks in aggregate taking CIA and ESE marks together.

9.6.4 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 from the first semester to the current semester.

11.3 The GPA is calculated by the formula

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

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 and

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.

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

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 and

G is the number of Courses passed in that semester.

G is the number of semesters

11.5 Evaluation of the performance of the student will be rated as shown in the Table.

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

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

11.6.1 For **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 or 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 For **First Class:** Candidates who have passed all the courses with a CGPA of 6.5 or above.

11.6.3 For **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 highest marks in all examinations at the first appearance alone will be considered 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.

12.3 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.

12.4 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.

12.5 Withdrawal is **not** granted for arrear examinations of courses in previous semesters and for the final semester examinations.

12.6 Candidates who have been granted permission to withdraw from the examination shall reappear for the course(s) when the course(s) are offered next.

12.7 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 sensitised 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.*

Annamalai University

Department of Botany

M.Sc. BOTANY (Two year) Programme

Programme Code: SBOT21

Programme Structure

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

Course Code	Course Title	Hours/ Week		C	Marks		
		L	P		CIA	ESE	Total
Semester-I							
19BOTC101	Plant Diversity – I(Algae and Bryophytes)	4	-	4	25	75	100
19BOTC102	Fungi, Lichens and Plant Pathology	4	-	4	25	75	100
19BOTC103	Microbiology and Immunology	4	-	4	25	75	100
19BOTP104	Practical – I (covering Plant Diversity – I, Fungi, Lichens, Plant Pathology, Microbiology and Immunology)	-	12	6	40	60	100
	Elective – I (IDE)	3	-	3	25	75	100
	Total			21			
Semester-II							
19BOTC 201	Plant Diversity - II (Pteridophytes, Gymnosperms and Palaeobotany)	4	-	4	25	75	100
19BOTC202	Anatomy, Embryology of Angiosperms and Morphogenesis	4	-	4	25	75	100
19BOTC203	Cell Biology, Genetics and Plant Breeding	4	-	4	25	75	100
19BOTP204	Practical – II (covering Plant Diversity – II, Anatomy, Embryology of Angiosperms, Morphogenesis, Cell Biology, Genetics and Plant Breeding)	-	12	6	40	60	100
	Elective - II (IDE)	3	-	3	25	75	100
19BOTE205.1/ 205.2	Elective – III (DE)	3	-	3	25	75	100
	Total			24			
Semester-III							
19BOTC301	Taxonomy of Angiosperms and Economic Botany	3	-	4	25	75	100
19BOTC302	Biochemistry and Molecular Biology	4	-	4	25	75	100
19BOTC303	Biological Techniques and Research Methodology	4	-	4	25	75	100
19BOTC304	Plant Bio-technology and Genetic Engineering	4	-	4	25	75	100
19BOTP305	Practical –III (covering Taxonomy of Angiosperms, Economic Botany, Biochemistry , Molecular Biology, Biological Techniques, Research Methodology, Plant Bio-technology and Genetic Engineering)	-	12	6	40	60	100
	Elective – IV (IDE)	3	-	3	25	75	100
19BOTE306.1/306.2	Elective – V (DE)	3	-	3	25	75	100
	Total			28			
Semester-IV							
19BOTC 401	Plant Physiology	4	-	4	25	75	100
19BOTC 402	Environmental Biology and Evolution	4	-	4	25	75	100
19BOTP 403	Practical – IV (covering Plant Physiology,	-	12	6	25	75	100

	Environmental Biology and Evolution)						
19BOTPJ 404	Project Work / In-Plant Training	-	10	6	25	75	100
	Total			20			
				Total Credits	**93**		
	Value Added Courses						
	On-line Courses (SWAYAM, MOOC and NPTEL)						

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

Note:

1. Students shall take both Department Electives (DEs) and Interdepartmental Electives (IDEs) from a range of choices available.
2. Students may opt for any Value-added Courses listed in the University website.

Elective Courses

Department Electives (DE)

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

Programme Outcomes (POs)

After the completion of the M.Sc Botany Programme, the students will be in a position 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 tasksindependently and asa 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)

By the end of the Programme, the students 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 - I **19BOTC101:Plant Diversity – I (Algae and Bryophytes)** **Credits:4**
Hours:4

Learning Objective(LO):

- To acquire knowledge on the structure, reproduction and life cycle 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 Khaling Mikawlrawng, 2014. Textbook of Bryophyta. Sonali Publications, New Delhi
3. Vashishta. B.R., A.K. Sinha and Adarsh Kumar. 2016. Botany for Degree students-Bryophyta. S. Chand and Company Ltd., New Delhi.
4. Vashishta. B.R., A.K. Sinha and Adarsh Kumar. 2015. Botany for Degree students - Algae. S. Chand and Company Ltd., New Delhi.

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.

Course Outcomes (COs):

On the successful completion of this course the students 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 phylogency 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

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 1	PS 2	PS 3	PS 4	PS 5
CO1	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	-
CO2	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	-
CO3	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	-
CO4	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	✓	-
CO5	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	✓

Semester - I 19BOTC102: Fungi, Lichens and Plant Pathology Credits:4
Hours:4

Learning Objectives(LOs):

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

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 : *Pilobolu*s.

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. Mycorhiza: 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. Sambamurthy A.V. S.S. 2006. A Textbook of Plant Pathology. I.K. International Pvt.Ltd., New Delhi.
2. Sharma,O.P.2005. The Text book of Fungi. Tata McGraw Hill publishing company Ltd, New Delhi.
3. Sharma,P.D.2009. The Fungi. Rastogi publications, Meerut.

4. Singh. R.S. 2015. Plant Diseases. Oxford & IBH publishing Co.Pvt Ltd. New Delhi

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. Dasgupta, M.K.2004. Principles of Plant Pathology. Allied publishers Ltd. New Delhi.
3. Rangaswami,G and A.Mahadeven. 2006. Diseases of crop plants in India. Prentice Hall Pvt.Ltd. New Delhi.

Course Outcomes(COs)

On the successful completion of this course the students 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

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 1	PS 2	PS 3	PS 4	PS 5
CO1	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	-
CO2	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	-
CO3	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	-
CO4	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	-
CO5	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	✓

Semester – I **19BOTC103: Microbiology and Immunology** **Credits:4 Hours:4**

Learning Objectives(LOs):

- To study the classification, structure and reproductive features of bacteria and viruses
- To understand the basic concepts of immunology

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 filteration, 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. Microbes used as Bio fertilizers – *Rhizobium, Azospirillum, Azotobacter, Azolla* and blue-green algae.

Immunology

Unit – 4

Immunology – Structure and development of immune system- Types of immunity – Cells of the immune system- Innate and adaptive immunity – Antibodies- antigen antibody

reactions – detailed aspects of receptor and functions of T cell and B cell. The immune response, cytokines, immunity in health and disease

Unit – 5

Development of cells in Thymus – Antigen and antigen antibody presentation – antibodies – Immunoflurescence – ELISA- Hyper sensitivity reactions – Tissue Transplantation – Vaccines – DNA vaccines- recombinant vaccines – Edible vaccines – multivalent, subunit and anti-idiotype vaccines, Autoimmune disorders

Text Books:

1. Dubey, R.C. and D.K. Maheswari, 2016. A Textbook of Microbiology, S. Chand & Company, New Delhi
2. Sharma, P.D. 2017. Microbiology. Rastogi Publications, Meerut.
3. Rao,C.V. 2008. Immunology. Naraso Publishing House, India

Supplementary Reading:

1. Brain D.Robertson and Brendan W.Wren.2012. Systems Microbiology: Current topic and Applications. ISBN. 978-1-908230.
2. P.J.Delves, SJ. Martin, D.R. IM. Roitt.2011. Roitt's Essential Immunology. Blacwell Scientific Publications, Oxford
3. John P.Harley.2007.Microbiology Lab Manual. 7th Edition. McGraw Hill Medical Publication division

Course Outcomes(COs):

On the successful completion of this course the students 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 techniques followed in immunology

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 1	PS 2	PS 3	PS 4	PS 5
CO1	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	-
CO2	✓	✓	-	-	-	-	-	✓	-	✓	-	✓	✓	-	-
CO3	✓	✓	-	-	-	-	-	✓	✓	✓	-	-	✓	-	✓
CO4	✓	✓	-	-	-	-	-	✓	-	✓	-	✓	✓	-	✓

Semester – I 19BOTP104:Practical – I (covering Plant Diversity – I, Fungi, Lichens, Plant Pathology, Microbiology and Immunology) Credits:6 Hours:12

Learning Objectives(LOs):

- To observe the structure of Algae, Bryophytes, Fungi and Lichens
- To observe the staining methods of Microorganism
- To find out the 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.

Immunology:

Blood group determination (Demonstration)

Course Outcomes(COs):

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

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

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 1	PS 2	PS 3	PS 4	PS 5
CO1	✓	-	✓	-	✓	✓	-	-	-	-	✓	✓	✓	-	-
CO2	✓	-	✓	-	✓	✓	-	-	-	-	✓	✓	✓	-	-
CO3	✓	-	✓	-	✓	✓	-	-	-	-	✓	✓	✓	-	-

Semester – II **19BOTC201: Plant Diversity – II** **Credits:4**
(Pteridophytes, Gymnosperms and Palaeobotany) **Hours:4**

Learning Objectives(LOs):

- To acquire knowledge on living and fossils forms of Pteridophytes and Gymnosperms.

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

Text Books:

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. Shirpad N.Agashe. 1995. Palaeobotany. Oxford & IBH Publishing Co.Pvt.Ltd, New Delhi.

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.

Course Outcomes(COs):

On the successful completion of this course the students 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

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 1	PS 2	PS 3	PS 4	PS 5
CO1	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	-
CO2	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	-
CO3	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	-
CO4	✓	✓	-	-	-	-	-	✓	-	✓	-	-	✓	-	✓
CO5	✓	✓	-	-	-	-	-	✓	-	✓	-	-	✓	✓	✓

Semester - II **19BOTC202: Anatomy, Embryology of Angiosperms and Morphogenesis** **Credits:4 Hours:4**

Learning Objectives(LOs):

- To acquire the knowledge on anatomy and embryology of vascular plants
- To apply knowledge on the organ development 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, secretary 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- Micropsporogenesis 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 imcompatability – 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*

Text Books:

1. Bhojwani,S.S., S.P. Bhatnagar and P.K.Dantu. 2015. The embryology of Angiosperms. Vikas publishing House pvt.,Ltd, Noida.
2. Tayal, M.S. 2008. Plant Anatomy. Rastogi publications, Meerut.
3. Pandey, S.N and A.Chadha.2005. Plant Anantomy and Embryology. Vikas Publishing House Pvt Ltd., New Delhi.

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 Jersy.
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.

Course Outcomes(COs):

On the successful completion of this course the students 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

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 1	PS 2	PS 3	PS 4	PS 5
CO1	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	-
CO2	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	-
CO3	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	-
CO4	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	-
	✓	✓								✓	✓	✓	✓	-	-

Semester - II 19BOTC203:Cell Biology , Genetics and Plant Breeding Credits:4
Hours:4

Learning Objectives(LOs):

- To acquire the knowledge on Plant cell and cell organells
- To understand the genetics and breeding of plants.

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. Synopsis, synaptinemal 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.

Text Books:

1. Inbasekar.2013. Cell Biology and Genetics. Panima Book Distributors, Bangalore.

2. Ramachandra R.K. 2014. Principles of Plant Breeding. Narendra Publishing House, New Delhi
3. Rastogi, S.C. 2016. Cell Biology. New age International Publications, New Delhi.

Supplementary Reading:

1. Basu.S.B. and M.Hossain.2004. Principles of Genetics. Books and Allied (P). Ltd, Kolkatta.
2. Gardner, Simmons, Snustad; 2006; Principles of Genetics; Wiley student edition.
3. Pragya Khanna; 2008; Cell and Molecular Biology ; I.K. International Publications-New Delhi.
4. Sanjay Kumar Singh.2005. Plant Breeding. Campus book international, New Delhi.

Course Outcomes(COs):

On the successful completion of this course the students 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

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 1	PS 2	PS 3	PS 4	PS 5
CO1	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	-
CO2	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	-
CO3	✓	✓	✓	-	-	-	-	-	-	✓	✓	✓	✓	-	-
CO4	✓	✓	-	-	-	-	-	✓	-	✓	✓	✓	✓	-	-
CO5	✓	✓	-	-	-	-	-	✓	-	✓	✓	✓	✓	-	-

Semester - II **19BOTP204:Practical – II (covering Plant Diversity – II, Anatomy, Embryology of Angiosperms, Morphogenesis, Cell Biology, Genetics and Plant Breeding)** **Credits:6 Hours:12**

Learning Objectives(LOs):

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

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 *Bougainvillaea, 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 axiliary 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

Course Outcomes(COs):

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

CO1: Analyze the structure of cell division

CO2: Analyze the chromosome types

CO3: Understand the Mendalian inheritance

CO4: Comprehend the various Plant propagation methods

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 1	PS 2	PS 3	PS 4	PS 5
CO1	✓	-	✓	-	✓	✓	-	-	-	-	✓	✓	✓	-	-
CO2	✓	-	✓	-	✓	✓	-	-	-	-	✓	✓	✓	-	-
CO3	✓	-	✓	-	✓	✓	-	-	-	-	✓	✓	✓	-	-
CO4	✓	-	✓	-	✓	✓	-	-	-	-	✓	✓	✓	-	-

Semester - III **19BOTC301:Taxonomy of Angiosperms and Economic Botany** **Credits:3 Hours:4**

Learning Objectives(LOs):

- To acquire knowledge on morphology, taxonomy and the economic importance of Angiosperms.

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.

Text Books:

1. Gurucharan Singh, 2017. Plant Systematics, Oxford & IBH Publishing company (P) Ltd, New Delhi
2. Pandey.B.P. 2009. Taxanomy of Angiosperms. S.Chand & Co. Ltd. New Delhi.
3. Singh,S.K and Seema Srivastava. 2009. Economic Botany. Campus Book International, New Delhi.

Supplementary Reading:

1. Jain, S.K.and R,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

Course Outcomes (COs):

On the successful completion of this course the students 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

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 1	PS 2	PS 3	PS 4	PS 5
CO1	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	-
CO2	✓	✓	-	-	-	-	-	-	-	✓	-	-	✓	-	-
CO3	✓	✓	✓	-	-	-	-	-	-	✓	✓	✓	✓	-	-
CO4	✓	✓	-	-	-	-	-	✓	-	✓	-	-	✓	-	✓

Semester - III **19BOTC302: Biochemistry and Molecular Biology** **Credits:4**
Hours:4

Learning Objectives(LOs):

- To acquire the knowledge on biochemistry and Molecular biology of plants

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.

Text Books:

1. Allison.A. 2007. Fundamental Molecular Biology. Blackwell Publishing, UK.
2. Bonner,J and W.H. Warner. Plant Biochemistry. Academic press. Inv.Ny.1961
3. Sambamurty A.V.S.S.; 2008; Molecular Biology; Narosa Publishers- New Delhi

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, Printice hall, International N.J, 7th Edition.

Course Outcomes (COs):

On the successful completion of this course the students 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

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 1	PS 2	PS 3	PS 4	PS 5
CO1	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	-
CO2	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	-
CO3	✓	✓	-	-	-	-	-	✓	-	✓	✓	✓	✓	-	-
CO4	✓	✓	-	-	-	-	-	✓	-	✓	✓	✓	✓	-	-

Semester - III **19BOTC303: Biological Techniques and Research Methodology** **Credits:4 Hours:4**

Learning Objectives(LOs):

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

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.

Text Books:

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. Sree Ramalu, V.S, 1988. Thesis writing. Oxford & IBH publications, New Delhi.

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.

Course Outcomes(COs):

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

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

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 1	PS 2	PS 3	PS 4	PS 5
CO1	✓	✓	-	✓	-	-	-	-	-	✓	-	-	✓	-	-
CO2	✓	✓	✓	✓	✓	✓	-	-	-	✓	-	-	✓	-	-
CO3	✓	✓	-	✓	-	-	✓	-	-	✓	-	-	✓	-	-
CO4	✓	✓	-	✓	-	-	-	✓	-	✓	-	-	✓	-	-
CO5	✓	✓	-	✓	-	-	-	✓	-	✓	-	-	✓	-	✓

Semester - III 19BOTC304: Plant Biotechnology and Genetic Engineering Credits:4 Hours:4

Learning Objectives(LOs):

- To understand different biotechnological methods
- To develop skills on genetic engineering of 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.

Text Books:

1. Dubey R.C.; 2009. A Textbook of Biotechnology; Chand & Company LTD. New Delhi.
2. Smith Rastogi and Neelam Pathak.2009. Genetic Engineering. Oxford Univ.press.
3. Mishra, S.P, 2016. Plant Tissue Culture. Ane Books Pvt ltd.

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.

Course Outcomes (COs):

On the successful completion this course the students 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

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 1	PS 2	PS 3	PS 4	PS 5
CO1	✓	✓	✓	✓	-	-	-	✓	-	✓	-	-	✓	-	✓
CO2	✓	✓	✓	✓	-	-	-	✓	-	✓	-	-	✓	-	✓
CO3	✓	✓	✓	✓	-	-	-	✓	✓	✓	-	-	✓	✓	✓

Semester - III **19BOTP305: Practical – III (covering Taxonomy of Angiosperms, Economic Botany, Biochemistry , Molecular Biology, Biological Techniques, Research Methodology, Plant Bio-technology and Genetic Engineering)** **Credits:6 Hours:12**

Learning Objectives(LOs):

- To identify the families of angiosperms
- To know about the various biochemical experiments
- To gain knowledge on the various experiments on 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

Course Outcomes(COs):
On the successful completion of this course the students 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

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 1	PS 2	PS 3	PS 4	PS 5
CO1	✓	-	✓	-	✓	✓	-	-	-	-	✓	✓	✓	-	✓
CO2	✓	-	✓	-	✓	✓	-	-	-	-	-	-	✓	-	✓
CO3	✓	-	✓	-	✓	✓	-	-	-	-	-	-	✓	✓	✓

Semester - IV **19BOTC401: Plant Physiology** **Credits:4**
Hours:4

Learning Objectives(LOs):

- To acquire knowledge on physiological aspects of 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: C_3, C_4 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.

Text Books:

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. William G. Hopkins, 1999. Introduction to Plant Physiology, John Wiley and sons, INC, New York.

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. Sinauver Associates Inc. Publishers, Sunderland, Massachusetts
3. Salisbury, F.B and Cleon Ross, 2007. Plant Physiology, Wadsworth Publishing Company, Belimont.

Course Outcomes(COs):

On the successful completion of this course the students 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

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 1	PS 2	PS 3	PS 4	PS 5
CO1	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓	-	-
CO2	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓	-	-
CO3	✓	✓	✓	✓	-	-	-	-		✓	✓	✓	✓	-	-
CO4	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓	-	-

Semester - IV 19BOTC402: Environmental Biology and Evolution Credits:4 Hours:4

Learning Objectives(LOs):

- To acquire knowledge on the components of environment.
- To know about Biodiversity and its conservation

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)

Text Books:

1. Sharma.P.D. 2017. Ecology and Environment. 13th edition, Rastogi Publishers, Meerut.
2. Subramaniyam N.S, A.V.S.Sambamurthy; 2008. Ecology. Narosha Publications, New Delhi.
3. Verma, P.S. & Agarwal, V.K. 2016. Cell Biology, Genentics, Molecular biology , Evolution and Ecology. S.Chand & Company pvt ltd., New Delhi.

Supplementary Reading:

1. Joshi, P.C. Namita Joshi, 2004. Biodiversity and Conservation, APH publishing company, New Delhi
2. Krishnamurthy, K.V. 2004. An advanced text book of Biodiversity. Oxford & IBH, New Delhi.
3. Odum, E.P. Gary W. Barrelt.2005. Fundamentals of Ecology- Brooks/Cole Cenage learning, UK.

Course Outcomes(COs):

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

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

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 1	PS 2	PS 3	PS 4	PS 5
CO1	✓	✓	-	-	-	-	-	✓	-	✓	✓	✓	✓	-	-
CO2	✓	✓	-	-	-	-	-	✓	-	✓	✓	✓	✓	✓	-
CO3	✓	✓	-	-	-	-	-	✓	✓	✓	✓	✓	✓	✓	-
CO4	✓	✓	-	-	-	-	-	✓	-	✓	✓	✓	✓	-	-
CO5	✓	✓	-	-	-	-	-	✓	-	✓	-	-	✓	✓	-

Semester - IV **19BOTP403:Practical – IV (covering Plant Physiology, Environmental Biology and Evolution)** **Credits:6 Hours:12**

Learning Objectives(LOs):

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

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 CO_2 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 O_2 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 heribicidal 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,

Course Outcomes(COs):

On the successful completion of this course the students 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

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 1	PS 2	PS 3	PS 4	PS 5
CO1	✓	-	✓	-	✓	✓	-	-	-	-	✓	✓	✓	-	-
CO2	✓	-	✓	-	✓	✓	-	-	-	-	-	-	-	-	-
CO3	✓	-	✓	-	✓	✓	-	-	-	-	-	-	✓	-	-

DEPARTMENT ELECTIVES (DE)

19BOTE205.1: Herbarium Keeping **Credits:3**
Hours:3

Learning Objectives(LOs):

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

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.

Practicals:

1. Field trips within and nearby areas in the campus, compilation of field notes and preparation of herbarium sheets of such plants wild or cultivated Plants.
2. Training in using floras and herbarium for the identification of specimens described in the class.

Textbooks :

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.

Supplementary Reading:

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

Course Outcomes(COs):

On the successful completion of this course the students 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

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 1	PS 2	PS 3	PS 4	PS 5
CO1	✓	✓	-	✓	-	-	-	-	-	✓	-	-	✓	✓	-
CO2	✓	✓	-	✓	-	-	-	-	-	✓	-	-	✓	✓	-
CO3	✓	✓	-	✓	-	-	-	-	-	✓	-	-	✓	✓	-
CO4	✓	✓	-	✓	-	-	-	-	-	✓	-	-	✓	✓	-
CO5	✓	✓	-	✓	-	-	-	-	-	✓	-	-	✓	✓	-

19BOTE205.2: Forest Technology **Credits:3**
Hours:3

Learning Objectives(LOs):

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

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. *Casuarina equisitifolia*
c. *Eucalyptus*
d. *Bomboosa sp*
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.

Practicals:-

Measurement of Tree diametre and girth-instruments - the foot rule, calliper, tape,dendrometers.

Methods of studying the form: - By comparison of standard form ratios (i) form factor

Wood preservatives: - oilborne, waterborne- non fixed water soluble type and fixed water soluble type.

Wedge prism - calculation of leaf area & canopy coverage.

Textbooks:

1. Shrivastava,M.B. 1998. Introduction to Forestry. South Asia Books; 1 edition, New Delhi
2. Sudhir,M. 2000.Applied biotechnology and plant genetics, Dominant Publishers, New Delhi
3. Vinod Kumar .1995.Nursery and Plantation practices in Forestry, Jodhpur. Scientific publishers

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.

Course Outcomes(COs):

On the successful completion of this course the students 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

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 1	PS 2	PS 3	PS 4	PS 5
CO1	✓	✓	-	-	-	-	-	✓	-	✓	✓	✓	✓	✓	-
CO2	✓	✓	-	-	-	-	-	✓	-	✓	✓	✓	✓	-	-
CO3	✓	✓	-	-	-	-	-	✓	-	✓	-	-	✓	-	✓
CO4	✓	✓	✓	-	✓	-	-	✓	-	✓	✓	✓	✓	-	-
CO5	✓	✓	✓	-	✓	-	-	✓	-	✓	-	-	✓	✓	✓

19BOTE306.1: Applied Botany **Credits:3**
Hours:3

Learning Objectives(LOs):

- To understand the Post harvest technology of fruits
- To study about the principles of seed storage
- To acquire knowledge on seed certification.

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.

Practicals:

1. Analysis of seed purity
2. Determination of seed moisture
3. Germination Test
4. Tetrazolium test for seed viability
5. Determination of seed vigour
6. Study of starch degradation during ripening of fruits
7. Effect of storage moisture on seed viability
8. Effect of storage temperature on seed viability

Textbooks:

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

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.

Course Outcomes(COs):

On the successful completion of this course the students 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

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 1	PS 2	PS 3	PS 4	PS 5
CO1	✓	✓	-	-	✓	✓	-	-	-	✓	✓	✓	✓	✓	-
CO2	✓	✓	-	-	✓	✓	-	-	-	✓	✓	✓	✓	-	-
CO3	✓	✓	-	-	✓	✓	-	-	-	✓	-	-	✓	-	✓
CO4	✓	✓	-	-	✓	✓	-	-	-	✓	✓	✓	✓	-	-
CO5	✓	✓	-	-	✓	✓	-	-	-	✓	-	-	✓	✓	✓

19BOTE306.2: Bioprospecting of Medicinal and Aromatic Plants **Credits:3 Hours:3**

Learning Objectives(LOs):

- To acquire knowledge on medicinal and aromatic plants
- To understand antioxidant metabolism
- To study about 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, ^{1}H NMR,^{13}C 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.

Textbooks:

1. Ananthanarayan, R. and C.K.J. Paniker. 1996. Text book of Microbiology. 5thEdn., Orient Longman Ltd., Chennai
2. Animal cell culture; A practical approach, 4th Edition by Wiley Publications.
3. Faroogi, A.A. and B.S.Sreeramu, 2004. Cultivation of medicinal and aromatic crops. Revised edition, Universities Press (India) Private Limited, Hyderabad.

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.

Course Outcomes(COs):

On the successful completion of this course the students 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

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 1	PS 2	PS 3	PS 4	PS 5
CO1	✓	✓	-	-	-	✓	-	-	-	✓	✓	✓	✓	-	-
CO2	✓	✓	-	-	-	✓	-	-	-	✓	-	-	✓	-	-
CO3	✓	✓	-	-	-	✓	-	-	-	✓	✓	✓	✓	-	✓
CO4	✓	✓	-	-	-	✓	-	-	-	✓	✓	✓	✓	-	-
CO5	✓	✓	-	-	-	✓	-	-	-	✓	-	-	✓	-	-

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