

**MAR ATHANASIUS COLLEGE (AUTONOMOUS)
KOTHAMANGALAM, KERALA - 686666**

*College with Potential for Excellence
NAAC Accredited 'A+' Grade Institution*

**Email: mac@macollege.in
www.macollege.in**



**REGULATION, SCHEME AND SYLLABUS
FOR
UNDERGRADUATE PROGRAMME
UNDER CHOICE BASED CREDIT SYSTEM
(MAC- UG-CBCS 2021)**

**BSc. BOTANY
MACUGSBOT1001**

**EFFECTIVE FROM THE ACADEMIC YEAR 2021-22
BOARD OF STUDIES IN BOTANY (UG)**



ACADEMIC COUNCIL

COMPOSITION – With Effect From 01-06-2020

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Principal
Mar Athanasius College (Autonomous), Kothamangalam

Experts/Academicians from outside the College representing such areas as Industry, Commerce, Law, Education, Medicine, Engineering, Sciences etc.

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Kothamangalam
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Kalady, Kerala, India
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Mar Athanasius College of Engineering,
Kothamangalam, Kerala - 686 666
 8. **Adv. George Jacob**
Senior Advocate
High Court of Kerala
-

Nominees of the University not less than Professors

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SAS SNDP Yogam College
Konni
10. **Dr. Suma Mary Sacharia**
UC College
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11. **Dr. V.B. Nishi**
Associate Professor
Sree Shankara College, Kalady.

Member Secretary

12. **Dr. M.S.Vijayakumary**
Dean – Academics
Mar Athanasius College (Autonomous)
Kothamangalam

Four teachers of the college representing different categories of teaching staff by rotation on the basis of seniority of service in the college.

13. **Dr. Bino Sebastian. V** (Controller of Examinations)
14. **Dr. Manju Kurian**, Asst. Professor, Department of Chemistry
15. **Dr. Smitha Thankachan**, Asst. Professor, Department of Physics
16. **Dr. Asha Mathai**, Asst. Professor, Department of Malayalam

Heads of the Departments

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 18. Dr. Mini Varghese, Head, Department of Hindi
 19. Ms. Shiny John, Head, Department of Computer Science
 20. Dr. Igy George, Head, Department of Economics
 21. Dr. Rajesh. K. Thumbakara, Head, Department of Mathematics
 22. Dr. Aji Abraham, Head, Department of Botany
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23. Dr. Selven S., Head, Department of Zoology
 24. Dr. Deepa. S, Head, Department of Physics
 25. Dr. Aswathy Balachandran, Head, Department of English
 26. Dr. Diana Ann Issac, Head, Department of Commerce
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 28. Ms. Diana Mathews, Head, Department of Sociology
 29. Ms. Sudha. V, Head, Department of Statistics
 30. Dr. Jani Chungath, Head, Department of History
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 34. Ms. Nivya Mariyam Paul, Head, Department of Microbiology
 35. Ms. Jaya Vinny Eappen, Head, Department of Biotechnology
 36. Ms. Shalini Binu, Head, Department of Actuarial Science
 37. Ms. Simi. C.V, Head, Post Graduate Department of History
 38. Ms. Sari Thomas, Head, Post Graduate Department of Statistics
 39. Ms. Sheeba Stephen, Head, Department of B.Com Model III- Tax Procedure and Practice
 40. Ms. Dilmol Varghese , Head, Post Graduate Department of Zoology
 41. Ms. Bibin Paul, Head, Post Graduate Department of Sociology
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BOARD OF STUDIES IN BOTANY (UG)

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Dr. Santhosh Nampy	Professor, Department of Botany University of Calicut.
ONE EXPERT TO BE NOMINATED BY THE VICE CHANCELLOR (MGU)	
Dr. I'ma Neerakkal	Associate Professor Sacred Heart College, Thevara, Ernakulam
MEMBER FROM INDUSTRY	
Dr. Sarala Samuel	General Manager (R&D) Kerala Ayurveda Ltd. Athani, Aluva.
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Dr. Giby Kuriakose	Asst. Professor, Dept. of Botany Sacred Heart College, Thevara, Ernakulam
MEMBER TEACHERS IN THE DEPARTMENT	
Dr. Siju Thomas T	Asst. Professor, Dept. of Botany Mar Athanasius College, Kothamangalam
Ms. Meril Sara Kurian	Asst. Professor (on contract), Dept. of Botany Mar Athanasius College, Kothamangalam
Ms. Meenu Elizabeth Benny	Asst. Professor (on contract), Dept. of Botany Mar Athanasius College, Kothamangalam
Ms. Gopika M	Asst. Professor (on contract), Dept. of Botany Mar Athanasius College, Kothamangalam

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PREFACE

Biology is a rapidly advancing field of science, with recent developments throwing more light into our understanding on the process of life. The Board of Studies in Botany has taken efforts to incorporate recent advances in plant biology while restructuring the syllabus of under graduate programme. The syllabus is structured to provide basic principles of biological sciences with special references to botany and its applied branches. While attempting the reforms, the existing conditions relating to infrastructure, work load and staff pattern have been properly taken care of and provision for full utilization of the existing facility is proposed.

We gratefully acknowledge the assistance and guidance received from the management and the university and all those who have contributed in different ways in the venture. I hope this restructured syllabus and curriculum would enrich and equip the students to meet future challenges.

*Chairperson and Members
Board of Studies of Botany (UG)
Mar Athanasius College (Autonomous)
Kothamangalam*

MAR ATHANASIUS COLLEGE (AUTONOMOUS)

KOTHAMANGALAM, KERALA - 686666

REGULATIONS OF THE UNDERGRADUATE

PROGRAMMES

UNDER CHOICE BASED CREDIT SYSTEM

(MAC- UG-CBCS 2021)

(2021 Admission onwards)

PREAMBLE

Education prepares a man to live with dignity and liberty. The ultimate aim of education is to deepen man's understanding of the universe and of himself-in body, mind and spirit –and to disseminate this understanding throughout society and to apply it in the service of mankind. This aim is accomplished when quality is ensured in the process of learning. Ever since Independence there has been several attempts on the part of Central and State Governments, University Grants Commission, AICTE and similar regulatory bodies as well as universities and colleges to improve the quality of instruction offered. However, because of heavy demand for access and consequent expansion of colleges and universities together with constraints on resources, standards of education could not cope with expansion. The affiliating system, which played a useful role in managing access in the past, occupied disproportionate time on administration of the system and undermined the capacities of universities and colleges to work towards research and development. Even curricular reform took a back seat in many universities. While there is no alternative in the present context to the system of affiliation, there is a felt need to seek fresh strategies for innovation and experimentation in the entire range of higher education activities at the institutional level. In this scenario, Government of India by Resolution dated 14 July 1964 appointed the Education Commission to advise Government on the national pattern of education and policies for the development of education at all stages and in all aspects. The Education Commission (1964 – 66) recommended “Autonomy” to Universities and colleges as instrumental in achieving and promoting academic excellence in higher education (Chapter XIII). In

consonance with this recommendation, the University Grants Commission prepared Guidelines for Autonomy (Annexure II) during XIth plan and the same has been revised subsequently during XIIth plan. In the context of UGC Guidelines, the Committee set up by the Kerala State Higher Education Council in December 2012 to recommend criteria for selection and steps for operationalization of “Autonomous Colleges” in Kerala, deliberated on the subject extensively. Accordingly, the 13th Kerala State Legislative Assembly as per the “the University Laws (Third Amendment) Bill, 2014 resolved to provide Autonomy to colleges and Universities in Kerala. Mar Athanasius College, Kothamangalam, in its pursuit of academic excellence, was accorded Autonomous Status as per the Letter No. F.22 – 1/2016 (AC), dated 9th March, 2016. Following the attainment of autonomous status, the expert committee constituted by the Principal has undertaken the task of designing a draft Regulations and Guidelines of all Undergraduate Programmes in the institution in 2016. During the academic year 2016-17(For the 2016 admission) the then prevailing M. G. University regulations was accepted by the institution without any change. In the academic year 2017 the institution prepared UG regulations after making necessary modifications. The total credit, internal assessment, evaluation of answer sheets, Question paper pattern and conduct of examination were strictly adherent to the parent university regulations. The modified regulation came in to force in academic year 2018(with effect 2018 admission onwards) and the same regulation continued until 2020-21. In due course as per the recommendations of the academic council held on 19.06.2020, the 2018 UG regulations has been hitherto, modified by incorporating the modifications put forward by M.G. University as per U.O No. 1417/AC A9/2020 MGU Dated 10.03.2020. The framework of the Common Guidelines and regulations are presented in the ensuing pages.

1. TITLE

- 1.1. These regulations shall be called “**REGULATIONS FOR UNDERGRADUATE (UG) PROGRAMMES UNDER CHOICE BASED CREDIT SYSTEM, 2021 (MAC- UG- CBCS 21)**” of Mar Athanasius College (Autonomous), Kothamangalam.

2. SCOPE

- 2.1 Applicable to all Undergraduate Programmes conducted by Mar Athanasius College (Autonomous), Kothamangalam with effect from 2021-22 admissions.

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

3. DEFINITIONS

- 3.1. **'Academic Week'** is a unit of five working days in which distribution of work is organized from Day One to Day Five, with five contact hours of one hour duration on each day.
- 3.2 **'Semester'** means a term consisting of a minimum of 90 working days, inclusive of tutorials, examination days and other academic activities, within a period of six months.
- 3.3 **'Programme'** means a three year programme of study with examinations spread over six semesters. The successful completion of the programme leads to the award of a Bachelor Degree.
- 3.4 **'Course'** means a portion of a subject, which will be taught and evaluated in a semester (similar to a paper under Annual scheme). Each Course is to be designed under lectures / tutorials / laboratory / fieldwork / seminar/ project / practical training / assignments and evaluation etc., to meet effective teaching and learning needs.
- 3.5. **'Common Course I'** means a course that comes under the category of courses for English.
- 3.6 **'Common Course II'** means additional language (Malayalam or Hindi).
- 3.7. **'Core Course'** means a course in the subject of specialization within an Under Graduate Programme. It includes a course on environmental studies and human rights.
- 3.8. **'Complementary Course'** means a course which would enrich the study of core courses.
- 3.9. **'Choice Based Course'** means a course that enables the students to familiarise the advanced areas of Core Course.
- 3.10. **'Open course'** means an optional course which the student is free to take at his/her will. Open Course shall be a non-major elective course offered by the Departments other than parent Department.
- 3.11 **'Certificate Course / Diploma Course'** means courses that permit an opportunity to the students for academic enrichment in an area other than the traditional programmes to which he/she is admitted. Such courses will lead the candidate toward entry level employment in a professional field. The duration and general frame of the courses are subject to the regulations prescribed by the UGC from time to time. Certificate/Diploma courses shall be conducted over and above regular working hours.

- 3.12. **'Credit'** is the numerical value assigned to a course according to the relative importance of the syllabus of the programme.
- 3.13. **'Grade'** means a letter symbol (e.g: A, B, C, etc.) that indicates the broad level of performance of a student in a course/ semester/programme.
- 3.14. **'Grade Point' (GP)** is the numerical indicator of the percentage of marks awarded to a student in a course.
- 3.15. **Institutional Average (IA)** means average marks secured (Internal + External) for a course at the college level
- 3.16. **'Credit Point (CP)'** of a course is the value obtained by multiplying the Grade Point (GP) by the Credit (C) of the course. $CP=GP \times C$.
- 3.17. **'Cumulative Credit Point Average (CCPA)'** 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.
- 3.18. **'Department'** means any Teaching Department in the College.
- 3.19. **'Parent Department'** means the department which offers core courses within an Under Graduate Programme.
- 3.20. **'Department Council'** means the body of all teachers of a department in the college.
- 3.21. **'Department Co-ordinator'** means a teacher from the parent department nominated by the Department Council, who will advise the student in the academic matters.
- 3.22. **'College Coordinator'** is a teacher nominated by the Principal to co-ordinate the continuous evaluation undertaken by various departments within the college.
- 3.23. **'Grace Marks'** means marks awarded to the candidates as per the orders issued by Mahatma Gandhi University, Kottayam, from time to time.
- 3.24. **'Skill Enhancement Programme'** means Programme intended to assist the students to acquire additional practical skill which should be conducted over and above the regular working hours.
- 3.24. Words and expressions used and not defined in this regulation shall have the same meaning assigned to them in the Act and Statutes of the Mahatma Gandhi University.

4. ELIGIBILITY FOR ADMISSION AND RESERVATION OF SEATS

- 4.1 Eligibility and Norms for admission and reservation of seats for various Under Graduate Programmes shall be according to the rules framed by the Mahatma Gandhi University/State Government from time to time.

5. DURATION

- 5.1 The duration of UG programmes shall be **6 semesters**.
- 5.2 There shall be two semesters in an academic year. The **ODD** semester commences in **June** and on completion, the **EVEN** semester commences. There shall be two months' vacation during April and May in every academic year.
- 5.3 A student may be permitted to complete the Programme, on valid reasons, within a period of 12 continuous semesters from the date of commencement of the first semester of the programme.

6. REGISTRATION

- 6.1 The strength of students for each course shall remain as per existing regulations as approved by Mahatma Gandhi University, Kottayam.
- 6.2 The college shall send a list of students registered for each programme in each semester giving the details of courses registered to the University in the prescribed form within 45 days from the commencement of the Semester.
- 6.3 Those students who possess the required minimum attendance and progress during a semester and could not register for the semester examination are permitted to apply for Notional Registration to the examinations concerned, enabling them to get promoted to the next class.

7. SCHEME AND SYLLABI

- 7.1. The UG programmes shall include (a) Common courses I and II, (b) Core courses, (c) Complementary Courses, (d) Choice Based Course and (e) Open Course. Common course II is exempted in the case of B.Com Model III.
- 7.2. There shall be one Choice Based course (Elective Course) in the sixth semester. In the case of B.Com Programme there shall be an elective stream from third semester onwards.

- 7.3 Credit Transfer and Accumulation System can be adopted in the programme. Transfer of Credit consists of acknowledging, recognizing and accepting credits by an institution for programmes or courses completed at another institution. The Credit Transfer Scheme shall allow students pursuing a programme in one College to continue their education in another College without break. Credit transfer shall be permitted as per the University Rules.
- 7.4. A separate minimum of 30% marks each for internal and external (for both theory and practical) and an aggregate minimum of 35% are required to pass a course. For a pass in a programme, a separate minimum of **Grade D** is required for all the individual courses. If a candidate secures **F Grade** for any one of the courses offered in a Semester/Programme only **F Grade will be awarded** for that Semester/Programme until he/she improves this to **D Grade** or above within the permitted period.
- 7.5. Students who complete the programme with “D” Grade under **“REGULATIONS FOR UNDERGRADUATE (UG) PROGRAMMES UNDER CHOICE BASED CREDIT SYSTEM, 2021 – MAC – UG- -CBCS 2021”** of Mar Athanasius College (Autonomous), Kothamangalam will have **one betterment chance within 12 months**, immediately after the publication of the result of the whole programme.
- 7.6 The UG Board of Studies concerned shall design all the courses offered in the UG programme. The Boards shall design new courses and modify or re-design existing courses to facilitate better exposure and training for the students.
- 7.7. The syllabus of a course shall include the title of the course, contact hours, the number of credits and reference materials.
- 7.8. Students discontinued from previous regulations CBCS 2018 of Mar Athanasius College (Autonomous), Kothamangalam can pursue their studies in the Mar Athanasius College (Autonomous) Kothamangalam under “Regulations for Under Graduate Programmes under Choice Based Credit System 2021” after obtaining readmission. These students have to complete the programme as per the Mar Athanasius College (Autonomous) “Regulations for Under Graduate Programmes under Choice Based Credit System 2021 (MAC – UG – CBCS 2021)”.

- 7.9. The practical examinations (external/internal) will be conducted only at the end of even semesters for all programmes. Special sanction shall be given for those programmes which are in need of conducting practical examinations at the end of odd semesters

8. PROGRAMME STRUCTURE

The structure of UG Programmes is as follows

Model I B.A/B.Sc.

a	Programme Duration	6 Semesters
b	Total Credits required for successful completion of the programme	120
c	Credits required from common course I	22
d	Credits required from common course II	16
e	Credits required from Core Course and Complementary Course including Project	79
f	Credits required from Open course	3
g	Minimum attendance required	75%

Model I 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 Course and Complementary Course	95
f	Credits required from Open course	3
g	Minimum attendance required	75%

Model III 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	Credits required from Open Course	3
G	Minimum attendance required	75%

9. EXAMINATIONS

9.1

The evaluation of each course shall contain two parts:

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

The in-semester to end semester assessment ratio shall be 1:4.

Both Internal and External marks are to be rounded to the next integer.

9.2 For all courses (theory & practical), grades are given on a **10- point scale**, based on the total percentage of marks (**ISA+ESA**) 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 Satisfactory	5
35 to below 45	D Pass	4
Below 35	F Failure	0
	Ab Absent	0

10. CREDIT POINT(CP) AND CREDIT POINT AVERAGE (CPA)

1. Credit Point (CP)

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

$$CP = C \times GP$$

Where:

C is the Credit and

GP is the Grade point

2. Credit Point Average (CPA)

Credit Point Average (CPA) of a Course (Common Course I, Common Course II, complementary Course I, Complementary Course II, and Core Course) is calculated using the following formula.

$$CPA = TCP/TC$$

Where:

TCP is the Total Credit Point of course and

TC is the Total Credit of that category of course

3. Semester Credit Point Average (SCPA)

Semester Credit Point Average (SCPA) of a Semester is calculated using the following formula.

$$SCPA = TCP/TC$$

Where:

TCP is the Total Credit Point of that semester and

TC is the Total Credit of that semester

4. Cumulative Credit Point Average (CCPA)

Cumulative Credit Point Average (CCPA) is calculated using the following formula.

$$CCPA = TCP/TC$$

Where;

TCP is the Total Credit Point of that Programme and

TC is the Total Credit of that programme

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

CPA	Grade
9.5 and above	S Outstanding
8.5 to below 9.5	A ⁺ Excellent
7.5 to below 8.5	A Very Good
6.5 to below 7.5	B ⁺ Good
5.5 to below 6.5	B Above average
4.5 to below 5.5	C Satisfactory
4 to below 4.5	D Pass
Below 4	F Failure

11. MARK DISTRIBUTION FOR EXTERNAL AND INTERNAL EVALUATION

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

11.1 FOR ALL COURSES WITHOUT PRACTICAL

a) Marks of External Examination : 80

b) Marks of Internal Evaluation : 20

All the four components of the internal assessment are mandatory.

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

11.2 FOR ALL COURSES WITH PRACTICAL

a) Marks of External Examination : 60

b) Marks of Internal Evaluation : 15

11.2.1 FOR THEORY

Components of In-Semester Evaluation of Theory	Marks
Attendance	5
Assignment /Seminar/Viva	2
Test papers (2x4)	8
Total	15

11.2.2 FOR PRACTICAL EXAMINATION

a) External 40

b) Internal 10

Components of In-Semester Evaluation of Practical	Marks
Attendance	2
Test papers (1x4)	4
Record*	4
Total	10

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

All three components of internal assessments are Mandatory.

11.3 PROJECT EVALUATION: (Maximum Marks 100)

All students are to do a project in the area of core course. This project can be done individually or in groups (not more than five students) for all subjects which may be carried out in or outside the campus. Special sanction shall be obtained from the Principal to those new generation programmes and programmes on performing arts where students have to take projects which involve larger groups. The projects are to be identified during the II semester of the programme with the help of the supervising teacher. The report of the project in duplicate is to be submitted to the department at the sixth semester and are to be produced before the examiners (Internal and External) appointed by the Controller of Examinations. External Project evaluation and Viva / Presentation is compulsory for all subjects and will be conducted at the end of the programme.

For Projects

a) Marks of External Evaluation :80

b) Marks of Internal Evaluation : 20

Components of External Evaluation of Project	Marks
Dissertation (External)	50
Viva – Voce (External)	30
Total	80

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

*Components of Internal Evaluation of Project	Marks
Punctuality	5
Experimentation/Data collection	5
Knowledge	5
Report	5
Total	20

11.4 ATTENDANCE EVALUATION FOR ALL COURSES

(Theory/Practical)

Percentage of attendance	Marks
90 and above	5
85 – 89	4
80-84	3
76-79	2
75	1
Below 75	0

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

12. ASSIGNMENTS

Assignments are to be done from first to fourth Semesters. At least one assignment should be done in each semester.

13. SEMINAR/VIVA VOCE

A student shall present a seminar in the Fifth semester for each course and appear for Viva-voce in the sixth semester for each course.

14. INTERNAL ASSESSMENT TEST PAPERS

Two Test papers are to be conducted in each semester for each course. The evaluations of all components are to be published and are to be acknowledged by the candidates. All documents of internal assessments are to be kept in the college for one year and shall be made available for verification. The responsibility of evaluating the internal assessment is vested on the teacher (s), who teaches the course.

14.1 GRIEVANCE REDRESSAL MECHANISM

Internal assessment shall not be used as a tool for personal or other type of vengeance. A student has every right to know, how the teacher arrived at the marks. In order to address the grievance of students, 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

Level2: Department Level: The Department cell chaired by the Head of the Department, Faculty Advisor and the Course Teacher concerned as members.

Level 3: College level: A committee with the Principal as Chairman, and HOD of concerned Department, Academic Coordinator, and two teachers of the College Grievance Cell as members.

14.2 Academic coordinator shall make arrangements for giving awareness of the internal evaluation components to students immediately after commencement of first semester.

14.3 The in-semester evaluation report in the prescribed format should reach the Controller of Examinations as per the academic calendar.

14.4 The evaluation of all components is to be published in the Department and is to be acknowledged by the candidates. All academic records of in-semester assessments are to be kept in the Department for three years and shall be made available for verification. The responsibility of evaluating the in-semester assessment is vested on the teacher(s), who teach the course.

15. EXTERNAL EXAMINATION

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

15.1 Students having a minimum of 75% average attendance for all the courses only can register for the examination. A candidate having a shortage of attendance of 10 days in a semester subject to a maximum of 2 times during the whole period of the programme can apply for Condonation in prescribed form on genuine grounds. This Condonation shall not be counted for internal assessment. Condonation of shortage of attendance, if any, should be obtained at least 7 days before the commencement of the concerned semester examination.

It shall be the discretion of the Principal to consider such applications and condone the shortage on the merit of each case in consultation with the concerned Faculty Advisor and Head of the Department.

Unless the shortage of attendance is condoned, a candidate is not eligible to appear for the examination.

Benefit of attendance may be granted to students attending University/College union/Co-curricular activities by treating them as present for the days of absence, on production of participation/attendance certificates, within one week, from competent authorities and endorsed by the Head of the institution. This is limited to a maximum of 10 days per semester and this benefit shall be considered for internal assessment also.

Those students who are not eligible to attend the end semester examination due to shortage of attendance, even with Condonation, should take re-admission along with the next batch.

- 15.2** Those candidates who cannot appear for End Semester Examination or who have failed in the end semester examinations of Fifth and Sixth Semester shall be eligible to appear for supplementary examination by paying separate fees. For reappearance/ improvement, for other semesters the students can appear along with the next batch. Notionally registered candidates can also apply for the said supplementary examinations.
- 15.3** A student who registers his/her name for the end semester examination will be eligible for promotion to the next semester.
- 15.4** A student who has completed the entire curriculum requirement, but could not register for the Semester examination can register notionally, for getting eligibility for promotion to the next semester.
- 15.5** 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. There shall be no improvement for internal evaluation.
- 15.6** Answer scripts of the external examination shall be made available to the students for scrutiny on request and revaluation/scrutiny of answer scripts shall be done as per the request of the candidate by paying fees.

16. PATTERN OF QUESTIONS

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

Pattern of Questions for External Examination for Course without Practical

Sl. No.	Pattern	Marks	Choice of questions	Total Marks
1	Short answer/ Problem Type	2	10/12	20
2	Short essay/ Problems	5	6/9	30
3	Essay/Problem	15	2/4	30
Total				80

Pattern of Questions for End Semester Examination for Course with Practical

Sl. No.	Pattern	Marks	Choice of questions	Total Marks
1	Short answer/ Problem Type	1	10/12	10
2	Short essay/ Problems	5	6/9	30
3	Essay/Problem	10	2/4	20
Total				60

17. RANK CERTIFICATE

The institution publishes rank list of top 3 candidates for each programme after the publication of 6th semester results. Rank certificate shall be issued to the candidate who secure first position in the rank list. Candidates shall be ranked in the order of merit based on the CCPA scored by them. Grace marks awarded to the students should not be counted fixing the rank/position. Rank certificate shall be signed by the Principal and Controller of Examinations.

18. MARK CUM GRADE CARD

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

- (a) Name of the University
- (b) Name of the College
- (c) Title & Model of the Under-Graduate Programme
- (d) Name of the Semester
- (e) Name and Register Number of the student
- (f) Code, Title, Credits and Maximum Marks (Internal, External and Total) of each course opted in the semester.
- (g) Internal, External and Total Marks awarded, Grade, Grade point and Credit point in each course opted in the semester
- (h) Institutional average of the Internal Exam and Average of the External Exam in each course.
- (i) The total credits, total marks (Maximum and Awarded) and total credit points in the semester
- (j) Semester Credit Point Average (SCPA) and corresponding Grade.
- (k) Cumulative Credit Point Average (CCPA), CPA corresponding to Common courses I and II, Core Course, Complementary Course and Open Course.
- (m) The final Mark cum Grade Card issued at the end of the final semester shall contain the details of all courses taken during the final semester examination and shall include the final grade (SCPA) scored by the candidate from **1st to 5th** semesters, and the overall grade for the total programme.

19. There shall be 2 level monitoring committees for the successful conduct of the scheme.

They are:

1. Department Level Monitoring Committee (DLMC), comprising HOD and two senior most teachers as members.
2. College Level Monitoring Committee (CLMC), comprising Principal, College Council secretary and A.O/Superintendent as members.

20. SKILL ENHANCEMENT PROGRAMME

In addition to the requirement prescribed for the award of Bachelor degree, each student shall participate in the Skill Enhancement Programme (SEP) conducted by each department for a total duration of 40 hours spread over Semester I to Semester VI of all Programmes. SEP is intended to train the students and to inculcate extra skills that enable them to be competent in academic and non-academic matters equally. Separate certificate shall be issued by the institution to the candidate on successful completion of the programme. SEP shall be conducted over and above the regular working hours of each programme.

21. CERTIFICATE/DIPLOMA COURSES

Certificate/Diploma courses such as basics of accounting, animation, photography, garment designing, etc. may be conducted for all Programmes as per the discretion of the Board of Studies of the concerned department. The Board of Studies should prepare the curriculum and Syllabi of Certificate/Diploma courses including contact hours and reference materials. Separate certificate will be issued to the candidate on successful completion of the course. An extra Credit of 2 will be awarded to all the candidates on successful completion of the certificate courses and same shall be inscribed in the cumulative grade card and the degree certificate of each candidate.

21. A FACTORY VISIT / FIELD WORK/VISIT TO A REPUTED RESEARCH INSTITUTE/ STUDENT INTERACTION WITH RENOWNED ACADEMICIANS
May be conducted for all Programmes.

22. TRANSITORY PROVISION

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

Annexure I – Model Mark cum Grade Card

Mar Athanasius College(Autonomous) Kothamangalam

Kothamangalam College P.O. – 686666, Kerala, India

Affiliated to Mahatma Gandhi University, Kottayam

Section:

Student ID:

Name of candidate :

Permanent Register Number (PRN) :

Programme :

Stream :

Name of Examination :

Course Code	Course Title	Credit (C)	Marks						Grade awarded (G)	Grade point (GP)	Credit point (CxGP)	Institutional Average (IA)	Result
			External		Internal		Total						
			Awarded (E)	Maximum	Awarded (I)	Maximum	Awarded (E+I)	Maximum					
	Common Course I												
	Common Course II												
	Core Course Complementary												
	Course I Complementary												
	Course II/ Vocational Course												
	Total												
	Total credit points (TCP)												
	Total credit (TC)												
	SCPA:												

	Grade:													
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Annexure II – Model Mark cum Grade Card (VI Semester)

Mar Athanasius College (Autonomous) Kothamangalam

Kothamangalam College P.O. – 686666, Kerala, India

Affiliated to Mahatma Gandhi University, Kottayam

MARK CUM GRADE CARD

Section:

Student ID:

Name of candidate :

Permanent Register Number (PRN) :

Programme :

Stream :

Name of Examination : Sixth Semester CBCS Examination Month & Year

Course Code	Course Title	Credit (C)	Marks						Grade awarded (G)	Grade point (GP)	Credit point (CxGP)	Institutional Average (IA)	Result
			External		Internal		Total						
			Awarded (E)	Maximum	Awarded (I)	Maximum	Awarded (E+I)	Maximum					
	Core 9 Core 10 Core 11 Core 12 Choice Based Course Project SCPA Grade												

		Credit	CPA	Grade	Month & Year	Result
	Semester I Semester II Semester III Semester IV Semester V Semester VI					

Common Course I Common Course II Complementary Course I Complementary Course II Core Course Open Course					
Overall programme CCPA:					

Annexure III

Reverse side of the Mark cum Grade Card

(COMMON TO ALL SEMESTERS)

Description of the Evaluation Process

Grade and Grade Point

The Evaluation of each Course comprises of Internal and External Components in the ratio 1:4 for all Courses.

Grades and Grade Points are given on a 10-point Scale based on the percentage of Total Marks (Internal + External) as given in Table 1.

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

Credit point and Credit point average. Grades for the different Semesters and overall Programme are given based on the corresponding CPA, as shown in Table I.

Table 1

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 Satisfactory	5
35 to below 45	D Pass	4
Below 35	F Failure	0

	Ab Absent	0
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Credit point (CP) of a paper is calculated using the formula $CP = C \times GP$, where C is the Credit; GP is the Grade Point.

Credit Point Average (CPA) of a Course/ Semester or Programme (cumulative) etc. is calculated using the formula $CPA = TCP/TC$; where TCP is the Total Credit Point; TC is the Total Credit.

For converting SCPA into Percentage, multiply secured SCPA by 10 (SCPA x 10)

For converting CCPA into percentage, multiply secured CCPA by 10 (CCPA x 10)

CPA	GRADE
Equal to 9.5 and above	S Outstanding
Equal to 8.5 and < 9.5	A+ Excellent
Equal to 7.5 and < 8.5	A Very Good
Equal to 6.5 and < 7.5	B+ Good
Equal to 5.5 and < 6.5	B Above Average
Equal to 4.5 and < 5.5	C Satisfactory
Equal to 4 and < 4.5	D Pass
Below 4	F Failure

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

ELIGIBILITY FOR ADMISSION

Admission to B.Sc. Botany programme shall be open only to candidates who have passed the Plus Two or equivalent examination or an examination recognized by Mahatma Gandhi University, Kottayam as equivalent thereto with Biology as one of the optional subjects.

CONSOLIDATED SCHEME FOR I TO VI SEMESTERS

PROGRAMME STRUCTURE

1. BSc BOTANY PROGRAMME – (MODEL - I)

Sem	Course Title	Course Category	Hours per week	Credits
I	English I	Common	5	4
	English II	Common	4	3
	Second Language (Hindi/Malayalam) I	Common	4	4
	Methodology of Science and an Introduction to Botany	Core	2	2
	Methodology of Science and an Introduction to Botany (P)	Core	2	1
	Complementary Chemistry	Complementary	2	2
	Complementary Chemistry Practical	Complementary	2	1
	Complementary Zoology	Complementary	2	2
	Complementary Zoology Practical	Complementary	2	1
II	English II	Common	5	4
	English III	Common	4	3
	Second Language (Hindi/Malayalam) II	Common	4	4
	Microbiology, Mycology and Plant Pathology	Core	2	2
	Microbiology, Mycology and Plant Pathology (P)	Core	2	1
	Complementary Chemistry	Complementary	2	2
	Complementary Chemistry Practical	Complementary	2	1
	Complementary Zoology	Complementary	2	2
	Complementary Zoology Practical	Complementary	2	1
III	English III	Common	5	4
	II Language	Common	5	4
	Phycology and Bryology	Core	3	3
	Phycology and Bryology (P)	Core	2	1
	Complementary Chemistry	Complementary	3	3
	Complementary Chemistry Practical	Complementary	2	1
	Complementary Zoology	Complementary	3	3

	Complementary Zoology Practical	Complementary	2	1
IV	English IV	Common	5	4
	II Language	Common	5	4
	Pteridology, Gymnosperms and Paleobotany	Core	3	3
	Pteridology, Gymnosperms and Paleobotany (P)	Core	2	1
	Complementary Chemistry	Complementary	3	3
	Complementary Chemistry Practical	Complementary	2	1
	Complementary Zoology	Complementary	3	3
	Complementary Zoology Practical	Complementary	2	1
V	Anatomy, Reproductive Botany and Microtechnique	Core	3	3
	Research methodology, Biophysics and Biostatistics	Core	3	3
	Plant Physiology and Biochemistry	Core	3	3
	Environmental Science and Human Rights	Core	3	3
	Horticulture and Nursery Management	Open	4	3
	Anatomy, Reproductive Botany and Microtechnique (P)	Core	2	1
	Research methodology, Biophysics and Biostatistics (P)	Core	2.5	1
	Plant Physiology and Biochemistry (P)	Core	2.5	1
	Environmental Science and Human Rights (P)	Core	2	1
VI	Genetics, Plant Breeding and Horticulture	Core	3	3
	Cell and Molecular Biology	Core	3	3
	Angiosperm Morphology, Taxonomy and Economic Botany	Core	4	3
	Biotechnology and Bioinformatics	Core	3	3
	Phytochemistry and Pharmacognosy	Choice based	3	3
	Genetics, Plant Breeding and Horticulture (P)	Core	2.5	1
	Cell and Molecular Biology (P)	Core	2	1
	Angiosperm Morphology, Taxonomy and Economic Botany (P)	Core	2.5	1
	Biotechnology and Bioinformatics (P)	Core	2	1
	Project and Viva			2

Complementary courses offered by the Department

Semester	Course Title	Hours per week	Credits
I	Cryptogams, Gymnosperms and Plant Pathology	36	2
	Cryptogams, Gymnosperms and Plant Pathology (P)	36	1
II	Plant Physiology	36	2
	Plant Physiology (P)	36	1
III	Angiosperm Taxonomy and Economic Botany	54	3
	Angiosperm Taxonomy and Economic Botany (P)	36	1
IV	Anatomy and Applied Botany	54	3
	Anatomy and Applied Botany (P)	36	1

Titles and Codes of Courses offered by the Department

Semester	Theory/Practical	Course Title	Course Code
Semester I	Core Theory	Methodology of Science and an Introduction to Botany	UG21BO1CR01
Semester II	Core Theory	Microbiology, Mycology and Plant Pathology	UG21BO2CR01
Semester I & II combined	Core Practical	Methodology of Science and an Introduction to Botany & Microbiology, Mycology and Plant Pathology (P)	UG21BO2CRP1
Semester III	Core Theory	Phycology and Bryology	UG21BO3CR01
Semester IV	Core Theory	Pteridology, Gymnosperms and Paleobotany	UG21BO4CR01
Semester III & IV combined	Core Practical	Phycology and Bryology & Pteridology, Gymnosperms and Paleobotany (P)	UG21BO4CRP1
Semester V	Core Theory	Anatomy, Reproductive Botany and Microtechnique	UG21BO5CR01
Semester V	Core Theory	Research methodology, Biophysics and Biostatistics	UG21BO5CR02

Semester V	Core Theory	Plant Physiology and Biochemistry	UG21BO5CR03
Semester V	Core Theory	Environmental Science and Human Rights	UG21BO5CR04
Semester V	Open Course Theory	Horticulture and Nursery Management	UG21BO5OC01
Semester VI	Core Theory	Genetics, Plant Breeding and Horticulture	UG21BO6CR01
Semester VI	Core Theory	Cell and Molecular Biology	UG21BO6CR02
Semester VI	Core Theory	Angiosperm Morphology, Taxonomy and Economic Botany	UG21BO6CR03
Semester VI	Core Theory	Biotechnology and Bioinformatics	UG21BO6CR04
Semester VI	Choice Based Course Theory	Phytochemistry and Pharmacognosy	UG21BO6CB01
Semester V & VI combined	Core Practical	Anatomy, Reproductive Botany and Microtechnique & Genetics, Plant Breeding and Horticulture (P)	UG21BO6CRP1
Semester V & VI combined	Core Practical	Plant Physiology and Biochemistry & Cell and Molecular Biology (P)	UG21BO6CRP2
Semester V & VI combined	Core Practical	Environmental Science and Human Rights & Biotechnology and Bioinformatics (P)	UG21BO6CRP3
Semester V & VI combined	Core Practical	Research Methodology, Biophysics and Biostatistics & Angiosperm Morphology, Taxonomy and Economic Botany (P)	UG21BO6CRP4
Semester VI	Core	Project and Viva	UG21BO6PV
Semester I	Complementary Theory	Cryptogams, Gymnosperms and Plant Pathology	UG21BO1CM01
Semester II	Complementary Theory	Plant Physiology	UG21BO2CM01
Semester I & II combined	Complementary Practical	Cryptogams, Gymnosperms and Plant Pathology & Plant Physiology (P)	UG21BO2CMP1

Semester III	Complementary Theory	Angiosperm Taxonomy and Economic Botany	UG21BO3CM01
Semester IV	Complementary Theory	Anatomy and Applied Botany	UG21BO4CM01
Semester III & IV combined	Complementary Practical	Angiosperm Taxonomy and Economic Botany & Anatomy and Applied Botany (P)	UG21BO4CMP1

Other Open Courses mentioned in the syllabus

Semester	Title with Course Code	Course Code	Hrs per week	Credits
V	Agri-based Microenterprises	UG21BO5OC02	4	3
V	Ecotourism	UG21BO5OC03	4	3

Other Choice Based Courses mentioned in the syllabus

Semester	Title with Course code	Course Code	Hrs per week	Credits
VI	Agribusiness	UG21BO6CB02	3	3
VI	Plant Genetic Resources Management	UG21BO6CB03	3	3

PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

UNDER GRADUATE PROGRAMME OUTCOMES

PO No.	Upon completion of undergraduate programme, the students will be able to:
PO-1	Apply and innovate
PO-2	Achieve a desire for higher learning
PO-3	Work as a team with enhanced communication and coordination skills
PO-4	Attain skills for employment and entrepreneurship
PO-5	Acquire awareness on socio-cultural and environmental issues
PO-6	Develop a sense of ethics, self-discipline and sustainability

B.Sc. BOTANY PROGRAMME

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO No.	Upon Completion of B.Sc. Botany Programme, the students will be able to	PO No.
PSO-1	Identify, differentiate and appraise the diversity and beauty of flora and fauna.	1,3,5
PSO-2	Demonstrate writing, speaking, reading and listening competence in two languages.	3,4
PSO-3	Apply concepts of Chemistry and Zoology relevant to plant science.	1,2,4
PSO-4	Acquire proficiency to use biological instruments and apply practical skills in the field.	1,4
PSO-5	Apply methodologies and techniques to explore plant and animal life comprehensively.	1,2,4
PSO-6	Integrate the knowledge acquired to preserve natural resources and lead an environmental friendly life.	5,6
PSO-7	Develop knowledge about environmental laws and human rights.	2,5,6

DETAILED SYLLABUS OF BSc. BOTANY PROGRAMME

SEMESTER 1

Core course 1

Code: UG21BO1CR01

METHODOLOGY OF SCIENCE AND AN INTRODUCTION TO BOTANY

(Theory 36 hrs; Practical 36 hrs; Credits 2 + 1)

Objectives:

- Understand the universal nature of science.
- Demonstrate the use of scientific method.
- To lay a strong foundation to the study in Botany
- Impart an insight into the different types of classifications in the living kingdom.
- Appreciate the world of organisms and its course of evolution and diversity.
- Develop basic skills to study Botany in detail.

Module 1: Introduction to science and the methodology of science (4 hrs)

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

Module 2: Experimentation in science (4 hrs)

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

Module 3: Origin and evolution of life (10 hrs)

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

Module 4: Diversity of life and its classification (12 hrs)

Diversity of life: two kingdom classification (Carolus Linnaeus, 1735); phylogenetic classification (August W Eichler, 1878); five kingdom classification (R H Whittaker, 1969). Three domains, six kingdom classification, (Carl Woese, 1990) – criteria for classification, general characters of each kingdom. The three domains of life: Archaea, Bacteria, Eucarya – general characters of each. Diversity of plants: study the salient features of algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms.

Module 5: Basic Botanical skills (6 hrs)

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

PRACTICAL (36 hrs)

1. Design an experiment to verify a given hypothesis.
2. Conduct a survey-based inquiry on a given topic (To test the validity of a given hypothesis. E.g., all angiosperm parasites are Dicot plants).
3. Select an important classical experiment and find out the different elements of the methodology of science (e.g., Robert Koch experiment).
4. Conduct field surveys to identify and collect plant specimens to appreciate the diversity of plant kingdom. Submit five preserved specimens (in bottles and/or herbarium) belonging to diverse groups.
5. Identification of plants with vascular elements, plants which produce flowers, fruits, seeds, cone, sporophyll, embryos and study their salient features.
6. Prepare temporary, stained hand sections (TS, TLS, RLS) of plant specimens appropriate for light microscopic studies.

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CO No.	EXPECTED COURSE OUTCOME Upon completion of this course, the students will be able to	KNOWLEDGE LEVEL	PSO No
1	Appraise the universal nature of science.	K5	1
2	Explain different types of classifications in living kingdom.	K2	5
3	Appraise the world of organisms and its course of evolution and diversity.	K4	1
4	Develop basic botanical skills like microscopy and specimen preparation.	K6	4
5	Summarize basic concepts in Botany.	K2	2
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.			

SEMESTER 2
MICROBIOLOGY, MYCOLOGY AND PLANT PATHOLOGY
(Theory 36 hrs; Practical 36 hrs; Credits 2 + 1)
Core course 2 **Code: UG21BO2CR01**

Objectives

- Understand the world of microbes, fungi and lichens.
- Appreciate the adaptive strategies of the microbes, fungi and lichens.
- To study the economic and pathological importance of microorganisms.

MICROBIOLOGY (Theory 9 hrs; Practical 9 hrs)

Module 1: Introduction (1 hr) Introduction to microbiology, scope of microbiology.

Module 2: Bacteria (4 hrs) Bacteria: general characters and classification based on staining, morphology and flagellation. Ultra structure of bacteria. Reproduction - binary fission. Genetic recombination in bacteria - conjugation, transformation and transduction. Economic importance of bacteria.

Module 3: Viruses (2 hrs) General characters of viruses, virioids and prions. Structure of TMV and Bacteriophage (λ). Multiplication of λ phage – lytic and lysogenic cycle.

Module 4: Applied microbiology (2 hrs) Isolation and culture of bacteria; media used – general purpose and selective media, applications of bacterial culture (brief study only). Role of microbes: in producing antibiotics, wine, vinegar, curd – role in N_2 fixation, as biofertilizers – role in food spoilage (Brief study only).

PRACTICAL (9 hrs)

1. Gram staining - curd, root nodules.
2. Isolation of microbes from soil through serial dilution and streak plate method.
3. Demonstrate the culture of bacteria.
4. Microbes and type of fermentation - wine, vinegar, curd.

MYCOLOGY (Theory 18 hrs; Practical 18 hrs)

Module 5: Introduction, classification and types of fungi (13 hrs) General characters of fungi. Classification of fungi - Ainsworth (1973). Distinguishing characters of the different classes of fungi with special reference to reproductive structures and life history of the genera mentioned in each group: Myxomycotina – *Physarum*; Mastigomycotina – *Albugo*; Zygomycotina - *Rhizopus*; Ascomycotina – Hemiascomycetes - *Saccharomyces*; Plectomycetes - *Penicillium*; Pyrenomycetes – *Xylaria*; Discomycetes - *Peziza*; Basidiomycotina – Teliomycetes – *Puccinia*; Hymenomycetes – *Agaricus*; Deuteromycotina – *Fusarium*.

Module 6: Economic importance of fungi (3 hrs) Useful and harmful effects of fungi - medicinal, industrial, agricultural, biological control, food, genetic studies, spoilage, fungal toxins and diseases. Mycorrhiza: ecto- and endomycorrhiza, significance.

Module 7: Lichens (2 hrs) General characters, types, general internal structure. Economic and ecological significance of lichens. Structure, reproduction and life cycle of *Parmelia*.

PRACTICAL (18 hrs)

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

PLANT PATHOLOGY (Theory 9 hrs; Practical 9 hrs)

Module 8: Plant disease development (3 hrs) History of plant pathology. Classification of plant diseases on the basis of causative organism and symptoms. Host parasite interaction - defence mechanisms in host, mechanism of infection, transmission and dissemination of diseases.

Module 9: Common plant diseases (4 hrs) Study of following diseases with emphasis on symptoms, cause, disease cycle and control: Bunchy top of Banana, Bacterial blight of Paddy, Root wilt of Coconut, Abnormal leaf fall of Rubber, Root knot disease of Pepper, Leaf mosaic disease of Tapioca, Citrus canker.

Module 10: Control of diseases (2 hrs) Prophylaxis - quarantine measures, seed certification; Therapeutic - physical therapy, chemotherapy; Biological control and its significance. Fungicides - Bordeaux mixture. Tobacco and Neem decoction (Brief study only).

PRACTICAL (9 hrs)

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

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CO No.	EXPECTED COURSE OUTCOME Upon completion of this course, the students will be able to	COGNITIVE LEVEL	PSO No
1	Compare different microbes, fungi and lichens.	K4	1,2
2	Appraise the adaptive strategies of the microbes, fungi and lichens.	K5	5
3	Analyze the economic and pathological importance of microorganisms.	K4	1,5
4	Explain ecological and economic significance of Lichens.	K2	1,2,5
5	Identify selected plant diseases and analyze control measures.	K4	5
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.			

SEMESTER 3

Core course 3

Code: UG21BO3CR01

PHYCOLOGY AND BRYOLOGY (Theory 54 hrs; Practical 36 hrs; Credits 3 + 1)

Objectives

- To study the evolutionary importance of Algae as progenitors of land plants
- Understand the unique and general features of Algae and Bryophytes and familiarize it
- To study the external morphology, internal structure and reproduction of different types of Algae and Bryophytes
- Familiarize the application of Phycology in different fields.

PHYCOLOGY (Theory 36 hrs; Practical 27 hrs)

Module 1: Introduction to Phycology and classification of Algae (9 hrs) Introduction: general characters, habitat diversity, range of thallus structure and pigments in algae; structure of algal flagella. Different types of life cycle and alternation of generations in algae. Classification: by Fritsch (1945); brief introduction to the modern classification by Lee (2009) [up to divisions].

Module 2: Type study (18 hrs) Salient features, thallus structure and reproduction of algae in the following groups with special reference to the type(s) mentioned: Cyanophyceae - *Nostoc*; Chlorophyceae - *Volvox*, *Oedogonium*, *Cladophora*, *Chara*; Xanthophyceae – *Vaucheria*; Bacillariophyceae - *Pinnularia*; Phaeophyceae – *Ectocarpus*, *Sargassum*; Rhodophyceae - *Polysiphonia*.

Module 3: Applied phycology and economic importance of Algae (9 hrs) Algal culture: isolation, cultivation and preservation of micro- and macro-algae. Economic importance of algae: algae as food, SCP, fodder, green manure, role in N₂ fixation, medicine and biofuels. Commercial products from Algae - carrageenin, agar-agar, alginates and diatomaceous earth. Role of algae in pollution studies: as indicators of pollution and as bioremediation agents. Eutrophication – algal bloom; harmful and toxic algal blooms – neurotoxins and parasitic algae.

PRACTICAL (27 hrs)

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

BRYOLOGY (Theory 18 hrs; Practical 9 hrs)

Module 4: General introduction and classification of bryophytes (4 hrs) Introduction, general characters and classification of bryophytes by Rothmaler (1951); a very brief account of systems and classifications by Goffinet *et al* (2008).

Module 5: Type study (12 hrs) Distribution, morphology, anatomy, reproduction and life cycle of the following types (developmental details are not required): Hepaticopsida - *Riccia*, *Marchantia*; Anthocerotopsida - *Anthoceros*; Bryopsida - *Funaria*. Evolution of gametophyte and sporophyte among Bryophytes.

Module 6: Economic importance (2 hrs) Economic importance of Bryophytes – biological, ecological, medicinal and as potting material.

PRACTICAL (9 hrs)

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

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13. Shaw J A, Goffinet B, 2000. Bryophyte Biology. Cambridge University Press.
14. Smith G M, 1938. Cryptogramic Botany Vol. II. Bryophytes and pteridophytes. McGraw Hill Book Company, London.
15. Sporne K R, 1967. The Morphology of Bryophytes. Hutchinson University Library, London.
16. Vasishta B R. Bryophyta. S Chand and Co. New Delhi.
17. Watson E V, 1971. The structure and life of Bryophytes. Hutchinson University Library, London.
18. Bower F O, 1935. Primitive Land Plants. Cambridge, London.

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to	Cognitive level	PSO No
1	Assess the general characters of algae and bryophytes	K5	1,5
2	Explain the structure and reproduction of algae and identify the types studied.	K2	1,2
3	Compare the structure, lifecycle and evolution of bryophytes and identify the types studied.	K2 K4	1,2,5
4	Analyse the application of Phycology and Bryology in different fields.	K4 K3	4,6
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.			

SEMESTER 4

Core course 4

Code: UG21BO4CR01

PTERIDOLOGY, GYMNOSPERMS AND PALEOBOTANY

(Theory 54 hrs; Practical 36 hrs; Credits 3 + 1)

Objectives

- Understand the diversity in habits, habitats and organization of various groups of plants.
- To impart an insight into the modern classifications in lower forms of plants.
- Understand the evolutionary trends in Pteridophytes and Gymnosperms.
- Study the anatomical variations in vascular plants.
- Understand the significance of Paleobotany and its applications.

PTERIDOLOGY (Theory 27 hrs; Practical 27 hrs)

Module 1: General introduction and classification of Pteridophytes (5 hrs) Introduction, general characters and classification of Pteridophytes up to classes by Smith (1955) and a very brief account of the PPG system of classification.

Module 2: Type study (18 hrs) Study the distribution, morphology, anatomy, reproduction, life cycle and affinities of the following types (Developmental details are not required): Psilophyta - *Psilotum*; Lycophyta - *Lycopodium*, *Selaginella*; Sphenophyta - *Equisetum*; Pterophyta - *Pteris*, *Marsilea*. Stellar evolution in Pteridophytes; Heterospory and seed habit.

Module 3: Economic importance (4 hrs) Importance of Pteridophytes: medicinal, ornamental, as biofertilizer.

PRACTICAL (27 hrs)

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

GYMNOSPERMS (Theory 18 hrs; Practical 9 hrs)

Module 4: General introduction and classification of Gymnosperms (5 hrs) Introduction, General characters, classification of Gymnosperms by Sporne (1965) and a very brief account of the classification by Christenhusz *et al* (2011).

Module 5: Type study (11 hrs) Distribution, morphology, anatomy, reproduction, life cycle and affinities of the following types (Developmental details are not required): Cycadopsida – *Cycas*; Coniferopsida – *Pinus*; Gnetopsidae – *Gnetum*. Affinities of Gymnosperms with Pteridophytes and Angiosperms.

Module 6: Economic importance of Gymnosperms (2 hrs) Uses of Gymnosperms: as food, medicine, in industry and as ornamental plants.

PRACTICAL (9 hrs)

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

PALEOBOTANY (Theory 9 hrs)

Module 7: Fossils (6 hrs) Introduction to paleobotany and its significance. Fossil formation, types of fossils. Study of fossil Bryophyte - *Naiadita lanceolata*; fossil Pteridophytes – *Rhynia*, *Calamites*; fossil Gymnosperm – *Williamsonia*. Applied aspects of Paleobotany - exploration of fossil fuels.

Module 8: Paleobotany in India (3 hrs) Brief study of the fossil deposits in India. Important Indian Paleobotanical Institutes, contributions of Indian Paleobotanists - Birbal Sahni.

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

CO No.	Expected Course Outcomes Upon completion of this course, the students will be able to	Cognitive level	PSO No
1	Compare general characters of Pteridophytes and Gymnosperms	K2 K4	1,5
2	Explain the morphology, structure and lifecycle and identify the types mentioned in the course.	K2 K1	1,2
3	Analyze the economic importance of Pteridophytes and Gymnosperms.	K4 K5	5,6
4	Explain the types of fossils and process of fossilization	K2	5
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.			

SEMESTER 5

Core course 5

Code: UG21BO5CR01

ANATOMY, REPRODUCTIVE BOTANY AND MICROTECHNIQUE

(Theory 54 hrs; Practical 36 hrs; Credits 3 + 1)

Objectives

- Imparting an insight into the internal structure and reproduction of the most evolved group of plants, the Angiosperm.
- Understand individual cells and tissues.
- Understand the structural adaptations in plants growing in different environment.
- Understand the morphology and development of reproductive parts.
- Get an insight in to the fruit and seed development.
- Understand the techniques used to preserve and study plant materials.

ANATOMY (Theory: 27 hrs. Practical: 18 hrs)

Module 1: Structure and composition of plant cells (8 hrs) Cell wall: structure of cell wall; sub-microscopic structure - cellulose, micelle, micro fibril and macro fibril; structure and function of plasmodesmata, simple and bordered pits; different types of cell wall thickening in treacherly elements; extra cell wall thickening materials. Growth of cell wall - apposition, intussusception. Non-living inclusions in plant cells: food products, secretory products, excretory (waste) products - nitrogenous and non-nitrogenous.

Module 2: Organization of tissues (9 hrs) Tissues: meristematic tissue – characteristic features, functions and classification. Theories on apical organization - apical cell theory, histogen theory, tunica-cortex theory. Permanent tissues - structure and function of simple and complex tissues. Secretory tissues: external secretory tissue - glands and nectaries; internal secretory tissues - laticifers.

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

Module 3: Plant body structure (6 hrs) Primary structure of stem, root and leaf (dicot and monocot). Normal secondary growth in dicot stem and root. Periderm: structure and development - phellum, phellogen, phelloderm, bark, and lenticels. Anomalous secondary thickening: *Bignonia* stem, *Boerhaavia* stem and *Dracaena* stem.

Module 4: Wood anatomy (4 hrs) Basic structure of wood - heart wood, sap wood; hard wood, soft wood; growth rings and dendrochronology; porous and non-porous wood; ring porous and diffuse porous wood, tyloses. Reaction wood: tension wood and compression wood.

PRACTICAL (18 hrs)

1. Study of cell types and tissues.
2. Non-living inclusions - starch grains, cystolith, raphides, aleurone grains.

3. Primary structure of stem, root and leaf - Dicots and Monocots.
4. Dissect and identify the stomatal types - anomocytic, anisocytic, paracytic and diacytic.
5. Secondary structure of dicot stem and root.
6. Anomalous secondary structure of *Bignonia* stem, *Boerhaavia* stem, and *Dracaena* stem.

REPRODUCTIVE BOTANY (Theory 18 hrs; Practical 9 hrs)

Module 5: Introduction (2 hrs) Introduction to embryology, floral morphology - parts of flower.

Module 6: Microsporangium and male gametophyte (4 hrs) Microsporangium: structure and development of anther, microsporogenesis, dehiscence of anther, structure of pollen. Male gametophyte development.

Module 7: Megasporangium and female gametophyte (6 hrs) Megasporangium: types of ovules – anatropous, orthotropous, amphitropous, campylotropous, circinotropous. Megasporesis – female gametophyte – structure of a typical embryo sac, types of embryo sacs - monosporic (*Polygonum* type), bisporic (*Allium* type) and tetrasporic (*Peperomia* type).

Module 8: Fertilization (2 hrs) Mechanism of pollination, agents of pollination, germination of pollen grains; double fertilization.

Module 9: Endosperm and embryo (4 hrs) Endosperm: types – cellular, nuclear and helobial. Embryology, structure of dicot and monocot embryo, seed formation. Polyembryony.

PRACTICAL (9 hrs)

1. Dissect and display parts of different types of flowers.
2. Identification of C.S. of anther, embryo sac and embryo.
3. Identification of various anther types - monothealous, dithealous.
4. Identify the different types of ovules.

MICROTECHNIQUE (Theory 9 hrs; Practical 9 hrs)

Module 10: Preservation of plant specimens, sectioning and mounting (9 hrs) Introduction to microtechnique: killing and fixing - purpose. Dehydration - purpose, agents used - ethyl alcohol. Sectioning: hand sections, serial section; Microtome - rotary, sledge (application only). Staining technique: principle of staining; stains - hematoxylin, fast green, acetocarmine; vital stains - neutral red, Evans blue; mordants - purpose with examples. Types of staining - single staining, double staining. Mounting and mounting media – purpose, mounting media - glycerine, DPX, Canada balsam. Use of permanent whole mounts; permanent sections; maceration, smear and squash preparation.

PRACTICAL (9 hrs)

1. Familiarize preparation and use of stains, fixatives and mounting media.
2. Preparation of smears and squash.

3. Demonstration of microtome sectioning.
4. Maceration and identification of tracheary elements.
5. Preparation of single stained hand sections (Permanent – demonstration only).

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CO No.	EXPECTED COURSE OUTCOME Upon completion of this course, the students will be able to	COGNITIVE LEVEL	PSO No
1	Illustrate the mechanism of reproduction of angiosperms.	K2	2,5
2	Explain the structure and function of cells and tissues.	K2	2, 5
3	Compare the structure of root, stem and leaves.	K2	1,2
4	Analyse the structural adaptations in plants growing in different environments.	K4	5
5	Apply the techniques used to preserve and study plant materials.	K3	6
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.			

Core course 6

Code: UG21BO5CR02

RESEARCH METHODOLOGY, BIOPHYSICS AND BIostatISTICS

(Theory 54 hrs; Practical 36 hrs; Credits 3 + 1)

Objectives

- To equip the students to conduct independent research and prepare research reports.
- To make the students acquaint with different tools and techniques used in research work.
- To equip the students with basic computer skills necessary for conducting research.
- To enable the students to have enough numerical skills necessary to carry out research.

RESEARCH METHODOLOGY (Theory: 18 hrs. Practical: 18 hrs)

Module 1: Introduction (4 hrs) - Objectives of research. Types of research - pure and applied. Identification of research problem. Review of literature: purpose, literature sources – names of reputed National and International journals in life science (2 international & 3 national); reprint acquisition - INSDOC, INFLIBNET.

Module 2: Process of research (7 hrs) Conducting research: define the problem, identify the objective, design the study, collection of data, analysis and interpretation. Preparation of research report: preparation of dissertation - IMRAD system - preliminary pages, introduction and review of literature, materials and methods, results, discussion, conclusion and bibliography.

Module 3: Use of computer in research (7 hrs) Introduction to MS - WINDOWS and LINUX, application of MS WORD - word Processing, editing tools (cut, copy, paste), formatting tools. MS EXCEL - creating worksheet, data entry, sorting data. Statistical tools (SUM, MEAN, MEDIAN and MODE). Preparation of graphs and diagrams (Bar diagram, pie chart, line chart, histogram). MS-POWERPOINT - presentation based on a biological topic; inserting tables, charts, pictures. Open source and free alternatives to MS Office: Libre Office, Open Office (brief study). Search engines: Google.com; meta search engine – dogpile.com; academic search - Google scholar. Educational sites related to biological science - Scitable, DNai.

PRACTICAL (18 hrs)

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

BIOPHYSICS (Theory 18 hrs; Practical 9 hrs)

Module 4: Introduction (2 hrs) Introduction to biophysics; branches of biophysics - molecular, cellular, membrane and biomedical instrumentation (scope only).

Module 5: Biophysical instrumentation (16 hrs) Principle, working and applications of the following: Microscopy: compound microscope, phase-contrast microscope and electron microscope – SEM. Colorimeter, spectrophotometer. Centrifuge: ultracentrifuge. Chromatography: paper, thin layer and column. Electrophoresis, PAGE. pH meter. Haemocytometer.

PRACTICAL (9 hrs)

1. Measurement of pH and adjusting pH using pH meter.
2. Separation of plant pigments using TLC.
3. Determination of the concentration of a sample solution using colorimeter.
4. Demonstration of column chromatography.
5. Count the number of cells/spores using Haemocytometer.

BIOSTATISTICS (Theory 18 hrs; Practical 18 hrs)

Module 6: Introduction Introduction, statistical terms and symbols (Brief study only). Sampling: concept of sample, sampling methods - random and non-random sampling. Collection and representation of data: diagrammatic and graphic representation - line diagram, bar diagram, pie diagram, histogram, frequency curve. Measures of central tendency: mean, median, mode, (discrete and continuous series). Measures of dispersion: standard deviation. Distribution patterns: normal distribution, binomial distribution. Tests of significance: Chi-square test - uses, procedure.

PRACTICAL (18 hrs)

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

REFERENCES

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CO No.	EXPECTED COURSE OUTCOME Upon completion of this course, the students will be able to	COGNITIVE LEVEL	PSO No
1	Explain different tools and techniques used in plant science research.	K2	2,4
2	Explain the principle and applications of analytical instruments.	K2	2,4
3	Apply basic statistical skills in research.	K3	5
4	Develop basic computer skills necessary for conducting research and apply them for preparation of research reports.	K3, K6	2,5
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.			

Core course 7

Code: UG21BO5CR03

PLANT PHYSIOLOGY AND BIOCHEMISTRY

(Theory 54 hrs; Practical 45 hrs; Credits 3 + 1)

Objectives

- Acquire basic knowledge needed for proper understanding of plant functioning.
- Familiarize with the basic skills and techniques related to plant physiology.
- Understand the role, structure and importance of the bio molecules associated with plant life.

PLANT PHYSIOLOGY (Theory 36 hrs; Practical 27 hrs)

Module 1: Water relations (6 hrs) Plant water relations - diffusion, imbibition, osmosis, OP, DPD, TP; water potential - concepts and components (pressure potential, gravity potential, osmotic potential and matric potential). Absorption of water - active and passive, pathway of water movement - apoplastic and symplastic pathway. Ascent of sap - cohesion-tension theory. Transpiration - types, mechanism, theories (Starch-sugar, Proton-K⁺ ion exchange), significance; antitranspirants. Guttation.

Module 2: Mineral nutrition (3 hrs) Role of major and minor elements in plant nutrition, deficiency symptoms of essential nutrients; mineral uptake - passive (ion exchange) and active (carrier concept).

Module 3: Photosynthesis (12 hrs) Photosynthetic pigments, photo excitation - fluorescence, phosphorescence; red drop and Emerson enhancement effect. Photosystems - components and organization; cyclic and non-cyclic photophosphorylation; carbon assimilation pathways - C₃, C₄ plants - kranz anatomy, CAM. Photorespiration. Factors affecting photosynthesis – Blackmann’s law of limiting factors. Translocation of solutes: pathway of phloem transport, mechanism - pressure flow, mass flow hypothesis; phloem loading and unloading.

Module 4: Respiration (8 hrs) Respiration: anaerobic and aerobic; glycolysis, Krebs's cycle, mitochondrial electron transport system - components, oxidative phosphorylation, ATPase, chemiosmotic hypothesis. RQ - significance. Factors affecting respiration.

Module 5: Plant growth and development (5 hrs) Plant hormones: their physiological effect and practical applications - auxins, gibberellins, cytokinins, ABA, and ethylene. Plant movements: tropic movements - geotropism and phototropism; nastic movements - seismonastic and nyctinastic movements. Physiology of flowering - phytochrome, photoperiodism, vernalization.

Module 6: Stress physiology (2 hrs) Concepts of plant responses to abiotic stresses (water, salt, temperature), biotic stress (pathogens). Allelopathy.

PRACTICAL (27hrs)

Core Experiments (any four compulsory):

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

Demonstration experiments:

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

BIOCHEMISTRY (Theory 18 hrs; Practical 18 hrs)

Module 7: Water (3 hrs) Physical and chemical properties of water, acids and bases; pH - definition, significance; measurement of pH – colorimetric, electrometric (brief study only). Buffers: buffer action, uses of buffers.

Module 8: Carbohydrates (3 hrs) General structure and functions; classification - mono (glucose and fructose), di (maltose and sucrose) and polysaccharides (starch and cellulose).

Module 9: Proteins (4 hrs) General structure and classification of amino acids - peptide bond; structural levels of proteins - primary, secondary, tertiary and quaternary; functions of proteins.

Module 10: Lipids (2 hrs) General features and roles of lipids, types of lipids; fatty acids - saturated and unsaturated; fatty acid derivatives - fats and oils; compound lipids (brief study only).

Module 11: Enzymes (6 hrs) Classification and nomenclature, mechanism of action. Enzyme kinetics, Michaelis-Menten constant (brief study only). Regulation of enzyme action. Factors affecting enzyme action.

PRACTICAL (18 hrs)

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

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CO No.	EXPECTED COURSE OUTCOME Upon completion of this course, the students will be able to	COGNITIVE LEVEL	PSO No
1	Explain the various physiological phenomena in plants.	K2	2,5
2	Identify the basic concepts and techniques in plant physiology.	K3	4
3	Appraise the role of enzymes in plant life.	K5	1
4	Assess the role, structure and importance of biomolecules associated with plant life.	K5	1,5
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.			

Core course 8

Code: UG21BO5CR04

ENVIRONMENTAL SCIENCE AND HUMAN RIGHTS

(Theory 54 hrs; Practical 36 hrs; Credits 3 + 1)

Objectives:

- Acquaint the student with the significance of Environmental Science and Human rights.
- Make the students aware about the extent of the total biodiversity and the importance of their conservation.
- Help the student to design novel mechanisms for the sustainable utilization of natural resources.
- Enable the students to understand the structure and function of the ecosystems.
- Enable the students to understand various kinds of pollution in the environment, their impacts on the ecosystem and their control measures
- Make the students aware about various environmental laws in India and the role of various movements in the protection of nature and natural resources

ENVIRONMENTAL SCIENCE (36 hours)

Module 1: (10 hrs)

Unit:1 Introduction to ecology- introduction, definition, scope and relevance; sub-divisions of ecology - autecology, synecology and ecosystem ecology. Population: population size, density, natality, mortality, age, rate of natural increase, growth form and carrying capacity, population interactions between species - competition, parasitism, predation, commensalism, mutualism, neutralism. Community: community concept, biotic community, species diversity, species richness, dominance; growth forms and structure, trophic structure, ecotone, edge effect, habitat, ecological niche, micro-climate, ecological indicators, keystone species.

Unit 2: Ecosystems -Structure and function of ecosystems, ecosystem components: abiotic and biotic - producers, consumers, decomposers. Productivity - primary and secondary – gross and net productivity - homeostasis in the ecosystem.

Unit 3: Concept of energy in ecosystems - energy flow, food chain, food web, trophic levels, trophic structure and ecological pyramids - pyramid of numbers, biomass, energy. Nutrient cycles - biogeochemical cycles of C and N₂. Ecosystem development: ecological succession, process, climax community, hydrosere, xerosere.

Module 2: (8hrs)

Unit 1: Biodiversity: definition, types, examples – endemism - hot spots; hot spots in India - Western Ghats as hot spot. Wetlands and their importance. Biodiversity loss - IUCN threat categories, Red data book; causes and rate of biodiversity loss - extinction, causes of extinction. Conservation: methods - in-situ, ex-situ. Joint Forest management – people’s participation in biodiversity conservation: community reserve, eg. Kadalundi-vallikkunnu.

Unit 2: Remote sensing and GIS: introduction, principle, application of remote sensing and GIS in environmental studies and biodiversity conservation (brief account).

Unit 3: Ecotourism: ecotourism centers in Kerala - Thenmala and Thattekkad WLS.

Module 3: (8 hrs)

Unit 1: Environmental pollution - introduction, definition; Air pollution - air pollutants, types, sources, effect of air pollution on plants and humans, control measures; Water pollution – common pollutants, sources, impact, control measures; water quality standards - DO and BOD; eutrophication. Soil Pollution - causes, sources, solid waste, biodegradable, nonbiodegradable, management of solid waste, composting, e – waste.

Unit2: Environmental issues - global warming, greenhouse effect, climate change - causes and impact, ozone layer depletion. Carbon sequestration.

Module 4: (10 hrs)

Unit 1: Conservation of nature- Global conservation efforts - Rio Earth summit - Agenda 21, Kyoto protocol, COP15 (15 The Conference of the parties under the UN framework convention on climate change) and Paris protocol - major contributions. Conservation strategies and efforts in India and Kerala. Organizations, movements and contributors of environmental studies and conservation: organizations - WWF, Chipko, NEERI; contributors - Salim Ali, Sunder Lal Bahuguna, Madhav Gadgil, Anil Agarwal, Medha Patkar, Vandana Siva (brief account only).

Unit2: Environmental Legislation and Laws: Environment (protection) Act 1986, Air (protection and control of pollution) act, 1981 Water (protection and control of pollution) Act, 1974, Wildlife (protection) Act, 1972, Forest (conservation) Act, 1980, Biological Diversity Act (2002) [brief account only].

Module - 5 (18 Hours)

Unit 1 - Human Rights

An Introduction to Human Rights, Meaning, concept and development –History of Human Rights–Different Generations of Human Rights- Universality of Human Rights- Basic International Human Rights Documents - UDHR, ICCPR, ICESCR-Value dimensions of Human Rights.

Unit 2 - Human Rights and United Nations

Human Rights co-ordination within UN system- Role of UN secretariat- The Economic and Social Council- The Commission Human Rights-The Security Council and Human rights- The Committee on the Elimination of Racial Discrimination- The Committee on the Elimination of Discrimination Against Women- the Committee on Economic, Social and Cultural Rights- The Human Rights Committee- Critical Appraisal of UN Human Rights Regime.

Unit 3- Human Rights National Perspective

Human Rights in Indian Constitution – Fundamental Rights- The Constitutional Context of Human Rights- directive Principles of State Policy and Human Rights- Human Rights of Women children –minorities- Prisoners- Science Technology and Human Rights- National Human Rights Commission- State Human Rights Commission- Human Rights Awareness in Education.

PRACTICAL (36 hrs)

1. Estimation of CO, Cl, and alkalinity of water samples (Titrimetry)
2. Determination of pH of soil and water.
3. Assessment of diversity, abundance, and frequency of plant species by quadrat method (Grasslands, forests).
4. Study of the most probable number (MPN) of Coliform bacteria in water samples.
5. EIA studies in degraded areas (Sampling, Line transect, Quadrant).

6. Ecological adaptations in xerophytes, hydrophytes, epiphytes, halophytes and mangroves.

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46. Basic documents in Human rights, Ian Brownlie.
47. Universal Human Rights in Theory and practice, Jack Donell Future of Human rights, Upenda Baxi.
48. Understanding Human Rights An over view O P Dhiman
49. Reforming Human Rights, D P Khanna
47. Human Rights in Historical and Political Perspective
48. Human Rights in Post colonial India edited by Om Prakash Dwivedi and V G Julie Rajan.

CO No.	EXPECTED COURSE OUTCOME Upon completion of this course, the students will be able to	COGNITIVE LEVEL	PSO No
1	Analyse the structure and function of the ecosystems.	K4	5
2	Discuss major environmental problems and its causes and suggest control measures.	K2, K6	2, 5, 6
3	Create awareness about the extent of the total biodiversity, its loss and need of conservation.	K6	6,7
4	Analyse national and international human rights.	K4	7
5	Appraise various environmental laws and human rights in India.	K5	7
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.			

Open course

Code: UG21BO5OC01

HORTICULTURE AND NURSERY MANAGEMENT

(Theory 72 hrs; Credits 3)

Objectives

- Understand the importance of horticulture in human welfare.
- Understand the propagation and cultural practices of useful vegetable, fruit and garden plants.
- Understand the impact of modern technologies in biology on horticultural plants.
- Understand the basic concepts of landscaping and garden designing.
- Inculcate interest in landscaping, gardening and flower and fruit culture.

HORTICULTURE (48 hrs)

Module 1: Introduction (10 hrs) Introduction to horticulture: definition, history; classification of horticultural plants, disciplines of horticulture. Soil: formation, composition, types, texture, pH and conductivity. Garden tools and implements. Preparation of nursery bed; manures and fertilizers - farm yard manure, compost, vermicompost, biofertilizers; chemical fertilizers - NPK; time and application of manures and fertilizers, foliar spray. Irrigation methods - surface, sub, drip and spray irrigations - advantages and disadvantages - periodicity of irrigation.

Module 2: Propagation of plants (10 hrs) Propagation of horticultural plants - by seeds; seed development and viability, seed dormancy, seed health, seed testing and certification. Growing seedlings in indoor containers and field nurseries, seed bed preparation, seedling transplanting; 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; micropropagation.

Module 3: Gardening (10 hrs)

Gardening - ornamental gardens, indoor gardens, kitchen gardens- terrestrial and aquatic gardens - garden adornments; garden designing; garden components - lawns, shrubs and trees, borders, hedges, edges, drives, walks, topiary, trophy, rockery, vertical gardens; famous gardens of India. Landscape architecture - home landscape design, urban planning, parks, landscaping and public buildings, industrial and highway landscaping. Physical control of plant growth - training and pruning - selection of plant, bonsai containers and method of bonsai formation.

Module 4: Floriculture (6 hrs) Introduction, commercial floriculture - jasmine, orchid, anthurium, rose, gladiolus; production of cut flowers, quality maintenance, packing, marketing. Flower arrangements - basic styles - upright and slanting - japanese Ikebana, dry flower arrangement.

Module 5: Olericulture (4 hrs) Olericulture - types of vegetable growing - home gardens and market gardens; cultivation practices of leafy vegetable (Amaranthus), tuber (Potato), fruit (Tomato), flower (Cauliflower).

Module 6: Pomology (4 hrs) Pomology - cultivation of fruit crops - mango, banana and pine apple - preparation of land, spacing, planting, irrigation, hormones, harvest and storage. Factors affecting duration of storage. Principles of preservation - temporary and permanent - agents for fruit preservation. Preparation of pickles, jams, jellies and squashes using locally available fruits.

Module 7: Gardening – additional features (4 hrs) Garden friends - honey bees, ladybirds, frogs, spiders, earthworms, centipedes and millipedes. Garden foes - pests, pathogenic fungi, bacteria, virus. Control measures - pesticides and fungicides; neem tobacco decoction. Hazards of chemical pesticides; equipments used in controlling horticultural pests - sprayers, dusting equipments - sterilization, fumigation. Weeds - annual, perennial; weed control - prevention, eradication - hand weeding, tillage, burning, mowing, biological control, use of herbicides - selective and non selective - mechanisms involved in herbicidal actions.

NURSERY MANAGEMENT (6 hrs)

Module 8: Nurseries (6 hrs) Nursery: definition, types; management strategies - planning, layout, budgeting - production unit, sales unit. Plant growing structures - green houses, fernery, orchidarium, arboretum.

ON HAND TRAINING (18 hrs)

1. Preparation of potting mixture of known combination and potting in earthen pots/poly bags.
2. Preparation of nursery beds.
3. Preparation of compost/vermicompost using different substrates.
4. Working knowledge and identification of garden tools and implements.
5. Practical knowledge in different plant propagation techniques listed in syllabus.
6. Cultivation of a vegetable/ornamental plant/fruit crop listed in the syllabus.
7. Practice of different pruning operations (top dressing, shaping and topiary) in the following plants: (1) Bougainvillea (2) Phyllanthus.
8. Visit a well established nursery and submit report.

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CO No.	EXPECTED COURSE OUTCOME Upon completion of this course, the students will be able to	COGNITIVE LEVEL	PSO No
1	Analyse the importance of horticulture in human welfare.	K2	1
2	Choose methods for preserving fruits and vegetables	K3	4
3	Analyse the advantages and disadvantages of various propagation techniques.	K4	5
4	Assess the basic concepts and develop interest in landscaping and garden designing.	K5	4,6
5	Develop interest in floriculture, olericulture, pomology and nursery management.	K6	4,5
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.			

Open course

Code: UG21BO5OC02

AGRI-BASED MICROENTERPRISES

(Theory 72 hrs; Credits 3)

Objectives:

- Provide basic information about the business opportunities in plant sciences.
- Inform the student about sustainable agriculture and organic farming.
- Inculcate an enthusiasm and awareness about ornamental gardening, nursery management and mushroom cultivation.

Module 1: Organic farming and composting techniques (9 hrs)

Advantages of organic manures and fertilizers. Composition of fertilizers – NPK content of various fertilizers. Common organic manures – bone meal, cow dung, poultry waste, oil cakes, organic mixtures and compost. Preparation of compost - aerobic and anaerobic - advantages of both; vermicompost - preparation, vermiwash. Biofertilizers: definition, types – Trichoderma, Rhizobium, PGPR. Biopesticides – Tobacco and Neem decoction. Biological control.

Module 2: Horticulture and Nursery management (18 hrs)

Soil components. Preparation of potting mixture. Common Garden tools and implements. Methods of plant propagation - by seeds - advantages and disadvantages. Vegetative propagation - advantages and disadvantages. Natural methods of vegetative propagation. Artificial methods - cutting, grafting, budding and layering. Use of growth regulators for rooting. Gardening - types of garden - ornamental, indoor garden, kitchen garden, vegetable garden for marketing.

Module 3: Food spoilage and preservation techniques (9 hrs)

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

Module 4: Mushroom cultivation and Spawn production (9 hrs)

Types of mushrooms - button mushroom, oyster mushroom and milky mushroom, poisonous mushroom –

methods of identification. Spawn – isolation and preparation. Cultivation milky mushrooms – using paddy straw and saw dust by polybag. Value added products from mushroom – pickles, candies, dried mushrooms.

Module 5: Plant tissue culture and micropropagation (9 hrs)

Concept of totipotency. Micropropagation: different methods – shoot tip, axillary bud and meristem culture; organogenesis, somatic embryogenesis. Infra structure of a tissue culture laboratory. Solid and liquid media - composition and preparation. Sterilization techniques. Explant - inoculation and incubation techniques. Stages of micropropagation – hardening and transplantation. Packaging and transportation of tissue culture regenerated plantlets.

ON HAND TRAINING (18 hrs)

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

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Open course

Code: UG21BO5OC03

ECOTOURISM
(Theory 72 hrs; Credits 3)

Objectives:

- Make the students to opt various ecotourism programs in the self employment stream
- Make the students aware of the usefulness of ecotourism in the conservation of natural resources.
- Help the students to assess various ecotourism programs

Module 1: Introduction (4 hrs)

Definition, concept, introduction, history, relevance and scope.

Module 2: Key principles and characteristics of ecotourism (4 hrs)

Nature area focus, interpretation, environmental sustainability practice, contribution to conservation, benefiting local communities, cultural respect, customer satisfaction, responsible marketing.

Module 3: Components of Ecotourism (12 hrs)

Travel, tourism industry, biodiversity, local people, cultural diversity, resources, environmental awareness, interpretation, stake holders, capacity building in ecotourism.

Module 4: Ecotourism terms (10 hrs)

Adventure tourism, certification, commercialization chain, cultural tourism, canopy walkway, conservation enterprises, ecosystem, ecotourism activities, ecotourism product, ecotourism resources, ecotourism services, endemism, ecolabelling, ecotourism “lite”, geotourism, greenwashing, stakeholders, sustainable development, sustainable tourism, leakages

Module 5: Ecotourism resources in India and Kerala (14 hrs)

Major ecosystems vegetation types and tourism areas in Kerala. Festivals and events, entertainment, overview, culture, famous destinations, sightseeing, historical monuments, museums, temples, national parks & wildlife sanctuaries, hill stations, waterfalls, rivers, reaches, wildlife watching and bird watching sites, agricultural sites, tribal areas, tribal museums, tribal arts, rural handicrafts, tribal medicines, archeological sites, adventure sports, sacred groves, mountains, etc.

Module 6: Forms of Ecotourism in India and Kerala (8 hrs)

Eco regions, eco places, waterfalls in Kerala and India, eco travel, dos and don't on eco travel, eco trips. Potential of ecotourism in Kerala. Community based ecotourism, ecotourism and NGOs.

Module 7: Ecotourism Planning (16 hrs)

Background, objectives, strategy, design of activities, target groups, opportunities, capacity building, threats, expectations positive and negative impacts, strength and weakness, benefits and beneficiaries, stakeholders, linkages, economics, ecotourism auditing. Problems with ecotourism. Carrying capacity of ecotourism. ecotourism facilities – Green report card. Ecotourism management – issues.

Module 8: Ecotourism and livelihood security (4 hrs)

Community, biodiversity conservation and development – Eco-development committees.

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SEMESTER 6

Core course 9

Code: UG21BO6CR01

GENETICS, PLANT BREEDING AND HORTICULTURE

(Theory 54 hrs; Practical 45 hrs; Credits 3 + 1)

Objectives

- Imparting an insight into the principles of heredity
- Understand the patterns of inheritance in different organisms
- Understand the inheritance pattern of nuclear and extra nuclear genes
- Understand the methods of crop improvement
- Understand the importance of horticulture in human welfare
- Develop skill in gardening technique among students

GENETICS (Theory 27 hrs; Practical 27 hrs)

Module 1: Origin and development of Genetics (3 hrs) Genetics as a science: origin - experiments of Mendel with *Pisum sativum*, general terminology used in genetics. Principles of inheritance, Mendelian laws - monohybrid and dihybrid cross, test cross and backcross.

Module 2: Exceptions to Mendelism (10 hrs) Modification of Mendelian ratios: incomplete dominance - *Mirabilis*; Co-dominance - MN blood group in man; Lethal genes – pigmentation in Snap dragon.. Geneic interaction: epistasis, (a) Dominant - fruit colour in summer squashes (b) Recessive - coat colour in mice; Complementary genes - flower colour in sweet pea. Non-epistasis - comb pattern in Fowls. Multiple alleles – ABO blood groups in man; self-sterility in *Nicotiana*.

Module 3: Linkage of genes (3 hrs) Linkage and crossing over: chromosome theory of linkage; crossing over - types of crossing over, mechanism of crossing over. Linkage map - 2 point cross, interference and coincidence.

Module 4: Determination of sex (6 hrs)

Sex determination: sex chromosomes and autosomes; chromosomal basis of sex determination; XX-XY, XX-XO mechanism; sex determination in higher plants (*Melandrium album*). Sex linked inheritance: X-linked - Morgan's experiment e.g. eye colour in *Drosophila*, Haemophilia in man; Y-linked inheritance; sex limited and sex influenced inheritance. Pedigree analysis.

Module 5: Quantitative inheritance (2 hrs) Quantitative characters: polygenic inheritance, continuous variation - kernel color in wheat, ear size in maize.

Module 6: Extra-chromosomal inheritance (2 hrs) Extra chromosomal inheritance: chloroplast mutation - variegation in 4O'clock plant; mitochondrial mutations in yeast. Maternal effects - shell coiling in snail; infective heredity - kappa particles in *Paramecium*.

Module 7: Population genetics (1 hr) Concept of population, gene pool, Hardy-Weinberg principle (brief).

PRACTICAL (36hrs)

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

PLANT BREEDING (Theory 13 hrs; Practical 9 hrs)

Module 8: Introduction to plant breeding (1 hr) Introduction and objectives of plant breeding. Plant breeding centers in Kerala, their achievements – CPCRI, CTCRI, RRII.

Module 9: Plant introduction (2 hrs) Plant introduction: domestication - centers of origin - procedure of plant introduction - quarantine regulations, acclimatization, agencies of plant introduction in India, major achievements.

Module 10: Selection (2 hrs) Plant Selection: mass, pure-line, clonal.

Module 11: Hybridization (4 hrs) Hybridization: types, procedure, important achievements. Heterosis in plant breeding, inbreeding depression, genetics of heterosis and inbreeding depression. Handling segregating generation - pedigree method, bulk method, back cross method. Disease resistance breeding.

Module 12: Mutation breeding and polyploidy breeding (2 hrs) Mutation breeding: methods, applications and important achievements. Polyploidy breeding: methods and applications.

Module 13: Tissue culture as method in plant breeding (2 hrs) Application of meristem culture, embryo culture and pollen culture in plant breeding. Role of tissue culture in the creation of transgenic plants.

PRACTICAL (9hrs)

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

HORTICULTURE (Theory 14 hrs; Practical 18 hrs)

Module 14: Introduction (3 hrs) Introduction to horticulture - definition, history. Classification of horticultural plants. Disciplines of horticulture - pomiculture, olericulture, floriculture, arboriculture. Garden implements - budding knife, secateurs, hedge shear, hand cultivator, sprayers, lawn mower, garden rake, spade. Irrigation methods: surface, sub, drip and spray irrigations; mist chambers - advantages and disadvantages.

Module 15: Plant propagation: (5 hrs) Seed propagation: seed testing and certification, seed bed preparation, seedling transplanting, hardening of seedling; advantages and disadvantages of seed propagation. Vegetative propagation: natural and artificial; artificial methods - cutting, layering, grafting and budding, micro-propagation; advantages and disadvantages of vegetative propagation.

Module 16: Gardening (6 hrs) Types of garden: brief study on ornamental garden, indoor garden, kitchen garden, aquatic garden, vertical garden, medicinal garden, terrace garden, terrarium. Garden designing: garden components - lawns, shrubs and trees, borders, topiary, hedges, edges, walks, drives. Physical control of plant growth: training and pruning. Bonsai - selection of plant - bonsai containers and method of bonsai formation. Plant growing structures: green house, orchidarium, conservatory; Potting mixture – components.

PRACTICAL (9hrs)

1. Approach grafting (demonstration only), budding (T, patch), air layering.
2. Identification of different garden tools and their uses.
3. List out the garden components in the photograph of the garden given.
4. Visit to established horticultural/agricultural/ornamental/kitchen gardens and observe the components there.

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CO No.	Expected Course Outcome Upon completion of this course, the students will be able to	Cognitive Level	PSO No
1	Explain the principles of heredity and pattern of inheritance	K2	2,5
2	Analyse gene interactions, multiple allelism, linkage and its significance.	K4	4,5
3	Explain the mechanism of sex determination	K2	5
4	Compare breeding techniques and their applications.	K2	4
5	Illustrate vegetative propagation techniques.	K2	4
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.			

Core course 10

Code: UG21BO6CR02

CELL AND MOLECULAR BIOLOGY

(Theory 54 hrs; Practical 36 hrs; Credits 3 + 1)

Objectives

- Understand the ultra structure and functioning of cell in the sub-microscopic and molecular level.
- Get an idea of origin, concept of continuity and complexity of life activities.
- Familiarization of life processes.
- Understand the basic and scientific aspect of diversity.
- Understand the cytological aspects of growth and development.
- Understand DNA as the basis of heredity and variation.

CELL BIOLOGY (Theory 27 hrs; Practical 27 hrs)

Module 1: Ultra structure of cell components (8 hrs) Cell biology through ages: a brief history of cell biology. Cytosol - chemical composition. Composition, structure and function of plasma membrane - fluid mosaic model. The ultra-structure of a plant cell with structure and function of the following organelles: Endoplasmic reticulum, chloroplasts, Mitochondria, Ribosomes, Dictyosomes, Microbodies - peroxisomes and glyoxisomes, lysosomes and vacuole. Cytoskeleton - microtubules and microfilaments. Ultra structure of nucleus: nuclear envelope - detailed structure of pore complex, nucleoplasm -composition, nucleolus.

Module 2: Chromosomes (6 hrs) Chromosomes: introduction, chromosome number, autosomes and allosomes, morphology -metacentric, submetacentric, acrocentric and telocentric. Structure - chromatid, chromonema, chromomere, centromere and kinetochore, telomere, secondary constriction and nucleolar organizer. Chromatin fibres: heterochromatin and euchromatin. Karyotype and ideogram. Chemical composition of chromatin: histones and non-histones, arrangement of proteins and DNA in chromatin - the 10 nm fibre (nucleosome model), 30 nm fibre (solenoid model) and central axis with radial loops of 300 nm fibre. Special type of chromosomes: giant chromosomes (salivary gland chromosomes, Lamp brush chromosomes), supernumerary chromosomes (B chromosome).

Module 3: Cell division (6 hrs) Cell cycle - definition, different stages – interphase (G₁, S and G₂) and division phase. Mitosis: karyokinesis and cytokinesis, significance of mitosis. Meiosis: stages - first meiotic division (reduction division) and second meiotic (equational division), structure and function of synaptonemal complex, significance of meiosis; comparison of mitosis and meiosis.

Module 4: Chromosomal aberrations (4 hrs) Numerical: heteroploidy; euploidy – haploidy; polyploidy – autopolyploidy, allopolyploidy (*Raphanobrassica*); aneuploidy - monosomy, trisomy (Fruit morphology in *Datura*), nullisomy (*Triticum*). Numerical chromosomal abnormalities in man: Down's syndrome, Klinefelter's syndrome, Turner's syndrome. Structural: deletion (Cri-du-chat syndrome), duplication (Bar eye in *Drosophila*), inversions (paracentric and pericentric) and Translocations (Robertsonian translocation).

Module 5: Mutation (3 hrs) Mutation: definition, importance. Types of mutations: somatic and germinal; spontaneous and induced; chromosomal and gene or point mutations. Molecular basis of mutation: frame shift, transition, transversion and substitution. Mechanism of mutation induction: base replacement, base alteration, base damage, errors in DNA replication. Mutagens: physical - non-ionizing and ionizing radiations; chemical - base analogs, alkylating agents, deaminating agents.

PRACTICAL (36hrs)

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

MOLECULAR BIOLOGY (Theory 27 hrs; Practical 9 hrs)

Module 6: The genetic material (8 hrs) Molecular biology: a brief historical prelude. Identification of DNA as genetic material: direct evidences – transformation experiment by Avery *et al.*; Hershey and Chase Experiment. Evidences for RNA as genetic material in some viruses. Nucleic acids: DNA and RNA, important features of Watson and Crick model of DNA; Chargaff's rule. Alternate forms of DNA - comparison of A, B and Z forms. Structure and function of different types of RNA - tRNA, mRNA, rRNA, snRNA, miRNA.

Module 7: Replication of DNA (4 hrs) Semiconservative replication of DNA - Messlson and Stahl's experiment; process of semiconservative replication with reference to the enzymes involved in each step.

Module 8: Gene expression (8 hrs) Gene expression: concept of gene, split genes, one gene one enzyme hypothesis, one gene one polypeptide hypothesis, the central dogma, reverse transcription. Details of transcription in prokaryotes and eukaryotes; hnRNA, splicing, release of mRNA. Translation - initiation, elongation and termination. Genetic code and its features, wobble hypothesis.

Module 9: Regulation of gene expression (5 hrs) Regulation of gene expression in prokaryotes: operon concept, inducible and repressible systems, negative control and positive control. Lac operon, catabolic repression. Tryptophan operon, attenuation. Regulation in eucaryotes (brief account only).

Module 10: Genetics of cancer (2 hrs) Genetic basis of cancer – brief description of proto-oncogenes and oncogenes, tumour suppressor genes; characteristics of cancer cells.

PRACTICAL (9hrs)

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

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CO No.	Expected Course Outcome Upon completion of this course, the students will be able to	Cognitive Level	PSO No
1	Analyse the structure and function of cell and its components.	K4	1,4
2	Explain the mechanism of cell division.	K2	4
3	Analyse the consequence of ploidy and chromosomal aberrations.	K4	4
4	Explain mutation, its causes and significance.	K2	3,5
5	Understand the mechanism of gene regulation and expression.	K2	4
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.			

Core course 11 **Code: UG21BO6CR03**
ANGIOSPERM MORPHOLOGY, TAXONOMY AND ECONOMIC BOTANY
(Theory 72 hrs; Practical 45 hrs; Credits 3 + 1)

Objectives

- Acquaint with the aims, objectives and significance of taxonomy.
- Identify common species of plants growing in Kerala and their systematic position.
- Develop inductive and deductive reasoning ability.
- Acquaint with the basic technique in the preparation of herbarium.
- Familiarizing with the plants having immense economic importance.

ANGIOSPERM MORPHOLOGY

Module 1: Leaf, Inflorescence and Fruit morphology (13 hrs) Leaf Morphology: types, venation, phyllotaxy. Morphology of flower: flower as modified shoot; detailed structure of flowers - floral parts - their arrangement, relative position - symmetry, aestivation and placentation types - cohesion and adhesion. Floral diagram and floral formula. Inflorescence: racemose types - simple raceme, corymb, umbel, spike, spadix, head and catkin; cymose types - simple cyme; monochasial - scorpioid and helicoid, dichasial and

polychasial; special type - cyathium, hypanthodium, verticillaster, thyrsus and panicle. Fruits: simple - fleshy, dry - dehiscent, schizocarpic, indehiscent, aggregate, multiple (sorosis and syconus).

TAXONOMY

Module 2: Principles of Plant systematics (12 hrs)

Aim, scope, significance and components of taxonomy. Types of classification - artificial (brief account), natural – Bentham and Hooker (Detailed account) and Phylogenetic (Brief account). Angiosperm phylogeny group system (introduction only). Plant nomenclature - binomial, International Code of Nomenclature for algae, fungi and plants – Shenzhen Code 2017 (Brief account only) ICBN Principles - rule of priority and author citation. Interdisciplinary approach in taxonomy. Cytotaxonomy and Chemotaxonomy. Herbarium technique – importance of herbarium; preparation of herbarium and their preservation. Important herbaria in India, BSI.

Module 3: Detailed study of families (30 hrs) Study the following families of Bentham and Hooker's System with special reference to their vegetative and floral characters; special attention should be given to common and economically important plants within the families: Annonaceae, Nymphaeaceae, Malvaceae, Rutaceae, Anacardiaceae, Leguminosae (Mimosaceae, Caesalpiniaceae and Fabaceae), Combretaceae, Myrtaceae, Cucurbitaceae, Umbelliferae (Apiaceae), Rubiaceae, Compositae (Asteraceae), Sapotaceae, Apocynaceae, Asclepiadaceae, Solanaceae, Convolvulaceae, Scrophulariaceae, Acanthaceae, Verbenaceae, Labiatae (Lamiaceae), Amaranthaceae, Euphorbiaceae, Orchidaceae, Palmae (Arecaceae), Graminae (Poaceae).

ECONOMIC BOTANY AND ETHNOBOTANY (Theory 17 hrs; Practical 9 hrs)

Module 4: Economic botany (12 hrs) Study the following groups of plants with special reference to the botanical name, family and morphology of the useful part and uses: Cereals - Rice, Wheat; Millets Ragi; Pulses - Green gram, Bengal gram, Black gram; Sugar yielding plants – Sugarcane; Fruits - Apple, Pineapple, Orange, Mango and Banana; Vegetables - Bittergourd, Ladies finger, Carrot and Cabbage; Tuber crops - Tapioca; Beverages - Tea, Coffee; Oil yielding plants - Ground nut, Coconut, Gingelly; Spices – Cardamom, Pepper, Cloves, Ginger; Timber yielding plants - Teak wood and Rose wood; Fibre yielding plants - Coir, Jute, Cotton; Rubber yielding plants - Para rubber; Gums and Resins - White dammar, Gum Arabic, Asafoetida; Insecticide yielding Plants - Tobacco and Neem.

Module 5: Ethnobotany (5 hrs) Introduction, scope and significance of ethnobotany. Study of the following plants used in daily life by tribals and village folks for food, shelter and medicine: Food - *Artocarpus heterophyllus*, *Corypha*; Shelter - *Bambusa*, *Ochlandra* and *Calamus*; Medicine – *Curcuma longa*, *Trichopus zeylanicus* and *Alpinia galanga*.

PRACTICAL (45hrs)

1. Identify the following inflorescence and fruits with reference to their morphological specialities: (a) Inflorescence - simple raceme, spike, corymb, head, simple cyme, cyathium and hypanthodium. (b) Fruits - simple - (fleshy) - berry drupe, pepo, hesperidium. Dry indehiscent - nut. Dry dehiscent - legume, capsule (loculicidal). Aggregate.

2. Preparation of floral formula and floral diagram from floral description (of families studied).
3. Identify the families mentioned in the syllabus by noting their vegetative and floral characters.
4. Students must describe the floral parts, draw the L.S., floral diagram and write the floral formula of at least one flower from each family.
5. Prepare herbarium of 25 plants with field notes.
6. Conduct field work for a period of not less than 5 days under the guidance of a teacher and submit field report.
7. Study the finished products of plants mentioned in the syllabus of economic botany with special reference to the morphology of the useful part, botanical name and family.
8. Identify and describe the ethnobotanical uses of the items mentioned in the syllabus.

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CO No.	Expected Course Outcome Upon completion of this course, the students will be able to	Cognitive Level	PSO No
1	Acquaint with aims, objectives and significance of taxonomy.	K2	1
2	Categorize plants to their respective families on the basis of vegetative and floral characters.	K3	1,5
3	Outline nomenclature and classification and apply preservation techniques.	K2, K3	4,5
4	Evaluate the economic and ethnobotanical importance of plants.	K5	5
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.			

Core course 12

Code: UG21BO6CR04

BIOTECHNOLOGY AND BIOINFORMATICS

(Theory 54 hrs; Practical 36 hrs; Credits 3 + 1)

Objectives

- Understand the current developments in the field of Biotechnology and Bioinformatics.
- Equip the students to carry out plant tissue culture.
- Introduce the vast repositories of biological data knowledge.
- Equip to access and analyze the data available in the databases.

BIOTECHNOLOGY (36 hrs)

Module 1: Plant tissue culture (6 hrs) Biotechnology - an overview; plant tissue culture - basic concepts, totipotency, differentiation, de-differentiation and re-differentiation. Tissue culture media: components, role of plant growth regulators in tissue culture. Preparation of MS medium; sterilization of equipments, glassware and culture medium, surface sterilization of explants.

Module 2: Applications of plant tissue culture (10 hrs) Micropropagation, methods - axillary bud proliferation, adventitious regeneration – shoot organogenesis and somatic embryogenesis - direct and indirect; meristem culture. Stages of micropropagation, hardening and transplantation. Advantages and disadvantages of micropropagation - somaclonal variations. Embryo culture, callus and cell suspension culture, *in vitro* production of haploids - anther and pollen culture; uses of haploids. Protoplast culture: isolation of protoplast, culture methods, applications; protoplast fusion - cybrids. Artificial seeds, advantages and disadvantages. *In vitro* production of secondary metabolites; cell immobilization, bioreactors (brief study only).

Module 3: Recombinant DNA technology and its applications (10 hrs) Steps in rDNA technology, cloning vectors and their desirable properties; plasmids, cosmids, phage vectors, Phasmids, YAC and BAC; structure and applications of pBR322, M13 and Ti plasmid. Cutting and joining of DNA molecules - Restriction endonucleases and ligases - ligation techniques. Transformation and selection of transformants

- using antibiotic resistances markers and complementation. Achievements of recombinant DNA technology: in medicine (Human insulin and gene therapy); in agriculture – Bt cotton; in environmental cleaning - super bugs.

Module 4: Techniques in rDNA technology (10 hrs) DNA isolation, agarose gel electrophoresis, southern hybridization, autoradiography. DNA finger printing and its applications. PCR and its applications. DNA sequencing by Sanger's dideoxy method. Uses of refrigerated centrifuges, UV trans-illuminator, gel documentation system and Laminar Air Flow chamber (brief account only).

GENOMICS AND BIOINFORMATICS (18 hrs)

Module 5: Genomics (4 hrs) A brief account on genomics and proteomics; major findings of the following genome projects – *E. coli*, Human, *Arabidopsis thaliana*.

Module 6: Basic bioinformatics (7 hrs) An introduction to bioinformatics, objectives and applications of bioinformatics. Biological data bases: types - primary, secondary and composite databases; nucleotide sequence databases – NCBI (GenBank), EMBL, DDBJ; Protein Sequence databases - SWISS-PROT, PIR; Protein structure database – PDB; bibliographic database – PubMed.

Module 7: Sequence analysis and molecular phylogeny (7 hrs) Sequence analysis tools - BLAST and FASTA, Molecular visualisation tool - RASMOL (basic commands), Sequence alignment - Scoring matrices, global and local alignment, Pairwise and multiple sequence alignment; common software used in alignment - CLUSTAL W & CLUSTAL X. Molecular phylogeny - homologs, orthologs and paralogs; phylogenetic tree - rooted and unrooted tree, advantages of phylogenetic tree, use of PHYLIP software.

PRACTICAL (36 hrs)

1. Preparation of nutrient medium – Murashige and Skoog medium (Demonstration only).
2. Sterilization and inoculation of plant tissue in culture media.
3. Establishing shoot tip, axillary bud cultures (Demonstration only).
4. Immobilization of whole cells or tissues in sodium alginate.
5. Isolation of DNA from plant tissue.
6. Agarose gel electrophoresis of the isolated DNA (Demonstration only).
7. Familiarise the instruments included in the syllabus such as Autoclave, laminar air flow chamber, UV-trans-illuminator, PCR machine, Electrophoresis apparatus, centrifuge etc. and prepare short notes with diagrammatic sketch or photographs.
8. Familiarizing GENBANK, DDBJ, ENA, SWISS-PROT and PDB databases (Demonstration only).
9. Analysis of structural features of proteins using RASMOL.
10. Local alignment of sequences using BLAST (Demonstration only).
11. Retrieving a few research papers related to genetic engineering from PubMed (Demonstration only).

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CO No.	Expected Course Outcome Upon completion of this course, the students will be able to	Cognitive Level	PSO No
1	Explain with latest developments in the field of Biotechnology and Bioinformatics.	K2	3,4
2	Appraise the technique of tissue culture, its applications and limitations.	K2, K3	4,5
3	Analyse the biological data available in the databases.	K4	5
4	Utilize sequence analysis and molecular phylogeny tools.	K2	5
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.			

Programme elective course

Code: UG21BO6CB01

PHYTOCHEMISTRY AND PHARMACOGNOSY

(Theory: 54 hours; Credit 3)

Objectives

- Understand the structure and function of basic secondary metabolites in medicinal and aromatic plants.
- Familiarize with the common separation and characterization techniques used in phytochemistry
- Understand the basic officinal part present in the common medical plants and their use in ayurvedic formulations.

PHYTOCHEMISTRY

Module 1: Introduction (2 hrs) Introduction to phytochemical approaches: morphological, organoleptic, microscopic - to study drug and aromatic plants.

Module 2: Extraction of phytochemicals (4 hrs) Extraction and characterisation techniques: cold extraction, hot extraction - soxhlet-clevenger apparatus; Solvents - petroleum ether, chloroform, ethanol, water. Separation techniques - TLC, Column, HPLC. Characterization techniques - GC/MS, HPTLC, UV Spectra, IR Spectra.

Module 3: Effect of phytochemicals (10 hrs) 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, naphthoquinones, anthraquinone, and coumarins.

Module 4: Plants of importance (20 hrs) Study of the following plants with special reference to habit, habitat and systematic position and morphology of the useful part; organoleptic, anatomical and chemical evaluation of the officinal part; phytochemistry and major pharmacological action of plant drugs and ayurvedic formulations made using the plant: *Tinospora cordifolia*, *Papaver somniferum*, *Aegle marmelos*, *Punica granatum*, *Adhatoda vasica*, *Withania somnifera*, *Achyranthes aspera*, *Asparagus racemosus*, *Sida acuta*, *Carica papaya*, *Azadirachta indica*, *Phyllanthus niruri*, *Datura stramonium*, *Aloe vera*, *Tylophora indica*, *Acorus calamus*.

Module 5: Aromatic plants and their uses (10 hrs) Study of the following aromatic plants - volatile oils and methods of extraction *Vetiveria zizanoides*, *Cinnamomum zeylanicum*, *Syzygium aromaticum*, *Santalum album*, *Eucalyptus*, *Ocimum basilicum*, *Rosa*, *Mentha piperita*, *Cymbopogon*, *Cananga*, *Pelargonium*.

PHARMACOGNOSY

Module 6: Pharmacognosy (4 hrs) Introduction, tools for identifying adulteration; methods in pharmacognosy - microscopy, phytochemical methods - study of starch grains of maize, wheat, rice, potato, curcuma.

Module 7: Ethnomedicine (4 hrs) Traditional plant medicines as a source of new drugs – The process of modern drug discovery using ethnopharmacology – Taxol, Artemisinin, Galathamine and Flavopyridole as examples of drug discovery based on ethnopharmacological approach. Jeevani-Pushpangadan model of benefit sharing.

Suggested additional topics: 1. Basic principles in spectroscopy - UV, NMR, IR etc. 2. Use of secondary metabolites for protection against pathogens, herbivores.

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CO No.	Expected Course Outcome Upon completion of this course, the students will be able to	Cognitive Level	PSO No
1	Compare the extraction and separation techniques used in phytochemistry.	K2	3,4
2	Explain the structure and function of basic secondary metabolites in medicinal plants.	K2	3,4,5
3	Analyse organoleptic, anatomical and chemical characters of plant parts.	K4	3,4
4	Apply microscopy and phytochemical methods to identify plants from their adulterants	K2	4,5
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.			

Programme elective course

Code: UG21BO6CB02

AGRIBUSINESS
(Theory: 54 hours; Credit 3)

Objectives:

- Inculcate and impart an idea about the business opportunities in the field of plant sciences.
- Develop an entrepreneurial mindset and also to stick on to the core subject among the Botany students.
- Give an idea about the need of sustainable development and organic farming.
- Harness the opportunities and potentials in the field of ecotourism, processing technology and

food sciences.

Module 1: Entrepreneurship (2 hrs)

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

Module 2: Value added food products (8 hrs)

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

Module 3: Processing techniques (8 hrs)

Processing of latex: centrifuged latex products and galvanized rubber products. Processing, storage and marketing of Cocoa, Coconut (Copra, Coir and Tender coconut), Rice (par boiled, raw rice and rice flour), Pepper, Cardamom, Ginger, Arrowroot, Tapioca, Cashew, Mango, Jack fruit, Guava, Grapes, Lemon, Papaya, Musa, Garcinia.

Module 4: Nursery management (6 hrs)

Preparation of potting mixtures, polybags. Plant growing structures - green houses, shaded houses, polyshed, mist chamber, sprinkling system, drip irrigation. Modern strategies in propagation by root initiation of cutting, layering technique, budding and grafting technique; micropropagation. Planting,

transplanting and hardening of seedlings, after care of seedlings. Packing and transport of seedlings.

Module 5: Organic farming and composting techniques (6 hrs)

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

Module 6: Cultivation of vegetables, fruits and medicinal plants (6 hrs)

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

Module 7: Floriculture and Apiculture (6 hrs)

Floriculture: problems and prospects of floriculture in Kerala. Scope of growing Anthurium, Orchids and Jasmine in Kerala. Common cut flowers - Rose, Gerbera, Gladiolus, Aster, Chrysanthemum, Anthurium and Orchids. Common leaves used in flower arrangement - Cyprus, Podocarpus, Asparagus, Palms, Cycads and Ferns.

Apiculture: scope and significance. Structure, installation and maintenance of an Apiarium. Extraction, processing, preservation and marketing of honey.

Module 8: Flower arrangement (4 hrs)

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

Module 9: Ornamental garden designing (4 hrs)

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

Module 10: Mushroom cultivation and farming (4 hrs)

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

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Programme elective course

Code: UG21BO6CB03

PLANT GENETIC RESOURCES MANAGEMENT

(Theory: 54 hours; Credit 3)

Objectives:

- Acquaint the student with the history and evolution of crop plants, and their diversity.
- Familiarize the student with the available plant genetic wealth and the measures adopted for the conservation of these resources.
- Help the student to identify the crop plants and their wild relatives.
- Help the student to explore the potentialities of various underutilized plants to project as the future food prospects.
- Understand the significance of modern technology to locate the distribution of endangered species.

Module 1: Introduction (5 hrs)

Introduction - historical developments in crop botany, Centers of origin - Vavilovian concept - primary and secondary centers. Exploration and collection of genetic resources - importance of wild relatives of crop plants and their genetic diversity in crop improvement.

Module 2: Plant genetic resources (10 hrs)

Major threats to the genetic resources: human interference and deforestation, alien invasive plants, over exploitation of resources. Endemism and biodiversity hot spots. Conservation of genetic resources: in situ - biosphere reserves, national parks and wildlife sanctuaries; ex situ - in vivo - botanic gardens, field gene banks; in vitro - seed banks - short term, medium term and long term storage of seeds, tissue culture storage and cryopreservation.

Module 3: Study of biodiversity (5 hrs)

Remote sensing: principle, concept of remote sensing and components of remote sensing, application of remote sensing in conservation of endangered plants and habitat studies; IUCN - role and activities. Documentation of endangered and threatened plants - red data book.

Module 4: Ethnobotany and conservation (4 hrs)

Ethnobotany in relation to conservation of genetic resources: mythology and conservation of ecosystems, sacred groves and their role in the conservation of gene pool; taboos for conservation of selected plant species.

Module 5: Regulations and rules (4 hrs)

Role of Governmental and non-governmental organizations in plant genetic resource management; Governmental organizations - regional – TBGRI and KFRI; national - BSI and NBPGR; International – IPGRI (IBPGR) and ICRISAT; Non-Governmental Organizations - WWF and MNHS.

Module 6: Crop plants of Kerala (18 hrs)

Important Crop plants of Kerala - taxonomy and uses and cultivation of, food crops - Rice, Tapioca; Vegetables - Elephant foot yam, Cow pea, Bitter gourd; Spices. Ginger, Black pepper, Nutmeg, Cardamom; Medicinal plants - Vasaka, Aloe; Plantation crops – Rubber, Coffee; cashew, Coconut and Tea; Fruits - Banana, Pineapple and Mango.

Module 7: Unexploited and underutilized plants (9 hrs)

Underutilized plants and its importance for future food requirements. Botany and uses of the following under exploited edible plants - Vegetables - *Averrhoa bilimbi* (Bilimbi, Chemmeenpuli, Irumbampuli), *Averrhoa carambola* (Carambola apple, Chathurappuli), *Dioscorea esculenta* (Cherukizhangu, Nanakizhangu), *Canavalia gladiata* (Sword bean, Valpayar), *Psophocarpus tetragonolobus* (Winged bean, Chathurapayar), (Sessile joyweed), *Sauropus androgynus* (Velicheera, Chikurmanis, Sauropus), *Ipomoea turbinata* (Nithya Vazhuthana); Fruits; *Artocarpus heterophyllus* (Jack, Plavu, chakka), *Artocarpus hirsutus* (Anjili, Ayani, Wild jack), *Aporosa cardiosperma* (Vetti), *Spondias pinnata* (Ambazham, Hog plum), *Syzygium cumini* (Njara, Njaval, Black plum), *Flacourtia montana* (Kattuloovika). Millets - *Echinochloa crus-galli* (Barnyard grass, Indian Barnyard Millet).

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COMPLEMENTARY COURSES

B.Sc. BOTANY PROGRAMME SEMESTER –I COMPLEMENTARY COURSE –I UG21BO1CM01

CRYPTOGAMS, GYMNOSPERMS AND PLANT PATHOLOGY

(Theory: 36 hrs; Practical: 36 hrs)

(Theory credit 2 Practical Credit 1)

Objectives

- Acquire fundamental knowledge in plant science and to make the student to understand that Botany is an integral part of the human life and developments.
- Foster and encourage an attitude of curiosity, appreciation and enquiry of various life forms of plants.
- Understand the identifying characters of the different types included in the syllabus.
- Understand the diversity of plants with respect to Algae, Fungi, Lichens, Bryophytes, Pteridophytes and Gymnosperms.

CRYPTOGAMS (27 hrs)

Module 1: Algae (13 hrs)

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

Module 2: Fungi and lichens (9 hrs)

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

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

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

Module 3: Bryophytes (2 hrs)

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

Module 4: Pteridophytes (3 hrs)

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

Module 5: Gymnosperms (4 hrs)

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

PLANT PATHOLOGY (5 hrs)

Module 6: Plant diseases (5 hrs)

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

PRACTICAL

(36 hrs)

1. Micropreparation and identification preparation of the following:
 - (i) Algae: vegetative structure of Nostoc, Volvox, Spirogyra, Oedogonium, Cladophora, Polysiphonia. Vegetative and reproductive structure of Sargassum.
 - (ii) Fungi: vegetative and reproductive structure of Rhizopus, Xylaria, Puccinia.
 - (iii) Lichen: morphology of Usnea thallus and Apothecium.
 - (iv) Bryophytes: Riccia thallus anatomy.
 - (v) Pteridophytes: Selaginella - anatomy of stem and morphology of strobilus.
 - (vi) Gymnosperms: Cycas - Anatomy of leaflet, morphological features of megasporophyll, microsporophyll and ovule.
2. Identify plant diseases mentioned in the syllabus.

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CO No.	EXPECTED COURSE OUTCOME Upon completion of this course, the student will be able to	COGNITIVE LEVEL	PSO No
1	Appreciate various life forms of plants.	K2	1
2	Analyse the diversity of plants with respect to Algae, Fungi, Lichen, Bryophyte, Pteridophytes and Gymnosperms.	K5	1
3	Identify selected plant diseases and disease control measures.	K4	4,5
4	Summarize the economic importance of Algae, Fungi, Lichens, Bryophytes, Pteridophytes and Gymnosperms.	K2	2,5
5	Identify cryptogams and gymnosperms mentioned in the course.	K3	1,4
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.			

SEMESTER –II

COMPLEMENTARY COURSE –2

UG21BO2CM01

PLANT PHYSIOLOGY

(Theory 36 hrs; Practical 36 hrs)

(Theory Credits 2, Practical credit 1)

Objectives:

- Make the students realize the importance of physiological processes which take place in plants.
- Understand the mechanism of various physiological processes related to plant life.

Module 1: Water relations (11 hrs)

Plant water relations: Physical aspects of water absorption - Diffusion, DP, DPD. Imbibition. Osmosis - OP, Exosmosis, Endosmosis, Plasmolysis. Water potential and its components. Mechanism of water absorption by root - active and passive absorption. Movement of water towards xylem by apoplast and symplast pathway. Ascent of sap – theories - transpiration pull theory, root pressure theory; guttation. Transpiration: types, mechanism of transpiration and stomatal movement (K⁺ - ABA theory), significance and factors affecting transpiration, antitranspirants.

Module 2: Mineral nutrition (4 hrs)

General account on Micro and macro nutrients. Absorbable form, function and deficiency symptoms of the following mineral nutrients: N, P, K, Mg, B, Fe, Zn.

Module 3: Photosynthesis and translocation of photosynthate (15 hrs)

Basic requirements of Photosynthesis: Light - PAR; organs and site of photosynthesis; chloroplast. Photosynthetic pigments, photosynthetic unit; red drop and Emerson's enhancement effect; two pigment systems. Mechanism of photosynthesis: light dependent reaction - cyclic and non-cyclic photo phosphorylation. Light independent reaction (dark reactions) C₃ cycle, brief account on C₄ and CAM Cycles. Factors affecting photosynthesis. Photorespiration (brief study only). Translocation of photosynthate and organic solutes: path of translocation, mechanism of translocation (Pressure Flow Hypothesis).

Module 4: Growth and Development (6 hrs)

Seed dormancy - causes of seed dormancy - methods of breaking dormancy. Germination of seeds - physiological changes. Growth: Phases of growth, plant growth regulators - auxins, gibberellins, cytokinins, abscissic acid and ethylene and their physiological role (brief study only). Photoperiodism - definition, short day plants, long day plants, day neutral plants. Vernalization.

PRACTICAL (36 hrs)

Core Experiments:

1. Demonstration of osmosis using potato tuber osmoscope/Papaya petiole osmoscope.
2. Separation of leaf pigments by paper chromatography.
3. Compare the stomatal indices of hydrophytes and xerophytes.

Demonstration experiments:

1. Measure the rate of transpiration by Ganong's potometer.
2. Relationship between transpiration and absorption.
3. Measurement of growth using Arc Auxanometer.

4. Demonstration of geographic curvature using Clinostat.
5. Evolution of oxygen during photosynthesis.
6. Mohl's half leaf experiment.
7. Light screen experiment.

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CO No.	EXPECTED COURSE OUTCOME Upon completion of this course, the student will be able to	COGNITIVE LEVEL	PSO No
1	Summarize the plant water relations.	K2	2,5
2	Explain the mineral nutrition in plants.	K2	2,3
3	Appraise the mechanism of various physiological processes in plants.	K2	5
4	Acquire basic knowledge about growth and development in plants.	K2	4,5
5	Develop skills to carry out plant physiology experiments.	K6	3,4
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.			

SEMESTER –III

COMPLEMENTARY COURSE 3

(Theory 54 hrs; Practical 36 hrs)

UG21BO3CM01

(Theory Credits 3 Practical credit 1)

ANGIOSPERM TAXONOMY AND ECONOMIC BOTANY

Objectives

- Acquaint the student with the objectives and components of Taxonomy.
- Help the student to understand the systems of classification of angiosperms.
- Help the student to identify the common angiosperm species of Kerala.
- Familiarize the student with plants of immense economic importance.

ANGIOSPERM TAXONOMY (36 hrs)

Module 1: Morphology (10 hrs)

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

Module 2: Plant classification and Herbarium techniques (8 hrs)

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

Module 3: Angiosperm families (18 hrs)

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

ECONOMIC BOTANY (18 hrs)

Module 4: Classes of economically important plants (10 hrs)

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

Module 5: Medicinal plants (8 hrs)

Study of the following medicinal plants with special reference to their binomial, family, morphology of useful parts and uses: *Adhatoda*, *Aloe*, *Bacopa*, *Catharanthus*, *Eclipta*, *Neem*, *Ocimum*,

Phyllanthusamarus, Rauwolfia, Sida

PRACTICAL (36 hrs)

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

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CO No.	EXPECTED COURSE OUTCOME Upon completion of this course, the student will be able to	COGNITIVE LEVEL	PSO No
1	Explain the plant morphological terminologies.	K2	1,2
2	Appraise the system of angiosperm classification and nomenclature.	K5	1
3	Demonstrate herbarium technique.	K2	5
4	Identify common plants up to their families on the basis of key characters.	K1, K3	1
5	Evaluate the medicinal and economic importance of selected angiosperms.	K5	5
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Appling; K4-Analyzing; K5-Evaluating; K6-Creating.			

SEMESTER –IV

COMPLEMENTARY COURSE 4

UG21BO4CM01

ANATOMY AND APPLIED BOTANY

(Theory 54 hrs; Practical 36 hrs)

(Theory Credits 3, Practical credit 1)

Objectives

- Understand different types of plant tissues.
- Understand the internal structure of different plant organs with reference to their functions.
- Understand the process of normal and anomalous secondary thickening in plants.
- Know the morphological and anatomical adaptations of plants growing in different habitats.
- Understand how botanical knowledge could be applied for crop improvement.

PLANT ANATOMY (27 hrs)

Module 1: Cells and tissues (9 hrs)

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

Module 2: Anatomy of plant organs (12 hrs)

Primary structure of stem and root in dicots and monocots; anatomy of monocot and dicot leaf. Secondary thickening in dicot stem and dicot root, heart wood and sap wood; tyloses; hard wood and soft wood; growth rings, dendrochronology. Anomalous secondary thickening in *Bignonia*.

Module 3: Ecological anatomy (6 hrs)

Study of the morphological and anatomical adaptations of the following groups: Hydrophytes – *Nymphaea*, Hydrilla; Xerophytes – *Nerium*; Epiphytes - *Vanda*.

APPLIED BOTANY: Plant breeding, Horticulture and Micropropagation (27 hrs)

Module 4: Plant breeding (12 hrs)

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

Module 5: Artificial vegetative propagation methods (5 hrs)

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

Module 6: Plant tissue culture (10 hrs)

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

PRACTICAL (36 hrs)

1. Primary structure of stem and root of dicots and monocots; Dicot stem - *Centella*; Monocot stem – Bamboo, grass, asparagus; Dicot root - *Tinospora*; Monocot root - *Colocasia*, *Musa*.

2. Structure of dicot stem and dicot root after secondary thickening; Stem - Vernonia, Eupatorium; Root - Tinospora, Papaya.
3. Anomalous secondary thickening in *Bignonia*.
4. Anatomical adaptations of Hydrophytes – *Nymphaea* petiole, *Hydrilla* stem; Xerophytes – *Nerium* Leaf; Epiphytes - Velamen root of *Vanda*.
5. Emasculation of pea or *Caesalpinia* flower.
6. Demonstrate T and patch budding.
7. Demonstration of tissue culture techniques: culture media, surface sterilization and inoculation of explants.
8. Identification of non-living inclusions - cystolith, raphides.

REFERENCES

1. Christopher E P, 1958. *Introductory Horticulture*. McGraw – Hill, New York.
2. Esau K, 1965. *Plant Anatomy*. Wiley, New York.
3. Fahn A, 1985. *Plant Anatomy*. Pergamon Press, Oxford.
4. Hartman H T, 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.
7. Vasishta V C, 1978. *Plant Anatomy*. S Nagin and Company, Jalandhar.

CO No.	EXPECTED COURSE OUTCOME Upon completion of this course, the student will be able to	COGNITIVE LEVEL	PSO No
1	Classify different types of plant tissues	K4	1
2	Analyse the internal structure of different plant organs	K4	4
3	Compare the process of normal and anomalous secondary thickening in plants.	K2	2,4,5
4	Compare the morphological and anatomical adaptations of plants growing in different habitats.	K4	2,4,5
5	Explain the application of breeding techniques in crop improvement.	K2	4,6
Knowledge Levels: K1-Remembering; K2-Understanding; K3-Applying; K4-Analyzing; K5-Evaluating; K6-Creating.			

PROJECT REPORT GUIDELINES

All students are to do a project in the area of core course. This project can be done individually or in groups (not more than five students) for all subjects which may be carried out in or outside the campus. Special sanction shall be obtained from the Principal to those new generation programmes and programmes on performing arts where students have to take projects which involve larger groups. The projects are to be identified during the II semester of the programme with the help of the supervising teacher. The report of the project in duplicate is to be submitted to the department at the sixth semester and are to be produced before the examiners (Internal and External) appointed by the Controller of Examinations. External Project evaluation and Viva / Presentation is compulsory for all subjects and will be conducted at the end of the programme.

For Projects

a) Marks of External Evaluation :80

b) Marks of Internal Evaluation : 20

Components of External Evaluation of Project	Marks
Dissertation (External)	50
Viva – Voce (External)	30
Total	80

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

*Components of Internal Evaluation of Project	Marks
Punctuality	5
Experimentation/Data collection	5
Knowledge	5
Report	5
Total	20

MODEL QUESTION PAPERS

MAR ATHANASIUS COLLEGE (AUTONOMOUS) KOTHAMANGALAM

B.Sc. BOTANY C.B.C.S DEGREE EXAMINATION

Semester I

UG21BO1CR01

METHODOLOGY OF SCIENCE AND AN INTRODUCTION TO BOTANY

Time: 3 hours

Maximum marks: 60

PART A

(Answer any 10 questions. Each question carries 1 mark each)

1. What is a prokaryote?
2. Who proposed Theory of chemical evolution of life?
3. What are lichens?
4. What is a theory?
5. Define Hypothesis
6. Who proposed two kingdom classification?
7. What are Co-ascervates?
8. What are Methanogens?
9. Define Science
10. What is a mycelium?
11. What is a control?
12. Which group of plant is known as “Amphibians of Plant kingdom”? **(10x1=10)**

PART B

(Answer any 6 questions. Each question carries 5 marks each)

13. Explain three domain six kingdom classification.
14. Explain theory of biogenesis and abiogenesis.
15. Write down the salient characters of fungi.
16. Explain the modes of nutrition in bacteria.
17. Write differences between Inductive and Deductive reasoning.
18. Describe the major events in Coenozoic era.
19. What are fossils? Explain the major types of fossils.
20. Differentiate Null and Alternate hypothesis.
21. Describe the important features of algae. **(6x5=30)**

PART C

(Answer any 2 questions. Each question carries 10 marks each)

22. Write an essay on the five kingdom classification of the living world
 23. Explain Urey and Miller experiment with diagram.
 24. Give an account on cell structure and flagellation in bacteria.
 25. Write down the major events in each era in geological time scale. **(2x10=20)**
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MAR ATHANASIOUS COLLEGE (AUTONOMOUS), KOTHAMANGALAM
B.Sc. DEGREE (C.B.C.S) EXAMINATION
Semester II **UG21BO2CR01**
Core Course – MICROBIOLOGY, MYCOLOGY AND PLANT PATHOLOGY

Time: 3 hours

Maximum marks: 60

Part A

(Answer any ten questions. Each question carries 1 mark.)

1. What is hyphae?
2. What is the genetic material of TMV?
3. Define nucleoid.
4. Name a symbiotic nitrogen fixing bacteria.
5. What are mesosomes.
6. Name the lichen known as reindeer moss.
7. What is plasmid?
8. What are saprophytes?
9. What is virion?
10. What is pleomorphic bacteria?
11. Name the causative organism of root wilt of coconut?
12. Give two examples for fungi producing toxins.

(10x1=10)

Part B

(Answer any six questions. Each question carries 5 marks.)

13. Explain lytic cycle in virus.
14. Write a note on the economic importance of lichens.
15. Explain Bacteriophage with structure.
16. Differentiate between Gram positive and Gram negative bacteria
17. Classification of bacteria based on flagellation.
18. Give an account on Defense mechanism in plants?
19. Explain the internal structure of parmelia.
20. Describe different types of lichens based on external structure.
21. Write the symptoms of Abnormal leaf fall of Rubber.

(6x5=30)

Part C

(Answer any two questions. Each question carries 10 marks)

22. Write an essay on the economic importance of fungi.
23. Explain lytic and lysogenic cycle in lambda phage.
24. Give an account on the classification of Fungi by Ainsworth.
25. Write an essay on Applied microbiology.

(10x2=20)

MAR ATHANASIVS COLLEGE(AUTONOMOUS) KOTHAMANGALAM

B.Sc. BOTANY C.B.C.S DEGREE EXAMINATION

Semester III

UG21BO3CR01

PHYCOLOGY AND BRYOLOGY

Time: 3 hours

Maximum marks: 60

PART A

(Answer any 10 questions. Each question carries 1 mark each)

- 1.What are elators?
- 2.What is Aegagrophilous species?
- 3.Name an aquatic bryophyte.
4. What are Stoneworts?
5. Which group of plants are known as ‘amphibians of plant kingdom’?
- 6.Differentiate Pennales and Centrales.
7. What are liverworts?
- 8.What is Nannandrium?
- 9.Reserve food material in Bacillariophyceae is.....
- 10.Differentiate smooth and pegged rhizoid.
- 11.What is Haplostephanous condition?
- 12.What is fragmentation.

(10x1=10)

PART B

(Answer any 6 questions. Each question carries 5 marks each)

- 13.Explain the structure of globule and nucule with the help of suitable diagram.
- 14.Explain the structure of Funaria capsule.
- 15.Explain the characters of Bacillariophyceae.
16. Explain the morphology and anatomy of *Riccia* thallus.
- 17.Describe the cell structure of *Cladophora* with the help of suitable diagram.
18. Write down the vegetative reproductive methods in *Anthoceros*?
- 19.Explain the reproductive structures of *Vaucheria* with suitable diagrams.
20. Explain the structure of antheridiophore and archegoniophore of *Marchantia*.
- 21.Describe the macrandrous type of sexual reproduction in *Oedogonium*.

(6x5=30)

PART C

(Answer any 2 questions. Each question carries 10 marks each)

22. Explain the structure of *Anthoceros* sporophyte and point out its advanced characters.
- 23.Explain the reproduction in *Chara* with suitable diagram.
- 24.Explain the general characters of Bryophytes.
- 25.Explain reproduction in *Volvox* with the help of diagrams.

(10x2=20)

MAR ATHANASIOUS COLLEGE(AUTONOMOUS) KOTHAMANGALAM
B.Sc. BOTANY C.B.C.S DEGREE EXAMINATION
Semester IV Core Course 4 UG21BO4CR01
PTERIDOLOGY, GYMNOSPERMS AND PALEOBOTANY

Time: 3 hours

Maximum marks: 60

Part A

(Answer any ten questions. Each question carries 1 mark each)

1. Name an aquatic fern.
2. Which plant is known as 'horse tail'?
3. What is exoscopic embryo?
4. What are trabeculae?
5. Name the type of stele found in the *Lycopodium cernuum*.
6. What is a ligule?
7. Give an example of resurrection plant
8. Which is the alga found in coralloid roots of *Cycas*?
9. Name a gymnosperm with vessels.
10. Differentiate eusporangiate and Leptosporangiate development
11. What is circinate vernation?
12. What is transfusion tissue? (10x1=10)

Part B

(Answer any six questions. Each question carries 5 marks)

13. Briefly describe the salient features of Pteridophytes.
14. Explain the structure of *Psilotum* synangium with diagram.
15. Discuss the various views regarding the morphology of rhizophore of *Selaginella*.
16. Explain the structure of *Pinus* needle with the help of a diagram.
17. Write down the Pteridophyte classification by Smith.
18. Draw a neat labelled diagram of T.S of *Cycas* leaflet and explain its structure.
19. Explain the different types of gametophytes in *Lycopodium*.
20. Explain the structure of megasporophyll and microsporophyll of *Cycas*.
21. Describe the structure of *Pteris* petiole with the help of a labelled diagram. (4x5=20)

Part C

(Answer any two questions. Each question carries 10 marks)

22. Explain heterospory with the help of a type studied by you.
23. Explain the general characters of Gymnosperms.
24. Explain the different types of fossils.
25. Explain the structure and reproduction in *Gnetum* pointing out its advanced features. (1x10=10)

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MAR ATHANASIOUS COLLEGE (AUTONOMOUS), KOTHAMANGALAM

B.Sc. BOTANY C.B.C.S DEGREE EXAMINATION

Semester V

UG21BO5CR01

ANATOMY, REPRODUCTIVE BOTANY AND MICROTECHNIQUE

Time: 3 Hours

Max. Marks: 60

PART - A

(Answer any ten questions. Each question has 1 mark)

1. What is dendrochronology?
2. Differentiate between lamellar and angular collenchyma.
3. What is apposition?
4. What is double fertilization?
5. Briefly explain maceration.
6. What is the use of a sledge microtome?
7. Name a mounting medium.
8. What are lenticels?
9. Comment on double staining.
10. What are laticifers?
11. Differentiate between heart wood and soft wood.
12. What are mordants?

(10×1=10 marks)

PART - B

(Answer any six questions. Each question has 5 marks)

13. Differentiate between campylotropous and circinotropous ovules.
14. Describe the different types of vascular bundles with the help of suitable diagrams.
15. Explain the structure of dicot embryo with the help of a diagram.
16. Describe the different types of stomata with examples.
17. What is a monosporic embryosac? Explain its structure and development.
18. What is placentation? Explain any four types of placentation.
19. Explain the different theories on apical organization.
20. Draw a neat labelled diagram showing anomalous secondary thickening in *Boerhaavia* stem.
21. Middle lamella is not considered a true cell wall. Explain.

(6×5=30 marks)

Part - C

(Answer any two questions. Each question carries 10 marks)

22. Explain anomalous secondary thickening in Bignonia stem.
23. Explain the structure of an anther with the help of a diagram.
24. Give an account on staining and the steps involved in double staining.
25. Explain the different types of endosperm.

(2×10 =20 marks)

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MAR ATHANASIUS COLLEGE, KOTHAMANGALAM (AUTONOMOUS)

**B.Sc. BOTANY C.B.C.S DEGREE EXAMINATION
SEMESTER V UG21BO5CR02**

Core Course – RESEARCH METHODOLOGY, BIOPHYSICS AND BIOSTATISTICS

Time: 3 hours

Maximum marks: 60

Part - A

(Answer any ten questions. Each question carries 1 mark)

1. How do you sort and filter data in MS excel?
2. Define qualitative data.
3. What is Biostatistics?
4. What are journals?
5. Define magnification.
6. What is centrifuge?
7. Name two national journals.
8. What do you mean by identification of research problem?
9. Define mode.
10. What are measures of dispersion?
11. Give any two uses of compound microscope.
12. What is pie diagram?

(10x1=10)

Part - B

(Answer any six questions. Each question carries 5 marks)

13. Write a short note on open sources and free alternatives to MS Office.
14. Explain INFLIBNET.
15. Write a short note on standard deviation.
16. Give detailed account of haemocytometer.
17. Write short note on formatting tools in MS Word.
18. Briefly explain a) mean b) frequency curve.
19. Explain the principle, working and applications of colorimeter.
20. Write a short note on graphical representation of data.
21. How to carry out statistical analysis in MS Excel?

(6x5=30)

Part - C

(Answer any two questions. Each question carries 10 marks)

22. What is microscopy? Add note on electron microscopy.
23. Write an essay on use of computer in research.
24. Write an essay on Sampling techniques.
25. How to make a presentation on the topic Pollution?

(10x2=20)

MAR ATHANASIUS COLLEGE (AUTONOMOUS), KOTHAMANGALAM
B.Sc. BOTANY C.B.C.S DEGREE EXAMINATION

Semester V

UG21BO5CR03

PLANT PHYSIOLOGY AND BIOCHEMISTRY

Time: 3 hrs

Maximum: 60 marks

Part A

Answer any 10 questions. Each question carries 1 mark

1. A plasmolysed cell and tissue can be deplasmolysed by putting it in.....
2. Explain DPD.
3. Name any two anti-transparents.
4. What is root pressure?
5. Explain the role of magnesium and phosphorous.
6. What is hydroponics?
7. Explain the role of Abscisic acid in stomatal movement.
8. What are enzymes?
9. What is plasmolysis?
10. Why are enzymes known as biological catalysts?
12. What are lipids?

(10x1=10)

Part B

Answer any six questions. Each question carries 5 marks

13. Differentiate between OP and TP
14. Explain apoplastic and symplastic pathway.
15. Differentiate active and passive absorption.
16. Distinguish micro and macroelements.
17. Explain the physiological role of auxins.
18. Explain the role of root hairs in plant life.
19. What is pH?
20. Explain vernalisation?
21. What are phytochromes?

(6x5=30)

Part C

Answer any two questions. Each question carries 10 marks.

22. Explain the mechanism of water absorption by plants.
23. Differentiate micro and macro nutrients. Explain the roles and deficiency symptoms.
24. Give an account on Role of proteins.
25. Give an account on plant response towards abiotic stress.

(2x10=20)

MAR ATHANASIUS COLLEGE (AUTONOMOUS), KOTHAMANGALAM

B.Sc. BOTANY C.B.C.S DEGREE EXAMINATION
Semester V **UG21BO5CR04**
Core Course – ENVIRONMENTAL SCIENCE AND HUMAN RIGHTS

Time: 3 hours

Maximum marks: 60

Part -A

(Answer any ten questions. Each question carries 1 mark.)

1. What is commensalism?
2. Expand NEERI.
3. What is a food chain?
4. What is endemism?
5. What is edge effect?
6. List out the major contributions of Medha Patkar in environmental protection.
7. What are keystone species?
8. Write a short note on WWF.
9. What are ecads?
10. Describe JFM.
11. What is ecological niche?
12. Give name of the NGO founded by Anil Agarwal. **(10x1=10)**

Part - B

(Answer any six questions. Each question carries 5 marks.)

13. Write note on ecological pyramids.
14. Briefly explain the legal provisions for environmental protection in India.
15. Write a short note on Survivorship curve.
16. Differentiate primary productivity and secondary productivity.
17. Write a note on contributions of Salim Ali in conservation of biodiversity.
18. Briefly explain productivity of an ecosystem.
19. Give an account on morphological and anatomical adaptations of hydrophytes to environment.
20. Write a short note on concept of climax in succession.
21. Discuss the role of Chipko movement in conservation. **(6x5=30)**

Part - C

(Answer any two questions. Each question carries 10 marks)

22. Explain biogeochemical cycle with any two examples.
23. Give an account on conservation efforts at global level and their contributions.
24. Write an essay on Succession, its different stages, causes and types.
25. Describe the various strategies for biodiversity conservation **(10x2=20)**

MAR ATHANASIUS COLLEGE(AUTONOMOUS), KOTHAMANGALAM
CBCS DEGREE EXAMINATION

Semester V

UG21BO5OC01

OPEN COURSE

HORTICULTURE AND NURSERY MANAGEMENT

Time: 3 hrs

Total Marks: 80

Part - A

Answer any 10 out of 12 questions. 2 marks for each question.

1. What do you mean by eradication?
2. What is micropropagation?
3. Name any 2 garden foes.
4. What is seed dormancy?
5. Name any 2 dusting equipments involved in controlling horticultural pests.
6. What is scion?
7. What are the ingredients of neem tobacco decoction?
8. What is an autoclave?
9. Define Mowing.
10. What is embryogenesis?
11. What is fumigation?
12. Name different types of budding.

(10x2 = 20)

Part - B

Answer any 8 out of 9 questions. 5 marks for each question.

13. Briefly explain hazards of chemical pesticides.
14. Write a short note on seed testing.
15. Give an account on Garden friends.
16. Write a short note on layering.
17. Define micropropagation. Write down its advantages and disadvantages.
18. Write a short note on eradication of weed control.
19. What are the management practices for proper care and management of seedlings.
20. Write a short note on Herbicides.
21. Write a short note on preparation of nursery.

(8x5 = 40)

Part - C

(Answer any two questions. Each question carries 10 marks)

22. Give an account on ornamental gardens.
23. Give a detailed account on use of herbicides.
24. Give an account on dry flower arrangements.
25. Define soil. Describe the various components of soil add note on the process of soil formation.

(10x2 = 20)

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MAR ATHANASIUS COLLEGE, KOTHAMANGALAM (AUTONOMOUS)

B.Sc. BOTANY C.B.C.S DEGREE EXAMINATION
Semester – VI **UG21BO6CR01**
Core Course – GENETICS, PLANT BREEDING AND HORTICULTURE

Time: 3 hours

Maximum marks: 60

Part A

(Answer any ten questions. Each question carries 1 mark)

1. Define multiple allelism.
2. Write any 2 roles of tissue culture in the creation of transgenic plants.
3. Name any 2 plant breeding centers in Kerala.
4. What are quantitative characters?
5. Write down any 2 characteristics required for Bonsai containers.
6. What are complementary genes?
7. What are holandric genes?
8. What is double crossing over?
9. Define backcross.
10. Define terrarium.
11. What is meant by intergeneric hybridization?
12. What is meant by cutting in plant propagation? **(10x1=10)**

Part B

(Answer any six questions. Each question carries 5 marks)

13. Briefly explain the merits and demerits of plant introduction.
14. Mention sex linked abnormalities in man.
15. Why is pruning done? Explain the different methods of pruning and training?
16. Distinguish between complete and incomplete linkage.
17. Briefly explain ornamental gardens.
18. Briefly explain polygenic inheritance with examples.
19. What is Hardy- Weinberg law?
20. Write down the procedure for mutation breeding.
21. What is linkage map? How is it constructed? **(6x5=30)**

Part C

(Answer any two questions. Each question carries 10 marks)

22. Give an account on the chromosomal basis of sex determination with suitable examples.
23. Describe a) Green house b) Orchidarium c) Conservatory.
24. Illustrate with suitable examples explain extra nuclear inheritance.
25. Briefly describe pureline selection, its procedure, merits and demerits. **(10x2=20)**

MAR ATHANASIOUS COLLEGE(AUTONOMOUS) KOTHAMANGALAM
B.Sc. BOTANY C.B.C.S DEGREE EXAMINATION

Semester VI

CORE COURSE 10

UG21BO6CR02

CELL AND MOLECULAR BIOLOGY

Time: 3 hours

Maximum marks: 60

Part -A

(Answer any 10 questions. Each question carries 1 mark)

1. Why is mitosis called equational division?
2. What is an Idiogram?
3. Name the ribosome binding site of prokaryotes.
4. Explain Wooble hypothesis.
5. What are allosomes?
6. Explain the central dogma of molecular biology.
7. Explain secondary constriction.
8. What is meant by chromonema?
9. Explain Chargaff's rule.
10. Explain Nucleolar Organizer Region.
11. Define split gene concept.
12. Explain the role of rho protein in prokaryotes.

(10x1=10)

Part - B

(Answer any 6 questions. Each question carries 5 marks)

13. Explain the different types of chromosomes.
14. Explain the negative control of Lac operon.
15. Give an account on nucleosome model of chromosomes.
16. Write a note on nuclear pore complex.
17. Write note on any 5 proteins involved in replication.
18. Give an account on Messelson and Stahl's experiment.
19. Differentiate between Euchromatic and Heterochromatic chromosomes
20. Explain briefly; a) DNA damage checkpoint (b) CDK
21. What are transposons? Write a brief account on the types of transposons.

(6x5=30)

Part - C

(Answer any 2 question. Each question carries 10 marks)

22. Describe the process of mRNA processing.
23. Explain Genetic code and its features.
24. Briefly describe the different stages of meiosis along with its significance.
25. What are cell-cycle checkpoints? Describe the principal checkpoints in the cell cycle. **(2x10=20)**

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MAR ATHANASIOUS COLLEGE (AUTONOMOUS), KOTHAMANGALAM
B.Sc. BOTANY C.B.C.S DEGREE EXAMINATION
Semester VI

CORE COURSE 11

UG21BO6CR03

ANGIOSPERM MORPHOLOGY, TAXONOMY AND ECONOMIC BOTANY

Time: 3 hours

Maximum marks: 60

Part A

(Answer any ten questions. Each question carries 1 mark each)

1. List out any two primitive characters of Annonaceae.
2. Write the binomial of any two pulses.
3. What is papilionaceous corolla?
4. Write the binomial of any *two* spices.
5. Write the binomial of an ornamental plant of Asteraceae.
6. Name any two medicinal plants in Combretaceae.
7. What is a spirocyclic flower?
8. What is a regma? Give an example.
9. What is the typical fruit of Compositae?
10. Explain the type of fruit in Coconut.
11. What is the binomial of Potato?
12. What is gynostegium?

(10x1=10)

Part B

(Answer any six questions. Each question carries 5 marks)

13. Draw and explain the floral diagram of Malvaceae.
14. Compare the families Cucurbitaceae and Myrtaceae.
15. Explain the economic importance of Rutaceae.
16. Describe the key diagnostic characters of Annonaceae.
17. Write the binomial and family of Sweet potato, Aswagandha, Cumin, Quinine and Black gram.
18. Explain stipules in Rubiaceae.
19. Compare the reproductive structures of Apocyanaceae and Asclepiadaceae.
20. Explain adnation in Solanaceae.
21. What is a capsule? Explain different types of capsules.

(6x5=30)

Part C

(Answer any two questions. Each question carries 10 marks)

22. Explain Bentham and Hooker's system of classification pointing out its merits and demerits.
23. Give an account of the subfamilies of Leguminosae.
24. Justify the position of Asteraceae in Bentham and Hooker's system of classification.
25. Explain the different types of dry indehiscent fruits?

(2x10=20)

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MAR ATHANASIUS COLLEGE (AUTONOMOUS), KOTHAMANGALAM
B.Sc. BOTANY C.B.C.S DEGREE EXAMINATION
SIXTH SEMESTER

CORE COURSE 12

UG21BO6CR04

Core Course – BIOTECHNOLOGY AND BIOINFORMATICS

Time: 3 hours

Maximum marks: 60

Part A

(Answer any ten questions. Each question carries 1 mark.)

1. Expand DDBJ.
2. Distinguish between pairwise and multiple sequence alignment.
3. Give two examples for restriction endonuclease enzymes.
4. Define a database.
5. What are phylogenetic trees?
6. What are palindromic sequences?
7. Name the tracking dye used in agarose gel electrophoresis.
8. What is sequence alignment?
9. Name any two nucleotide sequence databases.
10. What are shuttle vectors?
11. Distinguish between orthologs and paralogs.
12. What is the use of uv transilluminator?

(10x1=10)

Part B

(Answer any six questions. Each question carries 5 marks.)

13. What are biological databases? Explain its various types.
14. Write a note on restriction endonucleases.
15. Give an account on scoring matrices.
16. Write a short note on laminar air flow chamber.
17. What is the role of ligase enzyme in rDNA technology? Explain
18. Distinguish between BLAST and FASTA.
19. Discuss the applications of pollen culture.
20. Write a short note on Rasmol.
21. Briefly explain the working of PCR.

(6x5=30)

Part C

(Answer any two questions. Each question carries 10 marks)

22. Give a detailed account on various vectors used in recombinant DNA technology.
23. What is bioinformatics? Add note on its objectives and applications.
24. Describe the process of protoplast culture and its applications.
25. Write an essay on Sangers sequencing.

(10x2=20)

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MAR ATHANASIOUS COLLEGE (AUTONOMOUS), KOTHAMANGALAM
B.Sc. DEGREE (C.B.C.S) EXAMINATION
SIXTH SEMESTER

CHOICE BASED COURSE 01

UG21BO6CB01

PHYTOCHEMISTRY AND PHARMACOGNOSY

Time: 3 hours

Maximum marks: 80

Part A

(Answer any ten questions. Each question carries 2 mark.)

1. What is hot extraction?
2. What are the properties of a good solvent in plant extraction?
3. What is separation efficiency?
4. Define Beer- Lambert's Law.
5. Expand HPTLC.
6. Write any four function of Triterpenoids in plants?
7. What are the methods used for the extraction of *Ocimum bacilicum*?
8. Name three naturally occurring naphthoquinones.
9. Define adulteration.
10. Differentiate between ethnomedicine and pharmacognosy.
11. What are the uses of menthol?
12. Write the scientific name of *Vetiver*. Give any two uses of it. **(10 x 2 = 20)**

Part B

(Answer any eight questions. Each question carries 5 marks.)

13. Write a note on habit and habitat of *Tinospora cordifolia*.
14. Explain steam distillation process of clove oil.
15. Explain the ayurvedic formulations of *Aloe vera*.
16. Write a short note on superficial fluid extraction of CO₂ from *Rosa*.
17. List out the physical properties of volatile oils.
18. What are the uses of the drugs galathamine and flavipyrindole?
19. Explain the microwave distillation method of extraction of essential oil from *Santalum album*.
20. Why do plants produce volatile oils? Write its composition.
21. Explain the significance of taxol and artemisinin. **(8 x 5=40)**

Part C

(Answer any two questions. Each question carries 10 marks)

22. Write an essay on principle and working of TLC, Column chromatography and HPLC.
23. Give an account on the Benefit- Sharing model.
24. Give a brief sketch of types of adulterants.
25. Explain the properties, classification and pharmacological uses of alkaloids. **(10x2=20)**

MAR ATHANASIUS COLLEGE (AUTONOMOUS), KOTHAMANGALAM
B.Sc. DEGREE (C.B.C.S) EXAMINATION
Semester I

Complementary Course I

UG21BO1CM01

CRYPTOGAMS, GYMNOSPERMS AND PLANT PATHOLOGY

Time: 3 hours

Maximum marks: 60

PART A

(Answer any 10 questions. Each question carries 1 mark each)

1. *Puccinia graminis tritici* causes of wheat.
2. What is homomerous lichen.
3. What is breathing pore.
4. What is autecious fungus.
5. What are akinetes.
6. Name a branched alga.
7. What you mean by holdfast.
8. Mention 2 functions of heretocyst.
9. What are periphysis
10. Comment on microcyclic fungi
11. What are lichens.
12. Comment on soredia.

(10x1=10)

PART B

(Answer any 6 questions. Each question carries 5 marks each)

13. Explain the internal structure of Usnea lichen.
14. Describe the general characters of Pteridophytes.
15. Write note on different spores in life cycle of *Puccinia*.
16. Why lichens are known as pollution indicators?
17. Explain classification of lichens based on its fungal partner.
18. Explain various means of vegetative reproduction in Algae
19. Write a note on pigmentation in Algae.
20. Comment on Breathing pores and Isidia.
21. Describe the harmful effects of fungi.

(6x5=30)

PART C

(Answer any 2 questions. Each question carries 10 marks each)

22. Explain economic importance of Fungi.
23. Explain the reserve food materials in Algae.
24. Explain sexual reproduction in *Riccia*.
25. Explain sexual reproduction in Algae.

(2x10=20)

MAR ATHANASIUS COLLEGE, KOTHAMANGALAM (AUTONOMOUS)
B.Sc. DEGREE (C.B.C.S) EXAMINATION

Second Semester

Complementary Course 2

UG21BO2CM01

Complimentary Course II – PLANT PHYSIOLOGY

Time: 3 hours

Maximum marks: 60

Part A

(Answer any ten questions. Each question carries 1 mark.)

1. What is diffusion?
2. What are short day plants?
3. Define DPD
4. Absorbable form of Nitrogen
5. Define osmotic potential
7. Expand CAM
8. What is photosynthesis
9. Give an example of antitranspirant
10. What is osmosis
11. Which hormone is responsible for fruit ripening
12. What are macronutrients?

(10x1=10)

Part B

(Answer any six questions. Each question carries 5 marks.)

13. Explain photoperiodism
14. What is Pressure flow hypothesis
15. Differentiate active and passive absorption
16. Explain vernalization
17. Give an account on Ascent of sap and its theories
18. What is photorespiration?
19. Explain red drop and Emerson's enhancement effect
20. What is seed dormancy? Explain its causes.
21. What are the factors affecting transpiration?

(6x5=30)

Part C

(Answer any two questions. Each question carries 10 marks.)

22. Explain cyclic and noncyclic photo-phosphorylation
23. Give an account on plant growth regulators and their physiological role
24. Explain water potential and its components
25. Give an account on C3 and C4 cycle.

(10x2=20)

MAR ATHANASIOUS COLLEGE, KOTHAMANGALAM (AUTONOMOUS)
B.Sc. DEGREE (C.B.C.S) EXAMINATION
THIRD SEMESTER

Complementary Course 3

UG21BO3CM01

Complementary Course III– ANGIOSPERM TAXONOMY AND ECONOMIC BOTANY

Time: 3 hours

Maximum marks: 60

Part A

(Answer any ten questions. Each question carries 1 mark)

1. What is Hypogynous flower?
2. Give an example for the Spadix inflorescence.
3. Expand ICBN.
4. Define Phyllotaxy. Name the different types.
5. What is Parietal placentation?
6. Differentiate between Zygomorphic and Actinomorphic flower.
7. What do you mean by Sorosis?
8. Write the binomial, family and useful part of Neem.
9. Differentiate between Parallel and reticulate venation?
10. Name any two important Herbaria of the world.
11. What is synandrous condition?
12. Define Cytotaxonomy.

(10x1=10)

Part B

(Answer any six questions. Each question carries 5 marks)

13. What are the different types of Aestivation?
14. Explain Racemose inflorescence.
15. What are the characteristics of family Malvaceae?
16. Write a short note on simple dry fruits.
17. Differentiate between Chemotaxonomy and Cytotaxonomy.
18. Write a note on the family Apocyanaceae.
19. Write the binomial, family, morphology of useful part, economic products and uses of beverages, Tea and Coffee.
20. Write a note on Aloe and its uses.
21. Differentiate between the families, Poaceae and Rubiaceae.

(6x5=30)

Part C

(Answer any two questions. Each question carries 10 marks)

22. Give a brief account on the Bentham and Hooker system of classification.
23. Write a note on the family Leguminosae.
24. Explain Herbarium techniques, types and importance. Cite examples of Herbaria.
25. Write an essay on the different types of plant classification.

(10x2=20)

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MAR ATHANASIUS COLLEGE, KOTHAMANGALAM (AUTONOMOUS)
B.Sc. DEGREE (C.B.C.S) EXAMINATION
FOURTH SEMESTER

Complementary Course 4

UG21BO4CM01

ANATOMY AND APPLIED BOTANY

Time: 3 hours

Maximum marks: 60

Part A

(Answer any ten questions. Each question carries 1 mark)

1. Expand NBPGR.
2. Distinguish interspecific and intergeneric hybridization.
3. What is budding?
4. Define plant breeding.
5. What is plant quarantine?
6. What is pureline selection?
7. What is emasculation?
8. What is dendrochronology?
9. Name any two chemical hybridizing agents.
10. What are raphides?
11. What is a scion?
12. What are hydathodes?

(10x1=10)

Part B

(Answer any six questions. Each question carries 5 marks)

13. What is cutting? Explain its various types.
14. Write a short note on objectives of plant breeding.
15. Give an account on mass selection.
16. Write a short note on various methods of emasculation.
17. Write a short note on mutation breeding.
18. Give an account on various steps involved in micropropagation.
19. Write a short note on types of meristems in plants.
20. Explain anomalous secondary thickening in *Bignonia*.
21. Briefly explain role of cambium in budding and grafting.

(6x5=30)

Part C

(Answer any two questions. Each question carries 10 marks)

22. What are hydrophytes? Write down the anatomical and morphological adaptations of hydrophytes.
23. Give an account on hybridization.
24. What is layering? Add note on various types of layering.
25. Write an essay on plant introduction.

(10x2=20)

PRACTICAL COURSES

MAR ATHANASIOUS COLLEGE KOTHAMANGALAM (AUTONOMOUS)

B.Sc. BOTANY (CBCSS) PROGRAMME

Core practical course 1 Semester I and II Combined UG21BO2CRP1

**METHODOLOGY OF SCIENCE AND AN INTRODUCTION TO BOTANY
&
MICROBIOLOGY, MYCOLOGY AND PLANT PATHOLOGY**

Time: 3 Hours

Max. marks: 40

1. Observe the given plants (**A - E**) and, (i) assign them to their major groups and write down the most significant reason for your decision in each case (ii) select a plant with/which can produce _____
(6 marks)
(Major group and reason – 5 x 1 = 5; Correctness of the selection – 1)
2. Take a CS of the given material **F**, stain with safranin and mount in glycerine (3 marks)
(Preparation – 3)
3. Gram stain the bacterial culture **G**. Write down the procedure/ flow chart. Identify and leave the preparation for valuation. (7 marks)
(Preparation – 4; Procedure/Flow chart – 2; Identification – 1)
4. Prepare suitable micropreparation of **H** and identify the material (6 marks)
(Preparation – 2; Identification – 1; Reasons – 2; Diagram – 1)
5. Spot at sight **I** and **J**. (1.5 x 2 = 3 marks)
(Major group – 0.5; Generic name – 0.5; Part displayed – 0.5)
6. Identify the disease and write the name of the causative organism in the specimens displayed as **K** and **L** (2 x 2 = 4 marks)
(Identification of the disease – 1; causative organism – 1)
7. Submit a field book and fresh or appropriately preserved specimens of two genera each from algae, fungi/lichen, bryophytes, pteridophytes, gymnosperms and angiosperms. (3 marks)
8. Practical record. (8 marks)

MAR ATHANASIUS COLLEGE (AUTONOMOUS), KOTHAMANGALAM
B.Sc. BOTANY (CBCS) PROGRAMME
Core practical course 2 Semester III and IV Combined UG21BO4CRP1
PHYCOLOGY AND BRYOLOGY
&
PTERIDOLOGY, GYMNOSPERMS AND PALAEOBOTANY

Time: 3 Hours

Max. marks: 40

1. Make micropreparation of **A**. Identify giving key characters. Submit the preparation for valuation (Preparation-1, Identification with class/sub division-2, Key Characters-2) (5 marks)
2. Make micropreparations of **B, C** and **D** and identify with key characters. Submit the preparations for evaluation. (Preparation-2, Labelled Diagram-1, Identification-0.5, Key characters-1.5) (5X3=15marks)
3. Make micropreparations and compare stelar types of **E&F** (Identification of stele-0.5 X 2, Labelled diagram-1X2, Comparison-1) (4 marks)
4. Comment on the reproductive structure of **G**. (Identification of Genus -1, Comment-1) (2 marks)
5. Spot at sight **H, I & J** (GenericName-0.5, Part Displayed-0.5) (1X3=3marks)
6. Submit an illustrated report of field visit to any one ecosystem with algal diversity (3 marks)
7. Practical Record (8 marks)

Key to the questions

1. **A**-Algal specimens mentioned in the syllabus (Microscopic)
2. **B, C & D**-Materials from Bryophytes, Pteridophytes and Gymnosperms (Vegetative Parts only)
3. **E & F**-Stem or Petiole of Pteridophytes
4. **G**-Reproductive structures of bryophytes or pteridophytes
5. **H, I, J**: Materials from Algae (Macroscopic or microscopic), Bryophytes, Pteridophytes and Gymnosperms

MAR ATHANASIUS COLLEGE, KOTHAMANGALAM (AUTONOMOUS)

B.Sc. DEGREE (CBCS) BOTANY PROGRAMME

Core practical course 3 Semester V and VI (Combined) UG21BO6CRP1

ANATOMY, REPRODUCTIVE BOTANY AND MICROTECHNIQUE

&

GENETICS, PLANT BREEDING AND HORTICULTURE

Time: 3 Hours

Max. Marks: 40

1. Make a stained transverse section of the material **A**, mount it in glycerin and identify.
(Preparation - 2; Labeled diagram - 1; Identification - 1; Reason – 2; Total 6 marks)
 2. Make a stained transverse section of the material **B**, mount it in glycerin and identify.
(Preparation - 2; Labeled diagram - 1; Identification - 1; Reason – 2; Total 6 marks)
 3. Work out the problem **C**.
(5 marks)
 4. Write critical notes on **D**.
(2 marks)
 5. Identify and comment on the cell inclusion **E**.
(Identification – 1; Comments – 1; Total 2 marks)
 6. Identify the anther type/embryo type/ovule **F** and write the identifying character.
(Identification – 1; Character – 1; Total 2 marks)
 7. Identify the stomatal type of the leaf sample **G₁**.
(Preparation – 2; Identification -1; Diagram -1; Total 4 marks)
- or
- Macerate and identify the tracheary elements in the given sample **G₂**.
(Preparation - 2; Identification – 1; Diagram – 1; Total 4 marks)
8. Conduct emasculation/ budding/ grafting on material **H** and draw a labeled diagram.
(Working – 2; Labeled diagram – 1; Total 3 marks)
 9. Identify the garden design/garden implement **I** and comment on it.
(2 marks)
 10. Practical record.
(8 marks)

Key to the questions

1. A - Primary structure of stem and root.
2. B – Secondary/Anomalous structure of stem/root.
3. C - Problems from classical genetics (dihybrid cross/gene interaction).
4. D - Biological stain/fixative/killing agent.
5. E – Nonliving inclusions mentioned in the syllabus
6. F – Photographs/slides showing typical structures, specified in the syllabus
7. G₁, G₂ – Draw lots so that half of the students in a batch gets G₁ and half gets G₂.
8. H - Supply suitable materials

9. I - Any garden design or implement mentioned in the syllabus

MAR ATHANASIOUS COLLEGE, KOTHAMANGALAM (AUTONOMOUS)

B.Sc. DEGREE (CBCS) BOTANY PROGRAMME

Core practical course 4 Semester V and VI (Combined) UG21BO6CRP2

PLANT PHYSIOLOGY AND BIOCHEMISTRY

&

CELL AND MOLECULAR BIOLOGY

Time: 3 Hours

Max. Marks: 40

1. Conduct the experiment **A**, and bring out the result.
(Requirements - 1; Procedure - 2; Setting the experiment - 3; Result and inference – 2; Total 8 marks)
2. Make an acetocarmine squash preparation of the root tip **B** supplied and identify any two stages of mitosis.
(Preparation - 2; Labeled diagram – 1 x 2; Identification - 1 x 2; Total 6 marks)
3. Write any two defects and the correct procedure of the experiment set up **C**.
(Defects – 1 x 2; Correct procedure – 1; Total 3 marks)
4. Detect any two organic compounds present in the sample **D**.
(Procedure – 2; Identification – 1; Total - 3 x 2 = 6 marks)
5. Identify the meiotic stage in the figure/ photograph **E**. Write a note on the meiotic stage.
(Identification - 1; Note – 1; Total 2 marks)
6. Identify and comment on the chromosomal anomaly of the given karyotype **F**.
(Identification - 1; Comment – 2; Total 3 marks)
7. Work out the problem **G**.
(4 marks)
8. Practical record.
(8 marks)

Key to the questions

1. A – Any experiment from the list of core experiments – draw lots
2. B - Preference should be given for metaphase and anaphase stage.
3. C - Any experiment in the syllabus for demonstration with minimum two defects.
4. D – Supply samples containing two organic compounds - Carbohydrate (glucose, sucrose, starch), Protein
5. E - Sub stage of meiotic prophase I
6. F - Down's syndrome/ Turner syndrome/ Klinefelter syndrome.
7. G - Elementary problem based on DNA structure/ replication/ transcription/ translation/ genetic code.

MAR ATHANASIOUS COLLEGE, KOTHAMANGALAM (AUTONOMOUS)
B.Sc. DEGREE (CBCS) BOTANY PROGRAMME

Core practical course 5 Semester V and VI (Combined) UG21BO6CRP3

ENVIRONMENTAL SCIENCE AND HUMAN RIGHTS

&

BIOTECHNOLOGY AND BIOINFORMATICS

Time: 3 Hours

Max. Marks: 40

1. Estimate the (CO₂, Cl/Salinity) in the given water sample **A**. Write the procedure.
(Procedure - 2; Experiment - 3; Result – 1; Total 6 marks)
2. Extract DNA from the plant material **B** using suitable methods.
(Requirements - 1; Procedure – 2; Working - 2; Results – 1; Total 6 marks)
3. Immobilize whole cell/ plant tissue **C** in alginate beads.
(Procedure – 2; Working and result – 2; Total 4 marks)
4. Using molecular visualization tool **Rasmol**, show the information of given protein **D**.
(Set up the color of background – 1; Display H bonds/Disulphide bond – 1; Display the labels specified - amino acid – 1; Display the protein structure in model specified – 1; Total 4 marks)
5. Find out the frequency/ abundance from the given data **E**.
(4 marks)
6. Identify and write critical note on the given pollutant **F**.
(2 marks)
7. Comment on the anthropogenic influence on environment deterioration in **G**.
(2 marks)
8. Comment on **H** and **I**.
(2 x 2 = 4 marks)
9. Practical record.
(8 marks)

Key to the questions

1. A – Provide water sample
2. B – Supply suitable plant material (onion, cauliflower etc.), necessary tools and reagents.
3. C – Supply Yeast cells /any suitable plant tissue.
4. D - Insulin/Haemoglobin.
5. E - Ecology problem.
6. F - Photograph/ material.
7. G – Photograph.
8. H, I – Equipments/Tools (their photographs)/Chemicals used in genetic engineering , Photographs of procedures or protocols in genetic engineering/Home page of NCBI/ Icon of Rasmol.

**MAR ATHANASIOUS COLLEGE, KOTHAMANGALAM (AUTONOMOUS)
B.Sc. DEGREE (CBCS) BOTANY PROGRAMME**

**Core practical course 6 Semester V and VI (Combined) UG21BO6CRP4
RESEARCH METHODOLOGY, BIOPHYSICS AND BIOSTATISTICS**

&

ANGIOSPERM MORPHOLOGY, TAXONOMY AND ECONOMIC BOTANY

Time: 3 Hours

Max Marks: 40

1. Identify the specimen **A** to the respective family giving key characters at each step.
(Identification – 1; Characters up to series – 1; Family characters – 3; Total 5 marks)
2. Describe the flower **B** in technical terms. Draw the VS, construct the floral diagram and write the floral formula.
(Description - 1; VS - 1; Floral formula - 1; Floral diagram – 1; Total 4 marks)
3. Identify the inflorescence and the fruit **C** and **D**.
(1 x 2 = 2 marks)
4. Identify the herbarium specimens **E1** and **E2** by their binomial and family.
(Binomial - ½; Family - ½; 1 x 2 = 2 marks)
5. Identify the product/part by binomial, family and morphology of the useful part of **F** and **G**.
(Binomial – 1; Family - ½; Morphology - ½; 2 x 2 = 4 marks)
6. Examine the compound leaf supplied and measure the length of the leaflets and group them into frequency classes according to their length. Prepare a histogram/line graph of the data using EXCEL.
(Frequency table – 1; Histogram – 2; Total 3 marks)
7. Determine the concentration of the given solution of CuSO₄ using colorimeter using standard graph.
(Standard graph - 1; Determination of concentration - 2; Total 3 marks)
8. Calculate the mean and standard deviation of a given data.
(Mean - 1; Standard deviation – 2; Total 3 marks)
9. Submit 25 herbarium and duly certified field book
(4 marks)
10. Field report (study tour report)
(2 marks)
11. Practical record
(8 marks)

Key to the questions

1. A – any family mentioned in the syllabus except monocots.
2. B – any flower from dicots mentioned in the syllabus. Flower should be large enough and fresh.
3. C, D - inflorescence – simple raceme, spike, corymb, head, dichasial cyme, cyathium; fruit – typical examples for the types specified in the syllabus.
4. E1, E2 – two herbarium sheets from submitted sheets
5. F, G – material from economic botany and ethnobotany syllabus
6. Supply suitable material; submit the printout of the graph
7. Give data to prepare standard graph
8. Biostatistics problem
9. 25 herbarium and a duly certified field book.

MAR ATHANASIOUS COLLEGE KOTHAMANGALAM (AUTONOMOUS)

B. Sc. ZOOLOGY MODEL – I

Semester II Complementary practical - Semester I and II (Combined) UG21BO2CMP1

CRYPTOGAMS, GYMNOSPERMS AND PLANT PATHOLOGY

&

PLANT PHYSIOLOGY

Time: 3 Hours

Max. marks: 40

1. Make stained micropreparations of **A** and **B**, mount in glycerine and identify giving diagnostic characters. Draw a neat and labelled diagram of each. (5 x 2 = 10 marks)
(Preparation – 2; Identification - 0.5; Reason - 1.5; Labelled diagram – 1)
2. Identify **C** with reasons and draw a labeled diagram (4 marks)
(Identification – 1; Reasons – 2; Labelled diagram – 1)
3. Identify at sight **D, E, F** and **G**. (1 x 4 = 4 marks)
(Genus - 0.5; Part displayed - 0.5)
4. Write note on pathological interest of **H**. (2 marks)
Name of the disease - 0.5; Causative organism - 0.5; Symptoms – 1)
5. Conduct the experiment **I**. Write the requirements, aim and procedure. (8 marks)
(Requirements – 1; Procedure – 2; Working – 3; Result and inference – 2)
6. Write any two defects and correct procedure of the experiment demonstrated as **J**. (4 marks)
(2 defects – 2; Correct procedure – 2;
7. Practical record (8 marks)

MAR ATHANASIOUS COLLEGE (AUTONOMOUS), KOTHAMANGALAM

B. Sc. ZOOLOGY MODEL – I

Complementary Course - Botany

Semester IV Practical - Semester III and IV (Combined) UG21BO4CMP1

ANGIOSPERM TAXONOMY AND ECONOMIC BOTANY

&

ANATOMY & APPLIED BOTANY

Time: 3 Hours

Max. marks: 40

1. Assign **A** to its family giving diagnostic characters. (4 marks)
Name of the family 1
Diagnostic Characters 3
2. Draw L.S Construct floral diagram and write the floral formulae of **B**
LS of Flower 2
Floral Diagram 1
Floral Formulae 1 (4 marks)
3. Identify **C & D** Write notes
Identification ½
Reason 1 (1 ½ x 2= 3 marks)
4. Write the binomial, family and morphology of useful part of **E, F & G**
Binomial 1
Family ½
Morphology ½ (2 x 3= 6 marks)
5. Make a stained transverse section of specimen **H**, mount in glycerin and identify giving Diagnostic characters
Preparation 3
Diagram 2
Identification with characters 3 (8 marks)
6. Identify the TS of the material **I** (1 marks)
7. Identify the cell inclusion **J** with reason (1 marks)
8. Assign **K** to the ecological group with reasons
Ecological group ½
Reasons 1½ (2 marks)
9. Carry out emasculation/ budding in **L**
Preparation 2
Aim & Procedure 1 (3 marks)
10. Record (8 marks)

Key to the questions

1. **A** A typical plant twig with flowers included in the syllabus from different subclasses of dicotyledons.
2. **B**: Fresh large flowers included in the syllabus.
3. **C**: From inflorescence (Raceme, Spike, Corymb, Umbel, Capitulum, Cyathium
D: From Fruits (Capsule, Hesperidium, Peppo, Berry, Drupe, Caryopsis).
4. **E, F & G**: Economic Botany specimens included in the syllabus
5. **H**: Stem or Root- Normal Secondary thickening or Anomalous secondary thickening in *Bignonia*
6. **I**: Slides of Primary structure of Stem or Root
7. **J**: Non living Inclusion (Cystolith / Raphide)
8. **K** : Specimens from ecological group mentioned in the syllabus
9. **L** : Suitable materials for Emasculation/ Budding
