



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

**CURRICULUM AND SYLLABI**  
**POST-GRADUATE PROGRAMME**  
**IN BOTANY**

**CREDIT**  
**SEMESTER**  
**SYSTEM**  
**(CBCS-PG)**

(EFFECTIVE FROM  
2020-2021  
ADMISSIONS)

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

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3. Dr. Mathew Dan (Scientist, JNTBGRI, Thiruvananthapuram)
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7. Dr. I'ma Neerakkal
8. Dr. Lesly Augustine
9. Mr. Kiran George Koshy
10. Mr. Ebin P.J.
11. Ms. PrincyMol A.P.

### **Special Invitee:**

1. Prof. Paul Karanthanam (Associate Professor, St.Thomas College, Pala)
2. Mr. Anto Joseph

# FOREWORD

In line with the changes in higher education, the state of Kerala had introduced the autonomy in its 13 selected colleges and, S H College, Thevara is proud to be one. Even while remaining affiliated to M G University, the academic autonomy was granted during 2014-2015 academic year onwards. In the undergraduate level the choice based course credit semester system was decided to be continued even after the attainment of autonomy to the institution. 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. 2020-2021 admissions onwards.

These are exciting times in Biology. The world of Biology has been transformed in the last few decades. There was too much to select from. However, 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.

The Board of Studies acknowledges the help rendered by many colleagues whose thoughtful reviews, and comments have helped in the preparation of the syllabus.

Thevara  
August 15, 2019

**Dr. (Fr.) Jose John**  
Chairman, BoS (PG) in Botany

# ***CURRICULUM***

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## **1. Title**

These regulations shall be called ‘**REGULATIONS FOR POST GRADUATE PROGRAMMES UNDER CREDIT SEMESTER SYSTEM (CSS) – 2020**’

## **2. Scope**

Applicable to all Post Graduate (PG) programmes of the college with effect from 2020-21 admissions. The provisions herein supersede all the existing regulations for the Post Graduate programmes of the college.

## **3. Definitions**

- i. ‘**Programme**’ means the entire course of study and examinations.
- ii. ‘**Duration of Programme**’ means the period of time required for the conduct of the programme. The duration of post-graduate programme shall be of 4 semesters and M Phil programmes shall be 2 semesters.
- iii. ‘**Semester**’ means a term consisting of a minimum of 90 working days, inclusive of examination, distributed over a minimum of 18 weeks of 5 working days, each with 5 contact hours of one hour duration
- iv. ‘**Course**’ means a segment of subject matter to be covered in a semester. Each Course is to be designed variously under lectures / tutorials / laboratory or fieldwork/ study tour /seminar / project / practical training / assignments / evaluation etc., to meet effective teaching and learning needs.
- v. ‘**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.
- vi. ‘**Extra credits**’ are additional credits awarded to a student over and above the minimum credits required for a programme
- vii. ‘**Programme Credit**’ means the total credits of the PG/M Phil Programmes. For PG programmes the total credits shall be 80 and for M.Phil. it shall be 40.
- viii. ‘**Programme Elective course**’ Programme Elective course means a course, which can be chosen from a list of electives and a minimum number of courses is required to complete the programme.
- ix. ‘**Programme Project**’ Programme Project means a regular project work with stated credits on which the student undergoes a project under the supervision of a teacher in the parent department / any appropriate Institute in order to submit a dissertation on the project work as specified.

- x. **‘Internship’** is on-the-job training for professional careers.
- xi. **‘Plagiarism’** Plagiarism is the unreferenced use of other authors’ material in dissertations and is a serious academic offence.
- xii. **‘Seminar’** seminar means a lecture by a student expected to train the student in self-study, collection of relevant matter from the books and Internet resources, editing, document writing, typing and presentation.
- xiii. **‘Evaluation’** means every course shall be evaluated by 25% continuous (internal) assessment and 75% end course/end semester (external) assessment.
- xiv. **‘Repeat course’** is a course that is repeated by a student for having failed in that course in an earlier registration.
- xv. **‘Audit Course’** is a course for which no credits are awarded.
- xvi. **‘Department’** means any teaching Department offering a course of study approved by the college / Institute as per the Act or Statute of the University.
- xvii. **‘Department Council’** means the body of all teachers of a Department in a College.
- xviii. **‘Faculty Advisor’** is a teacher nominated by a Department Council to coordinate the continuous evaluation and other academic activities undertaken in the Department.
- xix. **‘College Co-ordinator’** means a teacher from the college nominated by the College Council to look into the matters relating to CSS-PG System.
- xx. **‘Letter Grade’** or simply **‘Grade’** in a course is a letter symbol (O, A, B, C, D, etc.) which indicates the broad level of performance of a student in a course.
- xxi. Each letter grade is assigned a **‘Grade point’** (GP) which is an integer indicating the numerical equivalent of the broad level of performance of a student in a course.
- xxii. **‘Credit point’** (CP) of a course is the value obtained by multiplying the grade point (GP) by the Credit (Cr) of the course  $CP=GP \times Cr$ .
- xxiii. **‘Semester Grade point average’** (SGPA) is the value obtained by dividing the sum of credit points (CP) obtained by a student in the various courses taken in a semester by the total number of credits taken by him/her in that semester . The grade points shall be rounded off to two decimal places. SGPA determines the overall performance of a student at the end of a semester.
- xxiv. **‘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.
- xxv. **‘Grace Marks’** means marks awarded to course/s, as per the orders issued by the college from time to time, in recognition of meritorious achievements in NCC/NSS/Sports/Arts and cultural activities.

#### 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.

- i. **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.
- ii. The hour related calculation in a course is meant for awarding marks for the course concerned, where applicable.
- iii. **Late entry:** A student is supposed to be in time for the class. Late arrival related treatment is left to the discretion of the individual teacher. However, as a norm, a late arriving student may be permitted to the class, if it is not inconvenient or distraction to the class as such; though attendance MAY NOT BE GIVEN. Late arrival beyond 5 minutes is treated as ABSENCE; though the teacher may consider permitting the student to sit in the class.
- iv. **Leave :** A student has to formally report his/her absence with reasons either in advance, or immediately after the absence for obtaining an approved leave. This applies to all sorts of leave – medical, on duty or other.
- v. The student is supposed to report in prescribed format on the very next day of the absence; however, up to a week's time is permitted. Afterwards, the leave applications will not be considered.
- vi. 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.
- vii. **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 Head of the department, and submit it to the Vice Principal. The same will be forwarded by the Vice Principal for attendance entry. **SPORTS:** The approval of the Department of Physical Education and the class teacher is required. The time limit for submission mentioned above is applicable in the case of duty leave as well.
- viii. **Condonation:** A student may have the privilege of condonation of attendance shortage (up to a maximum of 10 days) on the basis of genuineness of the grounds of absence (medical reasons or college duty), duly recommended by the department. This is not a matter of right. It is a matter of privilege based on Principal's discretion and the good conduct of the student on the campus. A student of PG programme may have only one such opportunity.
- ix. **Re-admission:** A student whose attendance is inadequate will have to discontinue the studies. Such students, whose conduct is good, may be re-admitted with the approval of governing

council, on the basis of recommendation from the department, and assurance from the student and the guardian regarding good conduct and compliance in academic and discipline matters. For this the prescribed re-admission fee has to be paid.

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

- x. **Unauthorised absence & removal from rolls:** A student absent from the classes continuously for 10 consecutive working days without intimation or permission, shall be removed from the rolls, and the matter intimated to the student concerned. On the basis of recommendation of the department concerned, re-admission process may be permitted by the Principal.

## 5. PROGRAMME REGISTRATION

- i. A student shall be permitted to register for the programme at the time of admission.
- ii. A PG student who registered for the programme shall complete the same within a period of 8 continuous semesters from the date of commencement of the programme.

- 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.

## 7. EXAMINATIONS

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

## 8. EVALUATION AND GRADING

The evaluation scheme for each course shall contain two parts;

- a. **Continuous Internal Assessment (CIA) and**
- b. **End Semester Examination (ESE).**

The internal to external assessment ratio shall be 1:3, for both courses with or without practical. For all courses except the courses offered by the school of communications, there shall be a maximum of 75 marks for external evaluation and maximum of 25 marks for internal evaluation. In the case of courses offered by the school of communications, the internal to external assessment ratio shall be 1:1. (In their cases, the components for evaluation and their respective marks shall be determined by their Board of Studies). Both internal and external evaluation shall be carried out in the mark system

and the marks are to be rounded to the nearest integer.

- a. **Continuous Internal Assessment (CIA)/ Continuous Assessment:** The internal evaluation shall be based on predetermined transparent system involving periodic written tests, assignments, seminars/viva/field study/industrial visits/study tour etc. with respect to theory courses and based on written tests, lab skill/records/viva voce etc. with respect to practical courses. The marks assigned to various components for internal evaluation as follows.

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

	<b>Components</b>	<b>Marks</b>
i.	Assignments	5
ii	Seminar	5
iii	Quiz/Field study/Industrial Visit/Viva Voce/Study Tour	5
iv	Two Test papers(2x5)	10
	Total	25

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

<b>Components</b>	<b>Marks</b>
Punctuality	1
Content	2
Conclusion	1
Reference/Review	1
<b>Total</b>	<b>5</b>

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

<b>Components</b>	<b>Marks</b>
Content	2
Presentation	2
Reference/Review	1
<b>Total</b>	<b>5</b>

- iii. A quiz or viva or field survey or any suitable method shall be used by the course teacher to



- assess the students and a maximum of 5 marks shall be awarded for this component
- iv. **Class Tests:** Every student shall undergo two class tests as an internal component for every course.

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

Components	Marks
Laboratory Involvement	5
Written/ Lab Test (2 x 5)	10
Record	5
Viva Voce	5
Total	25

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

c. **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.
- vi. The mark and credit with grade awarded for the program project should be entered in the grade card issued by the college.

**Components of Internal Evaluation for Projects**

<b>Components</b>	<b>Marks</b>
Topic/Area selected	2
Experimentation/Data collection	5
Punctuality-Regularity	3
Compilation	5
Content	5
Presentation	5
<b>Total</b>	<b>25</b>

#### Vii Components of External Evaluation for Projects

<b>Components</b>	<b>Marks</b>
Topic/Area selected	5
Objectives	10
Experimentation/Data collection	15
Content/Analysis	20
Presentation	10
Conclusions/Findings/Summary	10
Reference	5
<b>Total</b>	<b>75</b>

#### d. **Comprehensive Viva-voce**

Comprehensive Viva-voce shall be conducted at the end of the programme, which covers questions from all courses in the programme as per the syllabus.

Note: The Board of studies of the concerned subject is permitted to make changes, if necessary, in the credits and internal-external ratio for the projects and comprehensive viva-voce without changing the total credit 80.

#### e. **Grade and Grade Points**

For all courses (theory & practical), grade points are given on a 8-point scale based on the total percentage of marks, (CIA+ESE) as given below:-

<b>Percentage of Marks</b>	<b>Grade Point (GP)</b>	<b>Grade</b>	<b>Indicator</b>
95 and above	10	<i>A+</i>	<i>Outstanding</i>
85 to below 95	9	<i>A</i>	<i>Excellent</i>
75 to below 85	8	<i>B+</i>	<i>Very Good</i>
65 to below 75	7	<i>B</i>	<i>Good</i>
55 to below 65	6	<i>C+</i>	<i>Fair</i>
45 to below 55	5	<i>C</i>	<i>Average</i>
40 to below 45	4	<i>D</i>	<i>Pass</i>

Below 40	0	<i>E</i>	<i>Deficient (Fail)</i>
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Grades for the different semesters and overall programme are given based on the corresponding SGPA/CGPA as shown below:

SGPA/CGPA	Grade	Indicator
9.0 and above	<i>A+</i>	<i>Outstanding</i>
Equal to 8.0 and below 9.0	<i>A</i>	<i>Excellent</i>
Equal to 7.0 and below 8.0	<i>B+</i>	<i>Very Good</i>
Equal to 6.0 and below 7.0	<i>B</i>	<i>Good</i>
Equal to 5.0 and below 6.0	<i>C+</i>	<i>Fair</i>
Equal to 4.0 and below 5.0	<i>C</i>	<i>Pass</i>
Below 4.0	<i>D</i>	<i>Deficient(Fail)</i>

A separate minimum of 40% marks required for a pass for both internal evaluation and external evaluation for every PG programme.

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

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

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

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

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

**SGPA = TCP/TCr**, where

$$\text{TCP} = \text{Total Credit Point of that semester} = \sum_{1}^{n} CP_i;$$

$$\text{TCr} = \text{Total Credit of that semester} = \sum_{1}^{n} Cr_i$$

Where n is the number of courses in that semester

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

$$\text{CGPA} = \frac{\Sigma(\text{SGPA} \times \text{TCr})}{\Sigma \text{TCr}}$$

*SGPA/CGPA shall be round off to two decimal places*

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

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.

## **9 Admission**

The eligibility criteria for admission to all PG programmes shall be published by the college along with the notification for admission.

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

## **11 Supplementary Examinations**

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

## **12 Improvement of Examination**

**There will be no improvement examinations for PG programmes/// ?????**

## **13 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.

#### **14. 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.

#### **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.

#### **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.

#### **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:** At the level of the concerned course teacher

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

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

## SEMESTERWISE DISTRIBUTION OF COURSES AND CREDITS

<b>SEMESTER I</b>				
<b>Course</b>	<b>Title</b>	<b>Theory hrs</b>	<b>Practical hrs</b>	<b>Credits</b>
<b>20P1BOTT01</b>	Microbiology + Phycology	27 + 45	27 + 36	4
<b>20P1BOTT02</b>	Mycology + Crop Pathology	45 + 27	36 + 18	4
<b>20P1BOTT03</b>	Ecology, Environmental Biology, Phytogeography & Research Methodology	54 + 18	27 + 9	4
<b>20P1BOTT04</b>	Cell Biology	54	27	3
<b>20P1BOTP01</b>	Practicals of <b>20P1BOTT01+ 20P1BOTT02</b>			2
<b>20P1BOTP02</b>	Practicals of <b>20P1BOTT03+ 20P1BOTT04</b>			2
<b>SEMESTER II</b>				
<b>20P2BOTT05</b>	Bryology + Pteridology	36 + 36	18 + 36	4
<b>20P2BOTT06</b>	Molecular Biology & Immunology	54 + 18	9 + 18	4
<b>20P2BOTT07</b>	Plant Anatomy, Angiosperm Systematics & Morphology	36 + 27 + 9	36 + 27	4
<b>20P2BOTT08</b>	Genetics & Biochemistry	18 + 36	18 + 18	3
<b>20P2BOTP03</b>	Practicals of <b>20P2BOTT05+ 20P2BOTT06</b>			2
<b>20P2BOTP04</b>	Practicals of <b>20P2BOTT07+ 20P2BOTT08</b>			2
<b>SEMESTER III</b>				
<b>20P3BOTT09</b>	Taxonomy of Angiosperms	72	45	4
<b>20P3BOTT10</b>	Gymnosperms, Evolution & Paleobotany	27 + 27	27 + 9	3
<b>20P3BOTT11</b>	Plant Physiology & Metabolism	72	36	4
<b>20P3BOTT12</b>	Plant Reproductive Biology, Palynology & Plant Breeding	36 + 18 + 18	36 + 9 + 9	4
<b>20P3BOTP05</b>	Practicals of <b>20P3BOTT09+ 20P3BOTT10</b>			2
<b>20P3BOTP06</b>	Practicals of <b>20P3BOTT11+ 20P3BOTT12</b>			2
<b>SEMESTER IV</b>				
<b>20P4BOTT13</b>	Genetic Engineering	72	18 + 18	3
<b>20P4BOTT14</b>	Genomics, Proteomics & Bioinformatics	27+45	18 + 27	4
<b>20P4BOTT15</b>	Tissue Culture & Microbial Biotechnology	36 + 18	18 + 18	3
<b>20P4BOTT16</b>	Biostatistics, Microtechniques & Biophysics	36+ 18+ 18	18 + 27 + 18	4
<b>20P4BOTP07</b>	Practicals of <b>20P4BOTT13+ 20P4BOTT14</b>			2
<b>20P4BOTP08</b>	Practicals of <b>20P4BOTT15+ 20P4BOTT16</b>			2
<b>20P4BOTPJ</b>	Research Project			3
<b>20P4BOTCV</b>	Comprehensive Viva Voce			2
	<b>TOTAL</b>			<b>80</b>

### Additional Credits: Components

Content	Minimum Hours	Credit
1. Internship	36	2

2. Virtual Lab Experiments	36	2
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## SACRED HEART COLLEGE (AUTONOMOUS) –THEVARA, KOCHI -13

### MARK CUM GRADE CARD

Name of the Candidate :  
 Name of the College :  
 Permanent Register Number (PRN) :  
 Programme : M. Sc. Botany  
 Name of the Examination : First Semester PG-CBCS Examination November 2020  
 Faculty : Science

Course Code	Course Title	Credits (Cr)	Marks						Grade awarded (G)	Grade Point (GP)	Credit Point (CP = Cr × GP)	Result
			Internal		External		Total					
			A	M	A	M	A	M				
16P1BOTT01	Microbiology & Phycology	4	15	25	75	75	90	100	A <sup>+</sup>	9	36	Pass
16P1BOTT02	Mycology & Crop Pathology	4	18	25	70	75	88	100	A <sup>+</sup>	9	36	Pass
16P1BOTT03	Ecology & Envnt. Biology & Research	4	15	25	60	75	75	100	A	8	32	Pass
16P1BOTT04	Methodology Cell Biology	3	12	25	50	75	62	100	B	6	18	Pass
16P1BOTP01	16P1BOTT01	2	9	10	39	40	48	50	A <sup>+</sup>	9	18	Pass
16P1BOTP02	&16P1BOTT0216P1BOTT03 &16P1BOTT04	2	8	10	38	40	46	50	A <sup>+</sup>	9	18	Pass
	Total	19					459	500			165	
	Semester Result <b>SGPA</b>								<b>A</b>	<b>8.68</b>		<b>Pass</b>

Checked by

Section Officer

Controller of Examinations

**SACRED HEART COLLEGE (AUTONOMOUS) –THEVARA,  
KOCHI -13**

**MARK CUM GRADE CARD**

Name of the Candidate :  
 Name of the College :  
 Permanent Register Number (PRN) :  
 Programme : M.Sc. Botany  
 Name of the Examination : Fourth Semester PG-CBCS Examination March 2022

Course Code	Course Title	C r e d i t s ( C r )	Marks						G r a d e a w a r d e d ( G )	G r a d e P o i n t ( G P )	C r e d i t P o i n t ( C P = C r × G )	Result
			Internal		External		Total					
			A w a r d e d	M a x .	A w a r d e d	M a x .	A w a r d e d	M a x .				
16P4BOTT13	Genetic Engineering	3	15	25	75	75	90	100	A <sup>+</sup>	9	36	Pass
16P4BOTT14	Genomics, Proteomics & Bioinformatics	4	18	25	70	75	88	100	A <sup>+</sup>	9	36	Pass
16P4BOTT15	Tissue Culture & Microbial Biotech.	4	15	25	60	75	75	100	A	8	32	Pass
16P4BOTT16	Biostatistics, Microtech. & Biophysics	3	12	25	50	75	62	100	B	6	18	Pass
16P4BOTP7	16P4BOTT13&16P4BOTT14	1.5	10	10	40	40	50	50	A <sup>+</sup>	9	13.5	Pass
16P4BOTP8	16P4BOTT15&16P4BOTT16	1.5	10	10	40	40	50	50	A <sup>+</sup>	9	13.5	Pass
16P4BOTPJ	Research Project	3	18	25	72	75	90	100	A <sup>+</sup>	9	27	Pass
16P4BOTCV	Comprehensive Viva Voce	2	17	25	67	75	84	100	A	8	16	Pass
	Total Semester Result <b>SGPA</b>	23					589	700	<b>A</b>	<b>8.34</b>	192	<b>Pass</b>
	Semester I (Nov 2020)	19					459	500	A	8.68	129	
	Semester II (Mar2021)	19					509	500	A	7.86	173	
	Semester III (Nov 2021)	19					365	500	A	8.94	129	
	Semester IV (Mar2022)	23					683	700	A	8.34	207	
	Final Result - <b>CGPA</b>	<b>80</b>					<b>1922</b>	<b>2200</b>	<b>A</b>	<b>8.45</b>	<b>638</b>	

Checked by

Section Officer

Controller of Examinations

**[Reverse side of the Mark cum Grade Card (COMMON TO ALL SEMESTERS)]**

**Description of the Evaluation Process- Grade and Grade Point**

**Table 1**

<b>Percentage of Marks</b>	<b>Grade Point (GP)</b>	<b>Grade</b>	<b>Indicator</b>
95 and above	10	<i>A+</i>	<i>Outstanding</i>
85 to below 95	9	<i>A</i>	<i>Excellent</i>
75 to below 85	8	<i>B+</i>	<i>Very Good</i>
65 to below 75	7	<i>B</i>	<i>Good</i>
55 to below 65	6	<i>C+</i>	<i>Fair</i>
45 to below 55	5	<i>C</i>	<i>Average</i>
40 to below 45	4	<i>D</i>	<i>Pass</i>
Below 40	0	<i>E</i>	<i>Deficient (Fail)</i>

The Evaluation of each Course comprises of Internal and External Components in the ratio 1:3 for all Courses. Grades and Grade Points are given on a 8-point Scale based on the percentage of Total Marks (Internal + External) as given in Table 1.

(Decimals are to be rounded mathematically to the nearest whole number)

**Semester Grade Point Average and Cumulative Grade Point Average**

Grades for the different Semesters and overall Programme are given based on the corresponding GPA, as shown in Table 2

**Table 2**

<b>SGPA/CGPA</b>	<b>Grade</b>
9.0 and above	<i>A+</i>
Equal to 8.0 and below 9.0	<i>A</i>
Equal to 7.0 and below 8.0	<i>B+</i>
Equal to 6.0 and below 7.0	<i>B</i>
Equal to 5.0 and below 6.0	<i>C+</i>
Equal to 4.0 and below 5.0	<i>C</i>
Below 4.0	<i>D</i>

$SGPA = TCP/TCr$ , where

$$TCP = \text{Total Credit Point of that semester} = \sum_{1}^{n} C P_i;$$

$$TCr = \text{Total Credit of that semester} = \sum_{1}^{n} C r_i$$

Where  $n$  is the number of courses in that semester

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

$$CGPA = \frac{\sum(TCP \times TCr)}{\sum TCr}$$

*GPA shall be round off to two decimal places*

## **PROGRAMME OUTCOMES (POs)**

At the end of the programme,

- PO1 the students are capable of exercising their critical thinking in creating new knowledge leading to innovation, entrepreneurship and employability
- PO2 the students are able to effectively communicate the knowledge of their study and research in their respective disciplines to their employers and to the society at large.
- PO3 the students are able to make choices based on the values upheld by the college, and have the readiness and know-how to preserve environment and work towards sustainable growth and development
- PO4 the students possess an ethical view of life, and have a broader (global) perspective transcending the provincial outlook
- PO5 the students possess a passion for exploring 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 To encourage a clear, comprehensive and advanced mastery in the field of Botany.
- PSO2 To provide basic principles of biological sciences with special reference to Botany and its applied branches.
- PSO3 To enable the students to explore the intricacies of life forms at cellular, molecular and nano level.
- PSO4 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.
- PSO5 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.

# SEMESTER I

Course	Title	Teaching Hrs Theory	Teaching Hrs Practical	Credits
<b>20P1BOTT01</b>	Microbiology + Phycology	27 + 45	9 + 36	4
<b>20P1BOTT02</b>	Mycology + Crop Pathology	45 + 27	36 + 18	4
<b>20P1BOTT03</b>	Ecology, Environmental Biology, Phytogeography & Research Methodology	54 + 18	27 + 9	4
<b>20P1BOTT04</b>	Cell Biology	54	27	3
<b>20P1BOTP01</b>	Practicals of <b>20P1BOTT01+ 20P1BOTT02</b>			2
<b>20P1BOTP01</b>	Practicals of <b>20P1BOTT03+ 20P1BOTT04</b>			2
<b>FIELD STUDY</b>	Students are expected to conduct field visit (one in each semester) to familiarize with the diversity of life forms dealt in the semester syllabus. Report of the field visit should be prepared and recorded as part of the practical record.			



## 20P1BOTT01: MICROBIOLOGY AND PHYCOLOGY

(Theory 27 + 45 hrs; Practical 9 + 36 hrs; Credits: 4)

COURSE OUTCOMES (COs)	
CO 1	Understand the world of microbial diversity and their evolutionary relationships
CO 2	Understand the reproductive behaviour in Algae and microbes
CO 3	Understand ecological significance of the lower groups of plants and protists
CO 4	Understand economic significance of the lower groups of plants and protists
CO 5	Collect various algal forms, identify and classify them in the laboratory
CO 6	Compare various life cycles exhibited different classes of algae

### MICROBIOLOGY (Theory 27 hrs, Practical 9 hrs)

**Module 1: Introduction to microbiology:** History of Microbiology, Scope of microbiology. Microbial diversity: Microbial taxonomy and phylogeny - Major groups and their characteristics (Five kingdom system and three domain system of classification), Microbes in everyday life.

#### Module 2: Bacteria (12 hrs)

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

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

(c) Major groups of Bacteria: Spirochetes, Mycoplasmas, Actinomycetes, Myxobacteria, Archaeobacteria. Extremophiles - thermophilic, halophilic, acidophilic and alkaliphilic bacteria.

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

(e) Bacterial Genetics: Organization and replication of genetic material in bacteria – bacterial chromosome, plasmid. Recombination in bacteria - conjugation, transformation and transduction. Sexduction.

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

#### Module 3: Applied Microbiology (4 hours)

Host-Microbe relationships and diseases;

Food Microbiology: food spoilage and preservation methods, Microbiology of fermented foods, Microorganisms as source of food-SCP.

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

#### **Module 4: Viruses (11hrs)**

(a) Nomenclature and classification, distinctive properties of viruses, morphology (symmetry) and a general account on different kinds of viruses. Capsid and their arrangements, types of envelopes and their composition. Viral genome.

(b) Structure of bacteriophages belonging to 'T' series. Lytic and Lysogenic phages. Ultra structure of TMV and HIV.

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

(d) Pathogenesis of viral infection: Stages of infection, Epidemiology and transmission of HIV, HPV. Viral oncogenesis.

#### **Practical (9 hrs)**

1. Preparation and sterilization of various microbial culture media and inoculation.
2. Differential staining of bacteria using Gram stain.
3. Isolation of *Rhizobium* from root nodules.
4. Isolation of microbes from soil: Serial dilution - pour plate/spread plate method.
5. Streak out a bacterial culture on an agar plate and isolation of colonies.
6. Antibacterial assay - disc diffusion/agar well method.

#### **References**

1. Bilgrami, Sinha. *Essentials of Microbiology*.
2. Black, J. G. *Microbiology: Principles and Explorations* vii<sup>th</sup> edition. JOHN WILEY & SONS, INC.
3. Carpenter P L (1967). *Microbiology*. W B Saunder & Co. Philadelphia.
4. Dube H C (2008). *Fungi, Bacteria and Viruses*. Agrobios.
5. Kanika Sharma (2005). *Manual of Microbiology: Tools and Techniques*. Ane Books.
6. Kumar H D (1990). *Modern concepts of Microbiology*. Vikas public. Delhi.
7. Lansing M Prescott, Harley, Klein (2002). *Microbiology* v<sup>th</sup> Edition.
8. Pelczar Michael J, Adams M R, Chan E C S, Krieg Noel R (2000). *Microbiology*. Tata McGraw Hill.
9. Pelczar (1990). *Microbiology*. T M H.
10. Purohit S S (1997). *Microbiology: Fundamentals and application*. Agrobotanical.
11. Powar C B, Dagainawala H F (1991). *General Microbiology* Vol II. Himalaya Publishing House.
12. Salle A J (1978). *Fundamentals of Bacteriology*. Asia TMH
13. Dubey R C, Maheswari D K (2004). *Microbiology*. S Chand.
14. Sharma P D (2003). *Microbiology*. Restogi pub.
15. F H Kayser, K A Bienz, J Eckert, R M Zinkernagel. *Medical Microbiology*.
16. L R Haahelm, J R Pattison, R J Whitley. *Clinical virology*.

# PHYCOLOGY (Theory 45 hrs; Practical 36 hrs)

**Introduction to the Course:** General characters of algae.

## Unit 1: Introduction (4 hrs)

- History of algal classification. Detailed study of the classification by F. E. Fritsch. Brief account on the classification (Upto groups and divisions) by Edward Lee (2008). Gene sequencing and algal systematics (Brief study only).
- Centers of algal research in India. Contributions of Indian phycologists – M. O. P. Iyengar, G.S. Venkataraman, T. V. Desikachary

## Module 2: General features of Algae (26 hrs)

- Habit, habitat and distribution of Algae, Major characteristics of Cyanophyceae, Chlorophyceae, Xanthophyceae, Bacillariophyceae, Dinophyceae, Phaeophyceae and Rhodophyceae
- Range of thallus structure.
- Algal components: Cell wall, flagella, eye-spot, pigments, pyrenoid, photosynthetic products.
- Reproduction in algae: Vegetative, asexual and sexual reproduction (development of sex organs not necessary)
- Major patterns of life cycle and post fertilization stages in Phaeophyceae and Rhodophyceae.
- Fossil algae.

## Module 3: Ecological and Economic importance of Algae (9 hrs)

- Ecological importance of Algae. Primary productivity. Algae in symbiotic association, Ultraviolet radiation absorption by algae.
- Algae as food, fodder, biofertilizer, medicine, industrial uses and other useful.
- Algae in experimental studies. (SCP, Biofuel, Live feeds, EPS.).
- Harmful effects of algae: Algal blooms, causative organisms, symptoms and toxins of major toxic algal blooms (Amnesic Shellfish Poisoning [ASP], Paralytic Shellfish Poisoning [PSP] and Cyanophycan toxins).

## Module 4: Algal biotechnology (6 hrs)

- Methods and techniques of collection, preservation and staining of Algae.
- Algal culture: Importance, methods; Algal culture media.

## Practical (36 hrs)

1. Critical study of diagnostic features and identification of the following genera based on morphological, anatomical and reproductive parts;

- |                       |   |                         |                      |                     |                      |
|-----------------------|---|-------------------------|----------------------|---------------------|----------------------|
| (a) Cyanophyceae      | - | <i>Gleocapsa,</i>       | <i>Gleotrichia,</i>  | <i>Spirulina,</i>   | <i>Microcystis,</i>  |
|                       |   | <i>Oscillatoria,</i>    | <i>Lyngbya,</i>      | <i>Anabaena,</i>    | <i>Nostoc,</i>       |
|                       |   | <i>Rivularia,</i>       | <i>Scytonema.</i>    |                     |                      |
| (b) Chlorophyceae     | - | <i>Chlamydomonas,</i>   | <i>Volvox,</i>       | <i>Tetraspora,</i>  | <i>Ulothrix,</i>     |
|                       |   | <i>Microspora,</i>      | <i>Ulva,</i>         | <i>Shizomeris,</i>  | <i>Cladophora,</i>   |
|                       |   | <i>Pithophora,</i>      | <i>Coleochaete,</i>  | <i>Chaetophora,</i> | <i>Drapernaldia,</i> |
|                       |   | <i>Trentepohlia,</i>    | <i>Fritschiella,</i> | <i>Cephaleuros,</i> | <i>Oedogonium,</i>   |
|                       |   | <i>Bulbochaete,</i>     | <i>Zygnema,</i>      | <i>Mougeotia.</i>   | <i>Desmedium,</i>    |
|                       |   | <i>Bryopsis,</i>        | <i>Codium,</i>       | <i>Caulerpa,</i>    | <i>Halimeda,</i>     |
|                       |   | <i>Neomeris,</i>        | <i>Chara,</i>        | <i>Nitella.</i>     |                      |
| (c) Xanthophyceae     | - | <i>Vaucheria.</i>       |                      |                     |                      |
| (d) Bacillariophyceae | - | <i>Biddulphia,</i>      | <i>Pinnularia.</i>   |                     |                      |
| (e) Phaeophyceae      | - | <i>Ectocarpus,</i>      | <i>Colpomenia,</i>   | <i>Dictyota,</i>    | <i>Padina,</i>       |
|                       |   | <i>Sargassum,</i>       | <i>Turbinaria.</i>   |                     |                      |
| (f) Rhodophyceae      | - | <i>Batrachospermum,</i> | <i>Compsopogon,</i>  | <i>Gelidium,</i>    | <i>Amphiroa,</i>     |
|                       |   | <i>Gracilaria,</i>      | <i>Polysiphonia.</i> |                     |                      |

2. Students are to collect and identify algae from different habitat or visit an Algal research station. Prepare and submit a report of the field work/research station visit.

## References

1. Andersen R A (Ed) 2004. *Algal Culturing Techniques*, Elsevier.
2. Bellinger E.G. and Sigeo D.C. (2010). *Freshwater algae: Identification and use as bioindicators*. Willey-Blackwell, UK, pp. 271.
3. Brodie J. and Lewis J. (2007). (Ed.) *Unravelling the algae: the past, present and future of algal systematics*. CRC press, New York, pp 335.
4. Chapman V J (1962). *The Algae*. Macmillan & Co. Ltd.
5. D'Silva M.S, Anil, A C Naik R K, D'Costa P M (2012). *Algal blooms: a perspective from the coasts of India*. *Nat Hazards*, 63:1225–1253 DOI 10.1007/s11069-012-0190-9 7.
6. Das S K, Adhikary S B (2014). *Freshwater Algae of Eastern India*. Astral International.
7. Cole K.M. and Sheath R.G. (1990). *Biology of the red algae*. Cambridge University Press. USA. pp. 503.
8. Desikachary T.V. (1959). *Cyanophyta*. ICAR, New Delhi.
9. Desikachary, T.V., Krishnamurthy, V. and Balakrishnan, M.S. 1990. *Rhodophyta Vol.I&II*. Madras Science Foundation, Chennai.
10. F E Fritsch (Vol. I, II) (1977). *The structure and reproduction of Algae*. Cambridge University Press.
11. Gilbert M Smith (1951). *Manual of Phycology*.
12. Gonzalves, E.A. 1981. *Oedogoniales*. Indian Council of Agricultural Research, New Delhi.
13. Graham L.E. and Wilcox L.W. (2000). *Algae*. Penticce-Hall, Inc, pp. 640
14. Harnold C Bold, Michael J Wynne (1978). *Introduction to Algae: Structure and reproduction*. Prentice Hall.
15. Iyengar M.O.P. and T V Desikachary (1981). *Cyanophyta*. ICAR Publication.
16. Iyengar, M.O.P. and Desikachary, T.V. 1981. *Volvocales*. Indian Council of Agricultural Research, New Delhi.
17. John J. and Francis M.S. (2013). *Illustrated Algal Flora of Kerala Vol.I*. GCS Books, Cochin.
18. Karthick, B., Hamilton P B and Kociolek, J.P. (2013). *An Illustrated Guide on Common Freshwater Diatoms of Peninsular India*. Gubbi Labs. ISBN: 978-81-924461-1-0
19. Krishnamurthy V. (2000). *Algae of India and neighboring countries I. Chlorophycota*, Oxford & IBH, New Delhi.
20. Lee R.E. (2008). *Phycology*. Cambridge University Press.
21. Misra J.N. (1996). *Phaeophyceae in India*. ICAR, New Delhi.
22. Pal, B.P. and Kundu, B.C. 1962. *Charophyta*. Indian Council of Agricultural Research, New Delhi.
23. Philipose, M.T. (1967). *Chlorococcales*. Indian Council of Agricultural Research, New Delhi.
24. Prescott G.W. (1969). *The algae*.
25. Pringsheim E G (1949). *Pure culture of Algae*. Cambridge University Press.
26. Randhawa, M.S.(1959). *Zygnemaceae*. Indian Council Agricultural Research, New Delhi.
27. Reynolds C S (2006). *Ecology of phytoplankton*, Cambridge University Press
28. Sharma O.P. (2010). *Text book of Algae*. Tata McGraw Hill Edition.
29. Smith G.M. (1950). *The fresh water algae of the United States*. Mc-graw Hill New York.
30. Van Den Hoek,C., Mann, D.G. and Jahns, H.,M., (1998). *Algae and Introduction to Phycology*. Cambridge University Press.

## 20P1BOTT02: MYCOLOGY AND CROP PATHOLOGY

(Theory 45 + 27 hrs; Practical 36 + 18 hrs; Credits: 4)

COURSE OUTCOMES (COs)	
CO 1	Able to collect, preserve, identify and classify different micro and macro fungi.
CO 2	Have a better understanding on different classification systems and their applications.
CO 3	Create awareness about the significance of mycotic diseases
CO 4	Have advanced learning about fungal associations, their usefulness and harmfulness
CO 5	Develop advanced theoretical and practical knowledge about phytopathogens and their control.

### MYCOLOGY (Theory 45hrs; Practical 36 hrs)

#### Introduction to the Course

General characters of fungi. Economic and ecological importance of fungi.

#### Module 1: General introduction (6 hrs)

General characters of Fungi and their significance. Principles of classification of fungi, Classifications by G C Ainsworth (1973) and C. J. Alexopoulos . Classification of true fungi (down to the level of class) according to the current 'AFTOL' scheme (Hibbett et al. 2007). Brief account of DNA barcoding in fungi.

#### Module 2: Thallus structure and reproduction in Fungi (30 hrs)

Mycelial structure and reproduction of;

- (a) Myxomycota - *Acrasiomycetes, Hydromyxomycetes, Myxomycetes, Plasmodiophoromycetes.*
- (b) Mastigomycotina - *Chytridiomycetes, Hyphochytridiomycetes, Oomycetes.*
- (c) Zygomycotina - *Zygomycetes, Trichomycetes.*
- (d) Ascomycotina - *Hemiascomycetes, Pyrenomycetes, Plectomycetes, Discomycetes, Laboulbeniomycetes, Loculoascomycetes.*
- (e) Basidiomycotina - *Teliomycetes, Hyphomycetes, Gastromycetes.*
- (f) Deuteromycotina - *Blastomycetes, Hyphomycetes, Coelomycetes.*

(g) Types of fruiting bodies in fungi.

#### Module 3: Fungal associations and their significance (9 hrs)

- (a) Symbionts - 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

### Practical (36 hrs)

1. Critical study of the following types by preparing suitable micropreparations:

<i>Stemonitis</i> ,	<i>Physarum</i> ,	<i>Saprolegnia</i> ,	<i>Phytophthora</i> ,	<i>Albugo</i> ,
<i>Mucor</i> ,	<i>Aspergillus</i> ,	<i>Penicillium</i> ,	<i>Pilobolous</i> ,	<i>Saccharomyces</i> ,
<i>Taphrina</i> ,	<i>Xylaria</i> ,	<i>Peziza</i> ,	<i>Phyllochora</i> ,	<i>Puccinia</i> ,
<i>Pleurotus</i> ,	<i>Auricularia</i> ,	<i>Polyporus</i> ,	<i>Lycoperdon</i> ,	<i>Dictyophora</i> ,
<i>Geastrum</i> ,	<i>Cyathus</i> ,	<i>Fusarium</i> ,	<i>Alternaria</i> ,	<i>Pestalotia</i> ,
<i>Tremella</i> ,	<i>Entoloma</i> ,	<i>Marasmius</i> ,	<i>Hexagonia</i> ,	<i>Ganoderma</i> ,
<i>Graphis</i> ,	<i>Parmelia</i> ,	<i>Usnea</i> .		

2. Isolation of fungi from soil and water by culture plate technique.

3. Estimation of mycorrhizal colonization in root.

4. Collection and identification of common field mushrooms (5 types).

### References

1. C J Alexopoulos, M Blackwell, C W Mims (1996). *Introductory Mycology (IV Edn)*.
2. Jim Deacon (2006). *Fungal Biology (IV Edn)*. Blackwell Publishing.
3. L N Nair (2010). *Methods of microbial and plant biotechnology*. New Central Book agency (P) Ltd.
4. Kanika Sharma (2005). *Manual of microbiology: Tools and techniques*.
5. G C Ainsworth, K F Sparrow, A S Sussman (1973). *The fungi: An advanced treatise*.
6. H C Dube (1983). *An introduction to fungi*. Vikas Publ. New Delhi.
7. M E Hale (1974). *The biology of lichens*.
8. A Misra, P R Agarwal (1994). *Lichens*.
9. M C Nair, S Balakrishnan (1986). *Beneficial fungi and their utilization*. Sci. publ. Jodhpur.
10. V Ahamjian, M E Hale (1973). *The Lichens*.
11. R Dayal (2000). *Predaceous Fungi*. Commonwealth Publishers.
12. Hibbet et al. (2007). A higher level phylogenetic classification of the fungi. *Mycological Researcher III* (2007) pp. 509-547.

## CROP PATHOLOGY (Theory 27hrs; Practical 18 hrs)

### Introduction to the Course

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 1: Process of infection and pathogenesis (4 hrs)

- (a) Disease triangle, Mazz's Disease Pyramid
- (b) Development of disease in plants: disease cycle (survival or persistence of pathogen between crops and during unfavorable seasons, dissemination of the pathogen, inoculation, recognition between host and pathogen, entry of pathogen (prepenetration & penetration), colonization)
- (c) Strategies used by pathogens to attack plants.
- (d) Mechanism of infection- Penetration and entry of pathogen into host tissue – mechanical, physiological and enzymatic.
- (e) Host-parasite interaction
- (f) Role of biochemicals in pathogenesis: enzymes, toxins (Tabtoxin, Phaseolotoxin, Tentoxin, Cercosporin, Victorin, T Toxin, HC Toxin), growth regulators and polysaccharides.
- (g) Detoxification of low molecular weight antimicrobial molecules produced by plants, suppression of plant defense responses Pathogenicity and virulence factors in viruses and viroids
- (h) Physiology of Parasitism: Effect of pathogens on the following processes of the host plant – photosynthesis, transpiration, translocation of water and nutrients, respiration, cell membrane permeability, transcription and translation, growth and reproduction

### Module 2: Defense mechanism in plants (4 hrs)

- (a) Non-host resistance, horizontal resistance, vertical resistance
- (b) Pre-existing defense mechanisms: structural and biochemical (Inhibitors released by the plant in its environment, inhibitors present in plant cells before infection, Defense through lack of essential factors)
- (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 3: Transmission of plant disease (2 hrs)**

Mass action concept by Horsfall; Autonomous or direct or active dissemination (seed, soil & plant organs) & Passive or indirect dissemination (through animate & inanimate agents)  
Spread and transmission of plant diseases by wind, water, seeds and vectors.

### **Module 4: Effect of environmental factors on the development of plant diseases (2 hrs)**

Effect of, temperature, moisture, wind, light, soil pH, host plant nutrition,

### **Module 5: Plant disease management (4 hrs)**

- (a) Prophylactic methods - Exclusion, eradication and protection.
- (b) Therapeutic Method Chemical means of disease control – common fungicides, antibiotics and nematicides. pesticides, and bactericides, types of pesticides based on toxicity- red, blue, yellow, green labels and residual effect. Method of application, different types of sprayers and their working.
- (c) Biological means of disease control - (*Psuedomonas*, *Trichoderma*, *Bruvaria*, *PGPR*, *VAM*) control of fungal plant pathogens by mycofungicides.
- (d) Production & use of disease resistant hybrids
- (e) Immunization of plants against pathogens – defense through plantibodies, induction of plant defenses by artificial inoculation with microbes or by treatment with chemicals
- (f) Transgenic approaches to disease resistance. Defense through genetically engineering disease resistant plants – Biotechnological approaches to disease resistance

### **Module 6: Major diseases in plants (10 hrs)**

- (a) Cereals: Rice - blast disease, bacterial blight; Wheat - black rust disease.
- (b) Vegetables: Chilly - leaf spot; Ladies finger - vein clearing disease, mosaic disease; Tomato - Damping off, Serpentine leaf miner, fusarium wilt; Cucurbita- Epinauca disease; Root knot in vegetables.
- (c) Fruits: Banana - bacterial leaf blight, leaf spot, Pseudo stem borer; Mango - Anthracnose; Fruit borer; Citrus - bacterial canker; Papaya – mosaic, mealy bug disease,
- (d) Spices: Ginger - rhizome rot; Pepper - quick wilt; Cardamom - marble mosaic disease.
- (e) Oil seeds: Coconut - grey leaf spot, bud rot disease.
- (f) Rubber yielding: *Hevea brasiliensis* - abnormal leaf fall, powdery mildew.
- (g) Sugar yielding: Sugarcane - red rot; root knot nematode.
- (h) Cash crops: Arecanut - nut fall disease.
- (i) Beverages: Tea - blister blight; Coffee - rust.
- (j) Ornamental plants: Anthurium – Bacterial wilt; Rose – Fungal Black Spot; Mite attack; Orchids- bud fall

### **Practical (18 hrs)**

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 serial dilution method.
3. Collection and preservation of specimens from infected plants. Submit 5 herbarium sheets/live specimens along with a report.
4. Tests for seed pathology – seed purity test.
5. Calculation of Spore load on seeds using Haemocytometer.

## References

1. K S Bilgrami, H C Dube (1976). *A text book of modern plant pathology*.
2. Gareth Johnes (1987). *Plant pathology: principles and practice*.
3. R S Mehrotra (2003). *Plant Pathology*.
4. M N Kamat (1953). *Practical plant pathology*.
5. V K Gupta, T S Paul (2001). *Fungi and Plant disease*.
6. Malhotra, Aggarwal Ashok (1986). *Plant Pathology*.
7. Rangaswamy, A Mahadevan (1998). *Diseases of crop plants in India*.
8. B P Pandey (2001). *Plant Pathology*.
9. George N Agrios (2006). *Plant pathology* (V Edn). Elsevier Academic Press.



## 20P1BOTT03: ECOLOGY, ENVIRONMENTAL BIOLOGY, PHYTOGEOGRAPHY & RESEARCH METHODOLOGY

(Theory 72 hrs; Practical 36 hrs; 4 Credits)

COURSE OUTCOMES (COs)	
CO 1	To enable the students to have a better understanding of the environment
CO 2	To enrich the students with advanced theoretical and practical knowledge on ecology and environmental science
CO 3	To train the students, both theoretically and practically, with different mathematical and statistical models and indices to explain natural phenomena and theoretical principles with which several ecological processes are explained.
CO 4	To enable the students to have detailed understanding about the environmental problems.
CO 5	To provide the students detailed learning about the origin of the Western Ghats and diversity and conservation in the Western Ghats
CO 6	To facilitate the students to have advanced learning about biodiversity, phytogeography, ecosystem functioning etc.
CO 7	To enrich the students with the principle, necessity and methods of conservation managements of natural ecosystems and rare, endemic and threatened species in the Western Ghats.
CO 8	To develop scientific aptitude and apply methodologies to pursue scientific researches.

### Introduction to the Course

- (a) Significance of habitat, biodiversity, ecological niche, trophic level, primary and secondary productivity, food chains, food webs, ecological pyramids, energy flow and nutrient cycles.
- (b) Water pollution: different types of pollutants and their consequences; a case study - water shed management, waste water treatment. Waste water treatment with aquatic macrophytes.
- (c) Air pollution: Air quality standards and index, ambient air monitoring using high volume air sampler, types and sources of air pollutants, air pollution and human health hazards, control of air pollution.
- (d) Noise pollution.
- (e) Radioactive and thermal pollution: Causes and hazardous effects, effective management.
- (f) Ecotourism - scope and importance in Kerala.
- (g) Natural Resources: Soil, water and air Resources – soils and parent materials – ecology of soil fertility - soil as a buffer system; Carbon in soils – humus – its chemistry and role in soil , Exchangeable and Soluble cations and anions in soils; run-off water – factors affecting percolation; Soil biology – role of soil biota - problems of irrigation - degradation and desertification of soils – soil reclamation – soil conservation – prevention of soil erosion - mulching, contour bunds – sustainable soil fertility. Soil profile- tropical and temperate, Types of soil in India.

- (h) Fresh water and marine resources: Global distribution of water resources – surface and ground water resources –water conservation – prevention of marine pollution – conservation of marine resources.
- (i) Atmospheric resources: Structure of atmosphere – climate and weather – climatic factors – precipitation, wind, temperature, aerosols –weather forecasting - environmental factors affecting precipitation – factors affecting global climate – global warming and its impact on vegetation, biodiversity and soils – measures to mitigate bad impacts of global warming – opportunities – carbon credit.
- (j) Principles of energy conservation :Conventional and non-conventional energy resources – measures to reduce energy uses – alternative energy resources - wind energy, solar energy, biomass energy – hydrogen fuel - biological and other process of generation of hydrogen fuel – biofuels – bio-oils and biodiesel – petroplants; Conservation and development- environment movement in India – NGOs - socio-economic and political realities – concept of sustainable development.

### **Module 1 Introduction to Ecology (4hrs)**

- (a) Definition, history and scope of ecology, sub divisions of ecology, ecology vs environmental science. Interdisciplinary nature of environmental science
- (b) Scope of ecology; interdisciplinary aspects of ecology, applications of ecology in different fields (EIA, Research, education, agriculture, healthy life, etc.)

### **Module-2. Autecological concepts: (8 hrs)**

- (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
- (b) Genecology - ecads, ecotypes, ecospecies, coenospecies; k-selection and r-selection populations; Molecular ecology and conservation genetics

### **Module-3. Synecological concepts (12hrs)**

- (a) Ecological processes of community formation, ecotone, edge effect.
- (b) Special plant communities - quantitative, qualitative and synthetic characteristics of plant communities. Important Value Index (IVI).  
Species diversity and its measurements - characteristics of plant communities, Alpha diversity and Beta diversity; definition and measures (Mergalef's index, Fishers Alpha, Shannon and Simpson diversity indices) of Alpha diversity with comparative data. Beta diversity, Jaccard's similarity/dissimilarity index, Sorenson's Index of similarity and Evenness index.
- (c) Ecological niche and Guild; functioning and significances in community studies.
- (d) Functional aspects of community; co-existence, resource partitioning, spatial correlates of communities, inter specific interactions with examples, co evolution and coexistence. Community network; competition, Predation, mutualism, symbiosis, commensalism and ammensalism.

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

#### **Module-4. Ecological succession (4hrs)**

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

(b) Retrogressive changes or the concept of degradation, concept of climax or stable communities, resilience of communities, ecological balance and survival thresholds.

#### **Module-5. Biosphere and Ecosystem (3hrs)**

Comparative study of the major world ecosystems: Different aquatic and terrestrial ecosystems with regard to their productivity, biodiversity, energy flow, food chains and trophic levels.

#### **Module-6. Environmental Pollution and Management (4 hrs)**

Methods of Pollution Control- bioremediation, Phytoremediation, bio-augmentation, bio-films, bio-filters, bio-scrubbers and trickling filters. Use of bioreactors in waste management

#### **Module-7. Climate Change and other Global Environmental Issues (5 hrs)**

Climate Change and other Global Environmental issues. Evidences of Climate change

Factors responsible for climate change,

Climate change mitigation – global conventions and protocols on climate change - *El-Nino* and *La Nina* phenomenon and its consequences - Environmental laws and biosafety, environmental monitoring and bio indicators, environmental safety provisions in Indian constitution, major environmental laws in free India. Major developments in the field of conservation ecology on a global perspective; their significances and applications in the present scenario.

#### **Module 8. Phytogeography (4)**

8.1 (a) Definition, principles governing plant distribution, factors affecting plant distribution, theories of species distribution, different types of vegetation on the earth, continuous and discontinuous distribution

(b) Climate, vegetation and botanical zones of India; Floristic provinces in the world

(c) Remote sensing of vegetational characteristics – principle, data acquisition; GIS and GPS and their application in vegetation studies

#### **Module -9. Conservation Biology - Biodiversity and its conservation (6)**

Definition – components of biodiversity (Ecosystem, species and genetic), concept of endemism and hot spots. Role of IUCN in conservation- rare, endangered and threatened species, keystone species, flag-ship species and red data book. Reasons for biodiversity loss. Basic principles of conservation - *ex-situ* and *in-situ* conservation techniques. Principles, methods and uses of remote sensing in conservation of natural resources. International conventions on biodiversity – CITES; national wildlife conservation policy and action plan, national forest policy.

Restoration ecology and their significances.

#### **Module-10. The Western Ghats and the Mangroves (4)**

- (a) Importance, origin, geology, vegetation types, diversity, resources, Concept of hotspot (The Western Ghats as a biodiversity hotspot).
- (b) Vegetation types of the Western Ghats.
- (c) Mangrove ecosystem and its significance in the western coast of Peninsular India.

### Practical (27 hours)

1. Analysis of water quality (a) Dissolved CO<sub>2</sub> (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. Physico-chemical analysis of soil: Total water soluble mineral ions
3. Quantitative and qualitative community analysis. Carry out a project on species structure and the frequency, abundance, density of different species and similarity index, basal area, IVI and evenness of different communities in a natural system.
4. Statistical analysis of diversity indices by using apt softwares
5. Phytoplankton counting using Sedgwick Rafter counter.
6. To determine organic 'C' and organic matter (biomass) in different (at least 3) locations (forest, agro ecosystem and polluted area.
7. Interpretation of GIS/remote sensing data for landscape differentiation
8. Field visit to natural ecosystem and identification of trophic levels, food webs and food chains, plant diversity (species and community)
9. Students should be aware of the common environmental problems, their consequences and possible solutions.

### References

1. Ahmedullah M, Nayar M P (1987). *Endemic plants of India*.
2. APHA, Awwa, Wep (2005). *Standard methods for the examination of water and waste water*.
3. Barbour M D, et. al., (1980). *Terrestrial plant ecology*. The Benjamin-Cummings Pub. Com.
4. Benton A H, Werner W E (1976). *Field biology and Ecology*. Tata McGraw Hill.
5. Clarke G L (1954). *Elements of Ecology*. John Wiley Pub.
6. Dash M C (1993). *Fundamentals of Ecology*. Tata McGraw Hill.
7. Eldon D, Enger, Bradley, Smith F (1995). *Environmental Science*. W C Brown publications.
8. *Ecological Guidelines for tropical costal developments*. UNESCO (1976).
9. Furley P A et. al., (1983). *Geography of the biosphere: An introduction to the nature, distribution and evolution of the world life zones*. Butterworths.
10. IUCN (2000). *The IUCN red list category*. IUCN England.
11. IUCN (2007). *The 2000 IUCN red list of threatened species*. IUCN. England.
12. Jain S K, Sastry A R K (1984). *The Indian plant red data book*. BSI, Calcutta.
13. Jones H G, Vaughan R A (2010). *Remote sensing of vegetation*. Oxford university press.
14. Kormondy E J (Ed) (1965). *Reading in ecology*. Prentice Hall.
15. Kormondy E J (Ed) (1999). *Concept of ecology*. Prentice Hall.
16. Kumar H D (1977). *Modern Concept of Ecology*. Vikas Publication.
17. Michael P (1984). *Ecological methods of field and laboratory investigations*. Tata McGraw Hill.
18. Misra K C (1991). *Manual of plant ecology*. Oxford and IBH Pub. Com. P. Ltd.
19. Odum E P (III Edn) (1991). *Fundamentals of ecology*. Saunders and Com

20. Pearcy R W et. al., (1989). *Plant physiological Ecology: Field methods and instrumentation*. Chapman and Hall.
21. Ramade F (1981). *Ecology of natural resources*. John Wiley and sons.
22. Sharma P D (1999). *Ecology and Environment*. Rastogy Pub.
23. Simons I G (1981). *Ecology of natural resources*. Edwin-Arnold Ltd.
24. Stiling, P. (2001). *Ecology: Theories and Applications*. Prentice Hall.
24. Trivedi R (1994). *International encyclopedia of ecology and environment* (Vol.1). IIEE, New Delhi.
25. Trivedi R K (1994). *Practical methods in Ecology and Environmental sciences*. Env't. pub.
26. Varma P S, Agarwal V K. *Principles of Ecology*. S Chand and Co.
27. Varma P S, Agarwal V K (2000). *Concept of Ecology*. S Chand and Co.
28. Walter (1987). *Vegetation of the earth*. Springer Verlag.
29. Sheil and Ghazoul (2010). *Tropical rain forest ecology, diversity, and conservation* Oxford University Press, New York, USA
30. OCLC (2003), *Summaries: Dewey decimal classification (DDC)* OCLC Inc., Dublin, Ohio.

## **RESEARCH METHODOLOGY (Theory 18 hrs; Practical 9 hrs)**

### **Introduction to the Course**

Primary and secondary sources. library classification - books, journals, periodicals, reference sources, abstracting and indexing sources, Reviews, Treatise, Monographs, Patents. Electronic information services such as online libraries, e-Books. Catalogue: Types of catalogues - Card catalogue, computerized catalogue.

### **Module 1: Introduction to Research methodology (8 hrs)**

- a) Definition of Science and Research, Research and scientific method; Logical methods - Induction, Deduction, deductive-inductive process.

- b) **Research Process**

Observation – critical thinking, theory, objectivity, reliability, validity. Finding a research problem.

- c) **Library Resources**

Classification of books: Universal Decimal System and Dewey decimal classification.

Journals: Indexing journals, abstracting journals, research journals, review journals, e-journals. Impact factor of journals, H-index, Citation Index, NCBI-Pub Med. Plagiarism. Style manuals.

### **Module 2: Defining and formulating the research problem (7 hrs)**

Selecting and defining of the problem – critical literature review, identifying gap areas from literature review; Formulation of hypothesis – testing of hypothesis - null and alternate hypothesis – preparation of research plan and classification of research and experimental design.

### **Module-3. Preparation of project proposals**

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, Different National funding agencies.

### **Module-4. Scientific writing**

Structure of a scientific paper, dissertation, monographs and review article, abstract, keywords - rules of title, introduction, tables, graphs, discussion and acknowledgement.

### **Module-5. Scientific Communication**

Presentation techniques, preparation and organizing poster display and PowerPoint presentation. Seminar, conference, debate, colloquium, symposium, workshop, – grading of publications and scholars – impact factor, H-index.

### **Module 6: Intellectual Property Rights (3 hrs)**

a) Copy right, Designs, Patents, Trademarks, Geographical indications.

#### **b) Laboratory etiquettes**

Safety and precaution - ISO standards for safety, accreditation of research Lab- NABL.

#### **c) Bioethics**

Definition, major ethical issues in experimentation involving animal and humans.

### **Practical (9 hours)**

1. Prepare a project proposal.
2. Prepare an outline of dissertation and research paper.
3. Prepare of 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.
5. Prepare a project proposal with the help of power point and submit the same for evaluation.

### **References**

1. Anderson J, Durston B H, Poole (1970). *Thesis and assignment writing*. Wiley eastern.
2. Bedekar V H (1982). *How to write assignment and research papers, dissertations and thesis*. Kanak publications.
3. Bercy R (1994). *The research project, how to write it*. Rutledge, London.
4. Clifford Hawkins (1996). Marco Sorghi. *Research: How to plan and speak about it and write about it*. Narosa Publishing Company.
5. Day R.A (1979). *How to write and publish a scientific paper*. Cambridge University press.
6. Joseph Gibaldi (2000). *MLA Handbook for writers of research papers*. Affiliated East West Press Pvt. Ltd.
7. Kothari C R (1990). *Research Methodology*. New Age International Publications, New Delhi.
8. Krishnakumar K (1981). *An Introduction to cataloguing practice*. Vikas Publishing house.
9. Judith Bell (1995). *How to complete your research project successfully*. UBS Publishers and Distributors Ltd.
10. Parshar R G (1989). *Index and indexing systems*. Me dallion press New Delhi.
11. Victoria E McMillan (1997). *Writing papers in the biological sciences (II Edn)*. Bedford books.
12. [www.opengate.com](http://www.opengate.com)

**20P1BOTT04: CELL BIOLOGY**  
(Theory 54 hrs; Practical 27 hrs; Credits: 3)

<b>COURSE OUTCOMES (COs)</b>	
<b>CO 1</b>	Understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles.
<b>CO 2</b>	Understand how the cells interact among themselves and with the environment through signal molecules.
<b>CO 3</b>	Acquire in depth knowledge in cytoskeleton, endomembrane system, protein trafficking and cell cycle.
<b>CO 4</b>	Familiarize with recent advancements in Chloroplast and Mitochondrial research.
<b>CO 5</b>	Learn the molecular mechanisms of cancer.
<b>CO 6</b>	Confident in 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 (8 hrs)**

- (a) The chemical composition of membranes: Membrane lipids, proteins and carbohydrates.
- (b) Membrane lipids and membrane fluidity: Importance of membrane fluidity, mechanisms for maintaining membrane fluidity.
- (c) The dynamic nature of the plasma membrane- dynamic nature of lipids and proteins
- (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.

**Module 2: Interactions between Cells and their Environment (5 hrs)**

- (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.

**Module 3: Nucleus (7 hrs)**

- (a) Structure of eukaryotic nucleus: Nuclear Envelope, Nuclear Pore Complex.
- (b) Transport into and out of the Nucleus: Nuclear-Localization Signals, Nuclear-Export Signals, Ran-GTP and Ran-Independent Mechanisms.
- (c) Bacterial Chromatin. Compaction of bacterial chromosome – Muk B and SMC proteins.
- (d) Structure of chromatin and chromosomes: histones and nonhistone proteins, nucleosome, higher levels of chromatin structure. Heterochromatin and Euchromatin.
- (e) Molecular structure of the Centromere and Telomere.

**Module 4: Cell Cycle (6 hrs)**

- (a) Phases of cell cycle.
- (b) Cell cycle checkpoints: DNA damage checkpoints, Spindle assembly checkpoint
- (c) Master controllers of the cell cycle: Cyclins and cyclin dependent kinases (CDKs), Types of CDK and cyclins
- (d) Regulation of CDK Activity, Regulation of Cyclin Levels, CDK Inhibitors (CKIs)

**Module 5: The Endomembrane System (10 hrs)**

- (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) Lysosomes.
- (f) Peroxisomes.
- (g) Plant cell vacuoles.
- (h) Targeting of proteins to mitochondria, chloroplasts and peroxisomes.
- (i) The endocytic pathway: endocytosis and phagocytosis.

**Module 6: The Cytoskeleton (6 hrs)**

- (a) Overview of the major functions of the cytoskeleton.
- (b) Microtubules: microtubule structure and organization, microtubule dynamics, microtubule-based motor proteins: kinesins and dyneins.
- (c) Microfilaments: microfilaments and actin structures, dynamics of actin filaments, actin-based motor proteins: myosins.
- (d) Intermediate filaments: intermediate filament assembly and disassembly, types and functions of intermediate filaments.

**Module 7: Cell Signaling (9 hrs)**

- (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.
- (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  $\text{Ca}^{2+}$ .



**Module 8: Apoptosis (3 hrs)**

- (a) Programmed cell death
- (b) Extrinsic and Intrinsic Pathway of Apoptosis
- (c) Proteins involved in the Apoptotic Pathway

**Practicals (Practical 27 hrs)**

1. Identification of different stages of meiosis from suitable plant material (Recorded by photomicrographs). MGU
2. Identification of different stages of mitosis and study of morphology of metaphase chromosomes from Onion root meristems (Recorded by photomicrographs). MGU
3. Study of mitotic index from suitable plant material.
4. Study on chromosomal abnormalities in humans.

**References**

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2008). *Molecular biology of the cell* (V Edn). Garland Science, Taylor and Francis group.
2. Gerald Karp (2013). *Cell and Molecular biology: Concepts and experiments* (VII Edn). John Wiley & Sons.
3. Harvey Lodish, Arnold Berk, Lawrence Zipursky, Paul Matsudaira, David Baltimore, James Darnell (2013). *Molecular cell biology* (VII Edn). W H Freeman & Company.
4. Geoffrey M Cooper, Robert E Hausman (2013). *The Cell: A molecular approach* (VI Edn). Sinauer.
5. Wayne M Becker, Lewis J Kleinsmith, Jeff Hardin (2012). *The world of the cell* (VIII Edn). Pearson
6. D Peter Snustad, Michael J Simmons (2012). *Principles of genetics* (VI Edn). John Wiley and Sons.
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.
9. Burton E Tropp (2012). *Molecular biology; from genes to proteins* (IV Edn).

## Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

M.Sc. Botany Semester I

20P1BOTT01: MICROBIOLOGY AND PHYCOLOGY

Time 3 hours

Total Marks 75

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I. Answer **any EIGHT** questions briefly; each question carries 2 marks.

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
11. Name any two parasitic algae
12. What is chantransia stage?

(8 x 2 = 16 marks)

II. Answer **any SEVEN** questions; each question carries 5 marks.

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

(7 x 5 = 35 marks)

III. Answer **any TWO** questions; each question carries 12 marks.

23. Trace the origin and evolution of sexuality in green algae. Illustrate your answer with suitable diagrams and examples.

OR

24. Give an account of the thallus organization of Chlorophyceae in an evolutionary perspective.
25. Explain the replication of bacterial DNA with a special mention about the role of enzymes involved in it.

OR

26. Explain various recombination methods in bacteria.

(2 x 12 = 24 marks)

## Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

M.Sc. Botany Degree Semester I

20P1BOT02: MYCOLOGY & CROP PATHOLOGY

Time 3 hours

Total Marks 75

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I. Answer **any Eight** questions. Each question carries 2 marks.

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 monoclinal antheridium
7. Differentiate sclerotium from soredium
8. What is Gleba?
9. What is Mitic system?
10. What is peridiole?
11. Name the causative organisms of i) Grey leaf spot of Coconut ii) Red rot of Sugarcane
12. What is Sclerotia?

(2x8= 16 marks)

II. Answer **any Seven** questions. Each question carries 5 marks

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.
19. Citing specific examples describe how genetic engineering can be used to control diseases?
20. Write an account on symbiotic fungi.
21. What are the major biotic causes of plant diseases?
22. Explain the terms (i) Septobasidium (ii) Statismospore

(7x5=35 marks)

III. Answer **any Two** questions. Each question carries 12 marks

23. Briefly describe the classification of Fungi proposed by Ainsworth.

OR

24. Write an essay on the common strategies adopted to control plant diseases

25. Describe the process of infection and pathogenesis in plants.

OR

26. 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?

(1x12=12marks)

## Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

M.Sc. Botany Semester I

20P1BOTT03: ECOLOGY, ENVIRONMENTAL BIOLOGY, PHYTOGEOGRAPHY &  
RESEARCH METHODOLOGY

Time 3 hours

Total Marks 75

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I. Answer any **Eight** of the following; each question carries 2 marks

1. What is ecological niche?
2. Define remote sensing.
3. What is bioremediation?
4. Write a short note on e-references?
5. What is ecotone?
6. What are RET species?
7. What are the consequences of eutrophication?
8. Explain resilience community.
9. What is INFLIBNET?
10. What is humus?
11. Name two National Parks and two Biosphere Reserves in Kerala
12. Define climax community

(8x2 = 16 marks)

II. Answer any **Seven** of the following; each question carries 5 marks

13. How do you prepare a scientific research proposal?
14. Describe the importance of literature survey in scientific research?
15. Write short note on ecological succession?
16. Give an account of conservation in biosphere reserves.
17. Describe the role of NGO's in conservation of natural resources in the Western Ghats.
18. What are the applications of remote sensing in environmental studies?
19. Explain the interdisciplinary nature of environmental science.
20. Explain different interactions within populations
21. What is ecological succession? Give the different types of succession and the important events in succession.
22. Write a brief account on sustainable development.

(7x5= 35marks)

III. Answer any **Two** of the following; each question carries 12 marks

23. Write an essay on how evolution, biogeography and ecology are interconnected?

**Or**

24. What are the major ecosystems in the world? Write a comparative account of them with reference to their productivity, biodiversity, energy flow, food chain and tropic levels.

25. Write an essay on different species diversity measurements.

**Or**

26. Discuss about the natural resources and their sustainable management in the Western Ghats.

(12x2 = 24marks)

**Model Question Paper**

**SACRED HEART COLLEGE (AUTONOMOUS), THEVARA**

**M.Sc. Botany Semester I  
20P1BOTT04: CELL BIOLOGY**

**Time 3 hours**

**Total Marks 75**

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I. Answer **any Eight** questions briefly; each question carries 2 marks

1. Write a short note on plant cell vacuoles.
2. Differentiate between passive diffusion, facilitated diffusion and active transport.
3. Comment on nuclear-localization signals.
4. Explain the phases of cell cycle.
5. Write a short note on the mitochondrial diseases.
6. What are Induced Pluripotent Stem (iPS) Cells.
7. Briefly explain secondary messengers.
8. Write a note on endocytosis and phagocytosis.
9. Write a short note on kinesins and dyneins.
10. What are the different modes of cell-cell signaling?
11. What are Muk B proteins?
12. Write a short note on the properties of cancer cells.

(8 x 2 = 16 marks)

II. Answer **any Seven** questions; each question carries 5 marks

13. Briefly explain Cell-cycle checkpoints.
14. Explain the Structure of the Chloroplast.
15. Discuss the types of vesicle transport and their functions.
16. Explain the chromosomal packing and structure of metaphase chromosome.
17. Explain oncogenes and tumor suppressor genes.
18. Explain Nuclear Pore Complex.
19. Discuss the molecular structure of the centromere and telomere.
20. Discuss the structure and function of Golgi complex.
21. Explain the functions of Plasma membrane.
22. Briefly explain the mitochondrial genome.

(5 x 7 = 35 marks)

III. Answer **any Two** questions; each question carries 12 marks

23. Illustrate and explain the structure and function of cytoskeleton.

OR

24. Describe the signaling molecules and their receptors.
25. Explain programmed cell death.

OR

26. With suitable diagrams explain the chemical composition of plasma membrane.

(12 x 2 = 24 marks)

## Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

M.Sc. Botany Semester I

Practical Course – 1 [Code: 20P1BOTP01]

MICROBIOLOGY, PHYCOLOGY, MYCOLOGY & CROP PATHOLOGY

Time 3 hours

Total Marks 40

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1. Make suitable micropreparations of A and B. Draw labelled diagrams and identify giving reasons.  
(Preparation- 1, Diagram- 1, Identification -1, Reasons -1) (2 x 4 = 8)
2. Write critical notes on C and D.  
(Identification –0.5, Critical note – 1) (2 x 1.5 = 3)
3. Sort out any three algae from the algal mixture E and make separate clear mounts. Identify and draw labelled diagrams.  
(Preparation -1, Identification:1, Diagram -1) (3 x 3 = 9)
4. Spot at sight F and G.  
(Identification 1, Part displayed –0.5) (2 x 1.5= 3)
5. Study the diseases in H and I and write the causative organism.  
(Identification –0.5, Causative organism – 0.5, Symptoms – 1) (2 x 2=4)
6. (a) Isolate Bacteria from the soil sample J by serial dilution - pour plate/spread plate method.  
(Working - 2, Procedure - 1)  
or  
(b) Calculate spore load on the given seed sample J.  
(Working - 1, Calculation -1, Result and Comments - 1) (1 x 3 = 3)
7. Practical Record (8)
8. Field Report (2)

### Key to the questions:Semester 1 Practical course 1

1. A - Alga; B - Fungi/Lichen/ Mycorrhiza.
2. C, D-Fungi.
3. E - Algal mixture containing four filamentous types.
4. F, G - One Alga, one Fungi/Lichen.
5. H, I - Herbarium or live/dry specimen showing the symptoms of any disease specified in the syllabus
6. J - Draw lots for the two experiments. Supply necessary soil /seed sample.
7. Awarding maximum marks 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 field study report(s)/Lab visit report(s), if any.

**Model Question Paper**

**SACRED HEART COLLEGE (AUTONOMOUS), THEVARA**

**M.Sc. Botany Semester I**

**Practical Course – 2 [Code: 20P1BOTP02]**

**ECOLOGY, ENVIRONMENTAL BIOLOGY, PHYTOGEOGRAPHY, RESEARCH  
METHODOLOGY & CELL BIOLOGY**

**Time 3 hours**

**Total Marks 40**

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1. Prepare a smear of the given anther **A** and identify any two stages of meiosis I.  
(Preparation - 1, Diagram - 1, Identification -1, Reasons -1) (2 x 4 = 8)
2. Identify the given chromosomal aberrations **B** and **C**.  
(Identification –1.5, Reasons – 1.5) (2 x 3 = 6)
3. Workout the problem **D** (1x 5 = 5)
4. Statistical analysis of diversity indices.  
(Working-2, Choosing correct method- 1, Interpretation – 1) (1 x 4 =4)
5. Quantify nitrite /phosphate /sulphate in the given sample **E** using Spectrophotometer/ Colorimeter.  
(Working – 1, Procedure – 1, Calculation- 1, Result and Comments –2) (1 x 5 = 5)
6. Comment on the diagrams/ pictures **F & G**. (2x 2 = 2)
  
- 9 Practical Record (8)
- 10 Field Report (2)

**Key to the questions**

1. A –Anther of Rheo/Onion.
2. B, C- Diagram/photograph.
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. F & G - Environmental consequence/ Vegetation type.
6. Awarding maximum marks 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.

## SEMESTER II

Course	Title	Teaching Hrs Theory	Teaching Hrs Practical	Credits
<b>20P2BOTT05</b>	Bryology + Pteridology	36 + 36	18 + 36	4
<b>20P2BOTT06</b>	Molecular Biology & Immunology	54 + 18	18 + 9	4
<b>20P2BOTT07</b>	Plant Anatomy, Angiosperm Systematics & Morphology	36 + 27 + 9	36 + 27	4
<b>20P2BOTT08</b>	Genetics & Biochemistry	15 + 39	9 + 18	3
<b>20P2BOTP03</b>	Practicals of <b>20P2BOTT05+ 20P2BOTT06</b>			2
<b>20P2BOTP04</b>	Practicals of <b>20P2BOTT07+ 20P2BOTT08</b>			2
<b>FIELD STUDY</b>	Students are expected to conduct field visit (one in each semester) to familiarize with the diversity of life forms dealt in the semester syllabus. Report of the field visit should be prepared and recorded as part of the practical record.			



**20P2BOTT05: BRYOLOGY AND PTERIDOLOGY**  
(Theory 36 + 36 hrs; Practical 18 + 36 hrs; Credits: 4)

<b>COURSE OUTCOMES (COs)</b>	
<b>CO 1</b>	Understand the diversity of primitive land plants.
<b>CO 2</b>	Familiarize with the morphological and anatomical features of Bryophytes and Pteridophytes.
<b>CO 3</b>	Identify the main characteristics of Bryophytes and Pteridophytes.
<b>CO 4</b>	Chart the development of land adaptations in the Bryophytes and Pteridophytes.
<b>CO 5</b>	Acquaintance with various lifecycle events in theBbryophyte and Pteridophytes.
<b>CO 6</b>	Understand the evolutionary trends primitive plant groups.
<b>CO 7</b>	Ability to identify various Bryophytes and Pteridophytes in their habitats.

**BRYOLOGY (Theory 36 hrs; Practical 18 hrs)**

**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 (5 hrs)**

- (a) Introduction to Bryophytes, their fossil history and evolution. Concept of algal and pteridophytic origin of Bryophytes. General characters of Bryophytes.
- (b) History of classification of Bryophytes. Modern trends in classification of Bryophytes.
- (c) Systematic way of collection, preservation and identification of Bryophytes with special reference to mosses. Conservation biology of Bryophytes.

**Module 2: Ecology and Economic importance of Bryophytes (5 hrs)**

- (a) Bryophyte habitats. Water relations - absorption and conduction, xerophytic adaptations, drought tolerance, desiccation and rehydration, ectohydric, endohydric and myxohydric Bryophytes.
- (b) Ecological significance of Bryophytes - role as pollution indicators.
- (c) Economic importance of Bryophytes; i) Sphagnum as 'Peat Moss' ii) Medicinal Uses iii) as source of food iv) as pollution indicators v) in experimental studies vi) Horticultural uses.

### **Module 3: Thallus structure (26 hrs)**

Comparative structural organization of gametophytes and sporophytes in an evolutionary perspective. Asexual and sexual reproductive structures, spore dispersal mechanisms and germination of the following groups with reference to the types mentioned in the practical (development of sex organs not necessary).

- (a) Hepaticopsida (Sphaerocarpaceae, Marchantiales, Metzgeriales, Jungermanniales and Calobryales).
- (b) Anthocerotopsida (Anthocerotales).
- (c) Bryopsida (Sphagnales, Polytrichales, and Bryales).

### **Practicals 18 hrs**

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

### **References**

1. Kashyap S R (1932). *Liverworts of Western Himalayas and the Punjab plains* (Vol. I & II). Research Co. Publications.
2. Chopra R N, P K Kumar (1988). *Biology of Bryophytes*. Wiley Eastern Ltd.
3. Chopra R S, S S Kumar (1981). *Mosses of Western Himalayas and adjacent plains*. Chronica Botanica.
4. Kumar S S (1984). *An approach towards phylogenetic classification of Mosses*. Jour. Hattori Bot. Lab. Nichinan, Japan.
5. Rashid A (1981). *An Introduction to Bryophyta*. Vikas publishing house Pvt. Ltd.
6. Richardson D H S (1981). *Biology of Mosses*. Blackwell Scientific publications, Oxford.
7. Sheffield W B (1983 – '84). *Introduction to Bryology* (Vol. 1, 2). Jour. Hattori Bot. Lab, Nichinan, Japan.
8. Vashishta B R, A K Sinha, A Kumar (2003). *Bryophyta*. S Chand & Co. Ltd.
9. Udak R (1976). *Bryology in India*. ChronicaBotanica Co.
10. Pandey B P (1994). *Bryophyta*. S Chand and Co. Ltd.
11. Goffinet B, A J Shaw (2009). *Bryophytic Biology* (II Edn). Cambridge University Press.
12. Dyer A F, J G Duckett (Eds) (1984). *The experimental Biology of Bryophytes*. Academic Press.
13. Bonver F O (1935). *Primitive land plants*. MacMillan & Co. Ltd.
14. Campbell, Ditt (1940). *The evolution of land plants*. Stanford University Press.
15. Srivastava S N (1992). *Bryophyta*. Pradeep Publications.
16. Watson E V, P Ricards (1963). *British Mosses and Liverworts*. Cambridge University Press.
17. Nair M C, Rajesh K P, Madhusoodanan P V (2005). *Bryophytes of Wayanad in Western Ghats*. Malabar Natural History Society.

## **PTERIDOLOGY (Theory 36 hrs; Practical 36 hrs)**

### **Introduction to the course**

- (a) Introduction, general characters, classification and evolution of pteridophytes
- (b) Structural organisation of sporophyte and gametophyte of pteridophytes with special reference to stellar structure, heterospory and seed habit.

### **Module 1: General introduction and classification (4hrs)**

Introduction, origin, general characteristics and history of the classification of pteridophytes. Brief account on Smith's classification (2006). DNA barcoding of pteridophytes.

### **Module 2: Structure of the plant body (26 hrs)**

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

- (a) Psilopsida (i) Rhyniales; *Rhynia*
- (b) Psilopsida (i) Psilotales; *Psilotum*

- (c) Lycopsidea (i) Protolepidodendrales; *Protolepidodendron* (ii) Lycopodiales; *Lycopodium*, (iii) Isoetales; *Isoetes* (iv) Selaginellales; *Selaginella*.
- (d) Sphenopsida (i) Hyeniales (ii) Sphenophyllales; *Sphenophyllum* (iii) Calamitales; *Calamites* (iv) Equisetales; *Equisetum*.
- (e) Pteropsida (A) Primofilices: (i) Cladoxylales; *Cladoxylon* (ii) Coenopteridales. (B) Eusporangiatae: (i) Marattiales; *Angiopteris* (ii) Ophioglossales; *Ophioglossum*. (C) Osmundales; *Osmunda*. (D) Leptosporangiatae: (i) Marsileales; *Marsilea* (ii) Salviniales; *Salvinia*, *Azolla* (ii) Filicales; *Pteris*, *Lygodium*, *Acrostichum*, *Gleichenia*, *Adiantum*.

### Module 3: Comparative study of Pteridophytes (4 hrs)

Stelar organization, soral and sporangial characters, gametophytes and sporophytes of Pteridophytes in an evolutionary perspective, an account on DNA barcoding of pteridophytes.

### Module 4: Ecology and Economic importance (2 hrs)

Ecological and economic significance of Pteridophytes.

### Practical (36 hrs)

1. Study of morphology and anatomy of vegetative and reproductive organs using clear whole mounts/sections of the following genera: *Psilotum*, *Lycopodium*, *Selaginella*, *Equisetum*, *Angiopteris*, *Ophioglossum*, *Marsilea*, *Salvinia*, *Azolla*, *Lygodium*, *Acrostichum*, *Gleichenia*, *Pteris*, *Adiantum*, *Polypodium* and *Dryopteris*.
2. Study of fossil Pteridophytes with the help of specimens and permanent slides.
3. Field trips to familiarize with the diversity of Pteridophytes in natural habitats and preparation of 5 pteridophyte herbarium and submit the report along with the record.

### References

1. Agashe S N (1995). *Palaeobotany*. Oxford and IBH publishing House.
2. Arnold C R (1977). *Introduction to Palaeobotany*. McGraw Hill Book Com.
3. Chandra S, Srivastava M (Eds) (2003). *Pteridology in the New Millennium*. Khumar Acad. Publishers.
4. Beddome C R H (1970). *Ferns of south India*. Today & Tommorrow's Publ.
5. Dyer A F (1979). *The experimental biology of ferns*. Academic Press.
6. Gifford E M, A S Foster (1989). *Morphology and evolution of Vascular plants* (III Edn). W H Freeman & Co.
7. Khullar S P (2000). *An illustrated fern flora of West Himalayas* (Vol I, II). International Book Distributers.
8. Kubitzki K (1976). *The families and Genera of Vascular plants: Vol. I Pteridophytes*. Vikas publishing house.
9. Rashid A (1976). *An introduction to Pteridophytes*. Vikas Publishing House.
10. Sporne K R (1982). *Morphology of Pteridophytes*. Hutchinson university Press.
11. Surange K R (1964). *Indian Fossil Pteridophytes*. CSIR.
12. Louis J D (1977). *Evolutionary patterns and processes in ferns: Advances in Botanical Research*.
13. Scott. *Studies in Fossil Botany*. Haffner publications.
14. Smith, Gilbert (1972). *Cryptogamic Botany* (Vol. II). Tata McGraw Hill publications.
15. Nayar B K, S Kaur (1971). *Gametophytes of homosporous ferns*. Bot. Rev.

## 20P2BOTT06: MOLECULAR BIOLOGY & IMMUNOLOGY (Theory 72 hrs; Practical 27 hrs; Credits: 4)

### COURSE OUTCOMES (COs)

<b>CO 1</b>	To understand the basic properties, structure and functions of genetic materials.
<b>CO 2</b>	To understand the central dogma of molecular biology.
<b>CO 3</b>	To get a thorough knowledge in gene expression mechanisms.
<b>CO 4</b>	To acquire a basic knowledge to prepare for competitive examinations in life science.
<b>CO 5</b>	Acquaintance with various lifecycle events in the Bryophyte and Pteridophytes.
<b>CO 6</b>	Understand the evolutionary trends primitive plant groups.
<b>CO 7</b>	Ability to identify various Bryophytes and Pteridophytes in their habitats.

## **MOLECULAR BIOLOGY (Theory 54 hrs; Practical 18 hrs)**

### **Introduction to the Course**

- Nucleic acids: Structure of DNA and RNA - basic features.
- Identification of DNA as genetic material: Transformation experiment, Hershey Chase experiment. RNA as the genetic material in some viruses.
- Important features of Watson and Crick model of DNA structure, Chargaff's rules.
- Replication of DNA: Meselson-Stahl experiment, semiconservative replication of DNA
- Gene expression: Concept of gene, central dogma, transcription in procaryotes and eucaryotes – basic features, RNA processing, translation - basic features, genetic code features
- Control of gene expression - positive and negative control - operon model.

### **Module 1: Genetic material and its molecular structure (18 hrs)**

- 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.
- Structure and function of different types of RNA - mRNA, tRNA, rRNA, SnRNA, and Micro RNA.
- Structure, Diversity and Versatility of RNA:** Primary, secondary, tertiary and quaternary structure of RNA. RNA as genetic material – plus, minus, double stranded RNA. Catalytic RNA: Ribozymes – Discovery, structure, mechanism and functions; HDV ribozyme, hammerhead ribozymes, self-splicing introns, RNaseP, RNase MRP, Peptidyl transferase. Noncoding RNA: Structure and biological roles of rRNA, tRNA, tmRNA, siRNA miRNA, piRNA, and lncRNA (Xist, HOTAIR). RNA tertiary structures. Ribozymes – Hammerhead ribozymes.
- C-value paradox, DNA renaturation kinetics, T<sub>m</sub>, Cot curve. Unique and Repetitive DNA – mini- and microsatellites.

### **Module 2: DNA replication, repair and recombination (14 hrs)**

- DNA replication: Unit of replication, 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. Process of replication – initiation, elongation and termination. Replication in the telomere - telomerase.
- 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 – Translation DNA polymerase.

- (c) Recombination: Homologous and nonhomologous recombination, molecular mechanism of homologous recombination. Site-specific recombination.
- (d) Transposable elements: General features, Types of transposons, Cut and paste transposons- IS Elements, Composite Transposons, Ac and Dselements, P Elements. Replicative transposon- Tn3 Elements. Retrotransposons- retroviruslike elements: Ty1 Element, Retroposons- LINES, SINES.

### Module 3: Gene expression (25 hrs)

- (a) Gene: Concept of gene; structural and genetic definitions – complementation test.
- (b) Transcription in procaryotes: 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 eucaryotes: 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 complex. 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, mRNA export. rRNA and tRNA synthesis and processing.
- (e) Translation: Important features of mRNA – ORF, RBS. Fine structure, composition and assembly of procaryotic and eucaryotic 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: Cracking the genetic code – simulation synthetic polynucleotides and mixed copolymers, synthetic triplets. Important features of the genetic code, proof for the triplet code, Exceptions to the standard code.
- (i) Protein sorting and translocation: Cotranslational and posttranslational – signal sequences, SRP, translocon. Membrane insertion of proteins. Post-translational modification of proteins. Protein folding – self-assembly, role of chaperones in protein assembly.

### Module 4: Control of gene expression (15 hrs)

- (a) Viral system: Genetic control of lytic and lysogenic growth in  $\lambda$  phage, lytic cascade
- (b) Procaryotic system: Transcription switches, transcription regulators. Regulation of transcription initiation; 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, riboswitches.
- (c) Eucaryotic system: Changes in chromatin and DNA structure – chromatin compaction, transcriptional activators and repressors involved in chromatin remodelling, gene amplification, gene rearrangement, alternate splicing, gene silencing by heterochromatization, and DNA methylation. Effect of regulatory transcription factors on transcription. Post-transcriptional control – mRNA stability, RNA interference. Role of small RNA in heterochromatization and gene silencing.
- (d) RNA interference- Discovery, RNAi path way, miRNA, siRNA, piwiRNA.

### Practical (27 hrs)

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

### References

# IMMUNOLOGY (12 hrs)

## Module 1 (6 hrs)

- a. Innate and acquired immunity. Cells and molecules involved in innate and acquired immunity, humoral and cellular immunity, Antigens, Epitopes.
- b. Structure, function and types of antibody molecules. Antigen-antibody interactions. Antigen processing and presentation.
- c. Activation and differentiation of B cells – formation, role. T cells – types, roles, T cell receptors.
- d. Complement system, pattern recognition receptors – toll-like receptors. MHC molecules.

## Module 2 (2 hrs)

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

## Module 3 (4 hrs)

- a. Vaccines: Basic strategies, inactivated and live attenuated pathogens, subunit vaccines, recombinant vaccines (e.g., Hepatitis B vaccine), DNA vaccines.
- b. Modern approaches to vaccine development - edible vaccines.

## Virtual lab experiments (18 hrs):

- 1) Collection of Serum from Blood
- 2) Blood Grouping Experiment
- 3) Latex Agglutination.
- 4) Antibody Labeling with HRP
- 5) Extraction of IgG Antibodies from Immunized Hen Egg
- 6) Isolation of lymphocytes from whole blood
- 7) Ouchterlony Double Diffusion-Titration-precipitation reactions
- 8) Ouchterlony Double Diffusion-Patterns- precipitation reactions
- 9) Purification of IgG Antibodies with Ammonium Sulphate
- 10) Removal of Thymus and Spleen from Mice
- 11) Mouse Anesthesia and Blood Collection
- 12) Parenteral Injections
- 13) Purification of IgG Antibodies using Affinity Chromatography
- 14) Fluorescent Labeling of Antibodies

## References

1. Abbas, A. K. and Lichtman, A. H. (2004) *Basic Immunology – Functions and Disorders of the Immune System* (2<sup>nd</sup> edition). Saunders- Elsevier
2. Benjamin A Pierce (2008). *Genetics: A conceptual approach* (IV Edn). W H Freeman and Co.
3. Benjamin Lewin (2006) *Genes IX*. Jones and Bartlett.
4. Bob B Buchanan, Wilhelm Gruissem, Russel L Jones (2000). *Biochemistry and Molecular biology of plants*. I K International Pvt. Ltd.
5. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2002). *Molecular biology of the cell* (IV Edn). Garland Science, Taylor and Francis group.
6. Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith, Roberts, Peter Walter (2010). *Essential Cell Biology*. Garland Science.
7. D Peter Snustad, Michael J Simmons (2010). *Principles of genetics* (V Edn). John Wiley and Sons.
8. Daniel J Fairbanks, W Ralph Anderson (1999). *Genetics: The continuity of life*. Brooks/Cole publishing company.

9. Daniel L Hartl, Elizabeth W Jones (2012). *Genetics: Analysis of genes and genomes* (VII Edn). Jones and Bartlett publishers.
10. David A Micklos, Greg A Freyer with David A Crotty (2003). *DNA Science: A first course* (II Edn). L K Inter.
11. David P Clark (2010). *Molecular biology*. Elsevier.
12. David R Hyde (2010). *Genetics and molecular biology*. Tata McGraw Hill.
13. Geoffrey M Cooper, Robert E Hausman (2009). *The Cell: A molecular approach* (V Edn). Sinauer.
14. Gerald Karp (2008). *Cell and Molecular biology: Concepts and experiments* (V Edn). John Wiley
15. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira (2007). *Molecular cell biology* (VI Edn). W H Freeman & Company.
16. Harvey Lodish, Arnold Berk, Lawrence Zipursky, Paul Matsudaira, David Baltimore, James Darnell (2000). *Molecular cell biology* (IV Edn). W H Freeman & Company.
17. Peter J Delver, Seamus J Martin, Dennis R Burton, Ivan M Roitt (2011). *Roitt's essential Immunology* (XII Edn). Wiley Blackwell.
18. James D Watson, Tania A Baker, Stephen P Bell, Alexander Gann, Michael Levine, Richard Losick (2009). *Molecular biology of the gene* (V Edn). Pearson.
19. James D. Watson, Amy A. Caudy, Richard M. Myers, Jan A. Witkowski (2007). *Recombinant DNA* (III Edn). W H Freeman.
20. Jeremy M Berg, John L Tymoczko, Lubert Stryer, Gregory J Gatto Jr. (2007). *Biochemistry*. W H Freeman & company.
21. Jocelyn E Krebs, Elliott S Goldstein, Stephen T Kilpatrick (2011). *Lewin's Genes X*. Jones and Bartlett Publishers.
22. Leland H Hartwell, Leroy Hood, Michael L Goldberg, Ann E Reynolds, Lee M Silver, Ruth C Veres (2004). *Genetics from genes to genomes* (II Edn). McGraw Hill.
23. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2002). *Molecular biology of the cell* (IV Edn). Garland Science, Taylor and Francis group.
24. Peter J Delver, Seamus J Martin, Dennis R Burton, Ivan M Roitt (2011). *Roitt's Essential Immunology* (XII Edn). Wiley Blackwell.
25. Richard A Goldsby, Thomas J Kindt, Barbara A Osborne, Janis Kuby (2003). *Immunology* (V Edn). W H Freeman and Company.
26. Robert F Weaver (2002). *Molecular biology* (II Edn). McGraw Hill.
27. Robert J Brooker (2009). *Genetics: analysis and principles* (III Edn). McGraw Hill.
28. Roberts, Peter Walter (2010). *Essential Cell Biology*. Garland Science.
29. Wayne M Becker, Lewis J Kleinsmith, Jeff Hardin (2007). *The world of the cell* (VI Edn). Pearson.
30. William H Elliott, Daphne C Elliott (2001). *Biochemistry and molecular biology* (II Edn). Oxford.
31. William S Klug, Michael R Cummings (2004). *Concepts of Genetics* (VII Edn). Pearson.

## **20P2BOTT07: PLANT ANATOMY, ANGIOSPERM SYSTEMATICS & MORPHOLOGY**

**(Theory 36 + 36 hrs; Practical 36 + 27 hrs; Credits 4)**

<b>COURSE OUTCOMES (COs)</b>	
<b>CO 1</b>	Understand the plant cell structure in a detailed manner
<b>CO 2</b>	Understand the tissue level organization in plant system
<b>CO 3</b>	Understand the morphological features of angiosperms
<b>CO 4</b>	Know and carry out the plant anatomical specimen preparations
<b>CO 5</b>	Understand the details of wood anatomy, plant fibres and secretory tissues
<b>CO 6</b>	Understand different inflorescence and fruit types in plant kingdom
<b>CO 7</b>	Compare different wood types looking into anatomical peculiarities
<b>CO 8</b>	Understands floral, nodal and reproductive anatomy of plants

### **PLANT ANATOMY (Theory 36 hrs; Practical 36 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 (*Drosera*, *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. Kranz 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 (36 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.

## References

1. Eames A J, McDaniel (1976). An introduction to plant Anatomy. Tata McGraw-Hill, New Delhi
2. Edred John, Henry Corner (1976). The seeds of dicotyledons (Vol. I, II). Cambridge University Press.
3. Ella Werker (1997). Seed Anatomy. Borntraeger. University of Michigan
4. Elizabeth G Cutter (1978). Plant Anatomy Part I & II. Clive and Arnold Ltd.
5. Esau K (1965). Vascular differentiation in plants. Rirehant and Winston, Inc.
6. Esau K (1977). Anatomy of seed plants. Wiley and sons.
7. Fahn A. (1997). Plant anatomy. Aditya Publishers. New Delhi
8. Foster A S (1942). Practical plant Anatomy.
9. Chowdhuri (Ed). Indian woods (6 volumes). Forest research institute, Dehradun
10. Ingrid Roth (1977). Fruits of Angiosperm. Gebruder Borntraeger.
11. Kuriachen P M, Thomas V, Dave Y (1992). Taxonomic and phylogenetic significance of fruit walls in Asclepiadaceae. Feddes R eptorium.
12. Kuriachen P M, Dave P Thomas V, Mercymol Sebastian (1992). SEM studies on seed surface of some Asclepiadaceae with taxonomic significance. Geophytology. Lucknow.
13. Metcalf C R, Chalk L (1950). Anatomy of Dicotyledons and Monocotyledons.
14. Metcalf C R, Chalk L (1983). Anatomy of the dicotyledons: Wood structure and conclusion of the general introduction. Oxford University press.
15. Pandey B P. Plant Anatomy. S Chand and Co. New Delhi.
16. Reghu C P (2002). Structural features of Rubber wood. Rubberwood Processing and utilization in India. Ganesh Publications, Bangalore.
17. Reghu C P, George B P, YA Varghese (2007). Screening of Hevea germplasm for wood quality using Cinnamyl Alcohol Dehydrogenase (CAD) activity and lignifications pattern. Natural Rubber Research, 20 (1&2): 1-7.
18. Sherwin John Carlquist (2001). Comparative wood anatomy: Systematic, ecological, and evolutionary aspects of dicotyledon wood. Springer Verlag Berlin.
19. Tharian George K, Reghu C P, Nehru CR (2000). By-products and ancillary sources of income. Natural Rubber: Agro management and Crop Processing, Rubber Research Institute of India, Kottayam. 507-510
20. Vasishta P C (1994). Plant anatomy. Pradeep publications.
21. Wardrop A B (1961). The structure and formation of reaction wood in Angiosperm: Problems of tree physiology. Recent advances in Botany (Vol II). University of Toronto press.
22. Wardrop A B (1964). Reaction wood Anatomy in Arborescent angiosperms. Formation of wood in forest trees (Ed, Zimmerman). Academic press, New York.

# ANGIOSPERM SYSTEMATICS & MORPHOLOGY

(Theory 27+9 = 36 hours; Practical 27 hrs)

## Introduction to the Course

- (a) Historical account on ICBN
- (b) Polynomial and binomial nomenclature systems

## ANGIOSPERM SYSTEMATICS (27 hrs)

### Module 1: Hierarchical Classification (6 hrs)

- (a) Concept of taxa and taxonomic rank
- (b) Species - ideal species, species concepts - typological species, taxonomic species, morpho-geographical species, biological species, evolutionary species, biosystematic species
- (c) Intraspecific ranks- subspecies, variety, and form.
- (d) Genus and family concepts

### Module 2: Botanical nomenclature (10 hrs)

- (a) Binomial nomenclature and development of botanical code and ICN
- (b) Naming of family, genus, species, intraspecific taxa, cultivated plants and hybrids
- (c) Typification, Author citation, Publication of names-formulation, description, typification, effective publication, Rejection and changing of names, Conservation of names, Principle of priority

### Module 3: Data sources of taxonomy (7 hrs)

- (a) Anatomy as tool for systematics – leaf, stem, node, wood, floral and cellular contents
- (b) Chemotaxonomy as tool for systematics – flavonoids, betalins, alkaloids, terpenoids,
- (c) iridoid compounds, proteins
- (d) Cytotaxonomy as tool for systematics – chromosome number, structure and behaviour

### Module 4: Molecular Taxonomy (4 hrs)

- (a) Types of molecular data- Mitochondrial DNA, Chloroplast DNA, Nuclear DNA
- (b) DNA barcoding as tool for systematics
- (c) Molecular phylogeny – any one case study

## MORPHOLOGY (9 hrs)

### Module 5: Morphology of Angiosperms (9 hrs)

- (a) Leaves- leaf parts, leaf structural types, leaf type, leaf attachment, leaf venation
- (b) Flowers- flower parts, flower sex and plant sex, flower attachment, flower cycly, flower symmetry, flower maturation
- (c) Perianth- perianth arrangement /cycly/merosity, perianth fusion, perianth parts, perianth type, perianth aestivation
- (d) Androecium- stamen type, stamen arrangement, cycly, position, and number, stamen attachment and insertion, stamen fusion, anther parts, type, and attachment, anther dehiscence
- (e) Gynoecium- gynoecial fusion, carpel/locule number, ovary attachment and position, perianth/androecial position, placentation, ovule parts, type, and position, style position / structural type, stigma /stigmatic region types

### **Practical (27 hrs)**

1. Workout nomenclatural problems regarding priority and author citations.
2. Study the morphology of leaf, flowers, perianth, androecium and gynoecium (mentioned in the theory).
3. Draw the L.S and floral diagram of flowers having different ovary positions.
4. Describe the vegetative and floral characters of plants in technical terms (at least 5 plants).  
Case study: Publication of a new species (based on a paper published in a peer-reviewed journal).

### **References**

1. Cole A J (1969). *Numerical Taxonomy*. Academic Press.
2. Cronquist A (1981). *An Integrated system of classifications of flowering plants*. Columbia University Press.
3. Davis P H, Heywood V M (1973). *Principles of Angiosperm Taxonomy*. Robert E Kereiger Publ.
4. Davis P H, V H Heywood (1991). *Principles of Angiosperm Taxonomy*. Today and Tomorrow Publications.
5. Gurcharan Singh (2004). *Plant Systematics: Theory and practice*. Oxford and IBH Publishing.
6. Harrison H J (1971). *New Concepts in Flowering Plant Taxonomy*. Heiman Educational Books Ltd.
7. Henry A N, Chandrabose M (1980). *An aid to the International Code of Botanical Nomenclature*.
8. Heywood V H, D M Moore (Eds) (1984). *Current concept in Plant Taxonomy*.
9. *International Code of Botanical Nomenclature* (latest)
10. Jeffrey C (1968). *An Introduction to principles of Plant Taxonomy*.
11. Lawrence George H M (1951). *Taxonomy of vascular plants*. Oxford and IBH Publ. Co. Pvt. Ltd.
12. Naik V V (1984). *Taxonomy of Angiosperms*. Tata McGraw Hill Publ. Co. Ltd.
13. Radford A E (1986). *Fundamentals of Plant Systematics*. Harper & Row Publ.
14. Sivarajan V V (1991). *Introduction to Principles of Plant Taxonomy*. Oxford IBH.
15. Stace C A (1989). *Plant Taxonomy and Biosystematics*. Etwaed Arnold.
16. Stuessy T F (2002). *Plant taxonomy: The systematic Evaluation of comparative data*. Bishen Singh, Mahendra Pal Singh. Dehradun.
17. Takhtajan A L (1997). *Diversity and Classification of Flowering Plants*. Columbia Univ. Press.
18. Taylor D V, L J Hickey (1997). *Flowering plants: Origin, evolution and phylogeny*. CBS Publishers & Distributors.
19. Wendy B Zomlefer (2006). *Guide to Flowering Plant Families*. Overseas Press India Private Ltd.
20. Woodland D W (1991). *Contemporary Plant Systematics*. Prentice Hall.

**20P2BOTT08: GENETICS & BIOCHEMISTRY**  
(Theory 18 hrs + 36 hrs = 54 hrs; Practical 18 hrs + 18 hrs = 36 hrs; Credits 3)

<b>COURSE OUTCOMES (COs)</b>	
<b>CO 1</b>	To understand the Mendelian and Non-Mendelian modes of inheritance that governs passage of genetic traits across generation.
<b>CO 2</b>	To understand the Hardy-Weinberg equilibrium.
<b>CO 3</b>	To have a clear cut idea of linkage and mapping which will help them to work out problems related to map distance, gene order, coefficient of coincidence and interference.
<b>CO 4</b>	To get a basic knowledge regarding the structure and functions of biomolecules.
<b>CO 5</b>	To learn a detailed account on enzymology, nucleotide metabolism and secondary metabolites.

## **GENETICS**

(Theory 18 hrs; Practical 18 hrs)

### **Introduction to the Course**

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

### **Module 1: Extensions of Mendelism and Epigenetics (4 hrs)**

- (a) Penetrance and expressivity of genes- Polydactyly in human
- (b) Epigenetics – Reasons- DNA methylation, Histone modifications, Epigenetic effects by RNA molecules, Epigenetic effects, Genomic imprinting, Epigenome, Epigenetics and Cancer

### **Module 2: Linkage and Genetic Mapping (5 hrs)**

- (a) Single cross over, multiple cross over, two-point cross, three-point cross, map distances, gene order, interference and coefficient of coincidence.
- (b) Haploid mapping (*Neurospora*)
- (c) Mapping in bacteria (interrupted mating)
- (d) Pedigree Analysis: Symbols used in pedigrees, 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

### **Module 3: Population Genetics (6 hrs)**

- (a) Gene pool, allele and genotype frequency
- (b) Hardy-Weinberg law – proof, and its applications

- (c) Factors affecting gene frequency - Mutation, Migration, Natural selection and Genetic drift (bottle neck effect and founder effect), Non-random mating
- (d) Populations in Genetic equilibrium - balancing selection, mutation-selection balance, mutation drift balance.

#### **Module 4: Cancer Genetics (3 hours)**

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

#### **Practical (18 hrs)**

1. Workout problems related to linkage and genetic mapping.
2. Workout problems related to human pedigree analysis.
3. Workout problems in population genetics – Allele and genotype frequency, Hardy-Wienberg law

#### **References**

1. D Peter Snustad, Michael J Simmons (2012). *Principles of genetics* (VI Edn). John Wiley and Sons.
2. Benjamin A Pierce (2017). *Genetics: A conceptual approach* (VI Edn). W H Freeman and Company.
3. Robert J Brooker (2017). *Genetics: analysis and principles* (VI Edn). McGraw Hill.
4. Daniel L Hartl, Elizabeth W Jones (2012). *Genetics: Analysis of genes and genomes* (VII Edn). Jones and Bartlett publishers.
5. Leland H Hartwell, Leroy Hood, Michael L Goldberg, Ann E Reynolds, Lee M Silver, Ruth C Veres (2011). *Genetics from genes to genomes* (IV Edn). McGraw Hill.

## **BIOCHEMISTRY (36+18 Hrs)**

### **Introduction to the Course**

- (a) Carbohydrates: Structure and Biological Functions. Monosaccharides: Classification, structure. Oligosaccharides: Structure, formation; common examples – sucrose, lactose. Polysaccharides: Classification, functions – structure of cellulose, starch and glycogen.
- (b) Lipids: Classification, properties, functions. Structure of fatty acids, essential fatty acids. Storage lipids – triglycerols.
- (c) 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. Measurement of pH – colorimetric methods and electrometric methods.

### **Module 1: pH and Buffer (4 hrs)**

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. Measurement of pH – colorimetric methods and electrometric methods.

### **Module 2: Sugar derivatives (2 hrs)**

Glycoproteins, proteoglycans, mucoproteins. Lectins.

### **Module 3: Lipids (3 hrs)**

Lipid biosynthesis, fat breakdown –  $\beta$  oxidation. glyoxylate cycle, gluconeogenesis.

### **Module 4: Amino acids (2 hrs)**

Structure and classification of amino acids.

### **Module 5: Proteins (7 hrs)**

Classification of proteins based on structure and function. Oligo- and polypeptides. Primary structure – peptide bond. Secondary structure – Ramachandran plots,  $\alpha$ -helix,  $\beta$  sheet. Tertiary structure – forces that stabilize tertiary structure. Quaternary structure, domains, motif and folds. Protein sequencing – Edman method. Functions of proteins. Degradation of proteins to amino acids.

### **Module 6: 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,

(e) proteolytic activation. Enzyme inhibition – reversible and irreversible inhibition, competitive, noncompetitive, uncompetitive inhibition, Dixon plot.

(f) Cofactors and coenzymes: Essential ions, Coenzymes; structure and role of metabolite coenzymes – ATP; structure and role of vitamin derived coenzymes – NAD<sup>+</sup>, NADP<sup>+</sup>, FAD, FMN, TPP, PLP, Biotin. Isozymes.

### **Module 7: Nucleotide metabolism (4 hrs)**

Functions of nucleotides, Nucleotide biosynthesis by de novo pathways and salvage pathways.

### **Module 8: Secondary metabolites (4 hrs)**

Classification, biosynthesis, and functions of terpenoids, alkaloids, phenolics.

### **Practical (18 hrs)**

1. Separation and analysis of lipids and amino acids by TLC.
2. Quantitative estimation of protein by Lowry's method.
3. Preparation of molal, molar, normal and percentage solutions and their dilutions.
4. Estimation of catalase activity.
5. Isolation and assay of amylase enzyme from germinating Pea seeds/appropriate plant material.

### **References**

1. David T Plummer (1998). *An introduction to practical biochemistry*. Tata Mc Graw Hill.
2. Jeremy M Berg, John L Tymoczko, Lubert Stryer, Gregory J Gatto Jr. (2007). *Biochemistry*. W H Freeman and company.
4. Michael M Cox, David L Nelson (2008). *Lehninger Principles of biochemistry* (V Edn). W H Freeman and company.

5. Donald Voet, Judith G Voet (2011). *Biochemistry* (IV Edn). John Wiley & Sons Inc.
6. Carl Branden, John Tooze (1999). *Introduction to protein structure* (II Edn). Garland Publishing.
7. Reginald H Garrett, Charles M Grisham (2005). *Biochemistry*. Thomson Brooks/Cole.
8. Robert K Murray, David A Bender, Kathleen M Botham, Peter J Kennelly, Victor W Rodwell, P Anthony Weil (2009). *Harper's Illustrated Biochemistry* (XXVIII Edn). Mc Graw Hill.
9. H Robert Horton, Laurence A Moran, Raymond S Ochr, J David Rawn, K Gray Scrimgeour (2002). *Principles of Biochemistry* (III Edn). Prentice Hall.
10. Bob B Buchanan, Wilhelm Gruissem, Russel L Jones (2000). *Biochemistry and molecular biology of plants*. L K International Pvt. Ltd.
11. S Sadasivam, A Manickam (1996). *Biochemical methods* (II Edn). New age international Publishers.



## Model Question Paper

SACRED HEART COLLEGE, THEVARA (AUTONOMOUS)  
M.Sc. BOTANY Semester II  
20P2BOTT05: BRYOLOGY AND PTERIDOLOGY

Time 3 hours

Total Marks 75

I. Answer **any EIGHT** of the following; each question carries 2 marks.

1. What is Massula, what is its function?
2. What is sporocarpiferous branch, 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. What is Prismatic Tissue?
10. Differentiate between Rhopalostachya and Urostachya.
11. What are elaters? What are its functions?
12. Give the structural characters of pteridophytes.

(8 x 2 = 16 marks)

II. Answer **any SEVEN** of the following; each question carries 5 marks.

13. Give a comparative account of the structure of Sporocarp of *Salvinia* & *Marsilea*.
14. Write a note on sporangial maturation & development.
15. Give a detailed description of the development of sporangium in *Osmunda*.
16. Write a short note on Rhizophore in *Selaginella*.
17. Give an account on fossil Bryophytes.
18. Compare the internal structures of *Lunularia* and *Marchantia* with the help of diagram.
19. Give an account on the gametophyte of *Bryum*.
20. Describe the economic importance of Pteridophytes.
21. Give an account of alternation of generation in *Psilotum*.
22. Explain the structure of velum.

(7 x 5 = 35 marks)

III. Answer **any TWO** of the following; each question carries 12 marks.

23. With the help of labeled diagrams describe different types of Stellar system found in Pteridophytes ?

OR

24. Give a detailed account on gametophyte of Lycopodium.
25. Explain the sporophytic structure of *Anthoceros* with a neat labelled diagram.

OR

26. Bring out the history of classification of Bryophytes with a critical discussion.

(2 x 12 = 24 marks)

## Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

**M.Sc. Botany Semester II**

**20P2BOTT06: MOLECULAR BIOLOGY AND IMMUNOLOGY**

**Time 3 hours**

**Total Marks 75**

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I. Answer **any Eight** of the following; each question carries 2 marks

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.
11. Explain the process of tRNA charging?
12. Write a short note on MHC molecules.

(8 x 2 = 16)

II. Answer **any Seven** of the following; each question carries 5 marks

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

(5 x 7 = 35)

III. Answer **any Two** of the following; each question carries 12 marks

23. Explain DNA replication in Prokaryotes.

OR

24. Explain the post-transcriptional modifications of mRNA.
25. Describe the control of gene expression in eukaryotes.

OR

27. Explain the production and uses of monoclonal antibodies.

(2 x 12 = 24)

**Model Question Paper**

**SACRED HEART COLLEGE (AUTONOMOUS), THEVARA**

**M.Sc. Botany Semester II**

# 20P2BOTT07: PLANT ANATOMY, ANGIOSPERM SYSTEMATICS & MORPHOLOGY

Time 3 hours

Total Marks 75

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I. Answer **any EIGHT** of the following; each question carries 2 marks.

1. Differentiate ray initials and fusiform initials.
2. Explain phylogenetic tree.
3. Comment on seed dormancy.
4. What is author citation? Give one example.
5. Write about artificial classification.
6. Enlist the anatomical adaptations of xerophytes.
7. What is 'rule of priority'?
8. What is nodal anatomy? Add a note on its evolution.
9. Explain leaf abscission.
10. Distinguish between paraphyly and polyphyly.
11. Explain bracts and bracteoles.
12. What is the significance of rejection of names?

(8 x 2 = 16 marks)

II. Answer **any SEVEN** of the following; each question carries 5 marks.

13. Differentiate effective and valid publication.
14. What are the physical, chemical and mechanical properties of wood?
15. Explain the concept of DNA barcoding and its significance in systematic.
16. Explain the origin of branches and lateral roots in angiosperms.
17. What are secretory trichomes? Give an account on their structure and distribution.
18. Describe the anatomical peculiarities of CAM plants.
19. Explain typification with examples.
20. Write on floral anatomy and its significance.
21. Explain various concepts of species.
22. Describe the different types of fruits.

(7 x 5 = 35 marks)

III. Answer **any TWO** of the following; each question carries 12 marks.

23. Explain with suitable examples and diagrams the root-stem transition in angiosperms.

OR

24. Give an account on anomalous secondary thickening in stem.

25. Critically evaluate the phenetic and cladistic approaches in plant systematics.

OR

26. Explain the role of Phytochemistry in plant anatomy.

(2 x 12 = 24 marks)

## Model Question Paper

SACRED HEART COLLEGE, THEVARA (AUTONOMOUS)  
M.Sc. BOTANY SEMESTER II  
**20P2BOTT08: GENETICS AND BIOCHEMISTRY**

Time: 3 Hours

Maximum Marks: 75

### PART – A

I. Answer *any Eight* of the following; each question carries 2 marks

1. Explain gene mapping in bacteria and bacteriophages.
2. What are the functions of nucleotides?
3. Explain Henderson-Hasselbalch equation.
4. Discuss the various factors affecting enzyme activity.
5. Distinguish between Mucoproteins and Glycoproteins.
6. Write short note on lectins.
7. Define cytoplasmic inheritance.
8. What you mean by genetic polymorphism.
9. What are isozymes?
10. Explain the structure of cellulose with a structural diagram?
11. What is Dixon plot?
12. Give an account on secondary metabolites.

(2x8=16)

### PART – B

II. Answer *any Seven* of the following; each question carries 5 marks

(5x7=35)

13. Describe buffer action, citing suitable examples?
14. Describe various factors that alter allele frequencies.
15. Explain Ramachandran plot and its application?
16. Discuss polygenic inheritance with suitable examples.
17. Describe the procedure of protein sequencing by Edman method.
18. Describe the structure and role of vitamin derived co-enzymes.
19. Explain the following with suitable examples;  
(a) Dominance (b) Incomplete dominance (c) Codominance (d) Over dominance
20. What is Hardy-Weinberg equilibrium? What are the applications of Hardy-Weinberg principles?
21. Discuss the  $\beta$  oxidation of fatty acids.
22. What is the significance of zwitter ions?

### PART – C

III. Answer *any Two* of the following; each question carries 12 marks.

23. Write an essay on structure, classification and biosynthesis of amino acids.

OR

24. Write an essay on secondary metabolites.  
25. Give an account on gene mapping of Haploid organisms.

OR

26. What is 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?

(12x2=24)

**SACRED HEAR COLLEGE (AUTONOMOUS), THEVARA**

**Semester II**

**M.Sc. Botany Practical Course – 20P2BOTP03**

**BRYOLOGY, PTERIDOLOGY, MOLECULAR BIOLOGY & IMMUNOLOGY**

**Time 3 hours**

**Total Marks 40**

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1. Make stained micropreparations of specimens A and B  
(Preparation - 1, Diagram – 1, Identification with reasons – 1) (2x3=6)
2. Make stained micropreparations of specimens C and D  
(Preparation - 1, Diagram – 1, Identification with reasons – 1) (2x3=6)
3. Workout the problems E and F (4+6) (10)
4. Identify at sight G, H, I and J.  
(Systematic position up to genus identification - 1, Part displayed - 1) (4x2=8)
5. Field visit report (2)
6. Practical record. (8)

**Key to the questions:**

1. A& B - Bryophytes
2. C& D - Two suitable specimens each from Pteridophytes.
3. E &F - Problems from molecular biology.
4. G, H, I and J - Two reproductive structures each from Bryophytes & Pteridophytes.

N.B. Awarding maximum marks 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.

**SACRED HEAR COLLEGE (AUTONOMOUS), THEVARA**

**M.Sc. Botany Semester II**

**Practical Course – 20P2BOTP04**

**PLANT ANATOMY, ANGIOSPERM SYSTEMATICS, GENETICS & BIOCHEMISTRY**

**Time 3 hours**

**Total Marks 40**

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1. Make suitable micropreparations of **A**. Draw labelled diagrams and identify giving reasons.  
(Preparation - 1, Diagram - 2, Identification -1, Reasons -1) (5)
2. Describe and compare the stomatal type and pattern in the material **B** and **C**.  
(Identification of stomatal types – 0.5, Diagram – 0.5, Comparison – 0.5) (2 x 1.5 = 3)
3. Describe the nodal feature of the material **D**.  
(Identification of nodal type -1, Description -1) (2)
4. Explain the given nomenclatural problem **E**. (3)
5. Identify the morphological type and write critical notes on material **F**.  
(Identification - 1, Critical note - 1) (2)
6. Describe the given material **G** in technical terms.  
Draw L.S. of the flower, floral diagram and write the floral formula.  
(Vegetative characters – 0.5, Floral characters – 1.5, L.S. – 1.5,  
Floral diagram – 1.5, Floral formula - 1) (6)
7. Work out the problems **H** and **I**.  
(Problem H – 4, Problem I - 2) (6)
8. Assay of amylase enzyme from germinating seeds/ Appropriate plant material **J**.  
(Principle & Procedure – 1.5, Working – 1.5, Calculation & Result – 2) (5)
1. Practical Record (8)

**Key to the questions:**

1. A – Anomalous secondary thickening in dicot/ monocot
2. B, C – Stomatal types – suitable leaves
3. D – Specimen for nodal anatomical study
4. E – Suitable nomenclatural problem.
5. F – Material for morphological study mentioned in the syllabus.
6. G – Suitable flower for LS and study
7. H and I – problems from Genetics
8. J – Amylase activity study
9. Awarding maximum marks 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.

## SEMESTER III

Course	Title	Teaching Hrs Theory	Teaching Hrs Practical	Credits
<b>20P3BOTT09</b>	Taxonomy of Angiosperms	72	45	4
<b>20P3BOTT10</b>	Gymnosperms, Evolution & Paleobotany	27 + 18 + 9	27 + 0 + 9	3
<b>20P3BOTT11</b>	Plant Physiology & Metabolism	72	36	4
<b>20P3BOTT12</b>	Plant Reproductive Biology, Palynology & Plant Breeding	36 + 18 + 18	36 + 9 + 9	4
<b>20P3BOTP05</b>	Practicals of <b>20P3BOTT09</b> + <b>20P3BOTT10</b>			2
<b>20P3BOTP06</b>	Practicals of <b>20P3BOTT11</b> + <b>20P3BOTT12</b>			2
<b>FIELD STUDY</b>	Students are expected to conduct field visit (one in each semester) to familiarize with the diversity of life forms dealt in the semester syllabus and Plant Breeding. Report of the field visit should be prepared and recorded as part of the practical record.			

**20P3BOTT09: TAXONOMY OF ANGIOSPERMS**  
(Theory 72 hrs; Practical 45 hrs; Credits 4)

<b>COURSE OUTCOMES (COs)</b>	
<b>CO 1</b>	
<b>CO 2</b>	
<b>CO 3</b>	
<b>CO 4</b>	
<b>CO 5</b>	

**Introduction to the Course**

- (a) Artificial, Natural and Phylogenetic systems of classification
- (b) Morphology – Inflorescence, fruits, flower and leaves
- (c) Herbarium – significance, methods involved in herbarium preparation
- (d) Binomial nomenclature and ICN
- (e) Families -Annonaceae, Nymphaeaceae, Malvaceae, Sterculiaceae, Cucurbitaceae, Rubiaceae, Sapotaceae, Convolvulaceae, Solanaceae, Amaranthaceae, Arecaceae.

**Module 1: Classification (9 hrs)**

Major classification systems of higher plants with an emphasis on conceptual basis of classifications of the following system of classification;

- (a) Carl Linnaeus
- (b) Bentham & Hooker's
- (c) Bessey's
- (d) APG (brief account)

**Module 2: Methodology of Identification of plants: (7 hrs)**

- (a) Indented and bracketed keys
- (b) Floras, Revisions, Monographs, Manuals, Indices, Journals- Rheedea, Taxon and Phytotaxa,
- (c) Brief accounts on - Flora of the British India, Flora of the Presidency of Madras, *Hortus Malabaricus*. Important Flora works of Kerala.
- (d) Updated version of floral formula

**Module 3: Angiosperm diversity with special reference to Tropical flora (42 hrs)**

Study of the following families (according to Bentham & Hooker's system) in detail with special reference to their salient features, evolutionary trends and economic significance.

- (a) **Polypetalae:** 1. Ranunculaceae 2. Magnoliaceae 3. Brassicaceae 4. Capparidaceae 5. Polygalaceae 6. Caryophyllaceae 7. Guttiferae 8. Tiliaceae 9. Rutaceae 10. Vitaceae 11. Rhamnaceae 12. Fabaceae 13. Caesalpiniaceae 14. Mimosaceae 15. Rosaceae 16. Melastomaceae 17. Rhizophoraceae 18. Combretaceae 19. Myrtaceae
- (b) **Gamopetalae:** 20. Asteraceae 21. Campanulaceae 22. Myrsinaceae 23. Loganiaceae 24. Oleaceae 25. Apocynaceae 26. Asclepiadaceae 27. Boraginaceae 28. Scrophulariaceae 29. Bignoniaceae 30. Acanthaceae 31. Verbenaceae 32. Lamiaceae



- (c) **Monochlamydeae:** 33. Polygonaceae 34. Aristolochiaceae 35. Lauraceae 36. Loranthaceae 37. Euphorbiaceae  
(d) **Monocots:** 38. Orchidaceae 39. Dioscoriaceae 40. Zingiberaceae 41. Cyperaceae 42. Poaceae.

**Module 4: Evolution and diversification of Angiosperms (9 hours)**

- (a) Basal living angiosperms and Paleo-herbs  
(b) Evolutionary trends in angiosperms- Evolution of xylem, carpels, stamens, pollen grains, evolution of Inferior ovary  
(c) Evolution of flowering plants  
(d) Factors and process of diversification of angiosperms.

**Module 5: Ethnobotany (5 hrs)**

- (a) History, Scope and significance of Ethnobotany in India  
(b) Sources and methods of ethno-botanical studies  
(c) Case study of *Trichopus zeylanicus*

**Practical (45 hrs)**

1. Prepare a key up to species for at least five species per family that are mentioned in the syllabus.
2. Workout at least one member from each family and draw suitable scientific sketches and description in technical terms.
3. Preparation of indented and bracketed keys.
4. Field Study: A field study for not less than five days under the guidance and supervision of course teachers and preparation of a minimum of 20 herbarium specimens (Five modern herbarium with scaled images and 15 conventional ones) of different families with supporting field book.

**References**

1. Lawrence H M G (1951). *Taxonomy of Vascular Plants*. The Macmillan Company. US.
2. Simpson M G (2010). *Plant Systematics*.
3. Singh G (2102). *Plant Systematics Theory and Practice* (3<sup>rd</sup> Edn). Oxford & IBH Publishing Co. New Delhi.
4. Battacharya B (2009). *Systematic Botany* (2<sup>nd</sup>Edn). Narosa Publishing House.
5. Iwatsuki K and Raven P H (1997). *Evolution and Diversification of Land Plants*. Springer.
6. Jain S K (1991). *Dictionary of Indian Folk medicine and Ethnobotany*.
7. Soltis P. S. and Soltis D. E. (2004). Origin and Diversification of Angiosperms. *American journal of Botany*. 91 (10): 1614-1626.
8. Paye G D (2000). *Cultural Uses of Plants: A Guide to Learning about Ethnobotany*. The New York Botanical Garden Press.
9. Hooker J D (1875-1897). *The flora of British India* (Vol. I – VII).
10. Gamble J S (1915-1935). *Flora of the Presidency of Madras*. (Vol. I – III).
11. Sasidharan N (2012). *Flowering Plants of Kerala*. KFRI.

**20P3BOTT10: GYMNOSPERMS, EVOLUTION & PALEOBOTANY**  
(Theory 27 + 27 + 9 hrs; Practical 27 + 0 + 9 hrs; Credits 3)

<b>COURSE OUTCOMES (COs)</b>	
<b>CO 1</b>	
<b>CO 2</b>	
<b>CO 3</b>	
<b>CO 4</b>	
<b>CO 5</b>	

**GYMNOSPERMS (Theory 27 hrs; Practical 27 hrs)**

**Introduction to the Course**

- (a) Introduction, general characters, classification, origin and evolutionary significance.
- (b) A preliminary study of morphology, anatomy and reproductive features of *Cycas*, *Pinus* and *Gnetum*

**Module 1: Introduction (3 hrs)**

Origin, general characteristics, distribution and classification of Gymnosperms (K R Sporne and C J Chamberlain). Distribution of living gymnosperms in India. DNA barcoding of gymnosperms.

**Module 2: Vegetative and reproductive structures of Gymnosperms (22 hrs)**

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

- (a) Class Progymnospermopsida: *Aneurophyton*
- (b) Class Cycadopsida: *Heterangium*, *Lyginopteris*, *Lagenostoma*, *Glossopteris*, *Medullosa*, *Caytonia*, *Bennettites*, *Williamsoniella*, *Nilsonia*, *Cycas*, *Zamia*, *Pentoxylon*.
- (c) Class Coniferopsida: General account of families under Coniferales, range of form and structure of stem, leaves; range of form, structure and evolution of female cones in coniferales such as *Pinus*, *Taxodium*, *Cupressus*, *Podocarpus*, *Agathis*, *Araucaria*, *Taxus* and *Ginkgo*.
- (d) Class Gnetopsida: *Gnetum*.

**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 (27 hrs)**

1. Study of the morphology and anatomy of vegetative and reproductive parts of *Cycas*, *Zamia*, *Pinus*, *Cupressus*, *Agathis*, *Araucaria* and *Gnetum*.
2. Study of fossil gymnosperms through specimens and permanent slides.
3. Conduct field trips to familiarise various gymnosperms in nature and field identification of Indian gymnosperms and submit a report.

**References**

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.

3. Beck C E (1995). *Gymnosperm Phylogeny*. Bot. Rev. 51-176.
4. Bhatnagar S P, Moitra A (2000). *Gymnosperms*. New Age International Ltd.
5. Biswas C. *The Gymnosperms*. Today and Tomorrows print.
6. Chamberlain C J (1935). *Gymnosperms: Structure and Evolution*. University of Chicago Press.
7. Coulter J M, Chamberlain C J (1977). *Morphology of Gymnosperms*. University of Chicago Press.
8. Dallimore W, A B Jackson (1964). *A Handbook of Coniferae and Ginkgoaceae* (IV Edn). Edward Arnold & Co.
9. Delevoryas T (1962). *Morphology and evolution of Fossil Plants*. Holt, Rinehart and Winston.
10. Meyen S V (1984). *Basic features of Gymnosperms' Systematics and Phylogeny as evidenced by the Fossil Record*. Bot. Rev.
11. Sharma O P, S Dixit (2002). *Gymnosperms*. Pragati Prakashan.
12. Sporne A R (1974). *The morphology of gymnosperms*. Hutchinson Univ. Library.

## **EVOLUTION: (Theory: 27 Hrs.)**

### **Introduction to the Course**

The Concept of evolution, Charles Darwin, Darwin's Evolutionary theory, The Voyage of HMS Beagle. Theories after Darwin, evidences of evolution.

### **Module 1: Origin of Life (2 hrs)**

Abiogenesis, Biogenesis experiment of Miller (1953). Theory of Organic evolution - Biochemical origin of life, Concept of Oparin and Haldane.

### **Module 2: Evidences for Evolution (2 Hrs)**

Morphology and Comparative Anatomy, Embryology, Physiology and Biochemistry, Paleontology, Biogeography, Micro and Macro-evolution and Punctuated Equilibrium.

### **Module 3: Patterns of Evolution (4 hrs)**

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

### **Module 4: Levels of Evolution (4 hrs)**

Biodiversity, Genetic variation, phenotypic variation, Macro evolution; evolution above the species level. Sex and Reproductive success; Paradox of sex, Inbreeding and outcrossing, Concept of sexual selection, sexual selection by mate choice.

### **Module 5: Speciation (4 hrs)**

Species concept; Morphological Species, Biological Species and Evolutionary Species. Types of speciation - Phyletic speciation and True speciation. Mechanism of speciation - Genetic divergences and isolating mechanisms. Patterns of speciation - allopatric, sympatric, quantum and parapatric speciation.

### **Module 6: Natural Selection (4 hrs)**

Natural selection and adaptation; Limiting factors, Origin of races and species, Kins Selection and Hamilton's Rule. Nature of adaptations, Significance of Genetic drift in natural selection.

### **Module 7: Modern Theories of Evolution (4 hrs)**

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

### **Module 8: Coevolution (2 Hrs)**

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

## References

1. Allan C. Hutchinson (2005). *Evolution and the Common Law*. Cambridge University Press.
2. Douglas J. Futuyma (2009). *Evolution*. Sinauer Associates. INC-Publishers. USA.
3. George Ledyard Stebbins (1971). *Process of Organic evolution*.
4. Gurbachan S. Miglani (2002). *Modern Synthetic theory of evolution*.
5. Hancock J. F (2003). *Plant Evolution and the Origin of Crop Species*. CABI.
6. Herbert H. Ross (1962). *A Synthesis of Evolutionary Theory*. Prentice Hall Of India.
7. Horatio Hacketrt Newmann (1932). *Evolution, Genetics and Eugenics*. University of Chicago press.
8. Katy Human (2006). *Biological evolution: An anthology of current thought*. The Rosen publishing group, Inc.
9. Kenneth V. Kardong (2005). *An introduction to Biological Evolution*. McGraw-Hill publications. New York.
10. Martin Ingrouille and Bill Eddie (2006). *Plants Diversity and Evolution*. Cambridge University Press.
11. Maxtoshi Nei and Sudhir Kumar (2000). *Molecular Evolution and phylogenetics*. Oxford University Press.
12. Monroe W. Strickberger (1990). *Evolution*. Jones and Bartlett publishers.
13. Paul Amos Moody (1970). *Introduction to Evolution*. Harper and Row publishers, Newyork.
14. Roderic D. M. Page and Edward C. Holmes (1998). *Molecular Evolution: A Phylogenetic approach*. Blackwell Science Ltd.
15. Shukla R. S. and P. S.Chandel (1974). *Cytogenetics, Evolution, Biostatistics and Plant Breeding*. S.Chand and Company Ltd. New Delhi.
16. Victor Rico-Gray, Paulo S. Oliveira (2007). *The Ecology and Evolution of Ant-Plant Interactions*. University of Chicago Press.
17. Volpe E. Peter (1993). *Understanding Evolution*. Universal Book Stall, New Delhi.
18. Willis K. J. and J. C. Mc Elwain (2002). *The Evolution of Plants*. Oxford University Press.

## **PALAEOBOTANY (Theory 9 hrs; Practical 9 hrs)**

### **Introduction to the course**

- (a) Evolutionary time scale: eras, periods and epochs.
- (b) Stages in primate evolution including *Homo*.
- (c) Fossils – definition, types of fossils
- (d) Fossilization: mode of preservation and their importance

### **Module 1 (3 hrs)**

Techniques in Palaeontology - mega fossils - microfossils - nannofossils - ichnofossils - collection, reformation & illustration - binomial nomenclature. Plant fossils – Preservation, preparation, age determination.\

### **Module 2 (3 hrs)**

Palaeobotany: *Lyginopteris*, *Pentoxylon*, *Lagenostroma*, *Cordaites*, *Cardiocarpus*, *Calamites*, *Sphenophyllum*, *Calamostachys* and *Glossopteris*.

**Module 3 (3 hrs)**

Fossil record – systematic, reconstruction and nomenclature; Applied aspects of paleobotany

**Practicals (9 hrs)**

1. Study of fossil plants based on permanent slides and photographs.

**References**

1. Ruap, D.M, Stanley, S.M, 1999: Principles of Palaeontology. W.H. Freeman and Co, Toppan Co. Ltd.
2. Stewart, W.N. and Rothwell G.W. (1993), Palaeobotany and the Evolution of Plants, Cambridge University Press.
3. Agashe, S.N. (1995), Palaeobotany, Oxford & IBH, New Delhi.
4. Siddiqui, K.A. (2002) Elements of Palaeobotany, Kitab Mahal, Allahabad.
5. Thomas, B.A. & Spicer R.A. (1987): The Evolution and Palaeobiology of land plants. Discordies Press, Fortland, USA.

# 20P3BOTT11: PLANT PHYSIOLOGY AND METABOLISM

(Theory 72; Practical 36; Credits: 4)

COURSE OUTCOMES (COs)	
CO 1	
CO 2	
CO 3	
CO 4	
CO 5	

## 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, diffusion. Passive and active transport.
- (a) Calvin cycle, Glycolytic pathway and its regulation, Citric acid cycle

## Module 1: Plant water relations (10 hrs)

- (a) Cell wall and membrane properties in relation with water- Turgor Pressure and Hydraulic conductivity. Aquaporins. Plant water status and Physiological processes.
- (b) Bulk flow of water. 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. Theories of stomatal movement. 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) Role of Mycorrhizae in nutrient uptake.
- (d) Theories of mineral salt absorption.

## Module 3: Transport of ions, solutes and macromolecules (6 hrs)

- (a) Electrical properties of membranes, Membrane potential.
- (b) Transport across cell membranes: Passive – diffusion, facilitated diffusion, membrane channels; gap junctions, porins, ion channels – gated channels, structure and working of K<sup>+</sup> ion channels.
- (c) Active transport: Carrier proteins; Na<sup>+</sup>K<sup>+</sup> pump, ABC transporters, Inophones, Symport, Antiport.

## Module 4: 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. Repair and Regulation of Photosynthetic Machinery- Photoprotection, Photoinhibition.
- (b) Structure and function of RuBisco. CO<sub>2</sub> fixation- Regulation of Calvin cycle. Photorespiration, role of photorespiration in plants. CO<sub>2</sub> concentrating mechanisms - C<sub>4</sub> cycle, CAM pathway. Synthesis and mobilization of chloroplast starch, starch degradation, Regulation of synthesis and degradation. Biosynthesis of sucrose and signalling.

**Module 5: 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 6: Respiration and lipid metabolism (12 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 F1 and F0 subunits, Chemiosmotic hypothesis, binding change mechanism of ATP synthesis.
- (c) Comparison of mitochondrial and chloroplast ATP synthesis.
- (d) Mechanisms that lower ATP yield- alternative oxidase, Uncoupling proteins, Rotenone- Insensitive NADH dehydrogenase.
- (e) Lipid metabolism: glyoxylate cycle.

**Module 7: Nitrogen metabolism: (6 hrs)**

N cycle. Nitrate assimilation- nitrogen reductase. Ammonium assimilation, Aminoacid biosynthesis, Biological Nitrogen fixation - free living and symbiotic. Symbiotic N fixation – nodule formation, leghaemoglobin. Process of N fixation and structure of nitrogenase enzyme complex. Transport of amides and ureides.

**Module 8: Stress physiology (5 hrs)**

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

**Module 8: Sensory photobiology (4 hrs)**

Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins. Responses to UV radiation. Photoperiodism and biological clocks – circadian rhythms. Vernalization. Floral induction and development.

**Module 9: Plant growth regulators (8 hrs)**

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

**Practicals (36 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 R<sub>f</sub> 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.

## References

1. Bob B Buchanan, Wilhelm Gruissem, Russel L Jones (2000). *Biochemistry and molecular biology of plants*. L K International Pvt. Ltd. , New Delhi
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2002). *Molecular biology of the cell* (IV Edn). Garland Science, Taylor and Francis group.
3. David E Sadava (2009). *Cell biology: Organelle structure and function*. CBS
4. Devlin, R. M., Witham, F. H. ( 1986). *Plant physiology*. 4th ed. CBS Publishers and Distributors. Shahadara, New Delhi.
5. Frank B Salisbury, Cleon W Ross (1992). *Plant Physiology* (IV Edn). Wadsworth Publishing Company. , New York
6. Gerald Karp (2008). *Cell and Molecular biology: Concepts and experiments* (V Edn). John Wiley & Sons.
7. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher,
8. Hidde Ploegh, Paul Matsudaira (2007). *Molecular cell biology* (VI Edn). W H Freeman & Company.
9. Hopkins, W. G. and Hüner, N. P. (1995). *Introduction to plant physiology* (Vol. 355) Wiley and sons, New York.
10. Jeremy M Berg, John L Tymoczko, Lubert Stryer, Gregory J Gatto Jr. (2007). *Biochemistry*. W H Freeman and company. , London.
11. Jones, H. G., Flowers, T. J., & Jones, M. B. (Eds.). (1989). *Plants under stress: Biochemistry, physiology and ecology and their application to plant improvement* (No.39). Cambridge University Press, England.
12. Kays, S. J. (1991). *Postharvest physiology and handling of perishable plant products*. Van Nostrand Reinhold Inc., USA.
13. Kumar, A. and Purohit, S. S. (1996). *Plant Physiology*. Agro botanical Publishers, Bikaner.
14. Lincoln Taiz, Eduardo Zeiger (2002). *Plant physiology* (II Edn). Sinauer Associates, Inc. Publishers.
15. Mohr, H. and Schopfer, P. (1995) *Plant Physiology*, Springer, London.
16. Moore, T. C. (1981). *Research experience in plant Physiology-A Lab Manual*, Springer-Verlag, New York.
17. Noggle, G. R., & Fritz, G. J. (1992). *Introductory plant physiology* (No. Ed. 2). Prentice- Hall Inc., New Jersey.
18. Reginald H Garrett, Charles M Grisham (2005). *Biochemistry*. Thomson Brooks/Cole
19. Robert Horton H, Laurence A Moran, Raymond S Ochr, J David Rawn, K Gray Scrimgeour (2002). *Principles of Biochemistry* (III Edn). Prentice Hall , New Jersey.
20. Sadasivam, S, Manickam, A (1996). *Biochemical methods* (II Edn). New age international Publishers.
21. William H Elliott, Daphne C Elliott (2001). *Biochemistry and molecular biology* (II Edn). Oxford



# 20P3BOTT12: PLANT REPRODUCTIVE BIOLOGY, PALYNOLOGY AND PLANT BREEDING

(Theory 36+18+18 hrs; Practical 18+9+9 hrs; Credits 4)

COURSE OUTCOMES (COs)	
CO 1	
CO 2	
CO 3	
CO 4	
CO 5	

## PLANT REPRODUCTIVE BIOLOGY (Theory 36 hrs; Practical 18 hrs)

### Introduction to the course (3 hrs)

- (a) Anther: Structure and development, microsporogenesis, male gametophyte development.
- (b) Ovule: Structure, ontogeny and types. Megasporogenesis. Embryosac development, types with one example each; ultrastructure and nutrition of embryosac. Female gametophyte development.

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

- (a) An overview of plant and animal interaction, Potency, Commitment, Specification, Induction, Competence.
- (b) Applications of reproductive biology (research, agriculture, Industry, Forensic & Horticulture).

### Module 2: Pollination (8 hrs)

- (a) Sexuality of flowers and plants. Pollination agents and floral adaptations.
- (b) Pollination syndromes; study of common pollinators from each syndromes.
- (c) Breeding system in plants. In breeding and Outbreeding mechanisms and significances.
- (d) Characters of flowers that determines different pollination syndromes
- (e) Types of stigma; wet and dry types (along with significance of each types)
- (f) 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.
- (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 (5hrs)

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 (6hrs)**

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: Eminent personalities in the field of reproductive biology with an emphasis on Indian contributions (4 hrs)**

Jack Heslop-Harrison, W A Jenson, P. Maheswari & K.R. Shivanna.

### **Practical (18 hrs)**

1. Embryo excision from young seeds.
2. Pollen germination studies. Study of pollen germination of flowers at different times in relation to anthesis
3. Breeding system experiments; Apomixes, Autogamy, Geitonogamy and Xenogamy.
4. Collection of data on pollination under openfield conditions and (correlate the same with geitonogamy or xenogamy).
5. Perform the pollen sterility test by Acetocarmine and viability test by in vitro germination (Impatiens, Croton, Cucurbits etc.)
6. Identification of different types of embryos, polyembryony, endosperm types, types of pollen grains, anther growth stages and types using permanent slides.
7. Tests for breaking dormancy in different seeds.
8. Identification of pollination syndromes with reasons of a given flower.

### **Suggested Assignment Topics**

1. Study of microsporogenesis and gametogenesis in anthers
2. Tests for pollen viability using stains and in vitro pollen germination.
3. Estimating percentage of pollen germination and pollen viability in vitro
4. Preparation of dissected whole mounts of endothecium, (tapetum and ovule)
5. Study of nuclear and cellular endosperm and suspensor through dissections and staining
6. Isolation of globular, heart shaped and torpedo stages of embryos from suitable seeds
7. Induction of callus and somatic embryogenesis
8. Preparation of artificial seeds
9. Isolation of protoplasts
10. Clonal propagation of forest plants
11. Identification of pollination syndromes by using morphological characters

### **References**

1. Scott F Gilbert (2000). Developmental Biology (IX Edn). Sinauer Associates. (available online).
2. Twyman R M (2001). Instant notes in Developmental Biology. Viva Books Private Limited.
3. Lincoln Taiz, Eduardo Zeiger (2002). Plant physiology (II Edn). Sinauer Associates, Inc. Publishers.
4. Robert J Brooker (2009). Genetics: analysis & principles (III Edn.). McGraw Hill

5. Bob B Buchanan, Wilhelm Gruissem, Russel L Jones (2000). Biochemistry and Molecular biology of Plants. L K International Pvt. Ltd.
6. Scott F Gilbert (2000). Developmental Biology(VIII Edn). Sinauer Associates.
7. Maheswari P (1950). An introduction to the embryology of Angiosperms. McGraw Hill.
8. Bewley J.D. and Black M. (1994) Seeds: Physiology of Development and Germination. Plenum Press.
9. Bhojwani S.S. and Bhatnagar S. P. (2000). The Embryology of Angiosperms. Vikas Publishing House.
10. Endress P. K. and Frus F. M. (1994). Early Evolution of Flowers. Springer-Verlag.
11. Leins P. Tucker S.C. and Endress P. K. (1988). Aspects of Flower Development. J. Cramer.
12. Meeuse AD. (1966). Fundamentals of Phytomorphology. Ronald Press Co.
13. Maheswari, P. (1963). Recent advances in the Embryology of Angiosperms.
14. Maheswari P. (1950). An Introduction to the Embryology of Angiosperms. McGraw Hill Book Co.
15. Raghavan V. (1966). Embryogenesis in Angiosperms. Cambridge Univ. Press.
16. Raghavan V. (1999). Development Biology of Flowering Plants. Springer-Verlag.
17. Sattler R. (1978). Theoretical Plant Morphology. Leiden University Press. 15
18. Shivanna K. R. and Rangaswamy N.S. (1992). Pollen Biology: A Laboratory Manual, Springer-Verlag.
19. Shivanna K. R. and Johri B. M. (1985). The Angiosperm Pollen Structure and Function. Wiley Eastern.
20. Shivanna K. R. and Sawhney V. K. (1997). Pollen Biotechnology for Crop Production and Improvement. Cambridge Univ. Press.
21. Shivanna and Tandon (2014). Reproductive Ecology of Flowering Plants: A Manual. Springer.
22. Shivanna K R. (2003). Pollen Biology and Biotechnology. Oxford and IBH publishing Co.Pvt. Ltd.
23. Sporne K. R. (1974). The Morphology of Angiosperms. Hutchinson University Press.
24. Swamy B.G.L. and Krishnamurthy K. V. K. (1980). From Flower to Fruit. Tata McGraw Hill Book Co.
25. Faegri, K., and Iversen, J. (1989 (also reprinted in 2000)). Textbook of Pollen Analysis, 4th Ed. Blackburn Press, Caldwell, NJ.

## **PALYNOLOGY (18 hrs)**

### **Module 1. Introduction (1 hr.)**

Introduction to palynology - History and scope of palynology, Terminologies used in spore and pollen description.

### **Module-2: Pollen development and structure (6 hrs.)**

A. Development of pollen grains.

B. Morphological characters of pollen grains - aperture type, pollen wall architecture, pollen unit, polarity, symmetry, shape and size.

C. The pollen wall - Pollen wall development - primexine model and undulation model, Pollen wall structure - exine and intine wall layers, Surface ornamentation and its importance in pollination ecology. - Special ornamentation features--bladders, viscin threads, spines and pollenkit.

D. Pollen apertures - Inaperturate grain, simple and compound, types, functions and arrangement. Role in pollen identification – NPC classification.

E. Pollen wall chemical composition (sporopollenin) and its relationship to pollen preservation.

### **Module- 3: Pollen Analysis (6 hrs.)**

- A. Production and dispersal of pollen grains, Factors affecting pollen deposition. Pollen rain.
- B. Laboratory techniques for pollen analysis – acetolysis. Techniques to find pollen in sediments, forensic samples, honey, rocks, archaeological sites and shipwrecks.
- C. Purpose of Pollen collection and storage.
- D. Pollen viability and vigour, Factors affecting pollen viability. Viability tests: - germination assay- *in vitro*, *in vivo*; non Germination assay – FCR/FDA test, Acetocarmine test for assessing sterility.
- E. r-values and pollen coefficients (for correcting over and under representation of pollen).

### **Module – 4 Applications and Methods in Palynology (5 hrs.)**

- A. Palynology and systematics.
- B. Pollen sampling and data gathering (how many samples to collect and what to collect). Modern pollen rain sampling and collection of important floral data, Sampling of deposits for pollen - Stratigraphic sampling of geologic terrestrial deposits, Sampling of lake and underwater archaeological deposits, Terrestrial archaeological sites, Forensic sampling, Entomo-palynological sampling, Melisso-palynological sampling.
- C. The statistical validity of using multiple vs. single samples from given locations.
- D. Tools and methods used for pollen sampling. E. Use of pollen in pharmaceuticals, nutrition and cosmetics. Pollen allergy.

#### **A. Suggested Assignment Topics**

1. Sampling procedures in palynology- Melisso-palynology and Entomo-palynology
2. Pollinators - Insects, birds, and bats, unique evolution of specific plant taxa and their pollinators
3. Melisso-palynology
4. Floral nectar types and pollen used by honeybees, history of the discipline
5. Extraction of pollen from honey samples
6. Counting pollen in honey: What are pollen coefficient values in honey? Why use them and how to establish them? Pollen concentration values, correct number and type of pollen counts needed, methods of reporting honey pollen data
7. Determining geographical origins and honey blends based on the pollen.
8. Insects (other than bees) and pollen
9. Crop pollination
10. Pollen as a method to track the migration movements of adult forms of many agricultural insect pests. Role in predicting insect migration routes (i.e., butterflies, moths)
11. Importance of pollen as a dietary item in the life cycle of insect pests (i.e., moths, butterflies, boll weevils, etc.).
12. Techniques used to examine pollen on the surface and gut of insects
13. SEM analyses and the development of photographic pollen keys.
14. What are relative pollen counts, absolute counts, secondary counts, and large-fraction-analysis counts?
15. Establishing pollen concentration values and the value of these data
16. When and how to use pollen influx techniques.
17. Recognition of real vs. artificial vegetational changes.
18. How to avoid making errors in pollen data interpretations.

19. Computer programs used to plot pollen data.
20. Are statistical methods valid for explaining pollen data?

### **Practical (9 hrs)**

1. Morphology of pollen grains.
2. Make a key based on external characters of pollen grains of a family or genus of known plants.

### **References**

1. Faegri, K., and Iversen, J. (1989) (also reprinted in 2000)). *Textbook of Pollen Analysis*, 4th Ed. Blackburn Press, Caldwell, NJ
2. Kapp, R. O., Davis, O. K. & King, J. E. (2000). *Guide to Pollen and Spores*. (2nd edition, 3rd printing). AASP Press, Dallas.
3. Erdtman, G. (1943) *An Introduction to Pollen Analysis*, World Public Library Association
4. Shivanna, K. R. and Rangaswamy, N. S. (1992). *Pollen Biology -A Laboratory Manual*, Springer-Verlag, Berlin
5. Nowicke, J. W. and Skvarla, J. J. (1979) *Pollen Morphology* (Vol. 66)
6. Stanley, R. G. and Linskens, H. F. (1974) *Pollen - Biology Biochemistry Management*, Springer - Verlag Berlin Heidelberg, New York
7. Simpson, M. G. (2010) *Plant Systematics - Palynology* (2nd Edition), Academic Press
8. Faegri, K. and Iversen, J. (1950) *Text-book of Modern Pollen Analysis*, Ejnar Munksgaard, Copenhagen
9. Clement, C., Pacini, E. and Audran, J. C. (1999) *Anther and Pollen – from Biology to Biotechnology*, Springer
10. Bhattacharya, K., Majumdar, M. R. and Bhattacharya, S. G. (2006). *A textbook of Palynology*, New Central Book Agency Pvt. Ltd., Kolkata
11. Shukla, A. K., Vijayaraghavan, M. R. and Chaudhry, B. (2014) *Biology of Pollen*, APH Publishing Corporation, New Delhi

## **PLANT BREEDING (18 hrs)**

### **Introduction to the Course**

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 (3 hrs)**

Objectives of plant breeding, important achievements and future prospects. Genetic variability and its role in plant breeding. Domestication and centers of origin of cultivated plants.

### **Module 2: Hybridization (3 hrs)**

Hybridization - role and methods, Inter-varietal, inter specific and inter generic crosses. Back-cross breeding. Heterosis, Inbreeding depression.

**Module 3: Breeding for resistance (4 hrs)**

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

**Module 4. Idiotypic breeding (2 Hrs)**

Role and Methods, Applications of Idiotypic Breeding.

**Module 5: Mutation breeding (4 hrs)**

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.

**Module 6: Modern breeding methods (2 hrs)**

Modern Trends in Plant Breeding: Tissue culture Technologies (DNA marker-assisted Selection (MAS) - A brief study only).

**Practical (9 hrs)**

1. Hybridization techniques in self and cross pollinated plants
2. Visit a plant breeding station with nursery/garden to familiarize with breeding programs. Submit a detailed report of the visit including techniques learned.

**References**

1. Allard R W (1995). *Principles of Plant Breeding*. John Wiley and Sons, Inc.
2. Denis Murphy (2007). *Plant Breeding and Biotechnology*. Cambridge University Press.
3. Ghahal G S and Gosal S S (2002). *Principles and procedures of Plant Breeding*. Narosa Publishing House.
4. Izak Bos and Peter Caligari (2007). *Selection methods in plant breeding*. Springer.
5. Kang M.S. (2002). *Quantitative Genetics, Genomics and Plant Breeding*. CABI.
6. Langridge P., K. Chalmers, Horst Lörz and Gerhard Wenzel (2005). *Molecular Marker Systems in Plant Breeding and Crop Improvement*. Springer-Verlag.
7. Sharma J R (1994). *Principles and practices of Plant Breeding*. Tata McGraw-Hill Publishers Company Ltd.
8. Singh B D (1996). *Plant Breeding: Principles and methods*. Kalyani Publications.

## Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA  
M.Sc. Botany Semester III  
20P3BOTT09 : TAXONOMY OF ANGIOSPERMS

Time : 3 Hours

Max. Marks: 75

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I. Answer **any Eight** questions briefly; each question carries 2 marks

1. Comment on the floral features of Euphorbiaceae.
2. Differentiate Between Flora , Manuals, and Monographs.
3. Compare the tendrils of Cucurbitaceae and Vitaceae.
4. Explain the ecological significance of Lauraceae.
5. Write a short note on the role of BSI in Indian taxonomic studies.
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 Polygalaceae.
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
11. What are the applications of GIS in taxonomy?
12. Give the family name and economic products of the following plants.  
(i) *Mentha arvensis* (ii) *Lagenaria vulgaris*  
(iii) *Cymbopogon citratus* (iv) *Foeniculum vulgare*

(8 x 2 = 16 marks)

II. Answer **any Seven** questions; each question carries 5 marks

13. What are the steps involved in herbarium preparation? Mention the significance of Herbarium.
14. Write a comparative account of the families Verbenaceae and Lamiaceae with the help of suitable diagrams.
15. Discuss the sources and methods of ethnobotanical studies.
16. Explain the economic importance of Aristolochiaceae and Zingiberaceae.
17. Critically evaluate the Bessey's system of classification based on its conceptual basis.
18. Explain the merits and demerits of APG system of classification.
19. Discuss the advanced features of Orchidaceae.
20. Differentiate between indented and bracketed keys.
21. Explain the economic importance Cruciferae.
22. Compare the floral features of Apocynaceae and Asclepiadaceae with suitable diagrams.

(5 x 7 = 35 marks)

III. Answer **any Two** questions; each question carries 12 marks

23. Discuss the primitive features of the families Rununculaceae, Magnoliaceae and Annonaceae.

OR

24. Compare the floral features of the families Lythraceae, Melastomaceae and Myrtaceae. Explain with suitable diagrams.

25. Differentiate the families Boraginaceae, Convolvulaceae and Solanaceae based on vegetative and floral features.

OR

26. Critically evaluate the system of classification of angiosperm by Hutchinson and compare it with that of Bentham and Hookers Classification.

(12 x 2 = 24 marks)

## Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

**M.Sc. Botany Semester III**  
**20P3BOTT10: GYMNOSPERMS, EVOLUTION & PALEOBOTANY**

Time : 3 Hours

Max. Marks: 75

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I. Answer **any Eight** questions briefly; each question carries 2 marks

1. Briefly explain the types gymnosperms based on stomata?
2. What are the 'fern' characters of the gymnosperm leaves?
3. What are corralloid roots?
4. Briefly explain methods of age determination of plant fossils?
5. Define the term 'demes'.
6. Write briefly about the salient features of Bennettitiales
7. What are palaeoendemics? Give two examples of palaeoendemics
8. Define multiple niche polymorphism
9. What is founder effect?
10. Explain the following; a) nannofossils b) ichnofossils
11. What is transfusion tissue?
12. Write a short note on the features of Progymnospermopsida.

(2 x 8 = 16)

II. Answer any **seven** of the following each question carries 5 marks.

13. Compare Gymnosperms with Angiosperms?
14. Write a note on the classification of Gymnosperms?
15. With the help of suitable diagrams explain the mega-gametophyte of *Ginkgo*?
16. Explain neolamarkism?
17. Write a note on evolutionary time-scale?
18. What is meant by genetic drift?
19. Describe genomic equivalence and cytoplasmic determinants?
20. What is fossilization? Explain different types of fossils with its significance
21. Give an illustrated account of the anatomy of the leaflet of cycas, and explain the function of various tissues found therein?
22. Explain geological time scale with a specific note on major changes in each time period.

(7x5= 35)

III. Answer any **two** of the following each question carries **12** marks

23. Write an account on the distribution, general characters, and outline classification of order coniferales.

**or**

24. Compare and contrast microspores in gymnosperms

25. Write an essay on speciation

**or**

26. Write an essay on sex and reproductive success in evolution

(2x12= 24)



## Model Question Paper

SACRED HEART COLLEGE, THEVARA (AUTONOMOUS)

M.Sc. Botany Semester III

20P3BOTT11 : PLANT PHYSIOLOGY

Time: 3 Hours

Maximum Marks: 75

### PART – A

I. Answer **any eight** questions briefly; each question carries 2 marks.

1. Comment on the source- sink concept in phloem transport.
2. Write a short note on Donnan Potential.
3. What are the apoplastic and symplastic pathways and how do they differ?
4. Write the mode of action of ethylene in plants.
5. What is the membrane potential and how it is generated?
6. Comment on ecophysiological significance of C<sub>4</sub> photosynthesis.
7. Write a note on Vernalisation.
8. Write a short note on Aquaporins.
9. Differentiate between root pressure and transpirational pull.
10. What is SPAC?
11. Write a short note on phytoalexins.
12. Give an account on HSP.

(8 x 2 = 16 marks)

II. Answer **any Seven** questions; each question carries 5 marks

13. "Transpiration is a necessary evil". Justify the statement.
14. Define water potential. Explain the relation between Osmotic Pressure, Turgor Pressure and Suction Pressure.
15. Write an account on photoperiodism.
16. Explain the mechanism of cyanide resistant pathway.
17. Write brief descriptions on the following:  
(a) Gluconeogenesis (b) Antiport (c) Circadian rhythm (d) Leghaemoglobin (e) Photoinhibition
18. Include in your answer a discussion on how light energy absorbed by a pigment is transferred to the reaction center of the photosystem.
19. Explain the mechanism of electron and proton transport in the thylakoid membrane.
20. Give an account of translocation in phloem
21. Describe briefly the mechanism of Biological Nitrogen fixation
22. What is the role of water oxidizing clock in plants and explain the mechanism

(5 x 7 = 35 marks)

III. Answer **any Two** questions; each question carries 12 marks

23. With the help of a diagram, describe the detailed structure of ATPase complex. Write the binding change mechanism of ATP synthesis.  
OR
24. What are the stresses to which plants are commonly exposed? Describe the stress tolerance mechanisms found in plants.  
OR
25. Describe the theories of water absorption by roots.  
OR
26. Give an account of mycorrhizae and their role in absorption of mineral salts by higher plants.

(12 x 2 = 24 marks)

## Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), Thevara

M.Sc. Botany - Semester III

20P3BOTT12: PLANT REPRODUCTIVE BIOLOGY, PALYNOLOGY AND PLANT BREEDING

Time 3 hours

Total Marks 75

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I. Answer any *eight* of the following (2 marks each)

1. What is geitonogamy?
2. What is Chiropterophily
3. What is tapetum? Mention any two significances of tapetum
4. What are viscin threads?
5. What is FDA test?
6. Describe - (a) Double fertilization (b) Tripple fusion
7. Write briefly about the contributions of P Maheswari to Embryology
8. What is seed dormancy?
9. What is mutation breeding?
10. What is the role of Gyberrellin.

8X2 =16

II. Answer any *seven* of the following (5 Marks each)

11. Explain embryogenesis in flowering plants.
12. With the help of suitable diagrams explain megasporogenesis?
13. Explain different seed dispersal mechanisms and agents involved in it?
14. Explain different mechanisms of incompatibility in flowering plants?
15. With the help of labelled diagrams explain the ultra-structure of pollen wall with an emphasis on -significance of each wall layer?
16. Explain Millennium Seed Bank Project?
17. Explain different sampling test involved in Palynology?
18. Write brief notes on the following;  
(a) Apomixis (b) Xenia (c) Polyembryony (d) Imprinting
19. Describe intergeneric and inter specific hybridization?
20. Explain modern trends in plant breeding.

7X5 =35

III. Answer any *two* of the following (12 marks each)

21. Explain the role of mutation induction in crop improvement. Enlist the advantages and disadvantages of mutation breeding.

or

22. Write an essay on the significances and applications of palynology.

23. Write an essay on the breeding systems and pollination syndromes in flowering plants

or

24. Explain the post-pollination events in flowering plants

12X2 =24

## Model Question Paper

**SACRED HEART COLLEGE (AUTONOMOUS), THEVARA**  
**M.Sc. Botany Semester III Practical Course –20P3BOTP05**  
**GYMNOSPERMS, EVOLUTION, PALAEOBOTANY, TAXONOMY OF ANGIOSPERMS AND**  
**ETHNOBOTANY**

**Time 3 hours**

**Marks- 40**

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1. Make stained micro-preparations (TS, TLS and RLS) of A. Draw labelled diagram and identify giving reasons.  
(Total marks 9 = Preparations – 0.5 each, Identification with reasons – 1.5 each, Diagrams – 1 each; 3x3= 9)
2. Write critical notes on B and C. (Total marks 4 = Identification 1, critical note 1; 2 x 2 = 4)
3. Identify the families of the given specimens D and E.  
(Total marks 4 = Identification up to series with reasons – 0.5, Identification up to cohort with reasons– 0.5, Identification of the family with reasons – 1; 2 x 2 = 4).
4. Identify the given material F up to genus.  
(Total marks 4 = Identification up to family with reasons – 1, Identification of genus with author -citation – 1.5, Genus key – 1.5).
5. Identify the given material G up to species.  
(Total Marks 5 = Identification up to family – 0.5, Identification of genus with author citation – 1, Genus key – 0.5, Identification of species with author citation – 2, Species key – 1).
6. a) Herbarium, field book and field study report & b) Identification of any 2 herbarium specimens -out of herbarium specimens.  
(Marks = 4+2=6)
7. Write critical notes on H & I (Marks= 1x2=2)
8. Practical record (Marks= 8)

### Key to the questions:

1. A- Specimens from Coniferales prescribed in the syllabus
2. B- Suitable Gymnosperm specimens; C - fossil slides/specimens specified in the syllabus
3. D & E– Plant materials for family identification
4. F– Material for genus identification
5. G– Material for species identification
6. Herbarium (35 nos) and field book certified by the head of the department and submitted by the student.
7. H & I- Raw or finished products of economically/ethnobotanically important plants
8. Awarding '8 marks' for the record of practical work shall be considered only if all the practical works specified in the syllabus are done completely and recorded properly with signature on all sheets.

## Model Question Paper

SACRED HEAR COLLEGE (AUTONOMOUS), THEVARA

Semester III

M.Sc. Botany Practical Course – 20P3BOTP06

PLANT PHYSIOLOGY & METABOLISM, PLANT REPRODUCTIVE BIOLOGY,  
PALYNOLOGY & PLANT BREEDING

Time 3 hours

Total Marks 40

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1. Conduct the experiment A  
(Total weight 14 = Principle, procedure and graph, if any – 1.5, Working – 1, Result – 0.5, Comments/Interpretation - 1)
2. Work out the given problem B & C (Marks 4 each,  $4 \times 2 = 8$ )
3. Embryo excision from young seed (D). (Marks 4, Preparation- 2, labelled diagram- 2, Total = 4)
4. Write critical notes on E & F.  
(Weight =  $3 \times 2 = 6$ )
5. Practical record  
(Weight = 8)

### Key to the questions:

1. A – Draw lots from the list of physiology experiments provided. A minimum of 6 experiments from the list should be included in the lots.
2. B & C work out given problem given from the syllabus
3. G - Seeds with young embryos – maximum credit for youngest stages
4. E - Permanent slide/Photograph of embryo types, polyembryony, endosperm types, pollen grains, anther developmental stages, types etc.
4. F- any palynology specimen mentioned in the syllabus
5. Awarding **8** marks for the record of practical work shall be considered only if all the practical works specified in the syllabus are done completely and recorded properly with signature of the teacher in charge.

### List of Plant Physiology experiments (Question 1-A)

1. Separate pigments of the given leaf sample by column chromatography. Collect the pigment fragments and submit. Comment on the result.
2. Determine the osmotic potential of the given plant tissue from the values corresponding to change in weight of the tissue. Comment on the result.
3. Estimate the proline content in the control (e.g., seeds germinated in fresh water) as well as the treated (e.g., seeds germinated in 50mM NaCl) sample. Prepare a standard graph from the given values. Comment on the result.
4. Estimate the phenol content in plant tissues affected by biotic stress and compare the same with non affected portions. Prepare a standard graph from the given values. Comment on the result.
5. Determine peroxidase activity in plant tissues affected by biotic/abiotic stresses. Prepare a standard graph from the given values. Comment on the result.
6. Estimate free amino acids in senescing leaves and compare the same with young leaves. Prepare a standard graph from the given values. Comment on the result.
7. Estimate the total chlorophyll in shade leaves and sun leaves and comment on the result
8. Estimate the leghaemoglobin in the root nodules.

# SEMESTER IV

## PROGRAMME ELECTIVE- I: BIOTECHNOLOGY

Course	Title	Teaching Hrs Theory	Teaching Hrs Practical	Credits
<b>20PE1BOTT13</b>	Genetic Engineering	54	36	3
<b>20PE1BOTT14</b>	Genomics, Proteomics & Bioinformatics	36+36	45	4
<b>20PE1BOTT15</b>	Tissue Culture & Microbial Biotechnology	36+ 18	18 + 18	3
<b>20PE1BOTT16</b>	Biostatistics, Microtechniques & Biophysics	36+ 18 + 18	18 + 27 + 18	4
<b>20PE1BOTP07</b>	Practicals of <b>20PE1BOTT13+ 20PE1BOTT14</b>			2
<b>20PE1BOTP08</b>	Practicals of <b>20PE1BOTT15+ 20PE1BOTT16</b>			2
<b>20P4BOTPJ</b>	Project			3
<b>20P4BOTCV</b>	Viva			2
<b>FIELD STUDY</b>	Students are expected to conduct field visit (one in each semester) to familiarize with the diversity of life forms dealt in the semester syllabus. Report of the field visit should be prepared and recorded as part of the practical record.			

**20P4BOTT13: GENETIC ENGINEERING**  
**(Theory 54 hrs; Practicals 36 hrs; Credits 3)**

<b>COURSE OUTCOMES (COs)</b>	
<b>CO 1</b>	
<b>CO 2</b>	
<b>CO 3</b>	
<b>CO 4</b>	
<b>CO 5</b>	

**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 (10 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) (6 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 (8 hrs)**

- (a) *Agrobacterium tumefaciens* mediated gene transfer in plants – structure of Ti plasmid, 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 (10 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 (12 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: Gene library (8 hrs)**

- (a) Genomic library and cDNA library - preparation and its significance.
- (b) Procedure for the construction of a genomic library using phage  $\lambda$  system.
- (c) Identification of desirable clones from library – hybridization probing, colony and plaque hybridization probing, immunological screening.
- (d) Locating and isolating a gene - *in situ* hybridization, positional cloning, chromosome walking and jumping.

### **Module 7: 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 (36 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.

### **References**

1. James D Watson, Amy A Caudy, Richard M Myers, Jan A Witkowski (2007). *Recombinant DNA* (III Edn). W H Freeman.
2. S B Primrose, R M Twyman (2006). *Principles of gene manipulation and genomics* (VII Edn). Blackwell publishing.
3. Robert J Brooker (2009). *Genetics: Analysis & principles* (III Edn). McGraw Hill.
4. T A Brown (2002). *Genomes* (II Edn). Bios.
5. Leland H Hartwell, Leroy Hood, Michael L Goldberg, Ann E Reynolds, Lee M Silver, Ruth C Veres (2004).
6. *Genetics: From genes to genomes* (II Edn). McGraw Hill.
7. Abul K Abbas, Andrew H Lichtmay, Shiv Pillai (2007). *Cellular and molecular immunology* (IV Edn). Elsevier..
8. Smita Rastogi, Neelam Pathak (2010). *Genetic engineering*. Oxford.
9. Bernard R Glick, Jack J Pasternak, Cheryl L Pattein (2010). *Molecular biotechnology: Principles and applications of recombinant DNA*. ASM press.
10. S B Primrose, R M Twyman, R W Old (2001). *Principles of gene manipulation* (VI Edn). Blackwell Science.
11. 10. Jeremy W Dale, Malcolm von Schantz (2002). *From genes to genomes*. John Wiley & Sons Ltd.

12. Daniel L Hartl, Elizabeth W Jones (2009). *Genetics: analysis of genes and genomes* (VII Edn). Jones and Bartlett publishers.
13. P Nagarajan, N Senthilkumar (2002). *Molecular biology: Principles and methods*. Sree Narmatha printers, Coimbatore.
14. Joseph Sambrook, David W Russell (2001). *Molecular cloning: A laboratory manual*. Cold spring harbour laboratory press.
15. David P Clark (2010). *Molecular biology*. Elsevier.
16. Jeremy M Berg, John L Tymoczko, Lubert Stryer, Gregory J Gatto Jr. (2007) *Biochemistry*. W H Freeman and company.
17. Desmond S T Nicholl (2010). *An introduction to genetic engineering* (III Edn). Cambridge.
18. D Peter Snustad, Michael J Simmons (2010). *Principles of genetics* (V Edn). John Wiley and Sons.
19. David A Micklos, Greg A Freyer with David A Crotty (2003). *DNA Science: A first course* (II Edn). L K Inter.
20. Benjamin A Pierce (2008). *Genetics: A conceptual approach* (IV Edn). W H Freeman and Company
21. Anthony J F Griffiths, Susan R Wesler, Sean B Carroll, John Doebley (2008). *Introduction to genetic analysis* (X Edn). W H Freeman and Company.
22. Benjamin Lewin (2006) *Genes IX*. Jones and Bartlett.
23. William J Thieman, Michael A Palladino (2009). *Introduction to biotechnology* (II Edn). Pearson.
24. Carl Branden, John Tooze (1999). *Introduction to protein structure* (II Edn). Garland Publishing.
25. T A Brown (1995). *Gene cloning: An introduction* (III Edn). Stanley Thomas (Publishers) Ltd.
26. S B Primrose (1999). *Molecular biotechnology* (II Edn). Panima Publishing Corporation.
27. Alan Fersht (1999). *Structure and Mechanism in Protein Science*. W H Freeman and Company.



**20P4BOTT14: GENOMICS, PROTEOMICS & BIOINFORMATICS**  
**(Theory 72 hrs; Practicals 45 hrs; Credits 4)**

<b>COURSE OUTCOMES (COs)</b>	
<b>CO 1</b>	
<b>CO 2</b>	
<b>CO 3</b>	
<b>CO 4</b>	
<b>CO 5</b>	

## **GENOMICS & PROTEOMICS (36 hrs)**

### **Introduction to the Course**

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

### **Module 1: Structural genomics (20 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. Construction of linkage maps using molecular markers – RFLP, RAPD, AFLP, SSLP, SNP. Physical mapping – restriction mapping, STS mapping, EST.
- c) Next generation sequencing strategies: Preparation of sequencing library. Pyrosequencing, Reversible terminator sequencing, ion torrent method, SOLiD. PacBio long range sequencing, nanopore sequencing.
- d) Sequence assembly – methods used. (Reference and de novo)
- e) Important findings of the completed genome projects: Human genome project, Rice genome project, Arabidopsis genome project, E. coli genome project, Wheat genome project, Tomato genome project. Banana Genome project

### **Module 2: Functional genomics (7 hrs)**

- a) Transcriptome/RNA seq, Exome sequencing, expression profiling (mRNA profiling), Real time quantitative PCR.
- b) Gene expression analysis using dot blotting and microarrays.
- c) Chromatin immunoprecipitation (ChIP) sequencing and its applications.
- d) Determinations of gene functions - knock out and knock down mutant

### **Module 3: Comparative genomics (5 hrs)**

- a) Orthologs and Paralogs
- b) Gene identification by comparative genomics
- c) Comparative genomics as a tool in evolutionary studies.
- d) Metagenomics.

### **Module 4: Proteomics (4 hrs)**

- a) Proteome, proteomics.
- b) Protein profiling – steps in protein profiling. Protein sequencing. Protein expression analysis using Protein microarray, protein localization using GFP.

## References

1. S B Primrose, R M Twyman (2006). *Principles of gene manipulation and genomics* (VII Edn). Blackwell publishing.
2. Robert J Brooker (2009). *Genetics: analysis & principles* (III Edn). McGraw Hill.
3. James D Watson, Amy A Caudy, Richard M Myers, Jan A Witkowski (2007). *Recombinant DNA* (III Edn). W H Freeman.
4. T A Brown (2002). *Genomes* (II Edn). Bios.
5. Leland H Hartwell, Leroy Hood, Michael L Goldberg, Ann E Reynolds, Lee M Silver, Ruth C Veres (2004). *Genetics: From genes to genomes* (II Edn). McGraw Hill.
6. *Science*, 16 february 2001, Vol. 291.
7. Jeremy M Berg, John L Tymoczko, Lubert Stryer, Gregory J Gatto Jr. (2007). *Biochemistry*. W H Freeman and company.
8. David P Clark (2010). *Molecular biology*. Elsevier.
9. D Peter Snustad, Michael J Simmons (2010). *Principles of genetics* (V Edn). John Wiley and Sons.
10. David A Micklos, Greg A Freyer with David A Crotty (2003). *DNA Science: A first course* (II Edn). L K Inter.
11. Benjamin A Pierce (2008). *Genetics: A conceptual approach* (IV Edn). W H Freeman and Company.
12. Anthony J F Griffiths, Susan R Wesler, Sean B Carroll, John Doebley (2008). *Introduction to genetic analysis* (X Edn). W H Freeman and Company.
13. Benjamin A Pierce (2008). *Genetics: A conceptual approach* (IV Edn). W H Freeman and Company.
14. C W Sensen (2002). *Genomics and Bioinformatics*. Wiley – VCH.
15. T A Brown (2002). *Genomes* (II Edn). Bios.
16. William J Thieman, Michael A Palladino (2009). *Introduction to biotechnology* (II Edn). Pearson
17. George Acquaaah (2005). *Understanding biotechnology*. Pearson.
18. Robert H Tamarin (2002). *Principles of genetics*. McGraw Hill.
19. Robert K Murray, David A Bender, Kathleen M Botham, Peter J Kennelly, Victor W Rodwell, P Anthony Weil (2009). *Harper's Illustrated Biochemistry* (XXVIII Edn). Mc Graw Hill.
20. *Nature*, 409 (6822): 860-921, 2001.
21. S R Pennington, M J Dunn (Edts) (2002). *Proteomics: From protein sequence to function*. Viva Books Private Limited.
22. Bernard R Glick, Jack J Pasternak, Cheryl L Pattein (2010). *Molecular biotechnology, principles and applications of recombinant DNA*. ASM press.
23. Burton E Tropp (2012). *Molecular biology: Genes to Proteins* (IV Edn). Jones and Bartlett Learning.
24. 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

- 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 - SWISS-PROT, 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. Database similarity search – query sequence search; BLAST - different versions; FASTA - different versions.
- d) 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. 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.
- b) Construction of phylogenetic trees – MEGA, Phylip

**Module: 4 (6 hrs)**

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

**Practicals (45 hrs)**

1. Protein visualization using Rasmol, Pymol and Swiss PDB viewer
2. Multiple sequence alignment using CLUSTAL X.
3. Phylogenetic analysis by Phylip, MEGA. Beast and Beauti.
4. Gene prediction programs – Grail/Exp, GENSCAN, ORF finder.
5. Locate specific sequences like TATA box, promoters, start signals, stop signals etc. in a DNA sequence using computer programmes. Eg. *E.coli* promoter, human promoter.
6. 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**

1. David W Mount (2001). *Bioinformatics: Sequence and genome analysis*. CBS publishers & distributors.
2. Jin Xiong (2006). *Essential Bioinformatics*. Cambridge University Press
3. Orpita Bosu, Simminder Kaur Thukral (2007). *Bioinformatics: Databases tools and algorithms*. Oxford University press.
4. Teresa K Attwood, David J Parry-Smith, Simiron Phukan (2007). *Introduction to Bioinformatics*. Pearson Education.
5. Zhumur Ghosh, Bibekanand Mallik (2008). *Bioinformatics: principles and applications*. Oxford University press.

**20PE1BOTT15: TISSUE CULTURE AND MICROBIAL BIOTECHNOLOGY**  
(Theory 54 hrs; Practical 36 hrs; Credits 3)

<b>COURSE OUTCOMES (COs)</b>	
<b>CO 1</b>	
<b>CO 2</b>	
<b>CO 3</b>	
<b>CO 4</b>	
<b>CO 5</b>	

**Module 1: Introduction (2 hrs)**

- (a) Culture protocol: General composition of the culture. Solid and liquid media – gelling agents. Preparation and standardization of MS medium for shoot and root differentiation. Sterilization of medium, glasswares, instruments, plant material, transfer area. Preparation of explants and inoculation, incubation.
- (b) Micropropagation: Techniques and stages of micropropagation. Advantages and disadvantages of micropropagation. Applications of tissue culture.

**Module 2: Plant tissue culture (4 hrs)**

- (a) Brief history and important milestones in plant tissue culture.
- (b) Cellular totipotency.
- (c) Types of cultures: organized structures - meristem, shoot tip, node, embryo, root cultures; unorganized structures - callus, suspension and protoplast cultures.

**Module 3: Tissue culture regeneration of plants (8 hrs)**

- (a) Adventitious regeneration: Direct regeneration, indirect regeneration. Factors influencing adventitious regeneration; genotype, explant – orientation of explant, position on mother plant.
- (b) Somatic embryogenesis: General aspects, initiation of embryogenic cultures, maturation of somatic embryos, regeneration of plants, factors regulating somatic embryogenesis, differences between somatic and zygotic embryos. Encapsulation of somatic embryos, synthetic seed production; desiccated and hydrated types. Applications and limitations of synthetic seeds.

**Module 4: Cytodifferentiation and morphogenesis (2 hrs)**

- (a) Differentiation of cells in callus - tracheid formation, factors influencing vascular differentiation.
- (b) Organogenic differentiation: factors influencing shoot bud differentiation, induction of organogenic differentiation.

**Module 5: Somaclonal variation (4 hrs)**

- (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 6: Production of ploidy variants (6 hrs)**

- (a) Haploids: 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.
- (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 7: Protoplast culture (3 hrs)**

- (a) Isolation and purification of protoplasts, culture of protoplasts, cell division and callus formation, plant regeneration.
- (b) Protoplast fusion (somatic hybridization) – chemical, mechanical, electrofusion. Selection, isolation of heterokaryons, cybrids and their applications. Applications of protoplast culture.

#### **Module 8: Production of secondary metabolites (4 hrs)**

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

#### **Module 9: Germplasm conservation (4 hrs)**

- a) Importance, methods of conservation: *In situ* and *ex situ* conservation.
- b) *In vitro* conservation, short and medium term storage, cryopreservation technique– importance of cryopreservation, pretreatment, freezing methods, cryoprotectants, vitrification.

#### **Module 10: Cell and enzyme technology (3 hrs)**

- a) Cell immobilization: Methods, advantages and applications.
- b) Enzyme immobilization: Preparation, applications
- c) Enzyme engineering.

#### **Module 11: Tissue engineering and Stem cell technology (4 hrs)**

- a) Regenerative medicine, methods and applications of tissue engineering.
- b) Stem cells – embryonic stem cell and adult stem cells – potential applications.

#### **Practical (36 hrs)**

1. Preparation of the stock solutions of MS medium.
2. Preparation of selective medium for drought or salinity resistance. Preparation of MS solid 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 embryo from any seed and culture it on a suitable solid medium.
6. Isolation of microbes producing amylase.

#### **References**

1. Hamish A Collin, Sue Edwards (1998). *Plant tissue culture*. Bios scientific publishers.
2. R A Dixon, R A Gonzales (2004). *Plant cell culture, a practical approach* (II Edn). Oxford University Press.
3. S S Bhojwani, M K Razdan (1996). *Plant tissue culture: Theory and Practice*. Elsevier.
4. Susan R. Barnum (1998). *Biotechnology an introduction*. Thomson Brooks/cole.
5. Nicholas C Price, Lewis Stevens (1999). *Fundamentals of enzymology* (III Edn). Oxford university press.
6. Trevor Palmer (2004). *Enzymes: Biochemistry, Biotechnology, Clinical chemistry*. T Palmer/Harwood Publishing Limited.

7. E M T El-Mansi, C F A Bryce, A L Demain, A R Allman (2007). *Fermentation Microbiology and Biotechnology* (II Edn). Taylor & Francis.
8. L Gomborg, G C Philips (Eds.) (2005). *Plant cell, tissue and organ culture: Fundamental methods*. Narosa Publishing House.
9. *In vitro cultivation of plant cells*. Biotechnology by open learning. Elsevier.
10. John L Ingraham, Catherine A Ingraham (2000). *Introduction to microbiology* (II Edn). Brooks/Cole
11. Kathleen Park Talaro, Arthur Talaro (2002). *Foundations in microbiology*. McGraw Hill.
12. Colin Ratledge, Bjorn Kristianson (2001). *Basic biotechnology*. Cambridge University press.
13. William J Thieman, Michael A Palladino (2009). *Introduction to biotechnology* (II Edn). Pearson.
14. D E Evans, J O D Coleman, A Kearns (2003). *Plant Cell Culture*. BIOS Scientific Publishers.
15. Bernard R Glick, Jack J Pasternak, Cheryl L Pattein (2010). *Molecular biotechnology, principles and applications of recombinant DNA*. ASM press.
16. Alexander N Glazer, Hiroshi Nikaido (2007). *Microbial Biotechnology: Fundamentals of applied microbiology*. Cambridge University Press.
17. Anne Kathrine Hvoslef-Fide, Walter Preil (Eds) (2005). *Liquid Culture Systems for in vitro Plant Propagation*. Springer.
18. Edwin F. George, Michael A. Hall, Geert-Jan De Klerk (2008). *Plant Propagation by Tissue Culture (Vol I): The Background*. Springer.
19. Michael R. Davey, Paul Anthony (2010). *Plant Cell Culture: Essential Methods*. Wiley-Blackwell A John Wiley & Sons, Ltd.
20. Trevor A. Thorpe and Edward C. Yeung (Eds) (2011). *Plant Embryo Culture: Methods and Protocols*. Springer, Heidelberg.
21. Barbara M. Reed (2008). *Plant Cryopreservation: A Practical Guide*. Springer, Heidelberg.
22. Erica E. Benson (1999). *Plant Conservation Biotechnology*. Taylor and Francis.
23. Pritchard H W (2004). *Modern methods in orchid conservation: The role of Physiology, Ecology and Management*. Cambridge University Press.
24. Wen-Huei Chen, Hong-Hwa Che (2007). *Orchid Biotechnology*. World Scientific Publishing Co. Pvt. Ltd.
25. Joseph Arditti (2008). *Micropropagation of Orchids* (Vol. I). Blackwell publishing.
26. Alisher Touraev, Brian P. Forster, S. Mohan Jain (Eds) (2009). *Advances in Haploid Production in Higher Plants*. Springer, Heidelberg.
27. S Mohan Jain, H. Häggman (Eds) (2007). *Protocols for Micropropagation of Woody Trees and Fruits*. Springer, Heidelberg.
28. L E Casida.(2005) *Industrial Microbiology*. New Age international limited.
29. Peter F Stanbury, Allan Whitaker (1999). *Principles of Fermentation technology*. Butterworth-Heinemann.
30. S. C. Prescott, Cecil Gordon Dunn (2004). *Industrial Microbiology*. CBS publishers and distributors.
31. A H Patel (2000). *Industrial Microbiology*. Macmillan Publishers.
32. Ashok Pandey (2001). *Solid state fermentation in biotechnology*. Asiatech publishers.
33. Pauline M. Doran (1995). *Bioprocess Engineering Principles*. Academic Press Ltd.
34. M L Srivasthava (2007). *Fermentation technology*. Alpha Science Intl Ltd.
35. Gary Walsh (2002). *Proteins: Biochemistry and Biotechnology*. John Wiley and Sons.
36. Ronald M Atlas, Jim Philip (2005). *Applied Microbial solutions for real-world environment clean up*. Amer Society for Microbiology.
37. Dennis Thomas, Rakhi chaturvedi (2008). *Endosperm culture: A novel method for triploid plant production*. Plant cell and organ culture, Springer science.
38. S. Ignacimuthu (2006). *Biotechnology: An introduction*. Narosa Publishing House.

**20PE1BOTT16: BIostatISTICS, MICROT ECHNIQUES & BIOPHYSICS**  
(Theory 36+ 18 + 18 hrs; Practical 18 + 27 + 18 hrs; Credits 4)

<b>COURSE OUTCOMES (COs)</b>	
<b>CO 1</b>	
<b>CO 2</b>	
<b>CO 3</b>	
<b>CO 4</b>	
<b>CO 5</b>	

**Course Objectives**

- To enable students to learn the tools and techniques available for studying biochemical and biophysical nature of life.
- To help students obtain skills in handling new instruments in modern researches.
- To acquire theoretical knowledge as well as practical knowledge in preparing plants for microscopic examination, general routines for the preparation of tissue; general histochemistry.

**BIostatISTICS (Theory 36 hrs; Practical 18 hrs)**

**Module 1. Introduction (6 hrs)**

- (a) Basic principles of Biostatistics: Methods of collection and classification of data; Primary and secondary data, qualitative and quantitative data. Frequency distribution, normal distribution and poisson distribution of data. Graphical representation of data.
- (b) Measures of central tendency; Mean, Median and Mode
- (c) Measures of dispersion: Mean deviation, Standard deviation, variance, standard error, co-efficient of variation.
- (d) Data entry and preliminary analysis using MS Excel.

**Module 2: Probability, Correlation and Regression (6 hrs)**

- a) Linear regression and correlation (simple and multiple).
- b) Probability - Definition, mutually exclusive events – sum rule, independent events – product rule. Introduction to Bayesian statistics
- c) Binomial, Normal and Poisson distribution.
- d) Application of probability statistics

**Module 3: Design of experiments (8 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 4: Tests of significance (10 hrs)**

Statistical inference – estimation - testing of hypothesis - t-test, Chi square test (goodness of fit, independence or association, detection of linkages), F-test, ANOVA.

**Module - 5. (6 hrs)**

Study of statistical analyses using a standard scientific paper.

### **Practical (18 hrs)**

1. Analysis of data to find the mean, median and mode using MS Excel.
2. Analysis of a given data for mean deviation and standard deviation.
3. Test the significance of a given data using t test, X<sup>2</sup> test, F-test and ANOVA.
4. Analysis of a set of data for correlation/regression.
5. Determine probability for different types of events.
6. Familiarization and data analysis using PAST/XLStat/SPSS or any other apt software.

### **References**

1. Chandel R S (1975). *A handbook of Agricultural statistics*. Achal Prakashan Mandir.
2. Gomez K A, Gomez A A (1984). *Statistical procedures for agricultural research*. John Wiley and Sons.
3. Gupta S P (1984). *Statistical methods*. S Chand and company.
4. Panse V G, Sukathme P V (1995). *Statistical methods for Agricultural workers*. ICAR.
5. Robert J Brooker (2009). *Genetics: analysis & principles* (III Edn). McGraw Hill.
6. Gerald van Belle, Lloyd D. Fisher, Patrick J Heagerty and Thomas Lumley (2004). *Biostatistics* (Second Edition); A Methodology for the Health Sciences.
7. Jerrold H. Zar (2010). *Biostatistical Analysis*. Pearson.
8. Thomas Glover and Kevin Mitchell (2015). *An Introduction to Biostatistics*. Waveland Pvt. Inc. 2 edition.
9. Chap T. Le and Lynn E. Eberly (2016). *Introductory Biostatistics*. WILEY.
10. Robert R. Sokal and F. James Rohlf (2009). *Introduction to Biostatistics*. Dover Publications Inc.; 2nd edition.
11. Alex Reinhart (2015). *Statistics Done Wrong*. No Starch Press.

## **MICROTECHNIQUE (Theory 18 hrs; Practical 27 hrs)**

### **Module 1: Killing and fixing (2 hrs)**

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

### **Module 2: Dehydration, clearing, embedding and sectioning (5 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-xylol method.
- (b) Embedding: Paraffin embedding.
- (c) Sectioning: Free hand sections – Prospects and problems; Sectioning in rotary microtome – sledge microtome and cryotome.

### **Module 3: Staining (3 hrs)**

- (a) Principles of staining; classification of stains, protocol for preparation of; (i) Natural stains -
- (b) Haematoxylin and Carmine (ii) Coal tar dyes – Fast green, Orange G, Safranine, Crystal violet, Cotton Blue and Oil Red O.
- (c) Techniques of staining: (i) Single staining; Staining with Safranine or crystal violet (ii) Double staining; Safranine-Fast green method, Safranine-Crystal violet method (iii) Triple staining; Safranine-Crystal violet-Orange G method.



(d) Histochemical localization of starch, protein, lipid and lignin.

#### **Module 4: Specimen preparation for transmission electron microscopy (3 hrs)**

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

#### **Module 5: Whole mounts (5 hrs)**

- (a) Principles and techniques of whole mounting, TBA/Hygrobutol method, Glycerine-xylol method.
- (b) Staining of whole mount materials (haematoxylin, fast green or Safranin-fast green combination).
- (c) Significance of whole mounts.
- (d) Techniques of smear, squash and maceration.
- (e) Mounting: Techniques, common mounting media used - DPX, Canada balsam, Glycerine jelly and
- (f) Lactophenol. Cleaning, labeling and storage of slides.

#### **Practical (27 hrs)**

1. Students are expected to be thorough with the following techniques.
  - (a) Preparation of semi permanent slides.
  - (b) Preparation of permanent slides.
  - (c) Preparation of whole mounts.
  - (d) Maceration.
  - (e) Preparation of fixatives (FAA, Carnoy's fluid, Houghton's adhesive).
  - (f) Preparation of dehydration series (Alcohol, Acetone, TBA).
  - (g) Preparation of paraffin blocks.
  - (h) Preparation of serial sections.
2. Candidates should prepare and submit 10 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**

1. Geoffrey A Meek (1976). *Practical electron microscopy*. John Wiley and sons.
2. Gray (1964). *Handbook of Basic Microtechnique*. McGraw Hill co.
3. Johanson D A (1940). *Plant microtechnique*. McGraw Hill co.
4. John E Sass (1967). *Botanical Microtechnique*. Oxford IBH Publ. Company.
5. Krishnamurthy K V (1987). *Methods in Plant Histochemistry*. S Viswanathan printers, Anand book depot, Madras.
6. Prasad M K, M Krishna Prasad (1983). *Outlines of Microtechnique*. Emkay Publications.
7. Toji Thomas (2005). *Essentials of botanical microtechnique* (II Edn). Apex infotech publishing company.

### **BIOPHYSICS (Theory 18 hrs; Practical 18 hrs)**

#### **Module 1: Microscopy (8 hrs)**

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

#### **Module 2: Principles and applications of instruments (10 hrs)**

- (a) Basic principles and applications of; (i) pH meter (ii) UV-visible spectrophotometers.
- (b) Centrifuges: Basic Principle, Table top centrifuge and ultra centrifuge. Centrifugation techniques-. Zonal Centrifugation, Equilibrium density gradient centrifugation. EtBr-CsCl density gradient.
- (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) Haemocytometer.
- (h) Mass Spectrometry.

### **Practical (18 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**

1. Ackerman E A, Ellis L E E, Williams L E (1979). *Biophysical Science*. Prentice-Hall Inc.
2. Chang R (1971). *Basic principles of spectroscopy*. McGraw Hill.
3. Pesce A J, Rosen C G, Pasty T L. *Fluorescence Spectroscopy: An introduction for Biology and Medicine*. Marcel Dakar.
4. Stanford J R (1975). *Foundation of Biophysics*. Academic press.
5. Henry B Bull (1971). *An Introduction to physical biochemistry*. F A Devis Co.
6. Perkampus H (1992). *UV-VIS Spectroscopy and its applications*. Springer-Verlag.
7. Garry D Christian, James E O'reilvy (1986). *Instrumentation analysis*. Alien and Bacon, Inc.
8. Friefelder D. *Physical Biochemistry*. W H Freeman and Co.
9. Mahadevan A, Sridhar R (1996). *Methods in Physiological Plant Pathology*. Sivakmi Publications.

## Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

M.Sc.Botany DEGREE EXAMINATION

SEMESTER IV

20PE1BOTT13: GENETIC ENGINEERING

Time : 3 Hours

Max. Marks: 75

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I. Answer **any eight** questions briefly; each question carries 2 marks

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 DNA profiling?
11. What are the applications of GFP?
12. Write a short note on Golden rice.

(8 x 2 = 16 marks)

II. Answer **any Seven** questions; each question carries 5 marks

13. Describe the important applications of Biosensors.
14. A patient is suffering from ADA deficiency. Can he be cured? How?
15. Describe the steps involved in the creation of a genomic library.
16. Describe the basic principles and the steps involved in artificial DNA synthesis.
17. Explain vectorless methods of gene transfer.
18. What are the steps involved in the isolation of plant genomic DNA.
19. Discuss the applications of protein engineering.
20. Write a short note on site-directed mutagenesis.
21. Explain the methods of screening and selection of recombinant cells.
22. Briefly explain the Phosphoramidite method of DNA synthesis.

(5 x 7 = 35 marks)

III. Answer **any Two** questions; each question carries 12 marks

23. Illustrate and explain the *Agrobacterium tumefaciens* mediated gene transfer in plants.

OR

24. Explain the applications of rDNA technology.
25. Explain the procedure and applications blotting techniques

OR

26. Discuss the ethical, legal, and social impact of modern biotechnology

(12x2 = 24marks)

**Model Question Paper**

**SACRED HEART COLLEGE (AUTONOMOUS), THEVARA**

**M.Sc.Botany DEGREE EXAMINATION**

**SEMESTER IV**

**20PE1BOTT14: GENOMICS, PROTEOMICS & BIOINFORMATICS**

Time : 3 Hours

Max. Marks: 75

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I. Answer **any eight** questions briefly; each question carries 2 marks

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?
11. What is the principle of 2D gel electrophoresis?
12. Write a short note on Metagenomics.

(8 x 2 = 16 marks)

II. Answer **any Seven** questions; each question carries 5 marks

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 Pyrosequencing..
17. Explain RNA secondary structure prediction.
18. Explain tools used for multiple sequence alignment.
19. Differentiate between genetic mapping and physical mapping.
20. Write a short note the procedure and applications of chromatin immunoprecipitation.
21. Explain Shot gun sequencing.
22. Explain SNP.

(5 x 7 = 35 marks)

III. Answer **any Two** questions; each question carries 12 marks

23. Explain the role of antisense RNA and RNAi techniques in genomic studies.

OR

24. Describe the protein identification using mass spectrometry.
25. Describe the procedure and applications of computer assisted drug design.

OR

26. Explain the application of bioinformatics in phylogenetic studies?

(12x2 = 24marks)

**Model Question Paper**

**SACRED HEART COLLEGE (AUTONOMOUS), THEVARA**

**M.Sc.Botany DEGREE EXAMINATION**

**SEMESTER IV**

**20PE1BOTT15: TISSUE CULTURE AND MICROBIAL BIOTECHNOLOGY**

Time : 3 Hours

Max. Marks: 75

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I. Answer **any eight** questions briefly; each question carries 2 marks

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

(8 x 2 = 16 marks)

II. Answer **any Seven** questions; each question carries 5 marks

13. Briefly explain downstream processing
14. Explain the large scale production of penicillin.
15. Differentiate between submerged and solid state fermentation.
16. Explain different types of Bioreactors..
17. Write a note on hairy root culture. Mention its applications.
18. Explain the methods, advantages and applications of cell immobilization:.
19. Discuss the methods and applications of regenerative medicine.
20. Discuss the reasons of somaclonal variation.
21. Explain the factors influencing vascular differentiation.
22. Explain suspension culture.

(5 x 7 = 35 marks)

III. Answer **any Two** questions; each question carries 12 marks

23. Write an essay on methods, advantages and applications of cell immobilization

OR

24. Explain the methods and applications of *In vitro* conservation of germplasm
25. Describe the isolation, purification and culture of protoplasts.

OR

26. Explain the methods of production of haploid plants and explain its applications.

(12x2 = 24marks)

**Model Question Paper**  
**SACRED HEART COLLEGE (AUTONOMOUS), THEVARA**  
**M.Sc.Botany DEGREE EXAMINATION**  
**SEMESTER IV**  
**20PE1BOTT16: BIOSTATISTICS, BIOPHYSICS & MICROTECHNIQUE**

**Time 3 hours**

**Max. Marks 75**

I. Answer any *eight* of the following in not less than 50 words; each question carries 2 marks.

1. What is student t- test?
2. What is the application of ANOVA?
3. What is standard error?
4. Describe the principles and techniques of fixing. Write the composition and use of FAA
5. Write the preparation and uses of haematoxylin and Safranin
6. Describe the following;  
(a) Coal tar dyes (b) Double staining.
6. 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?
7. Write the principle and use of Phase contrast microscope?
8. What is ELISA? What is its application?
9. How do you differentiate squash from maceration?
10. What is pH?
11. What is meant by resolving power?
12. What is DPX? (8x2 = 16 marks)

II. Answer any *seven* of the following in not less than 100 words; each question carries 5 marks.

13. What are the different stages of dehydration?
14. Briefly explain the working of rotary microtome. What is its application?
15. How can you prepare permanent whole mounts?
16. Explain histochemical staining and its significance. Describe the staining procedures for starch and protein
17. Give an account on various natural dyes.
18. How chi-square test is used for the detection of linkages?
19. Describe the principle of electron microscopy
20. Write a short essay on electrophoresis
21. Describe the basic principles and applications of ELISA
22. Describe the principles and applications of different chromatographic techniques. (7x5= 35marks)

III. Answer any *two* of the following in not less than 250 words; each question carries 12 marks.

23. Describe various steps in making permanent serial sections

**OR**

24. Write an essay on the principle and applications of Electron microscopy.

25. Explain with suitable illustrations various methods of data representation.

**OR**

26. Describe the experimental designs used for different types of studies

(12x2 = 24marks)

## Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

Semester IV

Practical Course: 20PE1BOTP07

BIOTECHNOLOGY, GENETIC ENGINEERING,  
GENOMICS, PROTEOMICS & BIOINFORMATICS

Time 3 Hours

Max. Marks 40

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1. Find out the phylogenetic relationship of Homo sapien's NG\_030288 protein sequence with other 5 organisms. Show the distance between each organism and phylogenetic tree and identify the query.  
(Working - 3, Comment - 2) (5)
2. Using hierarchial clustering performs multiple sequence alignment of NG\_030166 nucleotidesequence with 5 related sequences and show the similarity (Identify the query).  
(Working- 2 Result- 2) (4)
3. Isolation of plant genomic DNA  
(Procedure-1 Working- 3 Result- 1) (4)
4. Separate Nucleic acid by agarose gel electrophoresis  
(Procedure-1 Working- 3 Band vision – 1) (5)
5. Critical note on A, B, C and D.  
(Identification -1 Critical note- 2) (4x3=12)
6. Practical record. (8)
7. Laboratory visit. (2)

### Key to the questions:

1. PHYLIP
2. Clustal X
3. Supply necessary tissue samples
4. Supply pure samples of DNA/RNA, and necessary buffer
5. A, B - Vectors, procedures or equipments (photographs) used in genetic engineering.  
C and D- Home pages data bases GenBannk, EMBL, PDB etc and diagrams/ photographs related to genomics and proteomics.
6. 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.
7. Biotechnology lab visit report

## Model Question Paper

SACRED HEART COLLEGE(AUTONOMOUS), THEVARA

Semester IV Practical Course 20PE1BOTP08

TISSUE CULTURE, MICROBIAL BIOTECHNOLOGY, BIOSTATISTICS, BIOPHYSICS &  
MICROTECHNIQUE

Time 3 Hours

Max. Marks 40

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1. Selective isolation of amylase producing microbes from environment  
(Experiment - 1, Comment/Interpretation - 2) (3)
  2. Isolate embryo from the given seed in aseptic conditions and inoculate in the medium  
(Isolation of embryo – 1, inoculation - 1) (2)
  3. Prepare synthetic seeds by inserting somatic embryo/zygotic embryo/axillary bud/apical meristem in Sodium alginate (2)
  4. Select the anther in appropriate stage for anther culture (2)
  5. Comment on A, B, C & D. (1 x 4 = 4)
  6. (a) Determine the size of the given filament/pollen/spore **E** using micrometer.  
(Calibration - 1, Measurement, calculation and result -3) (4)  
**or**
  6. (b) Find out the number of spores/ml in the given spore suspension **E**.  
(Counting - 1, Calculation - 2, Result - 1) (4)  
**or**
  6. (c) Find the concentration of the given sample solution **E** using colorimeter.  
Prepare a standard graph from the given values. (4)  
(Principle, procedure and graph - 3, Working and Result - 1)
  - III. Workout the problem **F**. (7)  
The probability that the person 'A' will be living up to 60 years is  $\frac{3}{4}$  and the probability of another person 'B' will be living up to 60 years is  $\frac{2}{3}$ . Find the probability of  
(1) Both 'A' and 'B' will live up to 60 years?  
(2) Both die before reaching 60 years?
  - IV. Prepare a double stained micropreparation of material **G** and mount it as a permanent slide.  
(Sectioning and staining - 4, Mounting - 1) (5)
  - V. Prepare serial sections of **H** and mount on a glass slide. (5)  
(Microtome sectioning - 3, Mounting - 2)
  - VII. Permanent slides. (8)
  - VIII. Practical record. (4 + 4)

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### Instructions to the Examiners:

1. Preparation of plates and isolation of microbe has to be done 2-3 days before exam.
2. Give appropriate seeds
3. Give necessary reagents and materials
4. Give appropriate anthers
5. A, B, C, D, - Chemicals, Instruments, Photographs/Diagrams related to tissue Culture/ microbial biotechnology procedures specified in the syllabus.



# LIST OF VIRTUAL LAB EXPERIMENTS

## Bioinformatics

- 1) Locating the chromosome of a Gene
- 2) Retrieve gene expression data from GEO
- 3) Retrieving articles using PubMed
- 4) Finding ORF of a Given Sequence
- 5) Retrieving structural data of a protein using PDB database
- 6) Retrieving Motif Information of a Protein Using Prosite
- 7) Retrieving Gene Information from TAIR database
- 8) Designing a primer
- 9) Global alignment of two sequences - Needleman-Wunsch Algorithm
- 10) Smith-Waterman Algorithm - Local Alignment of Sequences
- 11) Pairwise Sequence Alignment using BLAST
- 12) Aligning Multiple Sequences with CLUSTALW
- 13) Construction of Cladogram
- 14) Phylogenetic Analysis using PHYLIP - Rooted trees
- 15) Phylogenetic Analysis using PHYLIP - Unrooted trees
- 16) Genome Annotation and Multiple Sequence Alignment.
- 17) Calculating the Distance between the Ligand and a Particular Amino acid
- 18) Finding the Active Site Pockets of a given Protein Molecule
- 19) Primary Structure Analysis of a Protein Using ProtParam
- 20) Secondary structure analysis of a protein using SOPMA
- 21) Surface Analysis of a Protein Using CASTp
- 22) Retrieving details of a drug molecule
- 23) Homology Modeling using Modeller
- 24) Protein-Ligand Interaction
- 25) Constructing computational model of a molecule
- 26) Introducing Hydrogen atoms to a molecule
- 27) Dihedral angle calculation of a molecule
- 28) Energy minimization of a molecule
- 29) Predict the structure of protein - Homology Modeling
- 30) Drug-Receptor Interaction
- 31) Absorption and Distribution Property Prediction in Drug Designing Process
- 32) Toxicity prediction of a Molecule
- 33) Pairwise sequence alignment using FASTA

## Ecology

- 1) Determination of pH of Waste Water Sample
- 2) Nitrogen Cycle
- 3) A Brief Introduction to Species Interactions in Ecology
- 4) Bacterial Population Growth
- 5) Population Invasion - A Threat to Ecosystem
- 6) Study of Foraging of Organisms in the Ecosystem
- 7) Interspecific Competition and Coexistence
- 8) Conserving Endangered Species
- 9) Interspecific Competition and Geographic Distributions
- 10) Metapopulation Dynamics
- 11) Parasitoid Host Dynamics
- 12) Spread of Pest Population invasion
- 13) Optimal Foraging

- 14) Optimal For Aging Pollinators
- 15) Optimal foraging Sit and wait predators that maximize energy

### **Biophysics**

- 1) Using a light microscope (Remote Trigger)
- 2) Observing an animal cell using a light microscope (Remote Trigger)
- 3) Study of RC Properties of Cell Membrane (Remote Trigger)
- 4) Study of Electrically excitable cells (Remote trigger)
- 5) Bursting phenomenon in biology via RC models (Remote Trigger)
- 6) Micrometry (Remote Trigger)
- 7) Multi-compartmental modelling of biophysical behaviour of neurons (Remote Trigger)
- 8) Understanding Photosynthesis as a Biologically Closed Process
- 9) Light Microscope
- 10) Hemocytometer (Counting of Cells)
- 11) Transmission Electron Microscopy
- 1) INDIRECT Elisa
- 2) DIRECT Elisa
- 3) SANDWICH Elisa
- 12) ELISPOT Assay

### **Biochemistry**

- 1) Qualitative Analysis of Carbohydrates
- 2) Isoelectric Precipitation of Proteins: Casein from Milk
- 3) Quantitative Estimation of Amino Acids by Ninhydrin
- 4) Separation of Amino Acids by Thin Layer Chromatography
- 5) Estimation of Saponification Value of Fats/Oils.
- 6) Detection of Adulteration in Milk
- 7) Qualitative Analysis of Amino Acid
- 8) Estimation of Iodine Value of Fats and Oils
- 9) Titration Curves of Amino acids
- 10) Estimation of blood glucose by Glucose oxidase method
- 11) Isolation of  $\beta$ -Amylase from Sweet Potato
- 12) Gelatin Zymography
- 13) Construction of Maltose Standard Curve by DNS Method
- 14) Structural Studies of Phycobiliproteins from Spirulina
- 15) Effect of Substrate Concentration on Enzyme Kinetics
- 16) Effect of temperature on enzyme kinetics
- 17) Hydrolysis of Ester using orange peel esterase
- 18) Quantification of Amino Acids Present in a Mixture
- 19) Quantification of Protein Present in a Sample
- 20) Quantification of Lignin in Tissue Sections

### **Immunology**

- 1) Collection of Serum from Blood
- 2) Blood Grouping Experiment
- 3) Latex Agglutination
- 4) Antibody Labeling with HRP
- 5) Extraction of IgG Antibodies from Immunized Hen Egg
- 6) Isolation of lymphocytes from whole blood
- 7) Ouchterlony Double Diffusion-Titration-precipitation reactions
- 8) Ouchterlony Double Diffusion-Patterns-precipitation reactions
- 9) Purification of IgG Antibodies with Ammonium Sulphate

- 10) Removal of Thymus and Spleen from Mice
- 11) Mouse Anesthesia and Blood Collection
- 12) Parenteral Injections
- 13) Purification of IgG Antibodies using Affinity Chromatography
- 14) Fluorescent Labeling of Antibodies
- 15) Fragmentation of IgG Using Papain
- 16) Fragmentation of IgG using pepsin

### **Microbiology**

- 1) Aseptic Technique and the Transfer of Microorganisms
- 2) Motility Test
- 3) Catalase and Coagulase Test
- 4) Selective and Differential Media for Identifying Microorganisms
- 5) Lecithinase Test
- 6) Bacterial Growth Curve
- 7) Carbohydrate Fermentation Test
- 8) Differential and Cytological Staining Techniques
- 9) Antibiotic Susceptibility Testing
- 10) Methylene Blue Reductase Test
- 11) Voges-Proskauer Test
- 12) Triple Sugar Iron Agar
- 13) Urease Test
- 14) Litmus Milk Test
- 15) Slide Culture Technique for Fungi
- 16) Bacteriophage Plaque Assay for Phage Titer
- 17) Isolation and Identification of Auxotrophic and Drug Resistant Mutants
- 18) Routes of Viral Inoculation in Embryonated Eggs
- 19) Quantification of Bacterial Colonies on an Agar Plate

### **Cell biology**

- 1) Cell Organization and Subcellular Structure Studies (Prokaryotic and Eukaryotic)
- 2) Isolation of Mitochondria
- 3) Isolation of Chloroplast
- 4) Isolation of Endoplasmic Reticulum
- 5) Glucose Uptake Assay
- 6) Transfection
- 7) Lignin Staining
- 8) Maintenance of Mammalian Cell Lines
- 9) Cell Attachment
- 10) Cell Migration
- 11) Mitosis in Onion Root Tips
- 12) Cell Proliferation
- 13) Actin Assembly
- 14) Maintenance and Storage of DH5 $\alpha$  E. coli cells
- 15) Quantification of Stained Liver Cells

### **Genetic Engineering**

- 1) Western Blotting
- 2) Preparation of Buffer stocks (TBE, TE and TAE)
- 3) Extraction of DNA from Fish Fins
- 4) Hot Shot Method of DNA Extraction
- 5) Agarose Gel Electrophoresis (AGE)

- 6) Restriction Digestion
- 7) Preparation of Competent Cell (Calcium Chloride Treatment)
- 8) Transformation of the Host Cells
- 9) Extraction of DNA from Agarose gel
- 10) Preparation of Equilibrated Phenol
- 11) Isolation of RNA
- 12) Polyacrylamide Gel Electrophoresis
- 13) Ligation (Using T4 DNA Ligase)
- 14) Polymerase Chain Reaction (PCR)
- 15) Electrophoresis
- 16) Plating of the Bacteriophage
- 17) Plasmid Curing
- 18) Extraction of Bacteriophage DNA from Large Scale Cultures Using Proteinase K and SDS
- 19) Preparation of stocks of bacteriophage lambda by plate lysis and elution
- 20) 16S Ribosomal RNA Sequencing.