SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

KOCHI, KERALA, 682013

CURRICULUM AND SYLLABI

POST-GRADUATE PROGRAMME

IN

BOTANY

CREDIT SEMESTER SYSTEM (CBCS-PG)

(EFFECTIVE FROM 2016-2017 ADMISSIONS)

BOARD OF STUDIES IN BOTANY

Sacred Heart College (Autonomous), Thevara, Kochi, Kerala

Members of the Board of Studies in Botany

1. Dr.M.S. Francis (Chairman)
2. Dr.John E.Thoppil (Professor, Dept. of Botany, University of Calicut)
3. Dr.C.G. Sudha (Scientist, JNTBGRI, Thiruvananthapuram)
4. Dr.Linu Mathew (Dept. of Biosciences, M.G. University, Kottayam)
5. Dr.Sanjai V.N. (Dept. of Botany, S.D. College, Alappuzha)
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7. Mr.Roy Zacharias
8. Dr.C.M. Joy
9. Dr.Giby Kuriakose
10. Dr.Fr.Jose John
11. Dr.I'ma Neerakkal

Invited Members:

1. Mr.Kiran George Koshy
2. Mr.Ebin P.J.

FORWORD

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. 2016-2017 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
December 04, 2015

Dr. M.S. Francis
Chairman, BoS (PG) in Botany

01 CURRICULUM

1. **SCOPE**

1.1. These regulations provided herein shall apply to all post-graduate programmes, conducted by Sacred Heart College (S.H.college), Thevara with effect from the academic year 2016-2017 admission onwards.

2. **DEFINITIONS**

2.1 **'Academic Committee'** means the Committee constituted by the principal under this regulation to monitor the running of the Post-Graduate programmes under the Choice Based Credit System (CBCS-PG).

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

2.3 **'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.

2.4 **'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

2.5 '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.

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

2.7 '**Programme Credit'** means the total credit of the PG Programmes, ie; **80 credits**.

2.8 '**Programme Core course'** Programme Core course means a course that the student admitted to a particular programme must successfully complete to receive the Degree and which cannot be substituted by any other course.

2.9 '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.

2.10 '**Programme Project'** Programme Project means a regular project work with stated credits on which the student undergo a project under the supervision of a teacher in the parent department / any appropriate Institute

in order to submit a dissertation on the project work as specified.

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

2.12 '**Tutorial'** Tutorial means a class to provide an opportunity to interact with students at their individual level to identify the strength and weakness of individual students.

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

2.14 '**Evaluation'** means every course shall be evaluated by 25% internal assessment and 75% external assessment.

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

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

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

2.18 '**Parent Department'** means the Department which offers a particular Post graduate programme.

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

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

2.21 '**College Co-ordinator** means a teacher from the college nominated by the College Council to look into the matters relating to CBCS-PG System

2.22 **'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.

2.23 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.

2.24 **'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.

2.25 **'Extra credits'** are additional credits awarded to a student over and above the minimum credits required for a programme for achievements in co-curricular activities carried out outside the regular class hours as directed by the College/ department.

2.26 '**Semester Grade point average'** (SGPA) is the value obtained by dividing the sum of credit points (CP) obtained by a student in the various courses taken in a semester by the total number of credits 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.

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

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

2.29 **'Words and expressions'** used and not defined in this regulation but defined in the Mahatma Gandhi University Act and Statutes shall have the meaning assigned to them in the Act and Statute.

3. **ACADEMIC COMMITTEE**

3.1 There shall be an Academic Committee constituted by the principal to manage and monitor the working of (CBCS-PG) 2016.

3.2 The Committee consists of

(a) The principal

(b) The vice principal

(c) Deans of the faculties of science, arts and commerce

(d) The Controller of Examinations

(e) IQAC –Co ordinator

(f) The superintendent of the college

4. PROGRAMME STRUCTURE

4.1 Students shall be admitted into post graduate programmes under the various faculties.

4.2 The programme shall include two types of courses, Program Core (C) courses and Program Elective (E) Courses. There shall be a Program Project (D) with dissertation to be undertaken by all students. The Programme will also include assignments, seminars, practical (P), viva (V), study tour etc., if they are specified in the Curriculum

4.3 There shall be various groups of four Programme Elective courses for a programme such as Group A, Group B etc. for the choice of students subject to the availability of faculty and infrastructure in the institution and the selected group shall be the subject of specialization of the programme.

4.4 Project work

4.4.1 Project work shall be completed by working outside the regular teaching hours.

4.4.2 Project work shall be carried out under the supervision of a teacher in the concerned department.

4.4.3. 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.

4.4.4 There should be an internal assessment and external assessment for the project work in the ratio 1:3

4.4.5 The external evaluation of the Project work is followed by presentation of work including dissertation and Viva-Voce.

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

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

4.6 Seminar Lecture: Every PG student may deliver one seminar lecture as an internal component for every course. 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.

4.7 Every student shall undergo **two class tests** as an internal component for every course.

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

4.9 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.

5. ATTENDANCE

5.1 The minimum requirement of aggregate attendance during a semester for appearing the end semester examination shall be 75%. Condonation of shortage of attendance to a maximum of 10 days in a semester subject to a maximum of two times during the whole period of Post Graduate programme may be granted by the College as forwarded on the recommendation by the class teacher/HOD.

5.2 If a student represents the college in University, State or Nation in Sports, NCC, NSS or Cultural or any other officially sponsored activities such as College union / University union activities, he/she shall be eligible to claim the attendance for the actual number of days participated subject to a maximum of 10 days in a Semester based on the specific recommendations of the Head of the concerned Department and Principal of the College.

5.3 A student who does not satisfy the requirements of attendance shall not be permitted to take the end Semester examinations.

5.4 Those students who are not eligible even with condonation of shortage of attendance shall repeat the course along with the next batch

6. **BOARD OF STUDIES AND COURSES.**

6.1 The Board of Studies concerned shall design all the courses offered in the PG programme. The Boards shall design and introduce new courses, modify or re-design existing courses and replace any existing courses with new/modified courses to facilitate better exposures and training for the students.

6.2 The syllabus of a course shall include the title of the course, contact hours, the number of credits and reference materials.

6.3 Each course shall have an alpha numeric code number which includes abbreviation of the subject in two letters, the semester number, the code of the course and the serial number of the course ('C' for Program Core course, 'E' for Program Elective course, 'O' for Open Elective course, 'P' for Practical and 'D' for Project/ Dissertation and 'V' for Comprehensive Viva voce).

6.4 Every Programme conducted under Choice Based Credit System shall be monitored by Academic committee and the College Council.

7. **REGISTRATION**.

7.1 A student shall be permitted to register for the programme at the time of admission. The duration of the PG Programme shall be 4 semesters.

7.2 A student who registered for the course shall complete the course within a period of 8 continuous semesters from the date of commencement of the programme.

8. **ADMISSION**

8.1 The admission to all PG programmes shall be as per the rules and regulations of the college.

8.2 The eligibility criteria for admission shall be as announced by the college from time to time.

8.3 There shall be provision for inter collegiate and inter University transfer within a period of two weeks from the date of commencement of the semester.

8.4 There shall be provision for credit transfer subject to the conditions specified by the Board of Studies concerned.

9. ADMISSION REQUIREMENTS

9.1 Candidates for admission to the first semester of the PG programme through CBCS shall be required to have passed an appropriate Degree Examination of Mahatma Gandhi University as specified or any other examination of any recognized University or authority accepted by the Academic council of the college as equivalent thereto.

9.2 The candidate must forward the enrolment form to the Controller of Examinations of the college through the Head of the Department.

9.3 The candidate has to register all the courses prescribed for the particular semester. Cancellation of registration is applicable only when the request is made within two weeks from the time of admission.

9.4 Students admitted under this programme are governed by the Regulations in force.

10. **PROMOTION**: A student who registers for the end semester examination shall be promoted to the next semester

11. EXAMINATIONS

11.1 There shall be an external examination at the end of each semester.

11.2 The answers must be written in **English** except for those coming under Faculty of languages.

11.3 Practical examinations shall be conducted by the college at the end of the semesters as per the syllabus.

11.4 Project evaluation and Comprehensive Viva -Voce shall be conducted as per the syllabus. Practical examination, Project evaluation and Comprehensive Viva-Voce shall be conducted by two external examiners. (For professional courses, one examiner can be opted from the same college itself).

11.5 There shall be one end-semester examination of 3 hours duration in each lecture based course (Theory).

11.6 A question paper may contain multiple choice /objective type, short answer type/annotation, short essay type questions/problems and long essay type questions. Different types of questions shall have different marks, but a general pattern may be followed by the Board of Studies.

12 **EVALUATION AND GRADING**

12.1 Evaluation: The evaluation scheme for each course shall contain two parts; (a) internal evaluation (ISA) and (b) external evaluation (ESA). 25 marks shall be given to internal evaluation and 75 marks to external evaluation so that the ratio between internal and external mark is 1:3. Both internal and external evaluation shall be carried out in mark system. Both internal and external marks are to be mathematically rounded to the nearest integer.

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

Table 1. Components of Internal Evaluation: Theory

Component	Marks
Attendance	5
Assignment	5
Seminar	5
Two Test Papers	10
TOTAL	25

Table 2. Evaluation of Attendance

% of Attendance	Mark
>95%	5
Between 90 and 95	4
Between 85 and 90	3
Between 80and 85	2
Between 75 and 80	1
<75	0

Table 3. Evaluation of Assignment

Component	Marks
Punctuality	1
Review	1
Content	2
Conclusion	1
Reference	1
TOTAL	5

Table 4. Evaluation of Seminar

Component	Marks
Content	2
Presentation	2
Review/ Reference	1
TOTAL	5

Table 5. Components of Internal Evaluation: Practical

Component	Marks
Laboratory Involvement	5
Written/ Lab Test	5
Attendance	5
Record	7
Viva	3
TOTAL	25

Table 6. Components of Internal Evaluation: Project

Component	Marks
Topic/ Area selected	2
Experimentation/ Data Collection	5
Punctuality	3
Compilation	5
Content	5
Presentation	5
TOTAL	25

Table 7. Components of External Evaluation: Project

Component	Marks
Area/Topic selected	5
Objectives	5
Review	5
Materials and methods	10
Analysis	15
Presentation	15
Conclusion/Application	10
References	10
TOTAL	75

(i) 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 at least one week before the commencement of external examination. There shall not be any chance for improvement for internal mark.

(ii) 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 and a copy should be kept in the college for at least two years for verification.

(a) **External evaluation**: The external examination in theory courses is to be conducted by the College with question papers set by external experts. The evaluation of the answer scripts shall be done by examiners based on a well defined scheme of valuation. The external evaluation shall be done immediately after the examination preferably through centralized valuation.

Photocopies of the answer scripts of the external examination shall be made available to the students for scrutiny on request and revaluation/scrutiny of answer scripts shall be done as per the existing rules.

The question paper should be strictly on the basis of model question paper set by BoS and there shall be a combined meeting of the question paper setters for scrutiny and finalization of question paper. Each set of question should be accompanied by its scheme of valuation.

10. Direct grading system

For all courses (theory and practical), letter grades and grade points are given on a 10-point scale based on the total percentage of marks (ISA +ESA) as follows:

Table 9. Direct grading system: Grade points:

Percentage of Marks	Grade	Grade Point (GP)
95 - 100	**O** Outstanding	**10**
85 - 95	**A**$^{+}$ Excellent	**9**
75 - 85	**A** Very Good	**8**
65 - 75	**A**$^{-}$ Good	**7**
55 - 65	**B**$^{+}$ Above Average	**6**
50 - 55	**B** Average	**5**
40 - 50	**C** Pass	**4**
0 - 40	**F** Fail	**0**
	Ab Absent	**0**

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

GPA	Grade
9.5 - 10	**O** Outstanding
8.5 – 9.5	**A**$^{+}$ Excellent
7.5 – 8.5	**A** Very Good
6.5 – 7.5	**A**$^{-}$ Good
5.5 – 6.5	**B**$^{+}$ Above Average
5.0 – 5.5	**B** Average
4.0 – 5.0	**C** Pass
0.0 - 4.0	**F** Failure

A separate minimum of 40% marks (C Grade) is required for both internal and external evaluation for a pass for a course.

A candidate who has not secured minimum marks/ credits in internal examinations can re-do the same by registering according to the examination manual.

A student who fails to secure a minimum marks/ grade for a pass in a course will be permitted to write the examination along with the next batch.

There will be no supplementary examinations. There shall not be any chance to improve the mark/ grade/ grade point of a course, if the student has passed the same.

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 a minimum SGPA of 4.0. 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 = $\sum_1^n$ CPi

TCr = Total Credit of that semester = $\sum_1^n$ 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 = $\sum$(TCP x TCr)/$\sum$TCr.

GPA shall be rounded off to two decimal places.

11. Pattern of questions

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

Table 11. Pattern of Questions for External Evaluation: Theory

Type of Questions	Total number of questions	Number of questions to be answered	Marks for each question	Total Marks
Short answer type questions	12	8	2	16
Short essay (problem solving type questions)	10	7	5	35
Long essay type questions	4	2	12	24
	26	**17**		**75**

12. GRADE CARD

The colleges under its seal shall issue to the students, a grade card on completion of each semester, which shall contain the following information.

a) Name of the College
b) Title of the Postgraduate Programme
c) Name of the Semester

d) Name and Register Number of the student

e) Code, Title, Credits and Max. Marks (Internal, External & Total) of each course (Theory & Practical) in the semester.

f) Internal, External and Total Marks awarded, Grade, Grade point and Credit point in each course in the semester

g) The total credits, total marks (Max. & Awarded) and total credit points in the semester

h) Semester Grade Point Average (SGPA) and corresponding Grade.

i) Cumulative Grade Point Average (CGPA)

j) The final Mark cum Grade Card issued at the end of the final semester shall contain the details of all courses (theory & practical) taken during the final semester examination and shall include the final grade/marks scored by the candidate from 1st to 3rd semester, and the overall grade/marks for the total programme.

14. **AWARD OF DEGREE**

The successful completion of all the courses with 'D' grade (40%) shall be the minimum requirement for the award of the degree

15**. MONITORING COMMITTEE**

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

16. GRIEVENCE 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 concerned Faculty, HOD of concerned department and one member of the Academic council nominated by the principal every year as members.

17. **TRANSITORY PROVISION**

Notwithstanding anything contained in these regulations, the Vice-Chancellor shall, for a period of three year from the date of coming into force of these regulations, have the power to provide by order that these regulations shall be applied to any programme with such modifications as may be necessary

18. **REPEAL**

The Regulations now in force in so far as they are applicable to programmes offered by the college and to the extent they are inconsistent with these regulations are hereby repealed. In the case of any inconsistency between the existing regulations and these regulations relating to the Choice Based Credit System in their application to any course offered in the College, the latter shall prevail.

SEMESTERWISE DISTRIBUTION OF COURSES AND CREDITS

SEMESTER I				
Course	**Title**	**Theory hrs**	**Practical hrs**	**Credi**
16P1BOTT01	Microbiology + Phycology	27 + 45	27 + 36	4
16P1BOTT02	Mycology + Crop Pathology	45 + 27	36 + 18	4
16P1BOTT03	Ecology and Environmental Science, Phytogeography & Research Methodology	54 + 18	27 + 9	4
16P1BOTT04	Cell Biology	54	27	3
16P1BOTP01	Practicals of **16P1BOTT01+ 16P1BOTT02**			2
16P1BOTP02	Practicals of **16P1BOTT03+ 16P1BOTT04**			2
SEMESTER II				
16P2BOTT05	Bryology + Pteridology	36 + 36	18 + 36	4
16P2BOTT06	Plant Anatomy, Principles of Angiosperm Systematics & Morphology	36 + 27 + 9	36 + 27	4
16P2BOTT07	Molecular Biology & Immunology	54 + 18	9 + 18	4
16P2BOTT08	Genetics & Biochemistry	18 + 36	18 + 18	3
16P2BOTP03	Practicals of **16P2BOTT05+ 16P2BOTT06**			2
16P2BOTP04	Practicals of **16P2BOTT07+ 16P2BOTT08**			2
SEMESTER III				
16P3BOTT09	Taxonomy of Angiosperms	72	45	4
16P3BOTT10	Gymnosperms, Evolution & Paleobotany	27 + 27	27 + 9	3
16P3BOTT11	Plant Physiology & Metabolism	72	36	4
16P3BOTT12	Plant Reproductive Biology, Palynology & Plant Breeding	36+18 + 18	36 + 9 + 18	4
16P3BOTP05	Practicals of **16P3BOTT09+ 16P3BOTT10**			2
16P3BOTP06	Practicals of **16P3BOTT11+ 16P3BOTT12**			2
SEMESTER IV				
16P4BOTT13	Biotechnology & Genetic Engineering	72	18 + 18	4
16P4BOTT14	Tissue Culture & Microbial Biotechnology	36 + 18	18 + 18	3
16P4BOTT15	Genomics, Proteomics & Bioinformatics.	27+45	18 + 27	4
16P4BOTT16	Biostatistics, Microtechniques & Biophysics	36+ 18+ 18	18 + 27 + 18	4
16P4BOTP07	Practicals of **16P4BOTT13+ 16P4BOTT14**			2
16P4BOTP08	Practicals of **16P4BOTT15+ 16P4BOTT16**			2
16P4BOTPJ	Research Project			2
16P4BOTCV	Comprehensive Viva Voce			2
	TOTAL			**80**

Additional Credits (Maximum of 10 Additional Credits during the programme) : Components

Content	Minimum Hours	Credit
1. Internship	36	2
2. Virtual Lab Experiments	36	2
3. Advanced Learning	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 2016

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 & 16P1BOTT02	2	9	10	39	40	48	50	A^+	9	18	Pass
16P1BOTP02	16P1BOTT03 & 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 2018

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	Biotechnology & Genetic Engg.	4	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 2016)	19					459	500	A	8.68	129	
	Semester II (Mar2017)	19					509	500	A	7.86	173	
	Semester III (Nov 2017)	19					365	500	A	8.94	129	
	Semester IV (Mar2018)	23					683	700	A	8.34	207	
	Final Result - **CGPA**	**80**					**1922**	**2200**	**A**	**8.45**	**638**	

Checked by

Section Officer Controller of Examinations

Description of the Evaluation Process - Grade and Grade Point (Common to all semesters)

The Evaluation of each Course comprises of Internal and External Components in the ratio 1:4 for all Courses. Grades and Grade Points are given on a 10-point Scale based on the percentage of Total Marks (Internal + External) as given in Table 1

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

Table 1

Percentage of Marks	Grade	Grade Point (GP)
95 and above	O Outstanding	10
85 to below 95	A^+ Excellent	9
75 to below 85	A Very Good	8
65 to below 75	B^+ Good	7
55 to below 65	B Above Average	6
45 to below 55	C Average	5
40 to below 45	D Pass	4
Below 40	F Failure	0
	Ab Absent	0

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

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

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

GPA shall be round off to two decimal places

Table 2

GPA	Grade
Equal to9.5 and above	***O Outstanding***
Equal to 8.5 and < 9.5	***A+ Excellent***
Equal to7.5 and < 8.5	***A Very Good***
Equal to 6.5 and < 7.5	***B+ Good***
Equal to5.5 and < 6.5	***B Above Average***
Equal to 4.5and < 5.5	***C Average***
Equal to 4.0 and < 4.5	***D Pass***
Below 4.0	***F Failure***

A **separate minimum of 40% marks** (D grade) required for a pass for both internal evaluation and external evaluation for every course

Total Additional Credits Securred :

Topics	Duration	Credits
Cell Biology	36 hrs	1
Virtual Lab Experiments	72 hrs	2
Internship	36 hrs	1

[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 1:4 for all Courses. Grades and Grade Points are given on a 10-point Scale based on the percentage of Total Marks (Internal + External) as given in Table 1

Percentage of Marks	Grade	Grade Point (GP)
95 and above	S Outstanding	10
85 to below 95	A^+ Excellent	9
75 to below 85	A Very Good	8
65 to below 75	B^+ Good	7
55 to below 65	B Above Average	6
45 to below 55	C Average	5
40 to below 45	D Pass	4
Below 40	F Failure	0
	Ab Absent	0

(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 = TCP/TCr, where

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

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

Where n is the number of courses in that semester

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

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

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

GPA shall be round off to two decimal places

SEMESTER I

Course	Title	Teaching Hrs Theory	Teaching Hrs Practical	Credits
16P1BOTT01	Microbiology + Phycology	27 + 45	9 + 36	4
16P1BOTT02	Mycology + Crop Pathology	45 + 27	36 + 18	4
16P1BOTT03	Ecology and Environmental Biology & Research Methodology	54 + 18	27 + 9	4
16P1BOTT04	Cell Biology	54	27	3
16P1BOTP01	Practicals of **16P1BOTT01** + **16P1BOTT02**			2
16P1BOTP01	Practicals of **16P1BOTT03** + **16P1BOTT04**			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.			

16P1BOTT01: MICROBIOLOGY AND PHYCOLOGY
(Theory 27 + 45 hrs; Practical 9 + 36 hrs; Credits: 4)

Course Objectives

- To enable the students to identify macro and micro algae
- To equip the students with advanced knowledge on Algae including their uses in day to day life
- To facilitate the students with advanced knowledge in Phycology including Algal Biotechnology
- To have a detailed understanding about microbial diversity, their cell structure, their helpful and harmful effects to human beings
- To help in gathering detailed understanding about different scopes of Microbiology at a broader spectrum
- To have advanced knowledge about some of the dreadful diseases such as AIDS, HIV, etc.
- To become aware of the multiple scopes and applications of these organisms

MICROBIOLOGY (Theory 27 hrs, Practical 9 hrs)

Introduction to the Course

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, Rickettsias, Chlamydias, 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. Application of bacteria recombinant technology and genomics.

(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.

Industrial Microbiology: Production of alcohol, vinegar, antibiotics, vitamins, steroids, vaccines, organic acids and amino acids.

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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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.

Module 1: Introduction (3 hrs)

(a) History of algal classification. Detailed study of the classification by F. E. Fritsch and G. M. Smith. Modern trends and criteria for algal classification- DNA barcoding.

(b) Centers of algal research in India. Contributions of Indian phycologists – M O P Iyengar, V Krishnamurthy, T V Desikachary, M.S. Randhawa.

Module 2: General features of Algae (30 hrs)
(a) Details of habit, habitat and distribution of Algae.
(b) Algal components: Cell wall, flagella, eye-spot, pigments, pyrenoid, photosynthetic products. (c) Range of thallus structure and their evolution.
(d) Reproduction in algae: Different methods of reproduction, evolution of sex organs.
(e) Major patterns of life cycle and post fertilization stages in Chlorophyta, Phaeophyta and Rhodophyta.
(f) Fossil algae.

Module 3: Algal ecology (3 hrs)
Ecological importance of Algae. Productivity of fresh water and marine environment. Algae in symbiotic association, Algae in polluted habitat, Algal indicators, Algal blooms.

Module 4: Economic importance of Algae (3 hrs)
(a) Algae as food, fodder, aquaculture, biofertilizer, biofuel, medicine, industrial uses, source of restriction endonuclease, pollution control and phycoremediation and other useful products. Harmful effects of algae.
(b) Use of Algae in experimental studies.

Module 5: 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, Gonium, Eudorina, Pandorina, Volvox, Tetraspora, Ulothrix, Microspora, Ulva, Shizomeris, Cladophora, Pithophora. Coleochaete, Chaetophora, Drapernaldia, Drapernaldiopsis, Trentepohlia, Fritschiella, Cephaleuros, Oedogonium, 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.

Additional Credit :

1. Photobiology and Molecular Biology of Cyanobacteria (18 hrs)

a. Molecular aspects of cyanobacterial nitrogen fixation: Genetic structure of the N_2 fixation system, molecular mechanisms of heterocyst differentiation and metabolism, genetic aspects of nitate, nitrite and ammonia assimilation

b. Accessory light harvesting complex: Phycobilisomes, phycobiliproteins, linker polypeptides, energy transfer, gene organization, chromatic adaptation and gene expression
c. Photobiology: Photobiological and molecular aspects of UV-induced damage and repair in cyanobacteria
d. Molecular mechanisms of photoprotection: Mycosporine-like amino acids (MAAs), scytonemin
e. Cyanobacterial toxins: Types of cyanobacterial toxin, molecular tools for the identification of toxic cyanobacteria, biochemical and molecular aspects of toxin production, ecological implications
f. Basic strategies for the generation of transgenic cyanobacteria.

2. Applied Phycology (18 hrs)

a. Models (Monod and Droop) of nutrient-regulated phytoplankton growth; common methods for mass cultivation of microalgae
b. Causal factors and dynamics of freshwater and marine algal blooms; physical and chemical means and bio-manipulation (top-down and bottom-up) for controlling nuisance blooms
c. Consequences of blooms including toxins of cyanobacteria and dinoflagellates; algal biofouling of ships and its control
d. Commercial potential of *Spirulina*, *Dunaliella* and *Porphyra*; hydrogen production by algae
e. High-rate algal ponds for the treatment of wastewaters and for the production of useful biomass and energy; immobilized and inactivated algal biomass for metal and nutrient removal
f. A brief account of cyanobacterial genomics and proteomics
g. Paddy field cyanobacteria: Qualitative and quantitative assessment of their biodiversity using molecular tools; their use as biofertilizer, reclamation of usar lands
h. Influence of salt, heavy metals and acid rain on algae: Physiological and biochemical effects; biochemical and molecular mechanisms of tolerance
i. Bioassays and field assessment of pollutant effects; single and multispecies laboratory bioassays; taxonomic and non-taxonomic approaches for the assessment of pollutant effects in nature

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21. Philipose, M.T. (1967). *Chlorococcales*. Indian Council of Agricultural Research, New Delhi.
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16P2BOTT02: MYCOLOGY AND CROP PATHOLOGY
(Theory 45 + 27 hrs; Practical 36 + 18 hrs; Credits: 4)

Course Objectives

- To enable the students to collect, preserve, identify and classify different micro and macro fungi.
- To have a better understanding on different classification systems and their applications.
- To enrich the significance of mycotic diseases
- To have advanced learning about fungal associations, their usefulness and harmfulness
- To develop advanced theoretical and practical knowledge about phytopathogens and their control.

MYCOLOGY (45hrs)

Course Introduction

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) [(12)]. 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).

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11. R Dayal. Predaceous Fungi. Commonwealth Publishers.
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CROP PATHOLOGY (Theory - 27hrs; Practical - 18 hrs)

Course Introduction

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

Module 1: Process of infection and pathogenesis (4 hrs)

(a) Disease triangle, Mazz's Disease Pyramid
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)
Strategies used by pathogens to attack plants:

(b) Mechanism of infection- Penetration and entry of pathogen into host tissue – mechanical, physiological and enzymatic.
(c) Host-parasite interaction
(d) Role of Biochemicals in Pathogenesis:
i. Role of enzymes in Pathogenesis:
ii. Role of toxins in Pathogenesis: (Tabtoxin, Phaseolotoxin, Tentoxin, Cercosporin, Victorin, T Toxin, HC Toxin).
iii. Role of growth regulators in Pathogenesis
iv. Role of polysaccharides in Pathogenesis
(e) Detoxification of low molecular weight antimicrobial molecules produced by plants, suppression of plant defense responses Pathogenicity and virulence factors in viruses and viroids

(f) 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)

Non-host resistance, horizontal resistance, vertical resistance
(a) 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)

(b) 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.

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16P3BOTT03: ECOLOGY, ENVIRONMENTAL BIOLOGY, PHYTOGEOGRAPHY AND RESEARCH METHODOLOGY
(Theory 54 + 18 hrs; Practical 27 + 9 hrs; Credits 4)

Course Objectives

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

Introduction to the Course

(a) Significance of habitat, biodiversity, ecological niche, trophic level, primary and secondary productivity, food chains, food webs, ecological pyramids, energy flow and nutrient cycles.
(b) Water pollution: different types of pollutants and their consequences; a case study - water shed management, waste water treatment. Waste water treatment with aquatic macrophytes.
(c) Air pollution: Air quality standards and index, ambient air monitoring using high volume air sampler, types and sources of air pollutants, air pollution and human health hazards, control of air pollution.
(d) Noise pollution.
(e) Radioactive and thermal pollution: Causes and hazardous effects, effective management.
(f) Ecotourism - scope and importance in Kerala.

Module 1: Intoroduction (2 hrs)

(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 Soil (3 hrs)

(a) Origin, development and formation of soil
(b) Soil profile- tropical and temperate.
(c) Types of soil in India,
(d) Importance of soil in C, N, P cycles.

Module 2: Population Ecology (6hrs)
Autecology

(a) Characteristics of populations - size and density (relative density), structure, dispersion, age structure, natality and mortality, carrying capacity, autecology and genecology.

(b) (b) Population growth - factors affecting population growth, environmental resistance, biotic potential, carrying capacity, positive and negative interaction, migration, subsistence density, security and optional density. Ecological consequence of overpopulations.
(c) Population fluctuations density dependent and independent controls. Life history strategies, *r &k* selection.
(d) Concept of meta-population
(e) Interactions within populations- inter-specific and intra specific interactions, migrations. Impacts (ecological and evolutionary) effects of competitions among individuals.
(f) Modelling population structure and interactions. Network analysis of interactions

Module 3: Community ecology (7hrs)

(a) Concept of community ecology- Community structure and attributes, ecotone, edge effect.

(b) 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, Evenness,

(c) Guild and its functioning in the community.

(d) Functional aspects of community; co-existence, resource partitioning, spatial correlates of communities, inter specific interactions, co evolution and coexistence. Community network; examples of interspecific interactions: competition, Predation, mutualism, symbiosis, commensalism, ammensalism.

(e) Modelling the interspecific interactions by using network analysis approach.

Module 4: Ecological succession (3 hrs)

(a) Concept of Ecological succession;
(b) Types of succession
(c) Mechanisms in succession
(d) Concept of climax community

Module 5: Biosphere and Ecosystem (3 hrs)

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: Phytogeography (5hrs)

(a) Definition, principles governing plant distribution, factors affecting plant distribution, theories of distribution, Age and area hypothesis, Satpura hypothesis, different types of distribution of vegetations on the earth, continuous and discontinuous distribution, endemic species.

(b) Biogeography: continental drift, land bridges, sea routes, Wallace effect; Island theory of biogeography; effect of altitude and latitude on species diversity.

(c) Geology and Climate in relation to phytogeography, vegetation and eco/biogeographical zones of India.

(d) Remote sensing: Definition and data acquisition techniques. Application of GIS in remote sensing of vegetation classification and resource mapping, understanding the key environmental issues and ecosystem management.

Module 7: Global warming and climate change (3hrs)

(a) Global warming, greenhouse gases, acid rain, ozone depletion.
(b) Holistic relationship between air water and land pollution.

Module – 8: The Western Ghats (5 hours);

(a) Importance, origin, geology, vegetation, diversity, resources, Concept of hotspot (The Western Ghats as a biodiversity hotspot).
(b) Conservation biology based on case studies from the Western Ghats.
(c) Vegetation types of the Western Ghats.
(d) Sustainable development based on the resources of the Western Ghats.
(e) Mangrove ecosystem and its significance in the western coast of Peninsular India.

Module- 9: Conservation Biology (3 hrs)

Definition, global and regional significance, Issues related to conservation of natural resources in the Western Ghats, Methods in conservation biology. Approaches in conservation biology: Hotspot concept, Major Tropical Wilderness Area concept, Endemic bird Area concept, UNESCO natural heritage site concept, Protected Areas concept, JFM, Agro-forestry concept, etc. Resource map of protected areas of Kerala. Red listed plants of Kerala flora based on latest IUCN information.

Module 10: Environmental biotechnology and solid waste management (3 hrs)

Concept of waste, types and sources of solid wastes including e-waste. Bioremediation, Phytoremediation, bioaugmentation, biofilms, biofilters, bioscrubbers and trickling filters. Use- of bioreactors in waste management.

Module- 11: Case studies (2 hours)

Any two relevant publications from peer reviewed journals.

Extra credit (36 hrs)

a) Behavioural Ecology: Altruism, Group Living, Foraging Behaviour, Mating Systems and Co-evolution.
b) Causes of Extinction (mass extinction).
c) Species Interactions; Competition and Coexistence, Facilitation, Herbivory, Predation, Parasitism, Population Regulation.
d) Island Biogeography
e) Biomes; Terrestrial Biomes, Marine Biomes, and Freshwater Biomes.
f) Life Tables and Demography
g) Physiological Ecology; Temperature, Water and Nutrients.
h) Degradation of organic matter in forest floor- role of soil microbes.
i) Soil nutrition.
j) EIA; with suitable case study.
k) Climate change; the present scenario on a global scale.

Practicals

1. Determination of soil profile
2. To determine organic 'C' and organic matter (biomass) in different (at least 3) locations (forest, agro ecosystem and polluted area.
3. Network analysis to find out the possible interspecific interaction in any local plant community.
4. Study the frequency, density, Basal Area, IVI and evenness of individuals/ species
5. Statistical analysis of diversity indices by using apt softwares
6. Interpretation of GIS/remote sensing data for landscape differentiation
7. Analysis of water collected from different localities (polluted, less polluted, and potable/tap water) to determine the toxicological levels
8. Field visit to a forested area and collect data on species diversity (measures) and community characteristics
9. Vegetation sampling methods
10. Quantification of nitrite /phosphate /sulphate in the water sample.

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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

RESEARCH METHODOLOGY (18 hrs)

Module 1: Introduction (2 hrs)
Need for research, stages of research; Generation of a research problem, execution of work.

Module 2: Tools in Review of literature (4 hrs)
(a) Library: (i) Structure of a scientific library, journals (current and back volumes), books.
(ii) Catalogue: Types of catalogues - Card catalogue, computerized catalogue (iii) Classification of books (Universal Decimal System).
(b) Journals: Indexing journals, abstracting journals, research journals, review journals, e-journals. Impact factor of journals, NCBI-Pub Med. Plagiarism. Style manuals.
(c) Other sources of references: (i) Reprints - acquisition and filing (ii) Secondary storage devices - pen drive, external hard drive, DVD and CD ROM (iii) Internet, open access initiative, INFLIBNET, INSDOC.
(d) Preparation of index cards: Author index and subject index; Open source bibliography management system.

Module 3: Preparation of project proposals (2 hrs)
(a) Title, Introduction, literature review and abstract (b) Aim and scope (c) Present status (d) Location of experiments (e) Materials and methods (f) Justification (g) Expected outcome (h) Plan of action (g) Estimated date of completion (h) Proposed Budget (i) References (j) Funding agencies.

Module 4: Management of Data (3 hrs)
(a) Different types of data (b) Arrangement and sorting of data (c) Analysis (d) Tools for data management (softwares) (e) Interpretation of data

Module 4: Presentation and publication of research outcomes (7 hrs)
(a) Preparation of a dissertation: (i) Consolidation of data, photographs, illustration, tables and graphs (ii) Preparation of the outline (iii) Preparation of manuscript - introduction, review of literature, materials and methods, results, discussion, bibliography/ references (methods of citing references, arrangement of references), summary (iv) Preliminary pages - title page, certificates, acknowledgements, and contents page.
(b) Preparation of research paper and short communications based on a model paper from 'Annals of Botany' or any other relevant Botany/ Ecology journals.
(c) Preparation of review articles.
(d) Proof reading - standard abbreviations for proof correction.
(e) Presentation of research findings in seminars and workshops; oral presentation and poster presentation.

Practical (9 hrs)
1. Prepare a review article based on a theme suggested by the course teacher.
2. Prepare a project proposal.
3. Prepare an outline of dissertation and research paper along with reference citation in standard format.
4. Present a project in the class with the help of 'pptx' and submit the soft copy for evaluation.

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3. Bercy R (1994). *The research project, how to write it*. Rutledge, London.

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11. Victoria E McMillan (1997). *Writing papers in the biological sciences* (II Edn). Bedford books.
12. www.opengate.com

16P4BOTT04: CELL BIOLOGY
(Theory 54 hrs; Practical 27 hrs; Credits: 3)

Course Objectives

- To understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles
- To understand how the cellsinteract among themselves and with the environment through signal molecules.
- To get an in depth knowledge in cytoskeleton, endomembrane system, protein trafficking and cell cycle.
- To get a chance to familiarize with recent advancements in Chloroplast and Mitochondrial research.
- To learn the molecular mechanisms of cancer.
- To get a 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
g) Basics of DNA replication, Transcription, and Translation.

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

(a) Brief history of studies on plasma membrane structure [1, 4, 5]. Fluid mosaic model [1, 2, 3, 4, 5].
(b) The chemical composition of membranes: the structure and functions of membrane proteins, lipids and carbohydrates [1, 2, 3, 4, 5].
(c) Membrane lipids and membrane fluidity: importance of membrane fluidity, maintaining membrane fluidity [1, 2, 3, 4].
(d) The dynamic nature of the plasma membrane [1, 2, 3, 4, 5].
(e) Transport of molecule across cell membrane: passive diffusion, facilitated diffusion, active transport [1, 2, 3, 4, 5].
(f) Membrane functions [1, 2].

Module 2: Nucleus (7 hrs)

(a) Structure of eukaryotic nucleus: Nuclear Envelope, Nuclear Pore Complex [1, 2, 3, 4, 5].
(b) Transport into and out of the Nucleus: Nuclear-Localization Signals, Nuclear-Export Signals, Ran-GTP and Ran-Independent Mechanisms [1, 2, 3, 4, 5].
(c) Bacterial Chromatin. Compaction of bacterial chromosome – Muk B proteins. [14]
(d) Structure of chromatin and chromosomes: histones and nonhistone proteins, nucleosomal organization of chromatin, higher levels of chromatin structure. Heterochromatin and Euchromatin, formation of heterochromatin. Chromosomal packing and structure of metaphase chromosome. Molecular structure of the Centromere and Telomere [1, 2, 3, 4, 5, 6, 11, 12, 13, 14].

Module 3: Cell Cycle (8 hrs)

(a) Phases of cell cycle [1, 2, 3, 4, 5, 6].
(b) Cell division: mitosis and meiosis. Significance of meiosis in generating genetic variation [1, 2, 3, 4, 5, 6].
(c) Cyclins and cyclin-dependent kinases, Regulation of CDK Activity, Commitment to the Cell Cycle and DNA Replication, Entry into Mitosis, Completion of Mitosis [1, 2, 3, 4, 5, 6].

(d) Surveillance Mechanisms in Cell Cycle Regulation- Cell-cycle checkpoints [1, 2, 3, 4, 5, 6].

Module 4: The Endomembrane System (9 hrs)

(a) Inrtoduction: outline of endomembrane system [1, 2, 3, 4, 5].
(b) The endoplasmic reticulum: smooth and rough endoplasmic reticulum, synthesis of proteins on membrane-bound and free ribosomes and processing [1, 2, 3, 4, 5].
(c) The golgi complex: glycosylation, movement of materials through the golgi complex [1, 2, 3, 4, 5].
(d) Types of vesicle transport and their functions [1, 2, 3, 4, 5].
(e) Lysosomes [1, 2, 3, 4, 5].
(f) (f) Peroxisomes [1, 2, 3, 4, 5].
(g) (g) Plant cell vacuoles [1, 2, 3, 4, 5].
(h) Targeting of proteins to mitochondria, chloroplasts and peroxisomes [1, 2, 3, 4, 5].
(i) The endocytic pathway: endocytosis and phagocytosis [1, 2, 3, 4, 5].

Module 5: Chloroplast and Mitochondria (6 hrs)

(a) Evolutionary Origin of Mitochondria, Structure and Morphology. Integration into the Cell, Biogenesis of Mitochondria, Mitochondrial Genome, Metabolic Pathways Inside Mitochondria, Mitochondrial Mutations and Disease, Mitochondrial DNA Sequencing, Mitochondria and Cancer, Mitochondria and Pharmacology [1, 2, 3, 4, 5, 7, 10].
(b) Historical Perspectives: The Beginnings of Research on Photosynthesis, Structure of the Chloroplast, Proplastid to Chloroplast Transformation, Characteristic Components of Chloroplast Membranes, The Chloroplast Genome and Its Expression, Development of Chloroplasts: Structure and Function, Development of Chloroplasts: Biosynthetic Pathways and Regulation [1, 2, 3, 4, 5, 8, 9].

Module 6: The Cytoskeleton (8 hrs)

(a) Overview of the major functions of the cytoskeleton [1, 2, 3, 4, 5].
(b) Microtubules: microtubule structure and organization, microtubule dynamics, microtubule-based motor proteins: kinesins and dyneins [1, 2, 3, 4, 5].
(c) Microfilaments: microfilaments and actin structures, dynamics of actin filaments, actin-based motor proteins: myosins [1, 2, 3, 4, 5].
(d) Intermediate filaments: intermediate filament assembly and disassembly, types and functions of intermediate filaments [1, 2, 3, 4, 5].
(e) Coordination and cooperation between cytoskeletal elements [2, 5].

Module 7: Cell Signaling (12 hrs)

(a) Modes of cell-cell signaling [2, 3].
(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 [1, 2, 3, 4, 5].
(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 [1, 2, 3, 4, 5].
(d) Pathways of Intracellular Signal Transduction: cAMP pathway, Cyclic GMP, Phospholipids and Ca^{2+} [1, 2, 3, 4, 5].

Module 8: Cell Death and Cell Renewal (5 hrs)

(a) Stem cells, Early Metazoan Development, Embryonic Stem Cells, Factors Controlling the Pluripotency of ES Cells, Induced Pluripotent Stem (iPS) Cells [1, 2, 3, 4, 5].
(b) Programmed cell death, Extrinsic and Intrinsic Pathway of Apoptosis, Proteins involved in the Apoptotic Pathway [1, 2, 3, 4, 5].

Module 9: Cancer Biology (8 hrs)

i) The Development and Causes of Cancer: Types of cancer, The development of cancer, Causes of cancer, Properties of cancer cells, Transformation of cells in culture [1, 2, 3, 4, 5].

ii) Tumor Viruses: Hepatitis 8 and C viruses, Small DNA tumor viruses, Herpesviruses, Retroviruses [1, 2, 3, 4, 5].

iii) Oncogenes Retroviral oncogenes, Proto-oncogenes, Oncogenes in human cancer, Functions of oncogene products [1, 2, 3, 4, 5].

iv) Tumor Suppressor Gene: Identification of tumor suppressor genes, Functions of tumor suppressor gene products, Roles of oncogenes and tumor suppressor genes in tumor development [1, 2, 3, 4, 5].

Practicals

1. Study of meiosis in *Rhoeo*/*Chlorophytum* by smear preparation of PMCs.
2. Study of giant chromosomes in Drosophila/Chironomus.
3. Determination of mitotic index in the squash preparation of onion root tip
4. Effect of drugs on cell division (Colchicine or any other inhibitor).
5. Chromosome banding and staining techniques- Giemsa Staining, Q-Banding, G-Banding, R-Banding, C-Banding.
6. Isolation of plant cell organells.

Additional Credits Topics (36 hrs)

Nucleus (4 hours)

(a) Variation in chromosome: variation in chromosome structure- duplications, deletions, inversions, and translocations. Variation in chromosome number: aneuploidy- types of aneuploidy. Polyploidy: autopolyploidy, allopolyploidy [11, 12, 13].

Interactions between Cells and their Environment (10 hrs)

(a) Extracellular matrix and its composition: collagens, elastin, proteoglycans, fibronectin, laminin, dystrophin [1, 2, 3, 4, 5].

(b) Proteins in cell-cell interaction: cadherins, immunoglobulin super family, integrins, and selectins[1, 2, 3, 4, 5].

(c) Cell-cell interactions: adhesion junction, tight junctions, gap junctions and plasmodesmata [1, 2, 3, 4, 5].

(d) Plant cell wall [1, 2, 3, 4, 5].

Cell Signaling (12 hrs)

(a) Pathways of Intracellular Signal Transduction: The Pl3-kinase/Akt and mTOR pathways, MAP kinase pathways, The JAK/STAT and TGF-β/Smad pathways, NF-κB signaling, The Hedgehog, Wnt, and Notch/Delta, SREBP pathways [1, 2, 3, 4, 5].

(b) Signal Transduction and Cytoskelton: lntegrins and signal transduction, Signaling from cell adhesion molecules, Regulation of the actin cytoskeleton [1, 2, 3, 4, 5].

(c) Signaling networks: Convergence, Divergence, and Cross-Talk among Different Signaling Pathways [1, 2, 3, 4, 5].

Cancer Biology (10 hrs)

(a) Cancer and Mutation of Cell Division and Checkpoint Regulators: G1-S, p53, Apoptotic genes, miRNA [1, 2, 3, 4, 5].

(b) Carcinogens and Caretaker Genes in Cancer: Direct-acting carcinogens, indirect-acting carcinogens. Cancer and of DNA-Repair Systems. Cancer and Telomerase [1, 2, 3, 4, 5].

(c) Molecular Approaches to Cancer Treatment [1, 2, 3, 4, 5].

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Model Question Paper

SACRED HEAR COLLEGE (AUTONOMOUS), THEVARA

M.Sc. Botany Semester I

16P1BOTT01: MICROBIOLOGY AND PHYCOLOGY

Time 3 hours **Total Marks 75**

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

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.

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

(7 x 5 = 35 marks)

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

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

OR

24. Give an account of the thallus organisation of Chlorophyceae in an evolutionary perspective.

31. 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 HEAR COLLEGE (AUTONOMOUS), THEVARA

M.Sc. Botany Degree Semester I

16P2BOT02: 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.
24. Write an essay on the common strategies adopted to control plant diseases
25. Describe the process of infection and pathogenesis in plants.
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=12 marks)

Model Question Paper

SACRED HEAR COLLEGE (AUTONOMOUS), THEVARA

M.Sc. Botany Semester I

16P3BOTT03: 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 to 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. Which 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 HEAR COLLEGE (AUTONOMOUS), THEVARA

M.Sc. Botany Semester I

16P4BOTT04: 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.
24. Describe the signaling molecules and their receptors.
25. Explain programmed cell death.
26. With suitable diagrams explain the chemical composition of plasma membrane.

(12 x 2 = 24 marks)

Model Question Paper

SACRED HEAR COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany Semester I
Practical Course – 1 [Code: 16P1BOTP01]
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 HEAR COLLEGE (AUTONOMOUS), THEVARA

M.Sc. Botany Semester I

Practical Course – 2 [Code: 16P1BOTP02]

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

Time 3 hours **Total Marks 40**

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, Caculation- 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: <u>Semester 1 Practical course 2</u>

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
16P2BOTT05	Bryology + Pteridology	36 + 36	18 + 36	4
16P2BOTT06	Molecular Biology & Immunology	54 + 18	9 + 18	4
16P2BOTT07	Plant Anatomy, Principles of Angiosperm Systematics & Morphology	36 + 27 + 9	36 + 27	4
16P2BOTT08	Genetics & Biochemistry	15 + 39	9 + 18	3
16P2BOTP03	Practicals of **16P2BOTT05 + 16P2BOTT06**			2
16P2BOTP04	Practicals of **16P2BOTT07 + 16P2BOTT08**			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.			

16P2BOTT05: BRYOLOGY AND PTERIDOLOGY
(Theory 36 + 36 hrs; Practical 18 + 36 hrs; Credits: 4)

Course Objectives

- To help students to understand the diversity of primitive land plants.
- To get familiarized with the morphological and anatomical features of bryophytes and pteridophytes.
- To identify the main characteristics of bryophytes and pteridophytes.
- To chart the development of land adaptations in the bryophytes and pteridophytes.
- To get acquainted with various lifecycle events in the bryophyte and pteridophytes.
- To understand the evolutionary trends primitive plant groups.
- To enable the identification skills.

BRYOLOGY (36 hrs)

Introduction Course

- General characters, Classification, evolution of bryophytes
- Morphology, anatomy and reproduction of Riccia, Marchantia&Anthoceros.
- Importance of bryophytes

Module 1: General introduction (5 hrs)
Introduction to Bryophytes, their fossil history and evolution. Concept of algal and pteridophytic originof Bryophytes. General characters of Bryophytes. History of classification of Bryophytes. Modern trends in classification of Bryophytes. DNA barcoding of bryophytes. 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, droughttolerance, 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 Usesiii) as source of foodiv) 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 thefollowing 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).

Practical (18 hrs)

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

2. Students are expected to submit 5 bryophyte specimen's herbarium and also a report of field trip to bryophyte's natural habitats to familiarize with the diversity of Bryophytes.

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PTERIDOLOGY (36 hrs)

Introduction Course

- Introduction, general characters, classification and evolution of pteridophytes
- 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):

(I) Psilopsida (a) Rhyniales; *Rhynia*
(II) Psilotopsida (a) Psilotales; *Psilotum*
(III) Lycopsida (a) Protolepidodendrales; *Protolepidodendron* (b) Lycopodiales; *Lycopodium*, (c) Isoetales; *Isoetes* (d) Selaginellales; *Selaginella*.
(IV) Sphenopsida (a) Hyeniales (b) Sphenophyllales; *Sphenophyllum* (c) Calamitales; *Calamites*

(d) Equisetales; *Equisetum*.

(V) Pteropsida (i) Primofilices (a) Cladoxylales; *Cladoxylon* (b) Coenopteridales.

(ii) Eusporangiatae (a) Marattiales; *Angiopteris* (b) Ophioglossales; *Ophioglossum*.

(iii) Osmundales; *Osmunda*.

(iv) Leptosporangiatae (a) Marsileales; *Marsilea* (b) Salviniales; *Salvinia, Azolla* (c) 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 inan evolutionary perspective, an account on 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.

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16P2BOTT06: MOLECULAR BIOLOGY AND IMMUNOLOGY
(Theory 54+18 hrs; Practical 9+18 hrs; Credits: 4)

Course Objectives

- To understand the basic properties, structure and functions of genetic materials.
- To understand the central dogma of molecular biology.
- To get a thorough knowledge in gene expression mechanisms.
- To acquire a basic knowledge to prepare for competitive examinations in life science.
- To learn about the structural features of the components of the immune system as well as their functions, but the primary emphasis of this course will be on the mechanisms involved in immune system development and responsiveness.

MOLECULAR BIOLOGY (T = 54 hrs, P =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, preferred tautomeric forms of bases.
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 (12 hrs)

a. Alternative conformations of DNA – A-DNA, Z-DN, C-DNA, E – DNA, triplex DNA, H-DNA and quadruplex DNA, circular and linear DNA, single-stranded DNA.
b. Structure and function of different types of RNA - mRNA, tRNA, rRNA, SnRNA, and Micro RNA. RNA tertiary structures. Ribozymes – Hammerhead ribozymes.
c. C-value paradox, DNA renaturation kinetics, Tm, Cot curve. Unique and Repetitive DNA – mini- and microsatellites.

Module 2: DNA replication, repair and recombination (13 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 Ds elements, 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 (13 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 (9 hrs)

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

IMMUNOLOGY (18 hrs)

Module 1 (10 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. Primary and secondary immune modulation, complement system, pattern recognition receptors – toll-like receptors. MHC molecules. Cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity, congenital and acquired immunodeficiencies.

Module 2 (3 hrs)

a. Generation of antibody diversity.
b. Production and uses of monoclonal antibodies, antibody engineering.

Module 3 (5 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.

Extra Credit:

1. Allergy, Hypersensitivities, and Chronic Inflammation - Allergy: Type I Hypersensitivity Reaction, Antibody-Mediated (Type II) Hypersensitivity Reactions, Immune Complex-Mediated (Type III) Hypersensitivity, Delayed-Type (Type IV) Hypersensitivity (DTH), and Chronic Inflammation. Transplantation Immunology, Cancer Immunotherapy.
2. Chemical bonds – weak bonds in biological systems.
3. DNA topology – DNA super coiling and topo-isomerase.
4. Homologous recombination and mating type switching.
5. Homeotic genes.

Virtual lab experiments (18 hrs):

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

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16P2BOTT07: PLANT ANATOMY, PRINCIPLES OF ANGIOSPERM SYSTEMATICS & MORPHOLOGY
(Theory 36 + 27 + 9 hrs; Practical 36 + 9 + 18 hrs; Credits 4)

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.

PLANT ANATOMY (36 hrs)
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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3. Ella Werker (1997). Seed Anatomy. Borntreager.
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5. Elizabeth G Cutter (1978). Applied Plant Anatomy. Clive and Arnald Ltd.
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23. Wardrop A B (1964). Reaction wood Anatomy in Arborescent angiosperms. Formation of wood in forest trees (Ed, Zimmerman). Academic press, New York.

PRINCIPLES OF ANGIOSPERM SYSTEMATICS & MORPHOLOGY (27 hrs)

Module 1: Scope and significance of Taxonomy (2 hr)
Historical background of classification - Artificial, natural and phylogenetic systems. Importance of taxonomy.

Module 2: Concepts of Taxonomic hierarchy (2 hrs)
Species/Genus/Family and other categories; species concept and intraspecific categories - subspecies, varieties and forms.

Module 3: Phylogeny of Angiosperms (6 hrs)
Important phylogenetic terms and concepts: Plesiomorphic and Apomorphic characters; Homology and Analogy; Parallelism and Convergence; Monophyly, Paraphyly and Polyphyly. Phylogenetic tree - Cladogram and Phenogram.

Module 4: Data sources of Taxonomy (3 hrs)
Concepts of character; Sources of taxonomic characters - Anatomy, Cytology, Phytochemistry and molecular taxonomy.

Module 5: Concept and principles of assessing relationships (4 hrs)
Phenetic - Numerical Taxonomy - principles and methods; Cladistic - Principles and methods.

Module 6: Botanical nomenclature (6 hrs)
History of ICBN, aims and principles, rules and recommendations: rule of priority, typification, author citation, retention, rejection and changing of names, effective and valid publication.

Module 7: Synthetic approaches to the systematics of angiosperms (4 hrs)

Chemotaxonomy, basic concepts of genome analysis – DNA bar coding.

Module 8: Morphology of Angiosperms (9 hrs)
Habitat and habit; Morphology of root, stem, leaf, bract and bracteoles, inflorescence, flowers, fruits and seeds.

Practical (27 hrs)

1. Morphology of leaf: Leaf attachment, Stipules, Patterns of leaf, Phyllotaxy, Shapes of leaf lamina, bases, margins and tips, Venation.
2. Inflorescence: Racemose - Simple raceme, Compound raceme, Spike, Spikelet, Catkin, Spadix, Corymb, Simple umbel, Compound umbel, Panicle, Capitulum. Cymose - Solitary cyme, Mono-, Di-and polychasial cyme. Special types - Cyathium, Verticillaster, Hypanthodium, Coenanthium.
3. Morphology of stamens: Mono-, Di- and Polyadelphous; Epipetalous, Syngenesious, Synandrous, Polyandrous, Didynamous, Tetradynamous, Basifixed, Dorsifixed, Versatile.
4. Morphology of carpels: Apocarpous, Syncarpous, Gynostegium. Placentation - Marginal, Parietal, Axile, Free central, Basal and Pendulous.
5. Morphology of fruits: Berry, Drupe, Hesperidium, Pepo, Balausta, Amphisarca, Achene, Follicle, Capsule, Legume, Lomentum, Nut, Caryopsis, Cypsela, Samara, Cremocarp, Siliqua, Carcerule, Regma.
6. Aggregate fruits; Composite fruits - Sorosis and Syconus; Pome.
7. Draw the L.S and floral diagram of at least 10 flowers having different ovary positions - hypogyny, perigyny and epigyny.
8. Workout nomenclatural problems regarding priority and author citations.

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3. Cole A J (1969). Numerical Taxonomy. Academic Press.
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16P2BOTT08: GENETICS AND BIOCHEMISTRY
(Theory 18 + 54 hrs; Practical 18 + 18 hrs; Credits 4)

Course Objectives

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

Introduction to the Course

Mendelian ratios, Incomplete dominance, gene interactions, epistasis, multiple alleles, Quantitative characters, linkage and crossing over, sex determination and extra-nuclear inheritance.

GENETICS (15hrs)

Module 1: History of Genetics (2 hrs)

Transmission genetics, Molecular genetics and Population genetics (brief introduction). Mendelism –basic principles (brief study). Extensions of Mendelism, penetrance and expressivity of genes. Nonmendelian inheritance – cytoplasmic inheritance. Sex determination in animals and plants.

Module 2: Linkage and genetic mapping (6 hrs)

Linkage and Crossing over - Stern's hypothesis, Creighton and McClintock's experiments, single cross over, multiple cross over, two-point cross, three-point cross, map distances, gene order, interference and co efficient of coincidence. Haploid mapping (Neurospora), Mapping in bacteria and bacteriophages. Inheritance of traits in humans; pedigree analysis, determination of human genetic diseases by pedigree analysis, genetic mapping in human pedigrees.

Module 3: Quantitative genetics (2 hrs)

Polygenic inheritance, QTL, effect of environmental factors and artificial selection on polygenic inheritance.

Module 4: Population genetics (5hrs)

(a) Gene pool, allele and genotype frequency. Hardy-Weinberg law and its applications, estimation of allele and genotype frequency of dominant genes, co-dominant genes, sex-linked genes and multiple alleles. Genetic equilibrium, genetic polymorphism.

(b) Factors that alter allelic frequencies; (i) mutation (ii) genetic drift - bottle neck effect and founder effect (iii) migration (iv) selection (v) nonrandom mating, inbreeding coefficient.

Practical (18 hrs)

1. Workout problems related to linkage, crossing over and gene mapping, human pedigree analysis.
2. Workout problems in population genetics - gene and genotype frequency, Hardy Wienberg equilibrium.

References

1. Benjamin Lewin (2000). Genes VII. Oxford university press.

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7. Daniel L Hartl, Elizabeth W Jones (2009). Genetics: Analysis of genes and genomes (VII Edn). Jones and Bartlett publishers.
8. D Peter Snustad, Michael J Simmons (2010). Principles of genetics (V Edn). John Wiley and Sons.

BIOCHEMISTRY (54 hrs)

Introduction to the Course

Carbohydrates
Structure and Biological Functions (2, 3, 4, 6, 8). Monosaccharides: Classification, structure, (2, 3, 4, 6, 8). Oligosaccharides: Structure, formation; common examples – sucrose, lactose (2, 6, 8). Polysaccharides: Classification, functions – structure of cellulose, starch and glycogen (2, 3, 4, 6, 8).

Lipids
Classification, properties, functions (2, 3, 4). Structure of fatty acids, essential fatty acids (2, 3, 4). Storage lipids – triglycerols.

Module 1: pH, Buffers (5 hrs)
Acids and bases (1), strength of acids – strong acids, weak acids (1, 7). Ionization of water – Kw, pH (1, 2, 3, 4, 7, 8). Dissociation of acids – pKa, Henderson-Hasselbalch equation (1, 2, 3, 4, 7, 8). Buffers (7) – definition, chemical composition, requirements for a good buffer, buffer action, buffer capacity (1). Measurement of pH – colorimetric methods and electrometric methods (1)

Module 2: Carbohydrates (3 hrs)
Sugar derivatives:Glycoproteins, proteoglycans, mucoproteins (2, 3, 4, 6). Lectins (2, 3).

Module 3: Lipids (3 hrs)
Structural lipids – membrane lipids. Lipid biosynthesis, fat breakdown – β oxidation (2, 3, 4, 6, 8)

Module 4: Amino acids (3 hrs)
Structure and classification of amino acids (2, 3, 6). Biosynthesis of amino acids (2, 9).

Module 5: Proteins (8 hrs)
Classification of proteins based on structure and function (2, 5). Oligo- and polypeptides (2, 3, 6). Primary structure – peptide bond (5, 6). Secondary structure – Ramachandran plots, α-helix, β sheet (2, 3, 4, 5, 6, 8). Tertiary structure – forces that stabilize tertiary structure (2, 3, 4, 5, 8). Quaternary structure, domains, motif and folds (5, 6). Protein sequencing – Edman method (2, 6, 7, 8). Functions of proteins (2, 6).

Module 6: Protein turnover and amino acid catabolism (5 hrs)
Degradation of proteins to amino acids, Protein turnover and its tight regulation, steps involved in amino acid degradation.

Module 7: Enzymes (15 hrs)
(a) Principles of catalysis: Activation energy of a reaction (2, 3, 4, 6). 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 (2, 6, 8). Factors affecting enzyme activity (6, 7).
(c) Enzyme Kinetics: Michaelis-Menton kinetics, Lineweaver-Burk plot (2, 4, 6, 7, 8). Mechanism of multi substrate reaction – Ping Pong, Bi-Bi mechanism (2, 7, 8).
(d) Regulation of enzyme activity: Allosteric effect, control proteins, reversible covalent modification, proteolytic activation (2, 3, 6, 7, 8). Enzyme inhibition – reversible and irreversible inhibition, competitive, non-competitive, uncompetitive inhibition (2, 6, 7, 8), dixon plot (7).
(e) Cofactors and coenzymes: Essential ions, Coenzymes; structure and role of metabolite coenzymes (7, 8) – ATP; structure and role of vitamin derived coenzymes – NAD+, NADP+, FAD, FMN, TPP, PLP, Biotin (8). Isozymes (2).

Module 7: Nucleotide metabolism (4 hrs)
Functions of nucleotides, nucleotide biosynthesis by de novo pathways and salvage pathways (2).

Module 8: Secondary metabolites (6 hrs)
Classification, biosynthesis, and functions of terpenoids, alkaloids, phenolics, flavonoids, coumarins (9).

Practical (18 hrs)
1. Preparation of buffers of various strength and pH.
2. Differentiating sugars based on osazone formation.
3. Quantitative estimation of reducing sugar using Dinitro salicylic acid (DNS) or Anthrone.
4. Separation and analysis of lipids and amino acids by TLC.
5. Quantitative estimation of protein by Lowry's method.
6. Preparation of molal, molar, normal and percentage solutions and their dilutions.
7. Estimation of purity of DNA (By DNA protein ratio).
8. Estimation of catalase activity.
9. 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.
3. Michael M Cox, David L Nelson (2008). Lehninger Principles of biochemistry (V Edn). W H Freeman and company.
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Model Question Paper

SACRED HEART COLLEGE, THEVARA(AUTONOMOUS)
M.Sc. BOTANY Semester II
16P2BOTT05: BRYOLOGY AND PTERIDOLOGY

Time 3 hours **Total Marks 75**

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

1. What is Massula, what is its function?
2. What is sporocarpiferous branch, what is its function?
3. With help of a diagram describe the type of Stele in Osmunda rhizome?
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 HEAR COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany Semester II
16P2BOTT06: 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. What is the phenomenon of 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
26. Explain the production and uses of monoclonal antibodies.

(2 x 12 = 24)

Model Question Paper

SACRED HEAR COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany Semester II

16P2BOTT07: PLANT ANATOMY, PRINCIPLES OF 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
16P2BOTT08: GENETICS AND BIOCHEMISTRY

Time: 3 Hours **Maximum Marks: 75**

PART – A

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

27. Explain gene mapping in bacteria and bacteriophages.
28. What are the functions of nucleotides?
29. Explain Henderson-Hasselbalch equation.
30. Discuss the various factors affecting enzyme activity.
31. Distinguish between Mucoproteins and Glycoproteins.
32. Write short note on lectins.
33. Define cytoplasmic inheritance.
34. What you mean by genetic polymorphism.
35. What are isozymes?
36. Explain the structure of cellulose with a structural diagram?
37. What is Dixon plot?
38. Give an account on secondary metabolites.

(2x8=16)

PART – B

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

39. Describe buffer action, citing suitable examples?
40. Describe various factors that alter allele frequencies.
41. Explain Ramachandran plot and its application?
42. Discuss polygenic inheritance with suitable examples.
43. Describe the procedure of protein sequencing by Edman method.
44. Describe the structure and role of vitamin derived co-enzymes.
45. Explain the following with suitable examples;
    a. Dominance b. Incomplete dominance c. Codominance d. Over dominance
46. What is Hardy-Weinberg equilibrium? What are the applications of Hardy-Weinberg principles?
47. Discuss the β oxidation of fatty acids.

(5x7=35)

PART – C

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

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

OR

49. Wrire an essay on secondary metabolites**.**
50. Give an account on gene mapping of Haploid organisms.

OR

51. 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 – 16P2BOTP03
BRYOLOGY, PTERIDOLOGY, MOLECULAR BIOLOGY & IMMUNOLOGY
Time 3 hours **Total Marks 40**

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 – 16P2BOTP03
PLANT ANATOMY, ANGIOSPERM SYSTEMATICS, GENETICS & BIOCHEMISTRY
Time 3 hours **Total Marks 40**

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

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
16P3BOTT09	Taxonomy of Angiosperms	72	45	4
16P3BOTT10	Gymnosperms, Evolution & Paleobotany	27 + 18 + 9	27 + 0 + 9	3
16P3BOTT11	Plant Physiology & Metabolism	72	36	4
16P3BOTT12	Plant Reproductive Biology, Palynology & Plant Breeding	36 + 18 + 18	36 + 9 + 18	4
16P3BOTP05	Practicals of **16P3BOTT09 + 16P3BOTT10**			2
16P3BOTP06	Practicals of **16P3BOTT11 + 16P3BOTT12**			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.			

16P3BOTT09: TAXONOMY OF ANGIOSPERMS
(Theory 72 hrs; Practical 45 hrs; Credits 4)

Introduction to the Course
Classification systems; (i) Linnaeus (ii) Bentham & Hooker.
Herbaria and herbarium specimens.
Families: Annonaceae, Malvaceae, Sterculiaceae, Rubiaceae, Sapotaceae, Amaranthaceae, Palmae.

Module 1: Classification (8 hrs)
Major systems of angiosperm classification with special emphasis on the conceptual basis of the classifications of; (i) De Candolle (ii) Engler & Prantl (iii) Bessey (iv) Takhtajan (v) APG.

Module 2: Tools of Taxonomy (6 hrs)
Functions of field study, , botanical gardens, BSI, Taxonomic literature- Floras, eFlora, Monographs, Journals (Rheedea & Taxon/Blumea), Reviews and GIS (Geographic Information System). Construction of taxonomic keys – Punched Card Key, indented and bracketed.

Module 3: Angiosperm diversity with special reference to Tropical flora (48 hrs)
Study of the following families (Bentham & Hooker) in detail with special reference to their salient features, interrelationships, evolutionary trends and economic significance.
Polypetalae: 1. Rununculaceae 2.Magnoliaceae 3.Menispermaceae 4.Cruciferae 5.Capparidaceae 6.Polygalaceae 7.Caryophyllaceae 8.Guttiferae 9.Dipteriocarpaceae 10.Tiliaceae 11. Geraniaceae 12. Rutaceae#* 13. Vitaceae 14. Sapindaceae 15. Fabaceae 16.Caesalpiniaceae 17. Mimosaceae 18. Rosaceae 19. Lythraceae 20. Melastomaceae 21.Rhizophoraceae 22. Combretaceae 23. Myrtaceae 24. Cucurbitaceae 25. Apiaceae 26.Aizoaceae
Gamopetelae: 27. Compositae 28. Campanulaceae 29. Myrsinaceae 30. Loganiaceae 31.Oleaceae 32. Apocynaceae 33. Asclepiadaceae 34. Boraginaceae 35. Convolvulaceae* 36.Solanacea* 37. Scrophulariaceae 38. Bignoniaceae 39. Acanthaceae 40. Verbenaceae 41.Lamiaceae
Monochlamydeae: 42. Polygonaceae 43. Aristolochiaceae 44. Piperaceae 45. Lauraceae 46.Loranthaceae 47. Euphorbiaceae 48. Moraceae. 49. Urticaceae
Monocots: 50. Orchidaceae 51. Cannaceae 52. Dioscoriaceae 53. Liliaceae 54. Zingiberaceae 55. Musaceae 56. Araceae 57. Cyperaceae 58. Poaceae.

Module 4: Evolution of flowering plants (4 hrs)
Evolution and diversity of woody and seed plants (based on chapter 5 Simpson 2010)

Module 5: Ethnobotany (6 hrs)
Scope and importance of ethnobotany, sources and methods of ethnobotanical studies.
Two typical ethno botanical studies from Kerala. Bioprospecting, Patenting and Marketing of Plants of Ethno-botanical importance (based on any case study from Kerala). Utility indices of ethnobotanical products.

Practicals (45 hrs)
1. Work out a minimum of two members from each family with suitable sketches and description in technical terms.
2. Study of flora, construction of keys and use of floras in the identification up to species from any field study.
3. Preparation of dichotomous keys based on 4 sample plant materials from the same family.
4. Students should collect any five Ethnobotanical products and submit in dry form along with detailed notes (including id, family morphology, uses with respect to any ethnic group, if any) and familiarize with all the economically/ethnobotanically important plants of the families mentioned in the syllabus.

Field study: A field study for not less than 5 days under the guidance and supervision of teachers and preparation of a minimum of 35 herbarium specimens of different families with supporting field book.

References

1. Jain S K (1991). Dictionary of Indian Folkmedicine and Ethnobotany.
2. Paye G D (2000). Cultural Uses of Plants: A Guide to Learning about Ethnobotany. The New York Botanical Garden Press.
3. Hooker J D. The flora of British India (Vol. I – VII).
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6. Cronquist A (1981). An integrated system of classification of flowering plants. Columbia University Press.
7. Heywood V H, Moore D M (Eds) (1984). Current concepts in Plant taxonomy.
8. Radiford A E (1986). Fundamentals of plant systematics. Harper & Row.
9. Rendle A E (1970). Classification of flowering plants. Vikas Co.
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11. Woodland D W (1991). Contemporary Plant Systematics. Prentice Hall.
12. Sivarajan V V (1991). Introduction to Principles of Plant Taxonomy. Oxford IBH.
13. Takhtajan A L (1997). Diversity and Classification of Flowering Plants. Columbia Univ. Press.

16P3BOTT10: GYMNOSPERMS, EVOLUTION & PALEOBOTANY
(Theory 27 + 18 + 9 hrs; Practical 27 + 0 + 9 hrs; Credits 3)

GYMNOSPERMS: (27 hrs)

Introduction to the Course

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)
General account on the male and female gametophyte development in Gymnosperms (Cycas). Economic significance of Gymnosperms.

Practical (27 hrs)
1. Study of the morphology and anatomy of vegetative and reproductive parts of Cycas, Zamia, Pinus, Cupressus, Agathis, Araucaria and Gnetum.
2. Study of fossil gymnosperms through specimens and permanent slides.
3. Conduct field trips to familiarise various gymnosperms in nature and field identification of Indian gymnosperms and submit a report.

References
1. Andrews H N Jr (1961). *Studies in Palaeobotany*. John Wiley and sons.
2. Arnold C A (1947). *An introduction to Palaeobotany*. John Wiley and sons.
3. Beck C E (1995). *Gymnosperm Phylogeny*. Bot. Rev. 51-176.
4. Bhatnagar S P, Moitra A (2000). *Gymnosperms*. New Age International Ltd.
5. Chamberlain C J (1935). *Gymnosperms: Structure and Evolution*. University of Chicago Press.
6. Meyen S V (1984). *Basic features of Gymnosperms' Systematics and Phylogeny as evidenced by the Fossil Record*. Bot. Rev.
7. Sharma O P, S Dixit (2002). *Gymnosperms*. Pragati Prakashan.
8. Sporne A R (1974). *The morphology of gymnosperms*. Hutchinson Univ. Library.
9. Biswas C. *The Gymnosperms*. Today and Tomorrows print.
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11. Dallimore W, A B Jackson (1964). *A Handbook of Coniferae and Ginkgoaceae* (IV Edn). Edward Arnold & Co.
12. Delevoryas T (1962). *Morphology and evolution of Fossil Plants*. Holt, Rinehart and Winston.

EVOLUTION & PALEOBOTANY

Evolution: (27 hrs)

Introduction to the Course

The Concept of evolution, Charles Darwin, Darwin's Evolutionary theory, Theories after Darwin, evidences of evolution

Module 1: Origin of life (6 hrs)
Abiogenesis, Biogenesis experiment of Miller (1953). Theory of Organic evolution - Biochemical origin of life, place and time of origin and experimental evidences. Concept of Oparin and Haldane.
Phylogeny and Evolution

Module 2: Patterns of Evolution (5 hrs)
History of Character Evolution, Patterns of Evolutionary change explained from systematics, Phylogeny and patterns of Evolution, Adaptive radiation, Patterns in genes and genomes

Module 3: Levels of Evolution (5 hrs)
Biodiversity, Genetic variation, phenotypic variation, evolution of life histories, 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 4: Speciation (5 hrs)
Genetic drift - Salient features; species concept; sub-species, sibling species, semi species, demes. 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 5: Natural selection (4hrs)
Natural selection and adaptation; nature of NS, examples of NS, levels of selection, nature of adaptations, The Genetical theory of natural selection; Fitness, models of selection, polymorphism maintained by balancing selection, multiple outcomes of evolutionary change, the strength of NS, molecular signatures of NS.

Module 6: Modern theories of evolution (2 hrs)
Modern synthetic theory of evolution, molecular evolution, concepts of natural evolution, molecular divergence and molecular clocks; molecular tools in phylogeny.

References
1. Gurbachan S Miglani (2002). *Modern Synthetic theory of evolution.*
2. George Ledyard Stebbins (1971). *Process of Organic evolution.*
3. Roderic D M Page, Edward C Holmes (1998). *Molecular Evolution: A phylogenetic approach.* Blackwell Science Ltd.
4. Maxtoshi Nei, Sudhir Kumar (2000). *Molecular Evolution and phylogenetics*. Oxford University Press.
5. Katy Human (2006). *Biological evolution: An anthology of current thought.* The Rosen publishing group, Inc.
6. Monroe W Strickberger (1990). *Evolution.* Jones and Bartlett publishers.

PALAEONTOLOGY (9 hrs)

Introduction to the course:

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

Module 1 - Techniques in Palaeontology - mega fossils - microfossils - nannofossils - ichnofossils - collection, reformation & illustration - binomial nomenclature. Plant fossils – Preservation, preparation, age determination. 3 hrs

Module 2 - Palaeobotany: *Lyginopteris, Medullosa, Ptilophyllum* Pentoxylon,Lagenostroma, Cordaites, Cardiocarpus, Calamites,Sphenophyllum, Calamostachys *and Glossopteris. **(select whichever is necessary)*** 3 hrs

Fossil record – systematic, reconstruction and nomenclature; Applied aspects of paleobotany 9 hrs

Practical

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

References

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

16P3BOTT11 : PLANT PHYSIOLOGY AND METABOLISM
(Theory 72; Practical 36; Credits: 4)

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)

(b) Classification of mineral nutrients based on biological function.
(c) Soil characters influencing nutrient availability – size and charge of soil particles, soil pH.
(d) Role of Mycorrhizae in nutrient uptake.
(e) Theories of mineral salt absorption.

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

(b) Electrical properties of membranes, Membrane potential.
(c) Transport across cell membranes: Passive – diffusion, facilitated diffusion, membrane channels; gap junctions, porins, ion channels – gated channels, structure and working of K+ ion channels.
(d) 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)

Materials translocated in the phloem- Sucrose and other materials. 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 Fo 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.

Practical (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.

Additional credit (36 hrs)

1. **Transport of ions, solutes and macromolecules (8 hrs)** : Cation Transporters- Cation channels, Cation carriers. Anion Transporters. Transporters for metals and metalloid ions. P-type ATPases. Ion transport in roots.
2. **Photosyntesis (8 hrs):** Effect of herbicides on Photosynthetic electron flow. The biosynthesis and breakdown of Chlorophyll. Photorespiration and Photosynthetic electron transportsystem. C2 cycle of Cyanobacteria. Photorespiration interaction with metabolic pathways. Enhancement of biomass production by engineering Photorespiration. Effect of leaf properties, light, temperature and Carbon dioxide on Photosynthesis.

3. **Stomatal biology (5 hrs):** Light dependent stomatal opening- blue light response of guard cells. Zeaxanthin mediated blue light response. Reversal of blue light stimulated opening.
4. **Asssimilation of inorganic nutrients (5 hrs)**: Sulfur assimilation, Phosphate assimilation, Cation assimilation energetics of nutrient assimilation.
5. **Signaling in Plants (8 hrs)**: Plant cell Signaling molecules and receptors. Signal amplification. Second messengers in plant cells: Ca^{2+}, pH, ROS and lipid molecules. Signal transmission and cell- cell communication- hormonal signaling pathways (detailed account). Phytochrome signaling pathways in response to abiotic stress.
6. **Seed and fruit physiology (1 hr)**: Seed coat development, seed maturation and desiccation tolerance, dormancy, release from dormancy, germination, mobilization of stored reserves, seedling growth and establishment, tropisms, photomorphogenesis, hade avoidance, vascular tissue differentiation, root growth and differentiation. Fruit development and ripening.
7. **Vegetative growth and organogenesis (1 hr)**: leaf development, establishment of leaf polarity, differentiation of epidermal cell types, venation pattern in leaves, shoot branching and architecture, secondary growth.

References

1. Lincoln Taiz, Eduardo Zeiger (2002). *Plant physiology* (II Edn). Sinaeur Associates, Inc. Publishers.
2. Bob B Buchanan, Wilhelm Gruissem, Russel L Jones (2000). *Biochemistry and molecular biology of plants*. L K International Pvt. Ltd. , New Delhi
3. Reginald H Garrett, Charles M Grisham (2005). *Biochemistry*. Thomson Brooks/Cole
4. Robert Horton H, Laurence A Moran, Raymond S Ochr, J David Rawn, K Gray Scrimgeour (2002). *Principles of Biochemistry* (III Edn). Prentice Hall , New Jersey.
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6. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2002). *Molecular biology of the cell* (IV Edn). Garland Science, Taylor and Francis group.
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8. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira (2007). *Molecular cell biology* (VI Edn). W H Freeman & Company.
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11. David E Sadava (2009). *Cell biology: Organelle structure and function*. CBS
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16P3BOTT12 : PLANT REPRODUCTIVE BIOLOGY, PALYNOLOGY AND PLANT BREEDING

(Theory-54 hr (36+18+18), Practical- 36 (18+9+9)) Credits - 4

PLANT REPRODUCTIVE BIOLOGY (36 hrs)

Introduction to the course

(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 development, Potency, Commitment, Specification, Induction, Competence. Applications of reproductive biology (research, agriculture, Industry, Forensic & Horticulture).

Module 3: Pollination (2 hrs)

(a) Sexuality of flowers and plants. Pollination agents and floral adaptations **(**

b) Pollination syndromes; study of common pollinators from each syndromes-

c) Breeding systems in plants, Types of pollen; wet and dry, types of stigma; wet and dry types (along with significance of each types)

Module 4: Post pollination changes (12 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, Origins of polarity, factors influencing embryogenesis.
(c) Endosperm-development and function, types of endosperm, endosperm haustoria.
(d) Apomixis and Polyembryony and their applications in agri-horticulture

Module 3: Breeding system and Self incompatibility: (5hrs)

Breeding system: Outbreeding devises and their efficacy

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 4: 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- 5. Eminent personalities in the field of reproductive biology with an emphasis on Indian contributions (**3 hrs)**

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

Suggestions for Assignments

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

Practical (18 hrs)

1. Embryo excision from young seeds.
2. Pollen germination study.
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 sterilitytest 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.

References

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3. Lincoln Taiz, Eduardo Zeiger (2002). *Plant physiology* (II Edn). Sinaeur Associates, Inc. Publishers.
4. Robert J Brooker (2009). *Genetics: analysis & principles* (III Edn.). McGraw Hill
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20. Shivanna K. R. and Sawhney V. K. (1997). Pollen Biotechnology for Crop Production and Improvement. Cambridge Univ. Press.
~~20.~~21. Shivanna and Tandon (2014). Reproductive Ecology of Flowering Plants: A Manual. Springer.
~~21.~~22. Shivanna K R. (2003). Pollen Biology and Biotechnology. Oxford and IBH publishing Co.Pvt. Ltd.
~~22.~~23. Sporne K. R. (1974). The Morphology of Agiosperms. Hutchinson University Press.
~~23.~~24. Swamy B.G.L. and Krishnamurthy K. V. K. (1980). From Flower to Fruit. Tata McGraw Hill Book Co.
~~24.~~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 (2 hrs.)
Introduction to pollen analysis~~,~~ :History and scope of palynology, Terminologies used in spore and pollen description, forensic palynology, paleopalynology

Module-2: Pollen structure and development (4hrs)
A. Development of pollen grains,
B. Pollen morphology- Shape and size, apertures types
-and ornamentation in pollination ecology, Special ornamentation features--bladders, viscin threads,
-spines, lipids.
C. The pollen wall - Pollen wall development and formation, Pollen wall structure, Surface ornamentation and its importance. Pollen wall chemical composition and its relationship to pollen preservation.

D. Pollen apertures - Inaperturate grain, simple and compound, Types, function and arrangement. Role
-and use in pollen identification
D may come under pollen morphology

Module- 3: Pollen Analysis (6hrs)

Laboratory techniques/ are these practicle or only explanation in theory?: how to find pollen in sediments, forensic samples, honey, rocks, archaeological sites and shipwrecks, etc., Production and Dispersal of pollen grains, where pollen is deposited. Purpose of Pollen collection and storage. Pollenviability- factors that affect pollen viability. Viability Test: - Germination assay, *in vitro, in vivo*. Non Germination assay FCR Test, FDA test (both are same).,Acetocarmine test for assessing sterility.

R values and pollen coefficients (correcting for over and under production and dispersal of pollen). Factors affecting pollen deposition.

Moodule – 4 Applications and Methods in palynology (5hrs)

Palynology and Systematics, Pollen sampling and data gathering (how many samples to collect and what to collect) Modern pollen rain sampling and collecting important floral data, Stratigraphic sampling of geologic terrestrial deposits (i.e., natural vs. artificial levels), Sampling lake and underwater archaeological deposits, Terrestrial archaeological site sampling, Forensic samples, Entomo-palynological samplingMelisso-palynology sampling, The

statistical validity of using multiple vs. single samples from given locations, Tools and methods used for pollen sampling. Sampling of deposits for pollen;
Uses of pollen in pharmaceuticals,Nutrition and in Cosmetics. Pollen allergy.

A. Suggested Assignment Topics

1. Sampling procedures in palynology, Melisso-palynology and Ento-mo-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.
C. Insects (other than bees) and pollen
8 Crop pollination
9. 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)
10. Importance of pollen as a dietary item in the life cycle of insect pests 5
(i.e., moths, butterflies, boll weevils, etc.)
11. Techniques used to examine pollen on the surface and gut of insects
12. SEM analyses and the development of photographic pollen keys
13. What are relative pollen counts, absolute counts, secondary counts, and large-fraction-analysis counts?
14. Establishing pollen concentration values and the value of these data
15. When and how to use pollen influx techniques
16. Recognition of real vs. artificial vegetational changes
17. How to avoid making errors in pollen data interpretations
18. Computer programs used to plot pollen data
19. Are statistical methods valid for explaining pollen data?

Practicals (9hrs)
1. Morphology of Pollen grains.
2. Make a key based on external characters of pollen grains of a family or genus of known plants.

References

Faegri, K., and Iversen, J. (1989 (also reprinted in 2000)). ***Textbook of Pollen Analysis***, 4th Ed.
Blackburn Press, Caldwell, NJ

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PLANT BREEDING (18 hrs)

Module 1: 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: Systems of reproduction in plants (3 hrs)
Reproductive systems and pollination control mechanisms; Sexual reproduction - Cross and self pollination; asexual reproduction, Incompatibility and Male sterility, their types.

Module 3: Hybridization (3 hrs)
Hybridization - role and methods, Inter-varietal, inter specific and inter generic crosses. Back-cross breeding. Heterosis, Inbreeding depression.

Module 4: Breeding for resistance (3 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 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; Modern agricultural techniques and practices like poly house farming, hydroponics, aquaponics and precision farming.

Practical: (9 hrs)
1. Hybridization techniques in self and cross pollinated plants
2. Visit a plant breeding station to familiarize with breeding programmes. Submit a report of the visit.

References
1. Allard R W (1995). *Principles of Plant Breeding*. John Wiley and Sons, Inc.
2. Ghahal G S and Gosal S S (2002). *Principles and procedures of Plant Breeding*. Narosa Publishing House.
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Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany Semester III
16P3BOTT09 : 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

16P3BOTT10: 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
12. How

(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 anessay onsex and reproductive success in evolution

(2x12= 24)

Model Question Paper

SACRED HEART COLLEGE, THEVARA (AUTONOMOUS)
M.Sc. Botany Semester III
16P3BOTT11 : 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
16P3BOTT12: 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 – 16P3BOTP05

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 – 16P3BOTP06
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 inweight 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

Course	Title	Teaching Hrs Theory	Teaching Hrs Practical	Credits
16P4BOTT13	Biotechnology & Genetic Engineering	72	36	4
16P4BOTT14	Genomics, Proteomics & Bioinformatics.	36+36	45	4
16P4BOTT15	Tissue Culture & Microbial Biotechnology	36+ 18	18 + 18	3
16P4BOTT16	Biostatistics, Microtechniques & Biophysics	36+ 18 + 18	18 + 27 + 18	4
16P4BOTP07	Practicals of **16P4BOTT13+ 16P4BOTT14**			2
16P4BOTP08	Practicals of **16P4BOTT15+ 16P4BOTT16**			2
16P4BOTPJ	Project			2
16P4BOTCV	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.			

16P4BOTT13 : BIOTECHNOLOGY & GENETIC ENGINEERING
(Theory 72 hrs; Practicals 36 hrs; Credits 4)

Introduction to the Course
History of biotechnology: Introduction to classical and modern biotechnology. GE - Basic principles, tools and techniques.

Module 1: Working with Nucleic acids (4 hrs)
Isolation and purification of DNA (genomic and plasmid) and RNA.

Module 2: rDNA Technology- Tools and Techniques (7 hrs)

(a) Vectors – necessary properties of a vector, Construction, important features and specific uses of vectors: plasmid - pBR322, pUC, Lambda phage, M13, artificial chromosomes – YAC, BAC, PAC, HAC. Shuttle vectors, expression vectors.
(b) Direct Gene Transfer Methods - microprojectiles, electroporation, microinjection, chemical, lipofection
(c) Restriction endonucleases – naming, types and reaction.
(d) Ligases – reaction, methods of blunt end joining - linkers and adaptors
(e) Topocloning
(f) Gateway cloning

.

Module 3: Procedure of gene cloning (in bacteria using pBR322 vector system) (6 hrs)
Creation of recombinant DNA, Introduction of recombinant DNA into host cell – preparation of competent host cells, transformation. Selection of transformed cells, identification of recombinant cells – insertional inactivation. Methods of screening and selection of recombinant cells – selectable markers, reporter systems – *Lac Z* system, GFP.

Module 4: Plant transformation (5 hrs)
(a) Agrobacterium tumefaciens mediated gene transfer in plants - details of vector system based on *A. tumefaciens*, binary vector and cointegrate vector. Steps involved in *Agrobacterium* mediated gene transfer to plants.
(b) Details of the creation of Bt plants, Golden rice, *Flavr Savr* Tomato.

Chemical synthesis of DNA (4 hrs)
Phosphodiester, phosphotriester, and phosphite-triester method of DNA synthesis (Brief study only). Phosphoramidite method, automated DNA synthesis. Artificial genome synthesis.

Protein engineering (3 hrs)
Applications of protein engineering, protein modification by site-directed mutagenesis, combinatorial methods.

Biosensors (3 hrs)
Design and operation, types. Applications - medical, food and agriculture, industrial, pollution monitoring. GMOs as biosensors.

Advanced transgenic technology (6 hrs)
Inducible expression systems – examples, site-specific recombination for *in vivo* gene manipulation, gene targeting, gene silencing using antisense RNA and RNAi. *In vitro* mutagenesis - site-directed mutagenesis.

Module 7: Gene library (8 hrs)
Genomic and cDNA library. Procedure for the construction of a genomic library using phage λ system. Identification of desirable clones from library – hybridization probing, colony and plaque hybridization probing,

immunological screening. Locating and isolating a gene - *in situ* hybridization, positional cloning, chromosome walking and jumping.

Module 8: Advanced tools and techniques (10 hrs)

(a) PCR - Procedure and applications, variants of PCR - Real time PCR and its applications.

(b) *In vitro* mutagenesis- Oligonucleotide directed, Error- prone PCR, Cassette Mutagenesis. Applications of *In vitro* mutagenesis.

(c) Blotting techniques - procedure and applications of southern, northern, western, and dot blotting. Microarray (gene chip) technology.

(d) Procedure and applications of DNA profiling, Footprinting.

(e) Procedure and applications of ELISA, RIA, Immunoprecipitation, flow cytometry, FISH, GISH.

Module 9: Gene therapy (5 hrs)

Approaches to gene therapy- somatic cell and germline therapy, vectors used in gene therapy. *In vivo* and *ex vivo* therapy. Gene therapy of SCID, Cystic fibrosis, gene augmentation therapy. Problems and fears associated with gene therapy.

Module 10: Applications of rDNA technology (7 hrs)

Uses of GM microbes: Bacteria and yeast - producing useful proteins, basic genetic research. Applications of GM animals: In basic research, producing novel proteins; disease studies, prevention and cure diseases0). Uses of transgenic plants: Herbicide, insect and disease resistance, stress resistance. Genetic engineering for increasing nutritional and other novel qualities in plants.

Module 11: Ethical, legal, and social impact of modern biotechnology (4 hrs)

Need for regulation, regulatory agency in India – GEAE. Patents – issues relating to patenting living organisms, their genes and other bioresources. Potential impact of GMOs on the ecosystem. GM food – effect on health and environment. Ethical problems of rDNA technology. Economic issues. Potential misuse of modern molecular biology tools and techniques, bioweapons, bioterrorism.

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 of DNA by agarose gel electrophoresis.
5. Separation of proteins by PAGE.
7. PCR.

References

1. James D Watson, Amy A Caudy, Richard M Myers, Jan A Witkowski (2007). *Recombinant DNA* (III Edn). W H Freeman.
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20. Benjamin A Pierce (2008). *Genetics: A conceptual approach* (IV Edn). W H Freeman and Company
21. Anthony J F Griffiths, Susan R Wesler, Sean B Carroll, John Doebley (2008). *Introduction to genetic analysis* (X Edn). W H Freeman and Company.
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23. William J Thieman, Michael A Palladino (2009*). Introduction to biotechnology* (II Edn). Pearson.
24. Carl Branden, John Tooze (1999). *Introduction to protein structure* (II Edn). Garland Publishing.
25. T A Brown (1995). *Gene cloning: An introduction* (III Edn). Stanley Thomas (Publishers) Ltd.
26. S B Primrose (1999). *Molecular biotechnology* (II Edn). Panima Publishing Corporation.
27. Alan Fersht (1999). *Structure and Mechanism in Protein Science*. W H Freeman and Company.

16P4BOTT14: GENOMICS, PROTEOMICS & BIOINFORMATICS
(Theory 72 hrs; Practicals 45 hrs; Credits 4)

GENOMICS & PROTEOMICS (36 hrs)

Introduction to the Course

(a) 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.
(b) 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. Cytogenetic and linkage map. Molecular markers – RFLP, RAPD, AFLP, SSLP, SNP. Construction of linkage maps using molecular markers – E.g., RFLP maps. Physical mapping – restriction mapping, STS, SNP, EST.
c) Sequence assembly – methods used.
d) Next generation sequencing strategies - Pyrrosequencing.

Module 2: Functional genomics (7 hrs)

a) Transcriptome, expression profiling (mRNA profiling).
b) Gene expression analysis using dot blotting and microarrays. Fabrication of microarrays – spotted arrays, *in situ* synthesis.
c) Chromatin immunoprecipitation (ChIP) and its applications.
d) Determination of gene functions - knock out and knock down mutants, antisense RNA and RNAi, gene overexpression.

Module 3: Comparative genomics (3 hrs)

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

Module 4: Proteomics (6 hrs)

a) Proteome, proteomics.
b) Separation and identification of cellular proteins by 2D gel electrophoresis and mass spectrometry. Protein expression analysis using Protein microarray, protein localization using GFP, other applications of 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
c) DNA sequence databases - Genbank, DNA databank, Nucleotide sequence databank (EMBI 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. Methods of sequence alignment – paired sequence alignment, multiple sequence alignment, scoring matrices.
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 search.
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, Mr.Bayes, RaXML

Module: 4 (6 hrs)

a) Computer assisted drug design - concept, methods and practical approaches.
b) Various computational methods applied to design drugs.

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

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2. Zhumur Ghosh, Bibekanand Mallik (2008). *Bioinformatics: principles and applications*. Oxford University press.
3. Orpita Bosu, Simminder Kaur Thukral (2007). *Bioinformatics: Databases tools and algorithms*. Oxford University press.
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Additional Credit: 36 hrs

1) Protein visualization tool: Pymol and Swiss PDB viewer
2) gene prediction programs – Grail/Exp, GENSCAN, ORF finder.
3) Construction of phylogenetic trees – Beast and Beauti.
4) Drug Designing Autodock Vienna and Discovery studio.
5) Theird generation sequencing:- Reversible terminators sequencing, ion semiconductor sequencing, sequencing by ligation, Single molecule sequencing, 454 GS FLX System
6) ENCODE project.
7) Gene over expression: DAVID, GSEA

16P4BOTT15: TISSUE CULTURE AND MICROBIAL BIOTECHNOLOGY

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

Introduction to the Course

1. **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.
2. **Micropropagation:** Techniques and stages of micropropagation. Advantages and disadvantages of micropropagation. Applications of tissue culture.

Module 1: 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 2: 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 3: Cytodifferentiation and morphogenesis (3 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 4: 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 5: 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 6: Protoplast culture (4 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 7: 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 8: 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 9: Cell and enzyme technology (3 hrs)

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

Module 10: 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.

Module 11: Microbial Bioechnology (10 hrs)

a) Screening of microbes for metabolite production. Selection of media, sterilization of media.
b) Bioreactors – airlift, stirred tank, bubble column, rotary drum. Fermentation process - batch, fed batch, continuous fermentation. Submerged and solid state fermentation Process control during fermentation- pH, aeration, agitation, temperature, foam control.
c) Downstream processing.
d) Large scale production of antibiotics - penicillin, streptomycin, industrial chemicals - ethanol, acetone, butanol, lysine. Microbial insecticides. Commercial production of enzymes and their uses - amylase, cellulase, polygalacturonase.

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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3. S S Bhojwani, M K Razdan (1996). *Plant tissue culture: Theory and Practice*. Elsevier.
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19. Michael R. Davey, Paul Anthony (2010). *Plant Cell Culture: Essential Methods*. Wiley-Blackwell A John Wiley & Sons, Ltd.
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16P4BOTT16: BIOSTATISTICS, MICROTECHNIQUES & BIOPHYSICS
(Theory 36+ 18 + 18 hrs; Practical 18 + 27 + 18 hrs; Credits 4)

Course Objectives

1. To enable students to learn the tools and techniques available for studding biochemical and biophysical nature of life.
2. To help students obtain skills in handling new instruments in modern researches.
3. 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)

Introduction to the Course

1) Basic principles of Biostatistics: Methods of collection and classification of data; Primary and secondary data, qualitative and quantitative data. Frequency distribution, graphical representation.
2) Measures of central tendency
   (a) Mean, (b) Median and (c) Mode
3) Measures of dispersion: Mean deviation, Standard deviation, variance, standard error, co-efficient of variation.

Module 1: Correlation and Regression (6 hrs)
Linear regression and correlation (simple and multiple).

Module 2: Probability (6 hrs)

(a) Probability - Definition, mutually exclusive events – sum rule, independent events – product rule. Probability of unordered combination of events.
(b) Binomial, Normal and Poisson distribution.

Module 3: Design of experiments (8 hrs)

(a) Experimental designs: Principles - replication 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 (16 hrs)
Statistical inference – estimation - testing of hypothesis - t-test, Chi square test (goodness of fit, independence or association, detection of linkages), F-test, ANOVA.

Practical (18 hrs)

1. Analysis of data to find the mean, median and mode.
2. Analysis of a given data for mean deviation and standard deviation.
3. Test the significance of a given data using t test, X2 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 Instat.

References

1. Chandel R S (1975). *A handbook of Agricultural statistics*. Achal prakashan Mandir.
2. Gomez K A, Gomez A A (1984). *Statistical procedures for agricultndural research*. John Wiley and sons.

3. Gupta S P (1984). *Statistical methods*. S Chand and company.
4. Panse V G, Sukathme P V (1995). *Statistical methods for Agricultural workers*. ICAR.
5. Robert J Brooker (2009). *Genetics: analysis & principles* (III Edn). McGraw Hill.

MICROTECHNIQUE (18 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 - Haematoxylin and Carmine (ii) Coal tar dyes – Fast green, Orange G, Safranine, Crystal violet, Cotton Blue and Oil Red O.
(b) 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.
(c) 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. Staining of whole mount materials (haematoxylin, fast green or Safranine-fast green combination). Significance of whole mounts.
(b) Techniques of smear, squash and maceration.
(c) Mounting: Techniques, common mounting media used - DPX, Canada balsam, Glycerine jelly and 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

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

Biophysics –References

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Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

M.Sc. Botany DEGREE EXAMINATION

SEMESTER IV

16P4BOTT13: BIOTECHNOLOGY & 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 ***anyTtwo*** 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

Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

M.Sc. Botany DEGREE EXAMINATION

SEMESTER IV

16P4BOTT14: 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?

Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

M.Sc. Botany DEGREE EXAMINATION

SEMESTER IV

16P4BOTT15: 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 the methods and applications of regenerative medicine.
20. Discuss the reasons of somaclonal variation.
21. Explain the factors influencing vascular differentiation.
22. Explain suspension culture.

(5 x 7 = 35 marks)

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

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

OR

24.Explain the methods and applications of *In vitro* conservation of germplasm

25. Describe the isolation, purification and culture of protoplasts.

OR

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

Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany DEGREE EXAMINATION
SEMESTER IV
16P4BOTT16: 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 16P4BOTP07

BIOTECHNOLOGY, GENETIC ENGINEERING, GENOMICS, PROTEOMICS & BIOINFORMATICS

Time 3 Hours **Max. Marks 40**

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 16P4BOTP08

TISSUE CULTURE, MICROBIAL BIOTECHNOLOGY, BIOSTATISTICS, BIOPHYSICS &, MICROTECHNIQUE

Time 3 Hours **Max. Marks 40**

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

Ecology

1) Determination of pH of Waste Water Sample
2) Nitrogen Cycle
3) A Brief Introduction to Species Interactions in Ecology
4) Bacterial Population Growth
5) Population Invasion - A Threat to Ecosystem
6) Study of Foraging of Organisms in the Ecosystem
7) Interspecific Competition and Coexistence
8) Conserving Endangered Species
9) Interspecific Competition and Geographic Distributions

10) Metapopulation Dynamics
11) Parasitoid Host Dynamics
12) Spread Pest Population invasion
13) Optimal For Aging
14) Optimal For Aging Pollinators
15) Optimal for aging Sit and wait predators that maximize energy

Biophysics

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

Biochemistry

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

Immunology

1) Collection of Serum from Blood
2) Blood Grouping Experiment

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

Microbiology

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

Cell biology

1) Cell Organization and Sub Cellular Structure Studies (Prokaryotic and Eukaryotic)
2) Isolation of Mitochondria
3) Isolation of Chloroplast
4) Isolation of Endoplasmic Reticulum
5) Glucose Uptake Assay
6) Transfection
7) Lignin Staining
8) Maintenance of Mamallian Cell Lines
9) Cell Attachment
10) Cell Migration
11) Mitosis in Onion Root Tips
12) Cell Proliferation

13) Actin Assembly
14) Maintenance and Storage of DH5alpha E.coli cells
15) Quantification of Stained Liver Cells

Genetic Engineering

1) Western Blotting
2) Preparation of Buffer stocks (TBE,TE and TAE)
3) Extraction of DNA from Fish Fins
4) Hot Shot Method of DNA Extraction
5) Agarose Gel Electrophoresis (AGE)
6) Restriction Digestion
7) Preparation of Competent Cell (Calcium Chloride Treatment)
8) Transformation of the Host Cells
9) Extraction of DNA from Agarose gel
10) Preparation of Equilibrated Phenol
11) Isolation of RNA
12) Polyacrylamide Gel Electrophoresis
13) Ligation (Using T4 DNA Ligase)
14) Polymerase Chain Reaction (PCR)
15) Electroblotting
16) Plating of the Bacteriophage
17) Plasmid Curing
18) Extraction of Bacteriophage DNA from Large Scale Cultures Using Proteinase K and SDS
19) Preparation of stocks of bacteriophage lambda by plate lysis and elution
20) 16S Ribosomal RNA Sequencing