Annamalai University

(Accredited with 'A' Grade by NAAC)

M.Sc. Botany (Five- year) Programme

Regulations & Curriculum-2019

UGC-SAP and DST-FIST Assisted

Department of Botany

ANNAMALAI UNIVERSITY

REGULATIONS FOR THE FIVE YEAR INTEGRATED POST GRADUATE PROGRAMMES UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

These Regulations are common to all the students admitted to the Five Year Integrated Master's Programmes in the Faculties of Arts, Science, Languages, Marine Sciences, and Education 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 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 of 90 working 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 Experiential Learning is a process of learning through experience. It is specifically defined as "learning through reflection on doing".

1.15 Extension activities are the activities that provide a link between the University and the community such as lab-to-land, literacy, population education, and health awareness programmes. These are integrated within the curricula with a view to sensitise the students about Institutional Social Responsibility (ISR).

1.16 Credit refers to the quantum of course work in terms of the 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.

1.17 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.

1.18 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.

1.19 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.

1.20 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.

1.21 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.

1.22 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.

1.23 Cumulative Grade Point Average (CGPA) is a measure of the overall cumulative performance of a student in all the semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters.

1.24 Letter Grade i**s** an index of the performance of a student in a particular course. Grades are denoted by the letters S, A, B, C, D, E, and RA.

2. Programmes Offered and Eligibility Criteria

The Integrated Programmes offered by the University and the eligibility criteria are detailed below.

Faculty of Science	
M.Sc. Botany	A pass in H.S.E. (10+2 level) regular or vocational with Botany/Biology or Vocational course with Agriculture/Plant Protection as one of the courses.

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

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 Five Year Master's Programmes consist of five academic years and ten semesters.

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 Five Year Integrated Programme consists of Language Courses, Core Courses, Allied Courses, Elective Courses, Soft Skills, Experiential Learning and Project. Students shall also participate in Extension Activities as part of their curriculum.

5.2 Language Courses

5.2.1 Each student shall take two languages of four courses each, one in each semester for the first two years of the programme.

5.2.2 Language-I shall be Tamil or another language such as Hindi or French.

5.2.3 Language-II shall be English.

5.3 Core courses

5.3.1 These are a set of compulsory courses essential for each programme.

5.3.2 The core courses include both Theory (Core Theory) and Practical (Core Practical) courses.

5.4 Allied Courses

5.4.1 Each student shall take courses in two disciplines allied to the main subject (Allied-I and Allied-II) of the programme in the first four semesters.

5.4.2 In Arts, Languages, and Education, there will be three Theory Courses each for Allied-I and Allied-II.

5.4.3 In Science and Marine Sciences, there will be two Theory courses and one Practical course each for Allied-I and Allied-II.

5.5 Elective Courses

5.5.1 Departmental Electives (DEs) are the electives that students can choose from a range of Electives offered within the Parent Department offering the Programme.

5.5.2 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.

5.5.3 *Students shall take a combination of both DEs and IDEs.*

5.6 Soft Skills

5.6.1 Soft skills are intended to enable students to acquire attributes that enhance their performance and achieve their goals with complementing hard skills.

5.6.2 Soft skills include communication skills, computer skills, social skills, leadership traits, team work, development of emotional intelligence quotients, among others.

5.6.3 Each student shall choose four courses on soft skills from a range of courses offered from the First to the Sixth Semester.

5.7 Value Education

All students shall take a course on Value Education that includes human values, sustainable development, gender equity, ethics and human rights.

5.8 Experiential Learning

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

5.8.2 In-plant training/field trips/internships/industrial visits (as applicable) fall under this category.

5.9 Extension Activities

5.9.1 It is mandatory for every student to participate in extension activities.

5.9.2 All the students shall enrol under NSS/NCC/YRC/RRC or any other Service Organisation in the University.

5.9.3 Students shall put in a minimum attendance of 40 hours in a year duly certified by the Programme Co-ordinator.

5.9.4 Extension activities shall be conducted outside the class hours.

5.10 Project

5.10.1 Each student shall undertake a Project in the final semester.

5.10.2 The Head of the Department shall assign a Project Supervisor to the student.

5.10.3 The Project Supervisor shall assign a topic for the project and monitor the progress of the student periodically.

5.10.4 Students who wish to undertake project work in recognised institutions/industry shall obtain prior permission from the University. The Project Supervisor will be from the host institute, while the Co-Supervisor shall be a faculty in the parent department.

5.11 Value Added Courses (VACs)

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

5.11.2 VACs enhance the students' employability and life skills. VACs are listed on the University website and in the Handbook on Interdepartmental Electives and VACs.

5.11.3 Each VAC carries 2 credits with 30 hours of instruction, of which 60% (18 hours) shall be Theory and 40% (12 hours) Practical.

5.11.4 Classes for VACs are conducted beyond the regular class hours and preferably in the VIII and IX Semesters.

5.12 Online Courses

5.12.1 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.

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

5.12 Credit Distribution

The credit distribution is detailed in the Table.

	Credits
Semester I to VI	
Language-I (Tamil or any other Language)	12
Language-II (English)	12
Core Courses	60-65
Allied-I	10
Allied-II	10
Electives	15
Soft skills	12
Environmental studies (UGC mandated)	2
Value Education	2
Experiential learning	4
Extension activities	1
Total Credits (Semester I to VI)	**140-145**
Semester VII to X	
Core Courses	65-75
Electives	15
Project	6-8
Total Credits (Semester VII to X)	**90-95**
Total Credits Semester I to X (Minimum requirement for the award of Degree)	***230-240**

**Each Department shall fix the minimum required credits for award of the Degree within the prescribed range of 230-240 credits.*

5.13 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 students 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 should earn a minimum of 75% attendance in 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.

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 a 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 for 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 one 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 (ESEs)

8.5.1 The ESEs for the odd semester will be conducted in November and for the even semester in May.

8.5.2 A candidate who does not pass the examination in any course(s) will be permitted to reappear in such course(s) 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	5
Assignment	5
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 Double Evaluation for the ESE is done by the University Teachers.

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 Review of literature, 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 of the Head of the Department, Project Supervisor, and a senior faculty.

9.4.7 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 VACs shall be evaluated completely by Internal Examiners.

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 candidate 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 of 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

$$GPA = \frac{\sum_{I=1}^{n} C_i G_i}{\sum_{I=1}^{n} C_i}$$

where, C_C is the Credit earned for the Course C in any semester;

C_C is the Grade Point obtained by the student for the Course C and

C 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.

$$CGPA = \frac{\sum_{I=1}^{m} \sum_{I=1}^{n} C_i G_i}{\sum_{I=1}^{m} \sum_{I=1}^{n} C_i}$$

where, C_C is the Credit earned for the Course C in any semester;

C_C is the Grade Point obtained by the student for the Course C and

C is the number of Courses passed in that semester.

C 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 to 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 candidate 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 completed successfully, 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 student has re-appeared.

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 or more 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), 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 (for which the student has secured RA Grade) 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) in the subsequent semester.

12.7 Withdrawal shall not be taken into account as an appearance for the examination when considering the eligibility of the student 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 department library or computer resources, stealing other students' notes/assignments, 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 Five Year Integrated 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 (Five year) Programme

Programme Code: SBOT51

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							
19ITAC11	Language – I	3	-	3	25	75	100
19IENC12	Language - II	3	-	3	25	75	100
19ICEC13	Civics, Health Sciences & Environmental Awareness	3	-	3	25	75	100
19IBOT14	Microbiology and Plant Pathology	4	-	4	25	75	100
19IBOA15	Ancillary – I (Paper –I)	4	-	4	40	60	100
19IBOTE 16.1/16.2	Elective – I (DE)	3	-	3	25	75	100
	Total			20			
Semester -II							
19ITAC21	Language – I	3	-	3	25	75	100
19IENC22	Language - II	3	-	3	25	75	100
19ICAC23	Computer Applications – I	4	-	3	25	75	100
19IBOT24	Algae, Fungi and Lichens	4	-	4	25	75	100
19IBOP25	Practical - I (covering Microbiology, Plant Pathology, Algae, Fungi and Lichens)	-	6	5	40	60	100
19 IBOA26	Ancillary – I (Paper –II)	4	-	4	25	75	100
19IBOAP27	Ancillary Practical - I	-	6	3	40	60	100
	Total			25			
Semester – III							
19ITAC31	Language – I	3	-	3	25	75	100
19IENC32	Language - II	3	-	3	25	75	100
19IBOT33	Bryophytes and Pteridophytes	4	-	4	25	75	100
19IBOP34	Practical - II (covering Bryophytes and Pteridophytes)	-	6	5	25	75	100
19IBOA35	Ancillary – II (Paper –I)	4	-	4	40	60	100
19IBOTE 36.1/36.2	Elective – II (DE)	3	-	3			
	Total			22			
Semester-IV							
19ITAC41	Language – I	3	-	3	25	75	100
19IENC42	Language - II	3	-	3	25	75	100
19IBOT43	Gymnosperms and Palaeobotany	4	-	4	25	75	100
19IBOP44	Morphology of Angiosperms	5	-	5	25	75	100
19IBOP45	Practical – III (covering Gymnosperms and Palaeobotany and Morphology of Angiosperms)	-	6	5	40	60	100
19IBOA46	Ancillary – II (Paper-II)	4	-	4	25	75	100
19IBOAP47	Ancillary Practical - II	-	6	3	40	60	100
	Total			27			
Semester - V							
19IBOT51	Anatomy and Embryology of Angiosperms	5	-	5	25	75	100

19IBOT52	Taxonomy of Angiosperms, Economic Botany and Evolution	4	-	5	25	75	100
19IBOT53	Biological Techniques	4	-	5	25	75	100
19IBOP54	Practical – IV (covering Anatomy, Embryology of Angiosperms, Taxonomy of Angiosperms, Economic Botany, Evolution and Biological Techniques)	-	12	6	40	60	100
19IBOTE 55.1/55.2	Elective – III (DE)	3	-	3			
	Total			24			
Semester- VI							
19IBOT61	Cytology, Genetics and Plant Breeding	4	-	5	25	75	100
19IBOT62	Plant Physiology and Biochemistry	5	-	5	25	75	100
19IBOT63	Ecology and Biodiversity	5	-	5	25	75	100
19IBOT64	Molecular Biology, Genetic Engineering and Biotechnology	4	-	5	25	75	100
19IBOP65	Practical -V(covering Cytology, Genetics, Plant Breeding, Plant Physiology, Biochemistry, Ecology , Biodiversity, Molecular Biology, Genetic Engineering and Biotechnology)	-	12	6	40	60	100
	Total			26			
Semester- VII							
19IBOT71	Plant Diversity – I(Algae and Bryophytes)	4	-	4	25	75	100
19IBOT72	Fungi, Lichens and Plant Pathology	4	-	4	25	75	100
19IBOT73	Microbiology and Immunology	4	-	4	25	75	100
19IBOP74	Practical – VI (covering Plant Diversity – I, Fungi, Lichens, Plant Pathology, Microbiology and Immunology)	-	12	6	40	60	100
	Elective – IV (IDE)	3	-	3	25	75	100
	Total			21			
Semester - VIII							
19IBOT81	Plant Diversity - II (Pteridophytes, Gymnosperms and Palaeobotany)	4	-	4	25	75	100
19IBOT82	Anatomy, Embryology of Angiosperms and Morphogenesis	4	-	4	25	75	100
19IBOT83	Cell Biology, Genetics and Plant Breeding	4	-	4	25	75	100
19IBOP84	Practical – VII (covering Plant Diversity – II, Anatomy, Embryology of Angiosperms, Morphogenesis, Cell Biology, Genetics and Plant Breeding)	-	12	6	40	60	100
	Elective - V (IDE)	3	-	3	25	75	100
19IBOTE 85.1/ 85.2	Elective – VI (DE)	3	-	3	25	75	100
	Total			24			
Semester - IX							
19IBOT91	Taxonomy of Angiosperms and Economic Botany	3	-	4	25	75	100
19IBOT92	Biochemistry and Molecular Biology	4	-	4	25	75	100
19IBOT93	Biological Techniques and Research Methodology	4	-	4	25	75	100
19IBOT94	Plant Bio-technology and Genetic Engineering	4	-	4	25	75	100
19IBOP95	Practical –VIII (covering Taxonomy of Angiosperms, Economic Botany, Biochemistry , Molecular Biology, Biological Techniques,	-	12	6	40	60	100

	Research Methodology, Plant Bio-technology and Genetic Engineering)						
	Elective – VII (IDE)	3	-	3	25	75	100
19IBOTE 96.1/96.2	Elective – VIII (DE)	3	-	3	25	75	100
	Total			28			
Semester - X							
19IBOT101	Plant Physiology	4	-	4	25	75	100
19IBOT102	Environmental Biology and Evolution	4	-	4	25	75	100
19IBOP103	Practical – IX (covering Plant Physiology, Environmental Biology and Evolution)	-	12	6	25	75	100
19IBOTPJ 104	Project Work / In-Plant Training	-	10	6	25	75	100
	Total			20			
Total Credits		**237**					
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.

Department Electives (DE)

S. No.	Course Code	Course Title	Hours/ week		C	Marks		
			L	P		CIA	ESE	Total
1.	19IBOTE 16.1	Mushroom Cultivation	3	-	3	25	75	100
2.	19IBOTE 16.2	Herbal Science	3	-	3	25	75	100
3.	19IBOTE 36.1	Floriculture	3	-	3	25	75	100
4.	19IBOTE 36.2	Pomology	3	-	3	25	75	100
5.	19IBOTE 55.1	Bio-fertilizer	3	-	3	25	75	100
6.	19IBOTE 55.2	Micro Propagation	3	-	3	25	75	100
7.	19IBOTE 85.1	Herbarium Keeping	3	-	3	25	75	100
8.	19IBOTE 85.2	Forest Technology	3	-	3	25	75	100
9.	19IBOTE 96.1	Applied Botany	3	-	3	25	75	100
10.	19IBOTE 96.2	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 **19IBOT14: Microbiology and Plant Pathology** **Credits:4**
Hours:4

Learning Objectives(LOs):

- To acquire the knowledge on micro organisms
- To know about the plant pathogens

Unit – 1

Introduction to microbiology-Scopes of microbiology – The concept of microbial species – Significance of study of microorganisms – Classification of microorganisms - Five kingdom classification – Eight kingdom classification –Three domain classification.

Unit – 2

Methods in microbiology: Microbial cultures – Physical methods –Chemical methods and Biological methods. Microbial growth – Culture media – Characterization of a medium – Types of Media and Microscopy.

Unit – 3

Virus: Morphology of Virus, Classification of Virus, Transmission of Virus- Virus-vector relationships - Structure of TMV and Bacteria phage: Bacteriophage replication – Lytic and lysogenic cycles. General account on mycoplasma

Unit – 4

Bacteria: Outline of bacterial classification – Bergey's manual of determinative bacteriology. Ultrastructure- Gram positive and gram negative bacteria, flagellation, nutrition, cell division, reproduction and genetic recombination- transformation, transduction and Conjugation. Economic importance of bacteria.

Plant Pathology

Unit - 5

History of Plant Pathology – Methods of studying plant disease – Koch's postulates – Symptoms of Plant Disease – Symptoms Causative organisms and control of the following disease:- Tikka disease (Groundnut), Smuts (Sorghum), Citrus canker- Little leaf of Brinjal, Bunchy top of Banana, Principles of plant disease control.

Text Books:

1. Dubey, R.C and D.K.Maheswari.2015. A Textbook of Microbiology (6th Edition) –McGraw Hill College, Dimensi
2. Dasgupta, M.K.2004. Principles of Plant Pathology. Allied publishers Ltd., New Delhi
3. Sambamurthy A.V.S.S.2006. A Textbook of Plant Pathology.I.K. Internatl.Pvt.Ltd., New Delhi

Supplementary Reading:

1. Abigall, A, Salyers, Dixie D. Whitt 2013. Microbiology-Diversity, Disease and the Environment. Panima Distributors, Meerut.
2. Rangaswami, G.A.Mahadevan,2006. Diseases of Crop plants in India. Prentice Hall Pvt., Ltd., New Delhi
3. Singh, R.S. 2015. Plant Diseases, Oxford & IBH publishing Co.Pvt.Ltd., New Delhi

Course Outcomes (COs):

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

- CO1: Understand classification, characterization, structure of various Microorganisms
- CO2: Understand the culture methods of Microorganism
- CO3: Appreciate the genetic makeup of Microorganisms
- CO4: Comprehend the plant pathogens and control measures
- CO5: Analyze the nature of Plant disease and their symptoms

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 **19IBOT24: Algae, Fungi and Lichens** **Credits:4**
Hours:4

Learning Objectives(LOs):

- To gain knowledge on the structure, reproduction and life cycle of Algae, Fungi and Lichens

Algae

Unit – 1

Introduction**:** General characteristic features, classification in Algae (Fritsh-1942). Chlorophyceae, Phaeophyceae,, Rhodophyceae and Cyanophyceae. Thallus structure. Pigmentation. Reserve food material. Reproduction, Life cycle in Algae.

Unit – 2

Range of structure and reproduction of *Chlamydomonas, Volvox, Chlorella*, *Sargassum*, *Polysiponia*, *Oscilatoria* and *Anabaena*. Economic importance of algae.

Fungi

Unit - 3:

General characters of Fungi, Classification with Text/Reference to Alexopoulos and Mims – range of structure, reproduction, life history, Economic importance of fungi.
Myxomycetes - *Stemonitis*
Chytridiomycetes – *Synchytrium*

General characters- classification, life history in Oomycetes : *Albugo, Pythium*
Plasmodiophoromycetes : *Plasmodiophora* ; Zygomycetes : *Mucor.*

Unit - 4:

General characters- classification, life history - Ascomycetes : *Yeast, Penicillium, Peziza***.** Basidiomycetes: *Puccinia,Polyporus.*
Deuteromycetes: *Cercospora.*

Lichens:

Unit - 5:

Classification, structure, nutrition, reproduction and economic importance of Lichens:- *Parmelia, Usnea.* Ecological importance of Lichens.

Text Books:

1. Dube, H.C. 2018. A Textbook of Fungi, Bacteria and Viruses, Vikas Publishing Houses Pvt Ltd.
2. 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. Alexopoulos.C.J., C.W. Mims and M. Blackwell. 2007. Introductory Mycology. IV Edition. Wiley India (P) Ltd., Daryaganj, New Delhi.
2. Geeta Sumbali . 2005. The Fungi. Narosa Publishing House, New Delhi.
3. Sundararajan, S. 2005. Practical manual of algae, Anmol publications Pvt.Ltd.

Course Outcomes(COs):

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

CO1: Appreciate the comparative account of various algae
CO2: Understand the structure and reproduction of fungi
CO3: Comprehend the structure of lichens and their importance

CO4: Appreciate the economic importance of Algae, 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	✓	✓	✓	-	-	-	-	-	-	✓	✓	✓	-	-	-
	✓	✓	✓							✓	-	-	-	-	✓

Semester – II **19IBOP25: Practical - I (covering Microbiology ,Plant Pathology, Algae, Fungi and Lichens)** **Credits:5 Hours:6**

Learning Objectives(LOs):

- To know about the microbes
- To gain knowledge on Algae, Fungi and Lichen

Microbiology and Plant Pathology

1. To study the structure of compound and dissection microscope
2. Preparation of culture media for bacteria, fungi-sterilization procedures
3. Isolation of rhizophere, rhizoplane, phylloplane microorganisms
4. Isolation of pure culture from soil-serial dilution
5. Gram staining procedure
6. Verification of Koch's postulates
7. Identification of Plant diseases included in the theory syllabus

Algae

Chlamydomonas, Volvox, Chlorella, Sargassum, Polysiponia, Oscilatoria and *Anabaene*

Fungi

Stemonitis, Synchytrium , Albugo,Pythium, Plasmodiophora, Mucor, Yeast, Penicillium, Peziza, Puccinia,Polyporus, Cercospora

Lichens

Parmelia, Usnea.

Course Outcomes(COs):

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

CO1: Analyze the various microbes (virus and bacteria)

CO2: Analyze the algae, 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	✓	-	✓	-	✓	✓	-	-	-	-	✓	✓	✓	-	-

Semester – III **19IBOT33: Bryophytes and Pteridophytes** **Credits:4 Hours:4**

Learning Objectives(LOs):

- To acquire the knowledge on the structure of Bryophytes and Pteridophytes

Unit – 1 Bryophytes

Introduction, General characteristic features, classification (Watson's), origin and evolution and alternation of generation

Unit – 2

Life cycle, Structure and reproduction(Vegetative, Asexual and Sexual) of *Marchantia, Anthoceros, Porella* and *Funaria*

Unit – 3 Pteridophytes

Introduction, General characteristic features, classification (Reimer's 1954) and Stelar evolution in Pteridophytes

Unit – 4

Reproduction (Vegetative, Asexual and Sexual) Apogamy and Apospory, Heterospory and Seed habit

Unit – 5

Life cycle, Structure and reproduction of Fossil forms, *Rhynia* and *Astroxylon*, Living forms *Lycopodium, Equisetum, Adiantum and Marsilea*

Text Books:

1. Gilbert Smith.1976. Cryptogamic Botany-Volume I, Tata McGraw Hill Book Company Ltd, New Delhi.
2. Parihar, N.S. 2005. An Introduction to Embryophyta – Bryophyta, Central Book Depot, Allahabad.
3. Vashishta. B.R., A.K. Sinha and Adarsh Kumar. 2016. Botany for Degree students-Bryophyta. S. Chand and Company Ltd., New Delhi

Supplementary Reading:

1. Sporne, K.R.1975. The Morphology of Pteridophytes. Hutchinson University Library, London.
2. Watson. E.V. 2003. Structure and Life of Bryophytes – B.I Publications, New Delhi.

Course Outcomes(COs):

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

CO1: Comprehend the Morphology and Systematic positions of Bryophytes
CO2: Appreciate the Morphology and systematic positions of Pteridophytes
CO3: Understand the economic importance of Pteridophytes
CO4: Comprehend the heterospory and the evolution of seed

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 **19IBOP34: Practical – II (covering Bryophytes and Pteridophytes)** **Credits:5 Hours:6**

Learning Objectives(LOs):

- To gain knowledge on Bryophytes
- To know about the morphology of Pteridophytes.

Bryophytes:

Marchantia, Anthoceros, Porella and *Funaria*

Pteridophytes

Fossil Forms:

Rhynia and *Asteroxylon*

Living Forms:

Lycopodium, Equisetum, Adiantum and *Marsilea*

Course Outcomes(COs):

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

CO1: Identify the given Bryophytes
CO2: Identify the given Pteridophytes

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	✓	-	✓	-	✓	✓	-	-	-	-	✓	✓	✓	-	-

Semester – IV **19IBOT43: Gymnosperms and Palaeobotany** **Credits:4**
Hours:4

Learning Objectives(LOs):

- To acquire knowledge on the structure and reproduction of Gymnosperms.
- To know the types of fossils and the techniques used to study the fossils

Gymnosperms

Unit - 1

General Characters and Classification of Gymnosperms by K.R.Sporne. Economic importance. Structure, reproduction and life cycle of *Cycas*

Unit - 2

External morphology, Internal structure of root, stem and leaves of *Pinus*, Reproduction and Life Cycle of *Pinus*

Unit - 3

External morphology, Internal structure of root, stem and leaves of *Gnetum*, Reproduction and Life cycle of *Gnetum*

Palaeobotany

Unit - 4

General Account of Palaeobotany. Types of fossils, process of preservation, techniques of fossil study. Study of Pollen (Palynology) – Acetolysis.

Unit - 5

Geological time scale – Determination of geological age of fossil (Carbon dating). Knowledge, Conservation and exploration of fossil fuels

Text Books:

1. Bhatnagar S.P and Alok Moitra. 2003. Gymnosperms. New Age Internat.(P) ltd, New Delhi.
2. Biswas.C and B.M.Johri 1999. The Gymnosperms, Narosa Publishing House, Chennai.
3. Agashe, S.N. 1995. Palaeobotany, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.

Supplementary Reading:

1. Stewart, W.N. and Rothwell,G.W.2010. Palaeobotany and evolution of plants. 2nd Edition., Cambridge University Press, London.
2. Sporne, K.R. 2015. The Morphology of Gymnosperms, Hutchin, University Ltd. London.

Course Outcomes (COs)

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

CO1: Understand the knowledge on the structure and reproduction of Gymnosperms
CO2: Comprehend the economic importance of Gymnosperms
CO3: Comprehend the advanced characters of Gnetopsida
CO4: Understand the types of fossils and the techniques used for their study
CO5: Appreciate the fossil fuels and their conservations

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 **19IBOT44: Morphology of Angiosperms** **Credits:5 Hours:5**

Learning Objectives(LO):

- To acquire knowledge on the morphological features of angiosperms.

Unit – 1

Parts of Plant: Root – Characteristics of the root; Tap root and its modifications; Branched root modification – Pneumatophores; Adventitious root and its modification; Epiphytes, Velamen and Assimilatory roots.

The Stem – Characteristics of the Stem; Nodes, Internodes and Buds. Modifications of Stem – Aerial and Sub aerial modifications – Thorn, Phylloclade, Cladode and Bulbil.

Unit – 2

Leaf: Phyllotaxy; Parts and Types of Leaves; Stipules and their kinds; Margin, Surface and Shape of leaves; Venation; simple and compound leaves; Modification of leaves and Heterophylly.

Unit – 3

Inflorescence: Racemose and its types: Cymose and its types; Special types of Inflorescences.

Flower: Perianth; Position of floral leaves on the Thalamus. Bract and its kinds; Symmetry of the flower – Actinomorphy and Zygomorphy; Polypetalous and Gamopetalous flowers; Aestivation; Cohesion and Adhesion of stamens.

Gynoecium - Apocarpous and Syncarpous; Pistillode; Placentation; Structure and types of Ovule.

Unit – 4

Methods of pollination and process of fertilization, Double fertilization and Triple fusion - Development of Embryo: Dicot and Monocot embryos;

Seed - Albuminous and Exalbuminous seeds.

Germination – Epigeal and Hypogeal – Viviparous. Development of seedling.

Unit – 5

Fruit: Development of Fruit – Dehiscence of fruits;

Classification - Simple – Dry dehiscent and Dry indehiscent; Splitting of Schizocarpic fruits; Simple, fleshy and its types; Aggregate and Multiple fruits.

Dispersal of seeds and fruits.

Text Books:

1. Pandey, B.P. 2015. College Botany. S.Chand & Co., New Delhi
2. Vashistha, B.R. 1999. Botany. S.Chand & Co., New Delhi.
3. Lowson J.M and Birbal Sahni. 1960. Text Book of Botany, University tutorial Press Ltd, London.

Supplementary Reading:

1. James D. Mauseth.2013. Botany Methods- An Introduction to Plant Biology. Panima Book Agency, Bangalore.
2. Arther J. Eames. Morphology of Angiosperms. 2015. Tata McGraw Hill Publishing, London, U.K.

Course Outcomes(COs)

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

CO1: Understand the Morphology of the root, shoot and leaf of plants

CO2: Comprehend the inflorescence type of various angiospermous plants

CO3: Appreciate the pollination mechanism involved in angiosperms

CO4: Analyze the types of fruits in Angiosperms

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 **19IBOP45: Practical – III (covering Gymnosperms and Palaeobotany)** **Credits:5 Hours:6**

Learning Objectives(LOs):

- To know about the characteristic features of Gymnosperms
- To gain knowledge of fossils

Gymnosperms:

Identification and description of *Cycas, Pinus,* and *Gnetum*

Palaeobotany:

Study of fossil types such as Impression, compression, casts, molds and petrifications.

Course Outcomes(COs):

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

CO1: Identify the given gymnosperms

CO2: Analyze the type of plant fossil

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	✓	-	✓	-	✓	✓	-	-	-	-	✓	✓	✓	-	-

Semester – V **19IBOT51: Anatomy and Embryology of Angiosperms** **Credits:5 Hours:5**

Learning Objectives(LO):

- To understand the anatomy and Embryology of Angiosperms.

Anatomy

Unit – 1:

Tissue Types and their distribution: Parenchyma, Collenchyma, Sclerenchyma, Xylem and Phloem, Tissue system: meristematic and permanent, simple and complex tissues. Vascular bundles: types - open and closed- – concentric, collateral, bicollateral and radial. endarch, exarch and mesarch xylem.

Unit – 2:

Root system – Structure of primary root in monocotyledons and dicotyledons. Shoot system structure- primary shoot in monocotyledons and dicotyledons. Secondary growth in root and shoot – Anomalous secondary thickening – cortical bundles – medullary bundles.

Unit – 3:

General structure of wood; characteristics of growth rings. Leaf anatomy: Internal structure of a monocotyledons and dicotyledons leaves – Stomata and its types.

Embryology of Angiosperms:

Unit - 4:

Structure of anther and pistil – types of pollination – Microsporogenesis: Morphology, cytology, development and formation of male gametes – role of vegetative and generative nuclei – pollen wall ornamentation.

Unit - 5:

Megasporogenesis: Types and organization of the embryo sac – role of synergids and antipodal haustoria, nutrition of embryo sac – Double Fertilization –Triple fusion , Embryo development in dicot and monocots.

Text Books:

1. Arthur J. Eames and Lawrence. H., Mac Daniels. 2005. An Introduction to Plant Anatomy. Tata McGraw Hill Publishing Co.Ltd, New Delhi.
2. Pandey, S.N and A.Chadha.2005. Plant Anatomy and Embryology. Vikas publishing House Pvt Ltd., New Delhi.
3. Singh.V., P.C. Pande and D.K.Jain. 2005. Embryology of Angiosperms. Rastogi Publications. Meerut.

Supplementary Reading:

1. Bhojwani, S.S and Bhatnagar, S.P. 2015. Embryology of Angiosperms. Vikas Publication Pvt Ltd, New Delhi.
2. Fahn,A. 1990. Plant Anatomy. Pergamon press, Oxford, UK.

Course Outcomes(COs)

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

CO1: Comprehend the plant tissue types
CO2: Understand the anatomy of leaves and stomatal types
CO3: Comprehend the properties of wood
CO4: Understand the Microphorogenesis and Megasporogenesis
CO5: Appreciate the types of embryo 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	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	-
CO5	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	-	-

Semester – V **19IBOT52: Taxonomy of Angiosperms, Economic Botany and Evolution** **Credits: Hours:4**

Learning Objectives(LOs):

- To acquire the knowledge on the salient features, classification and the economic importance of angiosperms
- To find out the evolutionary concepts

Taxonomy of Angiosperms:

Unit – 1

Principles of Taxonomy, Taxonomy and its importance. Classification of Angiosperms- Artificial Classification - Bentham and Hooker, Phylogenetic classification- Engler and Prantl.

Taxonomic hierarchy, ICN, Principles of ICN, Naming of Taxa(genus and species), author citation. Type Concept

Herbarium - Preparation and uses, National and International Herbaria. Modern trends in Taxonomy – Cytotaxonomy, Biosystematics. Botanical Survey of India - Headquarters and Regional offices – current activities of BSI.

Unit – 2

A detailed study on the diagnostic features and the economic importance of the following families

Nymphaeaceae
Capparidaceae
Portulacaceae
Malvaceae
Rutaceae
Lythraceae

Unit - 3

Asteraceae
Solanaceae
Asclepiadaceae
Convolvulaceae
Bignoniaceae
Amaranthaceae
Commelinaceae
Zingiberaceae
Cannaceae
Poaceae

Economic Botany:

Unit - 4

Importance of Economic Botany. Brief account of Binomial, sources and uses of the following : Fruits and vegetables – Mango, Papaya, Guava and Banana – Brinjal, Raphanus and cabbage. Cereals, millets, pulses and nuts-Rice, wheat, ragi, red gram, black gram, and Cashew - Fibres and fibre yielding plants – Textile fibres – Surface fibres (cotton) – Soft or bast fibres (Jute) – Hard fibres (coir) - Spices and Condiments -roots (*Ferula asafoetida*) underground stem (*Allium cepa*), bark (*Cinnamomum zeylanicum*) Drugs – obtained from roots, underground stems, bark, stems, leaves, flowers, fruits, seeds and entire plants

Evolution:

Unit - 5

Origin of life - Operon concept of chemical evolution. Evolutionary theories of Lamark, Darwin, De Vries, Modern synthetic theory of evolution.

Text Books:

1. Dutta, S.C. 2003. Systematic Botany, New age International (P) Ltd Publication, New Delhi
2. Gurucharan Singh, 2017. Plant Systematics, Oxford & IBH Publishing company (P) Ltd, New Delhi
3. Pooja.2011. Economic Botany. Discovery Publishing House, New Delhi

Supplementary Reading:

1. Kochhar.2016. Economic Botany in the tropics. Macmillan publishers
2. Sivarajan, V.V. 1999. Principles of Taxonomy. Oxford and IBH Publications, New Delhi.

Course Outcomes(COs):

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

CO1: Understand the basic principles of systematics
CO2: Understand the plant nomenclature
CO3: Comprehend the specimen preparation for Herbarium
CO4: Appreciate the diagnostic features and the economic importance of various Angiosperms.

CO5: Understand the various concepts of origin and evolution of life

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 – V **19IBOT53: Biological Techniques** **Credits:5**
Hours:4

Learning Objectives(LO):

- To acquire the knowledge on various biological techniques

Unit – 1

Microscopy: Compound Microscope, Parts of Compound Microscope, Phase contrast microscopy, Electron Microscopy- TEM, SEM, Tissue preparation in light and electron microscopy, Fixatives, Staining – single and double staining. Micrometry: Camera Lucida, Ocular and Stage Micrometer. Microtomy: types, material preparation for Microtomes - fixatives, dehydration, infiltration, preparation of paraffin wax block.

Unit- 2

Calorimetry and Photometry – Beer- Lambers Law; Colorimeter and Spectrophotometer, Electromagnetic Spectrum, UV Spectroscopy, pH Meter, EC Meter.

Unit - 3

Chromatography: Principles and applications, mobile and stationery phase, Rf value, paper chromatography, TLC, HPLC and Ion-Exchange chromatography.

Unit - 4

Centrifugation: Principles and Applications, Types of Centrifuges, parts of centrifuges, Velocity gradient centrifugation, Differential centrifugation

Unit - 5

Electrophoresis: Principles and Applications. Separation of micro and macromolecules by Agarose Gel Electrophoresis, SDS –PAGE, Blotting techniques

Text Books:

1. Jayaraman, J. 1992. Techniques in Biology. Higgin Bothams Pvt Ltd, Chennai.
2. Krishnamurthy, K.V, 1988. Methods in Plant Histochemistry. Viswanathan printers and publishers, Chennai.
3. Marimuthu,R. 2010. Microscopy and Microtechnique, MJP publishers, Chennai
4. Wilson, K and John Walker. 2000. Principles and Techniques of practical Biochemistry, Cambridge University Press.

Supplementary Reading:

1. Albert Schneider.2012. Microscopy and Microtechnique. Rare book club.com, United States, New York.
2. John E.Sass. 2007. Elements of Botanical Microtechnique. Bente press, London, UK.
3. Michael J.Bykstra.1992. Biological Electron Microscopy. Springer-Verlag, New York.
4. Srivastava, M.S. 2008. Bio- analytical Techniques, Narosa Publishing House, New Delhi.

Course Outcomes(COs):

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

CO1: Understand the working principles of various Microscopes

CO2: Comprehend various chromatographic techniques and their working principles
CO3: Appreciate the centrifugation methods
CO4: Understand the various Electrophoretic 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 – V **19IBOP54: Practical – IV (covering Morphology of Angiosperms, Anatomy, Embryology of Angiosperms, Taxonomy of Angiosperms, Economic Botany, Evolution and Biological Techniques)** **Credits:6 Hours:12**

Learning Objectives(LOs):

- To find out the Morphology, anatomy and Taxonomy of angiosperms and the economic importance
- To study the embryology of angiosperms

Morphology of Angiosperms

1. Parts of a plant
2. Types of Root and their modifications
3. Types of Stem and their modifications
4. Types of Leaves and their modifications
5. Inflorescence and their types
6. Floral parts of monocots
7. Floral parts of dicots
8. Methods of Pollination and process of fertilization
9. Classification of fruits and their characteristic features
10. Seed structure in monocot and dicot plants
11. Mechanisms of Fruit and Seed dispersal
12. Seed Germination Methods

Anatomy:

1. Examination of Root and Shoot Apices; Maceration,
2. Study of simple tissues and complex tissues.
3. Study of cross section in monocot and dicot root.
4. Study of monocot and dicot stem
5. Study of monocot and dicot leaf.
6. Types of stomata and stomatal index.
7. Anomalous secondary thickening in *Bougainvillaea, Boerhaavia and Nyctanthes* stem.

Embryology

1. Dissection of pollinium from Calotropis
2. Dissection of embryo from Tridax and Cleome
3. Development of microsporangium, pollengrains and their variations,
4. Different types of ovary, ovules and placentation,
5. Female gametophyte – monosporic, bisporic and tetrasporic embryo sacs
6. Endosperms and their haustorial apparatus,
7. Dissection of Anther and angiosperm embryos.

Taxonomy of Angiosperms, Economic Botany and Evolution:

1. Detailed study of the families mentioned in the theory with representative species from the local area.
2. Familiarity of the binomial nomenclature of the available species from the local flora using Gamble flora.
3. Identification of family, genus, species and morphology of the useful parts of plants mentioned in the theory.
4. Darwin, Lamarck, Anatomical evidence of Evolution

Biological techniques

1. Principles, identification and components of Light , Polarizing , TEM and SEM
2. Measurement of stomatal index using micrometry
3. Fixing , Embedding and Sectioning with microtome
4. Single and Double stained slide preparation with hand and microtome sections
5. Measurement of soil pH
6. Measurement of electrical conductivity
7. Separation of biological compounds using paper and TLC chromatography
8. Electrophoresis separation of proteins by SDS-PAGE

Course Outcomes (COs):

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

CO1: Identify the given plant family
CO2: Identify the given plant material of economic importance
CO3: Analyze the technique involved permanent slide preparation
CO4: Understand evolutionary concepts

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 – VI **19IBOT61: Cytology, Genetics and Plant Breeding** **Credits:5 Hours:4**

Learning Objectives(LOs):

- To acquire knowledge on the structure of cell and cell organelles
- To develop skill on genetics and Plant breeding

Unit – 1

Structure of cells: Prokaryotic cell – Bacterial cell and Blue green algae. Eucaryotic cell – Ultra structure of plant cell. Mitochondria – Ultra structure and functions. Plastids – Types, Ultra structure of chloroplast functions. Ribosomes – types, Ultra structure and functions. Structure and functions of Endoplasmic reticulum, Golgi apparatus and Lysosomes. Nucleus – Ultra structure, nuclear membrane and functions. Nucleolus – Fine structure and functions.

Types of cell division – Amitosis, Mitosis and Meiosis – Karyokinesis and Cytokinesis – Significance of mitosis and meiosis.

Unit – 2

Chromosomes – structure – types of chromosomes, Karyotype – Idiogram. Special types of chromosomes – Polytene and Lampbrush chromosomes. Structural changes of chromosomes – deficiency – duplication – translocation and inversion. Numerical changes of chromosomes – aneuploids and euploids. Polyploids – auto and allo polyploids

Unit – 3

Mendelian genetics – Introduction, Mendel's laws. Monohybrid cross, Dihybrid cross, Test cross, Back cross. Non-Mendalian Genetics- Introduction, Incomplete dominance and

Interaction of genes, Multiple alleles, Quantitative inheritance, linkage and crossing over, significance of crossing over, sex determination.

Unit – 4

Construction of chromosome map in *Drosophila*. Three point cross. Mutations – Spontaneous and Induced mutations, Molecular basis of gene mutations, Point and Frame shift mutations.

Plant Breeding

Unit – 5

Objectives of Plant breeding, Breeding methods: Methods of Plant breeding in self and cross pollinated crops. Hybrid vigour and hybridization. Breeding for special purposes- Breeding for diseases & pest resistance – breeding for quality- breeding for hybrid varieties.

Text Books:

1) Rastogi, S.C. 2016. Cell Biology. New Age International Publication, New Delhi.
2) Chaudhari,H.K. 1984. Elementary Principles of Plant Breeding. Oxford IBH, New Delhi.
3) Sambamurthy, A.V.S.S. 2006. Genetics. Narosa Publishing House, New Delhi

Supplementary Reading:

1. Gupta,P.K. 2003. Cytogenetics. Rastogi Publications, New Delhi.
2. Singh,B.D. 2001. Plant Breeding, Principles and Methods. Kalyani Publications, New Delhi
3. Vijendra Das, L.D. 2005. Genetics and Plant Breeding. New Age International (P) Ltd.,New Delhi.

Course Outcomes(COs):

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

CO1: Understand the general features of cell and cell organelles.
CO2: Comprehend the structure of Chromosomes and their types
CO3: Understand the basic principles of Mendelian genetics
CO4: Understand the effect of mutation on Plant development
CO5: Appreciate the technique involved in 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 – VI **19IBOT62: Plant Physiology and Biochemistry** **Credits:5**
Hours:5

Learning Objectives(LO):

- To acquire knowledge on Physiology and Biochemistry of plants

Plant physiology

Unit - 1

Importance of water to plant life – physical properties of water: diffusion, osmosis, absorption, transport of water and transpiration – physiology of stomata.

Absorption and translocation of minerals. Mineral nutrients – micro and macro nutrients and their role.

Unit - 2

Photosynthesis: Structure of Chloroplast, Mechanism of light absorption, photo-phosphorylation: Photosynthetic electron transport (cyclic and non-cyclic) Carbon metabolism: C_3,C_4 and CAM pathways and their distinguishing features.

Unit - 3

Respiration: Aerobic and anaerobic - Glycolysis, Kreb's cycle and electron transport system, factors affecting respiration, photo-respiration and its significance.

Unit - 4

Nitrogen metabolism, Biological Nitrogen fixation and Nitrogen cycle. Plant growth and development: Growth regulators: Auxins , Gibberellins, Cytokinins and Ethylene and their influence on plant growth.

Photoperiodism, Vernalization and Senescence.

Biochemistry:

Unit - 5

Structure, classification and properties of carbohydrates, lipids, proteins and Nucleic acids. Enzymes – properties, nomenclature and classification. Co-enzymes and co-factors. Mechanism of enzyme action.

Text Books:

1. Jain, V.K. 2017. Fundamentals of Plant Physiology, S.Chand & Company Ltd., New Delhi
2. Srivastava, H.S. and N.Shankar. 2013. Plant Physiology and Biochemistry. Rastogi publications.
3. Verma, S.K. 2018. A Text book of Plant Physiology, S.Chand & Co., New Delhi.

Supplementary Reading:

1. Hopkins,W.G. 1999.Introduction to Plant Physiology, John Wiley & Sons Inc., New York
2. Moore, T.C. 1994. Biochemistry and Physiology of Plant Hormones (second edition). Springer –Verlag, New York, USA.
3. Salisbury and Ross. 2007. Plant Physiology. Wordsworth Publishing co., Belimont, USA.

Course Outcomes(COs):

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

CO1: Understand the importance of water in the functioning plants
CO2: Comprehend the process of Photosynthesis
CO3: Understand the plant respiration mechanism and its types
CO4: Appreciate the knowledge of Plant nitrogen Metabolism
CO5: Understand the structure, classification and properties of Carbohydrates, lipids and proteins

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 – VI **19IBOT63: Ecology and Biodiversity** **Credits:5**
Hours:5

Learning Objectives:

- To acquire knowledge on the basic concepts of Ecology
- To know about Biodiversity and its conservation

Ecology

Unit – 1

Ecology – Introduction –Scope and Importance. Ecological Factors: Climatic, Edaphtic, and Biotic factors. The Environment –Atmosphere, Lithosphere, Hydrosphere and Biosphere.

Structure and functions of ecosystems – Producer, Consumer and Decomposer. Energy flow– Food chain, Food web, Trophic level and Ecological pyramids. Types of ecosystems. Terrestrial (Forest, Desert and Grassland) and Aquatic (Freshwater, Marine) Biogeochemical cycle: Hydrological, Gaseous and Sedimentary cycle.

Unit – 2

Natural resources – Forest, water, mineral, food, energy and land –conservation of natural resources.

Methods of studying vegetation- qualitative and quantitative characters. Quadrats:- types – Ecological succession: types, processes, causes, Theories of succession. Hydrosere and Xerosere. Ecological Indicators.

Unit – 3

Pollution – causes, effects and control of: Air, Water, Soil, Thermal, Noise and Radioactive pollution. Climate change: Global warming, Acid rain, Ozone layer depletion. Disaster management- Floods, earth quake, Cyclone, Tsunami and land slide.

Biodiversity

Unit – 4

Introduction – Definition – Genetic, species and ecosystem diversity – Values of biodiversity – biodiversity at global, national and local level. India as mega diversity nation – causes for loss of biodiversity – conservation of biodiversity (*In situ* and *Ex situ*) – Hot spots of biodiversity – Endangered and Endemic species of India

Unit – 5

Principles of Phytogeography –Vegetational types of India – Endemism – Age and area hypothesis – Altitudinal and latitudinal distribution of vegetation-continuous and discontinuous distribution of vegetation - Application of Remote sensing to ecological studies.

Text Books:

1. Ambasht. R.S. 1998. A Text book of Plant Ecology. Students & Friends Publications, Varnasi.
2. Sharma.P.D. 2017. Ecology and Environment. 13th edition, Rastogi Publishers, Meerut.
3. Asthana D.K and Meera Asthana. 2016. A Text book of Environmental Studies. S. Chand& Company, New Delhi.

Supplementary Reading:

1. Dash.M.C. 2007. Fundamentals of Ecology. Tata McGraw Hill Publishing Company Pvt. Ltd, New Delhi.
2. Joshi PC and Namita Joshi. 2004. Biodiversity and Conservation. APH Publishing Corporation, 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 basic and applied aspects of Environmental Biology
CO2: Understand the various types of pollution and its control measures
CO3: Comprehend the principles of biodiversity 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	✓	✓	✓	✓	✓	-	-	✓	✓	✓	✓	✓	✓	✓	✓

Semester – VI **19IBOT64: Molecular Biology, Genetic Engineering and Biotechnology** **Credits:5 Hours:4**

Learning Objectives(LOs):

- To study the basic concept of Molecular Biology
- To gain knowledge on applications of Genetic Engineering

Molecular Biology

Unit – 1

Nuclic Acid – structure and properties (Physical, chemical,spectroscopic and thermal), DNA types (A,B,C and Z), Watson and Crick model of DNA. DNA synthesis and replication, DNA Polymerase , Methylation of DNA, damage and repair of DNA , RNA synthesis- type, RNA polymerase role, transcription- initiation, elongation, termination, post transcriptional changes in RNA.

Unit - 2

Genetic code – Types of codons, Translation ribosomes assembly, formation of initiation complex, initiation factors, elongation and termination, Wobbel hypothesis, translational proof reading, translation inhibitors, post- translational modification of proteins, general principles of gene regulation, gene regulation in prokaryotes, Operon concepts, Lac Operon, positive and negative control, catabolite respiration- Gene silencing

Genetic Engineering

Unit - 3

Basic principles: Restriction endonucleases – method of gene transfer-Electrophoration – microinjection –plasmid and cosmids, phagemits. cDNA libraries, Southern and Northern plotting techniques

Unit – 4

Genetic Engineering of nif genes in non-leguminous plants- marker gene, enzymes, Organization and integration, Fungicidal and herbicidal resistance markers - biocontrol method of pest and disease. Transgenic plants (Bt-cotton, Bt- tomato and golden rice)

Biotechnology

Unit – 5

History of Plant tissue culture – Laboratory organization – Nutrient medium composition – Nutreint medium – MS and B5. Principles of tissue culture – Totipotency- Explant – Inoculation- incubation – Callus formation – Redifferntiation – Hardening- Meristem culture – Protoplast isolation, purification, fusion, somatic hybridization. Synthetic seeds – Applications of Plant Tissue Culture.

Text Books:

1. Allison.A. 2007. Fundamental Molecular Biology. Blackwell Publishing, UK.
2. Dubey,R.C.2008. A text book of Biotechnology. S.Chand publishers, Meerut.
3. Ignachimuthu, S.1997. Biotechnology: An Introduction-2nd Edition, Panima Book Distributors. Narosa Publishing House, New Delhi.
4. Sambamurthy A.V.S.S.; 2008; Molecular Biology; Narosa Publishers- New Delhi

Supplementary Reading:

1. Freifelder, 2000. Molecular Biology, Narosa Publishing House, New Delhi.
2. Lindsey. 2007. Plant Tissue Culture. Springer (India) Pvt. Ltd., New Delhi
3. William. J.Thieman, Michael A.Palladino. 2012. Introduction to Biotechnology. Benjamin Cummings publishers.

Course Outcomes(COs):

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

CO1: Understand the molecular mechanisms of gene and protein expression
CO2: Appreciate the gene manipulations in plants
CO3: Comprehend transgenic plants and their uses
CO4: Understand the principles of tissue culture and its uses

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 – VI **19IBOT65: Practical – V (covering covering Cytology, Genetics, Plant Breeding, Plant Physiology, Biochemistry, Ecology , Biodiversity, Molecular Biology, Genetic Engineering and Biotechnology)** **Credits:6 Hours:12**

Learning Objectives(LOs):

- To study the basic principles of Cell Biology
- To know the plant physiology and biochemistry
- To study the ecological principles

Practicals

Cell Biology

1. Learning and perfecting squash and smear techniques.
2. Study of cell division: Mitosis – *Allium cepa, Rhoeo.*
3. Meiosis – *Allium cepa, Helianthus*.
4. Preparation of Idiogram.
5. Study of special types of chromosomes

Genetics and Plant Breeding

Monohybrid cross and test cross, Dihybrid cross and test cross, Incomplete dominance, Gene interaction, Quantitative inheritance, Sex – Linked Inheritance, Chromosome map. Emasculation – Cross pollination, Hybridization Techniques

Plant Physiology and Biochemistry

1. Determination of osmotic potential by plasmolytic method.
2. Effect of monochromatic light on apparent photosynthesis
3. Separation of chloroplast pigments using paper chromatographic technique
4. Estimation of chlorophyll content using Arnon's method
5. Rice coleoptile straight growth test for Indole acetic acid.
6. Estimation of Protein content
7. Estimation of Reducing sugar content
8. Estimation of Starch content
9. Estimation of Lipid content
10. Estimation of α- amylase and β- amylase

Ecology and Biodiversity:

1. Identification of plants in Botanical Garden
2. Determination of Abundance of a particular species in a given area.
3. Determination of frequency of a particular species in a given area.
4. Determination of density of a particular species in a given area.
5. Determination of the biomass of a particular area.
6. Determination of the biotic components of pond ecosystem.
7. Determination of the biotic components of Grassland ecosystem.
8. Ecological adaptations of plants:

Hydrophytes: *Hydrilla, Eicchornia, Nymphaea*
Xerophytes: *Nerium, Casuarina, Opuntia*

9. Special mode of Nutrition (adaptation)
   (i) Symbiosis : Root nodules of blackgram
   (ii) Mycorrhiza: Root of *Pinus*
   (iii) Epiphyte: *Vanda*
   (iv) Insectivorus : *Nepenthes*
   (v) Parasitic Plant : *Cuscuta*
10. Determination of soil properties (pH, EC, moisture content, temperature, soil texture)

Molecular Biology, Genetic Engineering and Biotechnology:

1. Isolation of DNA from tender coconut
2. Separation of plant genomic DNA by electrophoresis
3. Quality checking of DNA by Electrophoresis
4. Southern blotting (Demonstration)
5. Western blot - detection of proteins (Demonstration)
6. Explaining the process of making Transgenic crops (Bt cotton, Bt Brinjal, Golden rice and Milk products)
7. Sterilisation of Explants
8. Preparation of Media
9. Callus, Embryo and Shoot tip culture
10. Artificial seeds and method of protection (synthetic seed)
11. Isolation of Protoplast by Enzymatic method

Course Outcomes (COs):

On the successful completion of this course the students will be able to
CO1: Understand cell and cell organelles
CO2: Analyze the principles of genetics and plant breeding
CO3: Understand the principles of plant physiology and biochemistry
CO4: Understand the techniques involved in genetic engineering and biotechnology
CO5: Comprehend the basic plant breeding 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	✓	-	✓	-	✓	✓	-	-	-	-	✓	✓	✓	-	-
CO5	✓	-	✓	-	✓	✓	-	-	-	-	✓	✓	✓	-	-

Semester - VII **19IBOT71: Plant Diversity – I (Algae and Bryophytes)** **Credits:4 Hours:4**

Learning Objectives(LOs):

- 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 Outcome (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
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 - VII **19IBOT72: 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- use 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 – VII **19IBOT73: 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 – VII **19IBOP 74: 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 – VIII **19IBOT81: Plant Diversity – II (Pteridophytes, Gymnosperms and Palaeobotany)** **Credits:4 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 - VIII **19IBOT82: Anatomy, Embryology of Angiosperms and Morphogenesis** **Credits:4 Hours:4**

Learning Objectives:

- 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 - VIII 19IBOT83: 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 - VIII **19IBOP 84: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

1. Different stages of anther, embryo sac, endosperm and embryo development
2. Pollen germination and viability test
3. Dissection of embryo – *Tridax, Crotalaria* and *Cleome*
4. Endosperm and endosperm haustoria – Cucurbitaceae members

Morphogenesis

1. Wounding of young stem and study of the wound healing response
2. Effect of removal of leaf primordium and auxiliary 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 - IX **19IBOT91:Taxonomy of Angiosperms and Economic Botany** **Credits:3 Hours:4**

Learning Objectives(LO):

- 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. Taxonomy 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 - IX **IBOT92: Biochemistry and Molecular Biology** **Credits:4 Hours:4**

Learning Objectives(LO):

- 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 - IX **19IBOT93: Biological Techniques and Research Methodology** **Credits:4 Hours:4**

Learning Objectives:

- 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 - IX **19IBOT94: 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 - IX **19IBOP 95: 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 - X **19IBOT101: Plant Physiology** **Credits:4**
Hours:4

Learning Objectives(LO):

- 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 - X **19IBOT102: Environmental Biology and Evolution** **Credits:4**
Hours:4

Learning Objectives:

- 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 **19IBOP 103: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

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

Soil analysis

1. Estimation of EC,pH
2. Soil moisture content
3. 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)

19IBOTE 16.1: Mushroom Cultivation **Credits:3**

Hours:3

Learning Objectives(LOs):

- To introduce the potential of Mushroom as the dietary supplement
- To introduce the cultivation techniques, problems faced and management of mushroom cultivation including harvesting and processing

Unit – 1 Introduction

Historical perspectives; classification of mushrooms, nutritional and dietary values of musrooms, edible and poisonous mushrooms

Unit – 2 Compost and Composting

Principles of Composting, Machinery required for compost making, material for compost preparation. Methods of Composting – Long method of composting (LMC) & Short Method of Composting (SMC).

Unit – 3 Spaen and Spawning

Facilities required for spawn preparation. Preparation of spawn substrate, preparation of pure culture, media used in raising pure culture, culture maintenance, storage of spawn.

Unit – 4 Cultivation Techniques for Selected Mushrooms

Cultivation techniques for commercially viable mushrooms- Paddy straw mushroom, Button mushroom – Spawning substrate preparation, growth, packing and maintenance of suitable environmental conditions. Factors influencing mushroom cultivation and harvesting. Mushroom delights.

Unit – 5 Pests Management during Mushroom Cultivation

Diseases and competitor moulds of mushrooms and their management. Dry bubble disease – Verticillium fungicola, Wet bubble disease – Mysogone perniciosia , cobweb – Clasdobotrylum dendroides and Green mould- *Trichoderma* sp. Flies and mites

Text Books:

1) Chang ST and Miles PG. 2002. Edible Mushroom and their Cultivation. CRC Press. Florida

2) Kannaiyan and K. Ramasamy. 1980. A handbook of edible mushroom. Today and Tomorrow printers and publishers, New Delhi
3) Pathak Yadav Gour.2010. Mushroom production and processing Technology. Agrobios, India

Supplementary Reading:

1) Singh,M., B. Vijay and S. Kamal., and G.C.Wakchaure. 2011. Mushrooms; Cultivation, Marketting and Consumption. Directorate of Mushroom Research, Indian Council of Agricultural Research, Salem, India
2) Muruc Kumar. 2014. Mushroom cultivation. Neha publishers and Distributors
3) Kannainan, S., T.Marimuthu and K.Lenin. 2011. Diversity and Production of Edible Mushrooms. Associated publishing company.

Course Outcomes (COs):

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

CO1: Appreciate the Principle involved in Mushroom Cultivation
CO2: Comprehend the knowledge on edible and poisonous mushroom
CO3: Understand the cultivation methods of Mushroom
CO4: Appreciate the knowledge on pest and disease control methods of mushroom

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	✓	✓	✓	-	-	-	✓	✓	-	-	✓	✓	✓	✓	✓

19IBOTE 16.2: Herbal Science

Credits:3
Hours:3

Learning Objectives(LOs):

- ✓ To study the Medicinal plants and its importance
- ✓ To find out the methods of cultivation and marketing of medicinal plants

Unit – 1 Morphology of Angiosperms

Root- Structure and function and root modifications – stem structure and modifications –Leaf structure and its modifications – structure and functions – modifications of leaf. Inflorescence types- floral parts – floral formula and floral diagram. Fruit- structure and classification.

Unit – 2 Internal structure of Plant

Angiosperms anatomy – Tissue system- basic internal anatomical fatures of monocot and dicot root, stem, bark and leaf, fruit and seed anatomy –structure of wood- types of wood secretary cells – type, Lacticifers – germs- mucilage – resin

Unit – 3

Study of the following families – giving importance to morphological features and medicinal importance

Rutaceae, Meliaceae, Rubiaceae, Asteraceae, Aselepiadaceae, Apocynaceae, Lamiaceae, Euphorbiaceae, Liliaceae and Zilngiperaceae

Unit - 4 Production technology of Medicinal crops

Cultivates variables – propagation methods and planting density – manuring – irrigation – weed control –crop protection –harvest maturity- harvest and post harvest handling methods- storage and processing – yield trend and cost /benefit analysis of *Gymnema*, pelliwinkle, Senna, Aloe, Ashwagandha and Brahmi

Unit – 5 Marketing Herbal Products

Herbal Marketing –Concept and definition – Marketting of folk and traditional medicine and raw material- herbal marketing techniques – quality control – market structure, model and price determination – Herbal Market Identification- closed marketing system and multilevel marketing (MLM) – Scope of contract farming in herbal production- Government inter reunion in herbal marketing- organizations for research and development – training needs for herbal farmers

Textbook :

1. James A.J and Mac. Daniels, L.H. 1972. Introduciton to Plant Anatomy. Tata McGraw Hill, New Delhi
2. Sharma R. 2004. Agrotechniques of Medicinal plants. Daya publishing House, New Delhi
3. Gureharan singh.2010. Plant systematic. Science publishers, Enfiled, NH, USA

Supplementary Reading:

1. Acharya, S.S and N.K. Akarwal. 2000. Agricultural Marketing in India. Oxford and IBH Publishing Ltd., New Delhi
2. Atal C.K., and B. M. Kapur. 1982. Cultivation and Utilization of Medicinal Plants, Regional Research Laboratory (CSIR), Jammu Tawi.
3. Kader Moideen, M. Arumugam, Shakila and A.anburani. 2006. Production technology of Medicinal and aromatic crops. Rasi printers, Chidambaram

Course Outcomes (COs):

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

CO1: Understand the role of Biotechnology in Fruit culture
CO2: Appreciate the cultivation of fruit trees
CO3: Comprehend the health benefits of various fruits
CO4: Appreciate the post harvest methods of fruits
CO5: Comprehend the knowledge on fruit processing industries

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	✓	✓	✓	-	-	✓	✓	✓	-	✓	✓	✓	✓	-	✓

19IBOTE 36.1: Floriculture **Credits:3**
Hours:3

Learning Objectives(LOs):

- To acquire knowledge on the flowers and their uses
- To understand the different cultivation practices of flower crops
- To apply the knowledge on post harvest technology of ornamental flowers

Unit – 1

Present scenario and scope of floriculture in global market. Employment avenues in floriculture sector. Study of outdoor room concept: public area, private area and service area. Different features of gardens like gate, walls, arches, pergolas, paths, roads, edges, hedges, stepping stones, sun dial, bird bath, statues, water fountain, lawns, herbaceous borders, bonsai, topiary etc.

Unit – 2

Concept of CAD (Computer aided designs) for landscape designs. Methods of establishing lawns and their management including irrigation, fertilization, mowing, insect-pest and diseases and their control. Production of indoor plants and their maintenance.

Unit - 3

Commercial cultivation of rose, chrysanthemum, gladiolus, marigold, tuberose, jasmine and crossandra. Protected cultivation of commercial flower crops like rose, carnation, chrysanthemum, gerbera, orchids, antirrhinum etc). Flower arrangements: types and styles.

Unit – 4

Methods of dry flower making like air drying, embedded drying, water drying, press drying, glycerin drying, freeze drying etc. and other value added products

Unit – 5

Post-harvest handling of commercial flower crops including harvesting, pre cooling, pulsing, holding, dry and wet storage, packing, packaging and transportation.

Textbooks:

1. Randhawa G. S., and Mukhopadhyay A., (2007). Floriculture in India. Allied Publishers Pvt. Ltd., New Delhi
2. Arora J. S., (1998). Introductory Ornamental Horticulture. Kalyani Publishers Pvt. Ltd., W. Bengal

Supplementary Reading:

1. Bose, T.K. (2012). Floriculture and Landscaping. Allied Publishers Private Limited, New Delhi.
2. Bhattacharjee S. K., (2004). Landscape gardening and design with plants. Pointer Publishers Pvt. Ltd., Jaipur.
3. Hartman H. T., and Kester D. E., (2002). Plant propagation: principles and practices. Prentice Hall, Inc. Kate Kinsella.
4. Bhattacharjee S. K. and L.C. De, (2005). Post-harvest technology of flowers and ornamental plants. Pointer Publisher Pvt. Ltd., Jaipur.

Course Outcomes (COs):

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

CO1: Comprehend cultivation methods and ornamental flower crops
CO2: Appreciate the knowledge on post harvest technology flowers
CO3: Understand the process of cultivation of indoor 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	✓	✓	✓	-	-	✓	✓	-	-	-	✓	✓	✓	✓	✓

19IBOTE 36.1: Pomology **Credits:3**
Hours:3

Learning Objectives(LOs):

- To acquire knowledge in the fruits and its uses
- To understand the different cultivation of fruit crops
- To apply the knowledge on post harvest technology of fruits

Unit - 1

Importance of fruit culture (economic preposition, health benefits etc.) Setting up of industry based on the fruits present position and scope of fruit processing and equipments required for setting up a processing unit. Cultivation of tropical fruits (mango, banana, papaya, sapota, pineapple etc.).

Unit - 2

Cultivation of sub–tropical fruits (pomeranate, litchi, citrus, grapes, ber, aonpla etc.) their Cultivation of temperature fruits (apple, pear, plum, Alume, Peach, apricot, walnut, almond) cultivation practices with special reference to origin, varieties (cultivars, climate, soil,

land preparation, planting, manuring, irrigation, harvesting, ripening of fruits, grading, packaging, marketing) control of insect pest and diseases. Cultivation of temperate of fruits (apple, pear, plum, peach, apricot, walnut, almond).

Unit – 3

Root stocks of different fruit crops, their propagation, nursery management. Management of rootstocks and mother stocks. Fertigation in fruit crops

Unit - 4

Role of biotechnology and micro–propagation of importance fruits crops. Orchard rejuvenation, head back and high density planting in fruits.

Unit - 5

Maturity standards, harvesting, ripening, grading of fruits etc. Mechanized harvesting of fruits. Packing, storage and value addition and value added products from fruits.Pesticide use, safety of operators and consumers, concept of minimum residue limit in fruits crops

Text Books:

1. Chattopadhyay, T.K. (2003). A textbook on Pomology. Volume 1. Kalyani Publishers, Ludhiana.

Supplementary Reading:

1. Bose, T.K., Mitra, S.K. and Sanyal, D. (2001). Fruits: Tropical and Subtropical (Vol. 1). Noya Udyog, Kolkata-6.
2. Chadha, K.L.(1991). Advances in Horticulture. Malhotra Publishing House, New Delhi, India.
3. Sharma, R.R. and Srivastav, M. (2004). Plant propagation and nursery management. Intl Book Distributing Co., Lucknow
4. Verma, L.R. and Joshi, V.K. (2000). Post harvest technology of fruits and vegetables. Indus Publishing Co., New Delhi.

Course Outcomes (COs):

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

CO1: Understand the role of Biotechnology in Fruit culture
CO2: Appreciate the cultivation of fruit trees
CO3: Comprehend the health benefits of various fruits
CO4: Appreciate the post harvest methods of fruits
CO5: Comprehend the knowledge on fruit processing industries

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	✓	✓	✓	-	-	✓	✓	✓	-	✓	✓	✓	✓	-	✓

19IBOTE 55.1: Biofertilizers

Credits:3
Hours:3

Learning Objectives(LOs):

- ✓ To gain knowledge on the various Biofertilizers

Unit – 1

Biofertilizers – Definition and types , importance of biofertilizers in agriculture

Unit – 2

Characteristics of biofertilizers- Rhizopium, Azotobactor, Azospirillum, Phosphate solubilizing microorganisms, Cyanobacteria, Azolla, Mycorrhizae

Unit – 3

Symbosis: Physiology, biochemistry and molecular genetics of symbiosis – Enzyme and their regulation, nitroganase, hydrogenase

Unit –4

Production technology: Strain selection, sterilization, growth and fermentation, mass production of various biofertilizers.

Unit –5

Application technology: standards and quality control, application for field and tree crops, nursery plants and seedlings. Application method for different biofertilizers.

Text Books:

1) Rangaswamy and Bagyaraj. Agricultural Microbiology. Prentice Hall India
2) Subbasrao, N.S. Biofertilizers in Agriculture

Supplementary Reading:

1. Tilak., K.V.B.R., K.K. Pal and Rin Ku Dey. Microbes for sustainable Agriculture.
2. Alex Ander, M. Introduction to Soil Microbiology
3. Subbarao, N.S. Soil Microorganism and Plant growth

Course Outcomes (COs):

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

CO1: Understand the importance of Biofertilizers
CO2: Appreciate the production technology of Biofertilizers
CO3: Comprehend the steps involved in Biofertilizer poduction

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	✓	✓	-	-	-	✓	✓	-	-	-	-	-	✓	✓	✓

19IBOTE 55.2: Micropropagation **Credits:3**
Hours:3

Learning Objectives (LOs):

- ✓ To gain knowledge on the various microprobagation methods of plants

Unit – 1

Vegetative propagation – Techniques of propagation by cuttings, grafting, budding and layering. Propagation by specialized stems and roots- Bulbs, Corms, Tubers, Rhizomes and Psudobulbs.

Unit – 2

Micropropagation in plants – Types of Micropropagation – Material and Advantages of Micropropagation – Methods and Applications of Micropropagation – General laboratory Facilitiesand Procedures – Disadvantages of Micro propagation.

Unit – 3

Techniques of Invitro culture for Micropropagation procedures – Establishment and stabilization- shoot multiplication – Root formation – Acclimation to greenhouse conditions.

Unit – 4

Plant Micropropagation – Herbaceous ornamentals – Forage and grain legumes and vine crops – woody legumes- Forest species – Explants used in Tissue culture – Protoplasts of Tree cultivars – Vitrification.

Unit – 5

Organ microculture – somatic embryogenesis in plants – techniques for Anther culture – Isolated pollen culture – Protoplast culture – Plant growth regulators role in micropropagation – infection of Host tissue – Host-nematode Interactions strategies using in vito systems for disease – resistance

Text Books:

1) Hudson, T. Hartmann, Dale E. Kester, Fred T. Davies, Jr. Robert L. Geneve.1997. Plant propagation. Principles and Practices. Pretice Hall of India Pvt Ltd., New Delhi
2) Purohit .2005. Plant Tissue Culture. Student Edition, Jodhpur- India

Supplementary Reading:

1. Narayanasamy,S. 1994. Plant Cell and Tissue Culture. Tata McGraw-Hill publishing Company limited, New Delhi
2. George,E.F and P.D. Sherrington.1984. Plant Propagation by tissue culture. Exegetics Ltd., UK
3. Lydiane kyte, John kleyn, Holly scoghins and Mark bridges. 2013. Plants from test tubes- An introduction to Micropropagation. Timber press Inc., China

Course Outcomes (COs):

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

CO1: Appreciate the knowledge on various vegetative propagation methods of plants
CO2: Understand the microprobagation methods of plants
CO3: Comprehend the Microprobagation methods of ornamental plants
CO4: Appreciate the various organ culture methods of 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	✓	✓	-	-	-	✓	✓	-	-	-	-	-	✓	✓	✓

19IBOTE 85.1: 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.

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	✓	✓	-	✓	-	-	-	-	-	✓	-	-	✓	✓	-

19IBOTE 85.2: 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 foresty, 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.

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	✓	✓	✓	-	✓	-	-	✓	-	✓	-	-	✓	✓	✓

19IBOTE96.1: 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.

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	✓	✓	-	-	✓	✓	-	-	-	✓	-	-	✓	✓	✓

19IBOTE 96.2: 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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