ST. ALBERT'S COLLEGE (AUTONOMOUS), ERNAKULAM

Affiliated to Mahatma Gandhi University, Kottayam, Kerala

SYLLABUS FOR UNDERGRADUATE PROGRAMME

BACHELOR OFSCIENCE IN BOTANY

UNDER CHOICE BASED CREDIT SYSTEM

(WITH EFFECT FROM 2019 ADMISSION)

Syllabus of B.Sc. Botany

Proposed by the Board of Studies on 26th February 2019

Dr. J. Jameson

Chairman, Board of Studies

Approved by the Academic Council on 28th February 2019

Dr. M.L Joseph, Principal

Chairman, Academic Council.

Adopted by the Governing Council on 4th May 2019

Fr. Antony Arackal

Chairman, Governing Council

Board of Studies

No.	Name	Designation
1	Dr. J. Jameson	Chairman, HOD and Associate Professor, St. Albert's College, Ernakulam.
2	Dr. Siju M. Varghese	Assistant Professor, Member Secretary, St. Albert's College, Ernakulam.
3	Dr. K. Madhusudhanan	Assistant Professor, St. Albert's College, Ernakulam
4	Smt . Drishya K. Reghuvaran	Assistant Professor, St. Albert's College, Ernakulam
5	Smt. Mary Joseph	Assistant Professor, St. Albert's College, Ernakulam
6	Dr. Anna Ancy Antony A	Assistant Professor, St. Albert's College, Ernakulam
7	Dr. Anisha S.	Assistant Professor, St. Albert's College, Ernakulam.
8	Dr Siril E.A.	Assistant Professor, Dept. of Botany, Kerala University.
9	Dr. Jose Puthoor	Associate Professor, Dept. of Botany, Calicut University.
10	Dr. Jomy Augustine	HoD and Associate Professor, St Thomas College, Pala.
11	Sri. Jose P.	Corporate Sector (Garden & Nursery)
12	Dr. Stephen Sequeira	Assistant Professor, Maharaja's College, Ernakulam
13	Dr. Vinoth Thomas	Scientist, Rubber Board of India, Kottayam
14	Mr. Nikesh R	Agricultural Assistant, Neriamangalam, Kerala
15	Dr. Krishnakumar KS	Assistant Professor, St. Albert's College, Ernakulam.

16	Dr. Bijoy VM	Assistant Professor, St. Albert's College, Ernakulam.

Acknowledgement

Established in 1947, the Department of Botany, St. Albert's College, Ernakulam, has been preparing knowledge seekers in Botany for the past 72 years. In 2016 as the College was granted academic autonomy by the University Grant's Commission, the Department has also been vested with the power of framing the curriculum to cater to the needs of students in Botany. With this aspect in mind, the Board of Studies in Botany - UG hereby proposes the new curriculum and syllabi for the students of 2019 admission to satisfy the local, regional, national and global requirement of the subject. We wish to acknowledge most gratefully the helpful criticisms, comments and suggestions received from the Teachers, Friends, Botanists and Educationists who have helped during the preparation of the syllabus.

In conclusion, we place on record our greatest gratitude to our Chairman, Principal and all the associating staff of the College and every member of the Board of Studies in UG Botany who were sincerely involved in the preparation and finalization of this syllabus.

BoS Botany - UG (2018-21)

"Live as if you were to die tomorrow. Learn as if you were to live forever."

--Mahatma Gandhi

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FOR TRUTH AND SERVICE

Preface

As envisaged in the recent regulations of Autonomous colleges in India by University Grants Commission, autonomous colleges enjoy the academic freedom to enrich the curriculum by incorporating recent trends and needs. Curriculum and syllabus of each academic program has to be revised periodically to impart major objectives like global competency, skill component, values and regional relevance. Academicians and scholars in the respective area of knowledge have to express a missionary zeal for this great purpose.

In 2016, when St. Albert's College was granted autonomy, we adopted the curriculum and syllabus followed by the Mahatma Gandhi University, Kottayam for the year 2016. In 2017, when the Mahatma Gandhi University made a comprehensive revision of their curriculum and syllabus, it was adopted by the college as it was a better curriculum that met the needs and current demands of the culture, the society, and the expectations of the population being served. However the Syllabus revision committee of the department studied the present curriculum in detail and proposed some reasonable changes for further enrichment which may be implemented from 2019 admission onwards.

Programme Outcomes

- At the completion of the UG programme, the student will be able to accomplish the following outcomes:
- Critical Thinking: Take an informed and analytical approach to learning and demonstrate in-depth factual and functional knowledge of the subject and give opinion(s) supported by logical reasoning that one has judged to be appropriate and understanding various approaches and using them.
- Effective Communication: Demonstrate proficiency in communicating competently in groups and organizations, competence in interpersonal communication; knowledge dissemination, possess skills to effectively deliver formal and informal presentations to a variety of audiences in multiple contexts
- Self-directed and Life-long Learning: Acquire the skill to be an independent lifelong learner embracing real-time changes in the socio-technological context, promoting continuous development and improvement of the knowledge and skills needed for employment and personal fulfillment.
- Environment and Sustainability: Discern the issues of environmental contexts and engage in promoting values and attitudes that claim coexistence and sustainable living with reduced, minimal, or no harm upon ecosystems.

Programme Specific Outcomes

- Identify the different groups of botany and appreciate plant diversity, habitat, heredity and various life processes. Exposure to the current developments in the different areas of botany and apply suitable methodologies and techniques learnt during the course of studying botany.
- Integrate the knowledge acquired in botany to solve problems, take appropriate decision making and innovate while working with plants.
- Share social and environmental consciousness with their fellow citizens and act as a responsible citizen for social changes, environmental protection and conservation.
- To foster entrepreneurial skills and capacity building of individuals and teams for taking up business opportunities in fields related to botany and deliver relevant applications of knowledge dissemination through effective written, verbal, graphical/ virtual communication and interact productively with people from various walks of life.

Regulations

1. TITLE

1.1 These regulations shall be called "ST.ALBERT'S COLLEGE (AUTONOMOUS), ERNAKULAM - REGULATIONS FOR UNDERGRADUATE PROGRAMMES UNDER CHOICE BASED CREDIT SYSTEM 2019"

2. SCOPE

2.1 Applicable to all regular B.A./ B.Sc. /B.Com /B.BA courses conducted by the College with effect from 2019 admissions.

2.2 Medium of instruction is English except in the case of language courses other than English unless otherwise stated therein.

2.3 The provisions supersede all the existing regulations for the Regular Undergraduate programmes to the extent herein prescribed.

3. DEFINITIONS

3.1. 'Academic Week' is a unit of five working days in which the distribution of work is organized from day-one to day-five, with five contact hours of one-hour duration on each day.

3.2. 'Choice Based Course' means a course that enables the students to familiarize themselves with the advanced areas of core course.

3.3. 'Common Course I' means a course that comes under the category of courses for English.

3.4. 'Common Course II' means additional language.

3.5. 'Complementary Course' means a course which would enrich the study of core courses.

3.6. 'Core Course' means a course in the subject of specialization within a degree programme. It includes a course on environmental studies and human rights.

3.7. 'Course' means a portion of a subject to be taught and evaluated in a semester (similar to a paper under annual scheme).

3.8. 'Credit' is the numerical value assigned to a paper according to its relative importance in the syllabus of the programme.

3.9. 'Department' means any teaching department in a college.

3.10. 'Examination Coordinator' is a teacher nominated by a Department Council to coordinate the continuous evaluation undertaken in that department.

3.11. 'Department Council' means the body of all teachers of a department in a college.

3.12. 'Class Tutor' means a teacher from the department nominated by the Department Council, who will advise the student on academic matters.

3.13. Grace Marks shall be awarded to candidates as per the Orders issued from the college from time to time, at par with the affiliating University.

3.14. 'Grade' means a letter (A, B, C, etc.), which indicates the broad level of performance of a student in a Paper/Course/ Semester/Programme.

3.15. 'Grade Point' (GP) is the numerical indicator of the percentage of marks awarded to a student in a course.

3.16. 'Institutional Average (IA)' means average mark secured (Internal + external) for a course at the college level.

3.17. 'Open Course' means an optional course which the student is free to take at his/her will. Open course shall be a non-major elective course offered by the Departments other than the parent Department.

3.18. 'Parent Department' means the department which offers core course/courses within an undergraduate programme.

3.19. 'Programme' means a three-year programme of study and examinations spread over six semesters, the successful completion of which would lead to the award of a degree.

3.20. 'Semester' means a term consisting of a minimum 90 working days, inclusive of tutorials, examination days and other academic activities within a period of five months.

3.21. 'Vocational Course' (Skill Enhancement Course) means a course that enables the students to enhance their practical skills and ability to pursue a vocation in their subject of specialization.

3.22. Words and expressions used and not defined in this regulation shall have the same meaning assigned to them in the Act and Statutes of the affiliating University.

4. ELIGIBILITY FOR ADMISSION AND RESERVATION OF SEATS

4.1. Eligibility for admissions and reservation of seats for various Undergraduate Programmes shall be according to the rules framed by the College in this regard, from time to time.

5. DURATION

5.1. The duration of U.G. programmes shall be 6 semesters.

5.2. There shall be two Semesters in an academic year, the "ODD" semester commences in June and on completion, the "EVEN" Semester commences. There shall be two months' vacation during April/May.

6. REGISTRATION

6.1. The strength of students for each programme shall be as per the existing orders issued by the college and as approved by the affiliating University.

7. SCHEME AND SYLLABUS

7.1. The U.G. programmes shall include (a) Common Courses I and II, (b) Core Course(s), (c) Complementary/Vocational Courses, and (d) Open Course.

7.2. There shall be one Choice Based course (Elective Course) in the sixth semester. In the case of B.Com Programme there shall be an elective stream from third semester onwards.

7.3. Credit Transfer and Accumulation system can be adopted in the programme. Transfer of Credit consists of acknowledging, recognizing and accepting credits by an institution for programmes or courses completed at another institution. The Credit Transfer Scheme shall allow students pursuing a programme in one University to continue their education in another University without break.

7.4. A separate minimum of 30% marks each for internal and external (for both theory and practical) and aggregate minimum of 35% are required for a pass for a course. The practical examinations (external/internal) will be conducted only at the end of each semester for all programmes.

7.5. Students who complete the programme with minimum "D" grade will have one betterment chance within 12 months, immediately after the publication of the result of the whole programme. In such cases they should appear for all the papers in a particular semester.

8. PROGRAMME STRUCTURE

Model I B.A/B.Sc

a	Programme Duration	6 Semesters
b	Total Credits required for successful completion of the Programme	120
c	Credits required from Common Course I	22
d	Credits required from Common Course II	16

e	Credits required from Core course and Complementary courses including Project	79
f	Open Course	3
g	Minimum attendance required	75%

Model 1 B.Com

a	Programme Duration	6 Semesters
b	Total Credits required for successful completion of the Programme	120
c	Credits required from Common Course I	14
d	Credits required from Common Course II	08
e	Credits required from Core course and Complementary courses including Project	95
f	Open Course	3
g	Minimum attendance required	75%

Model II B.A/B.Sc

a	Programme Duration	6 Semesters
b	Total Credits required for successful completion of the Programme	120
c	Credits required from Common Course I	16
d	Credits required from Common Course II	8
e	Credits required from Core + Complementary + Vocational Courses including Project	93
f	Open Course	3
g	Minimum attendance required	75%

Model III BA/BSc/B.Com

a	Programme Duration	6 Semesters
b	Total Credits required for successful completion of the Programme	120

c	Credits required from Common Course I	8
d	Credits required from Core + Complementary + Vocational Courses including Project	109
e	Minimum attendance required	75%

9. EXAMINATION

9.1. The evaluation of each paper shall contain two parts:

- Internal or In-Semester Assessment(ISA)
- External or End-Semester Assessment(ESA)

9.2 The internal to external assessment ratio shall be1:4.

Both internal and external marks are to be rounded to the next integer.

For all papers (theory and practical), grades are given on a 7-point scale based on the total percentage of marks, *(ISA+ESA)* as given below:

Percentage of Marks	Grade	Grade Point
95 and above	S Outstanding	10
85 to below 95	A^+ Excellent	9
75 to below 85	A Very Good	8
65 to below 75	B^+ Good	7
55 to below 65	B Above Average	6
45 to below 55	C Satisfactory	5
35 to below 45	D Pass	4
Below 35	F Failure	0
	Ab Absent	0

10. CREDIT POINT AND CREDIT POINT AVERAGE

Credit Point (CP) of a paper is calculated using the formula:

CP = C × GP, where C is the Credit and GP is the Grade point.

Semester Grade Point Average (SGPA) of a Semester is calculated using the formula:

SGPA = TCP/TC, where TCP is the Total Credit Point of that semester.

Cumulative Grade Point Average (CGPA) is calculated using the formula:

CGPA = TCP/TC, where TCP is the Total Credit Point of that programme.

Grade Point Average (GPA) of different category of courses viz. Common Course I,

Common Course II, Complementary Course I, Complementary Course II, Vocational course, Core Course is calculated using the formula:

GPA = TCP/TC, where TCP is the Total Credit Point of a category of course.

TC is the total credit of that category of the course.

Grades for the different courses, semesters and overall programme are given based on the corresponding CPA as shown below:

GPA	Grade	
9.5 and above	S	Outstanding
8.5 to below 9.5	A+	Excellent
7.5 to below 8.5	A	Very Good
6.5 to below 7.5	B+	Good
5.5 to below 6.5	B	Above Average
4.5 to below 5.5	C	Satisfactory
3.5 to below 4.5	D	Pass
Below 3.5	F	Failure

11. MARKS DISTRIBUTION FOR EXTERNAL AND INTERNAL EVALUATIONS

The external theory examination of all semesters shall be conducted by the college at the end of each semester. Internal evaluation is to be done by continuous assessment. For all courses without practical total marks of external examination is 80 and total marks of internal evaluation is 20. Marks distribution for external and internal assessments and the components for internal evaluation with their marks are shown below.

11.1. For all courses without practical

Marks of external Examination : 80

Marks of internal evaluation : 20

Components of Internal Evaluation of theory	Marks
Attendance	5
Assignment /Seminar/Viva	5
Test papers (2x5=10)	10
Total	20

For all courses with practical total marks for external evaluation is 60 and total marks for internal evaluation is 15.

11.2. For all courses with practical

Marks of external Examination : 60

Marks of internal evaluation : 15

Components of Internal Evaluation	Marks
Attendance	5
Assignment /Seminar/Viva	2
Test papers (2 x 4)	8
Total	15

For practical examinations, total marks for external evaluation is 40 and for internal evaluation is 10.

Components Internal evaluation of Practical	**Marks**
Attendance	2
Test paper (1 x 4)	4
Record*	4
Total	10

**Marks awarded for Record should be related to number of experiments recorded and duly signed by the teacher concerned in charge.*

All three components of internal assessments are mandatory.

11.3. For projects

Marks of external evaluation : 80

Marks of internal evaluation : 20

Components of External Evaluation of Project	Marks
Dissertation (External)	50

Viva-Voce (External)	30
Total	80

**Marks for dissertation may include study tour report if proposed in the syllabus.*

Components of internal Evaluation of Project	Marks
Punctuality	5
Experimentation/data collection	5
Knowledge	5
Report	5
Total	20

Attendance Evaluation for all papers

Percentage of attendance	Marks
90 and above	5
85 – 89	4
80-84	3
76-79	2
75	1

(Decimals are to be rounded to the next higher whole number)

12. ASSIGNMENTS

Assignments are to be done from 1st to 4th Semesters. At least two assignments should be done in each semester for all courses.

13. SEMINAR/VIVA

A student shall present a seminar in every semester for each paper and appear for Viva-voce in the 6th semester for each course.

14. INTERNAL ASSESSMENT / TESTPAPERS

At-least two test papers are to be conducted in each semester for each course.

15. Grievances regarding internal evaluation

There is provision for grievance redressal regarding internal evaluation which operates at four levels. Complaints regarding the internal evaluation shall be brought to the notice of the teacher concerned in the first instance. If the student is not satisfied with the decision of the teacher concerned, he may appeal to the Departmental Grievance Redressal Committee which shall have the Head of the department, the class Tutor and the teacher against whom the complaint is made, as members. The student will also have the freedom to make further appeal to the College Level Grievance Redressal Committee which shall have the Principal, the COE and the concerned Head of the department, as members. If the student is not satisfied, he may appeal to the Governing Council.

15.1. The COE shall make arrangements for giving awareness of the internal evaluation components to students immediately after commencement of semester I.

15.2. The internal evaluation marks/grades in the prescribed format should reach the office of Controller of Examinations, St. Albert's College before the commencement of study leave in each semester.

15.3. Students can register for end semester examination only if they pass internal evaluation.

16. EXTERNAL EXAMINATION (END SEMESTER EXAMINATION)

The external examination of all semesters shall be conducted by the College at the end of each semester.

16.1 Only students having a minimum of 75% average attendance for all the courses can register for the examination. Condonation of shortage of attendance to a maximum of 10 days in a semester, subject to a maximum of 2 times during the whole period of the programme, may be granted by the college on valid grounds. This condonation shall not be counted for internal assessment. Benefit of attendance may be granted to students attending University/College union/Co-curricular activities by treating them as present for the days of absence, on production of participation/attendance certificates, within one week, from concerned authorities and endorsed by the Head of the Department. This is limited to a maximum of 10 days per semester and this benefit shall be considered for internal assessment also. Those students who are not eligible even with condonation of shortage of attendance will not be readmitted.

16.2 All students are to do a project in the area of core course. This project can be done individually or in groups (not more than five students) for all subjects which may be carried out in or outside the campus. The projects are to be identified during the II semester of the programme with the help of the

supervising teacher. The report of the project in duplicate is to be submitted to the department at the sixth semester and are to be produced before the examiners appointed by the college. External Project evaluation and Viva / Presentation are compulsory for all subjects and will be conducted at the end of the programme.

16.3 There shall be supplementary exams only for fifth semester. For reappearance or improvement for other semesters the students can appear along with the next batch.

16.4 A student who registers his/her name for the external exam for a semester will be eligible for promotion to the next semester.

16.5 All courses shall have a unique alphanumeric code.

17. PATTERN OF QUESTIONS

Questions shall be set to assess knowledge acquired, standard and application of knowledge, application of knowledge in new situations, critical evaluation of knowledge and the ability to synthesize knowledge. The question setter shall ensure that questions covering all skills are set. She/he shall also upload a detailed scheme of answer type, short essay type /problem solving type and long essay type questions and to be generated from the question bank. A question paper shall be a judicious mix of short answer type, short essay type/problem solving type and long essay type questions and to be generated from the question bank.

17.1 Pattern of Questions Papers

17.1.1 Without practical

Sl. No	Pattern	Marks	Choice of questions	Total marks
1	Short Answer/problem type	2	10/12	20
2	Short essay/problem	5	6/9	30
3	Essay/problem	15	2/4	30
Total				80

17.1.2 With practical

Sl. No	Pattern	Marks	Choice of questions	Total marks

1	Short Answer/problem type	1	10/12	10
2	Short essay/ problem	5	6/9	30
3	Essay/problem	10	2/4	20
Total				60

Each Board of Studies shall specify the length of the answers in terms of number of words. Pattern of questions for external examination of practical papers will be decided by the concerned Board of Studies/Expert Committees.

18. MARK CUM GRADE CARD

The College, under its seal, shall issue to the students a MARK CUM GRADE CARD on completion of each programme, which shall contain the following information:

a. Name of the College

b. Title and Model of the Undergraduate Programme

c. Name of the Semester

d. Name and Register Number of the student

e. Date of publication of result

f. Code, Title, Credits and Maximum Marks (Internal, External and Total) of each course opted in the semester.

g. Internal, External and Total Marks awarded, Grade, Grade point and Credit point in each course opted in the semester.

h. The total credits and total credit points in the semester.

i. Semester Grade Point Average (SGPA) and corresponding Grade.

j. Cumulative Grade Point Average (CGPA), GPA corresponding to Common Courses I and II, Core Course, Complementary Courses, Vocational Courses and Open Course.

k. The final Mark cum Grade Card issued at the end of the final semester shall contain the details of all courses taken during the final semester examination and shall include the final Grade(SGPA) scored by the candidate from 1st to 5th semesters, and the overall Grade for the total programme.

19. RANK CERTIFICATE

The college publishes rank list of top 10 candidates for each programme after the publication of 6th semester results. Rank certificate shall be issued to candidates

who secure positions from 1st to 3rd in the rank list. Candidates who secure positions from fourth to tenth in the rank list shall be issued position certificate indicating their position in the rank list. Candidates shall be ranked in the order of merit based on the CGPA scored by them. Grace marks awarded to the students should not be counted fixing the rank/position. Rank certificate and position certificate shall be signed by the Controller of Examinations.

20. There shall be 3 level monitoring committees for the successful conduct of the scheme. They are -

20.1. Department Level Monitoring Committee (DLMC), comprising HOD and two senior most teachers as members.

20.2. College Level Monitoring Committee (CLMC), comprising Principal, Controller of Examinations and A.O/Superintendent as members.

20.3. Governing Council.

21. TRANSITORY PROVISION

Notwithstanding anything contained in these regulations, the Governing Council shall, for a period of one year from the date of coming into force of these regulations, have the power to provide by order that these regulations shall be applied to any programme with such modifications as may be necessary.

22. The Governing Council is authorized to make necessary criteria for eligibility for higher education in the grading scheme, if necessary, in consultation with affiliating University and other Universities. The Governing Council is also authorized to issue orders for the perfect realization of the Regulations.

Annexure I: Model Mark Cum Grade Card

St. Albert's College (Autonomous)

Ernakulam-682 018, Kerala, India.

Accredited by National Assessment and Accreditation Council (NAAC)at A Grade

ISO 9001: 2015 Certified

Affiliated to Mahatma Gandhi University, Kottayam, Kerala

GRADE CARD

NAME OF THE CANDIDATE	
PERMANENT REGISTER NUMBER (PRN):	
DEGREE	
PROGRAMME	
STREAM	
NAME OF THE EXAMINATION	
DATE OF ISSUE	

Student Photo

COURSE CODE	COURSE TITLE	CREDITS	MARKS						GRADE	GP	CGP	RESULT
			INTERNAL		EXTERNAL		TOTAL					
			AWARDED	MAXIMUM	AWARDED	MAXIMUM	AWARDED	MAXIMUM				
Common Course - I												
Common Course - II												
Core Course												
Complimentary Course												
TOTAL												
SEMESTER RESULT		SCPA :							SG :			

Controller of Examinations **Principal**

Annexure II: Model Mark Cum Grade Card

St. Albert's College (Autonomous)

Ernakulam- 682 018, Kerala, India.

Accredited by National Assessment and Accreditation Council (NAAC)at A Grade

ISO 9001: 2015 Certified

Affiliated to Mahatma Gandhi University, Kottayam, Kerala

CONSOLIDATED MARK CUM GRADE CARD

NAME OF THE CANDIDATE	
PERMANENT REGISTER NUMBER (PRN)	
DEGREE	
PROGRAMME	
STREAM	
DATE OF BIRTH	
DATE OF ELIGIBILITY	

Student Photo

SEMESTER RESULTS

SEMESTER	MARKS AWARDED	MAXIMUM MARKS	CREDITS	SCPA	GRADE	MONTH AND YEAR OF PASSING	RESULT
SEMESTER 1							
SEMESTER 2							
SEMESTER 3							
SEMESTER 4							
SEMESTER 5							
SEMESTER 6							
TOTAL							

PROGRAMME PART RESULTS

PROGRAMME PART	MARKS AWARDED	MAXIMUM MARKS	CREDIT POINTS	CREDITS	CCPA	GRADE
COMMON COURSE I:						
CORE COURSE:						
COMPLEMENTARY COURSE:						
OPEN COURSE:						

TOTAL						

FINAL RESULT			
CREDITS	CCPA	GRADE	RESULT

COURSE CODE	COURSE TITLE	CREDITS	MARKS										
			INTERNAL		EXTERNAL		TOTAL						
			AWARDED	MAXIMUM	AWARDED	MAXIMUM	AWARDED	MAXIMUM	GP	GRADE		IA	RESULT
SEMESTER 1													
Common Course - I													
Core Course													
Complementary Course													
SEMESTER RESULT					SCPA:				SG:				
SEMESTER 2													
Common Course - I													
Core Course													
Complementary Course													
SEMESTER RESULT					SCPA:				SG:				
SEMESTER 3													

Common Course - I												
Core Course												
Complementary Course												
SEMESTER RESULT						SCPA:						SG :
SEMESTER 4												
Common Course - I												
Core Course												
Complementary Course												
SEMESTER RESULT						SCPA:						SG:
SEMESTER 5												
Core Course												
Open Course												
SEMESTER RESULT						SCPA:						SG:
SEMESTER 6												
Core Course												
Project												
Choice Based Core Course												

SEMESTER RESULT							SCPA:					SG:

Controller of Examinations **Principal**

Annexure III: Reverse side of the mark cum Grade Card (Common to all Semesters)

DESCRIPTION OF EVALUATION PROCESS

Grade and Grade point

The evaluation of each course comprises Internal and External components with the ratiol:4 for all courses. Grade and grade points are given on 7-point scale based on the percentage of marks (internal + external) as given in table-I.

Decimals are corrected to next higher whole number

Table -1

% of Marks	Grade	Grade Point
95 and above	S — Outstanding	10
85 to below 95	A+ Excellent	9
75 to below 85	A — Very Good	8
65 to below 75	Good	7
55 to below 65	B — Above Average	6
45 to below 55	C — Satisfactory	5
35 to below 45	D- Pass	4
Below 35	F Failure	
	Ab Absent	

Credit Point and Credit Point Average

Credit Point (CP) of a course is calculated using the formula: — CP = C x GP, where C is the Credit and GP is the Grade point

Semester Credit Point Average (SCPA) or Cumulative Grade Point Average (CCPA) for a programme is calculated using the formula:- SCPA or CCPA = TCP/TC, where TCP is the Total Credit Point of that semester or programme , TC = Total Credit

GPA	Grade
9.5 and above	S — Outstanding
8.5 to below 9.5	A+ Excellent
7.5 to below 8.5	A Very Good
6.5 to below 7.5	B+ — Good
5.5 to below 6.5	B — Above Average
4.5 to below 5.5	C Satisfactory
3.5 to below 4.5	D - Pass
Below 3.5	F — Failure

Grade Point Average (GPA), of a course is calculated using the formula:- GPA = TCP/TC, where TCP is the

Total Credit Point of a course, TC is the total credit of that course

A separate minimum of 30% marks each for internal and external (for both theory and practical) and aggregate minimum of 35% are required for a pass for a course. For a pass in a programme, a separate minimum of Grade D is required for all the individual courses and an overall grade D or above is mandatory. If a candidate secures F Grade for any one of the courses offered in a Semester/Programme, only F grade will be awarded for that semester /programme until he/she improves this to **D Grade** or above within the permitted period.

Read By	
Verified By	

QR Code

Programme Design

SEMESTER I

No.	Course Code	Course Title	Course Category	Hours per week	Credits
1	BOT01-ENG1CCT0119	English	Common Course	5	4
2	BOT01-ENG1CCT0219	English	Common Course	4	3
3	BOT01-HIND1CLT0119 /BOT01-MAL1CLT0119/ BOT01-FRN1CLT0119	Second Language	Common Course	4	4
4	BOT01-BOT1CRT0119	Methodology of science and Introduction to Botany.	Core Course: Theory	4	3
5	BOT01-BOT1CRP0119	Practical: Methodology of science and Introduction to Botany.	Core Course: Practical	4	3
6	BOT01-CHE1CMT0119	Chemistry/ Biochemistry	Complementary Course: Theory	2	2
7	BOT01-CHE1CMP0119	Chemistry/ Biochemistry	Complementary Course: Practical	2	1
8	BOT01-ZOO1CMT0119	Zoology/ Non-Chordate Diversity	Complementary Course: Theory	2	2
9	BOT01-ZOO1CMP0119	Zoology/ Non-Chordate Diversity	Complementary Course: Practical	2	1

SEMESTER II

No.	Course Code	Course Title	Course Category	Hours per week	Credits
1	BOT01-ENG2CCT0119	English	Common Course	5	4
2	BOT01-ENG2CCT0219	English	Common Course	4	3
3	BOT01-HIND2CLT0119/ BOT01-MAL2CLT0119/ZOO01-FRN2CLT0119	Second Language	Common Course	4	4
4	BOT01-BOT2CRT0119	Microbiology, Mycology and Plant Pathology	Core Course: Theory	4	3
5	BOT01-BOT2CRP0119	Microbiology, Mycology and Plant Pathology	Core Course: Practical	4	3
6	BOT01-CHE2CMT0119	Chemistry/ Biochemistry	Complementary Course: Theory	2	2
7	BOT01-CHE2CMP0119	Chemistry/ Biochemistry	Complementary Course: Practical	2	1
8	BOT01-ZOO2CMT0119	Zoology/ Chordate Diversity	Complementary Course: Theory	2	2
9	BOT01-ZOO2CMP0119	Zoology/ Chordate Diversity	Complementary Course: Practical	2	1

SEMESTER III

No.	Course Code	Course Title	Course Category	Hours per week	Credits
1	BOT01-ENG3CCT0119	English	Common Course	5	4
2	BOT01-HIND3CLT0119/ BOT01-MAL3CLT0119/ BOT01-FRN3CLT0119	Second Language	Common Course	5	4
3	BOT01-BOT3CRT0119	Phycology and Bryology	Core Course: Theory	5	4
4	BOT01-BOT3CRP0119	Practical: Phycology and Bryology	Core Course: Practical	5	4
5	BOT01-CHE3CMT0119	Chemistry/ Biochemistry	Complementary Course: Theory	3	3
6	BOT01-CHE3CMP0119	Chemistry/ Biochemistry	Complementary Course: Practical	2	1
7	BOT01-ZOO3CMT0119	Zoology/ Physiology and Immunology	Complementary Course: Theory	3	3
8	BOT01-ZOO3CMP0119	Zoology/ Physiology and Immunology	Complementary Course: Practical	2	1

SEMESTER IV

No.	Course Code	Course Title	Course Category	Hours per week	Credits
1	BOT01-ENG4CCT0119	English	Common Course	5	4
2	BOT01-HIND4CLT0119/ BOT01-MAL4CLT0119/BOT01-FRN4CLT0119	Second Language	Common Course	5	4
3	BOT01-BOT4CRT0119	Pteridology Gymnosperms and Paleobotany	Core Course: Theory	5	4
4	BOT01-BOT4CRP0119	Practical- Pteridology Gymnosperms and Paleobotany	Core Course: Practical	5	4
5	BOT01-CHE4CMT0119	Chemistry/ Biochemistry	Complementary Course: Theory	3	3
6	BOT01-CHE4CMP0119	Chemistry/ Biochemistry	Complementary Course: Practical	2	1
7	BOT01-ZOO4CMT0119	Zoology/ Applied Zoology	Complementary Course: Theory	3	3
8	BOT01-ZOO4CMP0119	Zoology/ Applied Zoology	Complementary Course: Practical	2	1

SEMESTER V

No.	Course Code	Course Title	Course Category	Hours per week	Credits
1	BOT01-BOT 5CRT0119	Anatomy, Reproductive Botany, Microtechnique	Core Course: Theory	6	4
2	BOT01-BOT 5CRP0119	Anatomy, Reproductive Botany, Microtechnique	Core Course: Practical	6	4
3	BOT01-BOT 5CRT0219	Environmental science and human rights	Core Course: Theory	5	4
4	BOT01-BOT 5CRP0219	Environmental science and human rights	Core Course: Practical	5	4
5	BOT01-BOT 5CRT0319	Research Methodology, Biophysics and Biostatistics	Core Course Theory	5	4
6	BOT01-BOT 5CRP0319	Research Methodology, Biophysics and Biostatistics	Core Course: Practical	5	4
7	BOT01-BOT 5CRT0419	Plant Physiology and Biochemistry	Core Course: Theory	5	4
8	BOT01-BOT 5CRP0419	Plant Physiology and Biochemistry	Core Course: Practical	5	4
9	BOT01-BOT 5COT0119	Horticulture and Nursery Management/Agri. Based Microenterprises/ Ecotourism/ Biotechnology/ Bioinformatics	Open Courses for other Streams	4	4

SEMESTER VI

No.	Course Code	Course Title	Course Category	Hours per week	Credits
1	BOT01-BOT 6CRT0119	Genetics Plant Breeding and Horticulture	Core Course IX: Theory	7	4
2	BOT01-BOT 6CRP0119	Genetics Plant Breeding and Horticulture	Core Course IX: Practical	7	4
3	BOT01-BOT 6CRT0219	Biotechnology and Bioinformatics	Core Course X: Theory	5	4
4	BOT01-BOT 6CRP0219	Biotechnology and Bioinformatics	Core Course X: Practical	5	4
5	BOT01-BOT 6CRT0319	Angiosperm Morphology, Taxonomy and Eco. Botany	Core Course XI: Theory	5	4
6	BOT01-BOT 6CRP0319	Angiosperm Morphology, Taxonomy and Eco. Botany	Core Course XI: Practical	5	4
7	BOT01-BOT 6CRT0419	Cell and Molecular Biology	Core Course XII: Theory	5	4
8	BOT01-BOT 6CRP0419	Cell and Molecular Biology	Core Course XII: Practical	5	4
9	BOT01-BOT 6CBT0119	Plant Genetic Resources Management/Phyto chemistry/Agribusiness	Choice Based Core Elective Courses	3	3
10	BOT01-BOT 6CRP0119	Project Work	Project	-	1

Detailed Syllabus: Semester I

Core Course I: METHODOLOGY OF SCIENCE AND AN INTRODUCTION TO BOTANY (BOT1CRT0119)

36 Hours **2 Credits**

Course Outcomes

- Determine the broad steps required to solve a problem in an area of their interest.
- Design experiment for verifying hypothesis
- Identify the different plant groups and also assign plants to these groups.
- Utilize the possibilities of the field of Botany
- Identify basic experimental methods in Botany for specific purposes.

Module I: INTRODUCTION TO SCIENCE AND THE METHODOLOGY OF SCIENCE AND EXPERIMENTATION IN SCIENCE

(8 Hours)

Scientific method: steps involved - observation and thoughts, formulation of hypothesis; inductive reasoning - testing of hypothesis; deductive reasoning - experimentation - formulation of theories and laws.

Selection of a problem - searching the literature – designing of experiments - selection of variables, study area, and a suitable design. Need of control, treatments and replication. Mendel's experiments as an example of moving from observations to questions, then to hypothesis and finally to experimentation. Ethics in science.

Module II: ORIGIN AND EVOLUTION OF LIFE (10 Hours)

Origin of life on earth from molecules to life – Oparin's hypothesis, Haldane's hypothesis, Miller-Urey experiment, Panspermia, origin of cells and the first organisms. Evolutionary history of Biological diversity – fossil record; geological time scale – major events in each era. Evidences of evolution; theories of evolution - Wiesman, Wallace, Charles Darwin, Hugo De Vries. Neo-Darwinism – major postulates - isolation, mutation, genetic drift, speciation.

Module III: DIVERSITY OF LIFE AND ITS CLASSIFICATION (12 Hours)

Diversity of life: two kingdom classification (Carolus Linnaeus, 1735); phylogenetic classification (August W Eichler, 1878); five kingdom classification (R H Whittaker, 1969). Three domains, six kingdom classification, (Carl Woese, 1990) – criteria for classification, general characters of each kingdom. The three domains of life: Archaea, Bacteria, Eucarya – general characters of each.

Diversity of plants: study the salient features of algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms.

Module IV: BASIC BOTANICAL SKILLS (6 Hours)

(10 Hours)

Light microscope: dissection and compound microscope – parts and uses. Preparation of specimens for light microscopy - collection and preservation of plant specimens; killing and fixing; killing agents, formalin, ethyl alcohol; fixing agents – Carnoy's fluid, Farmer's fluid, FAA; herbarium (brief study only). Whole mounts and sections – use of whole mounting, hand sectioning – TS, TLS, RLS. Staining plant tissues: purpose; stains - safranine, acetocarmine, crystal violet. Temporary and permanent mounting, mountants.

PRACTICAL (36 Hours)

- Design an experiment to verify a given hypothesis.
- Conduct a survey-based inquiry on a given topic (To test the validity of a given hypothesis. E.g., all angiosperm parasites are dicot plants).
- Select an important classical experiment and find out the different elements of the

methodology of science (e.g., Robert Koch experiment).

- Conduct field surveys to identify and collect plant specimens to appreciate the diversity of plant kingdom. Submit five preserved specimens (in bottles and/or herbarium) belonging to diverse groups.
- Identification of plants with vascular elements, plants which produce flowers, fruits, seeds, cone, sporophyll, embryos and study their salient features.

Prepare temporary, stained hand sections (TS, TLS, RLS) of plant specimens appropriate for light microscopic studies

References

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Detailed Syllabus: Semester II

FOR TRUTH AND SERVICE

Core course II: MICROBIOLOGY, MYCOLOGY AND PLANT PATHOLOGY (BOT2CRT0119)

72 Hours **3 Credits**

Course Outcomes

- Discover the world of microbes in general, with more information about viruses, prokaryotes and eukaryotes.
- Identify fungi related to day to day human activities for their utilisation.
- Discuss the ecology, life cycle and economic importance of major groups of fungi.
- Describe the structure and ecological significance of lichens in nature.
- Identify common plant pathogens associated with their crops and can adopt suitable remedial measures to combat them.

MICROBIOLOGY

Module 1: Microbial world and its major areas (9 Hours)

Introduction to microbiology, scope of microbiology. 1. Bacteria: Bacteria: general characters and classification based on staining, morphology and flagellation. Ultra structure of bacteria. Reproduction - binary fission. Genetic recombination in bacteria - conjugation, transformation and transduction.Economic importance of bacteria. 2. Viruses: General characters of viruses, viriods and prions. Structureof TMV and Bacteriophage (λ). Multiplication of λ phage – lytic and lysogenic cycle. 3. Applied microbiology: Isolation and culture of bacteria; media used – general purpose and selective media, applications of bacterial culture (brief study only). Role of microbes: in producing antibiotics, vine, vinegar, curd – role in N2 fixation, as biofertilizers – role in food spoilage (Brief study only).

PRACTICAL **(9 Hours)**

1. Gram staining by using curd/ root nodules.
2. Isolation of microbes from soil through serial dilution and streak plate method.
3. Demonstrate the culture of bacteria: E.coli/Lactobacillus
4. Microbes and type of fermentation involved in- vine, vinegar, curd.

MYCOLOGY

Module 2: Introduction, classification and economic importance of fungi / lichens (8 Hours)

General characters of fungi. Classification of fungi - Ainsworth (1973).Useful and harmful effects of fungi - medicinal, industrial, agricultural, food, genetic studies, spoilage, fungal toxins and diseases. Mycorrhizae: ecto and endomycorrhiza, their significance.

General characters, types, general internal structure.Economic and ecological significance of lichens. Structure, reproduction and life cycle of Parmelia.

Module 3: Major types of fungi (12 Hours)

Distinguishing characters of the different classes of fungi with special reference to reproductive structures and life history of the genera mentioned in each group: Myxomycotina – Physarum; Mastigomycotina – Albugo; Zygomycotina - Rhizopus; Ascomycotina – Hemiascomycetes - Saccharomyces; Plectomycetes - Penicillium; Pyrenomycetes – Xylaria; Discomycetes - Peziza; Basidiomycotina – Teliomycetes – Puccinia; Hymenomycetes – Agaricus; Deuteromycotina – Fusarium.

PRACTICAL (18 Hours)

1. Micropreparation and detailed microscopic study of Rhizopus, Albugo, Saccharomyces, Penicillium,Xylaria, Peziza, Puccinia, Fusarium and Parmelia.
2. Staining and microscopic observation of endomycorrhizal fungus.
3. Investigation of fungal succession on cow dung.

PLANT PATHOLOGY

Module 4: Plant disease development and common plant diseases and their control (9 Hours)

History of plant pathology. Classification of plant diseases on the basis of causative organism and symptoms. Host parasite interaction - defence mechanisms in host, mechanism of infection, transmission and dissemination of diseases.

Study of following diseases with emphasis on symptoms, cause, disease cycle and control: Bunchy top of Banana, Bacterial blight of Paddy, Root wilt of Coconut, Abnormal leaf fall of Rubber, Root knot disease of Pepper, Leaf mosaic disease of Tapioca, Citrus canker.

Prophylaxis - quarantine measures, seed certification; Therapeutic - physical therapy, chemotherapy; Biological control and its significance. Fungicides - Bordeaux mixture. Tobacco and Neem decoction (Brief study only).

PRACTICAL (9 Hours)

1. Identify the diseases mentioned in the syllabus with respect to causative organisms and symptoms
2. Submit herbarium preparations of any three of the diseases mentioned.
3. Learn the technique of preparing Bordeaux mixture, Tobacco and Neem decoction.

References

1. Ahamadjian Vernon, Hale M E (eds), 1973. The Lichens. Academic press, New Delhi.
    a) Ainsworth G C, Sparrow K F, Sussman A S (eds), 1973. The Fungi: an advanced Treatise, Vol.
    b) 4a & 4b, a Taxonomic review with keys. Academic press, New York.
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Willy and sons, Inc. New York.

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11. Nair M C (eds), 1990. Mushroom Technical Bulletin 17. Kerala Agricultural University,Mannuthy.
12. Nita Bahl, 2002. Hand book on Mushrooms. Oxford & IBH Publishing C. Pvt.

Detailed Syllabus: Semester III

Core Course III: PHYCOLOGY AND BRYOLOGY (BOT3CRT0119)

54 Hours **3 Credits**

Course Outcomes

- Identify and differentiate between the different groups of algae based on their characteristics.
- Describe the variation in habitat, thallus, pigmentation, food reserves and reproduction in algae.
- Discuss about the economically important algae and how to utilise them in their daily lives.
- Explain the technique involved in algal culture.
- Identify the different groups of bryophytes and comment on their ecological and economic importance.

PHYCOLOGY

Module I

Introduction to Phycology and Classification of Algae (9 hours)

Introduction: general characters, habitat diversity, range of thallus structure and pigments in algae; structure of algal flagella. Different types of life cycle and alternation of generations in algae. Classification: by Fritsch (1945); brief introduction to the modern classification by Lee (2009) [up to divisions].

Module II

Type study (9 hours)

Salient features, thallus structure and reproduction of algae in the following groups with special reference to the type(s) mentioned: Cyanophyceae - Nostoc; Chlorophyceae - Volvox, Oedogonium, Cladophora, Chara.

Module III

Type study continued (9

hours)

Salient features, thallus structure and reproduction of algae in the following groups with special reference to the type(s) mentioned: Xanthophyceae – Vaucheria; Bacillariophyceae - Pinnularia; Phaeophyceae – Ectocarpus, Sargassum; Rhodophyceae– Gracilaria.

Module IV

Artificial culture and economic importance of Algae. (9 hours)

Algal culture: isolation, cultivation and preservation of micro- and macro-algae. Economic importance of algae: algae as food, SCP, fodder, green manure, role in N2 fixation, medicine and biofuels. Commercial products from Algae - carrageenin, agar-agar, alginates and diatomaceous earth. Role of algae in pollution studies: as indicators of pollution and as bioremediation agents. Eutrophication – algal bloom; harmful and toxic algal blooms – neurotoxins and parasitic algae.

PRACTICAL (27 hours)

5. Conduct a field visit to any one of the ecosystems rich in Algae to experience algal diversity. Submit a report with photographs.
6. Make micropreparations of vegetative and reproductive structures of the types mentioned in the syllabus
7. Algal Culture: isolation and cultivation of micro- and macro-algae in suitable growth media (Demonstration only)
8. Familiarizing the technique of algal collection preservation.

BRYOLOGY

Module V

General introduction, classification of bryophytes and Economic importance (6 Hours)

Introduction, general characters and classification of bryophytes by Rothmaler (1951); a very brief account of systems and classifications by Goffinet et al (2008).

Economic importance of Bryophytes – biological, ecological, medicinal and as potting

material.

Module VI

Type study (12 Hours)

Distribution, morphology, anatomy, reproduction and life cycle of the following types (developmental details are not required): Hepaticopsida - Riccia, Marchantia; Anthocerotopsida - Anthoceros; Bryopsida - Funaria. Evolution of gametophyte and sporophyte among Bryophytes.

PRACTICAL (9 Hours)

Study the habit, anatomy of thallus and reproductive structures of Riccia, Marchantia, Anthoceros, and Funaria.

References

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2. Fritsch F E, 1935. The structure and reproduction of the algae, Vol. 1 and II. Uni. Press. Cambridge.
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Detailed Syllabus: Semester IV

Core Course IV: PTERIDOLOGY, GYMNOSPERMS AND PALEOBOTANY (BOT4CRT0119)

54 Hours **3 Credits**

Course Outcomes

- Identify the Pteridophytes and Gymnosperms mentioned in the syllabus.
- Explain the useful aspects of these plants and their propagation.
- Compare the morphology, anatomy and reproductive structures of different Pteridophytes and Gymnosperms.
- Explain the process of formation and importance of fossils.
- Analyse the course of evolution from the lower groups of Cryptogams to the higher group of Phanerogams.

PTERIDOLOGY

Module I **(9 Hours)**

Introduction, general characters and classification of Pteridophytes up to classes by Smith (1955) and a very brief account of the classification by Christenhusz et al., 2011.

Importance of Pteridophytes: medicinal, ornamental, as biofertilizer.

Module II **(10 Hours)**

Study the distribution, morphology, anatomy, reproduction, life cycle and affinities of the following types (Developmental details are not required): Psilophyta - Psilotum; Lycophyta - Lycopodium, Selaginella; Sphenophyta – Equisetum.

Module III **(8 Hours)**

Study the distribution, morphology, anatomy, reproduction, life cycle and affinities of the following types (Developmental details are not required): Pterophyta - Pteris, Azolla. Stelar evolution in Pteridophytes; Heterospory and seed habit.

PRACTICAL **(27 Hours)**

Habit, TS of stem, LS of strobilus and sections of special structures of the following types: Psilotum, Lycopodium, Selaginella, Equisetum, Pteris, Azolla.

GYMNOSPERMS

Module IV **(7 Hours)**

Introduction, General characters, classification of Gymnosperms by Sporne (1965) and a very brief account of the classification by Christenhusz et al. (2011).Uses of Gymnosperms: as food, medicine, in industry and as ornamental plants.

Module V **(11 Hours)**

Distribution, morphology, anatomy, reproduction, life cycle and affinities of the following types (Developmental details are not required): Cycadopsida – Cycas; Coniferopsida – Pinus; Gnetopsidae – Gnetum. Affinities of Gymnosperms with Pteridophytes and Angiosperms.

PRACTICAL **(9 Hours)**

Study of the habit, TS of leaf and stem, morphology of reproductive structures of Cycas, Pinus and Gnetum.

PALEOBOTANY **(9 Hours)**

Module VI

Fossil formation, types of fossils. Study of fossil Pteridophytes – Rhynia, Calamites; fossil Gymnosperm – Williamsonia. Applied aspects of Paleobotany - exploration of fossil fuels.

Paleobotany in India: Brief study of the fossil deposits in India. Important Indian Paleobotanical Institutes, contributions of Indian Paleobotanists – Birbal Sahni.

References

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20. Maarten J M, Christenhusz, Xian-Chun Zhang, Harald Schneider. A linear sequence of extant families and genera of lycophytes and ferns.Phytotaxa 19: 7– 54 (2011) 15

21. Andrews H N, 1961. Studies in Paleobotany. John Wiley and Sons Inc., NewYork.

22. Arnold C A, 1947. Introduction to Paleobotany.Tata McGraw Hill, New Delhi.

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25. Sewart W N, 1983. Paleobotany and the Evolution of Plants. Cambridge Uni. Press, London.

26. Taylor T N. Paleobotany: An Introduction to Fossil Plant Biology. McGraw Hill, New York.

27. Watson J. An introduction to study of fossil plants. Adams and Charles Black Ltd. London

FOR TRUTH AND SERVICE

Detailed Syllabus: Semester V

Core Course V: ANATOMY, REPRODUCTIVE BOTANY AND MICROTECHNIQUE (BOT5CRT0119)

54 Hours **3 Credits**

Course Outcomes

- Examine the cell, tissues and tissue systems simultaneously and their respective functions.
- Discuss the structural adaptations in plants growing in different environments as well as on different parts such as stem, root and leaf etc.
- Analyse the morphology and development of reproductive structures in flowering plants and also development of fruits and seeds.
- Scope and application of embryo development and culture, endosperm development and polyembryony
- Devise and perform techniques to preserve and study plant materials and microscopic slide preparation for in depth study on internal structure of plant parts.

ANATOMY

Module I **(8 Hours)**

Cell wall: structure of cell wall; sub-microscopic structure - cellulose, micelle, micro fibril and macro fibril; structure and function of plasmodesmata, simple and bordered pits; different types of cell wall thickening in treachery elements; extra cell wall thickening materials. Growth of cell wall - apposition, intussusception. Non-living inclusions in plant cells: food products, secretory products, excretory (waste) products - nitrogenous and non nitrogenous.

Module II: Organization of tissues **(9 Hours)**

Tissues: meristematic tissue – characteristic features, functions and classification. Theories on apical organization - apical cell theory, histogen theory, tunica-corpus theory. Permanent tissues - structure and function of simple and complex tissues. Secretory tissues: external secretory tissue - glands and nectaries; internal secretory tissues - laticifers.

Tissue systems: epidermal tissue system - epidermis, cuticle, trichome; stomata – structure, types; bulliform cells. Ground tissue system - cortex, endodermis, pericycle, pith and pith rays. Vascular tissue system - structure of xylem and phloem, different types of vascular bundles and their arrangement in root and stem.

Module III: Plant body structure And Wood Anatomy (10 Hours)

Primary structure of stem, root and leaf (dicot and monocot).Normal secondary growth in dicot stem and root. Periderm: structure and development - phellum, phellogen, phelloderm, bark, and lenticels. Anomalous secondary thickening: Bignonia stem, Boerhaavia stem and Dracaena stem.

Wood anatomy- Basic structure of wood - heart wood, sap wood; soft wood,

dendrochronology; ring porous, diffuse porous wood, and non-porous wood; and reaction wood: tension wood and compression wood.

PRACTICAL (18 Hours)

1. Study of simple and complex tissues.
2. Non-living inclusions - starch grains, cystolith, raphides, aleurone grains.
3. Primary structure of stem, root and leaf - Dicots and Monocots.
4. Monocot stem- Cypress/ Bamboo
5. Monocot root- Musa/ Colocasia
6. Dicot stem- Centella/ Cephalandra
7. Dissect and identify the stomatal types - anomocytic, anisocytic, paracytic and diacytic.
8. Secondary structure of dicot stem and root.
    i. Dicot stem – Vernonia, Eupatorium and Leucas (Any two)
    ii. Dicot root – Ficus, Papaya and Tinospora (Any two).
9. Anomalous secondary structure of Bignonia stem, Boerhaavia stem, and Dracaena

stem.

10. Wood; growth rings and tyloses.

REPRODUCTIVE BOTANY

Module IV: Reproductory Botany- Introduction, Male gametophyte & Female gametophyte (12 Hours)

Introduction to embryology, floral morphology - parts of flower.

Microsporangium: structure and development of anther, microsporogenesis, dehiscence of anther, structure of pollen. Male gametophyte development.

Megasporangium: types of ovules – anatropous, orthotropous, amphitropous, campylotropous, circinotropous. Megasporogenesis – female gametophyte – structure of a typical embryosac, types of embryosacs - monosporic (Polygonum type), bisporic (Allium type) and tetrasporic (Peperomia type).

Module V: Fertilization, Endosperm and Embryo (6 Hours)

Mechanism of pollination, agents of pollination, germination of pollen grains; double fertilization.

Endosperm: types – cellular, nuclear and helobial.

Embryogeny, structure of dicot and monocot embryo, seed formation. Polyembryony.

PRACTICAL (9 Hours)

1. Dissect and display parts of flowers (Demo).
2. Identification of C.S. of anther, embryo sac and embryo.
3. Identification of various anther types - monothecous, dithecous.
4. Identify the different types of ovules.

MICROTECHNIQUE

Module VI: Preservation of plant specimens, sectioning and mounting (9 Hours)

Introduction to microtechnique: killing and fixing - purpose. Dehydration - purpose, agents used - ethyl alcohol. Sectioning: hand sections, serial section; Microtome -

rotary, sledge (application only). Staining technique: principle of staining; stains - haematoxylin, fast green, acetocarmine; vital stains - neutral red, Evans blue; mordants - purpose with examples. Types of staining - single staining, double staining. Mounting and mounting media – purpose, mounting media - glycerine, DPX, Canada balsam. Use of permanent whole mounts; permanent sections; maceration, smear and squash preparation.

PRACTICAL (9 Hours)

1. Familiarize preparation and use of stains, fixatives and mounting media.
2. Preparation of smears and squash.
3. Demonstration of microtome sectioning.
4. Maceration and identification of tracheary elements.
5. Preparation of single stained hand sections (Permanent – demonstration only).

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Core Course VI: RESEARCH METHODOLOGY, BIOPHYSICS AND BIOSTATISTICS (BOT5CRT0219)

54 Hours **3 Credits**

Course Outcomes

- Describe different methodologies, techniques and computer skills used in research work and apply them in their own research.
- Describe the features of MS word, Excel, PowerPoint and other free online office softwares and apply them in creation of documents and presentations etc..
- Explain the principle and working of various equipments and make use of them in experiments and studies.
- Classify the sampling techniques and choose the right one in real situations.
- Apply the appropriate statistical methodology to interpret data and use them to predict the probability of occurrence of events.

RESEARCH METHODOLOGY (22 Hours)

Module I **(11 Hours)**

Introduction, Process of Research: Objectives of research.Types of research - pure and applied. Identification of research problem. Review of literature: purpose, literature sources – names of reputed National and International journals in life science (2 international & 3 national); reprint acquisition - INSDOC, INFLIBNET.

Conducting research: define the problem, identify the objective, design the study, collection of data, analysis and interpretation. Preparation of research report: preparation of dissertation - IMRAD system - preliminary pages, introduction and review of literature, materials and methods, results, discussion, conclusion and bibliography.

Module II **(7 Hours)**

Use of Computer in Research: Introduction to MS - WINDOWS and LINUX, application of MS WORD - word Processing, editing tools (cut, copy, paste), formatting tools.MS EXCEL - creating worksheet, data entry, sorting data. Preparation of graphs

and diagrams (Bar diagram, pie chart, line chart, histogram). MS-POWERPOINT - presentation based on a biological topic; inserting tables, charts, pictures. Open source and free alternatives to MS Office: Open Office (brief study). Search engines: Google.com; meta search engine – dogpile.com; academic search - Google scholar. Educational sites related to biological science - Scitable, DNAi.

PRACTICAL **(18 Hours)**

1. Prepare outline of a dissertation (IMRAD system).
2. Prepare a list of references (not less than 10) on a topic in biological science.
3. Review the literature on a given topic.
4. Collect information on a topic related to biological science using the internet.
5. Make a report based on the collected information from the internet (using MS-WORD).
6. Prepare tables/charts/graphs using EXCEL.
7. Prepare a worksheet using a set of data collected and find out the SUM.
8. Prepare a PowerPoint presentation based on the report in Experiment 4.

BIOPHYSICS

Module III **(8 Hours)**

Biophysical instrumentation: Introduction to biophysics; branches of biophysics - molecular, cellular, membrane and biomedical instrumentation (scope only). Principle, working and applications of the following: Microscopy: compound microscope, phase-contrast microscope and electron microscope – SEM.

Module IV **(8 Hours)**

Colorimetry and other techniques: Colorimeter, spectrophotometer. Centrifuge: ultracentrifuge. Chromatography: paper, thin layer and column. Electrophoresis, PAGE, pH meter. Haemocytometer.

PRACTICAL **(9 Hours)**

Measurement of pH and adjusting pH using pH meter.

Separation of plant pigments using TLC.

Determination of the concentration of a sample solution using colorimeter.

Demonstration of column chromatography.

Count the number of cells/spores using Haemocytometer.

BIOSTATISTICS

Module V **(8 Hours)**

Introduction: Statistical terms and symbols, applications of biostatistics (Brief study only). Sampling: concept of sample, sampling methods - random and non random sampling. Collection and representation of data: diagrammatic and graphic representation - line diagram, bar diagram, pie diagram, histogram, frequency curve

Module VI **(10 Hours)**

Measures of central tendency: Measures of central tendency: mean, median, mode, (discrete and continuous series). Measures of dispersion: mean deviation, standard deviation. Distribution patterns: normal distribution, binomial distribution. Probability: Definition, mutually exclusive events, independent events, rules of probability (brief account only).

PRACTICAL **(18 Hours)**

1. Collect numerical data, tabulate and represent in different types of graphs and diagrams mentioned in the syllabus.
2. Problems related to mean, median, mode, mean deviation, standard deviation and probability

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20. SAGE Publications India Pvt Ltd, New Delhi.

Core Course VII: PLANT PHYSIOLOGY AND BIOCHEMISTRY (BOT5CRT0319)

54 Hours **3 Credits**

Course Outcomes

- Explain the physiological processes that regulate absorption of water and minerals with emphasis on N2 metabolism and transport across membranes.
- Examine the concept of light harvesting by plants and understanding its physiology in response with varying environmental situations.
- Experiment the basic skills in experiments related to photosynthesis, respiration and also biochemical processes take place in plants.
- Explain the overview of major biomolecules in Plant life.
- Analyse the structure and the mechanism of action of enzymes, learn the kinetics of enzyme catalysed reactions and understand various enzyme inhibitions and regulatory processes.

PLANT PHYSIOLOGY

Module I

Water relations & Mineral nutrition (8 Hours)

Plant water relations - diffusion, imbibition, osmosis, OP, DPD, TP; water potential - concepts and components Absorption of water - active and passive, pathway of water movement - apoplastic and symplastic pathway.Ascent of sap - cohesion-tension theory. Transpiration - types, mechanism, theories (Starch-sugar, Proton-K+ ion exchange), significance; antitranspirants. Guttation. Plasmolysis

Mineral nutrition - Role of major and minor elements in plant nutrition, deficiency symptoms of essential nutrients; mineral uptake - passive (ion exchange) and active (carrier concept).

Module II

Photosynthesis (12 Hours)

Photosynthetic pigments, photosynthetic apparatus, solar spectrum photo excitation - fluorescence, phosphorescence; red drop and Emerson enhancement effect. Photosystems - components and organization; cyclic and non-cyclic

photophosphorylation; carbon assimilation pathways - C3, C4 plants - kranz anatomy, CAM.Photorespiration. Factors affecting photosynthesis - Blackmann‟s law of limiting factors.

Translocation of solutes: pathway of phloem transport, mechanism - pressure flow, mass flow hypothesis; phloem loading and unloading.

Module III

Respiration (8 Hours)

Respiration: anaerobic and aerobic; glycolysis, Kreb‟s cycle, mitochondrial electron transport system- components, oxidative phosphorylation, ATPase, chemiosmotic hypothesis. RQ - significance.Factors affecting respiration.

Module IV

Plant growth and development & Stress Physiology (7 Hours)

Plant hormones: their physiological effect and practical applications - auxins, gibberellins, cytokinins, ABA, and ethylene. Plant movements: tropic movements - geotropism and phototropism; nastic movements - seismonastic and nyctinastic movements. Physiology of flowering - phytochrome, photoperiodism, vernalization.

Concepts of plant responses to abiotic stresses (water, salt, temperature), biotic stress (pathogens). Allelopathy.

PRACTICAL (27 Hours)

Core Experiments (any four compulsory):

1. Determination of osmotic pressure of plant cell sap by plasmolytic/weighing method.
2. Compare the stomatal indices of hydrophytes, xerophytes and mesophytes (any two).
3. Separation of plant pigments by TLC/Paper chromatography.
4. Measurement of photosynthesis by Wilmott's bubbler/any suitable method.
5. Estimation of plant pigments by colorimeter.

Demonstration experiments:

1. Papaya petiole osmoscope.
2. Demonstration of tissue tension.
3. Relation between transpiration and absorption.
4. Necessity of chlorophyll, light and CO2 in phytosynthesis.
5. Simple respiroscope.
6. Respirometer and measurement of RQ.
7. Fermentation.
8. Measurement of transpiration rate using Ganong's potometer/Farmer's potometer.

BIOCHEMISTRY

Module V **(8 Hours)**

Biopolymers

Carbohydrates: General structure and functions; classification - mono (glucose and fructose), di (maltose and sucrose) and polysaccharides (starch and cellulose).

Proteins: General structure and classification of amino acids - peptide bond; structural levels of proteins - primary, secondary, tertiary and quaternary; functions of proteins.

Lipids: General features and roles of lipids, types of lipids; fatty acids - saturated and unsaturated; fatty acid derivatives - fats and oils; compound lipids (brief study only).

Module VI **(9 Hours)**

Water and Enzymes Water: Physical and chemical properties of water, acids and bases; pH - definition, significance; measurement of pH – colorimetric, electrometric (brief study only). Buffers: buffer action, uses of buffers.

Enzymes: Classification and nomenclature, mechanism of action. Holoenzyme, apoenzyme, cofactors. Enzyme kinetics, Michaelis-Menten constant (brief study only). Regulation of enzyme action. Factors affecting enzyme action.

PRACTICAL **(18 Hours)**

1. General test for carbohydrates – Molisch's test, Benedict's test, Fehling's test.
2. Colour test for starch - Iodine test.
3. Colour tests for proteins in solution – Xanthoproteic test, Biuret test, Million's test, Ninhydrin test.
4. Action of various enzymes in plant tissues: peroxidase, dehydrogenase.
5. Quantitative estimation of protein using colorimeter.

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Core Course VIII: ENVIRONMENTAL SCIENCE AND HUMAN RIGHTS (BOT5CRT0419)

54 Hours **4 Credits**

Course Outcomes

- Formulate new methods of sustainable utilization of natural resources.
- Take necessary steps to control/ reduce environmental pollution.
- Perform more accountable with compassionate attitude towards environment and organisms
- Identify and explain various ecological adaptations and processes
- Exercise implementation of environmental laws in India for conserving biodiversity and natural resources

Module I **(12 Hours)**

Introduction to ecology and Human Rights: Ecology: introduction, definition, scope and relevance; sub-divisions of ecology - autecology, synecology and ecosystem ecology.

Population: population size, density, natality, mortality, age, rate of natural increase, growth form and carrying capacity, population interactions between species - competition, parasitism, predation, commensalism, protocooperation, mutualism, neutralism.

Community: community concept, biotic community, species diversity, species richness, dominance; growth forms and structure, trophic structure, ecotone, edge effect, habitat, ecological niche, micro-climate, ecological indicators, keystone species.

Introduction, meaning, concept and development. Three generations of human rights - civil and political rights, economic, social and cultural rights. Human Rights and United Nations: contributions; main human rights related organizations - UNESCO, UNICEF, WHO, ILO.

Environment and human rights: right to clean environment and public safety. Conservation of natural resources and human rights: reports, case studies and policy

formulation. Conservation issues of Western Ghats – Madhav Gadgil committee report, Kasturi Rangan report(Brief account). Over-exploitation of ground water resources, marine fisheries, sand mining etc.

Module II **(10 Hours)**

Ecosystems Structure and function of ecosystems, ecosystem components: abiotic - atmosphere, climate, soil, water; biotic - producers, consumers, decomposers. Productivity - primary and secondary - gross and net productivity - homeostasis in the ecosystem. Concept of energy in ecosystems - energy flow, food chain, food web, trophic levels, trophic structure and ecological pyramids - pyramid of numbers, biomass, energy.Nutrient cycles - biogeochemical cycles of C and N2.

Ecosystem development: ecological succession, process, climax community, hydrosere, xerosere. Adaptations of plants to environment - xerophytes, hydrophytes, epiphytes, halophytes, mangroves.

Module III **(10 Hours)**

Biodiversity and its conservation Biodiversity: definition, types, examples – endemism - hot spots; hot spots in India - Western Ghats as hot spot. Wetlands and their importance. Biodiversity loss - IUCN threat categories, Red data book; causes and rate of biodiversity loss - extinction, causes of extinction. Conservation: methods - in-situ, ex-situ. Joint Forest management – people's participation in biodiversity conservation: community reserve, eg. Kadalundi-vallikkunnu. Remote sensing and GIS: introduction, principle, application of remote sensing and GIS in environmental studies and biodiversity conservation (brief account). Ecotourism: ecotourism centers in Kerala - Thenmala and Thattekkad WLS.

Module IV **(10 Hours)**

Environmental pollution Environmental studies - definition, relation to other sciences, relevance. Environmental pollution - introduction, definition; Air pollution - air pollutants, types, sources, effect of air pollution on plants and humans, control measures; Water pollution – common pollutants, sources, impact, control measures; water quality standards - DO and BOD; eutrophication. Soil Pollution - causes, sources, solid waste, biodegradable, non-biodegradable, management of solid waste, composting, e – waste. Environmental issues - global warming, greenhouse effect,

climate change - causes and impact, ozone layer depletion. Carbon sequestration.

Module V **(12 hours)**

Conservation of nature Basic concepts in conservation- Green Protocol.Global conservation efforts - Rio Earth summit - Agenda 21, Kyoto protocol, COP15 (15th Conference of the parties under the UN framework convention on climate change) and Paris protocol - major contributions. Conservation strategies and efforts in India and Kerala.

Organizations, movements and contributors of environmental studies and conservation: organizations - WWF, Chipko, NEERI; contributors - Salim Ali, Sunder Lal Bahuguna, Madhav Gadgil, Anil Agarwal, Medha Patkar, Vandana Siva (brief account only).

Environmental Legislation and Laws: Environment (protection) Act 1986, Air (protection and control of pollution) act, 1981 Water (protection and control of pollution) Act, 1974, Wildlife (protection) Act, 1972, Forest (conservation) Act, 1980, Biological Diversity Act (2002) [brief account only].

PRACTICAL **(36 hours)**

1. Estimation of CO2, Cl, and alkalinity of water samples (Titrimetry)
2. Determination of pH of soil and water.
3. Assessment of diversity, abundance, and frequency of plant species by quadrat method (Grasslands, forests).
4. Study of the most probable number (MPN) of Coliform bacteria in water samples.
5. EIA studies in degraded areas (Sampling, Line transect, Quadrate).
6. Ecological adaptations in xerophytes, hydrophytes, epiphytes, halophytes and mangroves.

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FOR TRUTH AND SERVICE

Detailed Syllabus: Semester VI

Core Course IX: GENETICS, PLANT BREEDING AND HORTICULTURE (BOT6CRT0119)

54 Hours **3 Credits**

Course Outcomes

- Define the various terminologies used in genetics.
- Explain the role of genetic and cytoplasmic basis of heredity.
- Predict the occurrence of a trait using principles of heredity.
- Explain the various methods of plant breeding
- Apply horticultural principles and techniques in the construction of gardens and propagation of plants.

GENETICS

Module I **(13 Hours)**

Origin and development of Genetics and Exceptions to Mendelism

Genetics as a science: origin - experiments of Mendel with Pisum sativum, general terminology used in genetics. Principles of inheritance, Mendelian laws - monohybrid and dihybrid cross, test cross and backcross.Modification of Mendelian ratios: incomplete dominance - Mirabilis; Co-dominance - MN blood group in man; Lethal genes – pigmentation in Snapdragon. Geneic interaction: epistasis, (a) Dominant - fruit colour in summer squashes (b) Recessive - coat colour in mice; Complementary genes - flower colour in sweet pea. Non-epistasis - comb pattern in Fowls. Multiple alleles – ABO blood groups in man; self sterility in Nicotiana.

Module II **(9 Hours)**

Linkage of genes Determination of sex

Linkage and crossing over: chromosome theory of linkage; crossing over - types of crossing over, mechanism of crossing over. Linkage map - 2 point cross, interference and coincidence.Sex determination: sex chromosomes and autosomes; chromosomal basis of sex determination; XX-XY, XX-XO mechanism; sex determination in higher plants (Melandrium album). Environment and sex determination; hormonal control of

sex determination; gynandromorphs. Dosage compensation – hyperactivation of X-linked genes in Drosophila; Lyon hypothesis. Sex linked inheritance: X-linked - Morgan's experiment e.g. eye colour in Drosophila, Haemophilia in man; Y-linked inheritance; sex limited and sex influenced inheritance. Pedigree analysis.

Module III **(6 Hours)**

Quantitative inheritance, Extra-chromosomal inheritance and Population genetics Quantitative characters: polygenic inheritance, continuous variation - kernel color in wheat, ear size in maize.Extra chromosomal inheritance: chloroplast mutation - variegation in 4O‟clock plant; mitochondrial mutations in yeast. Maternal effects - shell coiling in snail; infective heredity - kappa particles in Paramecium.Concept of population, gene pool, Hardy-Weinberg principle (brief). Factors that alter allelic frequencies.

PRACTICAL **(18 Hours)**

Students are expected to work out at least two problems each from monohybrid, dihybrid, back-cross and all types of modified Mendelian ratios mentioned in the syllabus.

PLANT BREEDING

Module V **(13 Hours)**

Introduction to plant breeding and various methods

Introduction and objectives of plant breeding. Plant breeding centers in Kerala, their achievements – CPCRI, CTCRI, RRII.

Plant introduction **(2 Hours)**

Plant introduction: domestication - centers of origin - procedure of plant introduction - quarantine regulations, acclimatization, agencies of plant introduction in India, major achievements.

Selection **(2 Hours)**

Plant Selection: mass, pure-line, clonal. Hybridization (4 Hours) Hybridization: types, procedure, important achievements. Heterosis in plant breeding, inbreeding depression,

genetics of heterosis and inbreeding depression. Handling segregating generation - pedigree method, bulk method, back cross method. Disease resistance breeding.

Mutation breeding and polyploidy breeding (2 Hours)

Mutation breeding: methods, applications and important achievements. Polyploidy breeding: methods and applications.

Tissue culture as method in plant breeding (2 Hours)

Application of meristem culture, embryo culture and pollen culture in plant breeding. Role of tissue culture in the creation of transgenic plants.

PRACTICAL (9 Hours)

1. Emasculation and bagging.
2. Demonstration of hybridization in plants.
3. Estimation of pollen sterility/viability.

HORTICULTURE

Module VI (14 Hours)

Introduction, plant propagation and gardening.

Introduction to horticulture - definition, history.Classification of horticultural plants. Disciplines of horticulture - pomoculture, olericulture, floriculture, arboriculture

Garden implements - budding knife, secateurs, hedge shear, hand cultivator, sprayers, lawn mower, garden rake, spade.

Irrigation methods: surface, sub, drip and spray irrigations; mist chambers - advantages and disadvantages.

Plant propagation: (5 Hours)

Seed propagation: seed testing and certification, seed bed preparation, seedling transplanting, hardening of seedling; advantages and disadvantages of seed propagation. Vegetative propagation: natural and artificial; artificial methods - cutting, layering, grafting and budding, micro-propagation; advantages and disadvantages of vegetative propagation.

Gardening (6 Hours)

Types of garden: brief study on ornamental garden, indoor garden, kitchen garden, aquatic garden, vertical garden, medicinal garden, terrace garden, terrarium.

Garden designing: garden components - lawns, shrubs and trees, borders, topiary, hedges, edges, walks, drives.

Physical control of plant growth: training and pruning. Bonsai - selection of plant - bonsai containers and method of bonsai formation.

Plant growing structures: green house, orchidarium, conservatory; Potting mixture – components.

PRACTICAL **(18 Hours)**

Approach grafting, budding (T, patch), air layering.

Identification of different garden tools and their uses.

List out the garden components in the photograph of the garden given.

Preparation of potting mixture

Demonstration of seed germination.

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Core Course X: CELL AND MOLECULAR BIOLOGY (BOT6CRT0219)

54 Hours **3 Credits**

Course Outcomes

- Describe structure, function of various cell organelles, design a model of a cell.
- Compare and contrast various events in the cell cycle.
- Distinguish different types of chromosomal aberration.
- Explain the features of genetic material and its function
- Analyse the rapid advances in cell and molecular biology for a better understanding of diseases, including cancer.

CELL BIOLOGY

Module I **(14 Hours)**

Ultra structure of cell components & Chromosomes

Landmarks in cell biology Cytosol-chemical composition.Composition, structure and function of plasma membrane - fluid mosaic model. The ultra-structure of a plant cell with structure and function of the following organelles: Endoplasmic reticulum, chloroplasts, Mitochondria, Ribosomes, Dictyosomes, Microbodies - peroxisomes and glyoxisomes, lysosomes and vacuole. Cytoskeleton - microtubules and microfilaments.

Ultra structure of nucleus: nuclear envelope - detailed structure of pore complex, nucleoplasm - composition, nucleolus.

Chromosomes: introduction, chromosome number, autosomes and allosomes, morphology - metacentric, submetacentric, acrocentric and telocentric. Structure - chromatid, chromonema, chromomere, centromere and kinetochore, telomere, secondary constriction and nucleolar organizer. Chromatin fibres: heterochromatin and euchromatin. Karyotype and idiogram. Chemical composition of chromatin: histones and non-histones, Nucleosome solenoid model

Special type of chromosomes: giant chromosomes (salivary gland chromosomes, Lamp brush chromosomes), supernumerary chromosomes (B chromosome).

Module II **(13 Hours)**

Cell division & chromosomal aberrations

Cell cycle - definition, different stages – interphase (G1, S and G2) and division phase. Mitosis: karyokinesis and cytokinesis, significance of mitosis. Meiosis: stages - first meiotic division (reduction division) and second meiotic (equational division), structure and function of synaptonemal complex, significance of meiosis; comparison of mitosis and meiosis.

Chromosomal aberrations - Numerical: heteroploidy; euploidy – haploidy; polyploidy – autopolyploidy, allopolyploidy (Raphanobrassica); aneuploidy - monosomy, trisomy (Fruit morphology in Datura), nullisomy (Triticum). Numerical chromosomal abnormalities in man: Down's syndrome, Klinefelter's syndrome, Turner's syndrome. Structural: deletion (Cri-du-chat syndrome), duplication (Bar eye in Drosophila), inversions (paracentric and pericentric) and Translocations (Robertsonian translocation).

Mutation: definition, importance. Types of mutations: somatic and germinal; spontaneous and induced; chromosomal and gene or point mutations. Molecular basis of mutation: frame shift, transition, transversion and substitution. Mechanism of mutation induction: base replacement, base alteration, base damage, errors in DNA replication. Mutagens: physical - non-ionizing and ionizing radiations; chemical - base analogs, alkylating agents, deaminating agents.

PRACTICAL (27 Hours)

1. Make acetocarmine squash preparation of onion root tip to identify mitotic stages.
2. Study the mitotic index of onion root tip cells (Demonstration only).
3. Study of the different stages of meiosis and identification of different sub-stages of prophase I using photomicrographs or pictures.
4. Identify and study the chromosomal anomalies, patterns and karyotype in man such as Down's syndrome, Turner's syndrome and Klinefelter's syndrome.

MOLECULAR BIOLOGY

Module 3 (10 Hours)

The genetic material & Replication of DNA

Molecular biology: a brief historical prelude. Identification of DNA as genetic material

(Brief account) Nucleic acids: DNA and RNA, important features of Watson and Crick model of DNA; Chargaff's rule. Alternate forms of DNA - comparison of A, B and Z forms. Structure and function of different types of RNA – t RNA, mRNA, r RNA, sn RNA, mi RNA

Semi conservative replication of DNA - Messlson and Stahl's experiment; process of semi conservative replication with reference to the enzymes involved in each step. (prokaryotes)

Module 4 **(15 Hours)**

Gene expression & its Regulation and Genetics of cancer

Gene expression: concept of gene, split genes, one gene one enzyme hypothesis, one gene one polypeptide hypothesis, the central dogma, reverse transcription. Details of transcription in prokaryotes and eukaryotes; hn RNA, processing of RNA, release of mRNA. Translation - initiation, elongation and termination. Genetic code and its features, wobble hypothesis. Regulation of gene expression in prokaryotes: operon concept, inducible and repressible systems, negative control and positive control. Lac operon, catabolic repression. Tryptophan operon, attenuation. Regulation in eukaryotes by RNA interference, alternative splicing.

Genetics of cancer **(2 Hours)**

Genetic basis of cancer – brief description of proto-oncogenes and oncogenes, tumour suppressor genes; characteristics of cancer cells.

PRACTICAL **(9 Hours)**

Work out elementary problems based on DNA structure, replication, transcription and translation and genetic code.

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Core Course XI: ANGIOSPERM MORPHOLOGY, TAXONOMY AND ECONOMIC BOTANY (BOT6CRT0319)

72 Hours **3 Credits**

Course Outcomes

- Understand the technical terms used to describe a plant.
- Identify the common and economically useful plants in the various families and apply this knowledge in daily life.
- Differentiate between the morphological features of the plants belonging to various families.
- Learn the technique of preservation of plant specimens.
- Apply and enhance their observation skills during dissection of a flower and learn the technique of botanical illustration.

ANGIOSPERM MORPHOLOGY

Module I **(13 Hours)**

Leaf, Inflorescence and Fruit morphology Leaf Morphology: types, venation, phyllotaxy. Morphology of flower: flower as modified shoot; detailed structure of flowers - floral parts - their arrangement, relative position - symmetry, aestivation and placentation types - cohesion and adhesion. Floral diagram and floral formula. Inflorescence: racemose types - simple raceme, corymb, umbel, spike, spadix, head and catkin; cymose types - simple cyme; monochasial - scorpioid and helicoid, dichasial and polychasial; special type - cyathium, hypanthodium, verticillaster, thyrsus and panicle. Fruits: simple - fleshy, dry - dehiscent, schizocarpic, indehiscent, aggregate, multiple (sorosis and syconus).

TAXONOMY AND ETHNOBOTANY

Module II **(12 Hours)**

Principles of Plant systematics Aim, scope, significance and components of taxonomy.Types of classification – artificial- Linnaeus (brief account), natural – Bentham and Hooker (Detailed account) and Phylogenetic – Engler and Prantl (Brief account).Angiosperm Phylogeny Group (AGP) system (introduction only). Plant

nomenclature - binomial, ICBN/ICN principles. Interdiciplinary approach in taxonomy -Cytotaxonomy and Chemotaxonomy.Herbarium technique – importance of herbarium; preparation of herbarium and their preservation.Important herbaria in India, BSI.

Module 3 **(12 Hours)**

Detailed study of Dicot families: under

Polypetalae Study the following families of Bentham and Hooker's System with special reference to their vegetative and floral characters; special attention should be given to common and economically important plants within the families: Annonaceae, Nymphaeaceae, Malvaceae, Rutaceae, Anacardiaceae, Leguminosae (Mimosaceae, Caesalpiniaceae and Fabaceae), Myrtaceae, Cucurbitaceae, Umbelliferae (Apiaceae),

Module IV **(13 Hours)**

Detailed study of Dicot families continued: under Gamopetalae and Monochlamydeae

Rubiaceae, Compositae (Asteraceae), Sapotaceae, Apocynaceae, Asclepiadaceae, Solanaceae, Convolvulaceae, Scrophulariaceae, Acanthaceae, Verbenaceae, Labiatae (Lamiaceae), Amaranthaceae, Euphorbiaceae.

Module V **(10 Hours)**

Detailed study of monocot families and Ethnobotany

Orchidaceae, Liliaceae, Palmae (Arecaceae), Graminae (Poaceae).

Ethnobotany: Introduction, scope and significance of ethnobotany. Study of the following plants used in daily life by tribals and village folks for food, shelter and medicine: Food - Artocarpusheterophylla, Corypha; Shelter - Bambusa, Ochlandra and Calamus; Medicine – Curcuma longa, Trichopus zeylanicus and Alpinia galanga.

ECONOMIC BOTANY

Module VI **(12 Hours)**

Economic botany Study the following groups of plants with special reference to the botanical name, family and morphology of the useful part and uses: Cereals - Rice, Wheat; Millets-Ragi; Pulses - Green gram, Bengal gram, Black gram; Sugar yielding

plants – Sugarcane; Fruits - Apple, Pineapple, Orange, Mango and Banana; Vegetables - Bittergourd, Ladies finger, Carrot and Cabbage; Tuber crops - Tapioca; Beverages - Tea, Coffee; Oil yielding plants - Groundnut, Coconut, Gingelly; Spices – Cardamom, Pepper, Cloves, Ginger; Timber yielding plants – Anjili (Wild Jack) wood, Teak wood, Rose wood; Fibre yielding plants - Coir, Jute, Cotton; Rubber yielding plants - Para rubber; Gums and Resins - Chickle, Gum Arabic, Asafoetida; Insecticide yielding Plants - Tobacco and Neem.

PRACTICAL **(45 Hours)**

1. Identify the following inflorescence and fruits with reference to their morphological specialities: (a) Inflorescence - simple raceme, spike, corymb, head, simple cyme, cyathium and hypanthodium. (b) Fruits - simple - (fleshy) - berry drupe, pepo, hespiridium. Dry indehiscent - nut. Dry dehiscent - legume, capsule (loculicidal). Aggregate.
2. Preparation of floral formula and floral diagram from floral description (of families studied).
3. Identify the families mentioned in the syllabus by noting their vegetative and floral characters.
4. Students must describe the floral parts, draw the L.S., floral diagram and write the floral formula of at least one flower from each family.
5. Prepare herbarium of 25 plants with field notes.
6. Conduct field work for a period of not less than 5 days under the guidance of a teacher and submit field report.
7. Study the finished products of plants mentioned in the syllabus of economic botany with special reference to the morphology of the useful part, botanical name and family.
8. Identify and describe the ethnobotanical uses of the items mentioned in the syllabus.

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2. Cronquist A, 1968. The evolution and Classification of Flowering Plants.
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Core Course XII: BIOTECHNOLOGY AND BIOINFORMATICS (BOT6CRT0419)

54 Hours **3 Credits**

Course Outcomes

- Perform basic plant tissue culture experiments for propagation and conservation of plants
- Explore the possibilities of rDNA technology.
- Make use of the basic softwares in bioinformatics
- Practice the various techniques in rDNA technology
- Design experiments in rDNA technology

BIOTECHNOLOGY

Module I **(16 Hours)**

Plant tissue culture and its Applications

Biotechnology - an overview; plant tissue culture - basic concepts, totipotency, differentiation, de-differentiation and re-differentiation. Tissue culture media: components, role of plant growth regulators in tissue culture. Preparation of MS medium; sterilization of equipments, glassware and culture medium, surface sterilization of explants.

Micropropagation, methods - axillary bud proliferation, adventitious regeneration – shoot organogenesis and somatic embryogenesis - direct and indirect; meristem culture. Stages of micropropagation, hardening and transplantation. Advantages and disadvantages of micropropagation - somaclonal variations. Embryo culture, callus and cell suspension culture, in vitro production of haploids - anther and pollen culture; uses of haploids. Protoplast culture: isolation of protoplast, culture methods, applications; protoplast fusion - cybrids. Artificial seeds, advantages and disadvantages. In vitro production of secondary metabolites; cell immobilization, bioreactors (brief study only).

Module II **(10 Hours)**

Recombinant DNA technology and its applications

Steps in rDNA technology, cloning vectors and their desirable properties; plasmids, cosmids, phage vectors, Phasmids; structure and applications of pBR322, Ti plasmid. Cutting and joining of DNA molecules - Restriction endonucleases and ligases - ligation

techniques. Transformation and selection of transformants - using antibiotic resistances markers and complementation.

Achievements of recombinant DNA technology: in medicine (Human insulin and recombinant vaccines- any two); in agriculture – Bt cotton, Flavr savr tomato; in environmental cleaning - super bugs.

Module III **(10 Hours)**

Techniques in rDNA technology

DNA isolation, agarose gel electrophoresis, southern hybridization, autoradiography. DNA finger printing and its applications. PCR and its applications. DNA sequencing by Sanger's dideoxy method. UV trans-illuminator, gel documentation system and Laminar Air Flow chamber (brief account only).

GENOMICS AND BIOINFORMATICS

Module IV **(18 Hours)**

Genomics and Basic bioinformatics

A brief account on genomics and proteomics; major findings of the following genome projects – E. coli, Human, Arabidopsis thaliana.

An introduction to bioinformatics, objectives and applications of bioinformatics. Biological data bases: types - primary, secondary and composite databases; nucleotide sequence databases – NCBI (GenBank), EMBL, DDBJ; Protein Sequence databases - SWISS-PROT, PIR; Protein structure database – PDB; bibliographic database – PubMed.

Module V **(7 Hours)**

Sequence analysis and molecular phylogeny

Sequence analysis tools - BLAST and FASTA, Molecular visualisation tool - RASMOL (basic commands), Sequence alignment - global and local alignment, Pairwise and multiple sequence alignment; common software used in alignment - CLUSTAL W & CLUSTAL X. Molecular phylogeny - homologs, orthologs and paralogs; phylogenetic tree - rooted and unrooted tree, advantages of phylogenetic tree, Common softwares-

PHYLIP, MEGA.

Core Course XII: BIOTECHNOLOGY AND BIOINFORMATICS PRACTICAL (BOT6CRP0419)

(36 Hours)

PRACTICAL

1. Preparation of nutrient medium – Murashige and Skoog medium (Demonstration only).
2. Sterilization and inoculation of plant tissue in culture media.
3. Preparation of synthetic seed using sodium alginate.
4. Isolation of DNA from plant tissue.
5. Agarose gel electrophoresis of the isolated DNA (Demonstration only).
6. Familiarise the instruments and techniques included in the syllabus such as Autoclave, laminar air flow chamber, UV- trans-illuminator, PCR machine, Electrophoresis apparatus, centrifuge, Agrobacterium, T-DNA, membrane filter, micropipette etc. and prepare short notes with diagrammatic sketch or photographs.
7. Familiarizing GENBANK, DDBJ, ENA, SWISS-PROT and PDB databases (Demonstration only).
8. Analysis of structural features of proteins using RASMOL.
9. Familiarise with BLAST (Demonstration only).
10. Retrieving two research papers related to genetic engineering from PubMed (Demonstration only).
11. Visit to a Biotechnology or Plant Tissue Culture lab to familiarise with the recent developments in the field and submission of a report.

References

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3. G Smita Rastogi and Neelam Pathak. Genetic Engineering.Oxford Higher Education.

4. Jean-Michel Claverie, Cedric Notredame. Bioinformatics: A beginner„s Guide. Wiley India.
5. David W Mount. Bioinformatics: sequence and genome analysis. CBS Publishers.
6. Cynthia Gibas and Per Jambeck.Developing Bioinformatics and Computer Skills. O„Reilly.
7. T A Brown, 2002. Genomes.Wiley-Liss.
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Open Course

Open course (For Other Streams): AGRI-BASED MICROENTERPRISES (BOT5COT0119)

72 Hours **3 Credits**

Course Outcomes

- Explain sustainable agriculture and organic farming practices and its scope in the context of food, health and environmental security point of view.
- Examine the opportunities and potentials in the field of food processing technology
- Demonstrate various skills in agronomy, food technology .
- Devise and develop methods for skill acquisition in mushroom spawn production, mushroom cultivation and value addition/marketing.
- Explain various types of horticultural practices.

Module I **(14 Hours)**

Scope of Agri-based microenterprises and Organic farming in Kerala

Basic information about the business opportunities in plant sciences like ornamental gardening, nursery management, mushroom cultivation, Inform students about the scope and importance of sustainable agriculture and organic farming value addition and food preservation etc.

Definition of organic agriculture/ farming, sustainable agriculture, LEISA (Low External Input Sustainable Agriculture).Basic inputs of organic farming. Advantages of organic manures and fertilizers. Composition of fertilizers – NPK content of various fertilizers. Common organic manures – bone meal, cow dung, poultry waste, oil cakes, organic mixtures and compost. Preparation of compost - aerobic and anaerobic - advantages of both; vermicompost - preparation, vermiwash. Biofertilizers: definition, types – Trichoderma, Rhizobium, PGPR. Biopesticides – Tobacco and neem decoction. Preparation of panchagavya, fish amino acids. Green manure and green leaf manure. Use of Azolla and weeds for manuring/ composting. Biological control. Organic certification, Organic certification agencies in Kerala/India. Organic market outlets and selling organic products based on geographical index/ tagging.

Module II **(18 Hours)**

Horticulture and Nursery management

Soil components. Preparation of potting mixture. Common garden tools and implements. Methods of plant propagation - by seeds - advantages and disadvantages. Vegetative propagation - advantages and disadvantages. Natural methods of vegetative propagation. Artificial methods - cutting, grafting, budding and layering. Use of growth regulators for rooting. Gardening - types of garden - ornamental, indoor garden, kitchen garden, vegetable garden for marketing, Model kitchen garden in one cent land (Design and plants to be included for nutritional/ food security point of view). Scope of organic selling outlets and organic products based on geographical index or tags.

Module III **(8 Hours)**

Food spoilage and preservation techniques

Causes of spoilage. Preservation techniques - asepsis, removal of microorganisms, anaerobic conditions and special methods – by drying, by heat treatment, by low temperature storage and by chemicals (Food Additives). Preparation of wine, vinegar and dairy products.

Module IV **(9 Hours)**

Mushroom cultivation and Spawn production

Types of mushrooms - button mushroom, oyster mushroom and milky mushroom, poisonous mushroom – methods of identification. Spawn – isolation and preparation. Cultivation of milky/oyster mushrooms – using paddy straw and saw dust by polybag. Value added products from mushroom – pickles, candies, dried mushrooms. Pests and diseases of mushrooms.

Module V **(9 Hours)**

Plant tissue culture and micropropagation

Concept of totipotency. Micropropagation: different methods – shoot tip, axillary bud and meristem culture; organogenesis, somatic embryogenesis. Infra structure of a tissue

culture laboratory. Solid and liquid media - composition and preparation. Sterilization techniques. Explant - inoculation and incubation techniques. Stages of micropropagation – hardening and transplantation. Packaging and transportation of tissue culture regenerated plantlets.

HANDS ON TRAINING (16 Hours)

1. Prepare a chart showing the NPK composition of minimum 6 manures and fertilizers. (1 hour)
2. Identification and familiarization of the following organic manures: cow dung (dry), Coconut cake, vermicompost, neem cake, organic mixture, bone meal. Preparation of potting mixture (2 hours).
3. Make a vermicompost pit /pot in the campus/ house of the student (1 hour).
4. Familiarization of common garden tools and implements (1 hour).
5. Estimation of germination percentage of seeds and Demonstrate the effect of a rooting hormone on stem cutting (1 hour).
6. Demonstration of T budding and air layering on live plants (2 hours).
7. Familiarization of garden components from photographs (1 hour).
8. Preparation of vinegar/dairy product (any two) in class or home (2 hours).
9. Familiarization of different mushrooms and preparation of a polybag of Pleurotus using straw/sawdust (3 hours).
10. Visit to a well established tissue culture lab, nursery and mushroom cultivation unit (2 hours).

References

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Elective Course

Elective course: AGRIBUSINESS (BOT6CBT0119)

54 Hours **3 Credits**

Course Outcomes

- Identify the business opportunities in the field of plant sciences.
- Discover opportunities and potentials in the field of nursery management, food processing,
- Employ new methods in preservation and value addition technology.
- Practice sustainable agriculture and organic farming, organic certification and marketing organic products based on geo-tagging.
- Develop new mushroom cultivation techniques and preparation of value-added mushroom products and its marketing.

Module I **(10 Hours)**

Entrepreneurship and Value-added food products

Basic qualities of an Entrepreneur, functions of an entrepreneur. Types of entrepreneurs. Entrepreneurial practices in India. Financial assistance from Banks, role of Institutions like MSME Training Institute, Khadi and village industries board, self help groups, Co-operative sector, Kudumbasree projects and microenterprises.

Preparation and preservation techniques, causes of spoilage of food. Principles of preservation - asepsis, removal of microorganisms, anaerobic situation and special methods - drying, thermal processing - pasteurization, sterilization and canning - low temperature, use of chemical preservatives and food additives. Preparation of wine, vinegar, pickles, jam, jelly, syrups, dairy products - cheese, butter, yoghurt, paneer.

Module II **(8 Hours)**

Processing techniques

Processing, storage and marketing of Cocoa, Coconut (Copra ,Coir and Tender coconut), Rice (par boiled, raw rice and rice flour), Pepper, Cardamom, Ginger, Arrowroot, Tapioca, Cashew, Mango, Jack fruit, Guava, Grapes, Lemon, Papaya,

Musa, Garcinia.

Module III **(12 Hours)**

Nursery management,Organic farming and composting techniques Preparation of potting mixtures, polybags. Plant growing structures - green houses, shaded houses, polyshed, mist chamber, sprinkling system, drip irrigation. Modern strategies in propagation by root initiation of cutting, layering technique, budding and grafting technique; micropropagation. Planting, transplanting and hardening of seedlings, after care of seedlings. Packing and transport of seedlings.

Organic farming: definition, scope and significance, list out various inputs contributing organic farming. Organic certification: definition, scope. Organic manures and fertilizers, composition of fertilizers.NPK content of various fertilizers and preparation of fertilizer mixtures. Common organic manures - bone meal, cow dung, poultry waste, oil cakes, organic mixtures and compost. Preparation of compost - aerobic and anaerobic - advantages and limitations. Vermicompost - preparation; Vermiwash - preparation. Biofertilizers - definition and preparation of different types - Trichoderma, Rhizobium, PGPR, PSB, mycorrhiza. Application of biofertilizers. Biopesticides, Tobacco and Neem decoction. Biological control of disease and pests.

Module IV **(10 Hours)**

Floriculture Apiculture and Flower arrangement

Floriculture: problems and prospects of floriculture in Kerala. Scope of growing Anthurium, Orchids and Jasmine in Kerala. Common cut flowers - Rose, Gerbera, Gladiolus, Aster, Chrysanthemum, Anthurium and Orchids. Common leaves used in flower arrangement - Cyprus, Podocarpus, Asparagus, Palms, Cycads and Ferns. Apiculture: scope and significance. Structure, installation and maintenance of an Apiarium. Extraction, processing, preservation and marketing of honey.

Types - Western, Eastern (Japanese/ Ikebana) and modern. Vases, flower holders and floral foam. Vase life of flowers and leaves. After care of flower arrangements – Bouquets. Packing and maintenance of flowers and leaves.

Module V **(14 Hours)**

A. Cultivation of different category of plants Ornamental garden designing, Cultivation of vegetables, fruits and medicinal plants (9 Hours)

Garden components. Lawn preparation by seeds, seedling and turfing. Maintenance of garden by Irrigation, Pruning, Repotting. Disease and Pest control

Types - home gardening, market gardening and truck gardening. Packing and transporting of vegetables and fruits. Induction of flowering and weed control. Cultivation of medicinal and aromatic plants of common use and great demand.

B. Mushroom cultivation and farming (5 Hours)

Mushrooms: significance, nutritive value. Types of Mushrooms – Button – Pleurotus, Volvorella. Spawn production, storage and marketing. Growth of Mushrooms on paddy straw and saw dust by poly bag. Mushroom growing structures and maintenance of humidity. Pests and defects of mushrooms. Storage, transporting and marketing of mushrooms.

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17. Purohit S S, 2005. Plant Tissue Culture. Student Edition.

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20. Sharma R R, 2005. Propagation of Horticultural Crops.Kalyani Publishers.

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1.

Complementary Courses: Semester I

CRYPTOGAMS, GYMNOSPERMS AND PLANT PATHOLOGY (BOT1CMT0119)

36 Hours **2 Credits**

Course Outcomes

- Distinguish the different classes of Algae.
- To comprehend the structure and reproduction of various genera of fungi and lichen.
- Compare the characteristic features of Bryophytes and Pteridophytes.
- Explain the Characteristic features of Gymnosperms.
- Diagnose plant diseases and adopt proper control measures.

CRYPTOGAMS

Module I **(13 Hours)**

Algae

General characters of algae and their classification up to classes (F E Fritsch); range of thallus variation in Algae. Reproduction and life history of the following groups with reference to the types mentioned: Cyanophyceae - Nostoc; Chlorophyceae - Oedogonium (Volvox, Spirogyra, Cladophora - vegetative features only); Phaeophyceae – Sargassum; Rhodophyceae – Polysiphonia. Economic importance of Algae: food, industry, medicine, biofertilizers; algal bloom.

Module II **(9 Hours)**

Fungi and lichens

General characters and outline on the classification of fungi by Ainsworth. General characters, thallus structure, reproduction and life history of the following groups with reference to the types mentioned: Zygomycotina – Rhizopus; Ascomycetes – Xylaria; Basidiomycetes – Puccinia.

Economic importance of Fungi: as food, industry, decomposition of organic matter. Fungal toxins and human health.

Lichens: Classification based on thallus morphology. Usnea - morphology and anatomy of vegetative and reproductive structure. Economic importance of lichen: food, industry,

medicine.

Module III **(9 Hours)**

Bryophytes, Pteridophytes and Gymnosperms.

a) Bryophytes,

General characters of Bryophytes. Morphology, anatomy, reproduction and life cycle of Riccia.

b) Pteridophytes

General characters of Pteridophytes. Morphology, anatomy (stem), reproduction and life cycle of Selaginella.

c) Gymnosperms

General characters of Gymnosperms. Morphology, anatomy (leaf let), reproduction and life cycle of Cycas.

PLANT PATHOLOGY

Module IV **(5 Hours)**

Plant diseases Classification of plant diseases on the basis causative organism and symptoms. Study the following diseases with special emphasis on causative organism, symptoms and control measures: (i) Nut fall of Arecanut (ii) Bacterial blight of Paddy (iii) Leaf mosaic of Tapioca.

PRACTICAL **(36 Hours)**

1. Micropreparation and identification preparation of the following:

a) Algae: vegetative structure of Nostoc, Volvox, Spirogyra, Oedogonium, Cladophora,

b) Polysiphonia. Vegetative and reproductive structure of Sargassum.

c) Fungi: vegetative and reproductive structure of Rhizopus, Xylaria, Puccinia.

d) Lichen: morphology of Usnea thallus and Apothecium.

e) Bryophytes: Riccia thallus anatomy.

f) Pteridophytes: Selaginella - anatomy of stem and morphology of strobilus.

g) Gymnosperms: Cycas - Anatomy of leaflet, morphological features of megasporophyll,

h) microsporophyll and ovule.

2. Identify plant diseases mentioned in the syllabus.

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Complementary Courses: Semester II

PLANT PHYSIOLOGY (BOT2CMT0119)

36 Hours **2 Credits**

Course Outcomes

- Explaining the physiological processes that regulate water absorption and translocation in plants growth and developmental processes.
- Analyse and identify the physiological factors that regulate growth and developmental processes and strategies used by plants for resource utilization.
- Using various aspects of physiological processes related to plant growth hormones in different environmental situations.
- Compare and apply the modern laboratory practices in understanding and applying their knowledge.
- Experiment their knowledge of plant physiology to relevant cultural, social, and legal aspects of their lives in development entrepreneurship in the area of plant physiology.

Module I **(8 Hours)**

Water relations

Plant water relations: Physical aspects of water absorption - Diffusion, DP, DPD. Imbibition.Osmosis - OP, Exosmosis, Endosmosis, Plasmolysis.Water potential and its components.Mechanism of water absorption by root - active and passive absorption. Movement of water towards xylem by apoplast and symplast pathway.

Module II **(8 Hours)**

Water absorption, water loss and nutrition of plants

a) Ascent of sap – theories - transpiration pull theory, root pressure theory; guttation.

b) Transpiration: types, mechanism of transpiration and stomatal movement (K+ - ABA theory), significance and factors affecting transpiration, antitranspirants.

c) Mineral nutrition - General account on micro and macro nutrients. Absorbable form, function and deficiency symptoms of the following mineral nutrients: N, P, K, Mg, B, Fe, Zn.

Module III **(10 Hours)**

Photosynthesis and associated processes

Basic requirements of photosynthesis: Light - PAR; organs and site of photosynthesis; chloroplast. Photosynthetic pigments, photosynthetic unit; red drop and Emerson's enhancement effect; two pigment systems.

Mechanism of photosynthesis: light dependent reaction - cyclic and non-cyclic photo phosphorylation. Light independent reaction (dark reactions) C3 cycle, brief account on C4 and CAM cycles. Factors affecting photosynthesis. Photorespiration (brief study only).

Module IV (10 Hours)

Translocation of photosynthates, plant growth and dormancy

A. Translocation of photosynthate and organic solutes: path of translocation, mechanism of translocation (Pressure Flow Hypothesis). (3hrs)

B. Growth: Phases of growth, plant growth regulators - auxins, gibberellins, cytokinins, abscissic acid and ethylene and their physiological role (brief study only). Photoperiodism - definition, short day plants, long day plants, day neutral plants. Plant movements. (4hrs)

C. Seed dormancy - causes of seed dormancy - methods of breaking dormancy. Germination of seeds - physiological changes. (3hrs)

PRACTICAL (36 Hours)

Core Experiments:

1. Compare the rate of photosynthesis under varying environmental condition using suitable device.
2. Separation of leaf pigments by paper chromatography.
3. Compare the stomatal indices of hydrophytes and mesophytes.

Demonstration experiments:

1. Demonstration of osmosis using potato tuber osmoscope / Papaya petiole osmoscope.
2. Relationship between transpiration and absorption.

3. Measurement of growth using arc auxanometer.
4. Demonstration of geotropism using clinostat.
5. Evolution of oxygen during photosynthesis.
6. Mohl's half leaf experiment.
7. Demonstration of plasmolysis.

References

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2. Jain V K, 2008.Fundamentals of Plant Physiology. S Chand and Co.
3. Kochhar P L, Krishnamoorthy H N. Plant Physiology. Atmaram and sons, Delhi.
4. Kumar and Purohit. Plant Physiology: Fundementals and Applications. Agrobotanical Publishers.
5. Malik C P, 2002. Plant Physiology. Kalyani publishers.
6. Mukherjii S, Ghosh AK, 2005.Plant Physiology.New Central Book Agency, Culcutta.
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Complementary Courses: Semester III

ANGIOSPERMTAXONOMY AND ECONOMICBOTANY (BOT3CMT0119)

54 Hours **3 Credits**

Course Outcomes

- Describe plants using technical terms.
- Identify common Angiosperms (belonging to families prescribed in the syllabus) species systematically.
- Prepare herbarium sheets following international herbarium methods
- Improve their observation and drawing skills during dissection of a flower.
- Identify common and economically useful plants in the various families.

ANGIOSPERM TAXONOMY

Module I **(10 Hours)**

Morphology

Leaf - simple, compound; venation and phyllotaxy. Flower as a modified shoot, structure of flower - floral parts, their arrangement, relative position; cohesion and adhesion of floral parts, symmetry of flowers; types of aestivation and placentation; floral diagram and floral formula. Inflorescence: racemose - simple, spike, spadix, catkin, corymb, umbel and head; cymose - simple, monochasial- helicoid and scorpoid; special types – cyathium, verticillaster. Fruits: outline on the classification; Simple: Fleshy - drupe, berry, hesperidium; Dry - Dehiscent - legume, capsule; Indehiscent - Caryopsis, Cypsella, Schizocarpic - lomentum, carcerulus, regma, cremocarp with examples. Aggregate. Multiple: sorosis, syconus. (Examples should be from families prescribed in the syllabus).

Module II **(8 Hours)**

Plant classification and herbarium techniques

Importance of plant classification, types of classification - artificial, natural and phylogenetic (brief account only); binomial nomenclature; ICBN (brief account only). Bentham and Hooke's system of classification (up to series) and its merits and demerits. Cytotaxonomy and chemotaxonomy (brief account only). Herbarium techniques; importance of herbarium. A brief study on the importance of Botanical Gardens.

Module III **(18 Hours)**

Angiosperm families

Study of the following families of Bentham and Hooker's system of classification with special reference to major identifying characters and economic importance: Annonaceae, Malvaceae, Rutaceae, Leguminosae (Caesalpiniaceae and Fabaceae), Apiaceae (Umbelliferae), Rubiaceae, Asteraceae (Compositae), Apocynaceae, Solanaceae, Lamiaceae (Labiatae), Euphorbiaceae, Zingiberaceae, Poaceae (Gramineae).

ECONOMIC BOTANY

(18 Hours)

Module IV **(10 Hours)**

Classes of economically important plants

Classification of economically important plants based on their uses. Study of the following groups of plants with special reference to their botanical name, family, morphology of useful part, economic products and uses: Cereals - Paddy, Wheat; Pulses - Green gram, Bengal gram; Tuber crops - Tapioca; Spices - Pepper, Cardamom; Beverages - Tea, Coffee; Oil yielding plants - Coconut, Groundnut; Fibre yielding plants - Cotton, Coir; Timber yielding plants - Teak, Rose wood; Latex yielding plants - Para rubber, Sapota fruit; Bio pesticides - Neem, Tobacco; Ornamental plants - Orchids, Anthurium.

Module V **(8 Hours)**

Medicinal plants

Study of the following medicinal plants with special reference to their binomial, family, morphology of useful parts and uses: Adhatoda, Aloe, Bacopa, Catharanthus, Eclipta, Neem, Ginger, Turmeric, Ocimum, Phyllanthus amarus, Rauvolfia.

ANGIOSPERMTAXONOMY AND ECONOMICBOTANY- PRACTICAL (BOT3CMP0119)

36 Hours

1. Students should be trained to identify the different types of inflorescence and fruits of typical plants belonging to the families prescribed in the syllabus.
2. Students should be trained to identify typical local plants belonging to the families prescribed in the syllabus.
3. Students should be trained to describe the floral parts in technical terms and draw the L.S. of flower, construct the floral diagrams and write the floral formula of at least one flower from each family.
4. Study of the groups of plants mentioned in the economic botany syllabus with special reference to their botanical name, family, morphology of useful part, economic products and uses.
5. Students should study the botanical name, family, morphology of the useful part and the uses of the medicinal plants listed in the syllabus.
6. Students to be trained for herbarium techniques.

References

1. Eames A J, 1969. Morphology of Angiosperms. McGraw Hill, New York.
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7. Pandey S N, S P Misra, 2008. Taxonomy of Angiosperms. Ane Books India, New Delhi.
8. Sharma O P, 1993. Plant Taxonomy. Tata McGraw Hill Publishing Co Ltd., New Delhi.
9. Simpson B S, M Conner – Ogorzaly, 1986. Economic Botany: Plants in Our World. McGraw Hill Book Company, New York.
10. Singh G, 1999. Plant Systematics – Theory and Practice.Oxford & IBH, New Delhi.

Complementary Courses: Semester IV

ANATOMY AND APPLIED BOTANY (BOT4CMT0119)

54 Hours **3 Credits**

Course Outcomes

- Differentiate plant and plant parts anatomically.
- Identify plants with morphological and anatomical adaptations growing in different habitats.
- Take microscopic sections, handle related instruments and prepare good slides for microscopic observations.
- Explore various potentialities of horticulture and vegetative propagation methods.
- Investigate opportunities of plant tissue culture in improvement of crop plants.

PLANT ANATOMY **(27 Hours)**

Module I **(9 Hours)**

Cells and tissues Gross structure of primary and secondary cell walls; structure and function of plasmodesmata; non-living inclusions - cystolith, raphides; Tissues – meristematic and permanent, types of meristems; simple and complex tissues, secretory tissues (nectaries, hydathodes, mucilage ducts and lactiferous tissue).

Module II **(9 Hours)**

Anatomy of plant organs Primary structure of stem and root in dicots and monocots; anatomy of monocot and dicot leaf. Secondary thickening in dicot stem and dicot root, heart wood and sap wood; tyloses; hard wood and soft wood; growth rings, dendrochronology.

Module III **(9 Hours)**

Anomalous secondary growth and ecological anatomy Anomalous secondary thickening in Bignonia.Study of the morphological and anatomical adaptations of the following groups: Hydrophytes – Nymphaea, Hydrilla; Xerophytes – Nerium; Epiphytes – Acampae

APPLIED BOTANY

Plant breeding, Horticulture and Micropropagation (27 Hours)

Module IV (12 Hours)

Plant breeding

Objectives of plant breeding, methods of plant improvement - plant introduction, acclimatization, plant quarantine; selection - mass selection, pureline selection and clonal selection; hybridization - intervarietal, interspecific and intergeneric; procedure of hybridization.

Module V (15 Hours)

Horticulture (6 Hours)

Propagation of plants through cutting, layering - air layering; budding T and patch budding; grafting - tongue and splice grafting. Role of cambium in budding and grafting.

Micropropagation (9 Hours)

Principles of tissue culture, micropropagation - different steps - selection of explants, culture media – general composition and preparation; sterilization of media and explants; callus. Regeneration of plants: organogenesis, somatic embryogenesis; artificial seeds. Applications of plant tissue culture.

ANATOMY AND APPLIED BOTANY–PRACTICAL (BOT4CMP0119)

36 Hours

1. Primary structure of stem and root of dicots and monocots; Dicot stem - Centella; Monocot stem – Bamboo, grass, asparagus; Dicot root - Tinospora; Monocot root - Colocasia, Musa.
2. Structure of dicot stem and dicot root after secondary thickening; Stem - Vernonia, Eupatorium; Root - Tinospora, Papaya.
3. Anomalous secondary thickening in Bignonia.
4. Anatomical adaptations of Hydrophytes - Nymphaea petiole, Hydrilla stem; Xerophytes - Nerium Leaf; Epiphytes - Velamen root of Acambae.
5. Emasculation of Pea or Caesalpinia flower.
6. Demonstrate T and patch budding.
7. Demonstration of tissue culture techniques: culture media, surface sterilization and inoculation of explants.
8. Identification of non-living inclusions - cystolith, raphides.

References

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Gist of Changes

Gist of Changes proposed in the syllabus of B.Sc. BOTANY from 2019 admission onwards-

SEMESTER	PAPER	Module	CHANGES	
			ORIGINAL	MODIFIED
I	METHODOLOGY OF SCIENCE AND AN INTRODUCTION TO BOTANY	2	Origin and evolution of life (10 hrs) Evidences of evolution; theories of evolution – Wallace Whole mounts and sections – use of whole mounting,	Origin and evolution of life (10 hrs) Evidences of evolution; theories of evolution - ~~Wallace,~~ is replaced with -Wiesman, Whole mounts and sections – use of whole mounting, has been included in theory and practical as well. Preparation of whole mounts

II	MICRO BIOLO GY, MYCOL OGY AND PLANT PATHO LOGY	PR AC TIC AL	Demonstrate the culture of bacteria: Microbes and type of fermentation - wine, vinegar, curd.	Demonstrate the culture of bacteria: *E.coli/Lactobacillus (*specification made). Microbes and type of fermentation involved in- wine, vinegar, curd. (specification made)
III	PHYCO LOGY AND BRYOL OGY	2	Polysiphonia	Polysiphonia (removed and replaced with Gracilaria)
IV	PTERID OLOGY, GYMN OSPER MS AND PALEO BOTAN	2 2 P ra ct ic al s	Marsilea Marsilia Study of fossil Bryophyte - Naiaditalanceolata;	Marsilea (REPLACED WITH Azolla) Marsilea (REPLACED WITH Azolla) Study of fossil Bryophyte – Naiadita lanceolata; (REMOVED)

	Y	7 6		
V		Practical	Study of cell types and tissues. Primary structure root stem and leaf-Dicots and Monocots.	Study of simple and complex tissues. Monocot stem- Cypress/ Bamboo Monocot root- Musa/ Colocassia Dicot stem- Centella/ Cephalandra Dicot stem – Vernonia, Eupatorium and Leucas (Any two) (Types have been mentioned specifically)

	PLANT ANATOMY,REPRODUCTIVE BOTANY AND MICROTECHNIQUE ANATOMY, REPRODUCTIVE 5. 5.BOTANY AND MICROTECHNIQUE			

V	RESEARCH METHODOLOGY, BIOPHYSICS AND BIOSTATISTICS	3 Practical 6 Practical PRACTICAL	SUM, MEAN,MEDIAN and MODE), Libre Office Prepare a worksheet using a set of data collected and find out the SUM. Tests of significance: Chi-squire test - uses, procedure. Problems related to ….	Deleted- (SUM, MEAN,MEDIAN MODE), and Libre Office, Deleted- Prepare a worksheet using a set of data collected and find out the SUM. Added- applications of biostatistics, mean deviation, Added- Probability: Definition, mutually exclusive events, independent events, rules of probability (brief account only). Deleted- Tests of significance: Chi-squire test - uses, procedure. Added- mean deviation, probability (Deleted- Chi-square test)

V	PLANT PHYSIOLOGY AND BIOCHEMISTRY	1 111 1 6 888 8	Module 1 Water relations (6 hrs) Plant water relations - diffusion, imbibition, osmosis, OP, DPD, TP; water potential - concepts and components (pressure potential, gravity potential, osmotic potential and matric potential). Module 8 Classification and nomenclature, mechanism of action. Enzyme kinetics, Michaelis-Menten constant (brief study only). Factors affecting enzyme action.	Module 1: Water relations (6 hrs) Plant water relations - diffusion, imbibition, osmosis, OP, DPD, TP; water potential - concepts and components. Module 8 Classification and nomenclature, mechanism of action. Holoenzyme, apoenzyme, cofactors Enzyme kinetics, Michaelis-Menten constant (brief study only). ~~Regulation of enzyme action.~~ Factors affecting enzyme action

V	ENVIRONMENTAL SCIENCE AND HUMAN RIGHTS	5 6	Module 5 has been expanded to 12 hours (originally 10) Module 6 has been reduced to 4 hours (originally 6) by the removal of some portions and briefing of some others	Module 5 has been expanded to 12 hours (originally 10) by some addition (Basic concepts in conservation- Green Protocol). Module 6 has been reduced to 4 hours (originally 6) by the removal of some portions (Declarations for women and children, Universal declaration of human rights. Human rights in India: fundamental rights and Indian constitution, rights for children and women, scheduled castes, scheduled tribes, other backward castes and minorities. issues of industrial pollution; prevention, rehabilitation and safety aspect of new technologies such as chemical and nuclear technologies, issues of waste disposal, protection of environment.) and briefing of some others (Conservation of natural resources and human rights: reports, case studies and

				policy formulation. Conservation issues of Western Ghats – Madhav Gadgil committee report, Kasturi Rangan report (Brief account).
V	OPEN COURSES 1. AGRI-BASED MICROENTERPRISES	2 3 5	Module 2: Organic farming and composting techniques: Biological control. Module 3: Horticulture and Nursery management- Module 5: Mushroom cultivation and Spawn production- Cultivation of milky mushrooms	Module 2: Organic farming and composting techniques: LEISA (Low External Input Sustainable Agriculture).Basic inputs of organic farming. (Added) Preparation of panchagavya, fish amino acids. Green manure and green leaf manure. Use of Azolla and weeds for manuring/ composting. Biological control. Organic certification, Organic certification agencies in Kerala/India Module 3: Horticulture and Nursery management- Model kitchen garden in one cent land (Design and plants to be

				included for nutritional/ food security point of view). Module 5: Mushroom cultivation and Spawn production- Cultivation of milky/oyster mushrooms. Pests and diseases of mushrooms. References added: Package of Practices and Recommendations published by Kerala Agricultural University, Thrissur
VI	GENETICS, PLANT BREEDING AND HORTICULTURE	3	Module 3: Linkage of genes (3 hrs) Linkage and crossing over: chromosome theory of linkage; crossing over - types of crossing over, mechanism of crossing over. Linkage map - 2 point cross, interference and coincidence. PRACTICAL Demonstration of	~~Module 3: Linkage of genes (3 hrs)~~ Deletions Linkage and crossing over: chromosome theory of linkage; crossing over - types of crossing over, mechanism of crossing over. Linkage map - 2 point cross, interference and coincidence. PRACTICAL

			hybridization in plants.	Demonstration of hybridization in plants.
VI	CELL AND MOLECULAR BIOLOGY	1 2 6 8 9	Module1: Ultra structure of cell components (8 hrs) Cell biology through ages: a brief history of cell biology. module 2: Chromosomes (6 hrs) Chemical composition of chromatin: histones and non-histones, arrangement of proteins and DNA in chromatin - the 10 nm fibre (nucleosome model), 30 nm fibre (solenoid model) and central axis with radial loops of 300 nm fibre. Module 6: The genetic material (8 hrs) direct evidences – transformation experiment by Avery et al.; Hershey and Chase Experiment. Evidences for RNA as genetic material in some viruses. Module 8: Gene expression	Module1: Ultra structure of cell components (9 hrs) ~~Cell biology through ages: a brief history of cell biology.~~ Landmarks in cell biology module 2: Chromosomes (5 hrs) Chemical composition of chromatin: histones and non-histones, ~~arrangement of proteins and DNA in chromatin - the 10 nm fibre (nucleosome model), 30 nm fibre (solenoid model) and central axis with radial loops of 300 nm fibre.~~ Nucleosome solenoid model Module 6: The genetic material (5 hrs) ~~direct evidences – transformation experiment by~~

			(8 hrs) Splicing. Module 9: Regulation of gene expression (5 hrs) Regulation in eucaryotes (brief account only). .	~~Avery *et al.*; Hershey and Chase Experiment. Evidences for RNA as genetic material in some viruses.~~ (Brief account) Module 8: Gene expression (9 hrs) processing of RNA Module 9: Regulation of gene expression (6 hrs) ~~Regulation in eucaryotes (brief account only).~~ Regulation in eukaryotes by RNA interference , alternative splicing .
VI	ANGIOSPERM MORPHOLOGY, TAXONOMY AND ECONOMIC BOTANY	2 2 4	Types of classification artificial Rule of priority and author citation Timber yielding plants	Types of classification – artificial- Linnaeus, Phylogenetic – Engler and Prantl specified. Rule of priority and author citation (REMOVED) Timber yielding plants – Anjili (Wild Jack) wood and Resins – Chickle has been added

VI	BIOTECHNOLOGY AND BIOINFORMATICS BIOTECHNOLOGY	2 3 5	In Module 2, Deletion (YAC and BAC, M13) Gene therapy has been replaced by recombinant vaccines- any two. Uses of refrigerated centrifuges GENOMICS AND BIOINFORMATICS Scoring matrices) and use of PHYLIP software PRACTICALS Practical 3 Establishing shoot tip, axillary bud cultures (Demonstration only)	In Module 2, removed (YAC and BAC, M13) added (Flavr Saver Tomato). Gene therapy has been replaced by recombinant vaccines- any two. but the special mention included ~~(Scoring matrices) and use of PHYLIP software~~ has been replaced by Common softwares- PHYLIP, MEGA.. Total number of modules in Bioinformatics becomes 2. So, total number of modules in the paper becomes 5. Practical 3 Visit to biotechnology or plant tissue culture lab to familiarise with the recent developments in the field and submission of a report.). The title for Practical 4 has been changed to Preparation

				of synthetic seed using sodium alginate. The title for Practical10has been changed to Familiarise with BLAST (Demonstration only).. In Practical 11, "the retrieval of a few research papers" has been changed to "two research papers".
VI	PE 1. PROGRAMME ELECTIVE COURSE AGRIBUSINESS	1 2 3	Module 1 Addition Module 2 sauce, dry fruits Module 3 Deletion Module 5 Addition Module 6 Deletion	Module 1 Added- functions of an entrepreneur. Types of entrepreneurs. Entrepreneurial practices in India. Module 2 Deleted- Module 3 Deleted- Processing of latex: centrifuged latex products and galvanized rubber products. Module 5 Added- Organic farming: definition, scope and significance, list out various inputs contributing organic farming. Organic certification: definition, scope. Module 6 Deleted- Organic farming of fruit crops

COMPLEMENTARY ZOOLOY				
1	CM 1. CRYPTOGAMS, GYMNOSPERMS AND PLANT PATHOLOGY			No Change
2	CM 2. PLANT PHYSIOLOGY	4 PRACTICAL	Growth - Vernalization Core Compare the stomatal indices of hydrophytes and xerophytes Demonstration of geographic using Clinostat. Light screen experiment.	Growth: ~~vernalization~~ Plant movements. Compare the rate of photosynthesis under varying environmental condition using suitable device. (Replaces Practical 1)

				Compare the stomatal indices of ~~hydrophytes~~ xerophytes and mesophytes. Demonstration of ~~geographic~~ geotropism using Clinostat. ~~Light screen experiment~~ Demonstration of plasmolysis.
3	CM 3. ANGIOSPERMTAXONOMYAND ECONOMIC BOTANY	2 3 4 5	Module 3 Mimosaceae, Arecaceae (Palmae Module 4 Rose Module 5 -*Sida*	Module 2 Added- A brief study on the importance of Botanical Gardens. Module 3 Deleted- Mimosaceae, Arecaceae (Palmae) Added- Solanaceae, Zingiberaceae Module 4 Added- Sapota fruit Deleted- Rose Module 5 Added- Ginger, Turmeric Deleted-*Sida* PRACTICAL Added- Students to be trained for herbarium techniques.

4	CM 4. ANATOMY AND APPLIED BOTANY	3	Module 3: Anomalous secondary growth and Ecological anatomy (9 hrs) Nymphaea, Hydrilla; Xerophytes – Nerium; Epiphytes - Vanda. Practicals Anatomical adaptations of Hydrophytes - Nymphaea petiole, Hydrilla stem; Xerophytes - Nerium Leaf; Epiphytes - Velamen root of Vanda,	Module 3: Anomalous secondary growth and Ecological anatomy (9 hrs) Nymphaea, Hydrilla; Xerophytes – Nerium; Epiphytes - ~~Vanda.~~ Acampae PRACTICAL (36 hrs) Anatomical adaptations of Hydrophytes - Nymphaea petiole, Hydrilla stem; Xerophytes - Nerium Leaf; Epiphytes - Velamen root of ~~Vanda,~~ Acampae.