SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
KOCHI, KERALA, 682013

CURRICULUM AND SYLLABI

CHOICE BASED CREDIT AND SEMESTER SYSTEM (CBCSS)

BSc BOTANY

INTRODUCED FROM 2023 ADMISSION ONWARDS

BOARD OF STUDIES IN BOTANY
Sacred Heart College, Thevara, Kochi, Kerala

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1. Introduction

Education in India is at a revolutionary turning point with the introduction of NEP 2020. Research, research related aspects and hands-on training are getting more emphasis nowadays. Changing scenarios in the job market also make the process of education highly competent and challenging. Meticulous planning and thorough background preparations, is needed to design the curriculum; especially when we need to update the syllabus with contemporary developments in the concerned subject areas. It is challenging to cope with the demand of the students and the society for quality higher education, especially in a scenario in which research and development is at a high pace. This requires focused effort to identify and update every area of the subject. The present syllabus is the reflection of systematic and meticulous effort to incorporate advanced fields in each course. The syllabus revision is aimed at maximizing competency, skill development, enhancing research aptitude and instilling compassion in students.

The BoS of the Department of Botany initiated the revision of the BSc curriculum in July 2020. Various tasks were assigned to each course teacher as part of a step-wise process. Meticulous care has been taken to implement plans that were proposed and approved by BoS meetings. The BoS Secretary, Mr. Ebin P J initiated the process of getting feedback from various stakeholders including alumni, students, parents, etc. The feedback was then compiled and discussed in the BoS and areas to be addressed were identified. This made the syllabus revision process easy and effective. Course teachers presented their plans about changes in the syllabus in the BoS meeting. Several brainstorming sessions and discussions resulted in bringing about the current shape of the revised curriculum. The revision of the present syllabus was mostly focused on updating information to enhance the quality of contents in the syllabus. The major focus areas while changing the syllabus were as follows;

- Content updation.
- Changes as per the requirements of various stakeholders.
- Areas that have advanced in the recent past
- Change of title based on change in the content.
- Managing credit-hour ratio.

The present syllabus also contains features that maximize employability, entrepreneurship and skill development. Factors such as gender sensitivity, human values, professional ethics, environment and sustainability have also been considered and included in the revised syllabus.

The following table illustrates the courses with major content changes.

1.1. List of courses with major content changes

Sl. No.	Title	Course	Course Code	Semester
1	Agribased Microenterprises	Open Course	23U5BOTOC1	V
2	Cell Biology, Molecular Biology and Evolution	Core	23U5CRBOTT8	V
3	Phytochemistry and Pharmacognosy	Elective	23U6CRBOTT13	VI
4	Angiosperm Taxonomy and Plant Animal Interactions	Complementary	23U3CPBOTT03	III
5	Angiosperm Anatomy and Applied Botany	Complementary	23U4CPBOTT4	IV

The present syllabus introduces a new area, ie. Plant Animal Interactions for the complementary (Zoology) students. The new subject area would be dealt with as an interdisciplinary subject where both plants and animals and their interactions are included. The basic definitions, characteristics and significance of various plant-animal interactions and examples for each interaction will be discussed in brief.

The revision also considered a few changes in the practical part with an aim to provide more options and opportunities for the students to have hands-on experience. Without experimentation, science learning would be a herculean task. We also tried to maximize students' skills that would be helpful for their academic and professional future.

1.2.List of courses with new course titles

Sl. No.	Semester	Course	Previous Course Code	Pervious Course Title	Revised Course Code	Revised Course Title
1	II	Core	19U2CRBOT2	Mycology, Lichenology and Plant Pathology	23U2CRBOTT2	Mycology, Lichenology and Plant Pathogen Interaction
2	IV	Core	19U4CRBOT4	Anatomy, Microtechnique and Angiosperm Morphology	23U4CRBOTT4	Angiosperm Morphology, Anatomy and Microtechnique
3	V	Core	19U5CRBOT6	Environmental Science and Ecotourism	23U5CRBOTT6	Ecology, Environmental Science and Ecotourism
4	VI	Core	19U5CRBOT8	Cell and Molecular Biology and Evolution	23U5CRBOTT8	Cell Biology, Molecular Biology and Evolution
5	III	Compl*	19U3CPBOT3	Angiosperm Taxonomy and Economic Botany	23U3CPBOTT3	Angiosperm Taxonomy and Plant Animal Interactions
6	IV	Compl*	19U4CPBOT4	Anatomy and Applied Botany	23U4CPBOTT4	Anatomy of Angiosperms and Applied Botany

*complementary course

2. REGULATIONS FOR CHOICE BASED CREDIT AND SEMESTER SYSTEM (CBCSS) FOR UNDER GRADUATE PROGRAMMES -2023

Preamble

Sacred Heart College, Thevara became an autonomous college under Mahatma University Kottayam in 2014. Since then, academic programmes of the college are being conducted as per the curriculum and syllabus approved by the various Boards of studies and the academic council of the college. The college revised the syllabi of the undergraduate (UG) programmes in 2015-16 and 2019-20. The curriculum and syllabus under the choice based credit and semester system (CBCSS) for the undergraduate programmes effective from 2019-20 admissions offer Outcome Based Education (OBE). The new 'REGULATIONS FOR CHOICE BASED CREDIT AND SEMESTER SYSTEM (CBCSS) FOR UNDER GRADUATE PROGRAMMES -2023' is a continuation of the effort of the college for providing best education to the UG students of the college.

2.1 Title

These regulations shall be called **"SACRED HEART COLLEGE THEVARA REGULATIONS FOR CHOICE BASED CREDIT AND SEMESTER SYSTEM (CBCSS) FOR UNDER GRADUATE PROGRAMMES -2023**

2.2 Scope

Applicable to all undergraduate (UG) programmes of the college with effect from 2023 admissions onwards, except otherwise approved by the Academic Council of the College

2.3 Definitions

i. '**Programme**' means the entire course of study and examinations.

ii. 'Duration **of Programme'** means the period of time required for the conduct of the programme. The duration of undergraduate programmes shall be 6 semesters, post-graduate programme shall be of 4 semesters and M Phil programmes shall be 2 semesters.

iii. **'Semester'** means a term consisting of a minimum of 90 working days, inclusive of examination, distributed over a minimum of 18 weeks of 5 working days, each with 5 contact hours of one hour duration

iv. **'Course'** means a segment of subject matter to be covered in a semester. Each Course is to be designed variously under lectures / tutorials / laboratory or fieldwork / study tour /seminar / project / practical training / assignments/evaluation etc., to meet effective teaching and learning needs.

v. '**Common Course I'** means a course that comes under the category of courses for English and '**Common Course II**' means additional language, a selection of both is compulsory for all students undergoing undergraduate programmes(Model I)

vi. '**Core course'** means a course in the subject of specialization within a degree programme.

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

viii. '**Open course'** means a course outside the field of his/her specialization, which can be opted by a student.

ix. '**Additional core course**' means a compulsory course for all undergraduate students (as per the UGC directive) to enrich their general awareness.

x. The U.G. programmes shall include (a) Common courses (b) Core courses (c) Complementary Courses (d) Open Course (e) Study tour and (f) Internship for selected programmes.

xi. '**Additional Course'** is a course in which a student is joined over and above the minimum required courses.

xii. **'Credit' (Cr)** of a course is the numerical value assigned to a course according to the relative importance of the content of the syllabus of the programme.

xiii. '**Extra credits**' are additional credits awarded to a student over and above the minimum credits required for a programme for achievements in co-curricular activities carried out outside the regular class hours OR curricular activities/courses completed for value addition, as directed by the College/ department. It is the numerical value assigned to Club activities, Social service, Internship, add on courses etc. which is not added with the total academic credits of the students. Additional credit components

(a) Talent and career club activity (optional)

(b) Social service (mandatory)

(c) Internship for Commerce, Communication and Computer applications (mandatory).

(d) Internship (desirable for other programmes).

(e) Add on courses (optional)

xiv. '**Programme Credit'** means the total credits of the UG Programme.

xv. **'Programme Elective course'** Programme Elective course means a course, which can be chosen from a list of electives and a minimum number of courses is required to complete the programme.

xvi. '**Programme Project'** Programme Project means a regular project work with stated credits on which the student undergoes a project under the supervision of a teacher in the parent department / any appropriate Institute in order to submit a dissertation on the project work as specified.

xvii. '**Internship**' is on-the-job training for professional careers.

xviii. '**Plagiarism**' Plagiarism is the unreferenced use of other authors' material in dissertations and is a serious academic offence.

xix. '**Tutorial'** Tutorial means a class to provide an opportunity to interact with students at their individual level to identify the strengths and weaknesses of individual students.

xx. '**Seminar'** means a lecture by a student expected to train the student in self-study, collection of relevant matters from the books and Internet resources, editing, document writing, typing and presentation.

xxi. '**Evaluation'** means every course shall be evaluated by 25% continuous (internal) assessment and 75% end course/end semester (external) assessment.

xxii. '**Repeat course'** is a course that is repeated by a student for having failed in that course in an earlier registration.

xxiii. **'Audit Course'** is a course for which no credits are awarded.

xxiv. '**Department'** means any teaching Department offering a course of study approved by the college / Institute as per the Act or Statute of the University.

xxv. '**Parent Department'** means the Department which offers a particular UG/PG programme in which a student get registered.

xxvi. '**Department Council'** means the body of all teachers of a Department in a College.

xxvii. **'Faculty Advisor'** is a teacher nominated by a Department Council to coordinate the continuous evaluation and other academic activities undertaken in the Department.

xxviii. '**College Co-ordinator** means a teacher from the college nominated by the College Council to look into the matters relating to CBCSS

xxix. **'Letter Grade'** or simply '**Grade**' in a course is a letter symbol (O, A, B, C, D, etc.) which indicates the broad level of performance of a student in a course.

xxx. Each letter grade is assigned a **'Grade point'** (GP) which is an integer indicating the numerical equivalent of the broad level of performance of a student in a course.

xxxi. **'Credit point'** (CP) of a course is the value obtained by multiplying the grade point

(GP) by the Credit (Cr) of the course CP=GP x Cr.

xxxii. '**Semester Grade point average'** (SGPA) is the value obtained by dividing the sum of credit points (CP) obtained by a student in the various courses taken in a semester by the total number of credits taken by him/her in that semester . The grade points shall be rounded off to two decimal places. SGPA determines the overall performance of a student at the end of a semester.

xxxiii. **Cumulative Grade point average'** (CGPA) is the value obtained by dividing the sum of credit points in all the courses taken by the student for the entire programme by the total number of credits and shall be rounded off to two decimal places.

xxxiv. '**Grace Marks'** means marks awarded to course/s, as per the orders issued by the college from time to time, in recognition of meritorious achievements in NCC/NSS/Sports/Arts and cultural activities.

2.4 Attendance

Being a regular college, physical presence in the regular activities, especially, classes and exams, is mandatory for the students. However, if a student secures 75% of attendance s/he is eligible to appear for the exams, provided there are no other impediments like disciplinary proceedings, malpractice record etc.

i. A maximum of 5 marks (5%) for a course is given for attendance

ii. **Absence:** A student found absent for one hour in the forenoon or afternoon session is deprived of the attendance for the entire session as far as eligibility for final exam is concerned.

iii. The hour related calculation in a course is meant for awarding marks for the course concerned.

iv. **Late entry**: A student is supposed to be on time in the class. Late arrival related treatment is left to the discretion of the individual teacher. However, as a norm, a late arriving student may be permitted to the class, if it is not inconvenient or a distraction to the class as such; though attendance MAY NOT BE GIVEN. Late arrival beyond 5 minutes is treated as ABSENCE; though the teacher may consider permitting the student to sit in the class.

v. **Leave**: A student has to formally report his/her absence with reasons either in advance, or immediately after the absence for obtaining an approved leave. This applies to all sorts of leave – medical, on duty or other.

vi. The student is supposed to report in prescribed format on the very next day of the absence; however, upto a week's time is permitted. Afterwards, the leave applications will not be considered.

vii. The student has to retain a copy/section of the approved leave form and produce the same as proof, in case there is any confusion regarding the leave sanctioning. In the absence of such proof, the claims will not be entertained.

viii. **Duty Leave**: A student representing the college in sports, arts, social service or academic matters, has to get sanction from the class teacher concerned and submit the leave application form duly endorsed by teacher concerned and the class teacher, and submit it to the faculty Dean (or Vice Principal). The same will be forwarded by the Dean/Vice Principal for attendance entry. **SPORTS**: The approval of the Department of Physical Education and the class teacher is required. The time limit for submission mentioned above is applicable in the case of duty leave as well.

ix. **Condonation**: a student may have the privilege of condonation of attendance shortage (upto a maximum of 10 days) on the basis of genuineness of the grounds of absence (medical reasons or college duty), duly recommended by the department. This is not a matter of right. It is a matter of privilege based on the Principal's discretion and the good conduct of the student on the campus. A student of UG programme may have a maximum of two such opportunities.

x. **Re-admission** – a student whose attendance is inadequate will have to discontinue the studies. Such students, whose conduct is good, may be readmitted with the approval of the Governing Body, on the basis of recommendation from the department, and assurance from the student and the guardian regarding good conduct and compliance in academic and discipline matters. For this the prescribed re-admission fee has to be paid.

As a condition for re-admission, the student should have cleared all academic arrears, or should have appeared for the exams in which he/she is having an arrear (if the results are not out), and should have fulfilled all academic assignments prescribed by the department for compensating for his lack of attendance.

xi. **UNAUTHORISED ABSENCE and REMOVAL FROM ROLLS**: A student absent from the classes continuously for 10 consequent days without intimation or permission, shall be removed from the rolls, and the matter intimated to the student

concerned. On the basis of recommendation of the department concerned, re-admission process may be permitted by the Principal.

2.5 Eligibility for admission

Pass in +2 Examination with Biology as an optional subject.

2.6 Programme Registration

i. A student shall be permitted to register for the programme at the time of admission.
ii. A UG student who registered for the programme shall complete the same within a period of 12 continuous semesters from the date of commencement of the programme.

2.7 Promotion

A student who registers for the end semester examination shall be promoted to the next semester. However, in extreme circumstances, a student having sufficient attendance who could not register for the end semester examination may be allowed to register notionally by the Principal with the recommendation of the Head of the department concerned and , by paying the prescribed fee.

2.8 Undergraduate Programme Structure

Model I BA/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 I/II 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	8
e	Credits required from Core and Complementary/ Vocational courses including Project	95
f	Open Course	3
g	Minimum attendance required	75%

Model II BA/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/B.Sc./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	Open Course	3
f	Minimum attendance required	75%

2.9 Examinations

All the End Semester Examinations of the college will be conducted by the Controller of Examination. The Principal will be the Chief Controller of Examinations. An Examination committee consisting of the Chief Controller of Examinations, Controller of Examinations, Additional Chief Superintendent, Deans, IQAC Coordinator and other faculty members nominated by the Principal will act as an advisory body of the matters relating to the conduct of examinations.

2.10 Evaluation and Grading

The evaluation scheme for each course shall contain two parts;

a. Continuous Internal Evaluation (CIA) and
b. End Semester Examination (ESE).

The internal to external assessment ratio shall be 1:3, for both courses with or without practical exception for (i) BA Animation and Graphics (ii) BA Animation and Visual effects and (iii) BBA. For courses without practical, there shall be a maximum of 75 marks for external evaluation and maximum of 25 marks for internal evaluation. For courses with practical, generally external evaluation shall be for a maximum of 60 marks and internal evaluation for 20 marks. Both internal and external evaluation shall be carried out in the mark system and the marks are to be rounded to the nearest integer.

The internal to external assessment ratio for BA Animation and Graphics, BA Animation and Visual effects and BBA shall be decided by the respective Board of studies subject to a minimum of 60 marks for external examinations.

2.10.1. Continuous Internal Assessment (CIA)/ Continuous Assessment

The internal evaluation shall be based on a predetermined transparent system involving periodic written tests, assignments, seminars/viva/field survey and attendance in respect of theory courses and based on written tests, lab skill/records/viva and attendance in respect of practical courses. The marks assigned to various components for internal evaluation as follows.

Components of Internal Evaluation (for theory without practical)

	Components	Marks
i.	Assignments	5
ii	Seminar/Quiz/Field survey /Viva etc.	5
iii	Attendance	5
iv	Two Test papers(2x5)	10
	Total	**25**

i. **Assignments**: Every student shall submit one assignment as an internal component for every course.

Components	Marks
Punctuality	1
Content	2
Conclusion	1
Reference/Review	1
Total	**5**

ii. **Seminar**: The seminar lecture is expected to train the student in self-study, collection of relevant matters from the books and Internet resources, editing, document writing, typing and presentation.

Components	Marks
Content	2
Presentation	2
Reference/Review	1
Total	**5**

iii. Evaluation of Attendance

The attendance of students for each course shall be another component of internal assessment.

% of attendance	Mark
Above 90%	5
Between 85 and below 90	4
Between 80 and below 85	3
Between 76 and below 80	2
Between 75 and below 76	1

Components of Internal Evaluation (for theory with practical)

Components of Theory – Internal Evaluation	**Marks**
Attendance	5
Seminar/ Assignment (Written assignments, preparation of models, charts, posters, field survey, field work etc.)	5
Test paper(s)	10
Total	**20**

Components of Practical- Continuous internal assessment

Components	**Marks**
Attendance and Lab involvement	2
Record	2
Viva/Model Exam	1
Total	**5**

iv. Class Tests: Every student shall undergo **two class tests** as an internal component for every course.

2.10.2 End Semester Examination (ESE)

The End Semester Examination in theory courses shall be conducted by the college

with question papers set by external experts/ question bank. The evaluation of the answer scripts shall be done by the examiners based on a well-defined scheme of evaluation given by the question paper setters/Prepared as per the direction of the Chairman, Board of Examiners. The evaluation of the End Semester Examinations shall be done immediately after the examination preferably through the centralised valuation.

2.10.3 Hands-on Training cum Project

Hands-on training cum Project work is a part of the syllabus of most of the programmes offered by the college. The guidelines for doing projects are as follows:

i. Hands-on training cum Project work shall be completed by working outside the regular teaching hours.
ii. Hands-on training cum Project work shall be carried out under the supervision of a teacher in the concerned department or an external supervisor.
iii. A candidate may, however, in certain cases be permitted to work on the project in an industrial / Research Organization/ Institute on the recommendation of the Supervisor.
iv. There should be an internal assessment and external assessment for the project work in the ratio 1:3
v. The external evaluation of the experimental part of the Hands-on training cum project work consists of valuation of the dissertation (project report) followed by presentation of the work and viva voce.
vi. The mark and credit with grade awarded for the Hands-on training cum project should be entered in the grade card issued by the college.

The following are the areas considered for hands on training:

1. Mushroom cultivation
2. Biodiversity Survey
3. Nursery Management
4. Flower arrangement and Vegetable carving
5. Topiary and Bonsai
6. Organic farming

7. Plant tissue culture
8. Natural fibre extraction and Handicrafts
9. Natural dyes and Mural painting
10. Vermi composting and Organic manure
11. Bio-fertilizers and Biological control
12. Floriculture and Cut flower marketing
13. Traditional and Natural food processing
14. Home-made Chocolate Making
15. Budding, Layering and Grafting

Components of Internal Evaluation for Hands-on training cum Projects

Components	**Marks**
Topic/Area selected	2
Experimentation/Data collection	5
Punctuality-Regularity	3
Results and Discussion	10
Presentation	5
Total	**25**

Components of External Evaluation for Hands-on training cum Projects

Components	**Marks**
Topic/Area selected	5
Experimentation/Data collection	15
Analysis	15
Results and Discussion	15
Presentation	10
Viva	15
Total	**75**

2.11 Grade and Grade Points

For all courses (theory and practical), Letter grades and grade point are given on a 10-point scale based on the total percentage of marks, (CIA+ESE) as given below:-

Percentage of Marks	Grade	Grade Point (GP)
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 Average	5
35 to below 45	D Pass	4
Below 35	F Fail	0
	Ab Absent	0

Grades for the different semesters and overall programme are given based on the corresponding SGPA/CGPA as shown below:

SGPA/CGPA	Grade
Equal to 9.5 and above	***S Outstanding***
Equal to 8.5 and below 9.5	***A+ Excellent***
Equal to 7.5 and below 8.5	***A Very Good***
Equal to 6.5 and below 7.5	***B+ Good***
Equal to 5.5 and below 6.5	***B Above Average***
Equal to 4.5 and below 5.5	***C Average***
Equal to 4.0 and below 4.5	***D Pass***
Below 4.0	***F Failure***

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. A candidate who has not secured minimum marks/credits in internal examinations can re-do the same registering along with the end semester examination for the same semester, subsequently. A student who fails to secure a minimum marks/grade for a pass in a course can be permitted to write the examination along with the next batch.

After the successful completion of a semester, Semester Grade Point Average (SGPA) of a student in that semester is calculated using the formula given below. For the successful completion of a semester, a student should pass all courses and score at

least the minimum CGPA grade **'D'**. However, a student is permitted to move to the next semester irrespective of her/his SGPA.

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

CP = Cr x GP, where Cr = Credit; GP = Grade point

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

SGPA = TCP/TCr, where

TCP = Total Credit Point of that semester $= \sum_1^n \quad CPi$**;**

TCr = Total Credit of that semester $= \sum_1^n \quad Cri$

Where n is the number of courses in that semester

Cumulative Grade Point Average (CGPA) of a Programme is calculated using the formula;

$$\textbf{CGPA} = \frac{\sum \quad (SGPA \times TCr)}{\sum \quad TCr}$$

$SGPA/CGPA\ shall\ be\ round\ off\ to\ two\ decimal\ places$

To ensure transparency of the evaluation process, the internal assessment marks awarded to the students in each course in a semester shall be published on the notice board/website at least one week before the commencement of external examination. There shall not be any chance for improvement for internal marks.

The course teacher and the faculty advisor shall maintain the academic record of each student registered for the course which shall be forwarded to the controller of examinations through the Head of the Department and a copy should be kept in the department for at least two years for verification.

2.12 Registration for the examination

a. All students admitted in a programme with remittance of prescribed fee are eligible for the forthcoming semester examinations.
b. Online application for registration to the various End Semester Examinations shall be forwarded to the CE along with prescribed fee for each course in prescribed format.

c. The eligible candidates who secure the prescribed minimum attendance of the total duration of the course and possess other minimum qualifications prescribed in the regulations for each course shall be issued the hall tickets. The hall ticket shall be downloaded by the students from the college website.

d. The mode of fee remittance shall be through the prescribed bank.

2.13 Supplementary Examinations

Candidates who failed in an examination can write the supplementary examination conducted by the College along with regular examinations.

2.14 Improvement of Examination

A candidate can improve his/her marks once by appearing again for the examination with the subsequent batch with the remittance of prescribed fee. In such cases the better of the two marks shall be taken as the marks awarded to him.

Internal assessment marks shall be carried over to the subsequent semester examination.

There shall not be any provision for improving internal assessment marks.

2.15 Promotion to the Next Higher Semester

A candidate shall be eligible for promotion from one semester to the next higher semester if;

a. He / she secures a minimum 75 % attendance and is registered for the End Semester Examination of the programme for which he/she is studying.

b. His / her progress of study and conduct are satisfactory during the semester completed, as per the assessments recorded by the course teachers and the Head of the Department concerned.

2.16 Certificates

1. Degree certificates are issued by the Mahatma Gandhi University, Kottayam as per the act and statues of the University on the submission of the consolidated mark / score cards of the students by the College.
2. A consolidated mark / scored card shall be issued to the candidates after the publication of the results of the final semester examination taken by the candidate.

3. A Course Completion Certificate with classification shall be issued to students till the provisional certificate is issued by the university.

2.16 Award of Degree

The successful completion of all the courses with 'D' grade shall be the minimum requirement for the award of the degree.

2.17 Monitoring

There shall be a Monitoring Committee constituted by the principal consisting of faculty advisors, HoD, a member from teaching learning evaluation committee (TLE) and the Deans to monitor the internal evaluations conducted by college. The Course teacher, Class teacher and the Deans should keep all the records of the internal evaluation, for at least a period of two years, for verification.

Every Programme conducted under Choice Based Credit System shall be monitored by the College Council under the guidance of IQAC Coordinator, Controller of Exams, academic deans and HoDs.

2.18. Grievance Redressal Mechanism

In order to address the grievance of students regarding Continuous internal assessment (CIA) a three-level Grievance Redressal mechanism is envisaged. A student can approach the upper level only if grievance is not addressed at the lower level.

Level 1: At the level of the concerned course teacher.

Level 2: At the level of a department committee consisting of the Head of the Department, a coordinator of internal assessment for each programme nominated by the HoD and the course teacher concerned.

Level 3: A committee with the Principal as Chairman, Dean of the Faculty concerned, HOD of the department concerned and one member of the Academic council nominated by the principal every year as members.

3. SCHEME OF CORE AND COMPLEMENTARY COURSES

3.1 SCHEME OF BOTANY *CORE* COURSES (*Semester-wise Distribution*)

Course Code	Course Title	Credits	Hours / Week	Hours / Sem.	Examination		
					ESE *Duration (Hrs.)*	**ESE** *Max. Marks*	**CIA** *Max. Marks*
SEMESTER I							
23U1CRBOTT1	Microbiology and Phycology	2	2	36	3	60	20
	*Practical 1		2	36			
SEMESTER II							
23U2CRBOTT2	Mycology, Lichenology and Plant Pathogen Interaction	2	2	36	3	60	20
	*Practical 2		2	36			
23U2PRBOTP1	Practical 1 and Practical 2 combined	2	4		3	30	10
SEMESTER III							
23U3CRBOTT3	Bryology, Pteridology, Gymnosperms and Paleobotany	3	3	54	3	60	20
	*Practical 3		2	36			
SEMESTER IV							
23U4CRBOTT4	Angiosperm Morphology, Anatomy and Microtechnique	3	3	54	3	60	20
	*Practical 4		2	36			
23U4PRBOTP2	Practical 3 and Practical 4 combined	2	4		3	30	10
SEMESTER V							
23U5CRBOTT5	Angiosperm Systematics and Economic Botany	2	3	54	3	60	20
	*Practical 5		2	36			
23U5CRBOTT6	Ecology, Environmental Science and Ecotourism	3	3	54	3	60	20
	*Practical 6		2				

23U5CRBOTT7	Genetics and Plant Breeding	3	3	54	3	60	20
	*Practical 7		2	36			
23U5CRBOTT8	Cell Biology, Molecular Biology and Evolution	3	3	54	3	60	20
	*Practical 8		2	36			
23U5OCBOTT1	Agribased Microenterprises *(Open Course)*	4	3	54	3	75	25
SEMESTER VI							
23U6CRBOTT9	Plant Physiology and Biochemistry	2	3	54	3	60	20
	*Practical 9		2	36			
23U6CRBOTT10	Perspectives of Science, Methodology and General Informatics	2	3	54	3	60	20
	*Practical 10		2	36			
23U6CRBOTT11	Biotechnology and Bioinformatics	2	3	54	3	60	20
	*Practical 11		2	36			
23U6CRBOTT12	Horticulture, Nursery Management, Embryology and Reproductive Biology	2	3	54	3	60	20
	*Practical 12		2	36			
23U6CRBOTT13EL	Phytochemistry and Pharmacognosy *(Elective Course)*	3	4	54	3	75	25
23U6PJBOT1	Hands-on Training Cum Project*	2	1	36	-	75	25
23U6PRBOTP3	Practical 5 and Practical 6 combined	2	4		3	30	10
23U6PRBOTP4	Practical 7 and Practical 8 combined	2	4		3	30	10
23U6PRBOTP5	Practical 9 and Practical 10 combined	3	4		3	30	10
23U6PRBOTP6	Practical 11 and Practical 12 combined	2	4		3	30	10

3.2 SCHEME OF BOTANY *COMPLEMENTARY* COURSES (*Semester-wise Distribution*)

(For students who have opted for Zoology as Core)

Course Code	Course Title	Credits	Hours / Week	Hours / Sem	Examination		
					ESE Duration (Hrs)	**ESE** Max. Marks	**CIA** Max. Marks
SEMESTER I							
23U1CPBOTT1	Cryptogams, Gymnosperms and Plant Pathology	2	2	36	3	60	20
	Practical 1		2	36			
SEMESTER II							
23U2CPBOTT2	Plant Physiology	2	2	36	3	60	20
	Practical 2		2	36			
23U2PCBOTP1	Practical 1 and Practical 2 combined	2	4		3	30	10
SEMESTER III							
23U3CPBOTT3	Angiosperm Taxonomy and Plant Animal Interactions	3	3	54	3	60	20
	Practical 3		2	36			
SEMESTER IV							
23U4CPBOTT4	Anatomy of Angiosperms and Applied Botany	3	3	54	3	60	20
	*Practical 4		2	36			
23U2PCBOTP2	Practical 3 and Practical 4 combined	2	4		3	30	10

CURRICULUM FOR B. Sc. DEGREE IN BOTANY PROGRAMME

COURSE STRUCTURE

Total Credits 120, Total Instructional hours 150

Semester 1			
Sl. No.	**Course Title**	**Hrs/week**	**Credit**
1	Common Course English -1	5	4
2	Common Course English -2	4	3
3	Common Course Second language -1	4	4
4	Core Course -1 Microbiology and Phycology + Practical	4	2
5	1st Complementary – Zoology- 1 + Practical	4	2
6	2nd Complementary- Chemistry -1 + Practical	4	2
Total		**25**	**17**

Semester 2			
Sl. No.	**Course Title**	**Hrs/ week**	**Credit**
1	Common Course -English -3	5	4
2	Common Course -English -4	4	3
3	Common Course - Second language -2	4	4
4	Core Course -2 Mycology, Lichenology and Plant Pathology + practical	4	4
5	1st Complementary - Zoology - 2 + Practical	4	4
6	2nd Complementary -Chemistry -2 + Practical	4	4
Total		**25**	**23**

Semester 3			
Sl. No.	**Course Title**	**Hrs/ week**	**Credit**
1	Common Course English -5	5	4
2	Common Course Second language -3	5	4
3	Core Course -3 Bryology, Pteridology, Gymnosperms and Paleo-botany + practical	5	3
4	1st Complementary - Zoology - 3 + Practical	5	3
5	2nd Complementary - Chemistry -3 + Practical	5	3
Total		**25**	**17**

Semester 4			
Sl. No.	**Course Title**	**Hrs/ week**	**Credit**
1	Common Course - English - 6	5	4
2	Common Course Second language -4	5	4
3	Core Course - 4 Anatomy, Microtechnique and Angiosperm Morphology + practical	5	5
4	1st Complementary - Zoology - 4	5	5
5	2nd Complementary - Chemistry - 4	5	5
Total		**25**	**23**

Semester 5			
Sl. No.	**Course Title**	**Hrs/ week**	**Credit**
1	Core Course - 5 Angiosperm Systematics, Floral Morphology and Economic Botany + Practical	5	3
2	Core Course - 6 Environmental Science and Ecotourism + Practical	5	3
3	Core Course -7 Genetics and Plant Breeding + Practical	5	3
4	Core Course - 8 Cell and Molecular Biology and Evolution + Practical	5	3
5	Open Course : Agribased Microenterprises	4	3
Total		**25**	**19**

Semester 6			
Sl. No.	**Course Title**	**Hrs/Week**	**Credit**
1	Core Course -9 Plant Physiology and Biochemistry + Practical	5	4
2	Core Course -10 Perspectives of Science, Methodology and General Informatics + Practical	5	4
3	Core Course -11 Biotechnology and Bioinformatics + practical	5	4
4	Core Course -12 Horticulture, Nursery Management, Embryology and Reproductive Biology + Practical	5	4
5	Core Choice Based – 13 Phytochemistry and Pharmacognosy	4	3
6	Hands on Training/Research Project	1	2
Total		**25**	**21**

B.Sc. BOTANY
Programme Outcomes (POs)

PO1	Critical Thinking and Deep Domain Knowledge
PO2	Effective Communication
PO3	Contribute to Nation Building
PO4	Care for the Environment
PO5	Ethical Values
PO6	Global Perspective

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO 1	Understand the functional and theoretical concepts of the biological world and their relative roles in the sustainability of natural habitats and biodiversity. (PO1, PO2, PO3, PO4, PO5, PO6)
PSO 2	Possess knowledge of the evolutionary relationships among plants. (PO1, PO4, PO6)
PSO 3	Understand the applications of plant biology in various disciplines. (PO1, PO3, PO4, PO5)
PSO 4	Perform laboratory procedures as per ethics and following standard protocols. (PO1, PO2, PO5)
PSO 5	Synthesize the scientific character of observation, reasoning and apply the knowledge in designing experiments. (PO1, PO2, PO3, PO5, PO6)

3. Syllabus of Core Courses

Semester I

Core Course 1

23U1CRBOTT01: MICROBIOLOGY AND PHYCOLOGY

(Theory: 36 hours; Practical: 36) **(Theory Credit 2, Practical Credit 1)**

COURSE OUTCOMES (COs)	
CO1	Determine the diversity of Microbes and Agal community
CO2	Comprehend the reproductive behaviour and its evolutionary significance in bacteria, Virus and Algae
CO3	Identify the futuristic applications of algae, bacteria and Virus
CO4	Enlist the ecological and economic significances of Algae, Bacteria and Virus

MICROBIOLOGY (Theory: 9 hours; Practical: 9 hours)

Module 1 Microbiology **(9 hours)**

a) Introduction to Microbiology

Scope of Microbiology.

b) Bacteriology

Bacteria: structure - cell wall - Peptidoglycan- cytoplasm - Nucleoid, Flagella.

Bacterial Classification based on morphology, ICNP (International Code of Nomenclature of Prokaryotes – brief account).

Reproduction - Binary fission

c) **Virology**

Virus – General structure.

Classification of viruses based on genetic material: RNA viruses, DNA viruses (with examples); ICTV code (Brief account).

Plant viruses – architecture of TMV.

d) **Applied Microbiology**

Role of microbes in Biofertilizers, Biopesticides, Biogas production, Waste management, Bioremediation, Antibiotics, Single cell protein (SCP) and Probiotics.

Practical (9 hrs)

1. Preparation of bacterial smear.
2. Gram's staining.
3. Isolation of microbes from soil (Serial dilution followed by streaking method).

PHYCOLOGY (Theory: 27 hours; Practical: 27 hours)

Module 2 Introduction to Phycology and Classification of Algae (3 hours)

General characters, range of thallus structure and pigments in algae; Different types of life cycle and alternation of generations in algae. Classification by Fritsch (1945) – up to Class.

Module 3 (20 hours)

General characters of the following major groups with special reference to the habitat, structure, reproduction and life cycles of the following types;

a. Cyanophyceae: *Nostoc*

b. Chlorophyceae: *Volvox, Oedogonium, Cladophora, Chara*

c. Xanthophyceae: *Vaucheria*

d. Bacillariophyceae: *Pinnularia*

e. Phaeophyceae: *Sargassum*

f. Rhodophyceae: *Polysiphonia*

Module 4 Economic importance (4 hours)

Algae as pollution indicator and in waste water treatment

Commercial products: Agar, Alginates, Carrageenin, Diatomaceous earth

Algae in soil fertility, Fertilizer, Nitrogen fixation, minerals, soil algae and symbiosis

Sources of food & medicine

Toxic algae – Algal blooms, red tides & fish poisoning

Role of algae in aquaculture.

Practical **(27 hours)**

1. Conduct a field visit to any one of the ecosystems rich in Algae to experience algal diversity. Submit a report of the visit with photographs.
2. Make micro preparation of vegetative and reproductive structures of the types mentioned in the syllabus and make labelled sketches of the specimens observed.
3. Identify the algal specimens up to the generic level by noting their key characters.

References

1. Agarwal S.K, 2008. *Foundation course in Biology*, Ane Books Pvt. Ltd., New Delhi.
2. Anand N, 1989. *Culturing and cultivation of BGA*. Handbook of Blue Green Algae.
3. Aneja K. R, 1996. *Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation*. Wishwa Prakasan, Delhi.
4. Bilgrama K. S and Saha L. C, 1996. *Text Book Of Algae*, C B S Publishers and Distributors
5. Carpenter P. L, 1967. *Microbiology*. W. B Saunderand Co, Philadelphia
6. Chapman, V. J, 1962. *The Algae*. Macmillanand co. Ltd, London
7. Christian Hoek, 1995. *Algae: An Introduction to Phycology*, Cambridge University Press.
8. Dube H.C, 2008. *Fungi, Bacteria and Viruses*, Agrobios, Meerut.
9. Frazier W C and Westhoff D.C, 1978. *Food Microbiology.* TMH Edn.
10. Fritsch F. E, 1945. *Structure and Reproduction of Algae*. Vol.1: Cambridge University Press, London.
11. Hans G Schlegel, 1995. *General Microbiology*. Cambridge University Press, London.
12. John J and Francis M.S, 2013. *An Illustrated Algal Flora of Kerala*, Vol.I: GCS Books, Cochin.
13. Kanika Sharma, 2005. *Manual of Microbiology tools and Techniques*. Ane books, Ansari road, New Delhi.
14. Karthick B, Hamilton P.B and Kociolek J.P, 2013. *An Illustrated Guide on Common Freshwater Diatoms of Peninsular India*. Gubbi Labs, Gubbi.
15. Lee Robert Edward, 2009. *Phycology*. 4th Edn. Cambridge University Press, New Delhi.
16. Mamatha Rao, 2009. *Microbes and Non flowering plants- impact and application* Ane Books P.Ltd.
17. Parihar L, 2008. *Advances in Applied Microbiology*, Agrobios, Meerut.
18. Pellczar M.J Reid and Chan E.C.S, 1977. *Microbiology*. Tata McGraw-Hill publishing Co., New Delhi.

19. Prescolt S.C, 2009.*Industrial Microbiology*, Agrobios, Meerut.

20. Sharma O.P, 2004. *Text Book of Algae*, Tata Mc. Graw Hill Co.

21. Sharma P. D, 2005. *Microbiology and Plant Pathology* Rastogi publication Meerut.

22. Vasishta B R, Sinha A.K, Singh V.P, 2004. *Botany for Degree Students. Algae*. S. Chand and Co. Ltd. New Delhi.

Websites

http://www.phycology.net/

http://www.algaebase.org/

http://www.seaweed.ie/

http://www.brphycsoc.org/ (British Phycological Society)

http://www.intphycsoc.org/ (International Phycological Society)

http://www.isaseaweed.org/ (International Seeweed Association)

http://botany.si.edu/projects/algae/

http://botany.si.edu/projects/algae/ (Smithsonian National Museum of Natural History)

Semester II

Course 2

23U2CRBOTT02: MYCOLOGY, LICHENOLOGY AND PLANT PATHOGEN INTERACTION

(Theory: 36 hours; Practical: 36 hours) (Theory Credit: 2, Practical Credit: 1)

COURSE OUTCOMES (COs)	
CO1	Determine the diversity, reproductive behaviour and applications of fungi and Lichens
CO2	Identify ecological and economical significance of fungi and lichens
CO3	Carry out the mushroom cultivation at a small-scale industry level
CO4	Recognize the plant diseases and provide control measures

MYCOLOGY AND LICHENOLOGY (Theory 27 hours; Practical: 27 hours)

Module 1 – Introduction to Mycology (18 hours)

a) Introduction, general characters, evolutionary trends. Classification based on Ainsworth (1973)

b) Distinguishing characters of different classes of fungi with special reference to reproductive structures of the genera mentioned in each group;

a) Myxomycotina - General Characters

b) Mastigomycotina - *Albugo*

c) Zygomycotina – *Rhizopus*

d) Ascomycotina

1. Hemiascomycetes - *Saccharomyces*
2. Plectomycetes - *Pencillium*
3. Pyrenomycetes - *Xylaria*
4. Discomycetes – *Peziza*

e) Basidiomycotina
    1. Teliomycetes - *Puccinia*
    2. Hymenomycetes - *Agaricus*

f) Deuteromycotina - *Fusarium*

Module 2 – Economic importance of Fungi (7 hours)

a) Economic importance of Fungi – Beneficial (Food, antiviral, antibiotic) and detrimental aspects (Food spoiling and poisoning, Wood degrading).
b) Fungi of Agricultural importance – mycoherbicides, myconematicides, mycoparasites, Mycorrhiza – diversity, function and significance.
c) Fungal biotechnology- Fundamental principles.
d) Mushrooms- edible and poisonous types. Cultivation technique-Spawn production of Oyster mushroom, cultivation of Oyster mushroom (General Outline)

Module 3 - General account on Lichens (2 hours)

General account, economic and ecological importance of lichen, Classification of lichens based of thallus and its significance; Structure and life cycle of *Parmelia.*

Practical (24 hours)

1. Students are expected to identify the following types by making suitable microprepartions and make labeled sketches *Albugo, Rhizopus, Saccharomyces, Pencillium, Xylaria, Peziza, Puccinia, Fusarium and Parmelia*
2. Staining of endomycorrhiza or fungus using Trypan Blue.

PLANT PATHOGEN INTERACTION (Theory 9 hours; Practical: 9 hours)

Module 1 – Introduction to plant-pathogen interaction (3 hours)

History of plant pathology (Brief study), Classification of plant diseases on the basis of causative organisms and symptoms, Plant-Pathogen Interaction (general outline), Defense mechanisms in Plants, Mechanism of infection, transmission and dissemination of plant diseases.

Module 2 - Control of plant diseases (2 hour)

Prophylaxis - quarantine measures, seed certification

Therapeutic – physical therapy, chemotherapy.

Biological control of plant diseases

Module 3 – Study on common plant diseases (4 hours)

a) Study of following diseases with emphasis on symptoms, cause and control: Bunchy top of Banana, Bacterial blight of Paddy, Root wilt of Coconut, Abnormal leaf fall of Rubber, Leaf mosaic disease of Tapioca, Quick-wilt of pepper.

b) Fungicides - Bordeaux mixture.

Practical (**9 hours)**

Students are expected to:

a) Identify the diseases mentioned in the syllabus with respect to causal organisms and symptoms

b) Submit herbarium preparations of various stages (3 stages) of any one of the diseases mentioned. (Imaging can be done with geo tag and recorded)

c) Students should be trained to prepare the fungicide – Bordeaux mixture, Tobacco decoction.

References

1. Mehrotra, R.S. and Aneja, K.R., 1990. *An introduction to mycology*. New Age International.
2. Agrios, G.N., 2005. *Plant pathology*. Elsevier.
3. Ainsworth, G.C. and Sussman, A.S. eds., 2013. *The fungal population: an advanced treatise*. Elsevier.
4. Alexopoulos, C.J., Mims, C.W. and Blackwell, M., 1996. *Introductory Mycology*. John Wiley & Sons. *Inc., New York, 868*.
5. Varma, A., Abbott, L., Werner, D. and Hampp, R. eds., 2007. *Plant surface microbiology*. Springer Science & Business Media.
6. Campbell, R., 1987. *Plant Microbiology*. ELBS Edward Arnold, London
7. Borkar, S.G., 2017. *History of Plant Pathology*. CRC Press.
8. Vasishta, B.R., Sinha, A. K., and Kumar, A., 2016. *Botany for Degree Students*, *Fungi*. S. Chand ang company Ltd, New Delhi.
9. Gupta, V. K. and Paul, T. S., 2004, *Fungi & Plant diseases*. Kalyani publishers, New Delhi

10. Deacon, J.W., 2013. *Fungal biology*. John Wiley & Sons.
11. Bush, J., 2019. *Genetics of Plant Diseases*. Scientific e-Resources.
12. Misra A and Agrawa P.R 1978 *Lichens*, New Delhi: Oxford and IBH.
13. Gogoi, R., Rathaiah, Y., Borah T. R., 1990, *Mushroom Cultivation Technology*. Scientific Publishers (India).
14. Nita Bahl 2002. *Hand book on Mushrooms*, Oxford & IBH Publishing C. Pvt. Ltd. New Delhi.
15. Sharma, P. D., 2004, *The Fungi* , 2nd Edition , Rasthogi publication

Websites

http://www.fungibank.csiro.au/

http://www.in2.dk/fungi/imageintroTxt.htm

http://www.fungi4schools.org/

http://www.fungiphoto.com/

Semester III

Course 3

23U3CRBOTT03 BRYOLOGY, PTERIDOLOGY, GYMNOSPERMS & PALEOBOTANY

(Theory: 54 hours; Practical: 36 hours) **(Theory Credit 3, Practical Credit 1)**

COURSE OUTCOMES (COs)	
CO1	Explain the habitat variation, morphological diversity and reproductive behaviour of bryophytes, pteridophyte, and gymnosperms
CO2	Identify the evolutionary trends and ecological significances in bryophytes, pteridophyte, and gymnosperms
CO3	Describe the economic significance of bryophytes, pteridophyte, and gymnosperms
CO4	Summarize the diversity and distributions of prehistoric flora

BRYOLOGY (Theory: 18 hours; Practical: 9 hours)

Module 1 – Introduction to Bryology **(3 hours)**

Introduction, general characters, classification of Bryophytes (Rothmaler 1957)

Module 2 - Morphology, anatomy and reproduction of Bryophytes (**12 hours)**

Study on Morphology, anatomy and reproduction in *Riccia, Marchantia, Anthoceros* and *Funaria.*

Evolution of sporophyte and gametophyte (Development of sex organs not necessary).

Module 3 - Ecological and economic importance of Bryophytes (**3 hours)**

Prevention of soil erosion, pollution monitoring and control, Antibiotics, Horticultural importance.

Practical **(9 hours)**

Make micro preparations of the types mentioned. Study vegetative and reproductive structures.

PTERIDOLOGY (Lycophytes and Ferns) (Theory:18 hours; Practical :18 hours)

Module 4 - Introduction to Pteridology **(4 hours)**

Introduction, general characters, Classification of Pteridophytes - Smith, 2006, PPG1 (up to the level of orders) and Stelar evolution of Pteridophytes.

Module 5 - Lycophytes **(4 hours)**

Structural organization of sporophyte and gametophyte (development of sex organs not necessary) of the following type with special reference to stelar structure, heterospory and seed habit.

- *Selaginella*

Module 6 - Ferns **(10 hours)**

Structural organization of sporophyte and gametophyte (development of sex organs not necessary) of the following types with special reference to stelar structure, and spore producing structures.

- *Psilotum*
- *Equisetum*
- *Pteris*
- *Marsilea*

Practical (18 hours)

Make micro preparations to study stelar structure and sporangia of the mentioned types. Identify at sight, noting the morphology. Habits and other morphological features can be imaged with geotag and recorded.

GYMNOSPERMS AND PALAEOBOTANY (Theory: 18 hours; Practical: 9 hours)

Module 7 – Introduction to Gymnosperms **(4 hours)**

Introduction, general characters, classification (K. R. Sporne, 1965), and evolutionary significance

Module 8 - Morphology, anatomy and reproduction of gymnosperms (9 hours)

Study of morphology, anatomy and reproductive features of *Cycas*, *Pinus* and *Gnetum.*

Practical (9 hours)

Study of the morphology, anatomy and reproductive structures of the types mentioned.

Module 10 – Introduction to Paleobotany (3 hours)

Introduction, study of geological time scale, formation of fossil, fossil types & technique of study. Indian contribution to Palaeobotany

Module 11 – Fossil plants (2 hours)

Detailed study of

Fossil Pteridophyte: *Rhynia*

Fossil Gymnosperm: *Williamsonia*

References

1. Arnold H.N, 1967. *Introduction to Paleobotany*, Tata Mc Graw- Hill, New Delhi
2. Biswas & John B .M, 2004.*Gymnosperms*, Naresa Publishing house.
3. Bower F.O, 1935. *Primitive Land Plants*. Cambridge, London.
4. Chopra R.N and Kumar P. K, 1988. *Biology of Bryophytes*, Wiley Eastern Ltd, New Delhi.
5. Coutler J.M & Chamberlain C. J, 1958. *Morphology of Gymnosperm*s. Central Book Depot Allahabad.
6. Dutta S.C, 1991, *An Introduction to Gymnosperms*, Kalyan Publishing Co. New Delhi.
7. Mamatha Rao, 2009, *Microbes and Non flowering plants- impact and application* Ane Boopks Pvt Ltd.
8. Rasheed A. 1999, *An Introduction to Pteridophyta*, Vikas Publishing House, New Delhi.
9. Rasheed A. 2000, *An Introduction to Bryophyta*, Vikas Publishing House, New Delhi.
10. Singh, Pande Jain *2007, Diversity of Microbes and Cryptogam, Rastogi Publications*

11. Vashista B. R, 1993. *Bryophyta*, S Chand & Co., New Delhi.
12. Vashista B. R, 1993. *Gymnosperms*, S Chand & Co., New Delhi.
13. Vashista B. R, 1993. *Pteridophyta*, S Chand & Co., New Delhi

Websites

http://www.artdata.slu.se/guest/SSCBryo/SSCBryo.html
http://www.northernontarioflora.ca/links.cfm?val=bryophytes
http://bryophytes.plant.siu.edu/
http://worldofmosses.com/
http://www.unomaha.edu/~abls/
http://www.anbg.gov.au/bryophyte/index.html
http://www.bryoecol.mtu.edu/
http://www.mobot.org/MOBOT/tropicos/most/Glossary/glosefr.html
http://www.fairhavenbryology.com/Master_Page.html
http://www.mygarden.ws/fernlinks.htm
http://www.anbg.gov.au/fern/index.html
http://www.bioimages.org.uk/HTML/T77.HTM
http://botany.csdl.tamu.edu/FLORA/gallery/gallery_query.htm
http://homepages.caverock.net.nz/~bj/fern/
http://www.home.aone.net.au/~byzantium/ferns/
http://www.northernontarioflora.ca/links.cfm?val=pteridophytes
http://www.fiu.edu/~chusb001/giant_equisetum.html
http://www.mygarden.ws/fernlinks.htm
http://www.nrm.se/en/menu/researchandcollections/departments/cryptogamicbotany/collections/pteridophytes.652_en.html
http://www.amerfernsoc.org/
http://www.gymnosperms.org/
http://www.plantapalm.com/vce/toc.htm
http://www.cycad.org/conservation.htm
http://allwebhunt.com/cgi.cfm/Top/Science/Biology/Flora_and_Fauna/Plantae/Cycadophyta/Cycadopsida/Cycadaceae/Cycas

Semester IV

Course 4

23U4CRBOTT04: ANGIOSPERM MORPHOLOGY, ANATOMY AND MICROTECHNIQUE

(Theory: 54 hours; Practical: 36 hours) **(Theory Credit: 3; Practical Credit: 1)**

COURSE OUTCOMES (COs)	
CO1	Explain the ultra-structure of cell wall and non-living inclusions of plant cell
CO2	Identify the tissues and tissue systems in plant system
CO3	Distinguish the primary and secondary anatomical features of plant system
CO4	Describe various microtechnical aspects used in plant anatomical studies
CO5	Identify the morphological features of flowering plants

Anatomy and Microtechnique (Theory: 45 hours, Practical: 27 hours)

Module 1: Plant Cell Wall and Non-Living Inclusions (9 hours)

a) Cell wall: Structure of plant cell wall – Primary wall, Secondary Wall and Middle lamella.

b) Ultrastructure of Cell Wall - Cellulose chain, Microfibril, Macrofibril, and Cellulose Fiber.

c) Pits – definition, types - simple and bordered pits; structure and function of Plasmodesmata.

d) Extra cell wall thickening materials – Lignin, Suberin and Cutin.

e) Growth of cell wall – Apposition and Intussusception.

f) Non-living inclusions in plant cells - Reserve food materials (Starch, Protein and Lipids), Secretory products (Pigments, Enzymes and Nectar) and Excretory Products (Alkaloids, Tannin, Gums, Resins, Essential oils, Mucilage, Latex and Mineral crystals).

Module 2: Tissues and Tissue Systems **(9 hours)**

a) Tissues – Definition, types – Meristematic tissue and Permanent tissue.
b) Meristematic tissue – definition, characteristic features and classification (on the basis of origin and on the basis of position).
c) Theories on apical organization - Apical cell theory, Histogen theory, Tunica-corpus theory and Korper - Kappe theory.
d) Permanent tissues – Simple tissues, Complex tissues, and Secretory tissues.
e) Simple tissues – Definition, Types - Parenchyma, Collenchyma and Sclerenchyma.
f) Complex tissues - Definition, Types – Xylem and Phloem.
g) Secretory tissues - Definition, Types – External and Internal secretory tissue systems
h) Tissue systems – Definition, Types - epidermal tissue system, Ground tissue system and Vascular tissue system

Module 3: Primary and Secondary Structure **(18 hours)**

a) Primary structure of stem – Dicot and monocot stem
b) Primary structure of root – Dicot and monocot root
c) Leaf anatomy – Dicot and monocot leaf
d) Normal Secondary Growth - Secondary growth in dicot stem and root, Periderm formation, Bark and Lenticels.
e) Anomalous secondary growth: *Bignonia* stem and *Dracaena* stem.
f) Growth rings and Dendrochronology
g) Wood – definition , basic structure of wood, tyloses formation
h) Heart wood and Sap wood; Hard wood and Soft wood
i) Reaction wood - Tension wood and compression wood.

Module 4: Microtechnique **(9 hours)**

a) Killing and fixing – fixative, FAA
b) Dehydration - agents used - Ethyl Alcohol dehydration series
c) Sectioning: Free-hand sectioning and Microtome sectioning (serial sectioning); Microtome - rotary, sledge (application only).
d) Staining technique: Stains, Mordants - example; Natural stains – Haematoxylin and Carmine; Synthetic stains – Safranin and Fast green; Vital stains - Neutral red and Evans blue.

e) Mounting media – purpose, properties of an ideal mounting media; Examples - Glycerine Jelly, DPX, Canada balsam.

f) Whole mount and Maceration

Practical **(27 hours)**

1. Non-living inclusions - Cystolith and Raphides.
2. Simple tissues – Parenchyma, Collenchyma and Sclerenchyma.
3. Complex tissues – Xylem and Phloem.
4. Primary structure of dicot stem.
5. Primary structure of monocot stem.
6. Primary structure of dicot root.
7. Primary structure of monocot root.
8. Leaf anatomy – Dicot and Monocot leaf
9. Stomatal types – Anomocytic, Anisocytic, Paracytic, Diacytic and Gramineous.
10. Normal secondary structure of dicot stem.
11. Normal secondary structure of dicot root.
12. Anomalous secondary structure of *Bignonia* stem.
13. Anomalous secondary structure of *Dracaena* stem.
14. Maceration of wood elements

Angiosperm Morphology (Theory 9 hours; Practical: 9 hours)

a) Leaf Morphology – types (simple and compound), Leaf venation, phyllotaxy

b) Morphology of flower – Parts of a flower, functions of floral organs; description of flower and its parts in technical terms.

c) Inflorescence - Racemose types - Simple Raceme, Corymb, Panicle, Umbel, Spike, Spadix, Head and Capitulum; Cymose types - Simple Cyme, Monochasial- Scorpoid and Helicoid, Dichasial; Special type- Cyathium, Hypanthodium, Verticillaster, Fascicle inflorescence, Cauliflorous inflorescence.

d) Fruits: Simple-Fleshy, Dry- dehiscent, indehiscent, Aggregate, Multiple (Sorosis and Syconus)

Practical **(9 hours)**

1. Leaf morphology – types of leaves - simple and compound.
2. Leaf phyllotaxy.
3. Inflorescence types.
4. Fruit types.

References

1. Esau, K. (2010). *Anatomy of Seed Plants*. Wiley Eastern Limited.
2. Fahn A. (1982). *Plant Anatomy* (3rd edition). Pergamon Press Oxford.
3. Dickinson W C, (2000). *Integrative Plant Anatomy*. Har cort Acdemic Press, USA.
4. Khasim S M, (2002). *Botanical Microtechnique: Principles and Practice*. Capital Publishing Company, New Delhi.
5. Toji Thomas (2005). *Essentials of botanical microtechnique* (II Edn). Apex infotech publishing company.
6. Johanson D A (1940). *Plant microtechnique*. McGraw Hill co.
7. Vasishta P C (1994). *Plant anatomy*. Pradeep publications.
8. Pandey B P. (2008). *Plant Anatomy*. S Chand and Co.
9. David F. Cutler, Ted Botha, Dennis Wm. Stevenson, 2008. *Plant Anatomy: An Applied Approach.* Wiley-Blackwell.
10. Gurcharan Singh (2004). *Plant Systematics: Theory and practice*. Oxford and IBH Publishing.
11. Lawrence George H M (1951). *Taxonomy of vascular plants*. Oxford and IBH Publ. Co. Pvt. Ltd.
12. Simpson M, (2019). Plant Systematics (3rd Edition). Academic Press.

Semester V

Course 5

23U5CRBOTT05: ANGIOSPERM SYSTEMATICS AND ECONOMIC BOTANY

(Theory: 54 hours; Practical: 36 hours) **(Theory Credit: 3, Practical Credit: 1)**

COURSE OUTCOMES (COs)	
CO1	Identify the floral morphological features in flowering plants
CO2	Explain the various systems of classifications and the interdisciplinary approaches in plant systematics
CO3	Categorize the plant families based on their morphological and floral characters
CO4	Interpret the relevance of economically and ethnobotanically significant plants

Module 1: Floral Morphology **(6 hours)**

a) Ovary position and types of flowers: Superior, Inferior and Half-inferior; Hypogyny, Perigyny, Epigyny, Epihypogynous and Epiperigynous

b) Floral symmetry- Actinomorphic, Biradial, Zygomorphic and Asymmetric.

c) Aestivation types- Imbricate, Twisted, Valvate, Imbricate-alternate, Quincuncial and Involute.

d) Placentation types- Axile, Apical, Apical-axile, Basal, Basal-axile, Marginal, Free-central, Laminar, Parietal, Parietal-axile and Parietal-septate.

e) Floral Diagram and Floral Formula.

Module 2: Systematic Botany **(8 hours)**

a) Types of Classification- Artificial System- Linnaeus System, Natural system- Bentham and Hooker's System, and Phylogenetic System-APG (Brief account).

b) Binomial Nomenclature, ICN and its Principles
c) Cytotaxonomy, Chemotaxonomy and Molecular Systematics
d) Herbarium technique- steps involved in the preparation of herbarium and its significance.
e) Brief study on Flora, Revision and Monographs.

Module 3: Angiosperm Families (30 hours)

Study the following families of Bentham and Hooker's System with special reference to their morphological and floral characters. (1) Annonaceae, (2) Capparidaceae, (3) Malvaceae, (4) Rutaceae, (5) Fabaceae, (6) Caesalpiniaceae, (7) Mimosaceae (8) Combretaceae, (9) Myrtaceae, (10) Cucurbitaceae, (11) Apiaceae, (12) Rubiaceae, (13) Asteraceae, (14) Sapotaceae, (15) Apocynaceae, (16) Asclepiadaceae, (17) Solanaceae, (18) Convolvulaceae, (19) Scrophulariaceae, (20) Acanthaceae, (21) Verbenaceae, (22) Lamiaceae, (23) Polygonaceae, (24) Orchidaceae, (25) Arecaceae, and (26) Poaceae.

Module 4: Economic Botany (7 hours)

Study of the following groups of plants based on their uses with special reference to the botanical name, family and morphology of the useful part

a) Cereals- Rice, Wheat
b) Millets- Ragi
c) Pulses - Green gram, Bengal gram, Black gram
d) Sugar yielding plants - Sugarcane
e) Fruits - Apple, Pineapple, Orange, Mango and Banana
f) Vegetables - Bitter Gourd, Ladies finger, Carrot and Cabbage.
g) Timber yielding plants - Teak wood and Jack wood
h) Beverages- Tea, Coffee
i) Fibre yielding plants - Coir, Jute, Cotton
j) Oil yielding plants - Ground nut, Gingelly
k) Rubber yielding plants- Para rubber
l) Gums and Resins - White damer, Gum Arabic, Asafoetida
m) Spices - Cardamom, Pepper, Cloves , Ginger
n) Insecticide yielding Plants - Tobacco and Neem

Module 5: Ethnobotany **(3 hours)**

Study of the following plants used in daily life by ethnic people and village folks for food, shelter and medicine.

a) Food - *Artocarpus* spp., *Dioscorea* spp., *Cycas circinalis.*

b) Shelter - *Dendrocalamus , Ochlandra travancorica and Calamus thwaitesii*

c) Medicine - *Curcuma longa, Trichopus zeylanicus and Alpinia galanga*

Practical **(36 hours)**

1. Ovary position and types of flowers
2. Aestivation types
3. Placentation types
4. Angiosperm families: Students are expected to work out at least one plant species for each family mentioned in the syllabus and draw the flower L.S, and floral diagram. Each student should prepare geotagged images of the habit, inflorescence, single flower, androecium, and the gynoecium of the given plant species.
5. Economic botany and ethnobotany: Study the raw/finished products of plants mentioned in the syllabus with special reference to the morphology, botanical name and family. Students are expected to prepare photo plates for each specimen.
6. Prepare and submit herbarium of 10 plants with duly certified field book.
7. Field Study: Students are expected to conduct fieldwork for a minimum of 4 days under the guidance of the course teacher and should submit the study report for valuation.

References

13. Gurcharan Singh (2004). *Plant Systematics: Theory and practice*. Oxford and IBH Publishing.
14. Lawrence George H M (1951). *Taxonomy of vascular plants*. Oxford and IBH Publ. Co. Pvt. Ltd.
15. Simpson M, (2019). *Plant Systematics* (3rd Edition). Academic Press.
16. Battacharya B (2009). *Systematic Botany* (2nd Edn). Narosa Publishing House.
17. Ashok Bendra and Ashok Kumar, 1980. *Economic Botany*. Rastogi publications, Meerut.
18. Heywood V.H. 1967. *Plant Taxonomy*. London: Edward Arnold.
19. Sreemali J.L. (1979) *Economic Botany*. Allahabad : Kitab MAhal.

20. Naik V.N. (1984) *Taxonomy of angiosperms*. Tata Mc Graw- Hill Publishing Company, New Delhi.
21. Jain S. K. (1981). *Glimpses of Indian Ethnobotany*.: Oxford and IBH. New Delhi.
22. Jain S K. (2004), *A Manual Of Ethnobotany*, Scientific Publishers, India.

Semester V
Course 6
23U5CRBOTT06: ECOLOGY, ENVIRONMENTAL SCIENCE AND ECOTOURISM

(Theory - 54 hours; Practical – 36 hours; Credits: Theory – 3, Practical - 1)

COURSE OUTCOMES (COs)	
CO 1	Create awareness about various environmental laws, human rights, current environmental issues and its global impacts.
CO 2	Create responsible citizens on conservation of nature and natural resources and design novel mechanisms for the sustainable utilization of natural resources.
CO 3	Analyze various ecosystems for its ecological interactions and impact on human life.
CO 4	Develop knowledge on organizations, movements and contributors of ecological studies.
CO 5	Develop ability to assess the positive and negative impacts of Ecotourism and its role in the sustainable utilization of resources for tourism.

ECOLOGY **(Theory - 16 hours)**

Module 1: Introduction to Ecology and Environmental science **(1 hour)**
Introduction, relevance and scope, public awareness, multidisciplinary nature.

Module 2: Natural Resources **(1 hour)**
Types of resources - renewable and non-renewable; ecological footprints.

Module 3: Ecosystems **(10 hours)**

Structure and function of ecosystem: Ecosystem components- abiotic and biotic, Productivity – primary and secondary-gross and net productivity. Decomposition in nature, homeostasis in ecosystem

Ecological energetics: energy flow, trophic levels, food chain and food web, ecological pyramids

Nutrient cycles: Biogeochemical cycles of C, N and S.

Module 4: Population and Community Ecology **(4 hours)**

Population characteristics: size, density, natality, mortality.

Community characteristics: Species diversity and species richness, dominance-resource partition, growth forms and structure, trophic structure.

Association of communities: plant association, ecotone and edge effect.

Ecotypes and ecological indicators.

Species – ecosystem interaction: Habitat, ecological niche, microclimate

Ecological succession: types of succession, process – migration, ecesis, colonization, stabilization and climax community; hydrosere, xerosere, lithosere.

ENVIRONMENTAL SCIENCE (Theory – 32 hours)

Module 5: Plants and environment (4 hours)

Ecological complexes and factors affecting plant growth and response:

Climatic factors: temperature and pressure; water - precipitation, humidity, soil water holding capacity; light - global radiation.

Topographic factors: altitude and aspects

Edaphic factors - profile and physical and chemical properties of soil

Biotic factors: positive and negative interactions.

Adaptation of plants to environment:

Water- Xerophytes, Hydrophytes;

Salinity – halophytes, mangroves;

Temperature – thermo periodicity, vernalization;

Light – photoperiodism, heliophytes, sciophytes.

Module 6: Environmental pollution and Management (12 hours)

Definition and general introduction

Air pollution: Causes and sources, types of pollutants-particulates - aerosol, mist, dust, smoke, fume, plume, fog, smog. Effect of air pollution on plants and animals – Silicosis, Bhopal Gas Tragedy.

Water pollution: Sources and types of pollutants. Water quality standards, water quality assessment. Groundwater pollution-blue baby syndrome. Accumulation of heavy metals, hydrocarbons. Eutrophication, BOD, Minamata disease, Periyar river pollution.

Soil pollution: Causes and sources-waste dumps, municipal wastes, agrochemicals, mining, solid waste management.

Noise pollution: Sources, standards and measurements, effect on health, control techniques.

Thermal pollution: Sources and effects, management

Nuclear hazards: Sources and impacts, management, Chernobyl incident

Environmental Impact Assessment (EIA): Significance, EIA in polluted areas.

Module 7: Global issues and the environment (2 hours)

Climate change, global warming and greenhouse gases, IPCC, Acid rain, Ozone layer depletion, nuclear accidents and nuclear holocaust.

Module 8: Environmental legislation and laws (1 hour)

Environment (protection) Act, 1986, (2) Air (Prevention and control of pollution) Act, 1981, (3) Water (Prevention and control of pollution) Act, 1974, (4) Wildlife (protection) Act, 1972, (5) Forest (Conservation) Act, 1980, (6) Biological Diversity Act (2002) (briefly).

Module 9: Biodiversity and Conservation biology (7 hours)

Biodiversity – definition; Endemism: Definition-types-factors. Hotspot of endemism-hotspots in India. IUCN-threat categories, RET. Red Data Book, Western Ghats as one of the hottest hotspots and its conservation.

Biodiversity loss: Causes and rate of biodiversity loss, negative and positive impacts, extinction-causes, influence of Exotic species.

Significance of umbrella species and keystone species in conservation of biodiversity.

Conservation efforts: Rio Earth Summit, Agenda 21, Kyoto protocol, CoP (Conference of the Parties under the UN Framework Convention on Climate Change). Conservation strategies and efforts in India and Kerala, *In situ* and *ex situ* conservation methods. Applications of remote sensing and GIS (brief account). Role of NGOs in biological conservation.

Module 10: Organizations, movements and contributors of Ecological studies (2 hours)

Organizations: WWF, CSE, NEERI, Green Peace, Chipko movement.

Famous contributors of Environmental science in India: Salim Ali, M.S. Swaminathan, Madhav Gadgil, M.C. Mehta, Anil Agarwal, Medha Patkar, John C. Jacob, Sunderlal Bahuguna.

Module 11: Environment and human rights (4 hours)

Environment and human rights: right to clean environment and public safety; issues of industrial pollution; Conservation of natural resources and human rights (briefly).

Conservation issues of the Western Ghats – Madhav Gadgil committee report- (brief study only).

ECOTOURISM (Theory - 6 hours)

Definition, concept, introduction, history, relevance and scope. Components of ecotourism. Types of ecotourism in India and Kerala. Ecotourism centers in Kerala. Positive and negative impacts of ecotourism.

Practical (36 hours)

1. Estimation of CO_2, Cl^-, and salinity of water samples (Titremetry)
2. Determination of pH of soil and water
3. Assessment of diversity, abundance, and frequency of plant species by quadrat method (e. g. Grasslands, forests)
4. Visit to any forests types including grasslands and preparation of the list of Rare and threatened (R&T) plants (no collection of specimens)
5. Collection, identification and preparation of list of exotic and invasive species in a given locality.
6. Identification of pollutants to respective pollution types.
7. Study of anatomical, morphological, physiological adaptation of plants to the environment (Xerophytic, Hydrophytic, Epiphytic, Halophytic).
8. Collection and recording of rain data by using simple rain gauge.

Ecotourism Field Visit

Students are expected to make a field visit to any Ecotourism Centre and prepare a field report.

References

1. Ahmedullah, M. &. Nayar, M. P. (1987). *Endemic Plants of the Indian Region*. Botanical Survey of India, Calcutta.
2. Asthana, D. K. & Asthana, M. (2006). *A Text Book of Environmental Studies*. S. Chand.
3. Basha, S. C. (1991). Distribution of Mangroves in Kerala. *Indian forester*. *117*(6): 439-448. DOI: 10.36808/if/1991/v117i6/8641
4. Bharucha, E. (2003). *The Biodiversity of India.* Mapin Publishing Co., New Delhi.
5. Bhatacharya, A. K. (2005). *Ecotourism and Livelihoods*. Concept Publishing Co. New Delhi.
6. Ceballos-Lascurain & Hector. (1996). *Tourism, Ecotourism and Protected areas*: *the state of nature-based tourism around the world and guidelines for its development* IUCN, Cambridge UK.

7. Champion, H. G. &. Seth, S. K. (1968). *A Revised Survey of the Forest Types of India*. Govt. of India Press, Delhi.
8. Champion, H. G. (1936). *A Preliminary Survey of Forests of India and Burma*. Ind. For. Rec. (n.s.) *1*: 1-236.
9. Chandrasekharan, C. (1962)a. *A General note on the Vegetation of Kerala State*; *Ind. For*.88: 440-441.
10. Chandrasekharan, C. (1962)b. *Ecological Study of the Forests of Kerala State*; *Ind.* For.88: 473-480.
11. Chandrasekharan, C. (1962)c. *Forest Types of Kerala State*. Ind. For. 88: 660-847.
12. Garg, M. R., Bansal, V. K. & Tiwana, N. S. (2007). *Environmental Pollution and Protection.* Deep and Deep Publishers, New Delhi.
13. Good, R. (1974). *The Geography of the Flowering Plants.* Addison-Wesley Longman Ltd.
14. IUCN. (2000). *The IUCN Red list categories*. IUCN. Gland
15. IUCN. (2007). The 2000 IUCN *Red list of Threatened Species*. IUCN. Gland
16. Jain, S. K. &. Sastry, A. R. K. (1984). *The Indian Plant Red Data Book*. Botanical Survey of India, Calcutta.
17. Joseph, K. & Raghavan, R. (2004). *Essentials of environmental studies*. Pearson Education Pvt. Ltd. New delhi
18. Kaur, H. (2012). *Environmental studies*. 3rd edition. Pragati Prakashan, Meerut.
19. Khopkar, S. M. (1995). *Environmental Pollution Analysis.* New Age International (P) Ltd.
20. Kumar, D. (2006). *Ecology for Humanity Eco Tourism.* Intellectual Book Bureau, Bhopal.
21. Kumar, H. D. (2000). *Modern Concepts of Ecology.* Vikas Publishing House, New Delhi.
22. Kumar, U. & Asija, M. (2006). *Biodiversity*: *Principles and conservation*. Agrobios India.
23. Lindberg, K. & Hawkins, D. E. (1999). *Ecotourism: A guide for planners and managers*. Natraj Publishers, Dehradun.
24. Mani, M. S. (1974). *Ecology and Biogeography in India*. Dr. W. Junk b.v. Publishers, Netherlands.
25. Misra, D. D. (2008). *Fundamental concepts in Environmental Studies*. S. Chand & Co. Ltd. New Delhi.
26. Myers, N. (1988). "Threatened Biotas" 'Hot spots' in Tropical Forests," *The Environmentalist. 8*(3): 187-208.
27. Nayar, M. P. & Giri. G. S. (1988). *Keywords to the Floristics of India*. Vol. 1. Botanic Survey of India. Calcutta.
28. Nayar, M. P. &. Sastry, A. R. K. (1987). *Red Data Book of Indian Plants*, Vols. I-III. Botanical Survey of India, Calcutta.
29. Nayar, M. P. (1996). *Hot Spots of Endemic Plants of India*, Nepal and Bhutan. Tropical Botanic Garden and Research Institute, Trivandrum.

30. Nayar, M. P. (1997). *Biodiversity challenges in Kerala and Science of conservation Biology.* In : P. Pushpangadan & K. S. S. Nair (Eds.), Biodiversity of Tropical Forests the Kerala Scenario. STEC, Kerala, Trivandrum.
31. Odum, E. P. (1971). *Fundamentals of Ecology*. WB Sunders.
32. Oza, G. M. (1992). *The Earth Summit*. *Ind. For.* 5: 338.
33. Raj, S. A. (2005). *Introduction to Environmental Science & Technology*. Laxmi Publications Pvt. Ltd., New Delhi.
34. Ravindranath, N. H. & Sudha, P. (2004). *Joint Forest Management: Spread performance and Impact*. Universities Press.
35. Santhra, S. C. (2004). *Environmental Science.* New Central Book Agency.
36. Shukla, R. S. & Chandel, P. S. (1989). *Plant Ecology and Soil Science*. S. Chand & Co. Ltd. New Delhi.
37. Waxena, H. M. (2006). *Environmental Studies*. Rawat Publications, New Delhi.
38. Wright, R. T. (2002). *Environmental Science: Toward a Sustainable Future.* 8th edition. Pearson Education.

WEBSITES

1. www.cseindia.org
2. www.envfor.nic.in
3. www.kalpavriksh.tripod.com
4. www.saconindia.com
5. www.wii.gov.in
6. www.wwfindia.org
7. http://www.enviroliteracy.org/
8. http://www.webdirectory.com/
9. http://environmentalresearchweb.org/cws/home
10. http://www.envirolink.org/
11. http://www.epa.gov/
12. http://www.biodiversityhotspots.org
13. http://www.conservation.org
14. http://wgbis.ces.iisc.ernet.in/biodiversity
15. http://ces.iisc.ernet.in/biodiversity
16. http://www.envirolink.org
17. http://www.biodiversityhotspots.org
18. http://www.iucnredlist.org
19. http://www.greenpeace.org
20. http://indiabiodiversity.org
21. http://atree.org
22. http://www.frlht.org.in
23. http://www.worldwildlife.org
24. http://www.ipcc.ch/

Semester V

Course 7

23U5CRBOTT07: GENETICS AND PLANT BREEDING

(Theory: 54 hours; Practical: 36 hours) (Theory Credit: 3, Practical Credit: 1)

COURSE OUTCOMES (COs)	
CO1	Describe the basic principles of classical genetics
CO2	Discuss the non-mendelian patterns seen in nature
CO3	Estimate the linkage based genetic mapping in eukaryotes
CO4	Explain the types of sex determination mechanisms in higher organisms
CO5	Describe the methods involved in plant breeding

Module 1: Introduction to Genetics (9 hours)

a) History of genetics and contributions of Gregor Johann Mendel.

b) General terminology and concepts in genetics – chromosome, chromosome number, maternal and paternal chromosome, gene, allele, locus, dominant and recessive alleles, homozygous and heterozygous condition, genotype, phenotype, true-breeding line, hybridization experiment, self-pollination, monohybrid cross, dihybrid cross, Punnett square, backcross and testcross.

c) Mendel's Experiments, selection of experimental plant, selection of characters for the experiment, monohybrid and dihybrid experiments, principle of dominance, principle of segregation, principle of independent assortment

Module 2: Modification of Mendelian ratios (9 hours)

a) Incomplete dominance: definition, example - flower colour in *Mirabilis jalapa.*

b) Co-dominance: definition, example - MN blood types in humans.

c) Lethal genes: definition, example - pigmentation in Snapdragon.

d) Epistasis: definition, types; Dominant epistasis: example - fruit colour in summer squashes; Recessive epistasis – coat colour in mice

e) Complementary gene interaction: definition, example - flower colour in *Lathyrus odoratus*.

f) Multiple alleles: definition, example - ABO blood groups in humans.

Module 3: Linkage and Genetic mapping (9 hours)

a) Linkage – definition, chromosome theory of linkage, complete and incomplete linkage.

b) Crossing Over – definition, mechanism of crossing over, types of crossing over – single, double and multiple.

c) Recombinant and non-recombinant gametes, parental and recombinant offsprings.

d) Testcross for linkage mapping: definition, linkage mapping with two-point testcross, calculation of distance between genes, recombination frequency, and map units.

Module 4: Sex Determination (9 hours)

a) Sex determination mechanisms: chromosomal, genic and environmental.

b) Chromosomal sex-determination: XX-XY, XX-XO, ZZ-ZW, Haplo-Diplo system, genic balance system.

c) Environmental Sex Determination: Sex determination in slipper limpet, Sex determination in Reptiles

d) X-linked inheritance - Haemophilia in man; Y-linked inheritance – SRY gene

e) Sex-limited Inheritance - example – feathering pattern in Fowl; Sex-influenced Inheritance - example – Baldness in humans

Module 5: Quantitative and Extra-chromosomal Inheritance (9 hours)

a) Quantitative characters: Multiple factor hypothesis; polygenic inheritance; example - kernel colour in wheat, ear size in maize.

b) Extra chromosomal inheritance: chloroplast mutation - variegation in 4 O'clock plant; mitochondrial mutations in yeast, Streptomycin resistance in *Chlamydomonas*; kappa particles in *Paramecium*.

Module 6: Plant Breeding (9 hours)

a) Plant breeding – definition; objectives of plant breeding

b) Plant introduction – definition, procedure of plant introduction, agencies in India, major achievements.

c) Selection – definition, types - mass, pureline, clonal; major achievements
d) Hybridization – definition, types - intergeneric, interspecific and intervarietal; hybridization procedure, emasculation – different methods; major achievements
e) Mutation breeding – definition, procedure, gamma garden; major achievements
f) Modern tools for plant breeding - Genetic engineering and genetically modified crops (brief account)

Practical **(36 hours)**

1. Problems: Problems related to monohybrid cross, dihybrid cross, modified Mendelian ratios.
2. Calculation of distance between genes by using two-point test crosses and linkage map construction.
3. Emasculation

References

1. Snustad D P & Simmons M J. (2016). Principles of Genetics (V Edn). John Wiley.
2. Singh B D. (1983). Plant Breeding. Kalyani Publishers, Ludhiana.
3. Sadhu M K. (1996). Plant propagation. New age international publishers, N. Delhi.
4. Shukla R S & Chandel P S (2004). Cytogenetics Evolution and Plant breeding. S. Chand & Co. Ltd, New Delhi.
5. Schilletter J C &, Richey H W. (1999). Text Book of General Horticulture. Biotech Books, New Delhi.
6. William S Klug & Michael R Cummings (1994). Concepts of Genetics. Prentice Hall.
7. Robert J Brooker (2009). Genetics: Analysis and principles (III Edn). McGraw Hill.
8. Daniel L Hartl & Elizabeth W Jones (2009). Genetics: Analysis of genes and genomes (VII Edn). Jones and Bartlett publishers.

Semester V
Course 8
23U5CRBOT08: CELL BIOLOGY, MOLECULAR BIOLOGY AND EVOLUTION

(Theory: 54 hours; Practical: 36 hours) **(Theory Credit: 3, Practical: 1)**

COURSE OUTCOMES (COs)	
CO1	Infer the physio-chemical organization of a eukaryotic cell
CO2	Interpret the chromosomal organization, cell cycle and mutation in eukaryotes
CO3	Deduce the structure of nucleic acids and estimate the gene expression aspects
CO4	Explain various views of origin of life and Neo-Darwinism

CELL BIOLOGY (Theory- 27 hours, Practical- 27 hours)

Module 1 Cell: The unit of life **(10 hours)**

The physio-chemical nature of plasma membrane and cytoplasm; Eukaryotic and Prokaryotic cell. The ultra-structure of plant cell with brief description and function of the following organelles-Endoplasmic reticulum, Plastids and vacuoles, Mitochondria, Ribosomes, Dictyosome, lysosomes. Nucleus - ultra structure, nucleolus structure and function. Cytoskeleton - microtubules and microfilaments.

Module 2 Chromosomes and Cell Cycle **(15 hours)**

Chromosomal organization – chemical organization of nucleosome –The 10 nm fibre (nucleosome model), 30 nm fibre (solenoid model) and central axis with radial loops of 300 nm fibre, nucleoproteins. Giant Chromosomes – Polytene, Lampbrush and B chromosome.

Cell cycle: General events in Interphase and division phase; Mitosis and Meiosis: Events and significance.

Chromosomal aberrations - Numerical: Aneuploidy, Euploidy and Polyploidy; Structural: deletion, duplication, inversions and translocations.

Module 3 Mutations **(4 hours)**

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. 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.
3. Study of meiosis in any flower bud by smear preparation of PMC's.
4. Identification of salivary gland chromosome.
5. Study the chromosomal patterns for Karyotype in autoploids, alloploids, and aneuploids using images.

MOLECULAR BIOLOGY (Theory- 18 hours, Practical- 9 hours)

Module 4 Nucleic acids (6 hours)

Structure of DNA; Primary structure; structure of ribose and deoxyribose sugars, Structure of N bases, Structure of nucleosides and nucleotides, phosphodiester bond and structure of polynucleotides. Secondary Structures; structure of DNA double helix, different forms of DNA [A, B and Z].

RNA - Basic features, structure and types; mRNA, tRNA- Structure of tRNA, clover leaf and 'inverted L' models of tRNA, rRNA, snRNA, miRNA.

Replication of DNA - Meselson-Stahl experiment - details of semi-conservative replication of DNA, Replication in prokaryotes.

Module 5 Gene expression (8 hours)

Genetic code and its features. 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; Brief study on eukaryotic transcription, hnRNA, splicing, release of mRNA. Translation - initiation, elongation and termination.

Module 6 Control of gene expression (3 hours)

Positive and negative control - operon model - Lac operon, catabolic repression. Tryptophan operon, attenuation. Regulation in eukaryotes – Histone remodeling (brief account only)

Practical (9 hours)

Problems based on Molecular Biology theory topics - DNA structure, Replication, Transcription, and Translation.

EVOLUTION (Theory- 9 hours)

Module 8 Introduction (5 hours)

Origin of life – Biochemical origin of life (Miller's Experiment), Progressive, Retrogressive, Parallel and Convergent evolution. Theories of evolution - Lamarck's, Darwin's, Weismann's and Hugo deVries.

Module 9 Neo Darwinism (4 hours)

Reproductive isolation (Prezygotic isolation mechanisms), Mutation, Genetic drift, Speciation (Sympatric and allopatric speciation). Variation and evolution, Hybridization and evolution, Polyploidy and evolution. Mutation and evolution.

References

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P., (2002) Molecular Biology of the Cell (4th Ed.), Garland Science, New York.
2. Becker, W. M. and Klein smith, L. J., (2005) World of the Cell (6th Ed.), Benjamin Cummings.
3. Cooper GM and Hausman (2013) The Cell, a molecular approach , 6th Edition, Sinauer Associates, Sunderland.
4. Gupta, P. K. (2003) Cell and Molecular Biology (2nd Ed.), Rastogi Publication, Meerut 17.
5. Harvey, L., Arnold, B., Lawrence, S., Zipursky, Paul, M., David, B., and James, (2000) Molecular Cell Biology (4th Ed.), W. H. Freeman, New York.
6. Stern, K.R. (2002), Introduction to plant Biology (8th Ed.),Mc Graw Hill, Boston.

Semester V
Open Course

23U5OCBOTT1 - AGRIBASED MICROENTERPRISES

(Theory: 54 hours) **(Theory Credit 3)**

COURSE OUTCOMES (COs)	
CO1	Identify the plausibleness of entrepreneurial aspects in plant science.
CO2	Analyse the basics of organic farming in agriculture
CO3	Compare sustainable agricultural practices
CO4	Know the importance of floriculture and cut flower industry
CO5	Understand the nursery management and it's industrial significance

Module 1. Organic Farming **(8 hours)**

Principles and advantages, Common organic manures. Preparation of compost, vermicompost, vermi-wash, Bio-fertilizers, Bio-pesticides. Biological control. Sustainable agriculture – comparative account of various practices with models, need of sustainable agriculture.

Module 2. Horticulture and Plant Nurseries **(12 hours)**

Preparation of potting mixture. Common Garden tools and implements. Vegetative and artificial plant propagations. Common growth regulators for rooting. Different types of gardens; rockery and artificial ponds. Garden lawns and turfing. Bonsai. Pruning of plants. Management and Maintenance of nurseries. Irrigation. Aquaponics, precision farming. Futuristic aspects of farm tourism/educational tourism.

Module 3. Floriculture and Flower Arrangement (6 hours)

Floriculture in Kerala - Scope and applications. Common leaves in flower arrangement, flower holders, floral foam, flower arrangement, Bio Bouquet.

Module 4. Mushroom Cultivation (6 hours)

Significance of Mushrooms, Different types of mushrooms, poisonous mushroom – general account. Spawn. Cultivation of oyster and milky mushrooms. Value added products from mushroom. Employment or entrepreneurship opportunities.

Module 5. Plant Tissue Culture (4 hours)

Infra-structure of a typical tissue culture laboratory. Basic steps involved in plant tissue culture. Applications of tissue cultured plants.

Module 6. Self-Employment and start-ups (6 hours)

Funding Agencies and self-employment schemes in India and Kerala, Procedure to get financial support (with an example; national or state), special scheme for women empowerment. Introduction to Start-up schemes.

Hands on Training (12 hours)

1. Visit to a farm where organic farming is practiced and prepare a report that should be submitted in the form of assignments.
2. Demonstration of Vermicomposting preparation.
3. Demonstration of T-budding, epicotyl grafting and air layering on live plants.
4. Demonstration of mushroom cultivation.
5. Visit to a well-established tissue culture lab.
6. Familiarization of common cut flowers in Kerala.
7. Fresh cut flower arrangement.
8. Preparation and arrangement of dry flowers.

References

1. Chandha., K. L (2003). *Handbook of Horticulture*. ICAR. New Delhi.
2. Acquciah, G. (2004). *Horticulture – Principles and Practices*. II Edn. Prentice Hall. India.
3. De. G. C. (2002). *Fundamentals of Agronomy*. Oxford and IBH Publishing House.

4. Hudson. T., Hartmann, T. and Kester, D. E. (2001). *Plant Propagation, Principles and Practices*. 6th Edn. Prentice Hall. India.
5. John, J. (2012). *Elements of Agribased Microenterprises*, Bulbul Scientific Publishers, Kottayam.
6. De, K. K. (1996). *Plant Tissue Culture*. New Central Book Agency (P) Ltd.
7. Kaul, T.N. (2002). *Biology and Conservation of Mushroom.* Oxford and IBH Publishing Co.
8. Kunte, K. and Yawalker C. (1997). *Principles of Horticulture and Fruit Growing*. Agri – Horticulture Co.
9. Neshamani, S. (2003). *Pazhangal, Pazhavibhavangal* (Malayalam). Kerala Bhasha Institute.
10. Pandey, R. K and S. K. Ghosh. (1996). *A Hand Book on Mushroom Cultivation*. Emkey Publications.
11. Arya, P. S. (2004). *Vegetable Seed Production Principles*. Kalyani Publishers.
12. Alex, P. and Nair R. A. (2003). *Ayurveda Avshodha Nirmanam – Sidhanthavum Prayogavum* (Malayalam). Kerala Bhasha Institute.
13. Purohit, S.S. (2005). *Plant Tissue Culture*. Student Edition.

Semester VI

Course 9

23U6CRBOTT09: PLANT PHYSIOLOGY AND BIOCHEMISTRY

(Theory - 54 hours; Practical – 36 hours; Credits: Theory – 3, Practical - 1)

COURSE OUTCOMES (COs)	
CO 1	Identify the relationship of plants with its habitat through plant water relations, stress physiology and plant responses to the environment.
CO 2	Examine the mechanism of mineral nutrition, photosynthesis, translocation of solutes and respiration.
CO 3	Describe the physiology of growth and development in plants
CO 4	Develop perception on structure and importance of the water and biomolecules associated with plant life.
CO 5	Develop basic skills and techniques related to plant physiology and biochemistry.

PLANT PHYSIOLOGY **(Theory - 36 hours, Practical - 27 hours)**

Module 1: Water relations **(6 hours)**

A. Physical aspects of absorption - Diffusion, imbibition, osmosis, OP, DPD, TP, WP, Concept of Water potential - osmotic/solute potential, gravity potential, matric potential, pressure potential.

B. Absorption of water - active & passive, radial pathway of water movement – apoplastic, symplastic & transmembrane pathway, Ascent of sap - cohesion tension theory and root pressure theory, Guttation. Transpiration-types-mechanism- (Active K+ ion transport theory)-significance – anti-transpirants.

Module 2: Mineral Nutrition and mechanism of absorption **(3 hours)**

Essential and non-essential elements- macro & micro- role- deficiency symptoms. Active and passive absorption of minerals.

Module 3: Photosynthesis **(10 hours)**

History – PAR, Photosynthetic pigments, photoexcitation- Fluorescence, Phosphorescence - Absorption and action spectra, Red drop and Emerson enhancement effect, Concept of photo systems, Cyclic and Non-cyclic photophosphorylation, Carbon assimilation pathways- C3, C4, CAM- Photorespiration –factors affecting photosynthesis - Blackmann's law of limiting factors.

Module 4: Translocation of solutes **(2 hours)**

Phloem transport-mechanism-pressure flow-phloem loading and unloading.

Module 5: Respiration **(8 hours)**

Definition, Aerobic and Anaerobic, Glycolysis, Krebs cycle, Electron transport system (ETS) and Oxidative phosphorylation, ATPases – chemi-osmotic hypothesis - RQ – significance, factors affecting respiration.

Module 6: Seed Physiology **(1 hour)**

Importance of seeds, seed structure and function, physiological and biochemical changes during seed germination.

Module 7: Physiology of growth and development **(4 hours)**

A. Physiological effects and practical applications of plant growth regulators - Auxins, Gibberellins, Cytokinins, Abscisic acid and Ethylene.

B. Physiology of flowering–phytochrome-photoperiodism-vernalization

Module 8: Stress physiology **(2 hours)**

Abiotic - concept of plant responses to water and salt stresses; Biotic – pathogens.

Plant Physiology practical **(27 hours)**

Core Experiments

1. Determination of osmotic pressure of plant cell sap by plasmolytic method.
2. Comparison of stomatal indices in different ecological groups of plants.
3. Separation of plant pigments by Paper Chromatography/ Thin Layer Chromatography (TLC).

4. Measurement of photosynthetic rate by Wilmotts bubbler/ Hydrilla plant experiment/ any other suitable method.

5. Estimation of plant pigments by Colorimeter/ Spectrophotometer.

Experiments only for demonstration.

1. Papaya petiole osmoscope.
2. Relation between transpiration and absorption - water balance experiment.
3. Necessity of chlorophyll, light and CO2 in photosynthesis.
4. Simple respiroscope.
5. Respirometer and measurement of R.Q.
6. Fermentation.
7. Measurement of transpiration rate using Ganong's photometer/ Farmer's Potometer.

BIOCHEMISTRY (Theory - 18 hours, Practical - 9 hours)

Module 1: Water, Solutions and pH (2 hours)

Physical and chemical properties of water, Acid and bases, pH - definition, significance, measurement, pH indicators, buffer action, pH and life.

Module 2: Chemistry of biomolecules (10 hours)

a) Carbohydrates- structure and role of mono-di & poly-saccharides-common sugars seen in plants.

b) Proteins-peptide bond-essential and non-essential amino acids - structural levels of proteins - primary, secondary, tertiary and quaternary - physiologically important proteins.

c) Lipids - general features and their roles - fatty acid types and structure - fatty acid derivatives- fats and oils, structure and functions - compound lipids.

Module 3: Enzymes (6 hours)

Nomenclature, characteristics, mechanism and regulation of enzyme action, enzyme kinetics, factors affecting enzyme action.

Biochemistry Practical (9 hours)

1. General test for carbohydrates- Molisch's test, Benedict's test, Fehling's test.
2. Colour test for starch – lodine test.
3. Colour tests for proteins in solution - Biuret test

4. Detect the presence of any three major organic compounds in the given food stuff/material viz. reducing /non-reducing sugar/fat proteins/starch, sucrose.
5. Estimation of protein using colorimeter.

References

1. Buchanan, B. B., Gruissem, W. and Jones, R. L. (2015). *Biochemistry and molecular biology of plants.* 2nd edition. Wiley Blackwell, New Delhi.
2. Datta, S. C. (1989). *Plant Physiology*, Central Book Depot, Allahabad.
3. Dayananda, B. (1999). *Experiments in Plant Physiology*. Narosa Publishing House, New Delhi.
4. De Robertis, E.D.P. & De Robertis, E.M.F.Jr. (2002). *Cell and Molecular Biology*, Lipponcott Williams and Wilkins. USA.
5. Devlin, R. M. (2017). *Outline of Plant Physiology*, Medtech Publishers.
6. Hopkins, W. G. & Huner, N. P. A. (2009). *Introduction to Plant Physiology*. 4th edition. John Wiley & Sons, Inc. New York.
7. Jain, J. L., Jain, S. & Jain, N. (2005). *Fundamentals of Biochemistry*. S. Chand & Company Ltd., New Delhi.
8. Jain, V. K. (2008). *Fundamentals of Plant Physiology*, S. Chand and Co.
9. Kochhar, P. L. & Krishnamoorthy, H. N. (1958) *A Textbook of Plant Physiology*. 4th edition. Atma ram and Sons, Delhi, Lucknow.
10. Kumar, A. & Purohit, S. S. (2011). *Plant Physiology – Fundamentals & Applications*. Agrobios Publishers.
11. Lehninger, A, L., Nelson, D. L. & Cox, M. M. (1993). *Principles of Biochemistry*. MacMillan Worth Publications.
12. Lehninger, A. L. (2021). *Biochemistry*, Kalyani Publishers, Ludhiana.
13. Leopald, A. C. (1988). *Plant Growth and Development*. Tata Mc graw-Hill, New Delhi.
14. Malik, C. P. & Srivastava, A. K. (2015). *Text Book of Plant Physiology*. Kalyani Publishers, New Delhi.
15. Malik, C. P. (2002). *Plant Physiology*, Kalyani Publishers.
16. Mukherjii, S. & Ghosh A. K. (2005). *Plant Physiology*. Calcutta New Central Book Agency.
17. Noggle, G. R. & Fritz, G. J. (1983). *Introductory Plant Physiology*. Prentice Hall of India.

18. Pandey, S. N. & Sinha, B. K. *Plant Physiology*. 4th edition. Vikas Publishing House, New Delhi.
19. Pessarakli, M. (editor) (2001). *Handbook of Plant and Crop Physiology*. 2nd edition. Marel Dekker, Inc., New York.
20. Plummer, M. U. & Plummer, D. T. (1988). *Introduction to Practical Biochemistry*. Tata McGraw-Hill Education, Noida.
21. Rolfe, S. & Opik, H. (2005). *The Physiology of Flowering Plants*. 4th edition. Cambridge University Press, UK.
22. Sadasivam, S & Manickam, A. (2004). *Biochemical Methods*. 2nd edition. New Age International (P) Ltd. New Delhi.
23. Salisbury, F. B. & Ross, C. W. (1992). *Plant Physiology*. 4th edition. Wadsworth Publishing Company, New York.
24. Sinha, A. K. (2004). *Modern Plant Physiology*. Narosa Publishing House, New Delhi.
25. Srivastava, H. S. (2004). *Plant Physiology & Biochemistry*. 7th edition. Rasthogi Publications.
26. Taiz, L. & Zeiger, E. (2010). *Plant physiology*. 5th edition. Sinauer Associates Inc., Publishers, U.S.A.
27. Verma, S. K. & Verma, M. (2006). *A Textbook of Plant Physiology, Biochemistry & Biotechnology*, S. Chand and Co.
28. Verma, V. (2007). *Textbook of Plant Physiology*. Ane Books Pvt Ltd.

Websites

http://www.plantphysiol.org/contents-by-date.0.shtml

http://4e.plantphys.net/

http://www.rsc.org/education/teachers/learnnet/cfb/Photosynthesis.htm

http://www.plantstress.com/

http://bioenergy.asu.edu/photosyn/education/learn.html

http://www.biologie.uni-hamburg.de/lehre/bza/eanfang.htm

http://www.ab.ipw.agrl.ethz.ch/~yfracheb/flex.htm

http://www.life.illinois.edu/govindjee/photoweb/subjects.html#ps

http://www.plant-hormones.

Semester VI

Course 10

23U6CRBOTT10: PERSPECTIVES OF SCIENCE, METHODOLOGY AND GENERAL INFORMATICS

(Theory 54 hours, Practical 36 hours) **(Theory Credit 3, Practical credit 1)**

COURSE OUTCOMES (COs)	
CO1	Apply the steps in scientific researches in a structured manner
CO2	Recognize the applications of biophysics and biostatistics in scientific research
CO3	Compute basic in applications of general informatics
CO4	Understand the statistical terms and its relevance in plant science
CO5	Manage a research project at undergraduate level

Perspectives of Science **(Theory 18 hours; Practical 4 hours)**

Module 1 - Introduction to science and scientific methods **(6 hours)**

Introduction to science

Need for research

Types of research

Steps in scientific methods

- observation and thoughts
- formulation of a hypothesis (Null- hypothesis and alternative hypothesis)
- designing of experiments
- testing of hypothesis
- formulation of theories

Module 2 - Components of Scientific Research **(12 hours)**

a) Selection of a problem

b) Searching the literature; Scientific literature, Books, Research and review articles, Research Journals, Reputed National and International journals in life sciences, INSDOC services

c) Selection of variables, study area, and a suitable design

d) Necessity of units and dimensions

Units of length, volume, area, concentration, temperature, pressure

e) Need of control, treatments and replication

f) Types of data and data analysis

g) Testing of hypothesis, need of statistical tools

h) Any one example of classical experiments in life sciences (Problem to Theory)

i) Contributions of Louis Pasteur and Robert Koch

j) Ethics in science

k) Laboratory Etiquette

l) Laboratory Hygiene

Practical **(4 hours)**

1. Prepare CuSO4. H2O solution of different molarity using a stock solution

2. Determination of the area of different types of leaves using graph paper.

Biophysics and Biostatistics (Theory 18 hours, Practical 18 hours)

Module 3 - Biophysics **(7 hours)**

a) Principles and applications of colorimeter, spectrophotometer and centrifuge, Beer-Lambert's Law,

b) Separation methods: - chromatography; thin layer, paper, column (principle and applications only), electrophoresis; PAGE, Agarose gel electrophoresis (Principle and applications only)

c) Microscopy – types (light, fluorescent and electron microscopy), principles and applications

Practical **(12 hours)**

1. Electrophoresis of nucleic acids (demonstration)

2. Column chromatography of plant pigments (demonstration)
3. Determination of the concentration of a given solution of CuSO4 using colorimetry

Module 4 - Biostatistics **(11 hours)**

a) Introduction, statistical terms and symbols
b) Concept of sample, sampling methods
c) Collection and representation of data, graphic representation of data (Line graph, bar graph, Pie chart, Histogram and scatter plot)
d) Measures of central tendency: mean, mode, median
e) Measures of dispersion: standard deviation, standard error
f) Distribution patterns: normal distribution, binomial distribution.
g) *t*-test; introduction, procedure and uses.
h) Chi-square test; introduction, procedure and uses.

Practical **(8 hours)**

1. Collect numerical data and find out the central tendencies with dispersion and prepare different types of graphs mentioned in the syllabus.
2. Familiarize with situations requiring t-test, chi-square test.

General Informatics **(Theory 18 hours, Practical 12 hours)**

Module 5 - Overview of the Information Technology **(3 hours)**

a) Internet as a tool for education, Academic search engines (Google Scholar), Educational sites related to life sciences (DNAi, Scitable), Specific sites for academics (Science direct and INFLIBNET)
b) Use of information technology in learning.

Module 6 - Use of Computers in science **(15 hours)**

a) MS-WINDOWS as operating system.
b) MS-WORD: Common command lines. Preparation of scientific reports and documents.

c) MS-Excel: Creating a worksheet, data entry and analysis, use of statistical tools in EXCEL (SUM, MEAN, MODE, MEDIAN, STDEV), preparation of graphs (bar diagram, pie chart and line graph)

d) MS-POWERPOINT: Preparation of PPT for scientific presentations.

Practical **(12 hours)**

1. Gather information and pictures on a given topic using the internet. Make a list of the sites visited for the purpose
2. Prepare a project report using MS-WORD based on the information and pictures gathered from the internet.
3. Prepare a worksheet using a set of data collected and find out the SUM, MEAN, MEDIAN and MODE using EXCEL
4. Prepare suitable tables/ charts/graphs based on the data using EXCEL
5. Prepare a PowerPoint presentation based on the 1 & 2 exercises

References

1. Agarwal SK, 2008, *Foundation course in Biology,* Ane Books Pvt.Ltd., New Delhi.

2.*Collins H.and T Pinch 1993 The Golem: What everyone should know about science,* University Press, Cambridge.

3.ColRuxton R, S N. Colegrave.2006. *Experimental Design for the life Science,* Oxford University Press

4. Cotteril R, 2002. *Biophysics an Introduction*. John Wiley and Sons.

5. Dany Spencer Adams, 2004. *Lab Math* I.K. International Pvt. Ltd. New Delhi.

6. David A Micklos, Greg A Freyer 2003.*DNA science*: A first course. Cold Spring Harbor Laboratory Press.

7. Day R.A, 1998. *How to Write and Publish a ScientificPaper,* University Press Cambridge.

8. Dwivedi J .N and R.B Singh (1990*) Essentials of Plant Techniques* – Scientific Publishers, Jodhpur.

9. GW Stout, DJ Taylor, 2008. *Biological Sciences*. NPO Green, University Press, Cambridge.

10. Harold C Bold, 1999.*The Plant Kingdom*. Prentice Hall of India Pvt. Ltd.

11. Holmes D Moody P and D.Dine 2006 , *Research Methods for the Biosciences* Oxford University Press

12. Holmes D Moody P and D. Dine 2006, *Research Methods for the Biosciences* Oxford University Press

13. Jeffrey A. Lee 2009; *The Scientific Endeavor Methodology and Perspectives of sciences,* Pearson

14. Johnson DA, 1940. *Plant Microtechnique*, McGraw Hill Co., New York.

15. Judson HF, 1979. *The eighth day of creation*. Simon Schuster, New York.

16. Krishnamurthy K.V (2004) *Advanced text book on biodiversity, principles and practice.* IBH Pub Oxford.

17. Mohanan K.V Biometry Biotechnology, Manjusha Publishers, Calicut.

18. Norman T.J Bailey, 2008. *Statistical Methods in Biology*, Cambridge.

19. Parthasarathy A, *2008. Essentials of programming in C for life* Sciences, Ane Books, India.

20. PatkiL. R, B.L Bhalchandra, I H Jeevaji 1983 An Introduction to Micro technique, Chand and Co.

21. Prasad M.K & Krishna Prasad M,1986. *Outlines of Micro Technique*, Emkay Publishers, New Delhi.

22. Prasad S. 2003. *Elements of Biostatistics*. Rastogi Publications, Meerut.

23. Prithipalsingh, 2007. An Introduction to Biodiversity, Ane Books India

24. Ray Spangenburg and Diane K Moser, 1999. *The history of science in the nineteenth century*. Universities Press.

25. Ray Spangenburg and Diane K Moser, 1999. *The history of science in the eighteenth century*. Universities Press

26. Ray Spangenburg and Diane K Moser, 1999.*The history of science from the ancient Greek to the scientific revolution*. Universities Press.

27. Schrodinger, AH1992. *What is life? The physical aspects of living cell with mind and matter*. University Press Cambridge.

28. Sharma O.P, 2002. *Experiments in Techniques Microbiology, Plant Pathology, Ecology and Soil Science, Polution Biochemistry and Plant Physiology,* Pragati Prakasam ,Merut

29. Sobti RC and Sharm V.L, 2008. *Essentials of Modern Biology*. Ane Books Pvt. Ltd.

30. Varantha Pallabhi & Gautham. N, 2005. *Biophysics* Norosa Publishing House, New Delhi.

Semester VI

Course 11

23U6CRBOTT11: BIOTECHNOLOGY AND BIOINFORMATICS

(Theory 54 hours; Practical: 36 hours) (Theory Credit 3, Practical Credit 1)

COURSE OUTCOMES (COs)	
CO1	Define the basics of plant tissue culture
CO2	Explain the fundamentals of recombinant DNA technology, gene cloning strategies
CO3	Debate the social and ethical issues related to gene cloning strategies
CO4	Enumerate the scope and relevance and futuristic aspects of genomics, transcriptomics and proteomics

BIOTECHNOLOGY (Theory 36 hours; Practical 27 hours)

Module 1: **Plant tissue culture** (**20 hours)**

a) Introduction to plant tissue culture.

b) Principles of tissue culture: Cellular totipotency, callus induction, organogenesis and somatic embryogenesis.

c) Tissue culture medium: Basic components in tissue culture medium, MS medium, Preparations of stock solutions.

d) Aseptic techniques in tissue culture: sterilization techniques - wet, dry and chemical; working principle of laminar air flow and autoclave.

e) Micropropagation: definition, different stages of micropropagation, advantages and disadvantages.

f) Somaclonal variation: Reasons, advantages and disadvantages, applications

g) Applications of tissue culture: Shoot tip and meristem culture, Synthetic seed production, embryo rescue culture, Protoplast culture, Somatic cell hybridization,

in vitro secondary metabolite production, *in vitro* production of haploids – androgenesis and gynogenesis, triploid plant production.

Module 2 **(8 hours)**

a) Introduction to Biotechnology, Recombinant DNA Technology

b) Gene cloning strategies – recombinant DNA construction – cloning vectors – plasmids (pBR322), bacteriophage-based vectors, Ti plasmids. Restriction endonucleases and ligases, transformation and selection of transformants using antibiotic resistances markers; PCR – types and applications (Brief account only).

c) Different methods of gene transfer – chemically stimulated DNA uptake by protoplast, transduction, electroporation, microinjection, microprojectiles, *Agrobacterium* mediated gene transfer, gene library (genomic and cDNA library)

Module 3 (**6 hours)**

Current trends in Biotechnology:

a) Tissue Engineering, Nanobiotechnology

b) Achievements of Biotechnology: Golden rice, Flavr Savr tomato

c) Production of disease/ stress resistant plants (Bt Brinjal and Bt cotton)

d) Gene therapy, DNA fingerprinting

Module 4 (**2 hours)**

Social and ethical issues, biosafety, bioweapon, patenting and IPR (brief account).

Practical **(27 hours)**

1. Preparation of nutrient medium – Murashige and Skoog medium, sterilization, preparation of explants, inoculation.
2. Extraction of DNA from plant tissue.
3. Immobilization of whole cells or tissues in sodium alginate.
4. Determination of appropriate flower bud containing uninucleate pollen for anther culture using cytological techniques
5. Study of genetic engineering tools and techniques using photographs/diagram (Southern blotting, DNA finger printing, PCR)
6. Visit a well-equipped biotechnology lab and submit a report along with the practical record.

BIOINFORMATICS (Theory: 18 hours; Practical: 9 hours)

Module 5 **(7 hours)**

Introduction to Bioinformatics

a) Introduction to Bioinformatics, scope and relevance, genome, transcriptome, proteome.

b) Biological data bases –

   i. Nucleotide sequence database – EMBL, NCBI Genbank, DDBJ.

   ii. Protein sequence database – PDB, UniProt

   iii. Organismal database – TAIR

c) Information retrieval from biological database (Entrez); Sequence alignment types and tools: pair wise sequence alignment, multiple sequence alignment; Use of BLAST.

Module 6 **(7 hours)**

Genomics and Proteomics

a) Genomics: DNA sequencing Sangers procedure-automation of DNA sequencing, genome sequence assembly (reference based and *de novo*), Genome projects – Major findings of the following genome projects – *Arabidopsis thaliana*, Rice, Tomato and Black Pepper; Application of genome projects.

b) Proteomics: Protein sequencing- Edman degradation method, automation of sequencing, protein structure prediction, Molecular visualization – use of RasMol (Brief account only)

Module 7 (4 hours)

Trending applications of bioinformatics

A brief account on

a) Molecular phylogeny and phylogenetic trees.

b) Molecular docking and computer aided drug design

Practical **(9 hours)**

1. Familiarizing with the different data bank mentioned in the syllabus.
2. Molecular visualization using Rasmol.
3. BLAST search.

References

1. Attwood TK & Parry, Smith DJ. 2003. *Introduction to Bioinformatics*. Pearson Education.
2. Balasubramanian, D. – Bryce CFA, Dharmalingam K. Green J, Kunthala Jayaraman, 2007. *Concepts in Biotechnology* – University Press India Pvt. Ltd.
3. Becker JM, Coldwell GA and Zachgo EA. 2007. *Biotechnology* – A Laboratory Course Academic Press.
4. Bhojwani and Razdan MK 2000 *Plant Tissue Culture – Theory and practice*. Elsevier India Pvt. Ltd.
5. Brown T.A. *Gene cloning and DNA analysis*. Black Well publishing.
6. Colin Ratledge and Bjorn Krishansen, 2008. *Basic Biotechnology*, Cambridge University Press.
7. Dixon R.A, 2003. *Plant Cell Culture*, IRC Press
8. Dubey R.C 2006. *A Text Book of Biotechnology* S.Chand and Company, New Delhi
9. Gupta P.K, 2006. *Biotechnology and Genomics*. Rastogi Publications.
10. Jogdand S.N. 1999. *Advances in Biotechnology*, Himalaya Publishers, Mumbai.
11. John E Smith 2006. *Biotechnology*, Cambridge University Press
12. Lewin. B. 2008 *Gene* IX. Jones and Barlett Publications.
13. Rastogi SC, Mendiratta M and Rastogi P. 2004. *Bioinformatics*: *concepts, Skills and Application* CBS.
14. Razdan M.K. 2000. *An introduction to Plant Tissue Culture*, Oxford IBH Publications, New Delhi.
15. Reinert and Bajaj YPS. 1989. *Applied and Fundamental Aspects of Plant Cell Tissue and Organ Culture*. Narora Publications, New Delhi.
16. Singh BD.2007. *Biotechnology*, Expanding Horizon, Kalyani Publications, Ludhiana.
17. Sobti RC and Suparna S. Panchauri. 2009. *Essentials of Biotechnology*, Ane Books Pvt. Ltd.
18. Timir Baran Jha and Biswajith Ghosh 2007, *Plant Tissue Culture*, University Press.
19. Veer Bala Rastogi 2008. *Fundamentals of Molecular Biology*, Ane Books Pvt. Ltd.
20. Kalyan De Kumar, 2006. *Plant Tissue Culture*, New Central Book Agency, Culcutta.
21. Narayana Swami S. 2005 *Plant Cell & Tissue culture*. Mc Graw Hill Company.
22. Rastogi S.C. Mandiratta N. Rastogi P. 2005. *Bioinformatics Methods & Application-*

23. Genomics, Proteomics & Drug Discovery Prentice Hall of India Pvt. Ltd., New Delhi.
24. Desmond S.T. Nicholl 1994. *An Introduction to Genetic engineering* (second edition) Cambridge University Press, Foundation Books Pvt. Ltd., New Delhi.
25. Jeremy W. Dale and Malcolm Von Schantz 2003, From *Genes to Genomes*. John Wiley & Sons, Ltd. New York.
26. Richard M. Twyman 2003 *Instant notes Bioinformatics* Viva Books, New Delhi.
27. Remawat K.G. 2006. *Plant Biotechnology* S. Chand & Company Ltd., New Delhi.
28. Purohit S S 2004. *A Laboratory Manual of Plant Biotechnology*. Agro bios India .
29. Thiel T. Bussen S. Lyons E M 2004. *Biotechnology DNA to protein*- A Laboratory Project in Molecular biology. Tata Mc Graw Hill Publishing Co.Ltd. New Delhi
30. Prasad. S, 2004, *Impact of Plant Biotechnology on Horticulture*. Agrobios India
31. Jin XIong, 2009, *Essential Bioinformatics*, Cambridge.
32. P Baldi and S Brunak 2000,*Bioinformatics : A Machine Learning Approach*.. MIT Press,
33. Cynthia Gibas and Per Jambeck, 2003, *Developing Bioinformatics Computer Skills*. O'Reilly.

Semester VI
Course 12
23U6CRBOTT12 HORTICULTURE, NURSERY MANAGEMENT AND PLANT REPRODUCTIVE BIOLOGY

(Theory 54 hours; Practical: 36 hours) (Theory Credit 3, Practical Credit 1)

	COURSE OUTCOMES (COs)
CO 1	Explain the principles and practices of propagation and nursery management for horticultural crops
CO 2	Enumerate the basic knowledge about the importance of ornamental gardening, organic farming, fruit, vegetable cultivation and floriculture
CO 3	Appraise the complexities in plant reproductive biology
CO 4	Discuss theory and practice of cultural and production techniques and methods

HORTICULTURE (Theory 18 hours; Practical 18 hours)

Module 1: Introduction to horticulture (2 hours)

Definition, classification of horticultural plants, disciplines of horticulture.

Module 2: Gardening and its components (6 hours)

a) Gardening- ornamental gardens, indoor gardens, home gardens- terrestrial and aquatic gardens- garden adornments; garden designing- garden components- lawns, preparation of lawns by seeds, seedling, turfing. Shrubs and trees, borders, hedges, edges, walks, drives- famous gardens of India.

b) Physical control of plant growth- training and pruning; repotting; disease and pest control.

Module 3: Organic farming and Composting Techniques (7 hours)

a) Organic manures and fertilizers, Composition of fertilizers. Common organic manures – bone meal, cow dung, poultry waste, oil cakes, organic mixtures and compost.

b) Preparation of compost –aerobic and anaerobic- advantages and limitations. Vermicompost and Vermiwash preparation.

c) Biofertilizers– Definition and preparation of different types –Rhizobium, PGPR, PSB, AM. Application of Biofertilizers.

d) Biopesticides – Tobacco and Neem decoction.

e) Biological control of disease and pests.

Module 4: Garden tools and implements (3 hours)

a) Garden tools and implements.

b) Irrigation methods- surface, sub, drip and spray irrigations, mist chambers - advantages and disadvantages.

Practical **(18 hours)**

1. Tongue grafting, budding ('T' and patch) and air layering.
2. Identification of different garden tools and their uses.
3. List out the garden components in the photograph of the garden given.

NURSERY MANAGEMENT (Theory 18 hours; Practical 9 hours)

Module 5: Basics of Nursery Management **(3 hours)**

Preparation of potting mixtures, Plant growth structures and its advantages - green house, polyhouse, fernery and orchidarium, Types of Nurseries – Management aspects and Maintenance.

Module 6: Propagation Methods **(8 hours)**

Propagation of horticultural plants- by seeds- Seed viability, seed dormancy, seed testing and certification, seed bed preparation, seedling transplanting, hardening of seedling; advantages and disadvantages of seed propagation. Vegetative propagation- organs used in propagation- natural and artificial vegetative propagation; methods- cutting, layering, grafting and budding; advantages and disadvantages of vegetative propagation.

Module 7: Cultivation of Vegetables, Fruits, Flowers and Medicinal Plants (5 hours)

a) Principles of vegetable, flowering plants and fruit crop cultivation; Induction of flowering and weed control.
b) Cultivation of common medicinal and spice plants.
c) Traditional production techniques, Post-harvest techniques and packaging techniques
d) Problems, prospects and scope of floriculture in Kerala. Floral arrangement: Types- Western, Eastern (Japanese/ Ikebana) and Modern.
e) Selection of plant for bonsai, bonsai containers and method of bonsai formation.

Module 8: Self Employment Opportunities **(2 hours)**

Funding Agencies and self-employment schemes, Procedure to get financial support, special scheme for women empowerment.

Practical **(9 hours)**

1. Familiarization of common fertilizers and manures.
2. Nursery visit (Familiarization of common cut flowers and leaves used in flower arrangements).

REPRODUCTIVE BIOLOGY (Theory 18 hours; Practical 9 hours)

Module 9: Introduction to Embryology (2 hours)

General account and interdisciplinary relevance of embryology, embryology in relation to taxonomy; experimental embryology.

Module 10: Microsporangium and Male gametophyte (4 hours)

Structure and development of anther, microsporogenesis, development of male gametophyte, anthesis and anther dehiscence, structure of pollen, pollen germination, pollen tube growth and pollen viability.

Module 11: Megasporangium and Female gametophyte (4 hours)

Structure and development of ovule, megasporogenesis, embryosacs-monosporic (Polygonum type), bisporic (Allium type) and tetrasporic (Peperomia type). Structure of mature embryo sac. Types of ovules.

Module 12: Pollination syndromes and Syngamy (4 hours)

Breeding/Reproductive systems and pollination syndromes (with examples for each syndrome) in angiosperms; pollen-pistil interaction; self-compatibility and incompatibility; double fertilization, and triple fusion; apomixis.

Module 13: Embryo Development (3 hours)

Development of endosperm and embryo in Dicots and Monocots; Poly-embryony; Factors affecting polyembryony.

Module 14: Pollination mechanism- A case study (1 hour)

Any Indian example from a reputed journal to study the pollination mechanisms and methods (eg. *Strobilanthes kunthianus*).

Practical (9 hours)

1. Identification of C.S. of anther, embryo sac and embryo.
2. Identification of various anther types-monothecous, dithecous.
3. Observation of pollen and locating pollen pore.
4. Identification of ovule types.
5. Pollen germination study.

References

1. Adams C R, Bamford K M, Early M P, 2004. Principles of Horticulture (V Edn).

Elsevier,
Linacre House, Jordan Hill, Oxford OX2 8DP, UK.

2. Edmond J B, Senn T L, Andrews F S, Halfacre P G, 1975. Fundamentals of Horticulture (IV Edn). TMHN, Delhi.
3. Jules Janick, 1979. Horticultural Science. Surjeet publications, New Delhi.
4. Kumar N, 1994. Introduction to Horticulture. Rajalakshmi Pub. Nagarcoil.
5. Manibhushan Rao K, 2005. Text Book of Horticulture (II Edn). Macmillan India Ltd.
6. Randhawa G S, Mukhopadhyay A, 1986. Floriculture in India. Allied Publishers Pvt. Ltd. Ahmedabad.
7. Sadhu M K, 1989. Plant propagation. New age international publishers, N. Delhi.
8. Schilletter J C, Richey H W, 2005. Text Book of General Horticulture. Biotech Books, New Delhi.Adams C.R., Early M.P. 2004. Principles of Horticulture. Elsevier, N. Delhi.
9. Barton West R. 1999. Practical Gardening in India. Discovery Pub. House, New Delhi.
10. Edmond J.B., Senn T.L., Andrews F.S., Halfacre P.G. 1975. Fundamentals of Horticulture. 4th Edn.TMH N.Delhi.
11. John Weathers. 1993. Encyclopaedia of Horticulture. Discovery Pub. House. New Delhi.
12. Kumar N. 1994. Introduction to Horticulture. Rajalakshmi Pub. Nagarcoil.
13. Manibhushan Rao K. 1991. Text Book of Horticulture. Macmillan India Ltd.
14. Randhawa G.S., Mukhopadhyay A. 1986. Floriculture in India. Allied Publishers Pvt. Ltd. Ahmedabad.
15. Sadhu M.K., 1996. Plant Propagation. New age International Pub. New Delhi.
16. Schilletter J.C., Richey H.W. 1999. Text Book of General Horticulture. Biotech Books, New Delhi.
17. Vishnu Swarup, 1997, *Ornamental Horticulture*. Mac. Millan India Ltd.
18. Linda William 2005, *Ornamental Science*- Demystified, Tata Mc Graw hill Co.
19. Percy Lancasher, 2004. *Gardening in India*. Oxford IBH Publishing Co. Pvt. Ltd.
20. Chandha., K. L, 2003 *Handbook of Horticulture*. ICAR. New Delhi.
21. George Acquciah, 2004 *Horticulture – Principles and Practices*. II Edn. Prentice Hall. India.
22. Gopal Chandha De, 2002 *Fundamentals of Agronomy*. Oxford and IBH Publishing House.
23. Hudson. T., Hartmann. Dale E. Kester, 2001 *Plant Propagation, Principles and Practices*. 6th Edn. Prentice Hall. India.
24. Kunte, Kawthalkar and Yawalker, 1997 *Principles of Horticulture and Fruit Growing*. Agri – Horticulture Co.
25. Neshamani, S, 2000 *Pazhangal, Pazhavibhavangal* (Malayalam). Kerala Bhasha Institute.

26. Prem Singh Arya, 2004 *Vegetable Seed Production Principles*. Kalyani Publishers.
27. Sharma, R.R, 2005 *Propagation of Horticultural Crops*. Kalyani Publishers.
28. Shivanna K. R. Pollination biology, breeding system and reproductive success of *Adhatoda vasica*, an important medicinal plant. *Current Science*. Vol. 96 (3): 408-412
29. Sharma, M.V., Kuriakose, G. and Shivanna K. R. (2008). Reproductive strategies of Strobilanthes kunthianus, an endemic, semelparous species in southern Western Ghats, India. *Botanical Journal of the Linnean Society*. 157:155-163. doi:10.1111/j.1095- 8339.2008.00786.
30. Maheshwari P. 1971. *An introduction to the Embryology of Angiosperms*. Tata Mc Graw- Hill Publishing Company Ltd., New Delhi.
31. Maheswari P. and Umaro Singh, 1965. *Dictionary of Economic Plants in India*, ICAR, New Delhi.
32. Shivanna K.R. and B.M. Joshi 1985. *The Angiosperm Pollen Structure & Function*. Wiley Eastern Ltd., New Delhi.
33. Shivanna, K. R. 2014. Biotic pollination: How plants achieve conflicting demands of attraction and restriction of potential pollinators. In: *Reproductive biology of plants* (edsRamawat, K. G., J. M. Merillon and K. R. Shivanna). pp 218-267. Boca Raton, FL, USA: CRC Press.

Websites

http://www.ashs.org/ http://www.ars.org/
http://www.oces.okstate.edu/kay/horticulture
http://www.aos.org
\http://www.aos.org//AM/Template.cfm?Section=Home
http://www.horticultureworld.net/
http://www.back-to-basics.net/

Semester VI

Core Course 13

23U6CRBOTT13: PHYTOCHEMISTRY AND PHARMACOGNOSY

(Theory 54 Hours, Credits 3)

COURSE OUTCOMES (COs)	
CO1	Recognize the morphological, organoleptic, microscopic approach to study drug and aromatic plants
CO2	Describe the extraction and characterization techniques in studying the secondary metabolites in plants
CO3	Identify the occurrence, structure, classification, functions and pharmacological uses of plant derived drugs
CO4	Distinguish the Phytochemical properties of common plant of Kerala
CO5	State the methods in pharmacognosy and examine the scope of Ethnomedicine

PHYTOCHEMISTRY

Module 1 **(2 hours)**

Introduction

Introduction to phytochemical approaches –morphological-organoleptic-microscopic- to study drug and aromatic plants.

Module 2 **(5 hours)**

Extraction and characterization techniques

Cold extraction- hot extraction—soxhlet apparatus, clevenger apparatus; Solvents - petroleum ether, chloroform, ethanol, methanol, water. Separation technique-TLC, Column, HPLC. Characterization technique-GC/MS, HPTLC, UV Spectra, IR Spectra.

Module 3 **(10 hours)**

Effect of phytochemicals

Study of the drug plants and their active principles. Alkaloids - introduction, properties, occurrence, structure, classification, functions, and pharmacological uses. Triterpenoids.

Introduction, properties, occurrence, classification, functions and pharmacological uses. Phenolics. Quinines - benzoquinones, napthoquinones, anthraquinone, and coumarins.

Module 4 **(18 hours)**

Study of the following plants with special reference to

(1) Habit, habitat and systematic position and morphology of the useful part.
(2) Organoleptic, anatomical and chemical evaluation of the officinal part.
(3) Phytochemistry and major pharmacological action of plant drugs.
(4) Ayurvedic formulations of;

- Triphala rasayana: *Phyllanthus emblica, Terminalia bellirica, Terminalia chebula.*
- Trikatu Choornam: *Piper longum, Piper nigrum, Zingiber officinalis*.
- Nalpamaram:

Module 5 **(8 hours)**

Study of the following aromatic plants - volatile oils and methods of extraction

Cympopogon citratus, Vetiveria zizanoides, Cinnamomum verum, Syzygium aromaticum, Santalum album, Zingiber officinale, Rosa centifolia.

PHARMACOGNOSY

Module 6 **(5 hours)**

Introduction

Introduction, tools for identifying adulteration; methods in pharmacognosy- microscopy, phytochemical methods- study of starch grains of maize, wheat, rice, potato, curcuma

Module 7 **(6 hours)**

Ethnomedicine

Traditional plant medicines as a source of new drugs – The process of modern drug discovery using ethnopharmacology – Taxol, Artemisinin, Galantamine and Flavopyridole as examples of drug discovery based on ethanopharmacological approach; Jeevani-Pushpangadan model of benefit sharing.

References

1. Ashutosh Kar, 2006, *Pharmacognosy and Pharmacobiotechnology*, New Age International, New Delhi
2. Atal.C.K. and Kapur, B.M. 1982. *Cultivation and Utilization of Medicinal Plants*.
3. Bhattacharjee S K, 2003, *Hand Book of Medicinal Plants*, Pointer Publishers, Jaipur
4. Daniel, M.,1991. , *Methods in Plant Chemistry and Economic Botany*, Kalyani publishers, New Delhi.
5. Glossary *of Indian Medicinal Plants with Active Principles* Part I & II, 1980. CSIR ,New Delhi.

6. *Indian Medicinal Plants* (5Vols) 1994. Arya Vaidya Sala Kottackal, Orient longoman New Delhi.
7. Irfan Ali Khan, 2008, *Medicinal and Aromatic plants of India*, Ukaaz Publishers, Hyderabad
8. Jain S K 2004, *A Manual Of Ethnobotany*, Scientific Publishers, India
9. Jain S.K. 1981. *Glimpses of Indian Ethnobotany*, Oxford and IBH, New Delhi
10. Khory R N 1999 *Materia Medica of India and their Therapeutics*, Komal Prakashan, Delhi
11. Krishnaswamy N R 2003, *Chemistry of Natural Products*, Universities press, Hyderabad
12. Pushpangaden P Nyman ULF George V *Glimpses of of Indian Ethno Pharmacology*. The Royan Danish School of Pharmacy Copenhagen, Denmark.
13. Trease and Evans (2002) *Pharmacognosy*, W.B. Saunder's Co., Ltd.
14. Trivedi P C,2007, *Medicinal Plants Utilisation and Conservation*, Avishkar Publishers, Jaipur
15. Upadhyaya R C, 2008, *The treatise on Aromatic plants*, Anmol Publications, New Delhi
16. Wallis T.E , 1997.*Text Book of Pharmacognosy*. CBS Publication & Distribution

4. Syllabus of Complementary Course

Semester I

Complementary Course – I

23U1CPBOTT01: CRYPTOGAMS, GYMNOSPERMS AND PLANT PATHOLOGY

(Theory: 36 hours; Practical: 36 hours) **(Theory credit 2 + Practical Credit 1)**

COURSE OUTCOMES (COs)	
CO1	Distinguish the diversity of cryptogams and gymnosperms
CO2	Interpret the reproductive behavior in algae, fungi, bryophytes, pteridophytes and gymnosperms
CO3	Estimate the ecological significance and economic importance of cryptogams and gymnosperms
CO4	Debate the evolutionary trends in cryptogams and gymnosperms
CO5	Identify the common plant diseases and its control measures

CRYPTOGAMS (27 hrs)

Module –1 Algae **(9 hours)**

Classification based on pigments, thallus structure and life history of the following groups - Cyanophyceae – General characters with an example*;* Chlorophyceae - *Volvox*, *Spirogyra;* Phaeophyceae – *Sargrassum;* Rhodophyceae – *Polysiphonia;* Economic importance of Algae.

Module –2 Fungi **(9 hours)**

Classification- Ainsworth (1973) – up to class, Characteristic features of fungal hyphae, and life history of the following groups- Zygomycetes - *Rhizopus*; Ascomycetes - *Peziza;* Basidiomycetes - *Agaricus;* Economic importance of Fungi.

Module-3 Lichens **(2 hrs)**

General account, Classification based on thallus structure, Ecological and economic importance of Lichens.

Module – 4 Bryophytes **(3 hours)**

General account; morphology, anatomy, reproduction and life cycle of *Riccia.*

Module – 5 Pteridophytes **(4 hours)**

General account, morphology, anatomy, reproduction and life cycle of *Pteris*.

GYMNOSPERMS (5 hrs)

Module – 6 Gymnosperms (5 hours)

Gymnosperms, general account; morphology, anatomy, reproduction and life cycle of *Cycas.*

PLANT PATHOLOGY (4 hours)

Module – 7 **(4 hours)**

Classification of plant diseases on the basis causative organism and symptoms; Study the following diseases with special emphasis on causative organism and symptoms - Nut fall of Arecanut, Bacterial blight of Paddy, Leaf mosaic of Tapioca.

Practical **(36 hrs)**

1. Identify specimens from cryptogams and gymnosperms and their structures, mentioned in the syllabus, make suitable micro-preparations wherever necessary.
2. Identify plant diseases mentioned in the syllabus.

References

1. Ahamdijan, Vernon and Mason H.E. (1973) *The Lichens.* New York: Academic press.
2. Alexopoulose C.J. and Mims C.W. (1983) *Introductory Micology.* New York: Wiley Eastern.
3. Bhatia K.N. (1975) *A treatise on Algae*. New Delhi. S. Chand and co.

4. Bilgramic K. S and Dube H. C (1976). *Text Book of Modern Plant Pathology*. New Delhi. Vikas Publishing House Pvt.Ltd

5. Bishwas S.B and Biswas A. (1973). *An Introduction to Viruses*. New Delhi. Vikas Publishing House Pvt. Ltd.

6. Chaube H.S. amdRamji S. (2001) *Introductory Plant Pathology.* International Book Distributing Co. Lucknow.

7. Chopra R.N. and Kumra P.K. (1988) *Biology of Bryophytes.* New Delhi, Wiley Eastern Ltd.

8. Fritsch F.E. (1945) *Structure and Reproduction of Algae Vol. I & II*. Cambridge University Press.

9. Gangulee H.C. and Kar A. K. (1993) *College Botany Vol.II*. Calcutta, New Central Book Agency.

10. Kanika Sharma (2009) *Manual of Microbiology.* Ane Books Pvt.Ltd.

11. Mamatha Rao (2009) *Microbes and Non-flowering plants, Impact and applications*. Ane Books Pvt. Ltd.

12. Pandey S.N. and Trivedi P.S. (1994). *A Text book of College Botany Vol. I*

13. Pandey S.N. and Trivedi P.S. (1998). *A Text book of College Botany Vol.II*

14. Pandey B.P. (2007) *College Botany Vol.I.* S. Chand and Company, New Delhi

15. Pandey B.P. (2007) *College Botany Vol.II.* S. Chand and Company, New Delhi

16. Sharma P.D. (2003) *Microbiology and Plant Pathology and Biotechnology.* Rasthogy Publications.

17. Vashishta B.R. (2010) *Bryophyta.* S. Chand and Co, New Delhi.

Semester II
Complementary Course 2
23U2CPBOTT02: PLANT PHYSIOLOGY

(Theory - 36 hours; Practical – 36 hours; Credits: Theory – 2, Practical - 1)

COURSE OUTCOMES (COs)	
CO 1	Explain basic mechanisms of various physiological processes related to plant life.
CO 2	Examine the plant water relations and its significance.
CO 3	Classify the plant responses to various environmental stresses and an insight on significance of plant stress physiology.
CO 4	Develop ability to assess the vital plant physiological functions such as photosynthesis, nitrogen fixation, growth and movements, translocation of solutes and seed dormancy in plants.
CO 5	Develop basic skills to carry out experiments related to plant physiology

Module 1: Plant water relations (9 hours)

1. (a) Physical aspects of water absorption –imbibition, diffusion and osmosis. Plant cell as an osmotic system. Diffusion pressure deficit, water potential, plasmolysis.
   (b) Mechanism of water absorption - Active and passive absorption. Ascent of sap – theories – transpiration pull theory, root pressure theory, guttation. (5 hours)
2. Transpiration – types, structure and mechanism of stomatal transpiration, Active K+ transport mechanism, significance and factors affecting transpiration, antitranspirants. (4 hours)

Module 2: Stress Physiology (2 hours)

Water and salt stress, adaptations

Module 3: Photosynthesis and translocation of photosynthate (16 hours)

1. Photosynthesis: Structure of chloroplast, Pigments, Red drop and Emerson's enhancement effect: Two pigments systems, light and dark reaction C3 – C4 and CAM mechanisms. External and internal factors affecting Photosynthesis, photorespiration. (14 hours)

2. Translocation of organic solutes: Path and mechanism of Translocation, Munch mass flow hypothesis.

Module 4: Nitrogen metabolism (2 hours)

Nitrogen cycle and nitrogen fixation.

Module 5: Plant growth and development (6 hours)

1. Seed dormancy: definition, factors causing dormancy, photoblastism, techniques to break dormancy.
2. Sigmoid curve, measurement of growth, regions of growth, general account of plant growth regulators - Auxins, Gibberellins, Cytokinins, Abscisic acid and Ethylene, synthetic auxins (brief account). Senescence and Abscission.
3. Plant movements: Tropic and nastic movements with reference to geotropism and phototropism. Seismonastic and nyctinastic movements.

Module 6: Interdisciplinary perspectives of Plant Physiology (1 hour)

Biochemistry and Seed physiology

Practical (36 hours)

Core Experiments:

1) Demonstration of osmosis using plant membrane.
2) Comparison of stomatal indices in different groups of plants.
3) Separation of plant pigments by Paper Chromatography.
4) Measurement of photosynthetic rate by Hydrilla plant experiment/ any other suitable method.

Demonstration Experiments:

1. Relation between transpiration and absorption – water balance experiment
2. Evolution of O2 during photosynthesis - Hydrilla plant method.
3. Necessity of light in photosynthesis – Ganong's light screen experiment.
4. Necessity of CO2 in photosynthesis – Mohl's half leaf experiment.
5. Necessity of chlorophyll in photosynthesis – experiment with variegated leaf
6. Measurement of plant growth using Arc Auxanometer
7. Experiment with Kleinostat.

References

1. Buchanan, B. B., Gruissem, W. and Jones, R. L. (2015). *Biochemistry and molecular biology of plants.* 2nd edition. Wiley Blackwell, New Delhi.
2. Devlin, R. M. (2017). *Outline of Plant Physiology*, Medtech Publishers.

3. Hopkins, W. G. & Huner, N. P. A. (2009). *Introduction to Plant Physiology*. 4th edition. John Wiley & Sons, Inc. New York.
4. Jain, V. K. (2008). *Fundamentals of Plant Physiology*, S. Chand and Co.
5. Kochhar, P. L. & Krishnamoorthy, H. N. (1958) *A Textbook of Plant Physiology*. 4th edition. Atma ram and Sons, Delhi, Lucknow.
6. Kumar, A. & Purohit, S. S. (2011). *Plant Physiology – Fundamentals & Applications*. Agrobios Publishers.
7. Malik, C. P. & Srivastava, A. K. (2015). *Text Book of Plant Physiology*. Kalyani Publishers, New Delhi.
8. Malik, C. P. (2002). *Plant Physiology*, Kalyani Publishers.
9. Mukherjii, S. & Ghosh A. K. (2005). *Plant Physiology*. Calcutta New Central Book Agency.
10. Noggle, G. R. & Fritz, G. J. (1983). *Introductory Plant Physiology*. Prentice Hall of India.
11. Pandey, S. N. & Sinha, B. K. *Plant Physiology*. 4th edition. Vikas Publishing House, New Delhi.
12. Pessarakli, M. (editor) (2001). *Handbook of Plant and Crop Physiology*. 2nd edition. Marel Dekker, Inc., New York.
13. Rolfe, S. & Opik, H. (2005). *The Physiology of Flowering Plants*. 4th edition. Cambridge University Press, UK.
14. Salisbury, F. B. & Ross, C. W. (1992). *Plant Physiology*. 4th edition. Wadsworth Publishing Company, New York.
15. Sinha, A. K. (2004). *Modern Plant Physiology.* Narosa Publishing House, New Delhi.
16. Srivastava, H. S. (2004). *Plant Physiology & Biochemistry*. 7th edition. Rasthogi Publications.
17. Taiz, L. & Zeiger, E. (2010). *Plant physiology*. 5th edition. Sinauer Associates Inc., Publishers, U.S.A.
18. Verma, S. K. & Verma, M. (2006). *A Textbook of Plant Physiology, Biochemistry & Biotechnology*, S. Chand and Co.
19. Verma, V. (2007). *Textbook of Plant Physiology*. Ane Books Pvt Ltd.

Semester III
Complementary course III

23U3CPBOTT03: ANGIOSPERM TAXONOMY AND PLANT ANIMAL INTERACTIONS

(Theory 54 hours; Practical 36 hours) **(Theory credit 3 Practical Credit-1)**

COURSE OUTCOMES (COs)	
CO 1	Describe the interdisciplinary aspects of taxonomy and plant animal interactions
CO 2	Discuss botanical nomenclature
CO 3	Employ the classification of angiosperms based on their floral features
CO 4	Identify plants with their respective characters, scientific names and Economic importance.
CO 5	Examine the plant interactions with various fauna

ANGIOSPERM TAXONOMY (Theory 36 hours; Practical 27 hours)

Module 1. Classification (1 hour)

Importance of plant classification, types of classification-Artificial, Natural and Phylogenetic (Brief account of APG).

Module 2. Nomenclature (2 hours)

Binomial nomenclature, ICN and its principles

Module 3. Inter disciplinary aspects of taxonomy (2 hours)

Cytotaxonomy and chemotaxonomy.

Module 4. Herbarium (1 hour)

Introduction to Herbarium: Field study, field note, significance of herbarium. Famous Herbaria

Module 5. Bentham and Hooker's system of classification (3 hours)

Outline of Classification (up to series), merits and demerits.

Module 6. Morphology of Angiosperms (5 hours)

Morphology of typical angiosperm flower, types of inflorescences, types of fruits.

Module 7. Families (22 hours)

Study of the following families of Bentham and Hookers system of classification with special reference to major identifying characters and economic importance of at least five species with binomial, morphology of useful parts and uses: 1. Annonaceae, 2. Malvaceae, 3. Rutaceae, 4. Leguminosae (4.1. Fabaceae, 4.2. Caesalpiniaceae and 4.3. Mimosaceae), 5. Myrtaceae, 6. Rubiaceae, 7. Asteraceae, 8. Apocynaceae, 9. Lamiaceae, 10. Euphorbiaceae, 11. Arecaceae, 12. Poaceae.

Plant Animal Interactions (Theory 18 hours, Practical 9 hours)

Module 8. Introduction (3 hours)

An overview of plant-animal interactions [Competitions, predations (carnivorous plants), herbivory (granivory and frugivory), parasitism, mutualism and commensalism].

Module 9. Herbivory (3 hours)

Definition, types, mechanisms of plants to respond to herbivory; chemical (Semio-chemicals, pheromones, Alkaloids, phenolics and terpinoids) and physical defenses (selective abscission, thick cuticle and grow next to unpalatable plants); adaptations of herbivores to overcome plant defense (strong mouth parts and special digestive enzymes).

Module 11. Pollination. (3 hours)

Syndromes - Types of pollination syndromes with adaptations of pollinators and plants for pollination with suitable examples (Abiotic - Hydrohily and Anemophily; Biotic - Zoophily, Entamophily, Cantherophily, Phalenophily, Psychophily, Mellitophily, Myrmecophily and Ornithophily).

Module 12. **(3 hours)**

Seed/fruit dispersal; Types with examples, adaptations of fruits/seeds and animals for dispersal.

Module 13. **(6 hours)**

Species interaction; Evolution of competitive ability (Increased competitive ability hypothesis, interference competition, exploitation competition and competitive exclusion); Multi-trophic interactions (bi-, tri- and tetra- trophic interactions), animal mediated plant galls, special glands (eg. Nosonov glands) and secretions (eg. Salivary gland secretions of phytophagous arthropods) for animal mediated interactions. Seduction and deception of animals by plants leading to pollen dispersal and dissemination in angiosperms.

Practical

Angiosperm Taxonomy – 27 Hours

1. Floral morphology.
2. Description of flower and floral parts in technical terms a typical flower.
3. Students should be able to identify typical plants belonging to the families prescribed in the syllabus. They should be able to describe the floral parts in technical terms.

Plant Animal Interactions – 9 Hours.

1. Students should be trained to identify pollination syndromes.
2. Types of various plant-animal interactions with evidences.
3. Collection and demonstration of plant materials with evidences of plant animal interactions and identification of interactions.

References

1. Eames, A. J. 1969. *Morphology of Angiosperms*. Mc Graw – Hill, New York.

2. Hill, A.F. 1952. *Economic Botany: A Text book of Useful Plants and Plant Products*. Tata McGraw-Hill Publishing Company Limited, New Delhi.

3. Kochhar, S.L. 1981. *Economic Botany in the Tropics.* Macmillan India Limited, Delhi.

5. Naik, V.N. 1984. *Taxonomy of Angiosperms*. Tata McGraw – Hill Publishing Co; New Delhi.

6. Sharma, O.P. 1993. *Plant Taxonomy*. Tata McGraw – Hill Publishing Co Ltd., New Delhi.

7. Simpson, B.S and M. Conner – Ogorzaly. 1986. *Economic Botany: Plants in Our World.* McGraw – Hill Book Company, New York.
8. Singh, G. 1999. *Plant Systematics – Theory and Practice.* Oxford & IBH, New Delhi.
9. Keshamma E. and Lokare P. (2022). Plant Animal Interaction. Book Saga Publications.
10. Simpson M. G. (2010). Plant Systematics. Academic Press 2nd edition.
11. Stiling P. (2001). Ecology: Theories and Applications. Pearson 4th edition.
12. Stiling P. (2011). Ecology - Global Insights and Investigations. McGraw-Hill Education.

Semester IV

Complementary Course 4

23U4CPBOTT04 ANGIOSPERM ANATOMY AND APPLIED BOTANY

(Theory 54 hours; Practical 36 hours) **(Theory credit 3 Practical Credit 1)**

COURSE OUTCOMES (COs)	
CO 1	Identify the cellular and tissue level organization in angiosperms.
CO 2	Recognize the anomalous anatomical features of angiosperms.
CO 3	Evaluate the morphological and anatomical adaptations of plants to different habitats.
CO 4	Operate various techniques and procedures in crop improvement.
CO 5	Establish mushroom cultivation and floriculture at a small scale level

ANATOMY (Theory 36 hours; Practical 27 hours)

Module 1. Cell **(4 hours)**

Cell types, ultrastructure of plant cell, living and non-living inclusions.

Module 2. Tissues **(6 hours)**

Simple and complex; meristems, secretary tissues.

Module 3. Cambium Cell **(4 hours)**

Origin, structure, function, role in budding and grafting.

Module 4. Primary structure **(3 hours)**

Primary structure of stem and root in dicots and monocots.

Module 5 – Secondary Structure **(8 hours)**

Secondary thickening in dicot stem and dicot root; growth rings and dendrochronology, anomalous secondary thickening in *Bignonia*, formation of periderm.

Module 6. Leaf Anatomy **(3 hours)**

Anatomy of monocot and dicot leaf.

Module 7 – Ecological Anatomy **(8 hours)**

Study of the morphological and anatomical adaptations of the following groups; Hydrophytes (*Nymphaea*), Xerophytes (*Nerium*), Epiphytes (*Vanda*) and Halophytes (*Avicennia/ Rhizophora*).

APPLIED BOTANY (Theory 18 hours; Practical- 9 hours)

Module 8. Asexual Reproduction **(3 hours)**

Apomixis (Apospory, Diplospory and Adventive embryony), Parthenocarpy and Polyembryony.

Module 9. Plant Breeding **(4 hours)**

Plant breeding- Definition and objectives of plant breeding. Mutation breeding- definition, mutagens involved, gamma gardens. Polyploidy breeding- definition, important applications. Hybridization- definition, types, emasculation, applications.

Module 10. Plant Introduction **(2 hours)**

Plant introduction- definition, types of introductions, quarantine and acclimatization.

Selection- definition, types and applications of mass selection, pure line selection and clonal selection.

Module 11. Horticulture and Floriculture **(5 hours)**

Horticultural practices – Plant propagation through cutting, layering, budding and grafting. Floriculture and its commercial importance with examples.

Module 12 Plant Tissue Culture **(2 hours)**

General steps and applications of plant tissue culture.

Module 13. Mushroom Cultivation **(2 hours)**

Stages, species used, significance.

Practicals (36 hours)

1. Types of tissue – simple and complex.
2. Primary structure of stem and root of dicots and monocots.
3. Structure of dicot stem and dicot root after secondary thickening.
4. Anomalous secondary thickening in *Bignonia.*
5. Morphological and anatomical adaptations of Hydrophytes (*Nymphaea* petiole), Xerophytes (*Nerium* leaf), Epiphytes (Velamen root of epiphytic orchid), Halophyte (Pneumatophore and vivipary of *Avicinia* or *Rhizophora*).
6. Emasculation of any apt flower.
7. 'T' budding, Patch budding, Tongue grafting.
8. Air layering (demonstration).
9. Mushroom cultivation demonstration only

References

1. Christopher, E.P. 1958. *Introductory Horticulture*. McGraw – Hill, New York.

2. Esau, K. 1965. Plant Anatomy. Wiley, New York.

3. Fahn. 1985. *Plant Anatomy*. Pergamon Press, Oxford.

4. Hartman, H.T. and D.E. Kester. 1991. *Plant Propagation – Principles and Practices*. Prentice – Hall of India, New Delhi.

5. Kumar, N. 1994. *Introduction to Horticulture*. Rajalakshmi Publications, Nagercoil.

6. Pandey, B.P. 1984. *Plant Anatomy*. S. Chand and Company, New Delhi.

5. MODEL QUESTION PAPERS - THEORY

B.Sc. Botany Programme Semester I Core Course 01

23U1CRBOTT01: MICROBIOLOGY AND PHYCOLOGY

Time 3 hours Maximum 60 Marks

Part A

Answer **ALL** questions; each question carries **ONE** mark. 8 x 1 = 8 marks

1. What is peptidoglycan?
2. Expand ICNP.
3. Write an example of an RNA virus.
4. What is SCP?
5. Name a prokaryotic alga.
6. What is diatomaceous earth?
7. Explain cryptostomata.
8. What are daughter colonies?

Part B

Answer **ANY SIX** questions; each question carries **TWO** marks. 6 x 2 = 12 marks

9. Differentiate between gram positive and negative bacteria.
10. Explain binary fission as a reproductive method of bacteria.
11. Classify virus based on genetic material.
12. Differentiate between vegetative and asexual reproduction.
13. What are probiotics? Give any one example.
14. What are autospores?
15. Explain the vegetative thallus of *sargassum*.
16. With the help of a suitable diagram, explain cap cell formation.
17. Comment on the role of algae in fish poisoning.
18. Evaluate the use of algae as pollution indicators.

Part C

Answer **ANY FOUR** questions; each question carries **FOUR** marks. 4 x 4 = 16 marks

19. Explain the architecture of TMV.
20. Comment on the role of microbes as biofertilizers.
21. Discuss the asexual reproductive methods in *Chara*.
22. Comment on commercial products extracted from algae.
22. Evaluate the role of algae as source of food and medicine.
23. Evaluate the division of labour in *Volvox*.

Part D

Answer **ANY TWO** questions; each question carries **TWELVE** marks. 2 x 12 = 24 marks

25. Explain the ultrastructure of a bacterial cell.

OR

26. Evaluate the economic importance of bacteria.

27. With the help of suitable diagrams, explain the life cycle of *Polysiphonia*.

OR

28. Explain the sexual reproduction in *Vaucheria*.

B.Sc. Botany Programme Semester II Core Course 02

23U4CRBOTT02: MYCOLOGY, LICHENOLOGY AND PLANT PATHOLOGY

Time 3 hours Maximum 60 Marks

Part A

Answer **ALL** questions; each question carries **ONE** mark. 8 x 1 = 8 marks

1. Name the cell wall material of fungi
2. What is the characteristic fruiting body of Ascomycetes?
3. What are basidia?
4. Why Deuteromycetes are called so?
5. What are the important characters of Myxomycotina?
5. Name the causative organism of Bunchy top disease of banana
7. What is aspergillosis?
8. Name any two economically important lichen

Part B

Answer **ANY SIX** questions; each question carries **TWO** marks. 6 x 2 = 12 marks

9. Describe the fruiting body of *Xylaria*
10. Draw a labeled sketch of *Peziza* fruiting body
11. What are the salient features of Ascomycotina
12. Describe the fruiting body of *Agaricus*
13. What is a macro cyclic fungus?
14. Name two harmful fungi
15. What is mycorrhiza?
16. Write down the steps for the spawn production of mushrooms
17. What is prophylaxis?
18. What is meant by biological control?

Part C

Answer **ANY FOUR** questions; each question carries **FOUR** marks. 4 x 4 = 16 marks

19. Explain the role of fungi in biotechnology
20. With help of suitable sketches, explain the life cycle of *Saccharomyces cerevisiae*
21. Explain the asexual reproduction in *Penicillium*
22. Explain the crozier formation in *Peziza*
23. Explain the methods of reproduction in *Parmelia*
24. Explain the preparation of Bordeaux mixture.

Part D

Answer **ANY TWO** questions; each question carries **TWELVE** marks. 12 x 2 = 24 marks

25. Explain the life cycle of *Puccinia* with suitable illustrations

OR

26. With suitable diagrams, illustrate the life cycle of *Agaricus*

27. Describe the agricultural importance of fungi

OR

28. Briefly explain the typical plant-pathogen interaction

B.Sc. Botany Programme Semester III Core Course 03

23U3CRBOTT03: BRYOLOGY, PTERIDOLOGY, GYMNOSPERMS AND PALEOBOTANY

Time 3 hours Maximum 60 Marks

Part A

Answer **ALL** questions; each question carries **ONE** mark. 8 x 1 = 8 marks

1. Name an aquatic Bryophyte?
2. Name a Bryophyte with branched photosynthetic filament?
3. Name a Bryophyte with pseudoelater?
4. Name a pteridophyte spore with Elater?
5. Name a pteridophyte with amphiphloeic siphonostele?
5. Name a Gymnosperm with winged seed?
7. Name a Gymnosperm with circinate ptyxis?
8. Name the paleobotanical centre in India?

Part B

Answer **ANY SIX** questions; each question carries **TWO** marks. 6 x 2 = 12 marks

9. Describe the Photosynthetic region of *Marchantia*?
10. Draw a labeled sketch of Pegged &Smooth rhizoids?
11. What are the salient features of Bryophytes ?
12. Describe the strobilus of *Selaginella*?
13. What is a Sporocarp, Give an example?
14. What is Eusporangiate and Leptosporangiate condition?
15. What is Endoscopic and Exoscopic embryo development?
16. What is Palisade tissue, what is its function?
17. What are the different types of Fossil formations?
18. What is Bars of sanio?

Part C

Answer **ANY FOUR** questions; each question carries **FOUR** marks. 4 x 4 = 16 marks

19. Explain the Sporophyte of *Riccia*?
20. With help of suitable sketches, explain the life cycle of *Anthoceros*?
21. Explain the stem anatomy of *Marsilea* rhizome?
22. Explain the xerophytic adaptations of *Equisetum* stem?
23. Explain the xerophytic adaptations of *Pinus* needle?
24. What are the Angiosperm characters of *Gnetum*?

Part D

Answer **ANY TWO** questions; each question carries **TWELVE** marks. 12 x 2 = 24 marks

25. What are the economic importance of Bryophytes?

OR

26. With suitable diagrams, illustrate the life cycle of *Funaria*?

27. Describe the various stelar structure in Pteridophytes?

OR

28. Write an essay on the anatomy of Gnetum stem with diagrams?

B.Sc. Botany Programme Semester IV Core Course 04

23U4CRBOTT04: ANGIOSPERM MORPHOLOGY, ANATOMY AND MICROTECHNIQUE

Time: 3 hours Maximum Marks: 60

Part A

Answer ALL questions; each question carries ONE mark. 8 x 1 = 8 marks

1. What is Casparian thichkening?
2. What is Plasmodesmata?
3. What is open vascular bundle?
4. What is Duramen?
5. Give the names of any two natural dyes.
6. What is a carpel?
7. What is a regma?
8. What is pinnately compound leaf?

Part B

Answer **ANY SIX** questions; each question carries **TWO** marks. 6 x 2 = 12 marks

9. Distinguish between Sapwood and Heartwood.
10. Distinguish between Diffuse porous wood and Ring porous wood.
11. Briefly explain apical cell theory.
12. Write brief notes on Laticifers.
13. What is a mordant? What is its function?
14. Draw a labelled diagram of a Bordered pit.
15. What are the major anatomical differences between dicot and monocot leaf?
16. What is Apposition and Intssuception?
17. What is Periderm?
18. What is a cymose inflorescence

Part C

Answer **ANY FOUR** questions; each question carries **FOUR** marks. 4 x 4 = 16 marks

19. What are the importance of fibres?
20. With the help of labelled diagram explain the tissue system in Dicot stem.
21. What are the different types of cell wall thickening of tracheid?
22. What is staining? Explain different types of staining techniques.
23. Distinguish between monochasial cyme and dichasial cyme.
24. Write a brief note on different dry dehiscent fruits.

Part D

Answer **ANY TWO** questions; each question carries **TWELVE** marks. 12 x 2 = 24 marks

25. With the help of suitable labelled diagrams, describe the anomalous secondary structures in *Bignonia*.

OR

26. With the help of suitable diagrams explain secondary growth in Dicot root.

27. Explain the structure and function of complex tissues in plants.

OR

28. Compare the anatomical differences between dicot and monocot stem.

B.Sc. Botany Programme Semester V Course 05

23U5CRBOTT05: ANGIOSPERM SYSTEMATICS AND ECONOMIC BOTANY

Time: 3 hours Maximum Marks: 60

Part A

Answer **ALL** questions; each question carries **ONE** mark. 8 x 1 = 8 marks

1. What is obdiplostemonous condition?
2. What is syngenesious anthers?
3. What is a pollinium?
4. What is corolline corona?
5. Write the binomial of any two economically important plants of the family Rutaceae.
6. Define antiphyllous condition.
7. Write common name and binomial of any pulse plant.
8. What is the characteristic feature of stigma in Apocynaceae.

Part B

Answer **ANY SIX** questions; each question carries **TWO** marks. 6 x 2 = 12 marks

9. What is synsndrous condition? Give example.
10. What is an epigynous flower?
11. Draw floral diagram of vexillary aestivation
12. Differentiate ray floret and disc floret.
13. With the help of a diagram explain stipule in Rubiaceae.
14. Write an account on the economic importance of Cucurbitaceae.
15. Describe the gynostegium in Orchidaceae.
16. Describe the essential whorls of Poaceae family.
17. Give the binomial of 2 economically important plants of Arecaceae.
18. Write a short note on the economic importance of the family Apiaceae.

Part C

Answer **ANY FOUR** questions; each question carries **FOUR** marks. 4 x 4 = 16 marks

19. Compare the floral features of Verbenaceae and Lamiaceae
20. Explain the general characters of Myrtaceae family.
21. Describe the floral features of Solanaceae.
22. Differentiate between Scrophulariaceae and Acanthaceae.
23. Describe the flower of Sapotaceae.
24. Discuss the primitive features of Annonaceae.

Part D

Answer **ANY TWO** questions; each question carries **TWELVE** marks. 12 x 2 = 24 marks

25. Elaborate and explain the features of Orchidaceae family.

OR

26. With the help of suitable diagrams explain the characteristic features of the family Euphorbiaceae.

27. Compare the floral characters of Leguminosae.

OR

28. Compare and contrast Apocynaceae and Asclepiadaceae families.

B.Sc. Botany Programme Semester V Core Course 06

23U5CRBOTT06: ECOLOGY, ENVIRONMENTAL SCIENCE AND ECOTOURISM

Time 3 hours Maximum 60 Marks

Part A

Answer **ALL** questions; each question carries **ONE** mark. 8 x 1 = 8 marks

1. What are umbrella species?
2. Define endemism.
3. Name a renewable energy source.
4. Write any two problems associated with food security.
5. What is Itai Itai disease?
6. Give an example for land degradation.
7. Name an ecotourism center.
8. Define Eutrophication.

Part B

Answer **ANY SIX** questions; each question carries **TWO** marks. 6 x 2 = 12 marks

9. Give an account on ecological pyramids.
10. What is the importance of the Forest (conservation) Act, 1980?
11. What is meant by blue baby syndrome?
12. Explain briefly on the Bhopal tragedy.
13. What is meant by EIA?
14. What are the famous ecotourism centers in Kerala?
15. Write a note on Chipko movement.
16. What is the contribution of Salim Ali in the field of ecology?
17. What are the components of ecotourism?
18. Briefly give an account on the mangrove ecosystem.

Part C

Answer **ANY FOUR** questions; each question carries **FOUR** marks. 4 x 4 = 16 marks

19. Write a note on the environmental laws in India.
20. Explain the sources of sound pollution and its control.
21. List out the problems due to Global warming?
22. Discuss the characteristics of the population?
23. Examine the role of biogeochemical cycles in nature.
24. Evaluate the positive and negative impacts of ecotourism.

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Part D

Answer **ANY TWO** questions; each question carries **TWELVE** marks. 12 x 2 = 24 marks

25. Give an account on ecological succession. Distinguish between xerosere and hydrosere.

OR

26. Discuss the effects of environmental pollution and its management.
27. Describe the components of ecotourism and explain different types of ecotourism

OR

28. Analyze the reasons for biodiversity loss. Explain the different methods for biodiversity conservation.

B.Sc. Botany Programme Semester V Core Course 07

23U5CRBOTT07: GENETICS AND PLANT BREEDING

Time: 3 hours Maximum Marks: 60

Part A

Answer ALL questions; each question carries ONE mark. 8 x 1 = 8 marks

1. Define gene.
2. What is meant by an 'allele'?
3. What is dominance?
4. What is a test cross?
5. How do you differentiate phenotype and genotype?
6. What is back cross?
7. Define reciprocal cross.
8. Name an X- linked gene.

Part B

Answer ANY SIX questions; each question carries TWO marks. 6 x 2 = 12 marks

9. Briefly describe complementary gene interaction.
10. Distinguish between epistasis and dominance.
11. What is meant by interference?
12. What is coincidence?
13. Describe briefly Turner's syndrome
14. Distinguish between Klinefelter's syndrome and Down's syndrome.
15. Describe haemophilia in man.
16. Write notes on cytoplasmic inheritance.
17. What are the objectives of plant breeding.
18. What are quarantine regulations?

Part C

Answer ANY FOUR questions; each question carries FOUR marks. 4 x 4 = 16 marks

19. What is recessive epistasis? Explain with suitable example.
20. Distinguish between Inter-genic interaction and Intra-genic interaction
21. Describe XX-X0 method of sex determination.
22. What is reversion or Atavism?
23. Examine the role of linkage in Mendel's experiments
24. What is sex linked inheritance? Explain with an example.

Part D

Answer ANY TWO questions; each question carries TWELVE marks. 12 x 2 = 24 marks

25. With suitable example, explain multiple allelism.

OR

26. Explain chromosome theory of heredity.

27. Write an essay on genetic engineering and products of genetically modified crops.

28. OR

29. Explain the procedures for plant introduction in the Indian context.

B.Sc. Botany Programme Semester V Core Course 08

23U2CPBOTT08: CELL BIOLOGY, MOLECULAR BIOLOGY AND EVOLUTION

Time 3 hours Maximum 60 Marks

Part A

Answer **ALL** questions; each question carries **ONE** mark. 8 x 1 = 8 marks

1. Name the substages of Prophase I of Meiosis
2. What is unit membrane?
3. Name the stages in which pairing and terminalization of homologous chromosome's take place.
4. At what locations in a eukaryotic cell does protein synthesis occur?
5. Name two purines
6. Give a short note on Okazaki fragment.
7. Differentiate between transition and transversion
8. What is Speciation?

Part B

Answer **ANY SIX** questions; each question carries **TWO** marks. 6 x 2 = 12 marks

9. Give an account on chloroplast DNA.
10. Differentiate eukaryotic cell from prokaryotic cell.
11. What is meant by cell cycle?
12. Describe the structure of tRNA
13. What are the unique features of lamp brush chromosomes?
14. What is upstream and downstream site?
15. Write short notes on Translocation.
16. What are exons?
17. Distinguish between Progressive and Retrogressive evolution.
18. Explain theory of evolution by Lamark.

Part C

Answer **ANY FOUR** questions; each question carries **FOUR** marks. 4 x 4 = 16 marks

19. List the differences between mitosis and meiosis.
20. With the help of a neat labeled diagram explain the structure of chloroplast.
21. Give an account on the events of M-Phase of cell cycle.
22. Explain the clover leaf model of tRNA with suitable diagram.
23. What is a promoter? Why is promoter significant in gene-function?
24. Explain various postulates of Lamarckism.

Part D

Answer **ANY TWO** questions; each question carries **TWELVE** marks. 2 x 12 = 24 marks

25. Give an account of structural aberrations of chromosomes.

OR

26. Describe the various phases of first meiotic division with diagrams

27. Illustrate detailed structure of DNA with suitable diagram. Give an account on various forms of DNA.

OR

28. Describe the major theories of evolution.

B.Sc. Botany Programme Semester VI Core Course 09

23U6CRBOTT09 PLANT PHYSIOLOGY AND BIOCHEMISTRY

Time 3 hours Maximum 60 Marks

Part A

Answer **ALL** questions; each question carries **ONE** mark. 8 x 1 = 8 marks

1. What is Guttation?
2. Define water potential
3. Name the end products of alcoholic fermentation.
4. Name a pentose sugar.
5. Name a volatile plant growth regulator.
6. Give an example of a monosaccharide.
7. Name the first stable product of the C4 cycle.
8. What is phloem loading?

Part B

Answer **ANY SIX** questions; each question carries **TWO** marks. 6 x 2 = 12 marks

9. What is cellobiose?
10. Explain the structure of chlorophyll.
11. Explain vernalization.
12. What is RUBISCO?
13. Write the importance of transpiration in plants.
14. What is pH? What is the significance of buffers?
15. What are anti-transpirants?
16. Explain the red drop phenomenon.
17. What are the factors affecting photosynthesis?
18. What is glycolysis?

Part C

Answer **ANY FOUR** questions; each question carries **FOUR** marks. 4 x 4 = 16 marks

19. Explain the pressure flow hypothesis by Munch.
20. Discuss the significance of carbohydrates.
21. Draw the schematic representation of photorespiration.
22. Describe the cyclic electron transport in chloroplast.
23. List out the major characteristics of enzymes.
24. Examine physiological roles of auxins and cytokinins.

Part D

Answer **ANY TWO** questions; each question carries **TWELVE** marks. 12 x 2 = 24 marks

25. Illustrate the path of carbon assimilation in the Calvin cycle.

OR

26. Discuss the role of plant growth regulators and its practical applications.t
27. Discuss the mechanism of enzyme action and factors affecting it.

OR

28. Give a comparative account of C3, C4 and CAM plants.

B.Sc. Botany Programme Semester VI Core Course 10

23U6CRBOTT10: PERSPECTIVES OF SCIENCE, METHODOLOGY AND GENERAL INFORMATICS

Time 3 hours Maximum 60 Marks

Part A

Answer **ALL** questions; each question carries **ONE** mark. 8 x 1 = 8 marks

1. What is the SI unit of pressure?
2. Explain hypothesis.
3. What is Laboratory Etiquette.
4. Expand SEM.
5. What is standard error?
6. Explain histogram.
7. What is DNAi?
8. What is an operating system?

Part B

Answer **ANY SIX** questions; each question carries **TWO** marks. 6 x 2 = 12 marks

9. Explain Beer-Lambert's Law.
10. Comment on INFLIBNET.
11. Differentiate between AGE and PAGE.
12. Explain the applications of spectrophotometer.
13. Comment on measures of central tendency.
14. What are academic search engines?
15. Differentiate between stationary phase and mobile phase.
16. Explain the need of control in experimentation.
17. Differentiate between dependent and independent variables.
18. Explain is scatter plot.

Part C

Answer **ANY FOUR** questions; each question carries **FOUR** marks. 4 x 4 = 16 marks

19. Explain Koch's postulates.
20. Comment on measures of dispersion.
21. Explain the parts of a compound microscope.
22. Discuss the use of *t*- test

22.Comment on different distribution patterns.

23.Expalin the use of statistical tools in Excel.

Part D

Answer **ANY TWO** questions; each question carries **TWELVE** marks. 2 x 12 = 24 marks

25. Write an essay on the contributions of Louis Pasteur.

OR

26. Explain principle, different types and application of chromatography.

27. Write an essay on sampling methods.

OR

28. Explain the steps in scientific method.

B.Sc. Botany Programme Semester VI Core Course 11

23U6CRBOTT11: BIOTECHNOLOGY AND BIOINFORMATICS

Time 3 hours Maximum 60 Marks

Part A

Answer **ALL** questions; each question carries **ONE** mark. 8 x 1 = 8 marks

1. Name a popular tissue culture medium
2. Name a transgenic plant
3. Name a surface sterilant
4. What is Rasmol?
5. Name a tissue culture technique used for producing haploid plants
6. Name a tissue culture technique to produce virus free plants
7. Name an Auxin.
8. Expand EMBL.

Part B

Answer **ANY SIX** questions; each question carries **TWO** marks. 6 x 2 = 12 marks

9. Name the enzyme used for joining DNA fragments
10. What is the enzyme used for degrading cellulose in cell wall during protoplast isolation
11. What is an autoclave?
12. What is Flavr Savr tomato?
13. Define micropropagation.
14. What is the pH of M S medium/
15. What is the respiratory substrate added in tissue culture medium
16. What is FASTA?
17. Explain molecular docking?
18. What is DDBJ?

Part C

Answer **ANY FOUR** questions; each question carries **FOUR** marks. 4 x 4 = 16 marks

19. What is PCR? Name the heat resistant polymerase enzyme used in PCR
20. What are databases? Give an account of different databases you have studied.
21. Name the various cloning vectors and explain how a plasmid can be used for genetic engineering experiments.
22. What is the use of laminar air flow bench in tissue culture? Comment on its working principle?
23. What are the potential uses of artificial seeds?
24. Write a note on pBR322.

Part D

Answer **ANY TWO** questions; each question carries **TWELVE** marks. 12 x 2 = 24 marks

25. Explain Sangers dideoxy method of DNA sequencing? Write a note on automated DNA sequencing?

OR

26. Explain Edman's degradation method for protein sequencing.

27. Write a comprehensive account of application of tissue culture.

OR

28. Explain different methods of gene transfer.

B.Sc. Botany Programme Semester VI Core Course 12

23U6CRBOTT12: HORTICULTURE, NURSERY MANAGEMENT AND PLANT REPRODUCTIVE BIOLOGY

Time 3 hours Maximum 60 Marks

Part A

I. Answer **ALL** questions; each question carries **ONE** mark. 8 x 1 = 8 marks

1. What is apomixis?
2. What is polyembryony?
3. What is tapetum?
4. What is topiary?
5. Give any two advantages of vegetative propagation?
6. What are hedges?
7. What is PGPR?
8. What is vermiwash?

Part B

II. Answer **ANY SIX** questions; each question carries **TWO** marks. 6 x 2 = 12 marks

9. Differentiate between hedges and edges.
10. Define self-incompatibility.
11. What is anemochory? Write any two advantages of anemochorous seeds?
12. Define syngamy and triple fusion.
13. Define micropropagation.
14. Differentiate between Western and Eastern arrangement.
15. Write short note on any two cut flowers used in flower arrangements.
16. Give the names of any two garden implements and their uses
17. How will you prepare vermiwash?
18. Explain the scope of floriculture in Kerala.

Part C

III. Answer **ANY FOUR** questions; each question carries **FOUR** marks. 4 x 4 = 16 marks

19. Define Megasporogenesis.
20. Illustrate the structure of mature embryosac.
21. Briefly explain the modern strategies in plant propagation.
22. Describe the structure and function of tapetum.
23. Explain the various plant growth structures?
24. Explain different methods of lawn preparation.

Part D

IV. Answer **ANY TWO** questions; each question carries **TWELVE** marks.12 x 2 = 24marks

25. Explain different pollination syndromes with examples for each syndrome.

OR

26. Explain microsporogenesis and megasporogenesis in angiosperms.

27. Write an essay on different vegetative propagation methods.

OR

28. Describe Mono, bi and tetra sporic embryosac development and compare.

B.Sc. Botany Programme Semester VI Core Course 13

23U6CRBOTT13: PHYTOCHEMISTRY AND PHARMACOGNOSY

Time 3 hours Maximum 75 Marks

Part A

Answer **ALL** questions; each question carries **ONE** mark. 7 x 1 = 7 marks

1. Define phytochemistry.
2. What type of phytochemicals can be extracted using solvents?
3. Name an alkaloid that is seen in fungus.
4. Which part of rose plant triterpinoids are present aplenty?
5. Name the phytochemical present in *Cympopogon citratus.*
6. Give the binomial of any one aromatic plant in which petals yield a volatile oil.
7. Name an alkaloid present in Taxus brevifolia.

Part B

Answer **ANY TEN** questions; each question carries **TWO** marks. 10 x 2 = 20 marks

8. Explain how to use organoleptic characters in the study of phytochemicals.
9. Name any two pyridine group of alkaloids.
10. Name any two tropane group of alkaloids.
11. Explain the structure of any one triterpinoid.
12. Write down any two important phytochemical constituents found in Punica granatum.
13. Name the following medicinal plants: a) A plant used in whooping cough b. A plant used in cancer treatment c. A plant used in leprosy
14. Write the chemical compounds present in rose oil.
15. Write the uses of *Santalum album*.
16. Write down the chief pharmacological action of taxol.
17. Write down the chief pharmacological action of artemisinin.
18. Differentiate between analytical and chemical methods of adulteration.
19. Write a note on Galathamine.

Part C

Answer **ANY FOUR** questions; each question carries **SIX** marks. 6 x 4 = 24 marks

20. Briefly explain the significances of phenolics.
21. Briefly explain the pharmacological uses of phenolics
22. Comment on the anatomical features of *Terminalia bellirica*.
23. Write the ayurvedic formulations and pharmacological uses of *Zingiber officinalis* and *Terminalia chebula*.
24. Explain the preparation of volatile oils.
25. Describe the microscopic methods in pharmacognosy to study starch grains of potato and Curcuma.

Part D

Answer **ANY TWO** questions; each question carries **TWELVE** marks. 2 x 12 = 24 marks

26. Explain the structure, principle and method of extraction using Clevenger apparatus.

OR

27. Explain the organoleptic, anatomical and chemical evaluation of medicinal plant part of *Phyllanthus emblica.*

28. Give an account on the extraction, uses and chemical components of *Cinnamomum verum*.

B.Sc. Botany Programme Semester I Complementary Course 01

23U2CPBOT01: CRYPTOGAMS, GYMNOSPERMS AND PLANT PATHOLOGY

Time 3 hours Maximum 60 Marks

Part A

Answer **ALL** questions; each question carries **ONE** mark. 8 x 1 = 8 marks

1. What is photobiont?
2. What is mycelium?
3. Explain coenobium.
4. What is agar?
5. Explain the function of transfusion tissue.
6. Give an example of a bacterial plant disease.
7. Name an aquatic pteridophyte.
8. Give an example of an edible fungus.

Part B

Answer **ANY SIX** questions; each question carries **TWO** marks. 6 x 2 = 12 marks

9. Explain the structure and function of columella.
10. Why pteridophytes are known as vascular cryptogams?
11. Differentiate between crustose and foliose lichen.
12. What is apothecium?
13. Explain tetraspore.
14. Draw the structure of female receptacle of *Sargassum*.
15. Discuss the anatomy of *Pteris* petiole.
16. What is coralloid root?
17. Write any two economic importance of algae.
18. What are the symptoms of nut fall of Arecanut.

Part C

Answer **ANY FOUR** questions; each question carries **FOUR** marks. 4 x 4 = 16 marks

19. Explain the general characteristics of cyanophyceae.
20. Comment on the internal structure of apothecium of *Peziza*.
21. With the help of suitable diagram, explain the anatomy of *Riccia*.
22. Briefly discuss the sexual reproduction in Pteris.
22. Comment on bacterial blight of paddy.
23. Discuss asexual reproduction in *Rhizopus*.

Part D

Answer **ANY TWO** questions; each question carries **TWELVE** marks. 2 x 12 = 24 marks

25. With the help of suitable diagrams, explain the life cycle of *Polysiphonia.*

OR

26. Explain the economic importance of fungus.

27. Explain the reproduction in *Cycas*.

OR

28. Write an essay on ecological and economic importance of lichens.

B.Sc. Botany Programme Semester II Complementary Course 02

23U2CPBOTT02 PLANT PHYSIOLOGY

Time 3 hours Maximum 60 Marks

Part A

Answer **ALL** questions; each question carries **ONE** mark. 8 x 1 = 8 marks

1. What is the Red drop effect?
2. Define Translocation.
3. What are the major factors affecting photosynthesis?
4. Expand CAM.
5. What is meant by water potential?
6. What is a nastic movement?
7. Name a volatile hormone.
8. What is Abscission?

Part B

Answer **ANY SIX** questions; each question carries **TWO** marks. 6 x 2 = 12 marks

9. What is photolysis of water?
10. Comment on Krantz anatomy?
11. Differentiate between PS 1 and PSII.
12. What are primary and accessory pigments?
13. Write a short note on RUBISCO.
14. What is the significance of phototropism?
15. What is meant by senescence?
16. What are antitranspirants?
17. Explain the mechanism of water absorption in plants.
18. What is meant by DPD?

Part C

Answer **ANY FOUR** questions; each question carries **FOUR** marks. 4 x 4 = 16 marks

19. Discuss various factors causing seed dormancy.
20. Write a brief note on nitrogen cycle.
21. Explain Munch mass flow of hypothesis.
22. Point out the differences between C3 and C4 cycle.
23. Analyse the factors affecting transpiration?
24. Distinguish between transpiration and guttation

Part D

Answer **ANY TWO** questions; each question carries **TWELVE** marks. 12 x 2 = 24 marks

25. With the help of a schematic diagram, describe the mechanism of photophosphorylation.

OR

26. Discuss the process of nitrogen fixation in plants.
27. Discuss the types and significance of plant movements.

OR

28. Examine the importance of Stress physiology in plants in view of water and salt stress.

B.Sc. Botany Programme Semester III Complementary Course 03

23U2CPBOT03: ANGIOSPERM TAXONOMY AND ECONOMIC BOTANY

Time 3 hours Maximum 60 Marks

Part A

Answer **ALL** questions; each question carries **ONE** mark. 8 x 1 = 8 marks

1. What are the essential whorls of a flower?
2. What is meant by a complete flower?
3. What is a zygomorphic flower? Give one example.
4. Explain the functions of calyx and corolla.
5. What do you mean by petalloid and sepaloid condition?
6. Who is considered as the Father of Taxonomy?
7. Define granyvory with a suitable example.
8. What is chemotaxonomy?

Part B

Answer **ANY SIX** questions; each question carries **TWO** marks. 6 x 2 = 12 marks

9. How will you distinguish artificial classification from natural classification? Give examples.
10. Comment on any two spices you have studied.
11. What is binomial nomenclature? How is it different from polynomial nomenclature?
12. Describe the androecium and gynoecium in Rubiaceae.
13. What is aestivation? Name the different types of aestivation you have studied.
14. Differentiate between polypetalous and gamopetalous condition.
15. Write down the binomial of any two oil yielding plants giving their uses.
16. With the help of a neat diagram, explain different parts of stamen.
17. What is placentation? Explain different types of placentation.
18. Define anemochory. Mention any two adaptations of anemochorous plants.

Part C

Answer **ANY FOUR** questions; each question carries **FOUR** marks. 4 x 4 = 16 marks

19. Explain the floral character with the help of a floral diagram of a flower belonging to the family Rubiaceae.
20. What is phylogenetic or evolutionary classification?
21. Briefly explain ICBN.
22. Explain the major characteristics of the family Lamiaceae. Mention any two economical important plants from the family.
22. Write a brief account on various multitrophic interactions with suitable examples?
23. What are the major criteria for biological classification?

Part D

Answer **ANY TWO** questions; each question carries **TWELVE** marks. 2 x 12 = 24 marks

25. Write an essay on different types of inflorescences with suitable diagrams and examples.

OR

26. Explain Bentham and Hooker's system of classification. Add a note on its merits and demerits.

27. Describe the salient features of the family Apocynaceae with a suitable example.

OR

28. Explain various pollination syndromes with an emphasis on adaptations of both plants and pollinators for each. Specify examples for each.

B.Sc. Botany Programme Semester IV Complementary Course 04

23U4CPBOT04 ANATOMY AND APPLIED BOTANY

Time 3 hours Maximum 60 Marks

Part A

Answer **All** questions; each question carries **ONE** mark. 8 x 1 = 8 marks

1. What is heterosis?
2. What is asepsis?
3. What is multiple cross?
4. What is plasmodesmata?
5. What is dendrochronology?
6. What is inter fascicular cambium?
7. What are bulliform cells?
8. What is vivipary?

Part B

Answer **ANY SIX** questions; each question carries **TWO** marks. 6 x 2 = 12 marks

9. What is layering, what are the different types of Layering?
10. What is mutation breeding, Give an example?
11. What is hybridization, mention different types?
12. What is plant introduction, mention the types of introduction?
13. Distinguish between sap wood and heart wood
14. Distinguish between storied cambium and non-storied cambium?
15. Distinguish between Schizogenous and lysigenous type of inter cellular formation?
16. What are the distinguishing features of monocot root?
17. Write two anatomical adaptations of hydrophytes.
18. What are velamen roots?

Part C

Answer **ANY FOUR** questions; each question carries **FOUR** marks. 4 x 4 = 16 marks

19. What is emasculation?
20. What is quarantine?
21. What is the anomaly in the secondary growth of *Bignonia*?
22. Explain the components of secondary Xylem.
23. What are bordered pits? Draw a labeled diagram.
24. What are the important extra cell wall materials? Name the tissues where each one is present?

Part D

Answer **ANY TWO** questions; each question carries **TWELVE** marks. 12 x 2 = 24 marks

25. Write an account of the primary structure of dicot stem and root.

OR

26. Explain Structure, function and seasonal activity of cambium? Mention the role of cambium in budding and grafting.

27. Write an essay on mushroom cultivation.

OR

28. Write an essay on plant breeding.

6. MODEL QUESTION PAPERS – PRACTICAL

B.Sc. Botany Programme Core Course Practical Course 1

23U2CRBOTP01: MICROBIOLOGY, PHYCOLOGY, MYCOLOGY, LICHENOLOGY AND PLANT PATHOGEN INTERACTION

(23U1CRBOTT1 & 23U2CRBOTT2 Combined)

Time: 3 hours **Maximum Marks: 30**

1. Conduct Gram Staining / Serial Dilution / Streaking method of sample **A.** (3 marks)
   Aim & Procedure – 1 mark
   Working – 1 mark
   Result - 1 mark

2. Make suitable micro preparation of sample **B.** (4 marks)
   Preparation - 1 mark
   Identification with reasons - 2 marks
   Labelled diagram - 1 mark

3. Make suitable micro preparation of sample **C.** (4 marks)
   Preparation - 1 mark
   Identification with reasons - 2 marks
   Labelled diagram - 1 mark

4. Spot at sight **D, E, F,** and **G.** (8 marks)
   Genus name - 1 x 4 = 4 marks
   Part displayed - 1 x 4 = 4 marks

5. Identify the disease in the given specimen **H.** (4 marks)
   Name of Disease - 1 mark
   Causative Organism – 1 mark
   Symptoms - 1mark
   Control Measures 1 mark

6. Prepare a bed for Oyster mushroom cultivation. (3 marks)
   Requirements and Procedure – 1 mark
   Working - 2 marks

7. Practical Record (4 marks)

Key:

1. A - Gram staining/serial dilution of soil sample to isolate microbes / streak plate method.
2. B – Algae
3. C - Fungus
4. D & E – Algae with reproductive structures, F & G - Fungi / Lichen with reproductive structures
5. H - Any one pathology specimen
6. Materials for bed preparation have to be provided.
7. Practical Record

B.Sc. Botany Programme Core Course Practical Course 2

23U4CRBOTP02: BRYOLOGY, PTRIDOLOGY, GYMNOSPERMS, PALEOBOTANY, ANGIOSPERM MORPHOLOGY, ANATOMY AND MICROTECHNIQUE
(23U3CRBOTT3 & 23U4CRBOTT4 Combined)

Time: 3 hours **Maximum Marks: 30**

1. Make micro preparation of the given material A. (3 marks)
   Preparation - 1 mark
   Labeled diagram – 1 mark
   Identification with reasons - 1 mark

2. Make micro preparation and compare stelar type of the materials B & C. (5 marks)
   Identification of stelar types- 0.5 x 2 = 1 mark
   Labeled diagram of stelar region- 1 x 2 = 2 marks
   Comparison - 1 x 2 = 2 marks

3. Take a T.S of given material D, stain and mount in Glycerine. (4 marks)
   Preparation - 1 mark
   Labelled diagram - 1 mark
   Identification with reason - 2 marks

4. Identify the stomata type of the material E & F. (4 marks)
   Identification- 1 x 2 = 2 mark
   Labelled diagram- 1 x 2 = 2 marks

5. Spot at sight G, H & I. (6 marks)
   Generic name- 1 x 3 = 3 marks
   Parts displayed- 1x 3 = 3 marks

6. Identify and comment on J & K. (4 marks)
   Identification- 1 x 2 = 2 marks
   Comment- 1 x 2 = 2 marks

7. Practical Record (4 marks)

Key:

1. A - Thallus of bryophyte / leaf of gymnosperm.
2. B & C - stem / petiole /rhizome of pteridophyte.
3. D - Normal secondary structure /anomalous secondary structure.
4. E & F - Stomata on leaf.
5. Spot at sight: G - reproductive structure of bryophyte; H- reproductive structure of pteridophyte; I- reproductive structure of Gymnosperm.
6. J- Morphology of inflorescence; K- Morphology of fruit.
7. Practical Record

B.Sc. Botany Programme Core Course Practical Course 3

23U6CRBOTP03: ANGIOSPERM SYSTEMATICS, ECONOMIC BOTANY, ECOLOGY, ENVIRONMENTAL SCIENCE & ECOTOURISM
(23U5CRBOTT5 & 23U5CRBOTT6 Combined)

Time: 3 hours **Maximum Marks: 30**

1. Identify the family of the given specimen **A**. (5 marks)
   Family identification - 1mark
   Key to family characters -2 marks
   Family characters - 2 marks

2. Scientific drawing of the given specimen **B**. (5 marks)
   Flower L.S – 2 marks
   Floral Diagram – 2 marks
   Floral formula – 1 mark

3. Estimate the CO_2/ Chlorine/ Salinity in the given water sample **C**. (5 marks)
   Aim & Procedure - 1 mark
   Working - 2 marks
   Calculation and Result - 2 marks

4. Identify the ecological group and ecological adaptation in **D**. (2 marks)
   Ecological group identification - 1 mark
   Ecological adaptations - 1 mark

5. Herbarium specimens (10 sheets) and filed book. (5 marks)

6. Identify the given materials **E & F.** (3 marks)
   Scientific name – 0.5 x 2 = 1 mark
   Family name – 0.5 x 2 = 1 mark
   Morphology of useful part – 0.5 x 2 = 1 mark

7. Write a critical note on the given environmental issue based on the given photograph **G**.
   Critical note – 1 mark (1 mark)

8. Practical Record (4 marks)

Key:

1. A - Flowering specimen from any angiosperm family mentioned in the syllabus
2. B - Flowering specimen from any angiosperm family mentioned in the syllabus
3. C - Water sample
4. D - Hydrophyte/ Xerophyte/ Halophyte/ Epiphyte
5. Herbarium Specimens and field book
6. E & F - Specimen with economic importance included in the syllabus
7. G - Photograph of any environmental issue.
8. Practical Record

B.Sc. Botany Programme Core Course Practical Course 4

23U4CRBOTP04: GENETICS, PLANT BREEDING, CELL AND MOLECULAR BIOLOGY AND EVOLUTION (23U5CRBOTT7 & 23U5CRBOTT8 Combined)

Time: 3 hours **Maximum Marks: 30**

1. Make acetocarmine squash preparations of the root tips (**A**) and submit any two stages of Mitosis.
   Slide preparation - 2 marks (6 marks)
   Identification of mitotic stages 1x 2 = 2 marks
   Labelled diagrams 1x 2 = 2 marks

2. Calculation of Mitotic Index. (2 marks)
   Tabulation - 1 mark
   Calculation and result - 1 mark

3. Identify and comment on the given stage of Meiosis in **B**
   Identification - 1 mark (2 marks)
   Comment - 1 mark

4. Conduct emasculation the given material **C.** (3 marks)
   Aim & Procedure – 1 mark
   Working – 2 marks

5. Work out the problem D (Mendelian Inheritance). (2 marks)

6. Work out the problem E (Non-Mendelian Inheritance). (3 marks)

7. Work out the problem F (Linkage and Mapping). (5 marks)

8. Work out the problem G (Molecular Biology). (3 marks)

9. Practical Record (4 marks)

Key:

1. A - Onion Root tip
2. Data from question number 1
3. B - Meiosis photograph/ diagram/ permanent slide
4. C- Material for emasculation.
5. Problem related to Mendelian Inheritance.
6. Problem related to Non-Mendelian Inheritance.
7. Problem related to Linkage and Mapping.
8. Problem related to DNA structure, replication and gene expression.
9. Practical Record

B.Sc. Botany Programme Core Course Practical Course 5

23U2CRBOTP05: PLANT PHYSIOLOGY, BIOCHEMISTRY, PERSPECTIVES OF SCIENCE, METHODOLOGY AND GENERAL INFORMATICS

(23U6CRBOTT9 & 23U6CRBOTT10 Combined)

Time: 3 hours **Maximum Marks: 30**

1. Conduct the experiment **A** and bring out the result. (10 marks)
   Aim and Requirements - 1 mark
   Procedure - 2 marks
   Working - 4 marks
   Labeled diagram - 1 mark
   Result and Inference - 2 marks

2. Examine the given compound leaf **B** and measure the lengths of the leaflets. (6 marks)
   a) Group them into frequency classes according to their length – 2 marks
   b) Calculate the mean and standard deviation of the data manually – 2 marks
   c) Prepare a histogram using EXCEL to represent the data – 2 marks
   d) Make a print out and submit.

3. Determine the concentration of the given solution **C** of $CuSO_4$ using colorimetry. Use the values supplied for the preparation of a standard graph. (4 marks)
   Standard graph - 2 marks
   Determination of concentration from standard graph - 2 marks

4. Comment on the defect in the experiment set up. (2 marks)
   Defects - 1 mark
   Correct set up – 1 mark

5. Detect any two organic compounds in the given sample (4 marks)
   Procedure -1 mark
   Working – 1 mark
   Result – 2 mark

6. Practical Record (4 marks)

Key:

1. A – Physiology core experiments
2. B - Compound leaves (at least 20-30 leaflets). Students should take the print out of the graph/ histogram.
3. Values of standard graph should be provided.
4. Any experimental set up with at least two defects.
5. Students should be supplied with samples containing non-reducing sugar/ reducing sugar/ protein.
6. Practical Record.

B.Sc. Botany Programme Core Course Practical Course 6

23U2CRBOTP06: BIOTECHNOLOGY, BIOINFORMATICS, HORTICULTURE, NURSERY MANAGEMENT, EMBRYOLOGY & REPRODUCTIVE BIOLOGY
(23U6CRBOTT11 & 23U6CRBOTT12 Combined)

Time: 3 hours **Maximum Marks: 30**

1. Extract DNA from the given plant material **A**. (5 marks)
   Aim, Requirements and Procedure - 2 marks
   Working - 2 marks
   Result - 1 marks

2. Immobilize the plant tissue **B** in Alginate beads. (5 marks)
   Aim, Requirements and Procedure - 2 marks
   Working - 2 marks
   Result - 1 marks

3. Sterilize the plant material **C** and inoculate into the medium supplied. (5 marks)
   Aim, Requirements and Procedure - 2 marks
   Working - 2 marks
   Result - 1 marks

4. Using RASMOL, show required information of given protein **D**. (5 marks)
   Visualization of any 5 character – 1 x 5 = 5 marks

5. Carry out pollen sterility study by germination method/staining method. (3 marks)
   Working – 1 mark
   Tabulation & Calculation – 1 mark
   Result - 1 mark

6. Conduct grafting/layering/budding experiments on the given plant material. (3 marks)
   Procedure - 1 mark
   Working - 2 marks

7. Practical Record. (4 marks)

Key:

1. A - Crude extract can be provided.
2. B - Any plant tissue can be provided
3. C - Nodal segment can be provided
4. D – downloaded sequence of any protein can be provided
5. Provide pollen and germination medium/stain for the experiment
6. Materials for budding/ grafting/ layering

B.Sc. Botany Programme Complementary Course Practical Course 1

23U3CPBOTP01: CRYPTOGAMS, GYMNOSPERMS, PLANT PATHOLOGY & PLANT PHYSIOLOGY

(23U1CPBOTT1 & 23U1CPBOTT2 Combined)

Time: 3 hours **Maximum Marks: 30**

1. Make suitable micropreparations of the given specimen **A.** (5 marks)
   Preparation - 1 mark
   Identification with reasons – 2 marks
   Labelled diagram - 2 mark

2. Make suitable micropreparations of the given specimen **B.** (5 marks)
   Preparation - 1 mark
   Identification with reasons – 2 marks
   Labelled diagram - 2 mark

3. Identify at sight **C, D, E & F.** (6 marks)
   Major group - ½ x 4 = 2 marks
   Genus name - ½ x 4 = 2 marks
   Part displayed - ½ x 4 = 2 marks

4. Conduct the experiment **G**. (6 marks)
   Aim, Requirement & Procedure – 2 marks
   Working – 2 marks
   Result – 2 mark

5. Comment on the defect in the experiment **H**. (4 marks)
   Defects – 1 x 2 = 2 marks
   Correct set up – 1 x 2 = 2 marks

6. Practical Record (4 marks)

Key:

1. A - Algae / Fungi
2. B – Bryophyte / Pteridophyte /Gymnosperms
3. C, D, E & F- reproductive structures of Algae / Fungi / Bryophyte / Pteridophyte / Gymnosperms
4. G – Physiology core experiments.
5. H - From demonstration experiments.
6. Practical Record

B.Sc. Botany Programme Complementary Course Practical Course 2

23U3CPBOTP02: ANGIOSPERM TAXONOMY, ECONOMIC BOTANY ANATOMY AND APPLIED BOTANY

(23U1CPBOTT3 & 23U1CPBOTT3 Combined)

Time 3 hours **Max.Marks-30**

1. Assign **A** to its family giving diagnostic characters. (3 marks)
   Name of the family with classification up to series-1
   Diagnostic characters-2

2. Draw L.S. Construct floral diagram and write the floral formula of **B** **(**4 marks)
   L.S of the flower-2
   Floral diagram-1
   Floral formula-1

3. Identify **C** and **D** with any two major characters. (3 marks)
   Identification -½
   Characters -1

4. Identify the interaction with their diagnostic characters of **E** **(**4 marks)
   Identification 1
   Diagnostic characters -3

5. Make stained transverse section of specimen **F**, mount in glycerin. (5 marks)
   Preparation-2
   Diagram-1
   Identification with reasons-2

6. Identify the given T S of the material **G** **(**1 mark)
   Identification with any two major characters-1

7. Assign **'H'** to the ecological group with reasons. (1 mark)
   Ecological group -1/2
   Reasons -1/2

8. Carry out emasculation /T-budding/patch-budding in '**I**' (3 marks)
   Demonstration-2
   Aim and procedure-1

9. Viva (2 marks)

10. Record (4 marks)

Key:

1. **A -** typical plant twigs with flowers included in the syllabus from different subclasses of dicotyledons.
2. **B -** Fresh large flowers included in the syllabus.
3. **C –** from inflorescences, D from fruits
4. **E –** Specimens with any plant animal interaction.
5. **F -** Stem or Root – Normal secondary thickening or Anomalous secondary thickening in *Bignonia*
6. **G -** Slides of Primary Structure of Stem or Root**.**
7. **H -** Specimens from ecological group mentioned in the syllabus.
8. **I -** Suitable materials for emasculation/ budding.