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

Members of the Board of Studies in Botany

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2. Dr. Dennis T. (Professor & Head, Dept. of Plant Sciences, Central University, Kasagod)
3. Dr. Mathew Dan (Scientist, JNTBGRI, Thiruvananthapuram)
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8. Mr. Ebin P.J.
9. Mr. Kiran George Koshy
10. Dr. Lesly Augustine
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

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 x 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)

	Components	Marks
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.

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

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

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

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

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

Vii **Components of External Evaluation for Projects**

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

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:-

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

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	***A+***	***Outstanding***

Equal to 8.0 and below 9.0	***A***	***Excellent***
Equal to 7.0 and below 8.0	***B+***	***Very Good***
Equal to 6.0 and below 7.0	***B***	***Good***
Equal to 5.0 and below 6.0	***C*** $^{+}$	***Fair***
Equal to 4.0 and below 5.0	***C***	***Pass***
Below 4.0	***D***	***Deficient(Fail)***

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
TCP = Total Credit Point of that semester $= \sum_1^n \mathrm{CPi}$**;**
TCr = Total Credit of that semester $= \sum_1^n \mathrm{Cri}$
Where n is the number of courses in that semester
Cumulative Grade Point Average (CGPA) of a Programme is calculated using the formula
CGPA $= \sum(\mathrm{SGPA} \times \mathrm{TCr}) \Big/ \sum \mathrm{TCr}$

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

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

Additional Credits: Components

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

Annexure I (a) Model Mark cum Grade Card

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					
			Awarded	Max.	Awarded	Max .	Awarded	Max .				
16P1BOTT01	Microbiology & Phycology	4	15	25	75	75	90	100	A^+	9	36	Pass
16P1BOTT02	Mycology & Crop Pathology	4	18	25	70	75	88	100	A^+	9	36	Pass
16P1BOTT03	Ecology & Envt. Biology & Research Methodology	4	15	25	60	75	75	100	A	8	32	Pass
16P1BOTT04	Cell Biology	3	12	25	50	75	62	100	B	6	18	Pass
16P1BOTP01	16P1BOTT01	2	9	10	39	40	48	50	A^+	9	18	Pass
16P1BOTP02	&16P1BOTT0216P1BOTT03 &16P1BOTT04	2	8	10	38	40	46	50	A^+	9	18	Pass
	Total	19					459	500			165	
	Semester Result **SGPA**								**A**	**8.68**		**Pass**

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**	Credits (Cr)	Marks						Grade awarded (G)	Grade Point (GP)	Credit Point (CP=Cr× *GP*)	Result
			Internal		External		Total					
			Awarded	Max.	Awarded	Max .	Awarded	Max .				
16P4BOTT13	Genetic Engineering	3	15	25	75	75	90	100	A^+	9	36	Pass
16P4BOTT14	Genomics, Proteomics & Bioinformatics	4	18	25	70	75	88	100	A^+	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^+	9	13.5	Pass
16P4BOTP8	16P4BOTT15&16P4BOTT16	1.5	10	10	40	40	50	50	A^+	9	13.5	Pass
16P4BOTPJ	Research Project	3	18	25	72	75	90	100	A^+	9	27	Pass
16P4BOTCV	Comprehensive Viva Voce	2	17	25	67	75	84	100	A	8	16	Pass
	Total Semester Result **SGPA**	23					589	700	**A**	**8.34**	192	**Pass**
	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 - **CGPA**	**80**					**1922**	**2200**	**A**	**8.45**	**638**	

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

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.

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

(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

SGPA/CGPA	Grade
9.0 and above	***A+***
Equal to 8.0 and below 9.0	***A***
Equal to 7.0 and below 8.0	***B+***
Equal to 6.0 and below 7.0	***B***
Equal to 5.0 and below 6.0	***C*** $^{+}$
Equal to 4.0 and below 5.0	***C***
Below 4.0	***D***

SGPA = TCP/TCr, where

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

TCr = Total Credit of that semester $= \sum_1^n \mathrm{Cri}$

Where n is the number of courses in that semester

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

$$\boldsymbol{CGPA} = \sum(\boldsymbol{TCP} \times \boldsymbol{TCr}) \Big/ \sum \boldsymbol{TCr}$$

GPA shall be round off to two decimal places

PROGRAMME OUTCOMES (POs)

At the end of the programme,

PO1

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

PO2

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

PO3

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

PO4

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

PO5

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

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1

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

PSO2

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

PSO3

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

PSO4

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

PSO5

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

SEMESTER I

Course	Title	Teaching Hrs Theory	Teaching Hrs Practical	Credits
20P1BOTT01	Microbiology + Phycology	27 + 45	9 + 36	4
20P1BOTT02	Mycology + Crop Pathology	45 + 27	36 + 18	4
20P1BOTT03	Ecology, Environmental Biology, Phytogeography & Research Methodology	54 + 18	27 + 9	4
20P1BOTT04	Cell Biology	54	27	3
20P1BOTP01	Practicals of **20P1BOTT01+ 20P1BOTT02**			2
20P1BOTP01	Practicals of **20P1BOTT03+ 20P1BOTT04**			2
FIELD STUDY	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	Describe the world of microbial diversity and their evolutionary relationships
CO 2	Explain the reproductive behaviour in Algae and microbes
CO 3	Discuss ecological significance of the lower groups of plants and protists
CO 4	Describe economic significance of the lower groups of plants and protists
CO 5	Collect and identify various algal forms
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, Archaebacteria. Extremophiles - thermophilic, halophilic, acidophilic and alkalophilic bacteria.

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

(e) Bacterial Genetics: Organization and replication of genetic material in bacteria – bacterialchromosome, 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 envelops 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.

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2. Black, J. G. Microbiology: Principles and Explorations viith 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* vth 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, Daginawala 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.

Unite 1: Introduction (4 hrs)

(a) 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).

(b) 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)

(a) Habit, habitat and distribution of Algae, Major characteristics of Cyanophyceae, Chlorophyceae, Xanthophyceae, Bacillariophyceae, Dinophyceae, Phaeophyceae and Rhodophyceae

(b) Range of thallus structure.

(c) Algal components: Cell wall, flagella, eye-spot, pigments, pyrenoid, photosynthetic products.

(d) Reproduction in algae: Vegetative, asexual and sexual reproduction (development of sex organs not necessary)

(e) Major patterns of life cycle and post fertilization stages in Phaeophyceae and Rhodophyceae.

(f) Fossil algae.

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

(a) Ecological importance of Algae. Primary productivity. Algae in symbiotic association, Ultraviolet radiation absorption by algae.

(b) Algae as food, fodder, biofertilizer, medicine, industrial uses and other useful.

(c) Algae in experimental studies. (SCP, Biofuel, Live feeds, EPS.).

(d) 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 Cyanophycean toxins).

Module 4: Algal biotechnology (6 hrs)

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

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

Gracilaria, Polysiphonia.

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.

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1. Andersen R A (Ed) 2004. *Algal Culturing Techniques*, Elsevier.
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14. Harnold C Bold, Michael J Wynne (1978). *Introduction to Algae: Structure and reproduction*. Prentice Hall.
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22. Pal, B.P. and Kundu, B.C. 1962. *Charophyta*. Indian Council of Agricultural Research, New Delhi.
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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
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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	Collectin nad identification of different micro and macro fungi.
CO 2	Describe different classification systems and their applications.
CO 3	Identify various fundal diseases diseases
CO 4	Describe fungal associations, their usefulness and harmfulness
CO 5	Compare 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:

Stemonitis,	*Physarum,*	*Saprolegnia,*	*Phytophthora,*	*Albugo,*
Mucor,	*Aspergillus,*	*Penicillium,*	*Pilobolous,*	*Saccharomyces,*
Taphrina,	*Xylaria,*	*Peziza,*	*Phyllochora,*	*Puccinia,*

Pleurotus,	*Auricularia,*	*Polyporus,*	*Lycoperdon,*	*Dictyophora,*
Geastrum,	*Cyathus,*	*Fusarium,*	*Alternaria,*	*Pestalotia,*
Tremella,	*Entoloma,*	*Marasmius,*	*Hexagonia,*	*Ganoderma,*
Graphis,	*Parmelia,*	*Usnea.*		

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

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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.
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8. A Misra, P R Agarwal (1994). *Lichens*.
9. M C Nair, S Balakrishnan (1986). *Beneficial fungi and their utilization*. Sci. publ. Jodhpur.
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11. R Dayal (2000). *Predaceous Fungi*. Commonwealth Publishers.
12. Hibbet et al. (2007). A higher level phylogenetic classification of the fungi. *Mycological Researcher 111* (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) Occurance

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 responsesPathogenicity 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) Prophylatic methods - Exclusion, eradication and protection.
(b) Therapeutic MethodChemical 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 *-(Psudeomonas, 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 braziliensis* - 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

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2. Gareth Johnes (1987). *Plant pathology: principles and practice.*
3. R S Mehrotra (2003). *Plant Pathology*.

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

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

COURSE OUTCOMES (COs)	
CO 1	Explain the basics of ecology and environmental science
CO 2	Discover the theoretical and practical knowledge on ecology and environmental science
CO 3	Demonstrate with different mathematical and statistical models and indices to explain natural phenomena and theoretical principles with which several ecological processes are explained.
CO 4	Identify global environment problems.
CO 5	Explain origin of the Western Ghats and diversity and conservation in the Western Ghats
CO 6	Define biodiversity, phytogeography, ecosystem functioning etc.
CO 7	Discover the methods of conservation managements of natural ecosystems and rare, endemic and threatened species in the Western Ghats.
CO 8	Integrate 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 desertificatication 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 allogeneic 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 CO2 (b) Dissolved oxygen (c) COD (d) Total dissolved minerals (e) Quantitative estimation of dissolved mineral anions and cations in water (f) Total alkalinity & Salinity (g) conductivity (h) Colorimetric/Spectrophotometric estimation of Nitrogen/Phosphorus in water samples.
2. 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 eveness 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*.
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4. Benton A H, Werner W E (1976). *Field biology and Ecology*. Tata McGraw Hill.
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7. Eldon D, Enger, Bradley, Smith F (1995). *Environmental Science*. W C Brown publications.
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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.
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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*. Envt. 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.
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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

20P1BOTT04: CELL BIOLOGY

(Theory 54 hrs; Practical 27 hrs; Credits: 3)

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

Introduction to the Course

(a) Historical Background of Cell Biology
(b) Difference between Prokaryotic and Eukaryotic Cell
(c) Difference between Plant and Animal Cell
(d) Basic Structure and Functions of Cell components.
(e) Endosymbiotic theory
(f) Central dogma of molecular biology
(g) Basics of DNA replication, Transcription, and Translation.
(h) Brief history of studies on plasma membrane structure. Fluid mosaic model.
(i) Functions of plasma membrane.
(j) Structure and function of chloroplast and mitochondria.

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

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2. Gerald Karp (2013). *Cell and Molecular biology: Concepts and experiments* (VII Edn). John Wiley &Sons.
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4. Geoffrey M Cooper, Robert E Hausman (2013). *The Cell: A molecular approach* (VI Edn). Sinaeur.
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9. Burtton E Tropp (2012). *Molecular biology; from genes to ptoteins (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**

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

(7x 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**

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 monoclinous 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**

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**

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 shrot 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**

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:<u>Semester 1 Practical course 1</u>

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
20P2BOTT05	Bryology + Pteridology	36 + 36	18 + 36	4
20P2BOTT06	Molecular Biology & Immunology	54 + 18	18 + 9	4
20P2BOTT07	Plant Anatomy, Angiosperm Systematics & Morphology	36 + 27 + 9	36 + 27	4
20P2BOTT08	Genetics & Biochemistry	15 + 39	9 + 18	3
20P2BOTP03	Practicals of **20P2BOTT05+ 20P2BOTT06**			2
20P2BOTP04	Practicals of **20P2BOTT07+ 20P2BOTT08**			2
FIELD STUDY	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)

COURSE OUTCOMES (COs)	
CO 1	Understand the diversity of primitive land plants.
CO 2	Classify Bryophytes and Pteridophytes based on their morphological and anatomical features.
CO 3	Compare the main characteristics of Bryophytes and Pteridophytes.
CO 4	Discuss the development of land adaptations in the Bryophytes and Pteridophytes.
CO 5	Compareh various lifecycle events in the Bryophyte and Pteridophytes.
CO 6	Explain the evolutionary trends primitive plant groups.
CO 7	Identify 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 (Sphaerocarpales, 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*.

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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 historyof 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 ofspore dispersal, gametophytic generation, sexuality, embryogeny of the following classes ofPteridophytes with reference to the genera mentioned (development of sex organs is not necessary):

(a) Psilopsida (i) Rhyniales; *Rhynia*
(b) Psilotopsida (i) Psilotales; *Psilotum*
(c) Lycopsida (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 recdord.

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

COURSE OUTCOMES (COs)	
CO 1	Explain the basic properties, structure and functions of genetic materials.
CO 2	Explain the central dogma of molecular biology.
CO 3	Devaelop a thorough knowledge in gene expression mechanisms.
CO 4	Explain the mechanism of DNA repair systems.
CO 5	Compare the alternate forms of DNA and its significance
CO 6	Compare the diversity RNA molecules and its diverse functions in biological systems.

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

Introduction to the Course

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

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

(a) Alternative conformations of DNA: A-DNA, Z-DNA, C-DNA, E – DNA, triplex DNA, H-DNA and quadruplex DNA, circular and linear DNA, single-stranded DNA. Tautomeric forms of bases.
(b) Structure and function of different types of RNA - mRNA, tRNA, rRNA, SnRNA, and Micro RNA.
(c) **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.
(d) C-value paradox, DNA renaturation kinetics, Tm, Cot curve. Unique and Repetitive DNA – mini- and microsatellites.

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

(a) 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.
(b) DNA repair mechanisms: Direct repair, excision repair – base excision repair and nucleotide excision repair (NER), eucaryotic excision repair – GG-NER, TC-NER. Mismatch repair, Recombination

repair – homologous recombination repair, nonhomologous end joining, SOS response – Transletion 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 eukaryotic ribosomes. tRNA charging, initiator tRNA.

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

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

(h) Genetic code: 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 λ 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 fromMice
11) Mouse Anesthesia and Blood Collection
12) Parenteral Injections
13) Purification of IgG Antibodies using Affinity Chromatography
14) Flourescent Labeling of Antibodies

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20P2BOTT07: PLANT ANATOMY, ANGIOSPERM SYSTEMATICS & MORPHOLOGY

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

COURSE OUTCOMES (COs)	
CO 1	Explain the basics of the plant cell structure
CO 2	Explain the tissue level organization in plant system
CO 3	llustrate the morphological features of angiosperms
CO 4	llustrate the anatomical features of plant specimens
CO 5	Summarize the details of wood anatomy, plant fibres and secretory tissues
CO 6	Compare different inflorescence and fruit types in plant kingdom
CO 7	Compare different wood types looking into anatomical peculiarities
CO 8	Discuss 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 (*Drocera, Nepenthes*), salt glands, colleters, nectaries, resin ducts and laticifers. Structure of bark and distribution pattern of laticifers in *Hevea brasiliensis.*

Module 3: Secondary structure (10 hrs)
(a) Vascular cambium and cork cambium: Structure and function, factors affecting cambial activity.
(b) Secondary xylem and phloem: Ontogeny, structure and function. Lignification patterns of xylem.
(c) Reaction wood: Compression wood and tension wood. Factors affecting reaction wood formation.
(d) Anomalous secondary growth in dicots and monocots (Piper, Strychnos)
(e) Wood: Physical, chemical and mechanical properties.
(f) Plant fibers: Distribution, structure and commercial importance of coir, jute, and cotton.

Module 4: Leaf and node (6 hrs)
(a) Leaf: Initiation, plastochronic changes, ontogeny and structure of leaf. Structure, development and classification of stomata and trichomes. Krantz anatomy, anatomical peculiarities in CAM plants. Leaf abscission.
(b) Nodal anatomy: Unilacunar, trilacunar and multilacunar nodes, nodal evolution.
(c) Root-stem transition in angiosperms.

Module 5: Reproductive anatomy (6 hrs)
(a) Floral Anatomy: Anatomy of floral parts - sepal, petal, stamen and carpel; Floral vasculature (*Aquilegia and Pyrola*). Vascular anatomy. Development of epigynous ovary - appendicular and receptacular theory.
(b) Fruit and seed anatomy: Anatomy of fleshy and dry fruits - follicle, legume, berry. Dehiscence of fruits. Structure of seeds. Anatomical factors responsible for seed dormancy and drought resistance.

Module 6: Ecological anatomy (4 hrs)
Morphological and structural adaptations in different ecological groups - hydrophytes, xerophytes, epiphytes and halophytes.

Module 7: Applied anatomy (2 hrs)
Applications of anatomy in systematics (histotaxonomy) and Pharmacognosy. Research prospects in anatomy.

Practical (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.

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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) Infraspecific 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- Mitochondial 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

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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)

COURSE OUTCOMES (COs)	
CO 1	Explain the Mendelian and Non-Mendelian modes of inheritance that governs passage of genetic traits across generation.
CO 2	Explainthe Hardy-Weinberg equilibrium.
CO 3	Describe of linkage and crossing over mechanisms
CO 4	Explain structure and functions of biomolecules.
CO 5	Explain enzymology, nucleotide metabolism and secondary metabolites.
CO 6	Calculate map distance, gene order, coefficient of coincidence and interference.
CO 7	Understant the structure and function of various biomolecules in living systems

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- quanitative 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 – β 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, α-helix, β 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+, NADP+, 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, LubertStryer, 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.

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

OR

24. Give a detailed account on gametophyte of Lycopodium**.**
25. Explain the sprorophytic 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**

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) Transletion 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**

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 phonetic 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 β 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. Wrire 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 bilogy.
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 properlv.

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 – Sutiable 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 properlv.

SEMESTER III

Course	Title	Teaching Hrs Theory	Teaching Hrs Practical	Credits
20P3BOTT09	Taxonomy of Angiosperms	72	45	4
20P3BOTT10	Gymnosperms, Evolution & Paleobotany	27 + 18 + 9	27 + 0 + 9	3
20P3BOTT11	Plant Physiology & Metabolism	72	36	4
20P3BOTT12	Plant Reproductive Biology, Palynology & Plant Breeding	36 + 18 + 18	36 + 9 + 9	4
20P3BOTP05	Practicals of **20P3BOTT09 + 20P3BOTT10**			2
20P3BOTP06	Practicals of **20P3BOTT11 + 20P3BOTT12**			2
FIELD STUDY	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)

COURSE OUTCOMES (COs)	
CO 1	Compare the various classification systems and its scope in angiosperm systematics
CO 2	Explain the morphological and molecular features of angiosperms in a systematic way
CO 3	Explain the economic and ethnobotanical significance of angiosperms
CO 4	Identification of Angiosperms by using literatrure.
CO 5	Describe the evolutionary trends in Angiosperms
CO 6	Describe various taxonomic literature and other tools in Angiosperm taxonomy

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, Solanacea, 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 & Hokker's system) in detail with special reference to their salient features, evolutionary trends and economic significance.

(a) **Polypetalae:** 1. Rununculaceae 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) **Gamopetelae:** 20. Asteraceae 21. Campanulaceae 22. Myrsinaceae 23. Loganiaceae24. Oleaceae 25. Apocynaceae 25. 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* (3rd Edn). Oxford & IBH Publishing Co. New Delhi.
4. Battacharya B (2009). *Systematic Botany* (2nd 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)

COURSE OUTCOMES (COs)	
CO 1	Describe the morphological diversity of gymnosperms
CO 2	Compare the reproductive behaviour in gymnosperms
CO 3	Explain the evolutionary trends in biological systems
CO 4	Describe ecological and economic significance of gymnosperms
CO 5	Explain the origin and phylogeny organisms
CO 6	Describe the diversity and distributions of prehistoric flora

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.

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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.

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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.

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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.
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20P3BOTT11: PLANT PHYSIOLOGY AND METABOLISM

(Theory 72; Practical 36; Credits: 4)

COURSE OUTCOMES (COs)	
CO1	Explain the relationship of plant with its habitat
CO2	Differentiate mineral nutrition and mechanism of absorption
CO3	Descibe the mechanism of photosynthesis
CO4	Explain the transport mechanism happening in plant system
CO5	Explain the respiration mechanism in plants
CO6	Compare the plant responses to various environmental conditions

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 regularion, Citric acid cycle

Module 1: Plant water relations (10 hrs)

(a) Cell wall and membrane properties in relation with water- Turgor Pressure and Hydraulic conductivicty. 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+ ion channels.
(c) Active transport: Carrier proteins; Na+K+ 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 syntesis. Repair and Regulation of Photosynthetic Machinery-Photoprotection, Photoinhibition.
(b) Structure and function of RuBisco.CO2 fixation- Regulation of Calvin cycle. Photorespiration, role of photorespiration in plants.CO2 concentrating mechanisms - C4 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 regularion.
(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 Rf value.
8. Demonstration of amylase activity and GA effect in germinating cereal seeds.
9. Estimation of pigment composition of a leaf.
10. Separation and collection of leaf pigments by silica gel column chromatography.
11. Determination of nitrate reductase activity.
12. Extraction and estimation of leghaemoglobin from root nodules.

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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	Explaind the basic concepts of developmental biology
CO 2	Describe the breeding system and self incompatibility in plants
CO 3	Explain the pollination and post pollination changes
CO 4	Comapre the structure of pollen grains and applications of palynology

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, Crotolaria, 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

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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 pollenkitt.

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).

Moodule – 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.

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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. Idiotype breeding (2 Hrs)
Role and Methods, Applications of Idiotype 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.

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Model Question Paper

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

Time : 3 Hours Max. Marks: 75

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

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_4 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 machanism

(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**

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**

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**

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, 4x2=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 = 3x2=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 sylabus

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
20PE1BOTT13	Genetic Engineering	54	36	3
20PE1BOTT14	Genomics, Proteomics & Bioinformatics	36+36	45	4
20PE1BOTT15	Tissue Culture & Microbial Biotechnology	36+ 18	18 + 18	3
20PE1BOTT16	Biostatistics, Microtechniques & Biophysics	36+ 18 + 18	18 + 27 + 18	4
20PE1BOTP07	Practicals of **20PE1BOTT13+ 20PE1BOTT14**			2
20PE1BOTP08	Practicals of **20PE1BOTT15+ 20PE1BOTT16**			2
20P4BOTPJ	Project			3
20P4BOTCV	Viva			2
FIELD STUDY	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)

COURSE OUTCOMES (COs)	
CO 1	Explain the fundamental and advanced aspects of recombinant DNA technology, gene cloning strategies
CO 2	Describe the various aspects of advanced transgenic technology
CO 3	Explain the social and ethical issues in the field of biotechnology
CO 4	Describe the scope and relevance of genome editing
CO 5	Explain the applications of rDNA technology

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 plamid, vir gene products and its function, opine synthesis genes, tumour causing genes,
(b) Mechanism of *Agrobacterium* infection and crown gall formation
(c) Vector system based on *A. Tumefaciens* - binary vector and cointegrate vector

Module 4: Advanced transgenic technology (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 - prepartion and it's significance.
(b) Procedure for the construction of a genomic library using phage λ 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.

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17. Desmond S T Nicholl (2010). *An introduction to genetic engineering* (III Edn). Cambridge.
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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.
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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)

COURSE OUTCOMES (COs)	
CO 1	Explain the structural features of genome
CO 2	Describe the fundamentals functional genomics
CO 3	Explain the social and ethical issues in the field of genomics
CO 4	Describe the scope and relevance of genome, transcriptome and proteome
CO 5	Explain the fundamentals of bioinformatics

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: Hierarchial 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. Pyrrosequencing, 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.

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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

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2. Jin Xiong (2006). *Essential Bioinformatics*. Cambridge University Press
3. Orpita Bosu, Simminder Kaur Thukral (2007). *Bioinformatics: Databases tools and algorithms*. Oxford University press.
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20PE1BOTT15: TISSUE CULTURE AND MICROBIAL BIOTECHNOLOGY
(Theory 54 hrs; Practical 36 hrs; Credits 3)

COURSE OUTCOMES (COs)	
CO 1	Explain the basic aspects of plant tissue culture
CO 2	Describe the fundamentals of microbial biotechnology
CO 3	Explain the various applications of plant tissue culture
CO 4	Describe the scope and relevance of Bioreactors and fermentation technology
CO 5	Describe the in vitro germplasm conservation strategies

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. Sterlization 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 soild medium from stock solutions containing auxin and cytokinin, NaCl or PEG, and inoculation.
3. Preparation of synthetic seeds.
4. Find out the uninucleate stage of anther and anther culture.
5. Dissect out an embryo from any seed and culture it on a suitable solid medium.
6. Isolation of microbes producing amylase.

References

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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.
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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.
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20PE1BOTT16: BIOSTATISTICS, MICROTECHNIQUES & BIOPHYSICS
(Theory 36+ 18 + 18 hrs; Practical 18 + 27 + 18 hrs; Credits 4)

COURSE OUTCOMES (COs)	
CO 1	Explain the tools and techniques available for studding biochemical and biophysical nature of life.
CO 2	Describe the basics of experimental design in research
CO 3	Describe the preparation of plants for microscopic examination and histochemical studies.
CO 4	Identify the various statistical tools and its applications in data processing
CO 5	Explain principles and working of various types of microscopes and other instruments in biological research

Course Objectives

- To enable students to learn the tools and techniques available for studding 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 knowledgein preparing plants for microscopic examination, general routinesfor 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 poison 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^2 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

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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 Safranine-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, Carnoys'fluid, Houpt'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

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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 Cenrtifugation, 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

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Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

M.Sc.Botany DEGREE EXAMINATION

SEMESTER IV

20PE1BOTT13: GENETIC ENGINEERING

Time : 3 Hours Max. Marks: 75

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 ***anyTwo*** 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

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 Pyrrosequencing..
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

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 shrot 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 themethods 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 Safranine
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. (4)
   (Calibration - 1, Measurement, calculation and result -3)

   or

6. (b) Find out the number of spores/ml in the given spore suspension **E**. (4)
   (Counting - 1, Calculation - 2, Result - 1)

   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 ¾ and the probability of another person 'B' will be living up to 60 years is ⅔. 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)

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) Locatingthechromosomeofa Gene
2) Retrievegeneexpressiondata from GEO
3) Retrieving articles using PubMed
4) Finding ORFofa GivenSequence
5) Retrieving structuraldataofa protein using PDBdatabase
6) RetrievingMotifInformationof a ProteinUsingProsite
7) RetrievingGene Informationfrom TAIR database
8) Designingaprimer
9) Global alignment oftwo sequences -Needleman-Wunsch Algorithm
10) Smith-Waterman Algorithm-Local Alignment ofSequences
11) Pairwise SequenceAlignmentusing BLAST
12) Aligning MultipleSequenceswith CLUSTALW
13) Constructionof Cladogram
14) Phylogenetic Analysis usingPHYLIP -Rooted trees
15) Phylogenetic Analysis usingPHYLIP -Unrootedtrees
16) GenomeAnnotationand MultipleSequenceAllignment.
17) CalculatingtheDistancebetweenthe Ligandanda Particular Aminoacid
18) FindingtheActiveSite Pockets of agivenProteinMolecule
19) PrimaryStructure Analysis ofa ProteinUsingProtParam
20) Secondarystructureanalysis ofaprotein using SOPMA
21) SurfaceAnalysis of a ProteinUsingCASTp
22) Retrievingdetails of a drugmolecule
23) HomologyModeling using Modeller
24) Protein-LigandInteraction
25) Constructing computational model of amolecule
26) IntroducingHydrogenatomsto a molecule
27) Dihedral anglecalculationofa molecule
28) Energyminimizationofa molecule
29) Predictthe structure ofprotein-HomologyModeling
30) Drug-ReceptorInteraction
31) AbsorptionandDistributionPropertyPredictioninDrug DesigningProcess
32) Toxicitypredictionofa Molecule
33) Pairwise sequence alignment using FASTA

Ecology

1) Determinationof pHofWasteWater Sample
2) Nitrogen Cycle
3) ABrief Introductionto Species Interactions inEcology
4) Bacterial PopulationGrowth
5) PopulationInvasion -A ThreattoEcosystem
6) Studyof ForagingofOrganisms inthe Ecosystem
7) InterspecificCompetitionandCoexistence
8) ConservingEndangeredSpecies
9) InterspecificCompetitionandGeographic Distributions
10) MetapopulationDynamics
11) ParasitoidHostDynamics
12) SpreadPestPopulation invasion
13) OptimalFor Aging

14) OptimalFor AgingPollinators
15) Optimal foraging Sit andwaitpredators thatmaximize energy

Biophysics

1) Usinga lightmicroscope (RemoteTrigger)
2) Observing an animal cell usinga light microscope(RemoteTrigger)
3) Studyof RC Properties of CellMembrane(Remote Trigger)
4) StudyofElectricallyexcitablecells (Remote trigger)
5) Burstingphenomenon inbiology via RC models (Remote Trigger)
6) Micrometry (Remote Trigger)
7) Multicompartmental modellingof biophysical behaviourofneurons (RemoteTrigger)
8) Understanding Photosynthesis as a BiologicallyClosedProcess
9) LightMicroscope
10) Hemocytometer (CountingofCells)
11) TransmissionElectronMicroscopy
1) INDIRECTElisa
2) DIRECT Elisa
3) SANDWICHElisa
12) ELISPOT Assay

Biochemistry

1) Qualitative Analysis of Carbohydrates
2) IsoelectricPrecipitationof Proteins:Caseinfrom Milk
3) Quantitative Estimation of Amino Acids by Ninhydrin
4) SeparationofAminoAcids byThin Layer Chromatography
5) Estimationof Saponification Value ofFats/Oils.
6) DetectionofAdulterationin Milk
7) Qualitative Analysis of AminoAcid
8) Estimationof IodineValue ofFats and Oils
9) TitrationCurves of Aminoacids
10) Estimationofblood glucosebyGlucose oxidasemethod
11) Isolationofβ-AmylasefromSweetPotato
12) GelatinZymography
13) Constructionof MaltoseStandardCurveby DNS Method
14) StructuralStudies of Phycobiliproteins fromSpirulina
15) EffectofSubstrate Concentrationon Enzyme Kinetics
16) Effectoftemperature onenzyme kinetics
17) Hydrolysis ofEster using orange peel esterase
18) Quantificationof Amino AcidsPresent ina Mixture
19) Quantificationof ProteinPresent ina Sample
20) Quantificationof Lignin inTissue Sections

Immunology

1) CollectionofSerum from Blood
2) BloodGroupingExperiment
3) Latex Agglutination
4) Antibody LabelingwithHRP
5) ExtractionofIgG Antibodies from Immunized Hen Egg
6) Isolationof lymphocytes from whole blood
7) Ouchterlony DoubleDiffusion-Titration-precipitationreactions
8) Ouchterlony DoubleDiffusion-Patterns- precipitationreactions
9) PurificationofIgG Antibodies with Ammonium Sulphate

10) Removal of Thymus and SpleenfromMice
11) MouseAnesthesia andBloodCollection
12) Parenteral Injections
13) PurificationofIgG Antibodies using Affinity Chromatography
14) FlourescentLabelingof Antibodies
15) Fragmentationof IgGUsing Papain
16) Fragmentationof IgGusingpepsin

Microbiology

1) Aseptic Technique and theTransfer ofMicroorganisms
2) MotilityTest
3) CatalaseandCoagulase Test
4) Selective and Differential Media for Identifying Microorganisms
5) Lecithinase Test
6) Bacterial Growth Curve
7) Carbohydrate Fermentation Test
8) Differential andCytological StainingTechniques
9) AntibioticSusceptibilityTesting
10) MethyleneBlue Reductase Test
11) Voges-Proskauer Test
12) Triple Sugar IronAgar
13) Urease Test
14) Litmus MilkTest
15) Slide CultureTechniquefor Fungi
16) BacteriophagePlaqueAssayfor PhageTiter
17) IsolationandIdentificationof Auxotrophic and Drug ResistantMutants
18) Routesof ViralInoculationin EmbryonatedEggs
19) Quantificationof Bacterial Colonies on an Agar Plate

Cell biology

1) Cell Organizationand SubCellular StructureStudies(Prokaryotic andEukaryotic)
2) IsolationofMitochondria
3) Isolationof Chloroplast
4) IsolationofEndoplasmicReticulum
5) Glucose UptakeAssay
6) Transfection
7) Lignin Staining
8) Maintenance of Mamallian Cell Lines
9) Cell Attachment
10) Cell Migration
11) Mitosis inOnionRootTips
12) Cell Proliferation
13) ActinAssembly
14) Maintenance and Storage ofDH5alphaE.coli cells
15) Quantificationof StainedLiver Cells

GeneticEngineering

1) WesternBlotting
2) PreparationofBuffer stocks (TBE,TEandTAE)
3) Extractionof DNAfromFish Fins
4) Hot ShotMethodofDNA Extraction

5) AgaroseGel Electrophoresis (AGE)
6) RestrictionDigestion
7) PreparationofCompetentCell (CalciumChloride Treatment)
8) TransformationoftheHostCells
9) Extractionof DNAfromAgarose gel
10) PreparationofEquilibratedPhenol
11) IsolationofRNA
12) PolyacrylamideGel Electrophoresis
13) Ligation (UsingT4 DNALigase)
14) PolymeraseChainReaction(PCR)
15) Electroblotting
16) PlatingoftheBacteriophage
17) PlasmidCuring
18) ExtractionofBacteriophageDNA from Large Scale Cultures UsingProteinase Kand SDS
19) Preparationofstocks ofbacteriophagelambda by plate lysis andelution
20) 16S Ribosomal RNA Sequencing.