SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

KOCHI, KERALA, 682013

CURRICULUM AND SYLLABUS

FOR

M.Sc. BOTANY

CREDIT AND SEMESTER SYSTEM (CSS)

INTRODUCED FROM 2024 ADMISSIONS ONWARDS

Prepared by :

BOARD OF STUDIES IN BOTANY

SACRED HEART COLLEGE (AUTONOMOUS) THEVARA,

KOCHI, KERALA

BOARD OF STUDIES IN BOTANY
SACRED HEART COLLEGE (AUTONOMOUS), THEVARA, KOCHI, KERALA

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ACKNOWLEDGEMENT

The designing of the M.Sc. Programme curriculum of the Department of Botany Sacred Heart College Thevara (Autonomous) was a year-long process, since it involved the purposeful, deliberate and systematic organization of the curricula. Care is taken to align the learning goals and outcomes of the courses with the programme specific outcome that in turn is set in line with the Postgraduate programme outcome and vision and mission of the Institution. The ultimate goal of the curriculum design is to improve student learning and also aid teachers in planning out the methods that they would adopt for transacting the syllabus and identifying what will be done, when and by whom. On behalf of the whole BoS, I thank the Management, Principal and IQAC, Sacred Heart College for the support provided for curriculum design.

The revision of the PG syllabus that will be effective from 2024-25 admissions is done with the contributions of various experts from respective fields. I would like to recall that all external members of the PG Board of Studies had gone through the previous and revised syllabi and provided invaluable inputs and corrections, wherever necessary. The external BoS members, Dr. Mathew Dan (Senior Scientist, Jawaharlal Nehru Tropical Botanic Garden & Research Institute, Palode, Thiruvananthapuram), Dr. Dennis Thomas T (Professor, Department of Plant Science, Central University of Kerala, Tejaswini Hills, Periye, Kasaragod), Dr. Santhosh Nampy (Professor, Department of Botany, University of Calicut, Malappuram), Dr. Bindu P.K (Assistant Professor, Department of Botany, Sanatana Dharma College, College, Alappuzha), and Mr. Binoy C (Manager, Ornamental Division, Indo-American Hybrid Seeds India Pvt. Ltd., Bengaluru) have contributed in providing their inputs in the development of various courses in which each person has expertise. They also helped in incorporating recent trends and applications of different research that is related to Botany. Moreover, they have provided insights on the knowledge base of students that different institutes and industries are looking for. Their active involvement also helped in developing the curriculum in par with international standards. We owe our gratitude to all the external BoS members. I would like to express my sincere gratitude to my colleagues for their dedicated efforts and outstanding work in shaping this syllabus into its excellent form.

Ebin P J
Chairperson
BoS in Botany

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1. INTRODUCTION

The world of Biology has been transformed in the last few decades. In line with the changes in higher education, the state of Kerala had introduced the autonomy in its 13 selected colleges in the year 2014 and, S H College, Thevara is proud to be one. However, the college remains affiliated to M G University. The Academic Council has resolved to stick on to Choice Based Course Credit Semester System (CBCSS). Exercising the opportune occasion of autonomy, the Department of Botany had thoroughly evaluated the existing syllabus of the parent university and revised it w.e.f. 2024-2025 admissions onwards. The entire syllabus revision has been followed by the Outcome Based Education (OBE). The BoS of the department scrutinized the Course Outcomes (COs). The syllabus revision considered employability, entrepreneurial and skill development for various courses. It also considered professional ethics, gender issues, human values, environment and sustainability, whichever necessary at suitable places in the syllabus.

The following courses or part of courses in the syllabus are identified as having the listed properties

Employability

1. Phycology and Microbiology
2. Mycology and Plant-pathogen interaction
3. Angiosperm Systematics
4. Plant Tissue Culture
5. Plant Breeding
6. Genetic Engineering
7. Biochemistry
8. Bioinformatics
9. Ecology & Phytogeography
10. Plant Anatomy & Microtechnique

Entrepreneurial

1. Mycology
2. Phycology
3. Pteridology
4. Microtechnique
5. Plant Reproductive Biology
6. Plant Breeding
7. Plant Tissue Culture
8. Angiosperm Systematics

Skill development

1. Microbiology & Phycology
2. Mycology & Plant Pathogen Interactions
3. Ecology & Phytogeography
4. Cell Biology

5. Bryology, Pteridology & Gymnosperms
6. Plant Anatomy & Microtechnique
7. Genetics & Evolution
8. Angiosperm Systematics
9. Genomics
10. Reproductive Biology

Eligibility for Admission

The BoS has included the following eligibility criteria for the admission of MSc Botany.
B.Sc Botany under Core Group (Core + Open + Complementary) or Botany - Biotechnology (double main + Subsidiary/Complementary subjects) with not less than CGPA of 5.0 out of 10.
B.Sc Botany under Part III (Main/Core + Subsidiary /Complementary subjects or Botany - Biotechnology (double main) with not less than 50% marks.

Based on thorough analysis, the Board of Studies designed the programme envisioning the following objectives:

- to encourage a clear, comprehensive and advanced mastery in the field of Botany.
- to provide basic principles of biological sciences with special reference to Botany and its applied branches.
- to enable the students to explore the intricacies of life forms at cellular, molecular and nano level.
- to sustain students' motivation and enthusiasm and to help them not only to appreciate the beauty of different life forms but also to inspire them in the dissemination of the concept of biodiversity conservation.
- to develop problem solving skills in students and encourage them to carry out innovative research projects thereby enkindling in them the spirit of knowledge creation.

2. REGULATIONS FOR POST GRADUATE PROGRAMMES UNDER CREDIT SEMESTER SYSTEM (CSS) – 2024

2.1 TITLE

These regulations shall be called 'SACRED HEART COLLEGE REGULATIONS FOR POST GRADUATE PROGRAMMES UNDER CREDIT SEMESTER SYSTEM (CSS) – 2024

2.2 SCOPE

Applicable to all Post Graduate (PG) programmes of the college with effect from 2024-25 admissions. The provisions herein supersede all the existing regulations for the post graduate programmes of the college.

2.3 DEFINITIONS

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

2.3.2 **'Duration of Programme'** means the period of time required for the conduct of the programme. The duration of the post graduate programme shall be of four semesters spread over two academic years.

2.3.3 **'Semester'** means a term consisting of a minimum of ninety working days, inclusive of examination, distributed over a minimum of eighteen weeks each having five working days, each with five contact hours of one hour duration.

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

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

2.3.6 '**Extra credits**' are additional credits awarded to a student over and above the minimum credits required for a programme.

2.3.7 '**Programme Credit'** means the total credits of the PG Programmes. For PG programmes the total credits shall be eighty.

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

2.3.9 'Elective Group' means a group consisting of elective courses for the programme.

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

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

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

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

2.3.14 'Evaluation' is the process by which the knowledge acquired by the students is quantified as per the criteria detailed in the regulations.

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

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

2.3.17 'Department' means any teaching department offering a programme of study approved by the college / institute as per the Act or Statute of the University.

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

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

2.3.20 'College Coordinator' means a teacher from the college nominated by the College Council to look into the matters relating to the CSS-PG system.

2.3.21 'Letter Grade' or simply **'Grade'** in a course is a letter symbol (A^+, A, B^+, B etc.) which indicates the broad level of performance of a student in a course.

2.3.22 'Grade Point' (GP), is an integer indicating the numerical equivalent of the broad level of performance of a student in a course.

2.3.23 'Grade Point Average' (GPA) is an index of the performance of a student in a course. It is obtained by dividing the sum of the weighted grade points obtained in the course by the

sum of the weights of the course (GPA = ∑WGP/∑W).

2.3.24 'Weighted Grade Point' (WGP) is obtained by multiplying the grade point by its weight (WGP = GP x weight).

2.3.25 'Credit Point' (CP) of a course is the value obtained by multiplying the grade point (GPA) by the credit (Cr) of the course (CP = GPA x Cr).

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

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

2.3.28 '**Grace Grade Points'** means grade points awarded to a student for course(s), in recognition of meritorious achievements in NSS/Sports/Arts and cultural activities, as per the orders issued by the college from time to time.

2.4 ATTENDANCE

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

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

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

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

2.4.4 Duty Leave: A student representing the college in sports, arts, social service or academic matters, has to get sanction from the class teacher concerned and submit the leave application form duly endorsed by the class teacher and the Head of the Department, and submit it to the Vice Principal. The same will be forwarded by the Vice Principal for attendance entry. The approval of the Department of Physical Education and the class

teacher is required for granting attendance related to sports. The time limit for submission mentioned above is applicable in the case of duty leave as well.

2.4.5 **Condonation**: A student may have the privilege of condoning attendance shortage (up to a maximum of ten days) on the basis of genuineness of the grounds of absence (medical reasons or college duty), duly recommended by the department. This is not a matter of right. It is a matter of privilege based on the Principal's discretion and the good conduct of the student on the campus. A student of a PG programme may have only one such opportunity.

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

2.4.7 **Unauthorized absence & removal from rolls**: A student, absent from the classes continuously for ten consecutive working days without due intimation or permission, shall be removed from the rolls, and the matter shall be intimated to the student concerned. On the basis of recommendation of the department concerned, re-admission process may be permitted by the Principal.

2.5 PROGRAMME REGISTRATION

2.5.1 A student shall be permitted to register for the programme at the time of admission.

2.5.2 A PG student who registered for the programme shall complete the same within a period of eight continuous semesters from the date of commencement of the programme.

2.6 PROMOTION

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

2.7 EXAMINATIONS

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

2.8 EVALUATION AND GRADING

2.8.1 Evaluation

The evaluation scheme for each course shall contain two parts:

a. **Continuous Internal Assessment (CIA)**

b. **End Semester Examination (ESE)**

25% weightage shall be given to internal evaluation and the remaining 75% to external evaluation and the ratio and weightage between internal and external is **1:3**, for the courses with or without practicals (except the courses offered by the School of Communications). In the case of courses offered by the School of Communications, the internal-external assessment ratio shall be **1:1**. In their case, the components for evaluation and their respective weightage shall be determined by their Board of Studies. Both internal and external evaluation shall be carried out in the grading system and the GPAs are to be rounded to two places of decimals.

2.8.2 Direct Grading: The direct grading for the components of CIA shall be based on six letter grades (A+, A, B, C, D and E) with numerical values of 5, 4, 3, 2, 1 and 0 respectively as per the following scale of accuracy/level of quality. The questions for internal test papers and the end semester examination shall be prepared in such a way that the answers can be awarded A+, A, B, C, D and E grades.

Grade	Grade Points	Scale of accuracy/Level of quality
A+	5	Greater than or equal to 90%
A	4	80% to less than 90%
B	3	60% to less than 80%
C	2	40% to less than 60%
D	1	20% to less than 40%
E	0	Less than 20%

2.8.3 Grade Point Average (GPA): Internal and external components are separately graded and the combined GPA shall be calculated for each course with weightage **1** for internal and **3** for external.

2.8.4 Components of Continuous Internal Assessment (CIA): Grades shall be given to the evaluation of theory/practical/project/comprehensive viva-voce and all internal evaluations are based on the Direct Grading System.

The Board of studies of the respective subject is permitted to make changes, if necessary, with regard to the weightages for the components of CIA without changing the total weightage of 5.

a. **Components of Internal Evaluation (for theory)**

Sl. No.	**Components**	**Weightage**
i.	Assignments	1
ii.	Seminar	1
iii.	Quiz/Field study/Industrial Visit/Viva Voce/Study Tour	1
iv.	Test paper-1	1
v.	Test paper-2	1
	Total	5

b. **Components of Internal Evaluation (for practical)**

Components	**Weightage**
Laboratory Involvement	2
Written/ Lab Test	2
Record	1
Total	5

c. **Components of Internal Evaluation (for project)**

Components	Weightage
Experimentation/ Data Collection (Project guide)	1
Punctuality (Project guide)	1
Compilation (Project guide)	1
Report (Project guide)	1
Presentation and Viva	1
Total	5

d. **Components of Internal Evaluation(for comprehensive viva voce)**

Components	Weightage
Subject Knowledge in Fundamental Topics	2
Subject Knowledge in Applied Topics	2
Subject Knowledge in Area of Specialization (Subject of Interest)	1
Total	5

2.8.5 Components of End Semester Examination (ESE):

a. **For Theory**

Evaluation shall be based on the following pattern of questions:

Sl. No.	Type of Questions	Weight	*Number of questions to be answered
1	Short answer type questions	1	8 out of 10
2	Short essay/problem solving type questions	2	6 out of 8

3	Long essay/problem solving type questions	5	2 out of 4

*Board of studies of respective subjects can decide on the number of questions in each type of questions.

b. **For Practical**

Components of External Evaluation (for practical)

Components	Weightage
Laboratory Involvement	3
Written/ Lab Test	6
Record	3
Viva Voce	3
Total	15

The Board of studies of the respective subject is permitted to make changes, if necessary, with regard to the weightages for the components of Practical Examinations (External) without changing the total weightage i.e. 15. The pattern of questions for external evaluation of practical examinations can also be prescribed by the respective Board of Studies.

c. **Components of External Evaluation (for project)**

Components	Weightage
Area/Topic/Theme selected	1
Objectives	1
Conduct of Experiment/Actual Work done	3
Results and Discussion including application of the findings	3
Project Report	3

Presentation	2
Viva	2
Total	15

d. **Components of External Evaluation(for comprehensive viva voce)**

Components	Weightage
Subject Knowledge in Fundamental Topics	5
Subject Knowledge in Applied Topics	5
Subject Knowledge in Area of Specialization (Subject of Interest)	5
Total	15

2.8.6 Project: Project work is a part of the syllabus of most of the programmes offered by the college. The guidelines for doing projects are as follows:

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

2.9 PERFORMANCE GRADING

2.9.1 Students are graded based on their performance (GPA/SGPA/CGPA) at the examination on a 7 point scale as detailed below

Range	Grade	Indicator
4.50 to 5.00	**A+**	**Outstanding**
4.00 to 4.49	**A**	**Excellent**
3.50 to 3.99	**B+**	**Very Good**
3.00 to 3.49	**B**	**Good (Average)**
2.50 to 2.99	**C+**	**Fair**
2.00 to 2.49	**C**	**Marginal (Pass)**
Up to 1.99	**D**	**Deficient (Fail)**

2.9.2 No **separate minimum** is required for internal evaluation for a pass, but a minimum a '**C'** grade is required for a pass in an external examination. However, a minimum '**C'** grade is required for pass in a course and the programme as well.

2.9.3 A student who fails to secure a minimum grade '**C'** for a pass in a course shall be permitted to write the examination along with the next batch.

2.9.4 Improvement of GPA: The candidates who wish to improve the GPA of the external examinations of a course/courses can do the same by appearing in the external examination of the semester concerned along with the immediate junior batch. The facility is restricted to first and second semesters of the programme.

2.9.5 Computation of SGPA and CGPA: For the successful completion of a semester, a student should pass all the courses and score at least the minimum SGPA grade **'C'**. After the successful completion of a semester, Semester Grade Point Average (**SGPA**) of a student in that semester is calculated as the ratio of the sum of the credit points of all courses taken by a student in the semester to the total credits of that semester.

For the successful completion of a programme, a student should pass all the courses and score at least the minimum CGPA grade **'C'**. However, a student is permitted to move to the next semester irrespective of her/his SGPA.

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

The course teacher and the faculty advisor shall maintain the academic record of each student

registered for the course which shall be forwarded to the controller of examinations through the Head of the Department and a copy should be kept in the department for at least two years for verification.

2.10 REGISTRATION FOR THE EXAMINATION

a. All students admitted in a programme with remittance of prescribed fee are eligible for the forthcoming semester examinations.
b. Online application for registration to the various End Semester Examinations shall be forwarded to the CE along with prescribed fee for each course in prescribed format.
c. The eligible candidates who secure the prescribed minimum attendance of the total duration of the course and possess other minimum qualification prescribed in the regulations for each course shall be issued the hall tickets. The hall ticket shall be downloaded by the students from the college website.

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

2.11 SUPPLEMENTARY EXAMINATIONS

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

2.12 PROMOTION TO THE NEXT HIGHER SEMESTER

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

a. He / she secures a minimum 75 % attendance and registered for the End Semester Examination of the programme for which he/she is studying.
b. His / her progress of study and conduct are satisfactory during the semester completed, as per the assessments recorded by the course teachers and the Head of the Department concerned.

2.13 CERTIFICATES

1. Diploma and Degree certificates are issued by the Mahatma Gandhi University, Kottayam as per the act and statues of the University on the submission of the consolidated mark / score cards of the students by the College.
2. A consolidated mark / scored card shall be issued to the candidates after the publication of the results of the final semester examination taken by the candidate.
3. A Course Completion Certificate with classification shall be issued to students till the provisional certificate is issued by the university.

2.14 RANK CERTIFICATE

Candidates shall be ranked in the order of merit based on the CGPA secured by them. Grace grade points awarded to the students shall not be counted for fixing the rank/positions. Rank certificates shall be issued to the candidates who secure positions from the first to the third in the order of merit. The position certificates shall be issued to the next seven candidates in the order of merit.

2.15 AWARD OF DEGREE

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

2.16 MONITORING

There shall be a Monitoring Committee constituted by the Principal consisting of faculty advisors, HoD, a member from Teaching Learning Evaluation Committee (TLE) and the Deans to monitor the internal evaluations conducted by college. The course teacher, class teacher and the deans should keep all the records of the internal evaluation, for at least a period of two years, for verification.

Every programme conducted under Credit Semester System shall be monitored by the College Council under the guidance of IQAC Coordinator, Controller of Exams, Academic Deans and HoDs. An academic committee consisting of the vice principal, deans and teachers nominated by the Principal shall look after the day-to-day affairs of these regulations.

2.17 GRIEVANCE REDRESSAL MECHANISM

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

Level 1: Level of the course teacher concerned

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

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

2.18 TRANSITORY PROVISION

Notwithstanding anything contained in these regulations, the Principal of the college has the power to make changes in these regulations, by due orders, that shall be applied to any programme with such modifications as may be necessary on the recommendations of the Board of Studies of the respective programme.

3. SYLLABUS

SEMESTER WISE DISTRIBUTION OF COURSES AND CREDITS

SEMESTER 1				
Course Code	**Course Title**	**Theory hours**	**Practical hours**	**Total Credits**
24P1BOTT01	Microbiology & Phycology	72	36	4
24P1BOTT02	Mycology & Plant Pathogen Interactions	72	36	4
24P1BOTT03	Ecology, Environmental Biology & Phytogeography	54	36	3
24P1BOTT04	Cell Biology	72	36	4
24P1BOTP01	Practical 1 (24P1BOTT01+ 24P1BOTT02)			2
24P1BOTP02	Practical 2 (24P1BOTT03+ 24P1BOTT04)			2
SEMESTER 2				
24P2BOTT05	Bryology, Pteridology & Gymnosperms	72	36	4
24P2BOTT06	Molecular Biology & Immunology	72	36	4
24P2BOTT07	Plant Anatomy & Microtechnique	72	36	4
24P2BOTT08	Genetics & Evolution	54	36	3
24P2BOTP03	Practical 3 (24P2BOTT05+ 24P2BOTT06)			2
24P2BOTP04	Practical 4 (24P2BOTT07+ 24P2BOTT08)			2
SEMESTER 3				
24P3BOTT09	Angiosperm Systematics	72	36	4
24P3BOTT10	Biostatistics & Research Methodology	54	36	3
24P3BOTT11	Plant Physiology & Biochemistry	72	36	4
24P3BOTT12	Plant Reproductive Biology & Plant Breeding	72	36	4
24P3BOTP05	Practical 5 (24P3BOTT09+ 21P3BOTT10)			2
24P3BOTP06	Practical 6 (24P3BOTT11+ 21P3BOTT12)			2

SEMESTER 4				
24P4BOTT13	Genetic Engineering & Biological Techniques	72	36	4
24P4BOTT14	Genomics, Proteomics & Bioinformatics	72	36	4
24P4BOTT15	Plant Tissue Culture	72	36	4
24P4BOTP07	Practical 7 (24P4BOTT13+24P4BOTT14)			2
24P4BOTP08	Practical 8 (24P4BOTT15)			2
24P4BOTRPJ	Research Project			4
24P4BOTCVV	Comprehensive Viva Voce			3
TOTAL CREDITS				**80**

Additional Credits: Components

Content	Minimum Hours	Credit
1. Internship	36	2
2. Virtual Lab Experiments	36	2

PROGRAMME OUTCOMES (POs)

At the end of the programme, the students will

PO1

Exercise their critical thinking in creating new knowledge leading to innovation, entrepreneurship and employability.

PO2

Effectively communicate the knowledge of their study and research in their respective disciplines to their stakeholders and to the society at large.

PO3

Make choices based on the values upheld by the institution, and have the readiness and know-how to preserve the environment and work towards sustainable growth and development.

PO4

Develop an ethical view of life and have a broader (global) perspective transcending the provincial outlook.

PO5

Explore new knowledge independently for the development of the nation and the world and are able to engage in a lifelong learning process.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1

Demonstrate a clear, comprehensive and advanced mastery in the field of Botany.

PSO2

Understand the basic principles of biological sciences with special reference to Botany and its applied branches.

PSO3

Explore the intricacies of life forms at cellular, molecular and nano level.

PSO4

Appreciate the beauty of different life forms, be aware of and disseminate the concept of biodiversity conservation.

PSO5

Develop problem solving skills and carry out innovative research projects, thereby fostering the spirit of knowledge creation.

SEMESTER 1

Sl. No.	Course Code	Course Title	Credits	Course Type	Theory Hours	Practical Hours
1	24P1BOTT01	Microbiology & Phycology	4 (1+3)	Theory	Microbiology: 18 Phycology: 54	Microbiology: 9 Phycology: 27
2	24P1BOTT02	Mycology & Plant Pathogen Interactions	4 (2+2)	Theory	Mycology: 36 Plant Pathogen Interactions: 36	Mycology: 18 Plant Pathogen Interactions: 18
3	24P1BOTT03	Ecology, Environmental Biology & Phytogeography	3 (2+1)	Theory	Ecology, Environmental Biology & Phytogeograph: 54	Ecology, Environmental Biology & Phytogeography: 36
4	24P1BOTT04	Cell Biology	4	Theory	Cell Biology: 72	Cell Biology Practical: 36
5	24P1BOTP01	Microbiology, Phycology, Mycology & Plant Pathogen Interactions	2	Practical		
6	24P1BOTP02	Ecology, Environmental Biology, Phytogeography & Cell Biology	2	Practical		

24P1BOTT01: MICROBIOLOGY AND PHYCOLOGY

(Theory: 72 hours; Practical: 36 hours; Theory Credits: 4; Practical Credit: 1)

COURSE OUTCOMES (COs)	
CO 1	Describe the world of microbial diversity and their evolutionary relationships
CO 2	Formulate new methods for culturing of microbes and algae
CO 3	Describe the applied aspects of microbiology and phycology
CO 4	Describe the world of algae and examine their general features.
CO 5	Examine possible applications and ecological significance of algae.
CO 6	Collect, compare, identify and culture various algal forms

MICROBIOLOGY (Theory 18 hours, Practical 9 hours)

Introduction to the course:

History and scope of microbiology; Koch's postulates; microbial diversity; microbial taxonomy and phylogeny; three and two domain systems of classifications; microbes in everyday life.

Module 1: Bacteria (10 hours)

(a) Bacterial morphology. Classification of Bacteria according to Bergey's manual of systematic bacteriology. Modern trends in bacterial taxonomy- DNA barcoding in Bacteria (16S rRNA).

(b) Culture of microorganisms: Methods for isolating pure cultures, types of culture media, maintenance and preservation of pure cultures.

(c) Ultra structure of Gram positive and Gram-negative bacteria; cell membrane, cell wall, External structures - flagella, pili, glycocalyx and S layer, Internal/cytoplasmic structures - Nucleoid, ribosome and endospores.

(d) Nutritional types - Photolithotrophs, chemolithotrophs, photoorganotrophs, and chemoorganotrophs.

(e) Recombination in bacteria - conjugation, transformation and transduction. Sexduction.

Module 2: Applied Microbiology (2 hours)

(a) Food Microbiology: food spoilage and preservation methods, Microbiology of fermented foods, Microorganisms as source of food-SCP; Probiotics and Prebiotics

(b) Agricultural Microbiology: Management of agricultural soils, bio-fertilizers, bio-pesticides.

Module 3: Viruses (6 hours)

(a) Nomenclature and Baltimore classification (2008), distinctive properties of viruses, morphology of viruses. Capsid and envelopes (SARS COV-2).

(b) Structure of bacteriophages belonging to 'T' series. Ultra structure of HIV.

(c) Sub viral particles - prions, viroids, virusoid.

Practical (9 hours)

1. Preparation and sterilization of various microbial culture media and inoculation.
2. Differential staining of bacteria using Gram stain.
3. Isolation of soil bacteria by serial dilution and spread plate method.
4. Streak out a bacterial culture on an agar plate and isolation of colonies.
5. Antibacterial assay - disc diffusion/agar well method.

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PHYCOLOGY (Theory 54 hours; Practical 27 hours)

Introduction to the Course: General characters of algae.

Module 5: Introduction (8 hours)

a) Classification of Algae by F. E. Fritsch (1977).
b) Brief account on the classification (Up to groups and divisions) by Edward Lee (2008).
c) DNA barcoding in algae.

Module 6: General features of Algae (30 hours)

a) Habit, habitat and distribution of Algae, Major characteristics of Chlorophyceae, Xanthophyceae, Bacillariophyceae, Dinophyceae, Phaeophyceae and Rhodophyceae
b) Phylogenetic affinities of Cyanobacteria and Algae
c) Range of thallus structure, Evolution of thallus in Chlorophyceae.
d) Algal components: Cell wall, flagella, eye-spot, pigments, pyrenoid, reserve food products.
e) Reproduction in algae: Vegetative, asexual and sexual reproduction (development of sex organs not necessary), Zoosporic origin of sex in algae, Evolution of sex.
f) Major patterns of life cycle and post fertilization stages in Chlorophyceae, Phaeophyceae and Rhodophyceae.
g) Fossil algae.

Module 7: Ecological and Economic importance of Algae (10 hours)

a) Ecological importance of Algae. Primary productivity. Algae in symbiotic association, Ultraviolet radiation absorption by algae.
b) Algae as food, fodder, biofertilizer, medicine, industrial uses.
c) Algae in experimental studies. (SCP, Biofuel, Live feeds)
d) Harmful effects of algae: Algal blooms, causative organisms, symptoms and toxins of major toxic algal blooms (Amnesic Shellfish Poisoning, and Paralytic Shellfish Poisoning)
e) Cyanobacterial toxins

Module 8: Collection and Culture of Algae (6 hours)

a) Methods and techniques of collection, preservation and staining of Algae.

b) Algal culture: Importance, methods; Algal culture media.

Practical (27 hours)

1. Critical study of diagnostic features and identification based on morphological, anatomical and reproductive parts using clear whole mounts/sections of the following genera (Geotagged clear images with proper contrast can be recorded and images can be used for labeling):
    a) Cyanobacteria - *Gleocapsa, Gleotrichia, Spirulina, Oscillatoria, Lyngbya, Anabaena, Nostoc, Rivularia, Scytonema*.
    b) Chlorophyceae - *Volvox, Ulothrix, Ulva, Cladophora, Pithophora, Trentepohlia, Fritschiella, Cephaleuros, Oedogonium, Zygnema, Mougeotia. Desmedium, Bryopsis, Codium, Caulerpa, Halimeda, Chara, Nitella*.
    c) Xanthophyceae - *Vaucheria*.
    d) Bacillariophyceae - *Pinnularia*.
    e) Phaeophyceae - *Ectocarpus, Dictyota, Padina, Sargassum, Turbinaria*.
    f) Rhodophyceac - *Batrachospermum, Comsopogon, Gelidium, Amphiroa, Gracilaria, Polysiphonia.*
2. Students are expected to collect and identify algae from different natural habitats or visit an Algal research station. Prepare and submit the report of the field work/research station visit for evaluation during the practical exam.

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24P1BOTT02: MYCOLOGY AND PLANT PATHOGEN INTERACTIONS

(Theory: 72 hours; Practical: 36 hours; Theory: 3 Credits; Practical: 1 credit)

COURSE OUTCOMES (COs)	
CO 1	Analyze the morphological diversity among different micro and macro fungi.
CO 2	Describe the principles behind the morphological and molecular classification systems and their applications.
CO 3	Examine the mycelial structure and reproductive system in fungi
CO 4	Evaluate fungal associations, their usefulness and harmfulness
CO 5	Explain the nuances of plant-pathogen interactions
CO 6	Distinguish the Phytopathogens responsible for diseases and recommend the control measures.

MYCOLOGY (Theory 36 hours; Practical 18 hours)

Introduction to the Course:

- General characters of Fungi.

Module 1: Fungal Classification **(10 hours)**

- Characteristic features with their modifications in fungi
- Principles of classification of fungi and the Classification by G C Ainsworth (1973).
- Classification of true fungi (down to the level of class) according to the current 'AFTOL' scheme (Hibbett et al. 2007).
- An account of DNA barcoding in fungi and oomycetes

Module 2: **Thallus structure and reproduction in Fungi (16 hours)**

Mycelial structure and reproduction of (in brief);

a) Myxomycota-*Acrasiomycetes, Hydromyxomycetes, Myxomycetes, Plasmodiophoromycetes*.
b) Eumycota
    I. Mastigomycotina - *Chytridiomycetes, Hyphochytridiomycetes, Oomycetes* (Mention the differences between Oomycetes from true fungi).
    II. Zygomycotina - *Zygomycetes, Trichomycetes*.
    III. Ascomycotina - *Hemiascomycetes, Pyrenomycetes, Plectomycetes, Discomycetes, Laboulbeniomycetes, Loculoascomycetes*.

IV. Basidiomycotina - *Teliomycetes, Hyphomycetes, Gastromycetes*.
V. Deuteromycotina - *Blastomycetes, Hyphomycetes, Coelomycetes*.

(f) Types of fruiting bodies in fungi and its evolutionary trends.

Module 3: **Fungal associations and their significance (10 hours)**

a) Mutualism - Lichens, Mycorrhiza, Fungus-insect mutualism.
b) Parasites - Common fungal parasites of plants, humans, insects, and nematodes.
c) Saprophytes - Fungal decomposition of organic matter, coprophilous fungi, cellulolytic fungi, lignolytic fungi.
d) Agricultural significance of Fungi: Beneficial - Decomposition and Nutrient Cycling, Soil Structure Improvement, Production of Bioactive Compounds, Fermentation and valued added agriproducts, Bioremediation (Also mention the harmful aspects from plant pathology)

Practical (18 hours)

1. Critical study of the following types by preparing suitable micropreparations and familiarise using geotagged photographs: *Stemonitis, Physarum, Saprolegnia, Phytophthora, Albugo, Mucor, Aspergillus, Penicillium, Pilobolous, Saccharomyces, Xylaria, Peziza, Phyllochora, Puccinia, Pleurotus, Auricularia, Polyporus, Dictyophora, Geastrum, Cyathus, Fusarium, Alternaria, Tremella, Entoloma, Marasmius, Hexagonia, Ganoderma, Lenzites, Lycoperdon, Graphis, Parmelia, Usnea.*
2. Estimation of mycorrhizal colonization in root.
3. Collection and identification of common field mushrooms and record using geotagged photographs (10 types).

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Plant Pathogen Interaction (Theory 36 hrs; Practical 18 hrs)

Introduction

- A brief history of plant pathology, Koch's postulates, Concept of Disease. Classification of plant diseases based on (a) Major causal agents - biotic and abiotic, (b) General symptoms, (c) Occurrence

Module 4: Process of infection and pathogenesis (10 hours)

a) An overview of immunity and defense in Plant – Pathogen interaction
b) How pathogens and pests cause disease
c) Strategies used by pathogens to attack plants.
d) Mechanism of infection- Penetration and entry of pathogens into host tissue – mechanical, physiological and enzymatic.
e) Role of biochemicals in pathogenesis: enzymes, toxins (Tabtoxin, Phaseolotoxin, Tentoxin, Cercosporin, Victorin, T Toxin, HC Toxin), growth regulators and polysaccharides.

Module 5: Defense mechanism in plants (8 hours)

a) Non-host resistance, horizontal resistance, vertical resistance
b) Pre-existing defense mechanisms: structural and biochemical
c) Post-Infection/Induced/Dynamic defense mechanisms: structural (cell wall defense structures, histological defense structures) and biochemical (Defense through Production of Secondary Metabolites, Pathogen elicitors, Hypersensitive defense reaction)

Module 6: Plant disease management (10 hours)

a) Prophylatic methods - Exclusion, eradication, and protection.
b) Chemical means of disease control – common fungicides, antibiotics and nematicides. Pesticides, and bactericides.
c) Biological means of disease control - (*Pseudomonas, Trichoderma, Beauveria*, PGPR, VAM); Control of fungal plant pathogens by Mycofungicides.
d) Immunization of plants against pathogens – defense through plantibodies, induction of plant defenses by artificial inoculation with microbes or by treatment with chemicals
e) Transgenic approaches to disease resistance

Module 7: Transmission of plant disease (2 hours)

a) Active dissemination (seed, soil & plant organs) & Passive dissemination (through Animate & inanimate agents)

Module 8: Common plant diseases in Kerala (6 hours)

a. Cereals: Rice - blast disease; Wheat - black rust disease.
b. Vegetables: Chilly - leaf spot; Okra - vein clearing disease; Tomato - Serpentine leaf miner.
c. Fruits: Banana - bacterial leaf blight; Mango - Anthracnose; Papaya – mosaic disease

d. Spices: Ginger - Fusarium wilt; Pepper - quick wilt; Cardamom - marble mosaic disease.
e. Oil seeds: Coconut - Grey leaf spot
f. Rubber - abnormal leaf fall.
g. Sugar yielding: Sugarcane - red rot
h. Beverages: Tea - blister blight; Coffee - rust.

Practical (18 hours)

1. Make suitable micropreparations and identify the diseases mentioned with due emphasis on symptoms and causative organisms.
2. Isolation of pathogens from diseased tissues (leaf, stem and fruit) by suitable method.
3. Collection and preservation of specimens from infected plants. Submit 5 herbarium sheets / live specimens/ geotagged photo plate along with a brief report.
4. Calculation of Spore load from seeds or fungal spore count using Haemocytometer.

References

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24P1BOTT03: ECOLOGY, ENVIRONMENTAL BIOLOGY AND, PHYTOGEOGRAPHY

(Theory: 54 hours; Practical: 36 hours; Theory Credits: 3; Practical credit: 1)

Course Outcomes

CO 1	Delivering with the basics of ecology and environmental science.
CO 2	Identifying the theoretical, practical, structural and functional aspects
CO 3	Demonstrating with different mathematical and statistical models and indices to explain natural phenomena and theoretical principles with which several ecological processes are explained.
CO 4	Identifying global environment problems and phytogeography.
CO 5	Explain the characteristics, resources and significance of the Western Ghats.
CO 6	Develop methods of conservation managements of natural ecosystems and rare, endemic and threatened species in the Western Ghats.

Module 1: Introduction to Ecology (4 hours)

(a) Definitions, history and scope of ecology, sub divisions of ecology, ecology vs environmental science. Interdisciplinary nature of environmental science

(b) Interdisciplinary aspects of ecology, applications of ecology in different fields (EIA, Research, education, agriculture, healthy life, etc.)

Module 2: Autecological concepts (**8 hours**)

(a) Characteristics of populations - ecological amplitude - population size and exponential growth, limits of population growth, population dynamics, life history pattern, fertility rate and age structure; Competition and coexistence, intra-specific interactions, scramble and contest competition model, mutualism and commensalism, prey-predator interactions. Lotka-Voltera model.

(b) Genecology - ecads, ecotypes, ecospecies, coenospecies; k-selection and r-selection populations.

Module 3: Synecological concepts (12 hours)

(a) Ecological processes of community formation, ecotone, edge effect.

(b) Quantitative – Species richness, Evenness, abundance, qualitative and synthetic characteristics of plant communities, Sorenson's Index of similarity, coefficient of communities

Characteristics of plant communities, Alpha, Beta and gamma diversity; definition and measures; Alpha diversity measures- Mergalef's index, Fishers, Shannon and Simpson diversity indices. Beta diversity measures, Jaccard's similarity/dissimilarity index, species accumulation curve, statistical estimators; chao-2 and Jackknife.

(c) Guild and its functioning in the community. Functional aspects of community; co-existence, resource partitioning, co evolution and coexistence. Community network; Models and examples of interspecific interactions: competition, Predation including adaptations of pray and predators, mutualism, symbiosis, commensalism, ammensalism.

(d) Dynamic community characteristics – cyclic replacement changes and cyclic no-replacement changes. Modelling the interspecific interactions by using network analysis approach.

Module 4: Ecological succession (4 hours)

(a) The concept – autogenic and allogenic succession, primary and secondary, autotrophic and heterotrophic successions.

(c) Applications of succession in restoration ecology with based on a case study.

Module 5: Biosphere and Ecosystem (4 hours)

Different aquatic (freshwater and marine) and terrestrial ecosystems with regard to their productivity, biodiversity, energy flow, food chains and trophic levels

Module 6: Pollution Management (3 hours)

a) Air pollution control: NAMP, NCAP, Impact of air pollution in Indian cities,
b) Plant-microbe based bioremediation for tackling soil contamination, Role of Microbes in wastewater treatment, Role of genetically engineered organisms in bioremediation
c) Ecosystem Restoration – significance, Ecosystem Restoration Alliance (ERA) – aims and projects.

Module 7: Climate Change and other Global Environmental Issues (6 hours)

a) Climate Change and other Global Environmental issues - *El-Nino* and *La Nina* phenomenon and its consequences

b) Factors responsible for climate change: Climate change mitigation – global conventions and protocols on climate change, UNEP - UNFCC; IPCC; Future Earth
c) Environmental safety provisions in Indian constitution, environmental monitoring and bio indicators
d) Disaster management -brief account

Module 8: Phytogeography (4 hours)

a) Definition, principles governing plant distribution, factors affecting plant distribution, theories of distribution of plants, distribution of different vegetations on the earth based on a vegetation map, continuous and discontinuous/disjunct distribution.
b) Climate, vegetation and botanical zones of India; Floristic provinces in the world
c) Remote sensing– principle, data acquisition; GIS and GPS and their applications.

Module 9: Conservation Biology (4 hours)

a) Concept of endemism and hot spots; IUCN Red List categories; Key stone species, flag-ship species; reasons for biodiversity loss;
b) Basic principles of conservation - *ex-situ* and *in-situ* conservation techniques;

Module 10: The Western Ghats and the Mangroves (5 hours)

(a) Importance, origin, geology, vegetation, diversity, resources, Concept of hotspot (The Western Ghats as a biodiversity hotspot).
(b) RET (Rare-Endemic/Endangered-Threatened) species and their conservation.
(c) Mangrove ecosystem and its significance in the western coast of Peninsular India.

Practical (36 hours)

1. Analysis of water quality (a) Dissolved CO2 (b) Dissolved oxygen (c) COD (d) Total dissolved minerals (e) Quantitative estimation of dissolved mineral anions and cations in water (f) Total alkalinity & Salinity (g) conductivity (h) Colorimetric/Spectrophotometric estimation of Nitrogen/Phosphorus in water samples.
2. Carry out life table analysis based on given data or data collected from a plant population and find out the life expectancy of the population.
3. Frequency, abundance, density, basal area, IVI, evenness and similarity/dissimilarity indices of different communities in a natural system using MS Excel.

4. Statistical analysis of diversity indices by using apt software such as PAST, EstimateS, Biodiversity Pro 2.0.
5. To determine organic 'C' and organic matter (biomass) in different (at least 3) locations (forest, agro ecosystem, polluted area, industrial area, road sides, urban and rural, etc.).
6. Field visit to natural ecosystem and identification of trophic levels, food webs and food chains, plant diversity (species and community).
7. Students should prepare a report based on the influence of pollution in various plant ecosystems in comparison with a control based on collected data and perform statistical analysis.

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24P1BOTT04: CELL BIOLOGY

(Theory: 72 hours; Practical: 36 hours; Theory Credits: 4; Practical Credit: 1)

COURSE OUTCOMES (COs)	
CO 1	Explain the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.
CO 2	Understand how the cells interact among themselves and with the environment through signal molecules.
CO 3	Explain about cytoskeleton, endomembrane system, protein trafficking and cell cycle.
CO 4	Understand recent advancements in Chloroplast and Mitochondrial research.
CO 5	Understand the molecular mechanisms of cancer.
CO 6	Develop basic knowledge to prepare for competitive examinations in life science.

Introduction to the Course

(a) Historical Background of Cell Biology

(b) Difference between Prokaryotic and Eukaryotic Cell

(c) Difference between Plant and Animal Cell

(d) Basic Structure and Functions of Cell components.

(e) Endosymbiotic theory

(f) Central dogma of molecular biology

(g) Basics of DNA replication, Transcription, and Translation.

(h) Brief history of studies on plasma membrane structure. Fluid mosaic model.

(i) Functions of plasma membrane.

(j) Structure and function of chloroplast and mitochondria.

Module 1: Structure and Function of the Plasma Membrane (9 hours)

(a) The chemical composition of membranes: Membrane lipids - Phosphoglycerides, Sphingolipids, Cholesterol; Membrane proteins - Integral proteins, Peripheral membrane proteins, Lipid-anchored proteins; Membrane carbohydrates, significance in ABO blood grouping.

(b) Membrane lipids and membrane fluidity: Transition temperature; factors affecting membrane fluidity- fatty acid composition, cholesterol content; Importance of membrane fluidity, mechanisms for maintaining membrane fluidity.

(c) The dynamic nature of the plasma membrane: Dynamic nature of membrane lipids- lateral diffusion, rotation, transverse diffusion- Flippase, Floppase Scramblase; and Dynamic nature of membrane proteins; Regulation of membrane protein mobility

(d) Transport of molecule across cell membrane: Simple diffusion – factors affecting diffusion, Facilitated diffusion - Carrier proteins, properties of carrier proteins, uniport, antiport and symport, Channel proteins – ion channels, porins and aquaporins, Active transport – direct and indirect mechanisms, ATPases – P type, F type, V type and ABC type.

Module 2: The Endomembrane System (9 hours)

(a) Introduction: outline of endomembrane system.

(b) The endoplasmic reticulum: smooth and rough endoplasmic reticulum, synthesis of proteins on membrane-bound and free ribosomes and processing.

(c) The Golgi complex: glycosylation, movement of materials through the Golgi complex.

(d) Types of vesicle transport and their functions.

(e) Peroxisomes.

(f) Targeting of proteins to mitochondria, chloroplasts and peroxisomes.

(g) The endocytic pathway: endocytosis and phagocytosis.

Module 3: The Cytoskeleton (9 hours)

(a) Overview of the major functions of the cytoskeleton.

(b) Microtubules: Structure and Organization, αβ-Tubulin Dimers, MTOCs, Microtubule Dynamics, Regulation of Microtubule Structure and Dynamics, Microtubule Based Motor Proteins: Kinesins and Dyneins, structure and functions- Kinesins and Dyneins Cooperated

Organelle Transport, Cilia and Flagella: Microtubule-Based Surface Structures –structure and movements, Intraflagellar Transport, role of microtubules and its motor proteins in cell division, Reorganization of Microtubules and plant Cell Wall formation in Mitosis.

(c) Microfilaments: Microfilaments: G-actin, F- actin Structure, properties and formation, Dynamics of Actin Filaments, Mechanisms of Actin Filament Assembly, Actin Polymerization Powered Intracellular Movements, Function of Microfilaments in Endocytosis, Toxins that affect actin Dynamics, Organization of Actin-Based Cellular Structures, Actin-Based Motor Proteins - Myosins- structure, Myosin-Powered Movements: Myosin-Dependent Mechanisms of muscle Contraction.

(d) Intermediate filaments: intermediate filament assembly and disassembly, types and functions of intermediate filaments.

Module 4: Nucleus (9 hours)

(a) Structure of eukaryotic nucleus: Nuclear Envelope, Nuclear Pore Complex.

(b) Transport into and out of the Nucleus: Nuclear-Localization Signals, Nuclear-Export Signals, Karyopherins, Ran-dependent and Ran-Independent Mechanisms.

(c) Bacterial Chromatin. Compaction of bacterial chromosome – Supercoiling of Bacterial DNA; Interaction with DNA-binding proteins – SMC and Muk B proteins.

(d) Structure of chromatin and chromosomes: histones and non-histone proteins, nucleosome, higher levels of chromatin structure. Heterochromatin and Euchromatin.

(e) Molecular structure of the Centromere and Telomere.

Module 5: Cell Cycle (9 hours)

(a) Phases of cell cycle.

(b) Cell cycle checkpoints: DNA damage checkpoints, Spindle assembly checkpoint

(c) Working mechanism of cell cycle checkpoints: Cyclin Dependent Kinases – key features, types of CDK, Cyclins - key features, types of cyclins

(d) Regulation of CDK Activity: Cyclin level, CDK-activating kinase, Inhibitory phosphorylation, CDK Inhibitors

(a) Cancer: Types of cancer, the development of cancer-clonal evolution, Properties of cancer cells; Oncogenes and proto-oncogenes, Functions of proto- oncogene; Tumor- suppressor genes and their normal functions

Module 6: Apoptosis (9 hours)

(a) Mechanism of programmed cell death
(b) Extrinsic pathway and Intrinsic pathways; Role of caspases in amplifying apoptotic signals, Role of mitochondria in regulating apoptosis, Pro-apoptotic proteins Bax and Bak and their interaction with outer mitochondrial membrane
(c) Inhibitors of apoptosis.
(d) Mechanism of aging.

Module 7: Cell Signaling (9 hours)

(a) Cell signaling - modes of cell-cell signaling.
(b) Signaling molecules and their receptors: Steroid hormones and the nuclear receptor superfamily, Nitric oxide and carbon monoxide, Neurotransmitters, Peptide hormones and growth factors, Eicosanoids, Plant hormones (Auxin).
(c) Cell Surface Receptors: G protein-coupled receptors, Receptor protein-tyrosine kinases, Cytokine receptors and nonreceptor protein-tyrosine kinases, Receptors linked to other enzymatic activities.
(d) Pathways of Intracellular Signal Transduction: cAMP pathway, Cyclic GMP, Phospholipids and Ca2+.

Module 8: Interactions between Cells and their Environment (9 hours)

(a) Extracellular matrix and its composition: collagens, elastin, proteoglycans, fibronectin, laminin, dystrophin.
(b) Proteins in cell-cell interaction: cadherins, immunoglobulin super family, integrins, and selectins.
(c) Cell-cell interactions: adhesion junction, tight junctions, gap junctions and plasmodesmata.

Practical (36 hours)

(a) Identification of different stages of meiosis from suitable plant material. Record the photographs of each stage.
(b) Identification of different stages of mitosis and study of morphology of metaphase chromosomes from Onion root meristems.
(c) Study of mitotic index from suitable plant material.
(d) Study on chromosomal abnormalities in humans.

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7. Robert J Brooker (2012). Genetics: analysis and principles (IV Edn). McGraw Hill.
8. Benjamin A Pierce (2012). Genetics: A conceptual approach (IV Edn). W H Freeman and Company.
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SEMESTER 2

Sl. No.	Course Code	Course Title	Credits	Course Type	Theory Hour	Practical Hour
1	24P2BOTT05	Bryology, Pteridology & Gymnosperms	4 (1+2+1)	Theory	Bryology: 18 Pteridology: 36 Gymnosperms: 18	Bryology: 9 Pteridology: 18 Gymnosperms: 9
2	24P2BOTT06	Molecular Biology & Immunology	4 (3+1)	Theory	Molecular Biology: 54 Immunology: 18	Molecular Biology: 36
3	24P2BOTT07	Plant Anatomy & Microtechnique	4 (2+2)	Theory	Plant Anatomy: 36 Microtechnique: 36	Plant Anatomy: 18 Microtechnique: 18
4	24P2BOTT08	Genetics & Evolution	3 (2+1)	Theory	Genetics: 36 Evolution: 18	Genetics: 36
5	24P2BOTP03	Bryology, Pteridology, Gymnosperms, Molecular Biology & Immunology	2	Practical		
6	24P2BOTP04	Plant Anatomy, Microtechnique, Genetics & Evolution	2	Practical		

24P2BOTT05: BRYOLOGY, PTERIDOLOGY & GYMNOSPERMS

(Theory: 72 hours; Practical: 36 hours; Theory Credits: 4; Practical credit: 1)

COURSE OUTCOMES (COs)	
CO 1	Classify Bryophytes, Pteridophytes and Gymnosperms based on their morphological and anatomical features.
CO 2	Identify Bryophytes, Pteridophytes and Gymnosperms in their habitats
CO 3	Explain the evolutionary trends primitive plant groups.
CO 4	Compareh various lifecycle events in the Bryophytes, Pteridophytes and Gymnosperms.
CO 5	Explain the adaptations in the Bryophytes, Pteridophytes and Gymnosperms
CO 6	Explain the economic and ecological significance of Bryophytes, Pteridophytes and Gymnosperms

BRYOLOGY (Theory 18 hours; Practical 9 hours)

Introduction to the course

(a) General characters, Classification, evolution of Bryophytes

(b) Morphology, anatomy and reproduction of *Riccia, Marchantia* & *Anthoceros*.

(c) Importance of Bryophytes

Module 1: General introduction (3 hours)

a) General characters
b) Recent system of classification (Shofield, 1985)
c) Contributions of Indian Bryologists
d) Origin and evolution of Bryophytes; Brief account on Fossil Bryophytes

Module 2: Ecological and Economic importance of Bryophytes (5 hours)

a) Ecological significance of Bryophytes - role as pollution indicators, role in ecological succession.
b) Economic importance of Bryophytes: Sphagnum as Peat Moss, Medicinal Uses, as source of food, Horticultural uses.

Module 3: Thallus structure (10 hours)

A general account of morphological and anatomical features, reproduction, life history of;

(a) Hepaticopsida (Marchantiales, Jungermanniales)

(b) Anthocerotopsida (Anthocerotales)

(c) Bryopsida (Polytrichales)

Practicals (9 hours)

1. Detailed study of the structure of gametophytes and sporophytes of the following genera of Bryophytes by suitable micropreparation: *Targionia, Marchantia, Dumortiera, Reboulia, Porella, Anthoceros and Pogonatum*.

2. Collection and identification of common bryophytes and record using geotagged photographs (minimum 5 types).

References

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17. Nair M C, Rajesh K P, Madhusoodanan P V (2005). *Bryophytes of Wayanad in Western Ghats*. Malabar Natural History Society.

PTERIDOLOGY (Theory 36 hours; Practical 18 hours)

Introduction to the course

- Introduction on the general characters of pteridophytes
- Structural organization of sporophyte and gametophyte of pteridophytes with special reference to stellar structure, heterospory and seed habit.

Module 1: General introduction and classification (4 hours)

a) Origin of pteridophytes
b) Brief account on Smith's classification (2006)
c) An account on DNA barcoding of pteridophytes
d) PPG I classification (up to the level of Orders)

Module 2: Paleopteridology (**6 hours**)

Brief description of the following form genus:

a) *Rhynia*
b) *Protolepidodendron*
c) *Sphenophyllum, Calamites*
d) *Cladoxylon*

Module 3: Lycophytes (**6 hours**)

Distribution, habitat, range, external and internal morphology of sporophytes, spores, mechanism of spore dispersal, gametophytic generation, sexuality, embryogeny of the following taxa of the lycophytes with reference to the genera mentioned below (development of sex organs is not necessary):

(Classification based on Bateman, 1996)

A. Class Lycopsida

- Order Isoetales - *Isoetes*
- Order Selaginellales - *Selaginella*
- Order Lycopodiales – *Lycopodiella*

Module 4: Monilophytes (Ferns) (14 hours)

Distribution, habitat, range, external and internal morphology of sporophytes, spores, mechanism of spore dispersal, gametophytic generation, sexuality, embryogeny of the following taxa of ferns with reference to the genera mentioned below (development of sex organs is not necessary):

(Classification based on Smith et al., 2006)

A. Class Psilotopsida

- Order Psilotales - *Psilotum*
- Order Ophioglossales - *Ophioglossum*

B. Class Equisetopsida

- Order Equisetales – *Equisetum*

C. Class Marattiopsida

- Order Marattiales – *Angiopteris*

D. Class Polypodiopsida

- Order Osmundales – *Osmunda*
- Order Gleicheniales – *Dicranopteris*
- Order Schizaeales – *Lygodium*
- Order Salviniales – *Marsilea, Azolla*
- Order Polypodiales – *Acrostichum*

Module 5: Comparative Study of Lycophytes and Ferns (4 hours)

a) Stelar organization, soral and sporangial characters, gametophytes and sporophytes of ferns and lycophytes in an evolutionary perspective.

Module 6: Ecology and Economic importance of pteridophytes (2 hours)

A. Ecological and economic significance of Pteridophytes.

Practical (18 hours)

1. What can lycophytes teach us about plant evolution and development? (Review paper Discussion)
2. Study of morphology and anatomy of vegetative organs using clear whole mounts/sections of the following genera (Geotagged clear images with proper contrast can be recorded and images can be used for labeling):
    a. *Psilotum, Lycopodiella, Selaginella, Equisetum, Angiopteris, Marsilea, Lygodium, Acrostichum, Dicranopteris, Pteris, Adiantum, Polypodium and Dryopteris*.
3. Study of sporangial and Soral studies of the following genera (Geotagged clear images with proper contrast can be recorded and images can be used for labeling);
    a. Psilotum, Ophioglossum, Equisetum, Lycopodiella, Selaginella, Lygodium, Dicranopteris, Ceratopteris, Pteris, Adiantum, Blechnum, Dryopteris, Asplenium, Drynaria, Odontosoria, Davalia, Acrostichum Marsilea, Salvinia, Azolla.

4. Field trips to familiarize with the diversity of Pteridophytes in natural habitats; 10 geotagged photographs of ferns and lycophytes with identification should be recorded; collection and preservation of 5 ferns or lycophytes; both should be supported with duly attested report.
5. Familiarize the trending ferns and lycophytes in the city by visiting various nurseries nearby, geotagged photographs for substantiating the visit.

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2. Arnold, C.A., 2013. *An introduction to paleobotany*. Read Books Ltd.
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GYMNOSPERMS (Theory 18 hours; Practical 9 hours)

Introduction to the Course

a) General characters of Gymnosperms

b) A preliminary study of morphology, anatomy and reproductive features of *Cycas*, *Pinus* and *Gnetum*

Module 1: Introduction (2 hours)

a) Distribution and classification of Gymnosperms (K R Sporne and C J Chamberlain).

b) DNA barcoding of gymnosperms.

Module 2: Vegetative and reproductive structures of Gymnosperms (14 hours)

Detailed study of the vegetative morphology, internal structure, reproductive structures, and evolution of the orders and families (with reference to the genera mentioned).

- Class Progymnospermopsida: *Aneurophyton*
- Class Cycadopsida: *Glossopteris, Medullosa, Cycas, Zamia, Pentoxylon*.
- Class Coniferopsida: *Pinus, Cupressus, Podocarpus, Agathis, Araucaria, Taxus* and *Ginkgo.*
- Class Gnetopsida: *Ephedra*

Module 3: Gametophyte development and economic importance of Gymnosperms (2 hrs)

a) General account on the male and female gametophyte development in Gymnosperms (*Cycas*).

b) Economic importance of Gymnosperms.

Practical (9 hrs)

1. Study of the morphology and anatomy of vegetative and reproductive parts of C*ycas, Zamia, Pinus, Cupressus, Agathis, Araucaria* and *Gnetum*.
2. Conduct field trips to familiarize various gymnosperms in nature and field identification of Indian gymnosperms and submit a report.
6. One day field visit: Field study to familiarize with the diversity of Gymnosperms in natural habitats/botanical garden; 10 geotagged photographs of Gymnosperms with identification should be recorded.

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1. Andrews H N Jr (1961). Studies in Palaeobotany. John Wiley and sons.
2. Arnold C A (1947). An introduction to Palaeobotany. John Wiley and sons.
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24P2BOTT06: MOLECULAR BIOLOGY & IMMUNOLOGY

(Theory: 72 hours; Practical: 36 hours; Theory Credits: 4; Practical Credit: 1)

COURSE OUTCOMES (COs)	
CO 1	Explain the basic properties, structure and functions of genetic materials.
CO 2	Explain the central dogma of molecular biology.
CO 3	Elaborate the regulations in gene expression and DNA repair mechanisms.
CO 4	Compare the alternate forms of DNA and RNA along with its significance
CO 5	Comprehend the functioning of the immune system.

MOLECULAR BIOLOGY (Theory 54 hours; Practical 36 hours)

Introduction to the Course

(a) Nucleic acids: Structure of DNA and RNA - basic features.

(b) Identification of DNA as genetic material: Transformation experiment, Hershey Chase experiment. RNA as the genetic material in some viruses.

(c) Important features of Watson and Crick model of DNA structure, Chargaff's rules.

(d) Replication of DNA: Meselson-Stahl experiment, semiconservative replication of DNA

(e) Gene expression: Concept of gene, central dogma, transcription in procaryotes and eucaryotes – basic features, RNA processing, translation - basic features, genetic code features

(f) Control of gene expression - positive and negative control - operon model.

Module 1: Genetic material and its molecular structure (10 hours)

(a) Alternative conformations of DNA: A-DNA, Z-DNA, C-DNA, E – DNA, triplex DNA, H-DNA and quadruplex DNA, circular and linear DNA, single-stranded DNA. Tautomeric forms of bases.

(b) C-value paradox, DNA renaturation kinetics, Tm, Cot curve. Unique and Repetitive DNA – mini- and microsatellites.

(c) Structure and function of different types of RNA: piRNA, snoRNA, lncRNA, SRP RNA, gRNA, and TERC

Module 2: DNA replication, repair and recombination (12 hours)

(a) DNA replication: Unit of replication, molecules, enzymes and proteins involved in replication (in both procaryotes and eucaryotes). Structure of the replication origin (in both procaryotes and eucaryotes), priming (in both procaryotes and eucaryotes), replication fork, fidelity of replication. Replication in the telomere - telomerase.

(b) DNA repair mechanisms: Direct repair, excision repair – base excision repair and nucleotide excision repair (NER), eucaryotic excision repair – GG-NER, TC-NER. Mismatch repair, Recombination repair – homologous recombination repair, nonhomologous end joining, SOS response.

(c) Recombination: Homologous and nonhomologous recombination, molecular mechanism of homologous recombination. Site-specific recombination.

Module 3: Gene expression (20 hours)

(a) Gene: Concept of gene.

(b) Transcription in prokaryotes: Initiation – promoter structure, structure of RNA polymerase, structure and role of sigma factors. Elongation – elongation complex, process of RNA synthesis. Termination – rho-dependent and rho-independent termination.

(c) Transcription in eukaryotes: Types, structure and roles of RNA polymerases. Promoters – important features of class I, II, & III promoters. Enhancers and silencers. General transcription factors and formation of pre-initiation complexes. Elongation factors, structure and function of transcription factors.

(d) Post-transcriptional events: Split genes, splicing signals, splicing mechanisms of group I, II, III, and tRNA introns. Alternative splicing, exon shuffling, *cis* and *trans* splicing. Structure, formation and functions of 5’ cap and 3’ tail of mRNA, RNA editing.

(e) Translation: Important features of mRNA – ORF, RBS. Fine structure, composition and assembly of procaryotic and eukaryotic ribosomes. tRNA charging, initiator tRNA.

(f) Stages in translation: Initiation – formation of initiation complex in procaryotes and eucaryotes, initiation factors in procaryotes and eucaryotes, Kozak sequence.

(g) Elongation – process of polypeptide synthesis, active centers in ribosome - 3-site model, peptidyl transferase, elongation factors. Termination – process of termination, release

factors, ribosome recycling.

(h) Genetic code: Important features of the genetic code, proof for the triplet code, Exceptions to the standard code.

Module 4: Control of gene expression (12 hours)

(a) Prokaryotic system: Regulatory proteins - activators and repressors. Structure of *Lac* operator, CAP and repressor control of *lac* genes. Regulation after transcription initiation – regulation of amino acid biosynthetic operons- attenuation of trp operon.

(b) Eukaryotic system: Changes in chromatin and DNA structure – chromatin compaction, transcriptional activators and repressors involved in chromatin remodeling, gene amplification, gene rearrangement, alternate splicing, gene silencing by heterochromatization, and DNA methylation.

Practical (36 hrs)

1. Work out problems based on DNA structure, replication, gene expression and genetic code.

IMMUNOLOGY (18 hrs.)

Module 5: Basics of Immunology (12 hours.)

a. Innate and adaptive immunity, humoral and cell mediated immunity.
b. Activation and differentiation of B cells – formation, role. T cells – types, roles, T cell receptors.
c. Structure, function and types of antibody molecules.
d. Antigens and epitopes, immunogenicity and antigenicity, antigen-antibody interactions. affinity and avidity, APCs, antigen processing and presentation. MHC molecules – types and functions.
e. Complement system, pattern recognition receptors – toll-like receptors.

Module 6: Antibodies (3 hours.)

a. Production and uses of monoclonal antibodies, antibody engineering.

Module 7: Vaccines (3 hours.)

a. Vaccines: Basic strategies, inactivated and live attenuated pathogens, subunit vaccines,

recombinant vaccines (e.g., Hepatitis B vaccine), DNA vaccines, RNA vaccines.

b. Modern approaches to vaccine development - edible vaccines.

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24P2BOTT07: PLANT ANATOMY & MICROTECHNIQUE

(Theory: 72 hours; Practical: 36 hours; Theory Credits: 4; Practical Credit: 1)

COURSE OUTCOMES (COs)	
CO 1	Understand plant cell structure in a detailed manner
CO 2	Appraise tissue level organization in plant system
CO 3	Know and carry out the plant anatomical specimen preparations
CO 4	Understand and compare wood anatomy, wood types, plant fibres and secretory tissues
CO 5	Analyze floral, nodal and reproductive anatomy of plants
CO 6	Apply microtechnique and microscopic examination in histochemical studies.
CO 7	Develop skills in techniques of botanical slide preparation.

PLANT ANATOMY (Theory 36 hrs; Practical 18 hrs)

Introduction to the Course:

(a) Scope and importance of Plant Anatomy; Interdisciplinary applications: - Histotaxonomy, Histochemistry, Pharmacognosy, Physiological Anatomy, Ecological Anatomy, Evolutionary trends in plant anatomy

(b) Study of Cell wall; Gross structure of primary and secondary cell walls, simple and bordered pits. Structure and function of plasmodesmata. Submicroscopic structure of cell wall- Cellulose, micelle, micro fibril and macro fibril. Different types of Cell wall thickening in tracheary elements

(c) Extra cell wall thickening materials: - Lignin, cutin, suberin and callose.

(d) Origin of cell wall; Growth of Cell wall- Apposition and intussusceptions – cavities & ducts, schizogenous & lysigenous developments

(e) Non living inclusions in plant cell: - Reserve food materials -carbohydrate (starch), protein (Aleurone grain) and lipids (fats and oil);

(f) Secretory products- pigments, enzymes and nectar.

(g) Metabolic byproducts: - tannin, gums, resins, essential oils, mucilage, latex, mineral

crystals and alkaloids

(h) Meristematic tissue- definition, structure, function and classification

(i) Apical organization and theories; Shoot apex- Apical cell theory, Histogen theory and Tunica- Corpus theory.

(j) Root apex - Histogen theory and Korper- Kappe theory.

(k) Permanent Tissue: - Structure and function of simple and complex tissues.

(l) Distribution and function of mechanical tissues in

plants. (m)Plant fibres-economic importance.

(n) Secretory tissues: External secretory tissue- glands and nectaries, and Internal secretory tissues- laticifers.

(o) Tissue System- Structure and Function in root, stem and leaves.

(p) Epidermal Tissue System- Epidermis, Cuticle, Trichome, Stomata, Bulliform cells, Cork and Silica cells.

(q) Ground Tissue System- Cortex, Endodermis, Pericycle, Pith and Pith rays.

(r) Vascular Tissue System- Different types of vascular bundles and their arrangement in root and stem.

(s) Vascular cambium: - Development, structure and function, Activity of cambium, role of cambium in budding, grafting and wound healing.

(t) Normal secondary growth in dicot stem and root.

(u) Wood anatomy- basic structure, heart wood, sap wood, hard wood, soft wood, growth rings and dendrochronology, porous and non porous wood, ring porous and diffuse porous wood, tyloses, knots.

(v) Wood rays: Structure and cell types, uniseriate and multiseriate rays; heterocellular and homocellular rays.

(w) Periderm: Structure and development- phellum, phellogen, phelloderm, bark, polyderm, rhytidome and lenticel.

(x) Anomalous secondary structure: Bougainvillea stem, Bignonia stem and Dracaena stem.

Module 1: Introduction (1 hr)

- Scope and significance of plant anatomy, interdisciplinary relations.

Module 2: Meristem (7 hrs)

(a) Apical organization: Stages of development of primary meristem; origin of branches and lateral roots.

(b) Secretory tissues in plants: Structure and distribution of secretory trichomes (*Drocera, Nepenthes*), salt glands, colleters, nectaries, resin ducts and laticifers. Structure of bark and distribution pattern of laticifers in *Hevea brasiliensis*

Module 3: Secondary structure (10 hrs)

(a) Vascular cambium and cork cambium: Structure and function, factors affecting cambial activity.

(b) Secondary xylem and phloem: Ontogeny, structure and function. Lignification patterns of xylem.

(c) Reaction wood: Compression wood and tension wood. Factors affecting reaction wood formation.

(d) Anomalous secondary growth in dicots and monocots (Piper, Strychnos)

(e) Wood: Physical, chemical and mechanical properties.

(f) Plant fibers: Distribution, structure and commercial importance of coir, jute, and cotton.

Module 4: Leaf and node (6 hrs)

(a) Leaf: Initiation, plastochronic changes, ontogeny and structure of leaf. Structure, development and classification of stomata and trichomes. Krantz anatomy, anatomical peculiarities in CAM plants. Leaf abscission.

(b) Nodal anatomy: Unilacunar, trilacunar and multilacunar nodes, nodal evolution.

(c) Root-stem transition in angiosperms.

Module 5: Reproductive anatomy (6 hrs)

(a) Floral Anatomy: Anatomy of floral parts - sepal, petal, stamen and carpel; Floral vasculature (*Aquilegia and Pyrola*). Vascular anatomy. Development of epigynous ovary - appendicular and receptacular theory.

(b) Fruit and seed anatomy: Anatomy of fleshy and dry fruits - follicle, legume, berry.

Dehiscence of fruits. Structure of seeds. Anatomical factors responsible for seed dormancy and drought resistance.

Module 6: Ecological anatomy (4 hrs)

- Morphological and structural adaptations in different ecological groups - hydrophytes, xerophytes, epiphytes and halophytes.

Module 7: Applied anatomy (2 hrs)

- Applications of anatomy in systematics (histotaxonomy) and Pharmacognosy. Research prospects in anatomy.

Practical (18 hrs)

1. Study of cambia - non storied and storied.
2. Study of the anomalous primary and secondary features in *Amaranthus, Boerhaavia, Mirabilis, Nyctanthes, Piper* and *Strychnos*.
3. Study of stomata, trichomes, and laticifers. Determination of stomatal index.
4. Study of the anatomical peculiarities of C4 and CAM plants (Leaf/Stem).
5. Study of nodal patterns.
6. Preparation of a histotaxonomic key.
7. Study of the pericarp anatomy of a legume, follicle and berry.
8. Identification of wood - soft wood and hard wood.

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MICROTECHNIQUE

(Theory: 36 hours; Practical: 18 hours)

Module 1: Botanical Microtechnique (2 hrs.)

Significance and applications; common methods for processing of cytological specimens; General reagents used for processing of plant specimens and adhesives.

Module 2: Killing and Fixation (6 hrs.)

Principles and techniques of killing and fixing; properties of reagents, fixation images; properties, uses and composition of important fixatives - Carnoy's Fluid, FAA, FPA, Chrome acetic acid fluids, Zirkle- Erliki's fluid.

Module 3: Dehydration, Clearing, Embedding and Sectioning (8 hrs.)

(a) Dehydration: Principles of dehydration, properties and uses of important dehydrating and clearing agents - alcohols, acetone, xylol, glycerol, chloroform, dioxan. Dehydration Methods: (i) Tertiary- butyl alcohol method (ii) Alcohol-xylene method.

(b) Embedding: method of paraffin embedding.

(c) Sectioning: Free hand sections – Prospects and problems; Sectioning in rotary microtome, sledge microtome and cryotome. Applications of microtomy.

Module 4: Staining (8 hours)

(a) Principle of staining; classification of stains and staining techniques, protocol for the preparation of; Natural dyes - Hematoxylin and Carmine

Coal tar dyes – Fast Green FCF, Orange G, Safranin O, Crystal violet, Lactophenol Cotton Blue and Oil Red O.

(b) Techniques of staining: (i) Single staining; Staining with Safranin O or Crystal violet (ii) Double staining; Safranin - Fast Green method, Safranine - Crystal violet method (iii) Triple staining; Safranin - Crystal violet - Orange G method.

(c) Histochemical staining of starch (Iodine-Potassium Iodide (IKI) stain/Lugol's solution), protein (Mercuric Bromophenol Blue (MBB) method & Millon's reagent test), total lipid (Sudan dyes) and lignin (Phloroglucinol-HCl (Ph-HCl) or Wiesner stain).

Module 5: Specimen preparation for Transmission Electron Microscopy (3 hours)

Material collection, fixing, dehydration, embedding, sectioning (glass knife preparation, grid preparation, ultra microtome) and staining.

Module 6: Whole mounts (6 hours)

(a) Significance of whole mounts. Principles and techniques of whole mounting, TBA/Hygrobutol method, Glycerine-xylol method.

(b) Staining of whole mount materials (Hematoxylin, Fast Green or Safranin-Fast Green combination).

(c) Special techniques for microscopic specimen preparation – smear, squash and maceration.

Module 7: Mounting and Labeling (3 hours)

(d) Mounting: Techniques, classification of mounting media – aqueous and resinous media, common mounting media used - DPX, Canada balsam, Glycerine jelly and Lactophenol.

(e) Cleaning, labeling, and storage of slides.

Practical (18 hours)

1. Students are expected to develop skills in the following techniques.
   (a) Preparation of semi-permanent slides.
   (b) Maceration.
   (c) Preparation of fixatives (FAA, Carnoys'fluid).
   (d) Preparation of Haupt's gelatin adhesive.
   (e) Preparation of dehydration series (Alcohol, Acetone, TBA).
   (f) Preparation of paraffin blocks.
   (g) Preparation of serial sections.
   (h) Preparation of permanent slides.
   (i) Preparation of permanent whole mounts.
2. Candidates should prepare and submit 6 permanent slides in which the following categories should be included;
   (a) Free hand sections (single/double stained).
   (b) Serial sections (single/double stained).
   (c) Wood sections and whole mounts.

References

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3. Krishnamurthy K V (1987). *Methods in Plant Histochemistry*. S Viswanathan printers, Anand book depot, Madras.
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7. Thomas T (2005). *Essentials of botanical microtechnique* (II Edn). Apex infotech publishing company.

24P2BOTT08: GENETICS & EVOLUTION

(Theory: 54 hours; Practical: 36 hours; Theory: 3 credits; Practical: 1 credit)

COURSE OUTCOMES (COs)	
CO 1	Explain the Hardy-Weinberg equilibrium and evolutionary forces responsible for shaping the gene pool.
CO 2	Analyze and solve problems related to map distance, gene order, Coefficient of Coincidence, Interference and population genetics.
CO 3	Explain the effect of epigenetic in inheritance of characters.
CO 4	Explain the process of evolution.
CO 5	Describe modern theories of evolution.
CO 6	Discuss adaptive radiation and speciation.

GENETICS (Theory 36 hours; Practical 36 hours)

Introduction to the Course

- Origin and development of Genetics- Mendelian laws - monohybrid and dihybrid cross, test cross and backcross.
- Exceptions to Mendelism -incomplete dominance, co-dominance, lethal genes, epistasis, complementary genes, multiple alleles
- Determination of Sex - sex determination mechanism- chromosomal, genic and environmental
- Quantitative inheritance- quanitative characters, polygenic inheritance
- Linkage and Crossing over - Stern's hypothesis, Creighton and McClintock's experiments
- Extra-chromosomal inheritance - chloroplast mutation, mitochondrial mutations, maternal effects

Module 1: Population Genetics (9 hrs)

(a) Population, Gene pool, polymorphic and monomorphic genes; allele frequency and genotype frequency; microevolution

(b) Hardy-Weinberg law – proof, and its applications; Hardy-Weinberg equilibrium; Implications of the Hardy–Weinberg Law; Extensions of the Hardy–Weinberg law

(c) Evolutionary forces: Mutation - mutation rate, Migration - conglomerate population, Natural selection - modern restatement of the principles of natural selection; fitness and selection; Darwinian fitness; Relative fitness types of selection- directional, stabilizing, disruptive; Genetic drift - bottle neck effect and founder effect, magnitude of genetic drift; Non-random mating- assortative mating, inbreeding, and outbreeding.

(d) Genetic equilibrium: Balancing selection – heterozygote advantage, mutation-selection balance, mutation drift balance.

(e) Sources of new genetic variation that occurs in populations (brief account) – Horizontal gene transfer, Exon shuffling, Changes in Repetitive Sequences, Independent assortment, Crossing over, Interspecies crosses, mutations, Gene duplications, changes in Chromosome structure and number.

Module 2: Linkage and Genetic Mapping (9hrs)

(a) Linkage and crossing over

(b) Genetic mapping: Mapping in bacteria - interrupted mating;

(c) Haploid mapping – tetrad analysis in *Saccharomyces*, haploid mapping in *Neurospora*

(d) Genetic mapping in higher organisms: test cross experiment, two-point cross, three-point cross, recombination frequency, map distances, gene order, interference and coefficient of coincidence.

(e) Physical mapping (brief account)

(f) Pedigree Analysis: Symbols used, Determination of human genetic diseases by pedigree analysis- Autosomal dominant traits, Autosomal recessive traits, X-linked dominant traits, X-linked recessive traits, Y-linked traits

(g) Mitotic recombination in *Drosophila* (twin spot)

Module 3: Epigenetics (18 hours)

(a) Epigenetics, Epigenome

(b) Major epigenetic mechanisms - DNA methylation and the methylome, histone modification and chromatin remodeling, noncoding RNAs (ncRNAs),

(c) Epigenetic changes associated with cell differentiation

(d) Transgenerational effects through paramutation

(e) X chromosome inactivation, dosage compensation, Lyon hypothesis, process of X-chromosome inactivation in mammals

(f) Genomic imprinting, monoallelic expression, genomic imprinting during gametogenesis, molecular mechanism of imprinting, genetic conflict hypothesis

(g) Epigenetic effects in monozygotic twins

(h) Epigenetics and cancer- DNA methylation and chromatin remodelling in cancer

(i) Behavioral Epigenetics - epigenetic changes induced by maternal behavior, epigenetic effects of early stress, epigenetics in cognition, epigenetic effects of environmental chemicals, epigenetic effects on metabolism

Practical (36 hours)

1. Workout problems related to linkage and genetic mapping.
2. Workout problems related to human pedigree analysis.
3. Workout problems from population genetics

References

1. D Peter Snustad, Michael J Simmons (2015). *Principles of genetics* (VI Edn). John Wiley and Sons.
2. Benjamin A Pierce (2020). *Genetics: A conceptual approach* (VI Edn). W H Freeman and Company.
3. Robert J Brooker (2023). *Genetics: analysis and principles* (VI Edn). McGraw Hill.
4. Klug, W. S., Cummings, M. R., Spencer, C. A., Palladino, M., Killian, D. (2020). Essent ials of Genetics, Global Edition. United Kingdom: Pearson Education.

EVOLUTION (Theory 18 hours)

Introduction to the Course

- Charles Darwin and Darwin's Evolutionary theory
- The Voyage of HMS Beagle and interesting observations
- Evidences for Evolution: Morphology and Comparative Anatomy, Embryology, Physiology and Biochemistry, Palaeontology, Biogeography

Module 1: Origin of Life (2 hrs)

- Abiogenesis and Biogenesis.
- Biochemical origin of life - Concept of Oparin and Haldane, Experiment of Urey and Miller (1953).
- Coacervates and microspheres

Module 2: Patterns of Evolution (3 hrs)

- Character Evolution, Convergent, divergent, and parallel evolution, Phylogeny and patterns of Evolution, Coevolution and coadaptation, Adaptive radiation.

Module 3: Natural Selection and adaptation (4 hrs)

- Adaptive evolution, the meaning of natural selection, Kins Selection and Hamilton's Rule. Levels of Selection – genic and species level, Nature of adaptations

Module 4: Speciation (4 hrs)

- Species concept; Morphological Species, Biological Species, and phylogenetic species concept.
- Mechanism of speciation – Genetic divergences and isolating mechanisms – geographic and reproductive isolation.
- Causes of speciation - allopatric, sympatric, Parapatric speciation.
- Micro and Macro-evolution, and Punctuated Equilibrium.

Module 5: Products of Evolution (3 hrs)

- Sex and Reproductive success; Concept of sexual selection, sexual selection by mate choice, Paradox of sex, Inbreeding and outcrossing,

- Coevolution: Symbiosis, Plant-animal Co-evolution; Mutualism, Commensalism. Protective - Colouration and Shape. Mimicry: Batesian and Mullerian- mimicry.

Module 6: Modern Theories of Evolution (2 hrs)

- Modern synthetic theory of evolution, molecular divergence, and molecular clocks; molecular tools in phylogeny.

References

1. Allan C. Hutchinson (2005). *Evolution and the Common Law*. Cambridge University Press.
2. Douglas J. Futuyma (4th ed. 2017 edition). *Evolution*. Sinauer Associates. INC-Publishers. USA.
3. Mark Ridley (2020, Second edition) *Evolution*. Oxford University Press
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7. Kenneth V. Kardong (2005). *An introduction to Biological Evolution*. McGraw-Hill publications. New York.
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10. Paul Amos Moody (1970). *Introduction to Evolution*. Harper and Row publishers, New york.
11. Victor Rico-Gray, Paulo S. Oliveira (2007). *The Ecology and Evolution of Ant-Plant Interactions*. University of Chicago Press.

SEMESTER 3

Sl. No.	Course Code	Course Title	Credits	Course Type	Theory Hours	Practical Hours
1	24P3BOTT09	Angiosperm Systematics	4	Theory	Angiosperm Systematics: 72	Practical: 36
2	24P3BOTT10	Biostatistics & Research Methodology	3 (2+1)	Theory	Biostatistics: 36 Research Methodology: 18	Biostatistics: 27 Research Methodology: 9
3	24P3BOTT11	Plant Physiology & Biochemistry	4 (3+1)	Theory	Plant Physiology: 54 Biochemistry: 18	Plant Physiology: 27 Biochemistry: 9
4	24P3BOTT12	Plant Reproductive Biology & Plant Breeding	4 (2+2)	Theory	Plant Reproductive Biology: 36 Plant Breeding: 36	Plant Reproductive Biology: 27 Plant Breeding: 9
5	24P3BOTP05	Angiosperm Systematics, Biostatistics & Research Methodology	2	Practical		
6	24P3BOTP06	Plant Physiology, Biochemistry, Plant Reproductive Biology & Plant Breeding	2	Practical		

24P3BOTT09: ANGIOSPERM SYSTEMATICS

(Theory: 72 hours; Practical: 36 hours; Theory: 4 credits; Practical: 1 credit)

COURSE OUTCOMES	
CO 1	Apply the principles of plant nomenclature in systematics
CO 2	Understand the various data sources of taxonomy and its applications in plant identification, classification and phylogeny
CO 3	Understand the various classification systems and literatures relevant to plant taxonomy
CO 4	Identification of angiosperms up to species level

Introduction to the Course

(a) Morphology of flowering plants

(b) Classifications - Linnaean system, Bentham & Hooker's system

(c) History of ICN and its principles; Binomial nomenclature system

(d) Herbarium – significance, methods involved in herbarium preparation

Module 1: Data sources of taxonomy (9 hours)

(a) Anatomy: Applications of anatomy in plant systematics; Vegetative Anatomy - Leaf Anatomy, Petiole Anatomy, Stem Anatomy, Nodal Anatomy, Wood Anatomy, Sclereids, Cellular Contents; Floral Anatomy

(b) Chemotaxonomy: Applications of chemotaxonomy in systematics; Flavonoids, Alkaloids, Terpenoids.

(c) Cytotaxonomy: Applications of cytotaxonomy in systematics – chromosome number, structure.

(d) Molecular Taxonomy: DNA barcoding, Applications DNA Barcoding in Plant Systematics, Basic features of barcoding sequence, barcodes in plants– ITS, *rbc*L, *mat*K, *trn*H–*psb*A, *trn*L–*trn*F.

(e) Any one case study based on the above-mentioned barcodes.

Module 2: Classification and Methodology of Identification of plants (9 hours)

(a) Systems of classification: Bentham & Hooker's System, APG system – principles, different versions, APG IV system

(b) Taxonomic literatures: Floras, Revisions, Monographs, Manuals, Indices, Journals

(c) Updated version of floral formula

(d) Taxonomic key - Indented and bracketed key

Module 3: ICN and Rules of Nomenclature (9 hours)

(a) Shenzhen Code 2019– key features, principles

(b) Basic concepts and terms-: taxon, nothotaxon, protologue, valid publication, legitimate name, correct name, homonym, autonym, isonym, basionym, tautonym, synonym-homotypic and heterotypic

(c) Author citation - single author and multiple authors

(d) Typification and its significance; Holotype, Isotype, Syntype, Paratype, Lectotype, Neotype, Epitype, and Topotype.

(e) Retention, Rejection and changing of names - Nomen nudum, Tautonym, Later homonym, Nomen superfluum, Nomen ambiguum, Later isonym, Nomen confusum, Nomen dubium; Conservation of Names

(f) Publication of names- Formulation, Diagnosis; Typification; Effective and valid publication

(g) Principles of priority

Module 4: Angiosperm Families (36 hours)

Study the following angiosperm families with special reference to their general characters, economic importance, ethnobotany, and evolutionary trends.

(a) **Polypetalae:** 1.Magnoliaceae 2.Capparidaceae 3.Malvaceae 4.Rutaceae 5.Rhamnaceae Leguminosae (6.Fabaceae 7.Caesalpiniaceae 8.Mimosaceae) 9.Rosaceae 10.Melastomaceae 11.Rhizophoraceae 12.Combretaceae 13.Myrtaceae 14.Apiaceae

(b) **Gamopetelae:** 15.Rubiaceae 16.Asteraceae 17.Campanulaceae 18.Sapotaceae 19.Myrcinaceae 20.Apocynaceae 21.Asclepiadaceae 22.Convolvulaceae 23.Solanaceae 24.Scrophulariaceae 25.Acanthaceae 26.Verbenaceae 27.Lamiaceae

(c) **Monochlamydeae:** 28.Aristolochiaceae 29.Lauraceae 30.Loranthaceae 31.Euphorbiaceae

(d) **Monocots:** 32.Orchidaceae 33.Dioscoriaceae 34.Zingiberaceae 35.Cyperaceae 36.Poaceae.

Practical (36 hours)

1. Identify the given plant species from the following families up to species level using the given family key and The Flora of the Presidency of Madras (Gamble, 192). Prepare the key to species for each specimen and draw the flower L.S, floral diagram and write the floral formula. The students should prepare geotagged images of the habit, inflorescence, single flower, flower L.S, androecium, and the gynoecium of the given plant species. 1.Capparidaceae 2.Malvaceae 3.Rhamnaceae 4.Fabaceae 5.Caesalpiniaceae 6.Mimosaceae 7.Rosaceae 8.Melastomataceae 9.Rhizophoraceae 10.Combretaceae 11.Myrtaceae 12.Apiaceae. 13.Rubiaceae 14.Asteraceae 15.Campanulaceae 16.Sapotaceae 17.Apocynaceae 18.Asclepiadaceae 19.Convolvulaceae 20.Solanaceae 21.Scrophulariaceae 22.Acanthaceae 23.Verbenaceae 24.Lamiaceae. 25.Aristolochiaceae 26.Loranthaceae 27.Euphorbiaceae
2. Preparation of indented and bracketed keys for at least 8 species from any two angiosperm families mentioned in the practical syllabus.
3. Work out the given nomenclature problems.
4. Field Study: The students are expected to conduct field study for not less than five days under the guidance of the course teacher and submit the field report for evaluation during practical exam.
5. Prepare five herbarium specimens (Simpson, 2019) and submit it for evaluation during practical exam.

References

1. Singh, G. (2019). Plant Systematics: An Integrated Approach, Fourth Edition. United Kingdom: CRC Press.
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24P3BOTT10: BIOSTATISTICS AND RESEARCH METHODOLOGY

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

COURSE OUTCOMES (COs)

CO 1	Define the principles and phenomena in biostatistics.
CO 2	Explain the tools and techniques available for studding biochemical and biophysical nature of life.
CO 3	Solve problems and research analysis with precision by applying biostatistical techniques and tools.
CO 4	Skill development in various computer tools in analysing data.
CO 5	Skill development in designing a research work, scientific writing and research communication
CO 6	Involve in research activities with knowledge on intellectual property right, laboratory etiquettes and bioethics.

BIOSTATISTICS (Theory: 36 hrs; Practical: 27 hours)

Module 1. Introduction (4 hrs)

a) Basic principles of Biostatistics: Methods of collection and classification of data; Primary and secondary data, qualitative and quantitative data. Various graphical representation of data – Bar diagram with SD/SE, quartile graph, scatter plot and multi-dimensional scaling (MDS).
b) Steps in Statistical studies, Data and Variable. Sample and population.
c) Data organisation, entry, preliminary data analysis and making different graphs using MS Excel.
d) Applications of biostatistics.

Module 2: Design of experiments (4 hrs)

a) Experimental designs: Principles – replication, local control and randomization.
b) Common designs in biological experiments: Completely randomized design, randomized block design, Latin square design, Factorial design, Duncan's Multiple Range Test.

Module 3. Measures of Central Tendency and dispersion (7 hrs)

a) Measures of Central Tendencies – Functions, types and applications of Mean, Median and Mode.
b) Measures of dispersion - Quartile Deviation, Mean Deviation and Standard Deviation. Standard Error and Relative measures of Dispersion, Skewness and Kurtosis.

Module 4: Probability, Correlation and Regression (8 hrs)

a) Linear regression and correlation - Simple Linear Regression (SLR) detailed study including derivation and analytical methods, Multiple Linear Regression concept and applications. Pearson's correlation coefficient and Spearman's rank correlation.
   Binomial, Normal and Poisson distribution.
b) Probability - Definition, mutually exclusive events – sum rule, independent events – product rule.
c) Applications of probability statistics.

Module 5: Tests of significance (10 hrs)

Inferential Statistics – Types of hypotheses, test of hypothesis - t-test, Chi square test, F-test, ANOVA. Test of significance – alpha value and p value.

Module - 6. Statistics in Life Science (**3 hrs**)

Study of statistical analyses using a standard scientific paper. Ref:

Practical (27 hours)

1. Analysis of data to find the mean, median and mode using MS Excel.
2. Preparation of various graphs: Bar diagram with SD/SE, quartile graph and scatter plot using MS Excel.
3. Analysis of a given data for mean deviation and standard deviation.
4. Test the significance of a given data using t test, X2 test, F-test and ANOVA.
5. Analysis of a set of data for correlation/regression.
6. Determine probability for different types of events.
7. Familiarization and data analysis using PAST/XLStat/SPSS or any other apt software.

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RESEARCH METHODOLOGY (Theory 18 hours; Practical 9 hours)

Module 1: Introduction to Research methodology (8 hrs)

a) Definition of Science and Research, Logical methods -Induction, Deduction, deductive-inductive process.
b) Research Process: Observation – critical thinking, theory, objectivity, reliability, validity.
c) Library Resources: Classification of books: Universal Decimal System and Dewey decimal classification.
d) Journals: Indexing journals, abstracting journals, research journals, review journals.
e) Grading of publications and scholars – impact factor, H-index.
f) Use online search literature services such as NCBI-Pub Med and ScienceDirect. (Hands-on session)
g) Plagiarism.

Module 2: Defining and formulating the research problem (2 hrs)

a) Selecting and defining of a research problem – critical literature review, identifying gap areas from literature review
b) Formulation of hypothesis – testing of hypothesis - null and alternate hypothesis
c) Preparation of research plan
d) Classification of research
e) Experimental design.

Module 3: Preparation of project proposals (1 hr)

a) Title, Introduction, literature review and abstract, Aim and scope, Present status, Location of experiments, Materials and methods, Justification, expected outcome, Plan of action, Estimated date of completion, Budget preparation, References,
b) Different National funding agencies supporting scientific research.

Module 4: Scientific writing (2 hrs)

a) Structure of a scientific paper (Research and review paper), dissertation,
b) Rules of title
c) Abstract (structure and its format) and keywords
d) Introduction, Methodology, Results, Discussion and Conclusion (structure and its format).
e) Style manuals.

Module 5: Scientific Communication (2 hrs)

a) Presentation techniques
b) Preparation and organizing a science poster presentation and Oral presentation.
c) Seminar, conference, colloquium, symposium, workshop.

Module 6: Intellectual Property Rights (1 hrs)

a) Copyright, Patents, Trademarks, Geographical indications.

Module 7: Laboratory Etiquettes and Bioethics (2 hrs)

a) Laboratory etiquettes: Safety and precaution - ISO standards for safety, accreditation of research Lab- NABL.
b) Bioethics: Definition, major ethical issues in experimentation involving animals and humans.

Practical (9 hours)

1. Prepare a project proposal.
2. Prepare an outline of a dissertation and research paper.
3. Prepare a review based on a research theme.
4. Use online search literature services such as PubMed, Science direct.
5. Prepare a model project proposal and submit the same for evaluation.
6. Prepare a project proposal with the help of powerpoint and submit the same for evaluation.

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24P3BOTT11: PLANT PHYSIOLOGY AND BIOCHEMISTRY

(Theory: 72 hours; Practical: 36 hours; Credits: Theory: 4; Practical: 1)

COURSE OUTCOMES (COs)	
CO 1	Explain plant -water relationship and mechanism of water absorption
CO 2	Examine the mechanism of photosynthesis, respiration, mineral nutrition nitrogen metabolism and translocation
CO 3	Develop a knowledge in photobiology and plant growth regulators
CO 4	Classify the plant responses to various environmental stresses
CO 5	Identify and compare the structure and functions of biomolecules.
CO 6	Perceive a detailed account on proteins, enzymology and nucleotide metabolism.

PLANT PHYSIOLOGY (Theory: 54 hours; Practical: 27 hours)

Introduction to the Course

(a) Structure and properties of water. Diffusion and Osmosis. Water Potential. Cohesion-tension theory. Entry of minerals into roots; bulk flow. Passive and active transport.

(a) Calvin cycle, Glycolytic pathway and its regulation, Citric acid cycle

Module 1: Plant water relations (8 hrs.)

(a) Cell wall and membrane properties in relation with water - Turgor Pressure and Hydraulic conductivity. Aquaporins.

(b) Water absorption by roots - pathways, root pressure and guttation. Water transport through xylem - pressure driven bulk flow. Water movement from the leaf to the atmosphere – hydraulic resistance, driving force of transpiration, pathway resistances. Leaf anatomy for regulating transpiration. Control of stomatal mechanism. Soil-plant-atmosphere continuum.

Module 2: Absorption of minerals (3 hrs.)

(a) Classification of mineral nutrients based on biological function.

(b) Soil characters influencing nutrient availability – size and charge of soil particles, soil pH.

(c) Theories of mineral salt absorption.

Module 3: Photosynthesis (14 hrs.)

(a) Basic principles of light absorption, excitation energy transfer, mechanism of electron transport. Light harvesting complexes: PS I, PSII; Structure and composition of reaction centers, photooxidation of water, organization of light-absorbing antenna systems, mechanism of chloroplast electron transport- complexes, Proton transport and ATP synthesis.

(b) Structure and function of RuBisco. CO_2 fixation- Regulation of Calvin cycle. Photorespiration, Role of photorespiration in plants. CO_2 concentrating mechanisms - C4 cycle, CAM pathway. Synthesis and mobilization of chloroplast starch, Regulation of synthesis and degradation. Biosynthesis of sucrose.

Module 4: Translocation in the Phloem (4 hrs.)

(a) Materials translocated in the phloem- Sucrose and other materials.

(b) Mechanism of phloem translocation - Pressure flow model of phloem transport. Phloem loading and unloading. Photosynthate allocation and partitioning.

Module 5: Respiration in plants (8 hrs.)

(a) Three stages of respiratory metabolism. (Brief study only). Gluconeogenesis. Pentose phosphate pathway and its regulation.

(b) Mitochondrial electron transport and ATP synthesis – structure of electron transfer complexes (complex I – IV). ATPase - detailed structure of F_1 and F_0 subunits, Chemiosmotic hypothesis, binding change mechanism of ATP synthesis.

(c) Mechanisms that lower ATP yield- alternative oxidase, Uncoupling proteins, Rotenone-Insensitive NADH dehydrogenase.

Module 6: Nitrogen metabolism: (4 hrs.)

Nitrate assimilation- nitrogen reductase. Ammonium assimilation, Symbiotic N fixation – nodule formation, leghaemoglobin. Process of N fixation and structure of nitrogenase enzyme complex.

Module 7: Stress physiology (4 hrs.)

Response of plants to biotic (pathogen and insects) and abiotic (water, temperature, salt, oxygen deficiency and heavy metal) stresses. Mechanisms of resistance to biotic stress and tolerance to abiotic stress.

Module 8: Sensory photobiology (4 hrs.)

Functions and mechanisms of action of phytochromes, cryptochromes and phototropins. Photoperiodism and biological clocks – circadian rhythms. Vernalization.

Module 9: Plant growth regulators (5 hrs.)

Biosynthesis, storage, breakdown, transport, physiological effects, and mechanism of action of plant growth hormones; Auxin, Cytokinin, Gibberellins, Abscisic acid.

Practical (27 hrs.)

1. Preparation of Molal, Molar and Percentage solutions.
2. Estimation of proline in plant tissues under various abiotic stresses.
3. Estimation of phenol in plant tissues affected by biotic stress.
4. Determination of peroxidase activity in plant tissues affected by biotic/abiotic stresses.
5. Estimation of free amino acids in senescing leaves to understand the source to sink transformation phenomenon.
6. Determination of osmotic potential by tissue weight method.
7. Separation of photosynthetic pigments by TLC/paper chromatography and calculating the Rf value.
8. Demonstration of amylase activity and GA effect in germinating cereal seeds.
9. Estimation of pigment composition of a leaf.
10. Separation and collection of leaf pigments by silica gel column chromatography.
11. Determination of nitrate reductase activity.
12. Extraction and estimation of leghaemoglobin from root nodules.

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BIOCHEMISTRY (Theory: 18 hrs.; Practical: 9 hrs.)

Introduction to the Course

- Acids and bases, strength of acids – strong acids, weak acids. Ionization of water – Kw, pH. Dissociation of acids – pKa, Henderson-Hasselbalch equation. Buffers – definition, chemical composition, requirements for a good buffer, buffer action, buffer capacity.

Module 1: Amino acids and Proteins (5 hrs.)

(a) Structure and classification of amino acids.

(b) Levels of protein structure - Primary structure – peptide bond. Secondary structure – Ramachandran plots, α-helix, β sheet. Tertiary structure – forces that stabilize tertiary structure. Quaternary structure.

(c) Functions of proteins.

(d) Protein turnover.

Module 2: Enzymes (10 hrs.)

(a) Principles of catalysis: Activation energy of a reaction. General characters of enzymes specificity, catalytic power, regulation. IUB system of enzyme classification and naming.

(b) Mechanism of enzyme activity: Formation of ES complex, acid-base catalysis, covalent catalysis, metal ion catalysis, proximity and orientation effect, strain and distortion theory. Factors affecting enzyme activity.

(c) Enzyme Kinetics: Michaelis-Menton kinetics, Lineweaver-Burk plot. Mechanism of multi substrate reaction – Single displacement and Double displacement reactions.

(d) Regulation of enzyme activity: Allosteric effect, reversible covalent modification,proteolytic activation.

(e) Enzyme inhibition – reversible and irreversible inhibition, competitive, noncompetitive, uncompetitive inhibition, dixon plot.

Module 3: Nucleotide metabolism (3 hrs.)

(a) Functions of nucleotides.

(b) Nucleotide biosynthesis by de novo pathways and salvage pathways.

Practical (9 hrs.)

1. Preparation of molal, molar, normal and percentage solutions and their dilutions.

2. Quantitative estimation of protein by Lowry's method.
3. Isolation and assay of amylase enzyme from germinating Pea seeds/appropriate plant material.

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24P3BOTT12: PLANT REPRODUCTIVE BIOLOGY AND PLANT BREEDING

(Theory: 72 hours; Practical: 36 hours; Theory credits: 4; Practical credit: 1)

COURSE OUTCOMES (COs)	
CO 1	Understand basic concepts of developmental biology, palynology and plant breeding
CO 2	Define plant breeding systems and self-incompatibility and their role in plant breeding in plants
CO 3	Explain different pollination syndromes and pollination and post pollination changes in flowering plants
CO 4	Explain pollen structure, characters and methods of pollen sampling.
CO 5	Apply pollination-, palynology- and plant breeding- techniques

PLANT REPRODUCTIVE BIOLOGY (Theory: 36 hours; Practical 27 hours)

Introduction to the course

(a) Anther: Structure and development, microsporogenesis, male gametophyte development.

(b) Ovule: Structure, ontogeny and types. Megasporogenesis. Embryo sac development, types with one example each; ultrastructure and nutrition of embryo sac. Female gametophyte development.

Module 1: Basic concepts of Developmental Biology (2 hrs.)

(a) An overview of plant and animal interaction,

(b) Applications of reproductive biology (research, agriculture, Industry, Forensic & Horticulture).

Module 2: Pollination (6 hrs.)

(a) Sexuality of flowers and plants. Agents of pollination and floral adaptations using apt examples.

(b) Pollination syndromes; study of common biotic and abiotic pollinations using specific features of pollinators and flowers.

(c) Field methods involved in pollination studies

Module 3: Post pollination changes (8 hrs.)

(a) Pollen pistil interactions; pollen on stigma, pollen tube trough style, pollen tube entry to the ovule. Molecules involved in pollen-pistil interactions.

(b) Fertilization: Double fertilization; Embryogenesis - different types, factors influencing embryogenesis.

(c) Endosperm-development and function, types of endosperm, endosperm haustoria.

(d) Apomixis and Polyembryony and their applications

Module 4: Self incompatibility (5 hrs.)

Self-incompatibility: Genetic basis of SI. Gametophytic and sporophytic SI, Physiology and biochemistry of incompatibility. Biological significance of incompatibility. Methods to overcome SI and interspecific incompatibility.

Module 5: Seed Biology (6 hrs.)

Seed development, Classification of Seeds, Importance of seeds, Seed dispersal; significance, agents and ecology of dispersal, Seed dormancy, Methods of breaking seed dormancy, soil seed banks, seed germination. Millennium seed project.

Module 6: Palynology (9 hrs.)

a) Introduction, brief history and applications of palynology; common terminologies used in spore and pollen description.
b) Seven categories of pollen morphological characters - aperture type, pollen wall architecture, pollen unit, polarity, symmetry, shape and size; pollen aperture – functions, role in pollen identification – NPC classification; special pollen structures (brief account only) – pollen bladders, viscin threads, pollen spines and pollenkitt.
c) Pollen wall – structure (exine and intine wall layers), chemical composition (sporopollenin) and its relationship to pollen preservation.
d) Production and dispersal of pollen grains, pollen rain. pollen viability and vigour; factors affecting pollen viability. Viability tests: - germination assay- in vitro and in vivo; non-germination assay – FCR/FDA test, Acetocarmine test for assessing sterility.
e) Pollen analysis – acetolysis technique; tools and methods used for pollen sampling from sedimentary rocks, underwater sediments, air, honey, insects, forensic samples and shipwrecks; Modern and fossil pollen rain sampling and collection of important floral data

- pollen diagram.

f) Use of pollen in nutrition and cosmetics. Pollen allergy.

Practical (27 hours)

1. Embryo excision from young seeds.
2. Pollen germination studies. Study of pollen germination of flowers at different times in relation to anthesis
3. Perform the pollen sterility test by Acetocarmine and viability test by in vitro germination (Impatiens, Crotolaria, Cucurbits etc.) and stigma receptivity test using Peroxidase.
4. Identification of different types of embryos, polyembryony, endosperm types, types of pollen grains, anther growth stages and types using permanent slides.
5. Tests for breaking dormancy in different seeds.
6. Identification of pollination syndromes with reasons of a given flower.
7. Morphology of pollen grains – exine ornamentation pattern.
8. Pollen key based on external characters of pollen grains of a family or genus of known plants.

References

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PLANT BREEDING (Theory: 36 hours; Practical: 9 hours)

Introduction to the Course

- Objectives of plant breeding, Plant introduction- procedure of plant introduction, quarantine regulations, acclimatization- agencies of plant introduction in India, major achievements.
- Selection- mass, pureline, clonal- genetic basis of selection- some achievements – semi dwarf wheat and Rice. Hybridization- Introduction, history, objectives and procedure.

Module 1: General Introduction (2 hrs.)

History of plant breeding, important achievements, characteristics improved by plant breeding and future prospects. Domestication and centers of origin (N. Vavilov) of cultivated plants and its significance

Module 2: Genetic basis of plant breeding (3 hrs.)

Genetic variability (origin and scale of variation) and its role in plant breeding. Genetic basis of breeding self- and cross –pollinated crops; Heritability and genetic advance, genotype-environment interaction; General and specific combining ability

Module 3: Reproductive systems (4 hrs.)

Influence of different reproductive systems in plant breeding: Autogamy, allogamy, Self-incompatibility and male sterility in crop plants and their commercial exploitation,

Module 4: Hybridization (4 hrs.)

Hybridization - role and methods, Inter-varietal, inter specific and inter generic crosses. Combination breeding and transgressive breeding, Back-cross breeding, Heterosis, Inbreeding depression and genetic basis. Population breeding methods in self pollinated and cross pollinated crops, Breeding of rice (varieties in Kerala) /wheat /potato.

Module 5: Germplasm conservation (6 hrs.)

Importance of germplasm in plant breeding, sources of germplasm, genetic vulnerability, germplasm conservation, types of germplasm collections, management of germplasm and significance of germplasm conservation, germplasm storage technologies, germplasm holdings at international agricultural research centres, IRRI, CIMMYT, Plant breeding research centres in India,

Module 6: Breeding for resistance (6 hrs.)

Breeding for biotic (disease) and abiotic (drought, salinity) stresses; loss due to diseases, disease development, disease escape, disease resistance types, vertical and horizontal resistances of biotic stress; methods of breeding for disease resistance.

Module 7: Breeding methods (11 Hrs.)

a) Ideotype breeding -Role and Methods, Dry matter partitioning, role of partitioning in crop yield, Applications of Ideotype Breeding. Achievements: (Wheat & Rice – Super Rice ideotypes).

b) Polyploidy breeding-Autopolyploidy and allopolyploidy. Role of chromosome manipulation. Chromosome addition and substitution lines. Achievements

c) Mutation breeding - Mutagens and crop improvement. Spontaneous and induced mutations, effects of mutation. Physical and chemical mutagens; principles and working of Gamma gardens, methods of mutation breeding, mutations in oligogenic traits, mutations in polygenic traits, limitations of mutation breeding, achievements of mutation breeding. Role of mutations in Plant Breeding. Use of mutagens in genomics, allele mining, TILLING

d) Modern breeding methods - Modern Trends in Plant Breeding: Tissue culture Technologies, Genomic and biotechnology in plant breeding- marker-assisted selection (MAS) for salinity and drought tolerance, marker-assisted backcrossing (MABC), marker-assisted recurrent selection (MARS) for quantitative trait loci (QTL).

Practical (9 hrs.)

1. Calculation of heritability and genetic advance.
2. Seed viability testing: germination test, tetrazolium test, excised embryo test
3. Study of Germplasm of Various Crops
3. Visit a plant breeding station with a nursery/garden to familiarize with breeding programs. Submit a detailed report of the visit including techniques learned.

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SEMESTER 4

PROGRAMME ELECTIVE: BIOTECHNOLOGY

Sl. No.	Course Code	Course Title	Credits	Course Type	Theory Hour	Practical Hour
1	24P4BOTT13	Genetic Engineering & Biological Techniques	4 (3+1)	Theory	Genetic Engineering: 54 Biological Techniques: 18	Genetic Engineering: 27 Biological Techniques: 9
2	24P4BOTT14	Genomics, Proteomics & Bioinformatics	4 (2+2)	Theory	Genomics, Proteomics – 36 Bioinformatics - 36	Genomics, Proteomics: 9 Bioinformatics: 27
3	24P4BOTT15	Plant Tissue Culture	4	Theory	Plant Tissue Culture: 72	Practical- 36
4	24P4BOTP07	Genetic Engineering, Biological Techniques, Genomics, Proteomics & Bioinformatics	2	Practical		
5	24P4BOTP08	Plant Tissue Culture	2	Practical		
6	24P4BOTPJ	Research Project	4	Project		
7	24P4BOTCV	Comprehensive Viva Voce	3	Viva		

24P4BOTT13: GENETIC ENGINEERING AND BIOLOGICAL TECHNIQUES

(Theory: 72 hours; Practical: 36 hours; Theory: 4 credits; Practical: 1 credit)

COURSE OUTCOMES (COs)	
CO 1	Explain the fundamental and advanced aspects of recombinant DNA technology, gene cloning strategies
CO 2	Describe the various aspects of advanced transgenic technology
CO 3	Explain the social and ethical issues in the field of biotechnology
CO 4	Describe the scope and relevance of genome editing & rDNA technology
CO 5	Develop an understanding of the many experimental methods that are frequently employed in research.

GENETIC ENGINEERING (Theory 54 hrs; Practicals 27 hrs)

Introduction to the Course

(a) History of biotechnology

(b) Genetic engineering- basic principles, tools and techniques

(c) Direct gene transfer methods - microprojectiles, electroporation, microinjection, chemical, lipofection

(d) PCR - Procedure and applications, variants of PCR.

(e) Blotting techniques - procedure and applications of southern, northern, western, and dot blotting.

Module 1: rDNA Technology- Tools and Techniques (9 hrs)

(a) Isolation of DNA and RNA from bacteria and plant cells

(b) DNA cutting and modifying enzymes: restriction endonucleases and Ligases – types, mode of action

(c) In vitro DNA ligation strategies: Joining with ligases – adaptors, linkers and homopolymer tailing

(d) Vectors – necessary properties of a vector, construction, important features and

specific uses of vectors: pBR322, pUC, Lambda phage, M13, artificial chromosomes – YAC, BAC, PAC, HAC.

Module 2: Procedure of gene cloning (in bacteria using pBR322 vector system) (9 hrs)

(a) Creation of recombinant DNA

(b) Introduction of recombinant DNA into host cell – preparation of competent host cells, transformation.

(c) Selection of transformed cells, identification of recombinant cells – insertional inactivation.

(d) Methods of screening and selection of recombinant cells – selectable markers and *Lac Z* system, blue white screening

Module 3: Plant transformation (9 hrs)

(a) *Agrobacterium tumefaciens* mediated gene transfer in plants – structure of Ti plamid, vir gene products and its function, opine synthesis genes, tumour causing genes,

(b) Mechanism of *Agrobacterium* infection and crown gall formation

(c) Vector system based on *A. Tumefaciens* - binary vector and cointegrate vector

Module 4: Advanced transgenic technology (9 hrs)

(a) Inducible expression systems – natural and recombinant

(b) Site-specific recombination – lox p and Cre recombinase

(c) Homologous recombination and gene knock out

(d) Gene silencing using antisense RNA and RNAi

(e) *In vitro* mutagenesis - site-directed mutagenesis

Module 5: Genome editing (9 hrs)

(a) Process of genome editing: basic principle and steps involved in genome editing.

(b) Genome editing methods: Meganucleases, ZFN, TALEN, CRISPR/Cas9.

(c) Applications of genome editing: tool to study gene function, in genetic engineering, in gene therapy.

Module 6: Applications of rDNA technology (9 hrs)

(a) Applications of GM microbes – in production of useful proteins, basic genetic research

(b) Applications of GM animals - in basic research, producing novel proteins, disease studies

(c) Applications of GM plants - herbicide tolerance, insect and disease resistance, stress resistance, increasing nutritional and other novel qualities in plants.

Practical (27 hrs)

1. Isolation of plant genomic DNA and its quantification.
2. Isolation of plasmids and its purification.
3. Isolation of bacterial genomic DNA and its quantification by using UV spectrophotometer.
4. Separation and visualization of DNA using agarose gel electrophoresis.
5. Separation of proteins by PAGE.
6. PCR

BIOLOGICAL TECHNIQUES (Theory 18 hrs; Practical 9 hrs)

Module 8: Microscopy (8 hrs)

Parts of microscope, principles of microscopy. Types of microscopes - simple and compound; Stereo microscope, Fluorescence microscope, Confocal microscope and electron microscope (TEM, SEM and E-SEM). Micrometry, Photomicrography and microphotograph.

Module 9: Principles and applications of instruments (10 hrs)

(a) Basic principles and applications of; (i) pH meter (ii) UV-visible spectrophotometers.

(b) Centrifuges: Basic Principle, Types; Table top centrifuge and ultra centrifuge.

(c) Chromatography: Principles and application; paper, TLC, Column chromatography, GC, HPLC.

(d) Immunoassay systems, ELISA - ELISA reader.

(e) Electrophoresis: SDS PAGE, AGE and PFGE.

(f) X-ray crystallography.

(g) Mass Spectrometry.

Practical (9 hrs)

1. Micrometry: Calibrate the ocular micrometer stage micrometer on a light microscope and measure the size of an object (e.g., diameter of spore/pollen grains, width of algal filaments).
2. Calibrate the pH meter and test the pH of different sample solutions.
3. Estimate the concentration of the given sample using calorimeter or spectrophotometer.
4. Prepare a plant extract and perform TLC.

References

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24P4BOTT14: GENOMICS, PROTEOMICS & BIOINFORMATICS

(Theory: 72 hours; Practical: 36 hours; Theory: 4 credits; Practical: 1 credit)

COURSE OUTCOMES (COs)	
CO 1	Compile and explain the history of genomics and the revolution happened in the field
CO2	Distinguish the ancient and modern techniques to understand the structural features of genome
CO 3	Elaborate the modern principles of functional genomics
CO 4	Simplify the evolutionary studies using the genomic tools and appraise the social and ethical issues with a scientific temper
CO 5	Formulate the genomic studies using the fundamentals of bioinformatics

GENOMICS & PROTEOMICS (36 hrs)

Introduction to the Course (2 hrs)

a) Genomics: Genome and Proteomics- History and Key concepts.

Module 1: Structural genomics (18 hrs)

a) Basic steps in genome sequencing. Shot gun sequencing of small genomes. Map based sequencing: Hierarchical shot gun sequencing (clone-by-clone approach) - steps involved; Whole genome shot gun approach - steps involved.
b) Genome mapping: Genetic mapping and physical mapping. Physical mapping – restriction mapping, STS mapping, EST. Construction of linkage maps using molecular markers – RFLP, RAPD, AFLP, SSLP, SNP.
c) Next generation sequencing strategies: Preparation of sequencing library. Pyrosequencing, Reversible terminator sequencing, ion torrent method, SOLiD. PacBio long range sequencing, nanopore sequencing.
d) Applications of NGS in modern science (Any five applications)
e) Sequence assembly – methods used. (Reference based and de novo assembly)
f) Important findings of the completed genome projects: *Arabidopsis* genome project, Rice genome project, Tomato genome project, Banana Genome project

Module 2: Functional genomics (8 hrs)

a) Expression profiling (mRNA profiling)
    a. RT-PCR
    b. Real time quantitative PCR (qPCR or RT-qPCR)
    c. Transcriptome/RNA seq
    d. Methyl-Sequencing
    e. DNA Microarray
b) Chromatin immunoprecipitation sequencing (CHIP-Seq) and its applications.

Module 3: Comparative genomics (4 hrs)

a) Gene identification by comparative genomics
b) Comparative genomics as a tool in evolutionary studies.
    i. Orthologous, Analogous, Paralogous and Xenologous genes
c) Metagenomics.

Module 4: Proteomics (4 hrs)

a) Proteome, proteomics.
b) Protein profiling – steps in protein profiling - 2D gel Electrophoresis, Mass Spectrometry (Basic principle).
c) Protein expression analysis using Protein microarray, protein localization using GFP.

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17. Jocelyn E Krebs, Elliott S Goldstein, Stephen T Kilpatrick (2011). *Lewin's Genes X* . Jones and Bartlett Publishers.

BIOINFORMATICS (36 hrs)

Introduction to the Course (2 hrs)

a) Introduction, aim and importance of bioinformatics.

b) Databases: primary and secondary databases (PROSITE, PRINTS, BLOCKS).

c) DNA sequence databases – NCBI Genbank, DNA databank of Japan, Nucleotide sequence databank (EMBL Bank); Specialized databases.

d) Protein databases - Uniport, PDB.

Module: 1 (16 hrs)

a) Submission and retrieval of databases – BankIt, ENTREZ.
b) Sequence analysis – significance. Global and local alignment. Methods of sequence alignment – paired sequence alignment, multiple sequence alignment.
c) Sequence comparison – dot matrix method, dynamic programming for sequence alignment; Global - Needleman Wunch algorithm; Local - Smith Waterman algorithms.
d) Database similarity search – query sequence search; BLAST - different versions; FASTA
e) Tools for multiple sequence alignment – CLUSTAL X/W.

Module: 2 (8 hrs)

a) Gene prediction strategies, ORF finder.
b) RNA secondary structure prediction
c) Protein structure and function prediction - tools used.
d) Bioinformatics for enzyme and protein design. Protein visualization tool – Rasmol

Module: 3 (6 hrs)

a) Applications of bioinformatics in evolutionary studies – molecular phylogenetics, molecular clock hypothesis.
b) Construction of phylogenetic trees – MEGA, Phylip

Module: 4 (4 hrs)

a) Computer assisted drug design - concept, methods and practical approaches.

Practicals (36 hrs)

1. Protein visualization using Rasmol, Pymol and Swiss PDB viewer
2. Multiple sequence alignment using CLUSTAL W.
3. Phylogenetic analysis by MEGA, Beast and Beauti.
4. Gene prediction programs – Grail/Exp, GENSCAN, ORF finder.
5. Multiple sequence alignment and ontology-based database searches on selected plant cytoskeletal genes to decipher the molecular phylogeny of cytoskeleton genes – record the results.
7. Drug Designing: Autodock Vienna and Discovery studio.

References

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24P4BOTT15: PLANT TISSUE CULTURE

(Theory: 72 hours; Practical: 36 hours; Theory: 4 credits; Practical: 1 credit)

COURSE OUTCOMES	
CO 1	Explain the role of plant growth regulators in tissue culture medium
CO 2	Apply the principles of plant tissue culture for the production of ploidy variants and somaclonal variants
CO 3	Describe organogenesis and somatic embryogenesis
CO 4	Identify various *in vitro* culture techniques
CO 5	Modify the secondary metabolite production by *in vitro* techniques
CO 6	Explain the in vitro conservation strategies

Introduction to the Course

- History of plant tissue culture, Principles of tissue culture: Cellular totipotency, callus induction, organogenesis and somatic embryogenesis.
- Tissue culture medium: Basic components in tissue culture medium, MS medium, Preparation medium
- Aseptic techniques in tissue culture: sterilization of instruments and glass wares, medium, explants; working principle of laminar air flow and autoclave.

Module 1: Plant Growth Regulators (9 hours)

a) Role of plant growth regulators tissue culture medium
b) Sterilization of plant growth regulators
c) Different types of plant growth regulators: Auxin, Cytokinin, Gibberellic acid, Abscisic acid, Brassinosteroid, Jasmonic acid, Salicylic acid, Strigolactones, Phloroglucinol, Lignosulfonate, Phytosulfokine-alpha, Pluronic F-68, Paclobutrazol, Fipexide, Trichostatin, Triacontanol, Nanoparticles

Module 2: Organogenesis and Somatic Embryogenesis (9 hrs)

a) Callus induction: callus, factors affecting
b) Somatic embryogenesis: Factors affecting somatic embryogenesis; Somatic embryogenesis developmental process - Embryo induction, development maturation, and germination; advantages and limitations; Encapsulation of somatic embryos, synthetic seed production; desiccated and hydrated types. Applications and limitations of synthetic seeds.
c) Organogenesis: Direct and Indirect organogenesis; Factors affecting organogenesis; Organogenesis developmental process; induction of organogenic differentiation; advantages and limitations

Module 3: Somaclonal variation (9 hours)

a) Isolation of somaclonal variants, molecular basis of somaclonal variation.
b) Origin of somaclonal variation – pre-existing variability, in vitro induced variability; Reasons–changes in ploidy level, changes in chromosome structure, gene mutations, gene amplifications, changes in extra nuclear genes, activation of transposable elements, DNA methylation.
c) Applications of somaclonal variation.

Module 4: Production of ploidy variants (13 hours)

a) Haploids: History of anther culture, Androgenesis - pretreatment of anther/pollen grains, media and growth regulators, Induction and stage of pollen development, regeneration, androgenic embryos, factors affecting androgenesis. Microspore culture - protocol, advantages over anther culture. Production of doubled haploid plant; Identification of haploid plants; Application of anther culture in crop improvements
b) Gynogenesis: Developmental stage at inoculation, in vitro maturation of embryo sacs, origin of embryos, triggering factors – pretreatment, medium. Uses and limitations of haploid plants.
c) Triploids: importance of triploid plants, conventional production of triploid plants, endosperm culture-advantages and limitations.

Module 5: *In vitro* Culture Techniques (14 hours)

a) Isolation and purification of protoplasts, culture of protoplasts, cell division and callus formation, plant regeneration; Protoplast fusion (somatic hybridization) – chemical, mechanical, electrofusion. Selection, isolation of heterokaryons, cybrids and their applications. Applications of protoplast culture.
b) Embryo rescue: History of embryo rescue; Culture medium for embryo rescue; Embryo culture technique – immature and mature culture; Applications of embryo culture
c) Meristem culture: Need for meristem culture; Meristem isolation from infected plants; Culture media for meristem culture; Eradication of plant viruses through meristem culture; Applications
d) Micropropagation: Techniques and stages of micropropagation. Advantages and disadvantages of micropropagation. Applications

Module 6: *In vitro* Secondary Metabolite Production (9 hours)

a) Culture conditions for producing secondary metabolites, selection of high yielding lines, elicitation, and immobilization of cells.
b) Hairy root culture – advantages of using hairy root culture, establishment of hairy root culture and production of secondary metabolites.
c) Cell immobilization: Methods, advantages and applications.

Module 7: *In vitro* Germplasm conservation (9 hours)

a) Potential application of *in vitro* technology for germplasm conservation; Explants used for germplasm conservation
b) Short and medium term conservation - Low-temperature storage, Use of minimal growth medium, Use of growth retardants, Storage under low oxygen environment, Encapsulation technology;
c) Long-term conservation by cryopreservation - pretreatment, freezing methods, cryoprotectants, vitrification, thawing

Practical (36 hours)

1. Preparation of the stock solutions of MS medium.
2. Preparation of selective medium for drought or salinity resistance. Preparation of MS soild medium from stock solutions containing auxin and cytokinin, NaCl or PEG, and inoculation.
3. Preparation of synthetic seeds.
4. Find out the uninucleate stage of anther and anther culture.
5. Dissect out an ovule from any ovary of any flower and culture it on a suitable solid medium
6. Dissect out an embryo from any seed and culture it on a suitable solid medium.
7. Micropropagation of any one plant species by node culture.
8. Visit a well-established plant tissue culture laboratory and submit the report on the lab visit for evaluation as part of the practical examination.

References

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4.MODEL QUESTION PAPER THEORY EXAMS

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany, Semester I
Model Question Paper
24P1BOTT01: MICROBIOLOGY AND PHYCOLOGY

Time 3 hours **Total Weight: 30**

PARTA

Answer any *eight* of the following; each question carries one weightage

1. What is a coenobium? Give an example
2. What are 'globule' and 'nucule'?
3. What do you mean by cryptophytes? Give example
4. What is 'eye spot'?
5. What are epiphytic algae?
6. Write short notes on Storage food in algae
7. What are Okasaki fragments?
8. Give an account on Rickettsias
9. Briefly describe the ultrastructure of flagellum of bacteria
10. Explain Hfr strain and write a note on its significance

(8 x 1 = 8)

PART B

Answer any *Six* of the following; each question carries two weightages.

11. Compare the algal classification by F.E. Fritsch and G.M. Smith.
12. Briefly explain the diplobiontic type of life cycle. Give an example.
13. Write short notes on (a) Algal bloom (b) Pyrenoids (c) Endospore (d) Heterocyst
14. Give the occurrence and distribution of algae with examples.
15. What are endospores? How does it differ from cysts?
16. Explain the importance of microbiology in modern industry
17. Give a detailed account on the ultra-structure of TMV.
18. With the help of suitable diagrams explain the ultra-structure of gram positive bacteria

(6 x 2 = 12)

PART C

Answer any *two* of the following; each question carries five weightages.

19. Trace the origin and evolution of sexuality in green algae. Illustrate your answer with suitable diagrams and examples.
20. Give an account of the thallus organization of Chlorophyceae in an evolutionary perspective.
21. Explain the replication of bacterial DNA with a special mention about the role of enzymes involved in it.
22. Explain various recombination methods in bacteria.

(2 x 5 = 10)

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany, Semester I
Model Question Paper
24P1BOTT02: MYCOLOGY AND PLANT PATHOGEN INTERACTIONS

Time 3 hours **Total Weight: 30**

PARTA

Answer any *eight* of the following; each question carries one weightage

1. Write short notes on spore dispersal in Nidulariales
2. Describe the abiotic causes of plant diseases.
3. How do contact fungicides differ from systemic fungicides?
4. What is macrocyclic lifecycle?
5. Name six fungal parasites in human beings.
6. Differentiate paragynous from monoclinous antheridium
7. Differentiate sclerotium from soredium
8. What is Gleba?
9. What is Mitic system?
10. What is peridiole?

(8x1= 8)

PART B

Answer any *Six* of the following; each question carries two weightages.

13. Write a brief account on the environmental significance of lignolytic and cellulolytic fungi.
14. Describe the sexual reproduction in Mastigomycotina.
15. Write a brief account on the common diseases, their symptoms and control in cereals.
16. What are the common structural features found in plants that prevent the colonization of a pathogen?
17. Explain/Write short notes on the following:
    (a) Plant quarantine (b) Prophylaxis (c) Necrosis
18. What are fungus gardens? Describe the type of interactions found there.

(6x2=12)

PART C

Answer any *two* of the following; each question carries five weightages.

19. Briefly describe the classification of Fungi proposed by Ainsworth.
20. Write an essay on the common strategies adopted to control plant diseases
21. Describe the process of infection and pathogenesis in plants.
22. Write the symptoms, etiology and control measures of any three common diseases of fruits you have studied. How are the pathogens disseminated from plant to plant?

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany, Semester I
Model Question Paper
24P1BOTT03: ECOLOGY, ENVIRONMENTAL BIOLOGY AND PHYTOGEOGRAPHY

Time 3 hours **Total Weight: 30**

PARTA

Answer any *eight* of the following; each question carries one weightage.

1. Analyze the term ecological niche.
2. Define remote sensing.
3. Explain bioremediation?
4. Write a short note on e-references.
5. Explain ecotone.
6. Discuss RET species.
7. Analyze the consequences of eutrophication?
8. Discuss resilience community.
9. What is bioscrubber?
10. What is *El Nino*? (8x1 = 8)

PART B

Answer any *Six* of the following; each question carries two weightages.

11. Briefly explain various interspecific interactions in plant communities.
12. Describe the importance of literature survey in scientific research.
13. Interpret ecological succession?
14. Give an account of conservation in biosphere reserves.
15. Predict the general pattern of ecological succession. Write about different types of succession and important events in succession.
16. Evaluate applications of remote sensing in ecology.
17. Explain the interdisciplinary nature of ecology.
18. Write a brief account on remote sensing with an emphasis on its role in conservation.

(6x2= 12)

PART C

Answer any *two* of the following; each question carries five weightages.

19. Critically evaluate how evolution, biogeography and ecology are interconnected.
20. Write an essay on different ecosystems in the world? Write a comparative account of them with reference to their productivity, biodiversity, energy flow, food chain and trophic levels.
21. Explain different methods of measuring species diversity.
22. Discuss about natural resources and their sustainable management in the Western Ghats.

(5x2 = 10)

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

M.Sc. Botany, Semester I

Model Question Paper

24P1BOTT04: CELL BIOLOGY

Time 3 hours **Total Weight: 30**

PARTA

Answer any *eight* of the following; each question carries one weightage.

1. Give an account of microtubules.
2. What is histone core?
3. What are cell cycle checkpoints?
4. What are proteoglycans?
5. Give an account on signal peptidase.
6. Why lysosomes are called as suicidal bags of a cell?
7. Explain the various steps occurring in the process of apoptosis.
8. Give an account on receptor tyrosine kinase receptors.
9. What are the different alcohol moieties of phosphoglycerides?
10. Give an account on the various types of secondary messengers in signalling.

(1 x 8 = 8)

PART B

Answer any *Six* of the following; each question carries two weightages.

11. With the help of a labelled diagram, explain the structure of mitochondria.
12. Give a brief account on plasmodesmata.
13. What is cell cycle? Explain the events in cell cycle.
14. Give an account on G protein-coupled receptor kinase (GRK).
15. Explain the structure and functions of integral membrane proteins.
16. Explain the molecular structure and functions of kinesin.
17. Give an account on intrinsic pathway of apoptosis.
18. What are the different types of movements exhibited by phospholipids?

(2 x 6 = 12)

PART C

Answer any *two* of the following; each question carries five weightages.

19. What is calmodulin? Give its functions.
20. With the help of suitable examples explain Facilitated diffusion.
21. Give an account on secretory pathway. Briefly explain how proteins are transported to plasma membrane and lysosomes.
22. Explain the organization of eukaryotic chromosomes. Write an account on heterochromation and euchromatin.

(5 x 2 = 10)

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany, Semester II
Model Question Paper
24P2BOTT05: BRYOLOGY, PTERIDOLOGY & GYMNOSPERMS

Time 3 hours **Total Weight: 30**

PARTA

Answer any *eight* of the following; each question carries one weightage.

1. What is Massula, what is its function?
2. What is sporocarpiferousbranch, what is its function?
3. With help of a diagram describe the type of Stele in Osmundarhizome?
4. What are the different types of spore germinations?
5. Briefly describe the economic importance of sphagnum.
6. Give the general characters of Metzgeriales.
7. Give an account on various habitats of bryophytes.
8. Differentiate hydroids and leptoids.
9. Briefly describe the general characters of gymnosperms.
10. Differentiate between Rhopalostachya and Urostachya.

(8 x 1 = 8)

PART B

Answer any *Six* of the following; each question carries two weightages.

11. Give a comparative account of the structure of Sporocarp of Salvinia&*Marsilea*.
12. Write a note on sporangial maturation & development.
13. Give a detailed description of the development of sporangium in *Osmunda*.
14. Briefly describe the reproductive structures in *Ginkgo*?
15. Give an account on fossil Bryophytes.
16. Compare the internal structures of *Lunularia* and *Marchantia* with the help of diagram.
17. Explain the economic importance of Gymnosperms.
18. Compare and contrast the sporophytic structures in liverworts.

(6 x 2 = 12)

PART C

Answer any *two* of the following; each question carries five weightages.

19. With the help of labeled diagrams describe different types of Stelar system found in Pteridophytes
20. Give a detailed account on gametophyte of Lycopodium**.**
21. Explain the sprorophytic structure of Anthoceros with a neat labelled diagram.
22. Explain the vegetative morphology, internal structure, reproductive structures in *Gnetum*.

(2 x 5 = 10)

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

M.Sc. Botany, Semester II

Model Question Paper

24P2BOTT06: MOLECULAR BIOLOGY & IMMUNOLOGY

Time 3 hours **Total Weight: 30**

PARTA

Answer any *eight* of the following; each question carries one weightage.

1. How does the spontaneous depurination of DNA repaired?
2. In what sense does attenuation provide a "fine tuning" mechanism for operons that control amino acid biosynthesis?
3. Explain the opposite polarity of the double stranded DNA.
4. Describe the function and importance of the 3' to 5' exonuclease activity of DNA polymerases.
5. Explain the role of the following enzymes/proteins;
   (a) Rho protein (b) Sigma factor (c) Gyrase (d) Cro protein
6. Write a short note on Kozak sequence.
7. Briefly explain the nucleotide excision repair.
8. Write a note on exon shuffling.
9. Write a short note on antigens and epitopes.
10. Compare DNA methylation and acetylation.

(1 x 8 = 8)

PART B

Answer any *Six* of the following; each question carries two weightages.

11. What are transposons? Write a brief account on the types of transposons.
12. Write briefly on the following;
    (a) Shine-Dalgarno sequence (b) Kozak sequence (c) Amber codons (d) DNA quadruplex
13. Describe the genetic control of the entry of a Lambda phage into lytic or lysogenic growth.
14. Describe the experimental methods used to crack the complete genetic code.
15. Describe the following;
    (a) Ribozymes (b) Riboswitches (c) Chargaff rules (d) Transletion polymerase
16. Explain RNAi? How is RNAi involved in gene regulation?
17. Write a short note on recombinant vaccines.
18. Briefly explain the structure, function and types of antibody molecules.

(2 x 6 = 12)

PART C

Answer any *two* of the following; each question carries five weightages.

19. Explain DNA replication in Prokaryotes.
20-. Explain the post-transcriptional modifications of mRNA.
21. Describe the control of gene expression in eukaryotes.
22. Explain the production and uses of monoclonal antibodies.

(5 x 2 = 10)

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany, Semester II
Model Question Paper
24P2BOTT07: PLANT ANATOMY & MICROTECHNIQUE

Time 3 hours **Total Weight: 30**

PARTA

Answer any *eight* of the following; each question carries one weightage.

1. Differentiate ray initials and fusiform initials.
2. Comment on seed dormancy.
3. Enlist the anatomical adaptations of xerophytes.
4. What is nodal anatomy? Add a note on its evolution.
5. Explain leaf abscission.
6. Describe the principles and techniques of fixing. Write the composition and use of FAA.
7. Write the preparation and uses of hematoxylin and safranin O.
8. Write the significance of dehydration.
9. Differentiate between coal tar dyes and natural dyes.
10. How do you differentiate squash from maceration?

(8 x 1 = 8)

PART B

Answer any *Six* of the following; each question carries two weightages.

11. What are the physical, chemical and mechanical properties of wood?
12. What are secretory trichomes? Give an account on their structure and distribution.
13. Describe the anatomical peculiarities of CAM plants.
14. Write on floral anatomy and its significance.
15. What are the different stages of dehydration in botanical microtechnique?
16. Briefly explain the working of rotary microtome. Write its application?
17. How can you prepare a permanent whole mount?
18. Explain histochemical staining and its significance. Describe the staining procedures for starch and protein.

(6 x 2 = 12)

PART C

Answer any *two* of the following; each question carries five weightages

19. Explain the role of Phytochemistry in plant anatomy.
20. Give an account on anomalous secondary thickening in stem.
21. Discuss the stages of preparation of serial sections.
22. Describe various steps involved in the specimen preparation for TEM .

(2 x 5 = 10)

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany, Semester II
Model Question Paper
24P2BOTT08: GENETICS & EVOLUTION

Time 3 hours **Total Weight: 30**

PARTA

Answer any *eight* of the following; each question carries one weightage.

1. Explain gene mapping in bacteria and bacteriophages.
2. What is Linkage and crossing over?
3. What is Genetic equilibrium?
4. What is Genetic drift?
5. What is Pedigree Analysis?
6. What is Epigenome?
7. What is Lyon hypothesis?
8. What are Coacervates?
9. What is coadaptation?
10. Explain the structure of cellulose with a structural diagram?

(8x1=8)

PART B

Answer any *Six* of the following; each question carries two weightages.

11. Explain Genomic imprinting.
12. Explain the Epigenetic effects in monozygotic twins
13. Explain interference and coefficient of coincidence?
14. Explain Mitotic recombination in *Drosophila.*
15. What are the Causes of speciation?
16. Explain different levels of selection.
17. Summarize the applications of Hardy-Weinberg principles?
18. Explain coevolution. (6x2= 12)

PART C

Answer any *two* of the following; each question carries five weightages

19. Elaborate speciation
20. Evaluate sex and reproductive success in evolution
21. Give an account on gene mapping of Haploid organisms.
22. Explain allele and genotype frequency? What is the relationship between them in a large, random mating, natural population? Name the processes that can change the allele frequencies in natural populations. Describe why these forces change the frequencies?

(5x2= 10)

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany, Semester III
Model Question Paper
24P3BOTT09: ANGIOSPERM SYSTEMATICS

Time 3 hours **Total Weight: 30**

PARTA

Answer any *eight* of the following; each question carries one weightage.

1. Comment on the floral features of Euphorbiaceae.
2. Differentiate between Flora, Manuals, and Monographs.
3. Compare the tendrils of Cucurbitaceae and Vitaceae.
4. What is the ecological significance of Lauraceae.
5. What is typification?
6. What are the advanced floral features of the family Asteraceae.
7. Comment on the androecium of Malvaceae and Tiliaceae
8. Write a note on the floral features of Caparidaceae.
9. Write the binomials and families of the following plants.
   (i)Vasaka (ii) Horse gram (iii) Rambutan (iv) Oats
10. Compare the gynoecium of Scrophulariaceae and Acanthaceae

(8 x 1 = 8)

PART B

Answer any *Six* of the following; each question carries two weightages.

11. Explain Chemotaxonomy.
12. Write a comparative account of Verbenaceae and Lamiaceae with suitable diagrams.
13. Explain the principles and applications of numerical taxonomy.
14. Explain the economic importance of Aristolochiaceae and Zingiberaceae.
15. What are the different types of taxonomic literatures?
16. Explain the merits and demerits of APG system of classification.
17. Discuss the advanced features of Orchidaceae.
18. Differentiate between indented and bracketed keys.

(6 x 2 = 12)

PART C

Answer any *two* of the following; each question carries five weightages.

19. Compare the floral features of Leguminosae.
20. Explain the evolutionary trends in Bicarpellatae.
21. Explain molecular taxonomy.
22. Explain the retention, rejection and changing of names

(2 x 5 = 10)

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany, Semester III
Model Question Paper

24P3BOTT10: BIOSTATISTICS AND RESEARCH METHODOLOGY

Time 3 hours **Total Weight: 30**

PARTA

Answer any *eight* of the following; each question carries one weightage.

1. What is a student t- test?
2. What is the application of ANOVA?
3. What is standard error?
4. Why is a statistical test necessary to determine whether an observed set of data yields an acceptable fit to the result expected from a particular hypothesis? What statistical test is used for this?
5. What is Sum of Squares?
6. What is a coefficient?
7. Define citation index? How does it helps a researcher?
8. Write a brief account about monographs.
9. Briefly explain deductive and inductive methods in research?
10. What is research? (8x1 = 8)

PART B

Answer any *Six* of the following; each question carries two weightages.

11. Explain briefly about regression. Explain the application of regression in life science.
12. Write a brief account on probability?
13. What is central tendency. Write briefly about different types and their respective applications.
14. What is chi-square test? Explain the steps involved in chi square test.
15. What is p value? How you calculate p value? Explain its significance in biostatistics.
16. Write a brief account on intellectual property rights.
17. How do you prepare a scientific research proposal?
18. Describe the importance of literature in scientific research? (6x2= 12)

PART C

Answer any *two* of the following; each question carries five weightages.

19. Write an essay on testing of hypothesis. Explain any two major tests of hypotheses with their respective applications.
20. Describe the principles and various experimental designs used in designing a research work.
21. Explain with suitable illustrations on various methods of graphical methods of data representation.
22. Designing research is a serious matter starting with identifying the right research problem up to publication of the research, justify.

(2x5 = 10)

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany, Semester III
Model Question Paper

24P3BOTT11: PLANT PHYSIOLOGY AND BIOCHEMISTRY

Time 3 hours **Total Weight: 30**

PARTA

Answer any *eight* of the following; each question carries one weightage.

1. Comment on the source-sink concept in phloem transport.
2. What is leghaemoglobin? Write its significance.
3. Differentiate between apoplastic and symplastic pathways.
4. Outline the mode of action of ethylene in plants.
5. Differentiate between root pressure and transpiration pull.
6. Comment on eco-physiological significance of C4 photosynthesis.
7. Write a short note on Aquaporins.
8. Summarize the functions of nucleotides?
9. Write a note on Dixon plot.
10. Differentiate secondary and tertiary structure of proteins.

(8 x 1 = 8)

PART B

Answer any *Six* of the following; each question carries two weightages.

11. "Transpiration is a necessary evil". Justify the statement.
12. Discuss the mechanism of biological nitrogen fixation.
13. Explain the mechanism of cyanide resistant pathway.
14. Write brief descriptions on the following;

(a) Gluconeogenesis (b) Nitrogenase enzyme (c) Circadian rhythm (d) HSP (e) Photoinhibition

15. Discuss how light energy absorbed by a pigment is transferred to the reaction center of the photosystem.
16. Illustrate and explain the mechanism of electron and proton transport in the thylakoid membrane.
17. Summarize the structure and classification of amino acids.
18. Explain Ramachandran plot and its applications?

(6 x 2 = 12)

PART C

Answer any *two* of the following; each question carries five weightages.

19. Illustrate and describe the structure of ATPase complex. Write the binding change mechanism of ATP synthesis.
20. Compare various stresses to which plants are commonly exposed? Evaluate the stress tolerance mechanisms found in plants.
21. Discuss SPAC and its driving forces.
22. Summarize various types of enzyme inhibition.

(2 x 5 = 10)

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany, Semester III
Model Question Paper

24P3BOTT12: PLANT REPRODUCTIVE BIOLOGY AND PLANT BREEDING

Time 3 hours **Total Weight: 30**

PARTA

Answer any *eight* of the following; each question carries one weightage.

1. Define Apomixis.
2. What is Chiropterophily?
3. Describe self-incompatibility.
4. What is FDA test?
5. Describe double fertilization and its significance.
6. What is mutation breeding?
7. What is genetic vulnerability?
8. Give an example of drought and salinity tolerant rice variety.
9. Differentiate autopolyploidy and allopolyploidy with examples.
10. What is disease escape?

(8 x 1 = 8)

PART B

Answer any *Six* of the following; each question carries two weightages

11. Explain dicot embryogenesis in flowering plants.
12. With the help of labelled diagram explain the structure of pollen wall.
13. Explain different seed dispersal mechanisms and agents involved in it?
14. Explain different mechanisms of incompatibility in flowering plants?
15. Differentiate between horizontal and vertical disease resistance.
16. Explain how mutation breeding improve oligogenic traits.
17. Explain the role of genetic variability in plant breeding.
18. What are the different sources of germplasm?

(6 x 2 = 12)

PART C

Answer any *two* of the following; each question carries five weightages.

19. Explain the role of mutation induction in crop improvement. Enlist the advantages and disadvantages of mutation breeding.
20. Explain different types of germplasm collection, management and significance of germplasm conservation.
21. Discuss various pollination syndromes in flowering plants.
22. Explain the post-pollination events in flowering plants.

(2 x 5 = 10)

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany, Semester IV
Model Question Paper

24P4BOTT13: GENETIC ENGINEERING AND BIOLOGICAL TECHNIQUES

Time 3 hours **Total Weight: 30**

PARTA

Answer any *eight* of the following; each question carries one weightage.

1. Write a short note on gene augmentation therapy.
2. Differentiate between linkers and adaptors.
3. Write a short note on artificial chromosomes. Give example.
4. Briefly discuss positional cloning.
5. Why restriction endonucleases are known as molecular scissors.
6. What are the important features of pUC.
7. Briefly explain DNA Microarray.
8. Differentiate between FISH and GISH.
9. Expand GEAE. Mention its significance.
10. What are the applications of Phase contrast microscope?

(1 x 8 = 8)

PART B

Answer any *Six* of the following; each question carries two weightages

11. A patient is suffering from ADA deficiency. Can he be cured? How?
12. Describe the steps involved in the creation of a genomic library.
13. Describe the basic principles and the steps involved in artificial DNA synthesis.
14. Explain vectorless methods of gene transfer.
15. What are the steps involved in the isolation of plant genomic DNA.
16. Describe the basic principles and applications of ELISA
17. Describe the principles and applications of different chromatographic techniques.
18. Write a short essay on electrophoresis.

(2 x 6 = 12)

PART C

Answer any *two* of the following; each question carries five weightages.

19. Illustrate and explain the Agrobacterium tumefaciens mediated gene transfer in plants.
20. Explain the applications of rDNA technology.
21. Explain the procedure and applications blotting techniques.
22. Write an essay on the principle and applications of Electron microscopy.

(5 x 2 = 10)

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany, Semester IV
Model Question Paper

24P4BOTT14: GENOMICS, PROTEOMICS & BIOINFORMATICS

Time 3 hours **Total Weight: 30**

PARTA

Answer any *eight* of the following; each question carries one weightage.

1. Write a short note on ORF search.
2. Discuss the applications of Rasmol.
3. Differentiate between pair wise and multiple sequence alignment.
4. Explain the significance of sequence alignment.
5. Write a short note on molecular clock.
6. Briefly explain BankIt.
7. Briefly explain dot blot analysis.
8. Write a note on (a) RFLP (b) RAPD and (c) AFLP.
9. Differentiate between knock out and knock down mutants.
10. What are the applications of GFP?

(8 x 1 = 8)

PART B

Answer any *Six* of the following; each question carries two weightages

13. Explain the features of ENTREZ.
14. Explain the working and important features of BLAST.
15. Discuss the sequence comparison using dot matrix method.
16. Explain Pyrrosequencing..
17. Explain RNA secondary structure prediction.
18. Explain tools used for multiple sequence alignment.

(6 x 2 = 12)

PART C

Answer any *two* of the following; each question carries five weightages

19. Explain the role of antisense RNA and RNAi techniques in genomic studies.
20. Describe the protein identification using mass spectrometry.
21. Describe the procedure and applications of computer assisted drug design.
22. Explain the application of bioinformatics in phylogenetic studies?

(2 x 5 = 10)

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany, Semester IV
Model Question Paper

24P4BOTT15: PLANT TISSUE CULTURE

Time 3 hours Total Weight: 30

PARTA

Answer any *eight* of the following; each question carries one weightage.

1. Write a short note on the advantages of endosperm culture.
2. Differentiate between cybrids and hybrids.
3. Comment on organogenic differentiation.
4. Write a short note on cellular totipotency.
5. Briefly explain Gynogenesis.
6. Briefly explain the applications of meristem culture.
7. Write a shrot note on synthetic seeds.
8. List out the factors influencing shoot bud differentiation?
9. Write a short note on vitrification.
10. Write a short note on enzyme engineering.

(8 x 1 = 8)

PART B

Answer any *Six* of the following; each question carries two weightages

11. Briefly explain downstream processing
12. Explain the large scale production of penicillin.
13. Differentiate between submerged and solid state fermentation.
14. Explain different types of Bioreactors.
15. Write a note on hairy root culture. Mention its applications.
16. Discuss the reasons for somaclonal variation.
17. Explain the factors influencing vascular differentiation.
18. Explain suspension culture.

(6 x 2 = 12)

PART C

Answer any *two* of the following; each question carries five weightages.

19. Write an essay on methods, advantages and applications of cell immobilization
20. Explain the methods and applications of *In vitro* conservation of germplasm
21. Describe the isolation, purification and culture of protoplasts.
22. Explain the methods of production of haploid plants and explain its applications.

(2 x 5 = 10)

MODEL QUESTION PAPER PRACTICAL EXAMS

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany, Semester I, Practical Course: 1
24P1BOTP01: MICROBIOLOGY, PHYCOLOGY, MYCOLOGY & PLANT PATHOGEN INTERACTIONS

Time 3 hours **Total Weightage 15**

1. Make suitable micropreparations of A and B. Draw labelled diagrams and identify giving reasons.
   (Total Weightage= **4**; 2x2; Preparation- 0.5, Labelled diagram-0.5, Identification -0.5, Reasons – 0.5)

2. Write critical notes on C and D.
   (Total Weightage = **2**; 1x2; Identification –0.5, Critical note – 0.5)

3. Sort out any three algae from the algal mixture E and make separate clear mounts. Identify and draw labelled diagrams.
   (Total Weightage =**3;** Preparation -1, Identification:1, Labelled diagram -1)

4. Spot at sight F and G.
   (Total Weightage =**1**; 0.5x2; Identification 0.25, Part displayed – 0.25)

5. Study the diseases in H and I and write the causative organism.

   (Total Weightage = **1**; 0.5x2, Identification –0.25, Causative organism – 0.25)

6. Isolate bacteria from the soil sample J by serial dilution and spread plate method.
   (Total Weightage =**1;** Working – 0.75, Requirements – 0.25)

7. Field Report (Total Weightage =**1**)

8. Practical Record (Total Weightage =**2**)

Key to the Examiners

1. A – Macroalgae (*Ulva, Caulerpa, Cephaleuros, Padina, Sargassum* – stipe & receptacle, *Gracilaria*); B – Fungi (*Albugo, Xylaria, Puccinia, Peziza, Pleurotus*).
2. C, D – specimens form fungi
3. E - Algal mixture containing any four filamentous types (*Nostoc, Anabaena, Rivularia, Gleotrichia, Oscillatoria, Lyngbya, Scytonema, Cladophora, Pithophora, Oedogonium, Schizomeris Mougeotia, Zygnema, Vaucheria, Ectocarpus, Batrachospermum, Comsopogan, Polysiphonia*).
4. F, G - One Alga, one Fungus/Lichen.
5. H & I - Herbarium or live/dry specimen showing the symptoms of any disease specified in the syllabus.
6. J - Supply necessary soil samples.

7 & 8. Awarding full weightage for the record of practical work shall be considered only if all the practical work specified in the syllabus are done completely and recorded properly. This also includes the field study report on algal collection.

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany, Semester I, Practical Course: 2
24P1BOTP02: ECOLOGY, ENVIRONMENTAL BIOLOGY, PHYTOGEOGRAPHY, RESEARCH METHODOLOGY & CELL BIOLOGY

Time: 3 hours **Total Weightage: 15**

1. Prepare a smear of the given anther **A** and identify **any two stages** of Meiosis.
(Total Weightage = 4; 2x2; Preparation – 1, Identification with reasons – 1)

2. Identify the given chromosomal aberrations **B** and **C**.
(Total Weightage =1; 0.5x2; Identification with reasons – 0.5)

3. Workout the problem **D**
(Total Weightage = 2)

4. Statistical analysis of diversity indices.
(Total Weightage = 3; Working -1.5, Table and Graph- 1, Interpretation – 0.5)

5. Quantify Nitrite /Phosphate in the given sample **E** using Spectrophotometer.
(Total Weight = 3; Working – 1.5, Procedure - 0.5, Calculation - 0.5, Result & Comments - 0.5)

6. Practical Record
(Total Weightage = 2)

Key to the Examiners

1. A –Anther of *Tradescantia*.
2. B, C- Karyotype Diagrams.
3. D- Data on frequency, density, Basal Area, IVI and evenness of individuals/ species.
4. Statistical analysis of diversity indices by using apt softwares.
5. Phosphate/Nitrate sample
6. Practical record: Awarding full to the record of practical work shall be considered only if all the practicals specified in the syllabus are done completely recorded properly and signed by the course teacher.

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

M.Sc. Botany, Semester II, Practical Course: 3

24P2BOTP03: BRYOLOGY, PTERIDOLOGY, GYMNOSPERMS, MOLECULAR BIOLOGY & IMMUNOLOGY

Time 3 hours **Total Weightage 15**

1. Make stained micro-preparations of specimens A, B and C
   (Total Weightage = 3; Preparation – 0.5, Diagram – 0.5, Identification with reasons – 0.5)

2. Make stained micro-preparations (TS, TLS and RLS) of D. Draw labelled diagrams and identify giving reasons.
   (Total Weightage =3 Preparation – 1, Diagram – 1, Identification with reasons – 1)

3. Workout the problems E and F
   (Total Weightage = 4; 2+2)

4. Identify at sight G, H, I and J.
   (Weightage = 2 - 4x0.5) Systematic position up to genus– 0.25, Part displayed – 0.25)

5. Field study report
   (Total Weightage =1)

6. Practical record.
   (Total Weightage =2)

Key to the questions:

1. A - Bryophyte B & C - Pteridophyte
2. D – Conifer wood.
3. E & F - Problems from Molecular Biology.
4. G – Reproductive structure from bryophyte H & I - Two reproductive structures from Pteridophytes, J - Reproductive structure from Gymnosperm
5. Field study report
6. Practical record: Awarding full to the record of practical work shall be considered only if all the practical's specified in the syllabus are done completely recorded properly and signed by the course teacher.

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany, Semester 2, Practical Course: 4
24P2BOTP04: PLANT ANATOMY, MICROTECHNIQUE, GENETICS & EVOLUTION

Time: 3 hours **Total Weightage: 15**

1. Make suitable micropreparations of **A**. Draw labelled diagrams and identify giving reasons. (Total Weightage = 2; Preparation – 0.5, labelled diagram – 0.5, Identification with reasons - 1)

2. Describe the nodal feature of the material **B**.
   (Total Weightage = 1; Identification - 0.5, Description - 0.5)

3. Prepare a double-stained micropreparation of material **C** and mount it as a permanent slide. (Total Weightage = 2; Sectioning and staining – 1.0, Mounting – 1.0)

4. Prepare serial sections of **D** and mount on a glass slide.
   (Total Weightage =2; Microtome sectioning – 1.5, Mounting – 0.5)

5. Permanent slides. (Total Weightage = 2)

6. Work out the given problem **E** from linkage mapping.
   (Total Weightage = 2)

7. Work out the given problem **F** from pedigree analysis.
   (Total Weightage = 1)

8. Work out the given problem **G** from population genetics
   (Total Weightage = 1)

9. Practical Record (Total Weightage = 2)

Key to the questions:

1. A – Anomalous secondary thickening in dicot/ monocot
2. B – Specimen for nodal anatomy
3. C – Suitable plant material for double staining
4. D- Embedded plant material
5. Permanent slides prepared by the students
6. E - problem form linkage mapping
7. F- problem form pedigree analysis
8. G- problem from population genetics
9. Practical Record

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

M.Sc. Botany, Semester III, Practical Course: 5

24P3BOTP05: ANGIOSPERM SYSTEMATICS, BIOSTATISTICS & RESEARCH METHODOLOGY

Time 3 hours **Total Weightage 15**

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1. Identify the family of the given specimen **A**.
   (Total Weightage **1**; Identification & key to family – 1)

2. Identify the given material **B** up to the genus level.
   (Total Weightage **3**; Key to family and family identification – 1; identification of the genus with author citation and genus key– 2)

3. Identify the given material **C** up to the species level.
   (Total Weightage **4**; Key to family and family identification-1; Identification of genus with author citation and genus key-1; Identification of species with author citation and species key-2).

4. Work out the given problem **D**.
   (Total Weightage = **1**)

5. Work out the given problem **E**.
   (Total Weightage = **2**)

6. Herbarium and field book
   (Total Weightage = **1**)

7. Field study report
   (Total Weightage = **1**)

8. Practical record
   (Total Weightage = **2**)

Key to the Examiners:

1. A- Plant materials for family identification – list families mentioned in the practical syllabus
2. B- Plant materials for genus identification – list families mentioned in the practical syllabus
3. C- Plant materials for species identification – list families mentioned in the practical syllabus
4. D – Nomenclature problem
5. E– Problem from Biostatistics
6. Herbarium and field book
7. Study tour report
8. Practical record: Awarding full to the record of practical work shall be considered only if all the practicals specified in the syllabus are done completely recorded properly and signed by the course teacher.

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany, Semester III, Practical Course: 6
24P3BOTP06: PLANT PHYSIOLOGY, BIOCHEMISTRY, PLANT REPRODUCTIVE BIOLOGY & PLANT BREEDING

Time 3 hours **Total Weightage 15**

1. Conduct the experiment **A**.
   (Weightage – **4:** Principle, procedure & graph, – 2, Working – 2, Result – 0.5, Comments/Interpretation – 0.5)

2. Assay of amylase enzyme from germinating seeds/ appropriate plant material **B**.
   (Weightage – **3:** Principle and Procedure – 1, Working – 1, Calculation and Result – 1)

3. Work out the pollen viability/stigma receptivity/Embryo excision from young seed **C.**
   (Weightage – **2**; preparation -1.5, calculation, – 1, Result and interpretation – 1)

4. Identify and comment on the pollen character in the given photograph **D**.
   (Weightage – **1:** identification – 0.5, comments – 0.5)

5. Calculate a) heritability and genetic advance or b) Seed viability **E.**
   (Weightage – **3:** Calculation/working– 1.5, result and interpretation – 1.5)

6. Practical record (Weightage – **2**).

Key to the Examiners:

1. A – Draw lots from the list of physiology experiments provided. Based on lots of a minimum of six experiments from the list provided below.
   1) Determine the **osmotic potential** of the given plant tissue; 2) Estimate the **proline content** in the seeds in normal and stress conditions; 3) Estimate the **phenol content** in normal and plants affected by biotic stress; 4) Estimate **free amino acids** in young and senescing leaves; 5) Estimate the **total chlorophyll** in shade leaves and sun leaves; 6) Separation of photosynthetic pigments by **TLC/ Paper chromatography**.
2. B – Experiment on Amylase activity in seeds.
3. C – Provide fresh pollen grains/stigma.
4. D – Identify the pollen character (exine ornamentation patterns/special pollen characters such as viscin threads/pollen bladder/pollenkitt) from the given photograph.
5. E – a) Problem from plant breeding, b) Seed viability using germination test or tetrazolium dye test.
6. Practical record: Awarding full to the record of practical work shall be considered only if all the practicals specified in the syllabus are done completely recorded properly and signed by the course teacher.

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
MSc Botany, Semester IV, Practical Course: 7
24P4BOTP07: GENETIC ENGINEERING & BIOLOGICAL TECHNIQUES, GENOMICS, PROTEOMICS & BIOINFORMATICS

Time: 3 Hours **Total Weightage: 15**

1. Find out the phylogenetic relationship of the given protein sequence with the other 5 plant species. Identify the given query sequence (Gene Annotation), and show the distance between each organism in the phylogenetic tree.

(*Total Weightage = **3** - Working – 2, Comment – 1)*

2. Using hierarchical clustering, perform multiple sequence alignment of the given nucleotide sequence with 5 related sequences and show the similarity (Identify the query).

(*Total Weightage = **3**- Working-2, Result- 1*)

3. Isolation of plant genomic DNA using the given sample

(*Total Weightage = **3** - Procedure-1, Working- 1, Result- 1*)

4. Visualize Nucleic acid by agarose gel electrophoresis

(*Total Weightage = **2** - Procedure- 0.5, Working- 1, Band vision – 0.5*)

5. Determine the size of the given filament/pollen/spore using micrometer.

(*Total Weightage =**2** - Calibration – 0.5, Measurement, calculation and result -1.5*)

6. Practical record.

(*Total Weightage=**2***)

Key to the Examiners:

1. MEGA or PHYLIP
2. Clustal W
3. Supply necessary plant tissue for DNA isolation
4. Supply pure samples of DNA/RNA or the isolated DNA in the Qn 3, and necessary buffer. Agarose gel can be prepared and provided
5. A, B - Vectors, procedures or equipment (photographs) used in genetic engineering.
6. C and D- Home pages of any relevant databases and diagrams/ photographs related to genomics and proteomics.
7. Practical record: Awarding full to the record of practical work shall be considered only if all the practicals specified in the syllabus are done completely recorded properly and signed by the course teacher.

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

MSc Botany, Semester IV, Practical Course: 8

24P4BOTP08: PLANT TISSUE CULTURE

Time 3 Hours **Total Weightage 15**

1. Select the anther in the appropriate stage for anther culture.
   (Total Weightage = 4; Aim & Procedure – 1, Working – 2, Result – 1)

2. Isolate the embryo from the given seed in aseptic conditions and inoculate in the medium
   (Total Weightage = 3; Aim & Procedure – 1, Working – 1, Result – 1)

3. Ovule Culture.
   (Total Weightage = 3; Aim & Procedure – 1, Working – 1, Result – 1)

4. Prepare synthetic seeds by inserting somatic embryo in Sodium alginate
   (Total Weightage = 2; Working – 1, Result – 1)

5. Tissue Culture Lab visit report
   (Total Weightage = 1)

6. Practical record
   (Total Weightage =2)

Key to the Examiners:

1. Provide flower bud for anther culture
2. Provide seed for embry dissection
3. Provide flower bud for ovule culture
4. Provide somatic embryos for synthetic seed preparation
5. Lab visit report
6. Practical record: Awarding full to the record of practical work shall be considered only if all the practicals specified in the syllabus are done completely recorded properly and signed by the course teacher.