

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

KOCHI, KERALA, 682013



CURRICULUM AND SYLLABI

POST-GRADUATE PROGRAMME

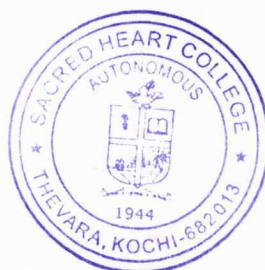
IN

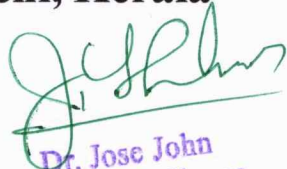
BOTANY

CREDITSEMESTER SYSTEM (CBCS-PG)

(EFFECTIVE FROM 2016-2017 ADMISSIONS)

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




Dr. Jose John
Principal in Charge
Sacred Heart College (Autonomous)
Thevara, Kochi-682 013

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)
6. Mr.Binoy C. (Tissue culture Lab, AVT, Cochin)
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.

FOREWORD

In line with the changes in higher education, the state of Kerala had introduced the autonomy in its 13 selected colleges and, S H College, Thevara is proud to be one. Even while remaining affiliated to M G University, the academic autonomy was granted during 2014-2015 academic year onwards. In the undergraduate level the choice based course credit semester system was decided to be continued even after the attainment of autonomy to the institution. Exercising the opportune occasion of autonomy, the Department of Botany had thoroughly evaluated the existing syllabus of the parent university and revised it w.e.f. 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 $CP=GP \times Cr$.
- 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 as 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 80 and 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

$CP = Cr \times GP$, where Cr = credit; GP = Grade Point

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

$SGPA = TCP/TCr$, where

$TCP = \text{Total Credit Point of that semester} = \sum_1^n CP_i$

$TCr = \text{Total Credit of that semester} = \sum_1^n Cr_i$

where n is the number of courses in that semester.

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

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

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.

- Name of the College
- Title of the Postgraduate Programme
- 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. GRIEVANCE REDRESSAL MECHANISM

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

Level 1: At the level of the concerned course teacher

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

Level 3: A committee with the Principal as Chairman, Dean of the 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 & Emt. 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
16P1BOTTP01	16P1BOTT01	2	9	10	39	40	48	50	A ⁺	9	18	Pass
16P1BOTTP02	&16P1BOTT0216P1BOTT03 &16P1BOTT04	2	8	10	38	40	46	50	A ⁺	9	18	Pass
	Total	19					459	500			165	
	Semester Result SGPA								A	8.68		Pass

Checked by

Section Officer

Controller of Examinations

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

MARK CUM GRADE CARD

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

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

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

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

Table 2

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

$SGPA = TCP/TCr$, where

$TCP = \text{Total Credit Point of that semester} = \sum_1^n CPI_i$;

$TCr = \text{Total Credit of that semester} = \sum_1^n C_{ri}$

Where n is the number of courses in that semester

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

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

GPA shall be round off to two decimal places

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 Secured :

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

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

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

(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

$$TCP = \text{Total Credit Point of that semester} = \sum_1^n CPI;$$

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

Where n is the number of courses in that semester

Cumulative Grade Point Average (CGPA)

of a Programme is calculated using the formula

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

GPA shall be round off to two decimal places

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 4.5 and < 5.5	C Average
Equal to 4.0 and < 4.5	D Pass
Below 4.0	F Failure

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, SARS, etc.
- To become aware of the multiple scopes and applications of these organisms

MICROBIOLOGY (Theory 27 hrs; Practical 9 hrs)**Introduction to the Course**

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 1: 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: Spirochaetes, Rickettsias, Chlamydias, Mycoplasmas, Actinomycetes, Myxobacteria, Archaeobacteria. 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 – bacterial chromosome, plasmid. Recombination in bacteria - conjugation, transformation and transduction. Sexduction.

Application of bacteria in 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 2: Applied Microbiology (4 hours)

(a) Host-Microbe relationships and diseases

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

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

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

Module 3: Viruses (11hrs)

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

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

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

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

Practical (9 hrs)

1. Preparation and sterilization of various microbial culture media and inoculation.

2. Differential staining of bacteria using Gram stain.

3. Isolation of *Rhizobium* from root nodules.

4. Isolation of microbes from soil: Serial dilution - pour plate/spread plate method.

5. Streak out a bacterial culture on an agar plate and isolation of colonies.

6. Antibacterial assay - disc diffusion/agar well method.

References

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

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)

- Critical study of diagnostic features and identification of the following genera based on morphological, anatomical and reproductive parts;
 - Cyanophyceae - Gleocapsa, Gleotrichia, Spirulina, Microcystis, Oscillatoria, Lyngbya, Anabaena, Nostoc, Rivularia, Scytonema.
 - Chlorophyceae - Chlamydomonas, Gonium, Eudorina, Pandorina, Volvox, Tetraspora, Ulothrix, Microspora, Ulva, Shizomeris, Cladophora, Pithophora, Coleochaete, Chaetophora, Draparnaldia, Draparnaldiopsis, Trentepohlia, Fritschiella, Cephaleuros, Oedogonium, Zygnema, Mougeotia, Desmedium, Bryopsis, Codium, Caulerpa, Halimeda, Neomeris, Chara, Nitella.
 - Xanthophyceae - Vaucheria.
 - Bacillariophyceae - Biddulphia, Pinnularia.
 - Phaeophyceae - Ectocarpus, Colpomenia, Dictyota, Padina, Sargassum, Turbinaria.
 - Rhodophyceae - Batrachospermum, Comosopogon, Gelidium, Amphiroa, Gracilaria, Polysiphonia.
- 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)**

- Molecular aspects of cyanobacterial nitrogen fixation: Genetic structure of the N_2 fixation system, molecular mechanisms of heterocyst differentiation and metabolism, genetic aspects of nitrate, nitrite and ammonia assimilation.
- Accessory light harvesting complex: Phycobilisomes, phycobiliproteins, linker polypeptides, energy transfer, gene organization, chromatic adaptation and gene expression.
- Photobiology: Photobiological and molecular aspects of UV-induced damage and repair in cyanobacteria.
- Molecular mechanisms of photoprotection: Mycosporine-like amino acids (MAAs), scytonemin
- Cyanobacterial toxins: Types of cyanobacterial toxin, molecular tools for the identification of toxic cyanobacteria, biochemical and molecular aspects of toxin production, ecological implications
- Basic strategies for the generation of transgenic cyanobacteria.

2. Applied Phycology (18 hrs)

- Models (Monod and Droop) of nutrient-regulated phytoplankton growth; common methods for mass cultivation of microalgae.
- 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.
- Consequences of blooms including toxins of cyanobacteria and dinoflagellates; algal biofouling of ships and its control
- 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 waste 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

References

1. Bellinger E.G. and Sigeo D.C. (2010). *Freshwater algae: Identification and use as bioindicators*. Willey-Blackwell, UK, pp. 271.
2. Brodie J. and Lewis J. (2007). (Ed.) *Unravelling the algae: the past, present and future of algal systematics*. CRC press, New York, pp 335.
3. Chapman V J (1962). *The Algae*. Macmillan & Co. Ltd.
4. Cole K.M. and Sheath R.G. (1990). *Biology of the red algae*. Cambridge University Press. USA. pp. 503.
5. Das Dutta and Gangulee. *College Botany Vol I*, Central Book Depot.
6. Desikachary T.V. (1959). *Cyanophyta*. ICAR, New Delhi.
7. Desikachary, T.V., Krishnamurthy, V. and Balakrishnan, M.S. 1990. *Rhodophyta Vol.I&II*. Madras Science Foundation, Chennai.
8. F E Fritsch (Vol. I, II) (1977). *The structure and reproduction of Algae*. Cambridge University Press.
9. Gilbert M Smith (1951). *Manual of Phycology*.
10. Gilbert M Smith (1971). *Cryptogamic Botany (Vol. 1): Algae and Fungi*. Tata McGraw Hill Edition.
11. Gonzalves, E.A. 1981. *Oedogoniales*. Indian Council of Agricultural Research, New Delhi.
12. Graham L.E. and Wilcox L.W. (2000). *Algae*. Penticce-Hall, Inc, pp. 640
13. Harnold C Bold, Michael J Wynne (1978). *Introduction to Algae: Structure and reproduction*. Prentice Hall.
14. Iyengar M.O.P. and T V Desikachary (1981). *Cyanophyta*. ICAR Publication.
15. Iyengar, M.O.P. and Desikachary, T.V. 1981. *Volvocales*. Indian Council of Agricultural Research, New Delhi.
16. John J. and Francis M.S. (2013). *Illustrated Algal Flora of Kerala Vol.I*. GCS Books, Cochin.
17. Karthick, B., Hamilton P B and Kociolek, J.P. (2013). *An Illustrated Guide on Common Freshwater Diatoms of Peninsular India*. Gubbi Labs. ISBN: 978-81-924461-1-0
18. Krishnamurthy V. (2000). *Algae of India and neighboring countries I. Chlorophycota*, Oxford & IBH, New Delhi.
19. Lee R.E. (2008). *Phycology*. Cambridge University Press, pp.547.
20. Randhawa, M.S.(1959). *Zygnemaceae*. Indian Council Agricultural Research, New Delhi.
21. Philipose, M.T. (1967). *Chlorococcales*. Indian Council of Agricultural Research, New Delhi.
22. Misra J.N. (1996). *Phaeophyceae in India*. ICAR, New Delhi.
23. Pal, B.P. and Kundu, B.C. 1962. *Charophyta*. Indian Council of Agricultural Research, New Delhi.
24. Prescott G.W. (1969). *The algae*.
25. Pringsheim E G (1949). *Pure culture of Algae*. Cambridge University Press.
26. Sharma O.P. (2010). *Text book of Algae*. Tata McGraw Hill Edition.
27. Smith G.M. (1950). *The fresh water algae of the United States*. Mc-graw Hill New York.
28. Srinivasan K.S. (1969). *Phycologia India*. Vol. I & II, BSI, Calcutta.
29. Van Den Hoek, C., Mann, D.G. and Jahns, H., M., (1998). *Algae and Introduction to Phycology*. Cambridge University Press. pp.627 .
30. Vashista B.R, Sinha A.K and Singh V.P. (2005). *Botany for degree students – Algae*, S.Chand's Publication.

16P1BOTT02: 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 (Theory 45hrs; Practical 36 hrs)**Introduction to the Course**

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

Module 1: General introduction (6 hrs)

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

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

Mycelial structure and reproduction of;

- Myxomycota – Acrasiomycetes, Hydromyxomycetes, Myxomycetes, Plasmodiophoromycetes.
- Mastigomycotina - Chytridiomycetes, Hyphochytridiomycetes, Oomycetes.
- Zygomycotina - Zygomycetes, Trichomycetes.
- Ascomycotina - Hemiascomycetes, Pyrenomycetes, Plectomycetes, Discomycetes.
- Laboulbeniomycetes, Loculoascomycetes.
- Basidiomycotina - Teliomycetes, Hyphomycetes, Gastromycetes.
- Deuteromycotina - Blastomycetes, Hyphomycetes, Coelomycetes.
- Types of fruiting bodies in fungi.

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

- Symbionts - Lichens, Mycorrhiza, Fungus-insect mutualism.
- Parasites - Common fungal parasites of plants, humans, insects and nematodes.
- Saprophytes - Fungal decomposition of organic matter, coprophilous fungi, cellulolytic fungi, lignolytic fungi
- Agricultural significance of Fungi

Practical (36 hrs)

- 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.
- Isolation of fungi from soil and water by culture plate technique.
- Estimation of mycorrhizal colonization in root
- Collection and identification of common field mushrooms (5 types).

References

1. C J Alexopoulos, M Blackwell, C W Mims (1996). Introductory Mycology (IV Edn).
2. Jim Deacon (2006). Fungal Biology (IV Edn). Blackwell Publishing.
3. L N Nair (2010). Methods of microbial and plant biotechnology. New Central Book agency (P) Ltd.
4. Kanika Sharma (2005). Manual of microbiology: Tools and techniques.
5. G C Ainsworth, K F Sparrow, A S Sussman (1973). The fungi: An advanced treatise.
6. H C Dube (1983). An introduction to fungi. Vikas Publ. New Delhi.
7. M E Hale (1974). The biology of lichens.
8. A Misra, P R Agarwal (1994). Lichens.
9. M C Nair, S Balakrishnan (1986). Beneficial fungi and their utilization. Sci. publ. Jodhpur.
10. V Ahamjian, M E Hale (1973). The Lichens.
11. R Dayal (2000). Predaceous Fungi. Commonwealth Publishers.
12. Hibbet et al. (2007). A higher level phylogenetic classification of the fungi. Mycological Researcher 111 (2007) pp. 509-547.

CROP PATHOLOGY (Theory 27hrs; Practical 18 hrs)**Introduction to the Course**

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

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

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

Module 2: Defense mechanism in plants (4 hrs)

- (a) Non-host resistance, horizontal resistance, vertical resistance
- (b) Pre-existing defense mechanisms: structural and biochemical (Inhibitors released by the plant in its environment, inhibitors present in plant cells before infection, Defense through lack of essential factors)
- (c) Post-Infection/Induced/Dynamic defense mechanisms: structural (cell wall defense structures, histological defense structures) and biochemical (Defense through Production of Secondary Metabolites, Pathogen elicitors, Hypersensitive defense reaction)

Module 3: Transmission of plant disease (2 hrs)

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

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

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

Module 5: Plant disease management (4 hrs)

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

Module 6: Major diseases in plants (10 hrs)

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

Practical (18 hrs)

1. Make suitable micropreparations and identify the diseases mentioned with due emphasis on symptoms and causative organisms.
2. Isolation of pathogens from diseased tissues (leaf, stem and fruit) by serial dilution method.
3. Collection and preservation of specimens from infected plants. Submit 5 herbarium sheets/live specimens along with a report.
4. Tests for seed pathology – seed purity test.
5. Calculation of Spore load on seeds using Haemocytometer.

References

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

9. George N Agrios (2006). *Plant pathology* (V Edn). Elsevier Academic Press.

16PIBOTT03: 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.

ECOLOGY, ENVIRONMENTAL BIOLOGY, PHYTOGEOGRAPHY (Theory 54 hrs; Practical 27 hrs)

Introduction to the Course

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

global climate – global warming and its impact on vegetation, biodiversity and soils – measures to mitigate bad impacts of global warming – opportunities – carbon credit.

- (j) Principles of energy conservation :Conventional and non-conventional energy resources – measures to reduce energy uses – alternative energy resources - wind energy, solar energy, biomass energy – hydrogen fuel - biological and other process of generation of hydrogen fuel – biofuels – bio-oils and biodiesel – petroplants; Conservation and development- environment movement in India – NGOs - socio-economic and political realities – concept of sustainable development.

Module 1 (30 hrs)

Introduction to Ecology (4hrs)

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

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

Autecological concepts: (7 hrs)

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

(b) Genecology - ecads, ecotypes, ecospecies, coenospecies; k-selection and r-selection populations; Molecular ecology, genetic analysis of single and multiple population, molecular approach to behavioural ecology, conservation genetics

Synecological concepts (12hrs)

(a) Ecological processes of community formation, ecotone, edge effect. Classification of communities - criteria of classification, dynamic system of classification by Clement

(b) Special plant communities - quantitative, qualitative and synthetic characteristics of plant communities, Sorenson's Index of similarity, coefficient of communities

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) Dynamic community characteristics – cyclic replacement changes and cyclic no-replacement changes. Modelling the interspecific interactions by using network analysis approach. 1

Ecological succession (4hrs)

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

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

Biosphere and Ecosystem (3hrs)

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

Module 2 (9 hrs)

Environmental Pollution and Management

Pollution Control- bioremediation, Phytoremediation, bioaugmentation, biofilms, biofilters, bioscrubbers and trickling filters. Use of bioreactors in waste management

Climate Change and other Global Environmental Issues

Climate Change and other Global Environmental issues - Factors responsible for climate change.

Climate change mitigation – global conventions and protocols on climate change - *El-Nino* and *La Nina* phenomenon and its consequences - Environmental laws and biosafety, environmental monitoring and bio indicators, environmental safety provisions in Indian constitution, major environmental laws in free India –UNEP – IPCC, UNFCC, annual environment summits – 1972 Stockholm conference to 2015 Paris Conference – new developments of annual UNFCC meetings in the coming years - Future Earth Programme.

Module 3 (13 hrs)

3.1 Phytogeography (4)

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

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

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

3.2 Conservation Biology - Biodiversity and its conservation (5)

Definition –Genetic, Species and ecosystem diversity – alpha, beta and gamma diversity - concept of endemism and hot spots - role of IUCN - rare, endangered and threatened species, key stone species, flag-ship species; reasons for biodiversity loss; red data book - basic principles of conservation - *ex-situ* and *in-situ* conservation techniques – principles, methods and uses of remote sensing in conservation of natural resources; International conventions on biodiversity – CITES; national wildlife conservation policy and action plan, national forest policy.

3.3 The Western Ghats and the Mangroves (4)

- (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 4 (2 hrs)**Case studies**

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, Adaptation, Predation, Parasitism, Population Regulation.
- (d) Island Biogeography
- (e) Biomes; Terrestrial Biomes, Marine Biomes and Freshwater Biomes.
- (f) Life Tables and Demography
 - a) Physiological Ecology; Temperature, Water and Nutrients.
 - b) Degradation of organic matter in forest floor- role of soil microbes.
 - c) Soil nutrition.
 - d) EIA; with suitable case study.
 - e) Climate change; the present scenario on a global scale.

Practical (27 hours)

1. Analysis of water quality (a) Dissolved CO₂ (b) Dissolved oxygen (c) COD (d) Total dissolved minerals (e) Quantitative estimation of dissolved mineral anions and cations in water (f) Total alkalinity & Salinity (g) conductivity (h) Colorimetric/Spectrophotometric estimation of Nitrogen/Phosphorus in water samples.
2. Physico-chemical analysis of soil: Total water soluble mineral ions
3. Quantitative and qualitative community analysis. Carry out a project on species structure and the frequency, abundance, density of different species and similarity index, basal area, IVI and evenness of different communities in a natural system
4. Statistical analysis of diversity indices by using apt softwares
5. Phytoplankton counting using Sedgwick Rafter counter.
6. To determine organic 'C' and organic matter (biomass) in different (at least 3) locations (forest, agro ecosystem and polluted area.
7. Network analysis to find out the possible interspecific interaction in any local plant community.
8. Interpretation of GIS/remote sensing data for landscape differentiation
9. Field visit to natural ecosystem and identification of trophic levels, food webs and food chains, plant diversity (species and community)
10. Students should be aware of the common environmental problems, their consequences and possible solutions.

References

1. Ahmedullah M, Nayar M P (1987). *Endemic plants of India*.
2. APHA, Awwa, Wep (2005). *Standard methods for the examination of water and waste water*.
3. Barbour M D, et. al., (1980). *Terrestrial plant ecology*. The Benjamin-Cummings Pub. Com.
4. Benton A H, Werner W E (1976). *Field biology and Ecology*. Tata McGraw Hill.
5. Clarke G L (1954). *Elements of Ecology*. John Wiley Pub.
6. Dash M C (1993). *Fundamentals of Ecology*. Tata McGraw Hill.
7. Eldon D, Enger, Bradley, Smith F (1995). *Environmental Science*. W C Brown publications.
8. *Ecological Guidelines for tropical costal developments*. UNESCO (1976).
9. Furley P A et. al., (1983). *Geography of the biosphere: An introduction to the nature, distribution and evolution of the world life zones*. Butterworths.
10. IUCN (2000). *The IUCN red list category*. IUCN England.
11. IUCN (2007). *The 2000 IUCN red list of threatened species*. IUCN. England.
12. Jain S K, Sastry A R K (1984). *The Indian plant red data book*. BSI, Calcutta.
13. Jones H G, Vaugham R A (2010). *Remote sensing of vegetation*. Oxford university press.
14. Kormondy E J (Ed) (1965). *Reading in ecology*. Prentice Hall.
15. Kormondy E J (Ed) (1999). *Concept of ecology*. Prentice Hall.
16. Kumar H D (1977). *Modern Concept of Ecology*. Vikas Publication.
17. Michael P (1984). *Ecological methods of field and laboratory investigations*. Tata McGraw Hill.
18. Misra K C (1991). *Manual of plant ecology*. Oxford and IBH Pub. Com. P. Ltd.
19. Odum E P (III Edn) (1991). *Fundamentals of ecology*. Saunders and Com
20. Pearcy R W et. al., (1989). *Plant physiological Ecology: Field methods and instrumentation*. Chapman and Hall.
21. Ramade F (1981). *Ecology of natural resources*. John Wiley and sons.
22. Sharma P D (1999). *Ecology and Environment*. Rastogy Pub.
23. Simons I G (1981). *Ecology of natural resources*. Edwin-Arnold Ltd.
24. Stiling, P. (2001). *Ecology: Theories and Applications*. Prentice Hall.
24. Trivedi R (1994). *International encyclopedia of ecology and environment (Vol.1)*. IIEE, New Delhi.
25. Trivedi R K (1994). *Practical methods in Ecology and Environmental sciences*. Env. pub.
26. Varma P S, Agarwal V K. *Principles of Ecology*. S Chand and Co.
27. Varma P S, Agarwal V K (2000). *Concept of Ecology*. S Chand and Co.
28. Walter (1987). *Vegetation of the earth*. Springer Verlag.
29. Sheil and Ghazoul (2010). *Tropical rain forest ecology, diversity, and conservation* Oxford University Press, New York, USA
30. OCLC (2003), *Summaries: Dewey Decimal Classification (DDC)* OCLC Inc., Dublin, Ohio.

RESEARCH METHODOLOGY (Theory 18 hrs; Practical 9 hrs)**Introduction to the Course**

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

Module 1: Introduction to Research methodology (8 hrs)

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

Research Process

Observation – critical thinking, theory, objectivity, reliability, validity.

Library Resources

Classification of books: Universal Decimal System and Dewey decimal classification

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

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

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

Preparation of project proposals

Title, Introduction, literature review and abstract, Aim and scope, Present status, Location of experiments, Materials and methods, Justification, Expected outcome, Plan of action, Estimated date of completion, Proposed Budget, References, Funding agencies.

Scientific writing

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

Scientific Communication

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

Module 3: Intellectual Property Rights (3 hrs)

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

Laboratory etiquettes

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

Bioethics

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

Practical (9 hours)

1. Preparation of bibliography using soft-wares like 'Mendeley'
2. Prepare a project proposal.
3. Prepare an outline of dissertation and research paper.
4. Prepare of a review based on a research theme.
5. Use online search literature services such as PubMed, Science direct.

6. Present a small project with the help of power point.**References**

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

16P1BOTT04: 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 cells interact 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 (7 hrs)

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

Module 2: Nucleus (5 hrs)

- (a) Structure of eukaryotic nucleus: Nuclear Envelope, Nuclear Pore Complex.
- (b) Transport into and out of the Nucleus: Nuclear-Localization Signals, Nuclear-Export Signals, Ran-GTP and Ran-Independent Mechanisms.
- (c) Bacterial Chromatin. Compaction of bacterial chromosome – Muk B proteins.
- (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.

Module 3: Cell Cycle (6 hrs)

- (a) Phases of cell cycle.
- (b) Cell division: mitosis and meiosis. Significance of meiosis in generating genetic variation.
- (c) Cyclins and cyclin-dependent kinases, Regulation of CDK Activity, Commitment to the Cell Cycle and DNA Replication, Entry into Mitosis, Completion of Mitosis.
- (d) Surveillance Mechanisms in Cell Cycle Regulation- Cell-cycle checkpoints.

Module 4: The Endomembrane System (9 hrs)

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

Module 5: Chloroplast and Mitochondria (4 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.
- (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.

Module 6: The Cytoskeleton (6 hrs)

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

Module 7: Cell Signaling (8 hrs)

- (a) Modes of cell-cell signaling.
- (b) Signaling molecules and their receptors: Steroid hormones and the nuclear receptor superfamily, Nitric oxide and carbon monoxide, Neurotransmitters, Peptide hormones and growth factors, Eicosanoids, Plant hormones.
- (c) Cell Surface Receptors: G protein-coupled receptors, Receptor protein-tyrosine kinases, Cytokine receptors and nonreceptor protein-tyrosine kinases, Receptors linked to other enzymatic activities.
- (d) Pathways of Intracellular Signal Transduction: cAMP pathway, Cyclic GMP, Phospholipids and Ca^{2+} .

Module 8: Cell Death and Cell Renewal (3 hrs)

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

Module 9: Cancer Biology (6 hrs)

- (a) 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.
- (b) Tumor Viruses: Hepatitis B and C viruses, Small DNA tumor viruses, Herpesviruses, Retroviruses.
- (c) Oncogenes: Retroviral oncogenes, Proto-oncogenes, Oncogenes in human cancer, Functions of oncogene products.

- (d) Tumor Suppressor Gene: Identification of tumor suppressor genes, Functions of tumor suppressor gene products, Roles of oncogenes and tumor suppressor genes in tumor development.

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 organelles.

Additional Credits Topics (36 hrs)

Nucleus (4 hours)

- (a) Variation in chromosome: variation in chromosome structure- duplications, deletions, inversions, and translocations.
- (b) Variation in chromosome number: aneuploidy- types of aneuploidy.
- (c) Polyploidy: autopolyploidy, allopolyploidy.

Interactions between Cells and their Environment (10 hrs)

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

Cell Signaling (12 hrs)

- (a) Pathways of Intracellular Signal Transduction: The PI3-kinase/Akt and mTOR pathways, MAP kinase pathways, The JAK/STAT and TGF- β /Smad pathways, NF- κ B signaling, The Hedgehog, Wnt, and Notch/Delta, SREBP pathways.
- (b) Signal Transduction and Cytoskeleton: Integrins and signal transduction, Signaling from cell adhesion molecules, Regulation of the actin cytoskeleton.
- (c) Signaling networks: Convergence, Divergence, and Cross-Talk among Different Signaling Pathways.

Cancer Biology (10 hrs)

- (a) Cancer and Mutation of Cell Division and Checkpoint Regulators: G1-S, p53, Apoptotic genes, miRNA.
- (b) Carcinogens and Caretaker Genes in Cancer: Direct-acting carcinogens, indirect-acting carcinogens. Cancer and of DNA-Repair Systems. Cancer and Telomerase.
- (c) Molecular Approaches to Cancer Treatment.

References

1. Gerald Karp (2013). *Cell and Molecular biology: Concepts and experiments* (VII Edn). John Wiley & Sons.
2. Harvey Lodish, Arnold Berk, Lawrence Zipursky, Paul Matsudaira, David Baltimore, James Darnell (2013). *Molecular cell biology* (VII Edn). W H Freeman & Company.
3. Geoffrey M Cooper, Robert E Hausman (2013). *The Cell: A molecular approach* (VI Edn). Sinauer.
4. Wayne M Becker, Lewis J Kleinsmith, Jeff Hardin (2012). *The world of the cell* (VIII Edn). Pearson
5. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2008). *Molecular biology of the cell* (V Edn). Garland Science, Taylor and Francis group.
6. Leland H Hartwell, Leroy Hood, Michael L Goldberg, Ann E Reynolds, Lee M Silver, Ruth C Veres (2011). *Genetics from genes to genomes* (IV Edn). McGraw Hill.
7. Immo E. Scheffler (2008). *Mitochondria* (II Edn), John Wiley & Sons, Inc., Publication.
8. J. Kenneth Hooper (1990). *Chloroplasts*, Plenum Press · New York and London.
9. J. Reinert (1980), *Chloroplasts*, Springer-Verlag Berlin Heidelberg GmbH.
10. Keshav K. Singh, Leslie C. Costello (2009) *Mitochondria and Cancer*, Springer Science.

11. D Peter Snustad, Michael J Simmons (2012). *Principles of genetics* (VI Edn). John Wiley and Sons.
12. Robert J Brooker (2012). *Genetics: analysis and principles* (IV Edn). McGraw Hill.
13. Benjamin A Pierce (2012). *Genetics: A conceptual approach* (IV Edn). W H Freeman and Company.
14. Burton E Tropp (2012). *Molecular biology; from genes to ptoteins* (IV Edn).

Model Question Paper**SACRED HEART 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.

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 phylogenetic 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 HEART COLLEGE (AUTONOMOUS), THEVARA****M.Sc. Botany Degree Semester I****16P1BOT02: 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 monoclinal antheridium
7. Differentiate sclerotium from soredium
8. What is Gleba?
9. What is Mitic system?
10. What is peridiole?
11. Name the causative organisms of i) Grey leaf spot of Coconut ii) Red rot of Sugarcane
12. What is Sclerotia?

(2x8= 16 marks)

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

13. Write a brief account on the environmental significance of lignolytic and cellulolytic fungi.
14. Describe the sexual reproduction in Mastigomycotina.
15. Write a brief account on the common diseases, their symptoms and control in cereals.
16. What are the common structural features found in plants that prevent the colonization of a pathogen?
17. Explain/Write short notes on the following:
(a) Plant quarantine (b) Prophylaxis (c) Necrosis
18. What are fungus gardens? Describe the type of interactions found there.
19. Citing specific examples describe how genetic engineering can be used to control diseases?
20. Write an account on symbiotic fungi.
21. What are the major biotic causes of plant diseases?
22. Explain the terms (i) Septobasidium (ii) Statismospore

(7x5=35 marks)

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

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

OR

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

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

OR

26. Write the symptoms, etiology and control measures of any three common diseases of fruits you have studied. How are the pathogens disseminated from plant to plant?

(1x12=12marks)

Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

M.Sc. Botany Semester I

16P1BOTT03: ECOLOGY, ENVIRONMENTAL BIOLOGY, PHYTOGEOGRAPHY & RESEARCH METHODOLOGY

Time 3 hours

Total Marks 75

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

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

(8x2 = 16 marks)

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

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

(7x5= 35marks)

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

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

Or

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

25. Write an essay on different species diversity measurements.

Or

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

(12x2 = 24marks)

Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

M.Sc. Botany Semester I

16P1BOTT04: 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 short note on kinesins and dyneins.
10. What are the different modes of cell-cell signaling?
11. What are Muk B proteins?
12. Write a short note on the properties of cancer cells.

(8 x 2 = 16 marks)

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

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

(5 x 7 = 35 marks)

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

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

OR

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

OR

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

(12 x 2 = 24 marks)

Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany Semester I
Practical Course – 1 [Code: 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: Semester 1 Practical course 1

1. A - Alga; B - Fungi/Lichen/ Mycorrhiza.
2. C, D-Fungi.
3. E - Algal mixture containing four filamentous types.
4. F, G - One Alga, one Fungi/Lichen.
5. H, I - Herbarium or live/dry specimens showing the symptoms of any disease specified in the syllabus
6. J - Draw lots for the two experiments. Supply necessary soil /seed sample.
7. Awarding maximum marks for the record of practical work shall be considered only if all the practical work specified in the syllabus are done completely and recorded properly. This also includes field study report(s)/Lab visit report(s), if any.

Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany Semester I
Practical Course – 2 [Code: 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, Calculation- 1 Result and Comments –2) | (1 x 5 = 5) |
| 6. Comment on the diagrams/ pictures F & G . | (2x 2 = 2) |
| 9. Practical Record | (8) |
| 10. Field Report | (2) |

Key to the questions

1. A –Anther of Rheo/Onion.
2. B,C- Diagram/photograph.
3. D- Data on frequency, density, Basal Area, IVI and evenness of individuals/ species.
4. Statistical analysis of diversity indices by using apt softwares.
5. F & G - Environmental consequence/ Vegetation type.
6. Awarding maximum marks for the record of practical work shall be considered only if all the practical work specified in the syllabus are done completely and recorded properly.

SEMESTER II

Course	Title	Teaching Hrs Theory	Teaching Hrs Practical	Credits
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 (Theory 36 hrs; Practical 18 hrs)

Introduction to the 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 origin of 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)

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

Module 3: Thallus structure (26 hrs)

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

- Hepaticopsida (*Sphaerocarpaceales*, *Marchantiales*, *Metzgeriales*, *Jungermanniales* and *Calobryales*).
- Anthocerotopsida* (*Anthocerotales*).
- Bryopsida* (*Sphagnales*, *Polytrichales*, and *Bryales*).

Practicals 18 hrs

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

References

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

PTERIDOLOGY (Theory 36 hrs; Practical 36 hrs)**Introduction to the course**

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

Module 1: General introduction and classification (4hrs)

Introduction, origin, general characteristics and history of the classification of pteridophytes.

Brief account on Smith's classification (2006). DNA barcoding of pteridophytes.

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

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

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

Module 3: Comparative study of Pteridophytes (4 hrs)

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

Module 4: Ecology and Economic importance (2 hrs)

Ecological and economic significance of Pteridophytes.

Practical (36 hrs)

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

References

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

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 (Theory 54 hrs; Practical 18 hrs)

Introduction to the Course

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

Module 1: Genetic material and its molecular structure (12 hrs)

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

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

- DNA replication: Unit of replication, enzymes and proteins involved in replication (in both prokaryotes and eukaryotes). Structure of the replication origin (in both prokaryotes and eukaryotes), priming (in both prokaryotes and eukaryotes), replication fork, fidelity of replication. Process of replication – initiation, elongation and termination. Replication in the telomere - telomerase.
- DNA repair mechanisms: Direct repair, excision repair – base excision repair and nucleotide excision repair (NER), eukaryotic excision repair – GG-NER, TC-NER. Mismatch repair, Recombination repair – homologous recombination repair, nonhomologous end joining, SOS response – Translesion DNA polymerase.
- Recombination: Homologous and nonhomologous recombination, molecular mechanism of homologous recombination. Site-specific recombination.
- 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, Retrotransposons- LINEs, SINEs.

Module 3: Gene expression (25 hrs)

- (a) Gene: Concept of gene; structural and genetic definitions – complementation test.
- (b) Transcription in prokaryotes: Initiation – promoter structure, structure of RNA polymerase, structure and role of sigma factors. Elongation – elongation complex, process of RNA synthesis. Termination – rho-dependent and rho-independent termination.
- (c) Transcription in eukaryotes: Types, structure and roles of RNA polymerases. Promoters – important features of class I, II, & III promoters. Enhancers and silencers. General transcription factors and formation of pre-initiation 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 prokaryotic and eukaryotic ribosomes. tRNA charging, initiator tRNA.
- (f) Stages in translation: Initiation – formation of initiation complex in prokaryotes and eukaryotes, initiation factors in prokaryotes and eukaryotes, 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) Prokaryotic 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) Eukaryotic 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 heterochromatinization, and DNA methylation. Effect of regulatory transcription factors on transcription. Post-transcriptional control – mRNA stability, RNA interference. Role of small RNA in heterochromatinization 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 (Theory 18 hrs; Practical 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.

Practicals (18 hrs)**Virtual lab experiments**

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

References

1. Wayne M Becker, Lewis J Kleinsmith, Jeff Hardin (2007). *The world of the cell* (VI Edn). Pearson.
2. Geoffrey M Cooper, Robert E Hausman (2009). *The Cell: A molecular approach* (V Edn). Sinauer.
3. Gerald Karp (2008). *Cell and Molecular biology: Concepts and experiments* (V Edn). John Wiley & Sons.
4. Harvey Lodish, Arnold Berk, Lawrence Zipursky, Paul Matsudaira, David Baltimore, James Darnell (2000). *Molecular cell biology* (IV Edn). W H Freeman & Company.
5. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2002). *Molecular biology of the cell* (IV Edn). Garland Science, Taylor and Francis group.
6. Robert J Brooker (2009). *Genetics: analysis and principles* (III Edn). McGraw Hill.
7. Jocelyn E Krebs, Elliott S Goldstein, Stephen T Kilpatrick (2011). *Lewin's Genes X*. Jones and Bartlett Publishers.
8. Bob B Buchanan, Wilhelm Gruissem, Russel L Jones (2000). *Biochemistry and Molecular biology of plants*. I K International Pvt. Ltd.
9. Daniel L Hartl, Elizabeth W Jones (2012). *Genetics: Analysis of genes and genomes* (VII Edn). Jones and Bartlett publishers.
10. James D Watson, Tania A Baker, Stephen P Bell, Alexander Gann, Michael Levine, Richard Losick (2009). *Molecular biology of the gene* (V Edn). Pearson.
11. William S Klug, Michael R Cummings (2004). *Concepts of Genetics* (VII Edn). Pearson.
12. Daniel J Fairbanks, W Ralph Anderson (1999). *Genetics: The continuity of life*. Brooks/Cole publishing company.
13. Robert F Weaver (2002). *Molecular biology* (II Edn). McGraw Hill.
14. Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2010). *Essential Cell Biology*. Garland Science.

15. Leland H Hartwell, Leroy Hood, Michael L Goldberg, Ann E Reynolds, Lee M Silver, Ruth C Veres (2004). *Genetics from genes to genomes* (II Edn). McGraw Hill.
16. 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.
17. James D. Watson, Amy A. Caudy, Richard M. Myers, Jan A. Witkowski (2007). *Recombinant DNA* (III Edn). W H Freeman.
18. William H Elliott, Daphne C Elliott (2001). *Biochemistry and molecular biology* (II Edn). Oxford.
19. Jeremy M Berg, John L Tymoczko, Lubert Stryer, Gregory J Gatto Jr. (2007). *Biochemistry*. W H Freeman & company.
20. David P Clark (2010). *Molecular biology*. Elsevier.
21. David R Hyde (2010). *Genetics and molecular biology*. Tata McGraw Hill.
22. D Peter Snustad, Michael J Simmons (2010). *Principles of genetics* (V Edn). John Wiley and Sons.
23. David A Micklos, Greg A Freyer with David A Crotty (2003). *DNA Science: A first course* (II Edn). L K Inter.
24. Benjamin A Pierce (2008). *Genetics: A conceptual approach* (IV Edn). W H Freeman and Company.
25. Peter J Delver, Seamus J Martin, Dennis R Burton, Ivan M Roitt (2011). *Roitt's essential immunology*(XII Edn). Wiley Blackwell.
26. Richard A Goldsby, Thomas J Kindt, Barbara A Osborne, Janis Kuby (2003). *Immunology* (V Edn). W H Freeman and Company.
27. Benjamin Lewin (2006) *Genes IX*. Jones and Bartlett.

16P2BOTT07: PLANT ANATOMY, PRINCIPLES OF ANGIOSPERM SYSTEMATICS & MORPHOLOGY**(Theory 36 + 36 hrs; Practical 36 + 27 hrs; Credits 4)****PLANT ANATOMY (Theory 36 hrs; Practical 36 hrs)****Introduction to the Course:**

- (a) Scope and importance of Plant Anatomy; Interdisciplinary applications: - Histotaxonomy, Histochemistry, Pharmacognosy, Physiological Anatomy, Ecological Anatomy, Evolutionary trends in plant anatomy
- (b) Study of Cell wall; Gross structure of primary and secondary cell walls, simple and bordered pits. Structure and function of plasmodesmata. Submicroscopic structure of cell wall- Cellulose, micelle, micro fibril and macro fibril. Different types of Cell wall thickening in tracheary elements
- (c) Extra cell wall thickening materials: - Lignin, cutin, suberin and callose.
- (d) Origin of cell wall; Growth of Cell wall- Apposition and intussusceptions – cavities & ducts, schizogenous & lysigenous developments
- (e) Non living inclusions in plant cell: - Reserve food materials -carbohydrate (starch), protein (Aleurone grain) and lipids (fats and oil);
- (f) Secretory products- pigments, enzymes and nectar.
- (g) Metabolic byproducts: - tannin, gums, resins, essential oils, mucilage, latex, mineral crystals and alkaloids
- (h) Meristematic tissue- definition, structure, function and classification
- (i) Apical organization and theories; Shoot apex- Apical cell theory, Histogen theory and Tunica-Corpus theory.
- (j) Root apex - Histogen theory and Korper- Kappe theory.
- (k) Permanent Tissue: - Structure and function of simple and complex tissues.
- (l) Distribution and function of mechanical tissues in plants.
- (m) Plant fibres-economic importance.
- (n) Secretory tissues: External secretory tissue- glands and nectaries, and Internal secretory tissues- laticifers.
- (o) Tissue System- Structure and Function in root, stem and leaves.
- (p) Epidermal Tissue System- Epidermis, Cuticle, Trichome, Stomata, Bulliform cells, Cork and Silica cells.
- (q) Ground Tissue System- Cortex, Endodermis, Pericycle, Pith and Pith rays.
- (r) Vascular Tissue System- Different types of vascular bundles and their arrangement in root and stem.
- (s) Vascular cambium: - Development, structure and function, Activity of cambium, role of cambium in budding, grafting and wound healing.
- (t) Normal secondary growth in dicot stem and root.
- (u) Wood anatomy- basic structure, heart wood, sap wood, hard wood, soft wood, growth rings and dendrochronology, porous and non porous wood, ring porous and diffuse porous wood, tyloses, knots.
- (v) Wood rays: Structure and cell types, uniseriate and multiseriate rays; heterocellular and homocellular rays.
- (w) Periderm: Structure and development- phellum, phellogen, phellogen, bark, polyderm, rhytidome and lenticel.
- (x) Anomalous secondary structure: Bougainvillea stem, Bignonia stem and Dracaena stem.

Module 1: Introduction (1 hr)

Scope and significance of plant anatomy, interdisciplinary relations.

Module 2: Meristem (7 hrs)

- (a) Apical organization: Stages of development of primary meristem; origin of branches and lateral roots.
- (b) Secretory tissues in plants: Structure and distribution of secretory trichomes (*Drosera*, *Nepenthes*), salt glands, colleters, nectaries, resin ducts and laticifers. Structure of bark and distribution pattern of laticifers in *Hevea brasiliensis*.

Module 3: Secondary structure (10 hrs)

- (a) Vascular cambium and cork cambium: Structure and function, factors affecting cambial activity.
- (b) Secondary xylem and phloem: Ontogeny, structure and function. Lignification patterns of xylem.
- (c) Reaction wood: Compression wood and tension wood. Factors affecting reaction wood formation.

- (d) Anomalous secondary growth in dicots and monocots (Piper, Strychnos)
- (e) Wood: Physical, chemical and mechanical properties.
- (f) Plant fibers: Distribution, structure and commercial importance of coir, jute, and cotton.

Module 4: Leaf and node (6 hrs)

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

Module 5: Reproductive anatomy (6 hrs)

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

Module 6: Ecological anatomy (4 hrs)

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

Module 7: Applied anatomy (2 hrs)

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

Practical (36 hrs)

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

References

1. Eames A J, McDaniel (1976). An introduction to plant Anatomy. Tata McGraw-Hill, New Delhi
2. Edred John, Henry Corner (1976). The seeds of dicotyledons (Vol. I, II). Cambridge University Press.
3. Ella Werker (1997). Seed Anatomy. Borntraeger. University of Michigan
4. Elizabeth G Cutter (1978). Plant Anatomy Part I & II. Clive and Arnald Ltd.
5. Elizabeth G Cutter (1978). Applied Plant Anatomy. Clive and Arnald Ltd.
6. Esau K (1965). Vascular differentiation in plants. Rirehant and Winston, Inc.
7. Esau K (1977). Anatomy of seed plants. Wiley and sons.
8. Fahn A. (1997). Plant anatomy. Aditya Publishers. New Delhi
9. Foster A S (1942). Practical plant Anatomy.
10. Chowdhuri (Ed). Indian woods (6 volumes). Forest research institute, Dehradun
11. Ingrid Roth (1977). Fruits of Angiosperm. Gebruder Borntraeger.
12. Kuriachen P M, Thomas V, Dave Y (1992). Taxonomic and phylogenetic significance of fruit walls in Asclepiadaceae. Feddes R eptorium.

13. Kuriachen P M, Dave P Thomas V, Mercymol Sebastian (1992). SEM studies on seed surface of some Asclepiadaceae with taxonomic significance. Geophytology. Lucknow.
14. Metcalf C R, Chalk L (1950). Anatomy of Dicotyledons and Monocotyledons.
15. Metcalf C R, Chalk L (1983). Anatomy of the dicotyledons: Wood structure and conclusion of the general introduction. Oxford University press.
16. Pandey B P. Plant Anatomy. S Chand and Co. New Delhi.
17. Reghu C P (2002). Structural features of Rubber wood. Rubberwood Processing and utilization in India. Ganesh Publications, Bangalore.
18. Reghu C P, George B P, YA Varghese (2007). Screening of Hevea germplasm for wood quality using Cinnamyl Alcohol Dehydrogenase (CAD) activity and lignifications pattern. Natural Rubber Research, 20 (1&2): 1-7.
19. Sherwin John Carlquist (2001). Comparative wood anatomy: Systematic, ecological, and evolutionary aspects of dicotyledon wood. Springer Verlag Berlin.
20. Tharian George K, Reghu C P, Nehru CR (2000). By-products and ancillary sources of income. Natural Rubber: Agro management and Crop Processing, Rubber Research Institute of India, Kottayam. 507-510
21. Vasishta P C (1994). Plant anatomy. Pradeep publications.
22. Wardrop A B (1961). The structure and formation of reaction wood in Angiosperm: Problems of tree physiology. Recent advances in Botany (Vol II). University of Toronto press.
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 (Theory 27 hrs; Practical 9hrs)

Introduction to the course

- (a) Morphology of flower as a modified shoot
- (b) Plant morphology- Calyx, Corolla, Androecium, Gynoecium, Venation, Phyllotaxy, Types of leaves, Aestivation, Placentation.
- (c) ICBN- History
- (d) Sources of taxonomic characters

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 ICN, 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, Tetrodynamous, 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.

References

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

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.

GENETICS (Theory 18hrs; Practical 18 hrs)

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.

Module 1: History of Genetics (3 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 (7hrs)

(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. Balancing of evolutionary forces.

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.
2. Gardner E J, Simmons M J, Snustad D P (1991). Principles of Genetics (III Edn). John Wiley and

Sons Inc.

3. Snustad D P, Simmons M J (2000). Principles of Genetics (III Edn). John Wiley and Sons.
4. Strickberger (2005). Genetics (III Edn). Prentice Hall of India Pvt. Ltd.
5. William S Klug, Michael R Cummings (1994). Concepts of Genetics. Prentice Hall.
6. Robert J Brooker (2009). Genetics: Analysis and principles (III Edn). McGraw Hill.
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 (Theory 54 hrs; Practical 18 hrs)

Introduction to the Course

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

Module 1: pH and Buffer (5 hrs)

Acids and bases, strength of acids – strong acids, weak acids. Ionization of water – K_w , pH. Dissociation of acids – pK_a , Henderson-Hasselbalch equation. Buffers – definition, chemical composition, requirements for a good buffer, buffer action, buffer capacity. Measurement of pH – colorimetric methods and electrometric methods.

Module 2: Carbohydrates (3 hrs)

Sugar derivatives: Glycoproteins, proteoglycans, mucoproteins. Lectins.

Module 3: Lipids (3 hrs)

Structural lipids – membrane lipids. Lipid biosynthesis, fat breakdown – β oxidation

Module 4: Amino acids (3 hrs)

Structure and classification of amino acids. Biosynthesis of amino acids.

Module 5: Proteins (8 hrs)

Classification of proteins based on structure and function. Oligo- and polypeptides. Primary structure – peptide bond. Secondary structure – Ramachandran plots, α -helix, β sheet.

Tertiary structure – forces that stabilize tertiary structure. Quaternary structure, domains, motif and folds. Protein sequencing – Edman method. Functions of proteins.

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. General characters of enzymes -specificity, catalytic power, regulation. IUB system of enzyme classification and naming.

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

(c) Enzyme Kinetics: Michaelis-Menton kinetics, Lineweaver-Burk plot. Mechanism of multi substrate reaction – Ping Pong, Bi-Bi mechanism.

(d) Regulation of enzyme activity: Allosteric effect, control proteins, reversible covalent modification,

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

f) Cofactors and coenzymes: Essential ions, Coenzymes; structure and role of metabolite coenzymes – ATP; structure and role of vitamin derived coenzymes – NAD⁺, NADP⁺, FAD, FMN, TPP, PLP

g) Biotin. Isozymes

Module 7: Nucleotide metabolism (4 hrs)

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

Module 8: Secondary metabolites (6 hrs)

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

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

Model Question Paper

SACRED HEART COLLEGE, THEVARA (AUTONOMOUS)

M.Sc. BOTANY Semester II

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 Stellar system found in Pteridophytes ?

OR

24. Give a detailed account on gametophyte of *Lycopodium*.

25. Explain the sporophytic structure of *Anthoceros* with a neat labelled diagram.

OR

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

(2 x 12 = 24 marks)

Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany Semester II
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) Translation polymerase
18. Explain RNAi? How is RNAi involved in gene regulation?
19. Write a short note on recombinant vaccines.
20. Discuss the important features of the genetic code.
21. Explain the molecular mechanism of homologous recombination.
22. Briefly explain the structure, function and types of antibody molecules.

(5 x 7 = 35)

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

23. Explain DNA replication in Prokaryotes.

OR

24. Explain the post-transcriptional modifications of mRNA.

25. Describe the control of gene expression in eukaryotes.

OR

26. Explain the production and uses of monoclonal antibodies.

(2 x 12 = 24)

Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

M.Sc. Botany Semester II

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

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

(2x8=16)

PART – B

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

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

(5x7=35)

PART – C

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

23. Write an essay on structure, classification and biosynthesis of amino acids.
OR
24. Write an essay on secondary metabolites.
25. Give an account on gene mapping of Haploid organisms.
OR
26. What is allele and genotype frequency? What is the relationship between them in a large, random mating, natural population? Name the processes that can change the allele frequencies in natural populations. Describe why these forces change the frequencies?

(12x2=24)

SACRED HEAR COLLEGE (AUTONOMOUS), THEVARA
Semester II
M.Sc. Botany Practical Course – 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 biology.
4. G, H, I and J - Two reproductive structures each from Bryophytes & Pteridophytes.

N.B. Awarding maximum marks for the record of practical work shall be considered only if all the practical work specified in the syllabus are done completely and recorded properly.

SACRED HEAR COLLEGE (AUTONOMOUS), THEVARA
M.Sc. Botany Semester II
Practical Course – 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)
9. Practical Record (8)

Key to the questions:

1. A – Anomalous secondary thickening in dicot/ monocot
2. B, C – Stomatal types – suitable leaves
3. D – Specimen for nodal anatomical study
4. E – Suitable nomenclatural problem.
5. F – Material for morphological study mentioned in the syllabus.
6. G – Suitable flower for LS and study
7. H and I – problems from Genetics
8. J – Amylase activity study
9. Awarding maximum marks for the record of practical work shall be considered only if all the practical work specified in the syllabus are done completely and recorded properly.

SEMESTER III

Course	Title	Teaching Hrs Theory	Teaching Hrs Practical	Credits
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 (6hrs)

- (a) Classification systems; (i) Linnaeus (ii) Bentham & Hooker.
- (b) Herbaria and herbarium specimens.
- (c) Families: Annonaceae, Malvaceae, Sterculiaceae, Rubiaceae, Sapotaceae, Convolvulaceae, Solanaceae, 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 (Rheede & Taxon/Blumea), Reviews and GIS (Geographic Information System). Construction of taxonomic keys – Indented and bracketed key, Punched Card key.

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. Ranunculaceae 2. Magnoliaceae 3. Menispermaceae 4. Brassicaceae 5. Capparidaceae 6. Polygalaceae 7. Caryophyllaceae 8. Guttiferaceae 9. Dipterocarpaceae 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

Gamopetalae: 27. Asteraceae 28. Campanulaceae 29. Myrsinaceae 30. Loganiaceae 31. Oleaceae 32. Apocynaceae 33. Asclepiadaceae 34. Boraginaceae 35. Scrophulariaceae 36. Bignoniaceae 37. Acanthaceae 38. Verbenaceae 39. Lamiaceae

Monochlamydeae: 40. Polygonaceae 41. Aristolochiaceae 42. Piperaceae 43. Lauraceae 44. Loranthaceae 45. Euphorbiaceae 46. Moraceae 47. Urticaceae

Monocots: 48. Orchidaceae 49. Cannaceae 50. Dioscoriaceae 51. Liliaceae 52. Zingiberaceae 53. Musaceae 54. Araceae 55. Cyperaceae 56. Poaceae

Module 4: Evolution of flowering plants (4 hrs)

Evolution and diversity of woody and seed plants.

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 scientific sketches and description in technical terms.
2. Study of flora, construction of keys and use of floras in the identification up to species from field study.
3. Preparation of dichotomous keys based on four 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 course 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. (1875-1897)The flora of British India (Vol. I – VII).
4. Gamble J S (1915-1935). Flora of the Presidency of Madras. (Vol. I – III).
5. Cronquist A (1960). Evolution and classification of flowering plants. Thomas & Nelson Co.
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). The Classification of flowering plants. Vikas Publishers House Pvt Ltd.
10. Stace C A (1989). Plant Taxonomy and Biosystematics (II Edn). CBS Publ.
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.
14. Simpson M G (2010). Plant Systematics.
15. Singh G (2102). Plant Systematics Theory and Practice (3rd Edn). Oxford & IBH Publishing Co. New Delhi.
16. Battacharya B (2009). Systematic Botany (2nd Edn). Narosa Publishing House.
17. Lawrence H M G (1951). Taxonomy of Vascular Plants. The Macmillan Company. US.
18. Sunil C N and Sivadasan M (2009). Flora of Alappuzha District. Bishen Singh Mahendra Publishers.
19. Anilkumar N, Sivadasan M and Ravi N (2005). Flora of Pathanamthitta. Daya Publishing House.
20. Sasidharan N (2012). Flowering Plants of Kerala. KFRI.
21. Ramesh B.R, Ayyappan N, Grard P, Prospero J, Aravajy S and Pascal J P (online). BIOTIK Western Ghats. <http://www.biotik.org/>

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

GYMNOSPERMS (Theory 27 hrs; Practical 27 hrs)

Introduction to the Course

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

Module 1: Introduction (3 hrs)

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

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

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

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

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

- (a) General account on the male and female gametophyte development in Gymnosperms (*Cycas*).
- (b) Economic importance of Gymnosperms.

Practical (27 hrs)

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

References

1. Andrews H N Jr (1961). *Studies in Palaeobotany*. John Wiley and sons.
2. Arnold C A (1947). *An introduction to Palaeobotany*. John Wiley and sons.
3. Beck C E (1995). *Gymnosperm Phylogeny*. Bot. Rev. 51-176.
4. Bhatnagar S P, Moitra A (2000). *Gymnosperms*. New Age International Ltd.
5. 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.
10. Coulter J M, Chamberlain C J (1977). *Morphology of Gymnosperms*. University of Chicago Press.
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 (Theory 27 hrs)**Introduction to the Course**

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

Module 1: Origin of life (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.

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 Natural Selection, 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 (Theory 9 hrs; Practical 9 hrs)**Introduction to the course**

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

Module 1 (3 hrs)

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

Module 2 (3 hrs)

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

Module 3 (3 hrs)

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

Practicals (9 hrs)

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

References

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

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 regulation, Citric acid cycle

Module 1: Plant water relations (10 hrs)

- (a) Cell wall and membrane properties in relation with water- Turgor Pressure and Hydraulic conductivity. Aquaporins. Plant water status and Physiological processes.
- (b) Bulk flow of water. Water absorption by roots- pathways, root pressure and guttation. Water transport through xylem - pressure driven bulk flow. Water movement from the leaf to the atmosphere – hydraulic resistance, driving force of transpiration, pathway resistances. Leaf anatomy for regulating transpiration. Control of stomatal mechanism. Theories of stomatal movement. Soil-plant-atmosphere continuum.

Module 2: Absorption of minerals (3 hrs)

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

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

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

Module 4: Photosynthesis (14 hrs)

- (a) Basic principles of light absorption, excitation energy transfer, mechanism of electron transport. Light harvesting complexes: PS I, PSII; Structure and composition of reaction centers, photooxidation of water, organization of light-absorbing antenna systems, mechanism of chloroplast electron transport- complexes, Proton transport and ATP synthesis. Repair and Regulation of Photosynthetic Machinery- Photoprotection, Photoinhibition.
- (b) Structure and function of RuBisCo. CO₂ fixation- Regulation of Calvin cycle. Photorespiration, role of photorespiration in plants. CO₂ concentrating mechanisms - C₄ cycle, CAM pathway. Synthesis and mobilization of chloroplast starch, starch degradation, Regulation of synthesis and degradation. Biosynthesis of sucrose and signalling.

Module 5: Translocation in the Phloem (4 hrs)

- (a) Materials translocated in the phloem- Sucrose and other materials.
- (b) Mechanism of phloem translocation - Pressure flow model of phloem transport. Phloem loading and unloading. Photosynthate allocation and partitioning.

Module 6: Respiration and lipid metabolism (12 hrs)

- (a) Three stages of respiratory metabolism. (brief study only).. Gluconeogenesis. Pentose phosphate pathway and its regulation.
- (b) Mitochondrial electron transport and ATP synthesis – structure of electron transfer complexes (complex I – IV). ATPase - detailed structure of F₁ and F₀ subunits, Chemiosmotic hypothesis, binding change mechanism of ATP synthesis.
- (c) Comparison of mitochondrial and chloroplast ATP synthesis.

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

(e) Lipid metabolism: glyoxylate cycle.

Module 7: Nitrogen metabolism: (6 hrs)

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

Module 8: Stress physiology (5 hrs)

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

Module 8: Sensory photobiology (4 hrs)

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

Module 9: Plant growth regulators (8 hrs)

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

Practicals (36 hrs)

1. Preparation of Molal, Molar and Percentage solutions.
2. Estimation of proline in plant tissues under various abiotic stresses.
3. Estimation of phenol in plant tissues affected by biotic stress.
4. Determination of peroxidase activity in plant tissues affected by biotic/abiotic stresses.
5. Estimation of free amino acids in senescing leaves to understand the source to sink transformation phenomenon.
6. Determination of osmotic potential by tissue weight method.
7. Separation of photosynthetic pigments by TLC/paper chromatography and calculating the 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)

(a) Transport of ions, solutes and macromolecules (4 hrs)

Cation Transporters- Cation channels, Cation carriers. Anion Transporters. Transporters for metals and metalloid ions. P-type ATPases. Ion transport in roots.

(b) Photosynthesis (6 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.

(c) 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.

(d) Assimilation of inorganic nutrients (5 hrs)

Sulfur assimilation, Phosphate assimilation, Cation assimilation energetics of nutrient assimilation.

(e) Signaling in Plants (6 hrs)

Plant cell Signaling molecules and receptors. Signal amplification. Second messengers in plant cells: Ca²⁺, pH, ROS and lipid molecules. Signal transmission and cell-cell communication- hormonal signaling pathways (detailed account). Phytochrome signaling pathways in response to abiotic stress.

(f) Seed and fruit physiology (6 hrs)

Seed coat development, seed maturation and desiccation tolerance, dormancy, release from dormancy, germination, mobilization of stored reserves, seedling growth and establishment, tropisms, photomorphogenesis, shade avoidance, vascular tissue differentiation, root growth and differentiation. Fruit development and ripening.

(g) Vegetative growth and organogenesis (4 hrs)

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). Sinauer 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.
5. Frank B Salisbury, Cleon W Ross (1992). *Plant Physiology* (IV Edn). Wadsworth Publishing Company. , New York
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.
7. Gerald Karp (2008). *Cell and Molecular biology: Concepts and experiments* (V Edn). John Wiley & Sons.
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.
9. William H Elliott, Daphne C Elliott (2001). *Biochemistry and molecular biology* (II Edn). Oxford
10. Jeremy M Berg, John L Tymoczko, Lubert Stryer, Gregory J Gatto Jr. (2007). *Biochemistry*. W H Freeman and company. , London.
11. David E Sadava (2009). *Cell biology: Organelle structure and function*. CBS
12. S Sadasivam, A Manickam (1996). *Biochemical methods* (II Edn). New age international Publishers.
13. Devlin, R. M., Witham, F. H. (1986). *Plant physiology*. 4th ed. CBS Publishers and Distributors. Shahadara, New Delhi.
14. Hopkins, W. G. and Hüner, N. P. (1995). *Introduction to plant physiology* (Vol. 355) Wiley and sons, New York.
15. Jones, H. G., Flowers, T. J., & Jones, M. B. (Eds.). (1989). *Plants under stress: Biochemistry, physiology and ecology and their application to plant improvement* (No.39). Cambridge University Press, England.
16. Kays, S. J. (1991). *Postharvest physiology and handling of perishable plant products*. Van Nostrand Reinhold Inc., USA.
17. Kumar, A. and Purohit, S. S. (1996). *Plant Physiology*. Agro botanical Publishers, Bikaner.
18. Mohr, H. and Schopfer, P. (1995) *Plant Physiology*, Springer, London.
19. Moore, T. C. (1981). *Research experience in plant Physiology-A Lab Manual*, Springer-Verlag, New York.
20. Noggle, G. R., & Fritz, G. J. (1992). *Introductory plant physiology* (No. Ed. 2). Prentice- Hall Inc., New Jersey.

16P3BOTT12: PLANT REPRODUCTIVE BIOLOGY, PALYNOLOGY AND PLANT BREEDING

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

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

Introduction to the course (6 hrs)

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

Module 1: Basic concepts of developmental Biology (2 hrs)

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

Module 2: Pollination (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 3: 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 4: Breeding system and Self incompatibility (5hrs)

- (a) Breeding system: Outbreeding devises and their efficacy
- (b) Self-incompatibility: Genetic basis of SI. Gametophytic and sporophytic SI Physiology and Biochemistry of incompatibility. Biological significance of incompatibility. Methods to overcome SI and interspecific incompatibility.

Module 5: Seed Biology (6hrs)

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

Module 6: Eminent personalities in the field of reproductive biology with an emphasis on Indian contributions (3 hrs)

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

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 sterility test by Acetocarmine and viability test by in vitro germination (Impatiens, Croton, Cucurbits etc.)
6. Identification of different types of embryos, polyembryony, endosperm types, types of pollen grains, anther growth stages and types using permanent slides.
7. Tests for breaking dormancy in different seeds.

Suggested Assignment Topics

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

References

1. Scott F Gilbert (2000). Developmental Biology (IX Edn). Sinauer Associates. (available online).
2. Twyman R M (2001). Instant notes in Developmental Biology. Viva Books Private Limited.
3. Lincoln Taiz, Eduardo Zeiger (2002). Plant physiology (II Edn). Sinauer Associates, Inc. Publishers.
4. Robert J Brooker (2009). Genetics: analysis & principles (III Edn.). McGraw Hill
5. Bob B Buchanan, Wilhelm Gruissem, Russel L Jones (2000). Biochemistry and Molecular biology of Plants. L K International Pvt. Ltd.
6. Scott F Gilbert (2000). Developmental Biology (VIII Edn). Sinauer Associates.
7. Maheswari P (1950). An introduction to the embryology of Angiosperms. McGraw Hill.
8. Bewley J.D. and Black M. (1994) Seeds: Physiology of Development and Germination. Plenum Press.
9. Bhojwani S.S. and Bhatnagar S. P. (2000). The Embryology of Angiosperms. Vikas Publishing House.
10. Endress P. K. and Frus F. M. (1994). Early Evolution of Flowers. Springer-Verlag.
11. Leins P. Tucker S.C. and Endress P. K. (1988). Aspects of Flower Development. J. Cramer.
12. Meeuse AD. (1966). Fundamentals of Phytomorphology. Ronald Press Co.
13. Maheswari, P. (1963). Recent advances in the Embryology of Angiosperms.
14. Maheswari P. (1950). An Introduction to the Embryology of Angiosperms. McGraw Hill Book Co.
15. Raghavan V. (1966). Embryogenesis in Angiosperms. Cambridge Univ. Press.
16. Raghavan V. (1999). Development Biology of Flowering Plants. Springer-Verlag.
17. Sattler R. (1978). Theoretical Plant Morphology. Leiden University Press. 15
18. Shivanna K. R. and Rangaswamy N.S. (1992). Pollen Biology: A Laboratory Manual, Springer-Verlag.

19. Shivanna K. R. and Johri B. M. (1985). The Angiosperm Pollen Structure and Function. Wiley Eastern.
20. Shivanna K. R. and Sawhney V. K. (1997). Pollen Biotechnology for Crop Production and Improvement. Cambridge Univ. Press.
21. Shivanna and Tandon (2014). Reproductive Ecology of Flowering Plants: A Manual. Springer.
22. Shivanna K. R. (2003). Pollen Biology and Biotechnology. Oxford and IBH publishing Co. Pvt. Ltd.
23. Sporne K. R. (1974). The Morphology of Agiosperms. Hutchinson University Press.
24. Swamy B.G.L. and Krishnamurthy K. V. K. (1980). From Flower to Fruit. Tata McGraw Hill Book Co.
25. Faegri, K., and Iversen, J. (1989 (also reprinted in 2000)). Textbook of Pollen Analysis, 4th Ed. Blackburn Press, Caldwell, NJ.

PALYNOLOGY (Theory 18 hrs; Practical 9 hrs)

Introduction to the Course

- (a) Types of pollination and pollination syndromes
- (b) Mechanism of pollination and fertilization

Module 1: Introduction to Palynology (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 may come under pollen morphology

Module 3: Pollen Analysis (6hrs)

Laboratory techniques: Methods 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. Pollen viability- 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.

Module 4: Applications and Methods in Palynology (5hrs)

Palynology and Systematics, Pollen sampling and data gathering (how many samples to be collected 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 sampling, Melisso-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.

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

Practical (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

1. Faegri, K., and Iversen, J. (1989 (also reprinted in 2000)). Textbook of Pollen Analysis, 4th Edn. Blackburn Press, Caldwell, NJ
2. Kapp R O, Davis O K, & King J E (2000). Guide to Pollen and Spores. (2nd Edn, 3rd printing). AASP Press, Dallas.

PLANT BREEDING (Theory 18 hrs; Practical 9hrs)

Introduction to the Course

Plant introduction- procedure of plant introduction, quarantine regulations, acclimatization- agencies of plant introduction in India, major achievements.

Selection- mass, pureline, clonal- genetic basis of selection- some achievements – semi dwarf wheat and Rice.

Hybridization- Introduction, history, objectives and procedure.

Module 1: 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.
3. Sharma J R (1994). Principles and practices of Plant Breeding. Tata McGraw-Hill Publishers Company Ltd.
4. Singh B D (1996). Plant Breeding: Principles and methods. Kalyani Publications.

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

(2 x 8 = 16)

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

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

(7x5= 35)

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

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

or

24. Compare and contrast microspores in gymnosperms

25. Write an essay on speciation

or

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

(2x12= 24)

Model Question Paper

**SACRED HEART COLLEGE, THEVARA (AUTONOMOUS)
M.Sc. Botany Semester III
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 C₄ photosynthesis.
7. Write a note on Vernalisation.
8. Write a short note on Aquaporins.
9. Differentiate between root pressure and transpirational pull.
10. What is SPAC?
11. Write a short note on phytoalexins.
12. Give an account on HSP.

(8 x 2 = 16 marks)

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

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

(5 x 7 = 35 marks)

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

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

(12 x 2 = 24 marks)

Model Question Paper

**SACRED HEART COLLEGE (AUTONOMOUS), Thevara
M.Sc. Botany - Semester III**

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 syllabus
5. Awarding **8** marks for the record of practical work shall be considered only if all the practical works specified in the syllabus are done completely and recorded properly with signature of the teacher in charge.

List of plant physiology experiments (Question 1-A)

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

SEMESTER IV

PROGRAMME ELECTIVE- I: BIOTECHNOLOGY

Course	Title	Teaching Hrs Theory	Teaching Hrs Practical	Credits
16PE1BOTT13	Biotechnology & Genetic Engineering	72	36	4
16PE1BOTT14	Genomics, Proteomics & Bioinformatics	36+36	45	4
16PE1BOTT15	Tissue Culture & Microbial Biotechnology	36+ 18	18 + 18	3
16PE1BOTT16	Biostatistics, Microtechniques & Biophysics	36+ 18 + 18	18 + 27 + 18	4
16PE1BOTP07	Practicals of 16PE1BOTT13+ 16PE1BOTT14			2
16PE1BOTP08	Practicals of 16PE1BOTT15+ 16PE1BOTT16			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.			

16PE1BOTT13: BIOTECHNOLOGY & GENETIC ENGINEERING
(Theory 72 hrs; Practicals 36 hrs; Credits 4)

Introduction to the Course

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

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

16PE1BOTT14: GENOMICS, PROTEOMICS&BIOINFORMATICS
(Theory 36+36 hrs; Practicals 0+45 hrs; Credits 4)

GENOMICS & PROTEOMICS (Theory 36 hrs)

Introduction to the Course

- (a) Genomics: Genome and Proteomics- basis and key concepts.
- (b) 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.

Module 1: Structural genomics (20 hrs)

- (a) Basic steps in genome sequencing. Shot gun sequencing of small genomes. Map based sequencing: Hierarchical shot gun sequencing (clone-by-clone approach) - steps involved; Whole genome shot gun approach - steps involved.
- (b) Genome mapping: Genetic mapping and physical mapping. 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 – Pyrosequencing, 454 GS FLX System.

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) Comparative 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.

References

1. S B Primrose, R M Twyman (2006). *Principles of gene manipulation and genomics* (VII Edn). Blackwell publishing.
2. Robert J Brooker (2009). *Genetics: analysis & principles* (III Edn). McGraw Hill.
3. James D Watson, Amy A Caudy, Richard M Myers, Jan A Witkowski (2007). *Recombinant DNA* (III Edn). W H Freeman.
4. T A Brown (2002). *Genomes* (II Edn). Bios.
5. Leland H Hartwell, Leroy Hood, Michael L Goldberg, Ann E Reynolds, Lee M Silver, Ruth C Veres (2004). *Genetics: From genes to genomes* (II Edn). McGraw Hill.
6. *Science*, 16 february 2001, Vol. 291.
7. Jeremy M Berg, John L Tymoczko, Lubert Stryer, Gregory J Gatto Jr. (2007). *Biochemistry*. W H Freeman and company.

8. David P Clark (2010). *Molecular biology*. Elsevier.
9. D Peter Snustad, Michael J Simmons (2010). *Principles of genetics* (V Edn). John Wiley and Sons.
10. David A Micklos, Greg A Freyer with David A Crotty (2003). *DNA Science: A first course* (II Edn). L K Inter.
11. Benjamin A Pierce (2008). *Genetics: A conceptual approach* (IV Edn). W H Freeman and Company.
12. Anthony J F Griffiths, Susan R Wesler, Sean B Carroll, John Doebley (2008). *Introduction to genetic analysis* (X Edn). W H Freeman and Company.
13. Benjamin A Pierce (2008). *Genetics: A conceptual approach* (IV Edn). W H Freeman and Company
14. C W Sensen (2002). *Genomics and Bioinformatics*. Wiley – VCH.
15. T A Brown (2002). *Genomes* (II Edn). Bios.
16. William J Thieman, Michael A Palladino (2009). *Introduction to biotechnology* (II Edn). Pearson
17. George Acquaaah (2005). *Understanding biotechnology*. Pearson.
18. Robert H Tamarin (2002). *Principles of genetics*. McGraw Hill.
19. Robert K Murray, David A Bender, Kathleen M Botham, Peter J Kennelly, Victor W Rodwell, P Anthony Weil (2009). *Harper's Illustrated Biochemistry* (XXVIII Edn). Mc Graw Hill.
20. *Nature*, 409 (6822): 860-921, 2001.
21. S R Pennington, M J Dunn (Edts) (2002). *Proteomics: From protein sequence to function*. Viva Books Private Limited.
22. Bernard R Glick, Jack J Pasternak, Cheryl L Pattein (2010). *Molecular biotechnology, principles and applications of recombinant DNA*. ASM press.
23. Burton E Tropp (2012). *Molecular biology: Genes to Proteins* (IV Edn). Jones and Bartlett Learning.
24. Jocelyn E Krebs, Elliott S Goldstein, Stephen T Kilpatrick (2011). *Lewin's Genes X*. Jones and Bartlett Publishers.

BIOINFORMATICS (Theory 36 hrs; Practical 45 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

References

1. Teresa K Attwood, David J Parry-Smith, Simiron Phukan (2007). *Introduction to Bioinformatics*. Pearson Education.
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.
4. David W Mount (2001). *Bioinformatics: Sequence and genome analysis*. CBS publishers & distributors.
5. Jin Xiong (2006). *Essential Bioinformatics*. Cambridge University Press

Additional Credit (36 hrs)

(a) Protein visualization tool: Pymol and Swiss PDB viewer

(b) Gene prediction programs – Grail/Exp, GENSCAN, ORF finder.

(c) Construction of phylogenetic trees – Beast and Beauti.

(d) Drug Designing Autodock Vienna and Discovery studio.

(e) Third generation sequencing:- Reversible terminators sequencing, ion semiconductor sequencing, sequencing by ligation, Single molecule sequencing.

(f) ENCODE project.

(g) Gene over expression: DAVID, GSEA

16PE1BOTT15: TISSUE CULTURE AND MICROBIAL BIOTECHNOLOGY
(Theory 54 hrs; Practical 36 hrs; Credits 3)**Introduction to the Course**

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

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

References

1. Hamish A Collin, Sue Edwards (1998). *Plant tissue culture*. Bios scientific publishers.
2. R A Dixon, R A Gonzales (2004). *Plant cell culture, a practical approach* (II Edn). Oxford University Press.
3. S S Bhojwani, M K Razdan (1996). *Plant tissue culture: Theory and Practice*. Elsevier.
4. Susan R. Barnum (1998). *Biotechnology an introduction*. Thomson Brooks/cole.
5. Nicholas C Price, Lewis Stevens (1999). *Fundamentals of enzymology* (III Edn). Oxford university press.
6. Trever Palmer (2004). *Enzymes: Biochemistry, Biotechnology, Clinical chemistry*. T Palmer/Harwood Publishing Limited.
7. E M T El-Mansi, C F A Bryce, A L Demain, A R Allman (2007). *Fermentation Microbiology and Biotechnology* (II Edn). Taylor & Francis.
8. L Gamborg, G C Philips (Eds.) (2005). *Plant cell, tissue and organ culture: Fundamental methods*. Narosa Publishinh House.
9. *In vitro cultivation of plant cells*. Biotechnology by open learning. Elsevier.

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

16PE1BOTT16: BIOSTATISTICS, MICROTECHNIQUES & BIOPHYSICS
(Theory 36+ 18 + 18 hrs; Practical 18 + 27 + 18 hrs; Credits 4)

Course Objectives

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

BIOSTATISTICS (Theory 36 hrs; Practical 18 hrs)

Introduction to the Course

- Basic principles of Biostatistics: Methods of collection and classification of data; Primary and secondary data, qualitative and quantitative data. Frequency distribution, graphical representation.
- Measures of central tendency; Mean, Median and Mode
- 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)

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

Module 3: Design of experiments (8 hrs)

- Experimental designs: Principles - replication and randomization.
- 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)

- Analysis of data to find the mean, median and mode.
- Analysis of a given data for mean deviation and standard deviation.
- Test the significance of a given data using t test, X² test, F-test and ANOVA.
- Analysis of a set of data for correlation/regression.
- Determine probability for different types of events.
- Familiarization and data analysis using Instat.

References

- Chandel R S (1975). *A handbook of Agricultural statistics*. Achal prakashan Mandir.
- Gomez K A, Gomez A A (1984). *Statistical procedures for agricultural research*. John Wiley and sons.
- Gupta S P (1984). *Statistical methods*. S Chand and company.
- Panse V G, Sukathme P V (1995). *Statistical methods for Agricultural workers*. ICAR.
- Robert J Brooker (2009). *Genetics: analysis & principles* (III Edn). McGraw Hill.

MICROTECHNIQUE (Theory 18 hrs; Practical 27 hrs)**Module 1: Killing and fixing (2 hrs)**

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

Module 2: Dehydration, clearing, embedding and sectioning (5 hrs)

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

(b) Embedding: Paraffin embedding.

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

Module 3: Staining (3 hrs)

(a) Principles of staining; classification of stains, protocol for preparation of; (i) Natural stains -

(b) Haematoxylin and Carmine (ii) Coal tar dyes – Fast green, Orange G, Safranin, Crystal violet, Cotton Blue and Oil Red O.

(c) Techniques of staining: (i) Single staining; Staining with Safranin or crystal violet (ii) Double

(d) staining; Safranin-Fast green method, Safranin-Crystal violet method (iii) Triple staining; Safranin-Crystal violet-Orange G method.

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

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

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

Module 5: Whole mounts (5 hrs)

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

(b) Staining of whole mount materials (haematoxylin, fast green or Safranin-fast green combination).

(c) Significance of whole mounts.

(d) Techniques of smear, squash and maceration.

(e) Mounting: Techniques, common mounting media used - DPX, Canada balsam, Glycerine jelly and

(f) Lactophenol. Cleaning, labeling and storage of slides.

Practical (27 hrs)

1. Students are expected to be thorough with the following techniques.

(a) Preparation of semi permanent slides.

(b) Preparation of permanent slides.

(c) Preparation of whole mounts.

(d) Maceration.

(e) Preparation of fixatives (FAA, Carnoy's fluid, Houghton's adhesive).

(f) Preparation of dehydration series (Alcohol, Acetone, TBA).

(g) Preparation of paraffin blocks.

(h) Preparation of serial sections.

2. Candidates should prepare and submit 10 permanent slides in which the following categories should be included:

(a) Free hand sections (single/double stained).

(b) Serial sections (single/double stained).

(c) Wood sections and whole mounts.

References

1. 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 Centrifugation, Equilibrium density gradient centrifugation. EtBr-CsCl density gradient.
- (c) Chromatography: Principles and application; paper, TLC, Column chromatography, GC, HPLC.
- (d) Immunoassay systems, ELISA - ELISA reader.
- (e) Electrophoresis: SDS PAGE, AGE and PFGE
- (f) X-ray crystallography.
- (g) Haemocytometer.
- (h) Mass Spectrometry.

Practical (18 hrs)

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

References

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

Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

M.Sc.Botany DEGREE EXAMINATION

SEMESTER IV

16PE1BOTT13: 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 **any Two** questions; each question carries 12 marks

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

OR

24. Explain the applications of rDNA technology.

25. Explain the procedure and applications blotting techniques

OR

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

(12x2 = 24marks)

Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

M.Sc.Botany DEGREE EXAMINATION

SEMESTER IV

16PE1BOTT14: 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 Pyrosequencing.
17. Explain RNA secondary structure prediction.
18. Explain tools used for multiple sequence alignment.
19. Differentiate between genetic mapping and physical mapping.
20. Write a short note the procedure and applications of chromatin immunoprecipitation.
21. Explain Shot gun sequencing.
22. Explain SNP.

(5 x 7 = 35 marks)

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

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

OR

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

OR

26. Explain the application of bioinformatics in phylogenetic studies?

(12x2 = 24marks)

Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

M.Sc.Botany DEGREE EXAMINATION

SEMESTER IV

16PE1BOTT15: 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 short note on synthetic seeds.
10. List out the factors influencing shoot bud differentiation?
11. Write a short note on vitrification.
12. Write a short note on enzyme engineering.

(8 x 2 = 16 marks)

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

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

(5 x 7 = 35 marks)

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

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

OR

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

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

OR

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

(12x2 = 24marks)

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

16PE1BOTT16: BIOSTATISTICS, BIOPHYSICS & MICROTÉCHNIQUE

Time 3 hours

Max. Marks 75

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

1. What is student t- test?
2. What is the application of ANOVA?
3. What is standard error?
4. Describe the principles and techniques of fixing. Write the composition and use of FAA
5. Write the preparation and uses of haematoxylin and Safranin
6. Describe the following;
 - (a) Coal tar dyes (b) Double staining.
6. Why is a statistical test necessary to determine whether an observed set of data yields an acceptable fit to the result expected from a particular hypothesis? What statistical test is used for this?
7. Write the principle and use of Phase contrast microscope?
8. What is ELISA? What is its application?
9. How do you differentiate squash from maceration?
10. What is pH?
11. What is meant by resolving power?
12. What is DPX? (8x2 = 16 marks)

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

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

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

23. Describe various steps in making permanent serial sections
- OR**
24. Write an essay on the principle and applications of Electron microscopy.
 25. Explain with suitable illustrations various methods of data representation.
- OR**
26. Describe the experimental designs used for different types of studies

(12x2 = 24marks)

Model Question Paper**SACRED HEART COLLEGE (AUTONOMOUS), THEVARA****Semester IV****Practical Course: 16PE1BOTP07****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 16PE1BOTP08****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.
(Calibration - 1, Measurement, calculation and result -3) (4)
- or**
6. (b) Find out the number of spores/ml in the given spore suspension **E**.
(Counting - 1, Calculation - 2, Result - 1) (4)
- or**
6. (c) Find the concentration of the given sample solution **E** using colorimeter.
Prepare a standard graph from the given values. (4)
(Principle, procedure and graph - 3, Working and Result - 1)
- III. Workout the problem **F**. (7)
The probability that the person 'A' will be living up to 60 years is $\frac{3}{4}$ and the probability of another person 'B' will be living up to 60 years is $\frac{2}{3}$. Find the probability of
(1) Both 'A' and 'B' will live up to 60 years?
(2) Both die before reaching 60 years?
- IV. Prepare a double stained micropreparation of material **G** and mount it as a permanent slide.
(Sectioning and staining - 4, Mounting - 1) (5)
- V. Prepare serial sections of **H** and mount on a glass slide. (5)
(Microtome sectioning - 3, Mounting - 2)
- VII. Permanent slides. (8)
- VIII. Practical record. (4 + 4)

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.

SEMESTER IV

PROGRAMME ELECTIVE – II : ECOTECHNOLOGY

Course	Title	Teaching Hrs Theory	Teaching Hrs Practical	Credits
16PE2BOTT13	Natural Resources and their Management	72	45	4
16PE2BOTT14	Environmental Sustainability	72	45	4
16PE2BOTT15	Environmental Monitoring	72	45	4
16PE2BOTT16	Sustainable Agriculture	54	36	3
16PE2BOTP07	Practicals of 16PE2BOTT13+ 16PE2BOTT14			2
16PE2BOTP08	Practicals of 16PE2BOTT15+ 16PE2BOTT16			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.			

16PE2BOTT13: NATURAL RESOURCES AND THEIR MANAGEMENT
(Theory 72 hrs; Practical 45 hrs Credit 4)

Module 1 (18 hrs)

Natural resources and their management: Concept of natural resources – renewable and nonrenewable. Preservation, conservation, and restoration of resources. Recycling, Reduction reuse, and substitution; Principles of resource management – Water, Land and Mineral resources

Water resources: Distribution of water resources in India, threats to water resources. Principles and approaches to surface water management, watershed management – catchment infiltration models, rainwater harvesting and storage, recharging of ground water. Management of degraded water resources. Drinking water quality and water treatment - desalination, ion-exchange, reverse osmosis, and disinfection of water; Land resources: Land as a resource, land degradation and its causes, desertification – causes and prevention; Land reclamation- Chemical and biological Mineral resources: Formation of mineral deposits. Types of mineral resources, environmental impact of mineral exploration, mining, processing and utilization. Conservation of mineral resources.

Module 2 (18 hrs)

Principles of resource management - Energy and food resources : Energy sources (a) Resource and reserves. Current national and global energy scenario; (b) Fossil fuels: Oil, Coal, Natural gas, Shale – sources, exploration, exploitation; environmental consequences of overexploitation; (c) Nuclear energy: Nuclear fission, fusion, nuclear minerals, nuclear fuel cycle, nuclear fuel production, nuclear reactors; Advantages and disadvantages of nuclear power. Environmental consequences of nuclear power – safety, terrorism, waste disposal and management; (d) Renewable and alternate energy sources – solar energy and isolation, photovoltaic cells; hydropower; tidal power; wind power; geothermal energy; ocean energy; fuel cells – advantages and disadvantages, environmental consequences; (e) Bio-energy: biomass as energy source, biomass production, energy farming, biomass conversion processes – thermochemical and biochemical. Biodiesel. Environmental consequences of biomass resource harnessing; Food resources - Food sources, effect of agriculture on the environment. World food problems, methods and strategies to alleviate food problems.

Module 3 (36 hrs)

Biological resources: (a) Forests as biological resources – importance, types of forests, deforestation, reforestation, conservation of forests; (b) Biodiversity and its importance: Types of biodiversity – wild biodiversity, agro-biodiversity, domesticated biodiversity. Values of biodiversity, ecosystem functions and biodiversity, mobile links and valuating ecosystem services. Drivers of biodiversity loss. Tools and techniques for biodiversity estimation: Biodiversity indices; methods of biodiversity monitoring; (c) Uses of biodiversity – source of food, medicine, raw material, aesthetic and cultural values. Threats to biodiversity; natural and anthropogenic, species extinctions, IUCN threat categories, red data book. Extinction: Types, Causes – population growth, overconsumption, pollution, climate change. Ecological extinction, biological extinction. Principles and strategies for biodiversity conservation - In-situ conservation: sanctuaries, biosphere reserves, national parks, nature reserves, preservation plots. Ex-situ conservation: botanical gardens, arboretum zoos, aquaria, homestead garden; herbarium; In-vitro Conservation: germplasm seed bank and gene Bank; tissue culture: pollen and spore bank, DNA bank. GEF-World Bank initiatives. Biodiversity hotspots and their characteristics, global distribution. National and international programmes for biodiversity conservation. CITES and TRAFFIC, Indian Biodiversity Act 2002 and Rules; (d) Biological Invasions: Introduction Elton's hypothesis – Invasion patterns and process biological attributes for invasion: Reproductive potential, Allelopathy Phenotypic plasticity fitness to the new environment. Hypotheses for invasion success: Natural enemy hypothesis evolution of invasiveness hypothesis, empty niche hypothesis,

novel weapon hypothesis, disturbance hypothesis and Propagule pressure hypothesis. Invasive alien species of India (plants and animals); (e) Impacts and management of invasions: Impacts of exotics on biodiversity, productivity, nutrient cycling. Management: Bio-control programmes, mechanical and chemical control. Positive utilization. Quarantine and EIA of biological invasion.

Practical (45 hrs)

1. Water Quality Analysis

- a. Determination of pH, Electrical conductivity, Alkalinity, Salinity, Hardness, TS, TSS and TDS
- b. Anions and Cations in water: Ammonium, Chloride, Potassium, Calcium, Magnesium, Nitrate, Phosphate and Silica
- c. Determination of primary productivity

2. Toxicity Analysis of Water: Heavy metals, pesticides and microcystin

3. Soil chemical analyses – Cation exchange capacity, soluble anions and cations, Soil Adsorption Complex, Percentage Saturation

References

- 1. APHA-AWWA-WPCF (1990). Standard Methods for the Examination of water and Waste water. (XXEdn). American Public Health Association.
- 2. Butter GC (1988). Principles of Ecotoxicology. John Wiley and Sons.
- 3. Cockerham GL, Shane BS (Eds) (1994). Basic Environmental Toxicology. CRC Press.
- 4. Eisenbude M (1998). Environmental Radioactivity. Academic Press.
- 5. Fellenberg G (1999). Chemistry of Pollution. John Wiley and Sons.
- 6. Hayes WA (2001). Principles and Methods of Toxicology. CRC Press.
- 7. James P, Lodge JR (1971). Methods of Air sampling and Analysis. ISc Lewis Pub. Inc.
- 8. Klaassen CD, Alkins JBW (2003). Essentials of Toxicology. McGraw-Hill Professional.
- 9. Khopkar SM (2004). Environmental Pollution: Monitoring and Control. New Age International.
- 10. Lutgens FK, Tarbuck JE (1992). The Atmosphere. Prentice Hall.

16PE2BOTT14: ENVIRONMENTAL SUSTAINABILITY
(Theory 72 Hrs; Practical 45 hrs Credits 4)

Module 1 (18 hrs)

Society and Environment : (a) Social perspectives of environment – Global and Indian issues; (b) Social impacts of growing human population and affluence, production and distribution of food, hunger, poverty, malnutrition, famine; (c) Social impacts of water crisis, global climate change, ozone depletion, nuclear accidents, acid rain, consumerism, tourism, and waste products; (d) Problems related to major dams and other developmental projects, resettlement and rehabilitation; (e) Environment and human health – epidemiological issues

Module 2 (18 hrs)

Environmental economics : (a) Definition, scope and basic theories of environmental economics; sustainable growth; (b) Economics of natural resources, environment cost-benefit analysis; (c) Agricultural development and environment: Modern agriculture and its impact on environment – monoculture plantations, use of insecticides, pesticides, chemical fertilizers, hybrid seeds, water consumption, desertification, watershed problem, soil erosion, deforestation, depletion of biodiversity. Sustainable agriculture – alternate methods in agriculture; (d) Industrial development and environment: impact of modern large scale industries on environment, problems related to modernization and urbanization. Green policies of industrialization

Module 3 (36 hrs)

Environment versus Development: Dominance of man on earth. Limits of growth. Industrial revolution and resource utilization, environmental consequences. Modern agriculture and green Revolution - environmental impacts. Conflicts of interest - mega developmental projects and issues of 3 R's, environment and development; Environmental ethics - Importance and need of environmental ethics. Moral relation among humans, nonhumans, and natural environment. Position of humans in the world, human responsibility to care the world, animal rights. Sustainable Development – Strategies and legislation: Principles of sustainability - Reliance on solar energy, biodiversity, population control, nutrient cycling. Sustainability indicators; (b) Our Common future and the idea of Sustainable Development - Concepts and dimensions. Basic needs - Imperatives relating to sustainable development. Johannesburg Conference 2002 and environmental and Earth summits till 2015 on sustainable development. Securing Sustainable futures Millennium development goals and strategies; the earth charter; need and scope for evolving participatory, community based environmental management strategies. Education for sustainability. Building sustainable societies and lifestyles. Ecological Foot Print analysis, types and their significance. Environmental concerns in traditional societies Environmental laws and policies: (a) Historical background of environmental law and policy in India. (b) The salient features of the following acts and rules: The water (Prevention and control of pollution) act, 1974; The air (Prevention and control of pollution) act, 1981; The environmental (Protection) act, 1986; The public liability insurance act, 1991; The wildlife protection act, 1972; The forest conservation act, 1980; The biodiversity act, 2002; The hazardous wastes (Management and handling) rules, 1989; The noise pollution (Regulation and control) rules, 2000. Manufacture, storage and import of hazardous chemicals rules 1989, Biomedical waste (Management and Handling) rules 1998.

Practical (45 hrs)

1. Conduct a green auditing in an educational institution/ industry and give suggestions for energy saving/ energy efficiency - Submit a report in not less than 10 pages

2. Case studies of environment issues in the rural and urban surroundings – critical analysis of the same in view of sustainable development - Submit a report in not less than 10 pages /video graph – documentary model
3. Field visit to industrial sites – Critically analyze violations of environment laws if any and make a report
4. Ecological foot print calculation – Carbon, Oxygen, Water.

References

1. Eagles PFJ (1987). The planning and Management of Environmentally Sensitive areas. Longman Group Ltd
2. Gadgil M, Guha R (1995). Ecology and Equity: The Use and Abuse of Nature in Contemporary India. Penguin India.
3. Knight RL, White L (2009). Conservation for a new generation redefining natural resources management. Island Press.
4. Meffe GK, Nielson L, Schenborn RK, (2002). Ecosystem management: Adaptive, Communitybased Conservation. Plenum Press.
5. Krishnamurthy KV (2004). An Advanced Textbook on Biodiversity: Principles and practice. Oxford and IBH. Publ. Co.
6. Michael L McKinney, Robert M Schoch (2002). Environmental science: Systems and Solutions. Westpublishing company.
7. Miller GT Jr. (2004). Environmental Science. Thomson, California.
8. Milner-Gulland EJ, Marcus Rowcliffe (2007). Conservation and sustainable use: A handbook of techniques. Oxford University Press.
9. Pullin AS (2002). Conservation Biology. Cambridge University Press.
10. Primack RB (1998). Essentials of Conservation Biology. Sinauer Associates.

16PE2BOTT15: ENVIRONMENTAL MONITORING
(Theory 72 Hrs; Practical 45 hrs Credits 4)

Module 1 (27 hrs)

Environmental Management: (a) Concepts, strategies and basic principles of environment management; Management of physical, social, and economic environment. Concepts and scope of environmental planning, regional planning and management. Cost-benefit analysis and Resource economics; (b) Environmental modeling: Simulation modeling, input-output modeling, Linear programming, Software and resource management; (c) Tool box for environmental management – An overview of Ecological foot prints, SEA, Ecological Economics, conflict resolution strategies. Eco-funds; (d) Environmental auditing and Standards Eco labeling and certification, accreditation – need, objectives and benefits; Corporate social responsibility and Corporate environmental responsibility, ISO standards for environmental managementsystems (EMS) ISO 14000, 14001 and 26001; OHSAS 18001

Ecosystem Management: (a) An overview Population, Resources and Ecosystem management □ Exponential growth in human numbers and the implications; (b) Major management concepts and methodologies: The five basic laws of Ecology and their relevance for ecosystem management; paradigm shifts in the management of Ecosystems - influence of economics in ecology; (c) Management practices for various ecosystems: grasslands, forests, mountains, wetlands and coastal areas; (d) Environmental planning and management of; waste lands, reclaimed lands, mining areas, human settlements, industrial lands and agricultural lands; (e) Ecorestoration/remediation; local knowledge and management systems; environmentally sound management of Biotechnologies; the common property resources and their management. Solid waste Management: Municipal solid wastes (MSW) - quantities and characteristics, waste collection and transport, waste processing, resources recovery and recycling, incineration, pyrolysis, aerobic and anaerobic systems composting, vermicomposting and sanitary landfills and biogas; Management of plastic and e-waste. Better management strategies (any two model case studies).

Module 2 (18 hrs)

Environment Toxicity Management: (a) Definition, scope and history of Toxicology, Acute and chronic toxicity, selective toxicity, dose, synergism and antagonism; (b) Toxic chemicals in the Environment – Air, water and Soil. Biochemical aspects of As, Cd, Pb, Hg, CO, O₃, PAN, pesticides, MIC, Dioxins, Furans and carcinogens in air, Bioaccumulation & biomagnifications; (c) Occupational toxicology – hazardous chemicals, disorders exposing from chemical exposure at work, assessment of occupational hazards; (d) Dose-Response relationships: Graded response, quantal response, Time action curves, Threshold Limit value (TLV); LC₅₀; Margin of safety; Toxicity curves; Cumulative toxicity and LD₅₀ & CTF; (e) Toxicity testing: Bioassay – Definition, purpose, criteria for selection of test organism, methodology, estimation of LC₅₀, Limitation and importance of Bioassay, Acute Toxicity (single); Sub acute Toxicity; Chronic Toxicity; Teratogenicity, Carcinogenicity and Mutagenicity; (f) Bio-monitoring of Toxic Chemicals - Objectives, programs and parameters, concepts of bio indicators. Bio-transformation of Xenobiotics.

Module 3 (27 hrs)

Environmental Impact Assessment: (a) Introduction, definition, history, aim, principles, concept and scope. Baseline data collection, Methods and steps – Ad hoc method, checklist method, matrices, Map overlays method, network method, index method; (b) Impact assessment and impact evaluation: EIA Processes, Stages, EIA Statement. Environment management plan - Risk assessment and disaster management programme. National Policy on EIA ; (c) Regulatory Framework: Environmental Impact Assessment Notification 2006 and Coastal Zone Notification

1991; Environmental Clearance Process in India; Legislative requirements (discharge requirements and area restrictions); Environmental Appraisal procedure for mining, industrial, thermal power, nuclear power and multipurpose river valley projects. EIA case studies. Life Cycle Assessment (LCA) and its significance.

Remote Sensing: (a) Principles and concepts of Remote Sensing. Electromagnetic spectrum; spectral characteristics of surface features (rocks, soils, vegetations, water). Space imaging Landsat, SPOT, IRS, NOAA, Seasat, ERS, RADARSAT, INSAT. Satellites and their sensors, geometry and radiometry; (b) Digital Image Processing: Principles, Image Rectification and restoration, Image enhancement and Mosaicing. Image classification. Supervised, Unsupervised, Ground truth data and training set manipulation, Classification accuracy assessment; (c) Geographical Information System (GIS): Basic principles and terminologies, Raster and vector data, Map projection, Topology creation, Overlay analysis, Data structure and Digital cartography; Software used in GIS Surveying: Leveling, Triangulation, Geodetic survey; Global Positioning System (GPS) Basic principles, Applications to environmental studies.

Practical (45 hrs)

1. Estimation of BOD and COD of polluted water
2. Isolation and Enumeration of microorganisms in soil (TBC or TMC) - Types of Bacteria and fungi.
3. Bacteriological quality testing of water and waste water (MPN) a. Presumptive Coliform test b. Confirmatory Coliform test.
4. Field Study: (Three/four days)-visit at least one Institution engaged in environment monitoring and management/conservation research and a sanctuary/national park and an industrial/polluted area.
5. Conduct an investigation and submit a Report of an Industrial/polluted Site - 10 page write up/print out giving the dates, methodology, inference and critical comments; Include photographs of the activity.

References

1. Agarwal NK (2004). Essentials of GPS. Spatial Networks Pvt. Ltd.
2. Agarwal NK (2002). Ecoinformatics. APH Publishing Corporation.
3. Asit K Biswas et.al., (1987). EIA for Developing Countries. United Nations University, Tokyo.
4. Carter L (1996). Environmental Impact Assessment. McGraw Hill.
5. Coronel C, Morris S, Rob P (2009). Database Systems: Design, Implementation and Management (IX Edn). Course Technology.
6. Eagles PFJ (1987). The planning and Management of Environmentally Sensitive areas. Longman Group Ltd.
7. Michael L McKinney, Robert M Schoch (2002). Environmental science: Systems and Solutions. West publishing company.
8. Floyd F, Sabins WH Jr. (1987). Remote Sensing, Principles and Interpretation (II Edn). Freeman & Company.
9. Lutgens FK, Tarbuek JE (1992). The Atmosphere. Prentice Hall.
10. Samuel G (1990). Nuclear Engineering. Academic Press.

16PE2BOTT16: SUSTAINABLE AGRICULTURE
(Theory 54 hrs; Practical 36 hrs Credits 3)

Module 1 (18 hrs)

Introduction to Sustainable agriculture - natural and organic farming: Concept of sustainability and sustainable agriculture - Natural, Ecological and organic farming – definition, concepts, and practices –management, principles, methods, merits and demerits. Components - Organic farming for sustainable agriculture - Features of organic orchards – Challenges to Sustainable agriculture – Productivity vs sustainability. Integrated organic farming: Integrated organic farming - concept, ideal planning for small and marginal farmers of rain fed regions - low cost production technologies for growing vegetables, field crops and fruit plants; Introduction of indigenous technical knowledge (ITK) and resource conserving techniques (RCT); Multi cropping systems, mixed cropping, rotation and integrated cropping methods and their advantages in organic and natural farming; Certification of organic products and systems, agencies involved at national and international levels, standards evolved by different agencies, Constraints in certification, organic horticulture and export, IFOAM and global scenario of organic movement, post-harvest management of organic products; Agronomy of organic and natural farming: Soil organic matter-decomposition, C: N ratios, mineralization and immobilization processes, humus, role of organic matter in soil quality – natural way to prevent soil degradation and erosion, types and control measures. Soil related water pollution- sources, different pollutants in soils and their managements.

Module 2 (9 hrs)

Plant nutrient management in sustainable agriculture: Bio-availability of nutrients in soils, deficiency symptoms on plants, nutrient interactions and chelated micronutrients. Soil fertility assessment in sustainable agriculture - evaluation and management for plant growth, soil testing and fertilizer recommendations. Biofertilizers – benefits - classifications, production - maintenance and application. Organic Manures – bulky and concentrated – FYM – Biocomposting, Compost – rural, urban, vermicompost and coirpith; Panchagavya preparation and other organic nutrients application - Enrichment of organic manures; Sewage and sludge; Green manures – potentials and limitations; Quality parameters of organic manures and specifications – Biofertilizers - Soil micro flora – nutrient transformations - Integrated Nutrient Management (INM) and Integrated Plant Nutrient Supply System (IPNS) - NPOP, organic produce quality considerations, certification, labelling, accreditation process and marketing.

Module 3 (27 hrs)

Biopesticides and biological control agents: Types of biocontrol agents- biological agents and pheromones, control of weeds, diseases and insect pests and field sanitation - competition, predation, antibiosis and fungistasis; Efficacy of traditional bio pesticides - Botanical insecticides- useful and beneficial insects like honeybee, lac insect, silkworm and pollinators. Biological control - concepts and potentialities for managing soil borne pathogens. Types of biological interactions, competition, mycoparasitism; Mycorrhizal associations, operational mechanisms and its relevance in biological control - biopesticides available in market – quality control system of bio-control agents, Biodynamic products, Biodynamic composting, Liquid manure, Influence of Bio-dynamic products on crop production. Preparation of soil samples for chemical and biological tests - Bio assay of available K; Soil fertility evaluation by Neubauer technique; Visit to Organic Farms. Allelopathy and Biological Weed Control: Definition and history - difference between allelopathy, allelopathy and allelomeditation, methodology to establish allelopathy, environment hormones, general nature of allelochemicals – retention, transformation and transport, mechanisms and process involved in the production of allelochemicals; Sources and release of allelochemicals and methods of isolation bioassay and identification – volatilization, leaching, root exudation, decomposition of plant residues; Mode of action of allelochemicals; Mode of

action of allelochemicals: direct and indirect actions, interactions in mineral uptake, cytology and ultra structure, phytohormones and balance, membranes and membrane permeability, photosynthesis and photosynthetic inhibitors, influence on respiration, protein synthesis, enzyme activity, conducting tissue, water relations, genetic material – factors affecting the production of allelochemicals, allelopathy and soil microbes; Application of allelopathy studies - understand the problems in improving the production of manipulated ecosystems, explanation for a specific vegetational pattern, understand the effect of weeds on crops, crops on weeds and crops on crops – biological weed control – role of allelopathy in weed science – application in weed control.

Practical (36 hrs)

1. Biocomposting - methods of preparation of compost, vermicompost and green manuring
2. Familiarise the methods of Precision farming and mixed cropping
3. Biofertilizers and their production
4. Preparation and testing of efficacy of traditional vs modern bio-pesticides
5. Panchagavya preparation and other organic nutrients application
6. Basics of Soil chemical analysis - Preparation of soil samples for chemical and biological tests - Bio assay of available K; Soil fertility evaluation by Neubauer technique
7. Documentation for certification of organic products - visit to organic Farms and Critical Reports
8. Separation and chemical characterization of allelochemicals – application on weed control – seed germinability test in presence of allelochemicals.

References

1. Allan Wild (1988). Russel's Soil Conditions and Plant Growth Longman group U.K.
2. Balasubramanian P and Palaniappan SP (2001). Principles and Practices of Agronomy, Agrobios Publishers, Jodhpur
3. Chatterjee BN et al (1989). Cropping Systems - Theory and Practice. Oxford and IBH Publication, New Delhi
4. Dahama AK (2007). Organic Farming for Sustainable Agriculture. 2nd Edn. Published by AGROBIOS (India) Jodhpur
5. Department of Commerce, Ministry of Commerce and Industry, Govt. of India. (2000) National Standards Programme for Organic Production and Organic Products
6. Gehlot D (2005). Organic Farming: Standards, Accreditation, Certification and Inseption, AGROBIOS (India) Jodhpur
7. Gupta PK (2007). Soil, Plant, Water and Fertilizer Analysis Published by AGROBIOS (India), Jodhpur
8. Sadasivam S and Manickam A (1992). Biochemical Methods for Agricultural Sciences Wiley Eastern Limited and Tamil Nadu Agricultural University, Coimbatore.

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

16PE2BOTT13: NATURAL RESOURCES AND THEIR MANAGEMENT

Time: 3 Hours

Max. Marks: 75

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

1. Write briefly on the advantages and disadvantages of nuclear power.
2. Explain the role of quarantine in controlling biological invasion
3. What is Bio diesel? Explain its potential as a renewable energy source.
4. Explain the environmental impacts of mineral exploration
5. Comment on the concept of recycling and re use of natural resources
6. What are the major threats to water resources?
7. Give an account on the features of biodiversity hot spots.
8. Discuss the anthropogenic factors responsible for biodiversity loss
9. Differentiate between ecological extinction and biological extinction
10. Comment on agroforestry and social forestry
11. Write a short note on depletion of natural resources
12. What are the different levels of biodiversity?

(8 x 2 = 16 marks)

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

13. Describe the Biological and chemical methods of control of biological invasion.
14. Discuss National and international programmes for biodiversity conservation
15. Explain the major causes of land degradation
16. Write on the major strategies adopted for conservation of mineral resources
17. Describe the pros and cons of our dependence on fossil fuels
18. Explain the Thermo-chemical and Biochemical conversion processes of Bio mass.
19. Write a detailed account on the impact of exotic plant species on biodiversity. Add a note on mechanical, chemical and biological control of exotics.
20. Give an account of world food problems giving emphasis to malnutrition and undernourishment.
21. Explain the different types of Biodiversity
22. Give a critical account of the major threats to Biodiversity.

(5 x 7 = 35 marks)

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

23. Write an essay on various hypotheses explaining the success of invasive alien plant and animal species

OR

24. Give a detailed account of methods of surface water management

25. Discuss the prospects of harnessing solar energy, hydropower, tidal power, wind power and ocean energy with special reference to Indian energy scenario.

OR

26. Explain in detail the principles and strategies for in-situ and ex-situ conservation of biodiversity

(12x2 = 24marks)

Model Question Paper
SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc.Botany DEGREE EXAMINATION
SEMESTER IV
16PE2BOTT14: ENVIRONMENTAL SUSTAINABILITY

Time: 3 Hours

Max. Marks: 75

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

1. Give an account of green policies of industrialisation
2. What are the social impacts of nuclear accidents?
3. Discuss the environmental concerns of traditional societies
4. Explain sustainability indicators
5. What is the importance of environment cost – benefit analysis?
6. Write on the importance and need of environmental ethics.
7. Explain any two Acts implemented for conservation of forests in India.
8. Discuss the advantages of building sustainable lifestyles in a society.
9. Evaluate the role of solar energy in sustainable development
10. Explain the problems associated with the global production and distribution of food
11. What is ecological footprint?
12. Discuss green auditing.

(8 x 2 = 16 marks)

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

13. What are the major environmental problems created by urbanisation?
14. Give an account of the role of alternate methods in sustainable agriculture
15. 'Water crisis is going to be the major social problem in near future' Discuss
16. Explain how epidemiological issues affect the society and environment.
17. Discuss the positive and negative aspects of promoting tourism from an environmental point of view.
18. Explain any 3 Acts enforced in India to control pollution
19. Discuss the role of industrial revolution in society and environment
20. Explain the need and scope of involving people in management of environment
21. Discuss in detail the practices in modern agriculture and its impact on environment
22. Write an essay on ecological footprint analysis.

(5 x 7 = 35 marks)

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

23. Give a detailed account of the social and environmental issues related with construction of large dams.

OR

24. Critically evaluate the Position of Humans in environment and the role Humans can play in *environment versus development* situations.

25. Explain the outcomes of Johannesburg conference 2002 and other important events like it till 2015 on sustainable development and environmental issues.

OR

26. Discuss in detail the impacts of Mega development projects to the environment.

(12x2 = 24marks)

Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

M.Sc.Botany DEGREE EXAMINATION

SEMESTER IV

16PE2BOTT15: ENVIRONMENTAL MONITORING

Time: 3 Hours

Max. Marks: 75

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

1. Explain ecological foot prints
2. What is meant by resource economics?
3. Briefly discuss on corporate environmental responsibility
4. What is pyrolysis?
5. What are sanitary landfills?
6. Explain quantal response
7. Explain environmental appraisal
8. Comment on space imaging
9. Explain image enhancement
10. Discuss about geodetic survey
11. Write a short note on EIA
12. What are the sources of solid waste?

(8 x 2 = 16 marks)

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

13. Elaborate on life cycle assessment and its significance
14. Critically evaluate the biotransformation of Xenobiotics
15. Explain the important steps associated with biomonitoring of toxic chemicals
16. Write a detailed account on Mutagenicity
17. Critically discuss the ISO standards for environmental management
18. Explain Ecolabelling and certification
19. Elaborate the concept of remote sensing
20. Write an account on environmental clearance process in India
21. Explain paradigm shifts in management of ecosystems
22. Explain the various steps and programmes associated with environmental planning and management of land depleted by human interference.

(5 x 7 = 35 marks)

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

23. Elaborate in detail the various in Toxicity testing and bioassays

OR

23. Critically comment on toxic chemicals in the environment. Explain the various possible mitigation programmes

25. Explain the methodology, scope and applications of EIA

OR

26. Explain the concept and methods of solid waste management

(12x2 = 24marks)

Model Question Paper
SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc.Botany DEGREE EXAMINATION
SEMESTER IV
16PE2BOTT16: SUSTAINABLE AGRICULTURE

Time: 3 Hours

Max. Marks: 75

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

1. What are the standards in certification of organic products?
2. Differentiate natural, ecological and organic farming
3. Give an account of any two nutrient deficiency symptoms on plants
4. What procedures are used to assess soil fertility?
5. Write briefly on any two biopesticides available in india
6. How can we use sewage and sludge to enrich organic manures?
7. Explain the general features of Organic orchards
8. Briefly explain the role of soil testing and fertiliser recommendation in modern agriculture
9. What are the factors affecting the production of allelochemicals?
10. Write the procedure for bio assay of available K
11. What are the advantages of biopesticides.
12. Name any two organic manure.

(8 x 2 = 16 marks)

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

13. What are the sources of water related soil pollution? How can it be controlled?
14. Explain the low cost technologies for growing crop plants
15. Give an account on the production and maintenance of bio pesticides
16. Explain any three methods of release of allelochemicals by plants
17. Explain how allelochemicals are produced by plants
18. Give an account on Biodynamic products
19. Explain the natural methods of prevention of soil degradation and erosion
20. Write an account on Botanical insecticides
21. Explain the applications of allelopathy studies
22. Explain the different methods of action of allelochemicals

(5 x 7 = 35 marks)

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

23. Write an essay on different cropping systems in natural and organic farming\

OR

24. Give a detailed account on the production and application of different types of organic manures.

25. Give an account on different types of bio fertilisers. Explain the procedures for introducing a new bio fertiliser in market

OR

26. Write an essay on biological control of soil borne pathogens

(12x2 = 24marks)

Model Question Paper**SACRED HEART COLLEGE (AUTONOMOUS), THEVARA****Semester IV****Practical Course: 16PE2BOTP07****NATURAL RESOURCES AND THEIR MANAGEMENT & ENVIRONMENTAL SUSTAINABILITY****Time 3 Hours****Max. Marks 40**

1. Determine the Dissolved oxygen content of the given sample A and determine the primary productivity using light & dark bottle method. 6 marks
2. Determine the BOD of the water sample B 6 marks
3. Examine the bacteriological quality of water sample C by performing presumptive coliform test and analyze the data by MPN index table. 5 marks
4. Demonstrate the preparation of Vermicomposting with materials supplied D 4 marks
5. E 1) Prepare a Bio pesticide and dilute it to concentration..... (specify) 4 marks
or
E 2) Prepare Panchagavya
6. Comment on F & G 2X1.5= 3 marks
7. Report of visit to industry 2 marks
8. Report of investigation conducted in a polluted area. 3 marks
9. Report of visit to organic farm 2 marks
10. Record 5 marks

Key to the questions:

1. A -Give appropriate sample
2. B - Incubate the sample for 5 days before the exam. First day oxygen data can be provided. Titration to find out the final value only is done at the time of exam.
3. C - Day before the exam, inoculate the MPN tubes with appropriate water sample
4. D -Give required materials
5. E 1 & E 2 -Give required materials
6. F & G Photographs / Illustrations showing Methods of farming, Biofertilisers, composting
7. Report of visit to institution
8. Report of investigation conducted in a polluted area.
9. Report of visit to organic farm
10. Record

Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

Semester IV

Practical Course: 16PE2BOTP08

ENVIRONMENTAL MONITORING & SUSTAINABLE AGRICULTURE

Time 3 Hours

Max. Marks 40

-
- | | |
|---|-----------------|
| 1. Estimate the specified anions/cations of the given sample A | 6 marks |
| 2. (a) Determine the TDS of the given sample B1. | |
| or | |
| (b) Toxicity analysis of water. Determine amount of chloride or ammonia present in the given polluted water sample B2 | 6 marks |
| 3. Calculate Ecological foot print (Carbon, Oxygen, Water.....) using the the data provided as C | 5 marks |
| 4. Analyse the soil sample D and find out | 5 marks |
| 5. Do a green auditing with the data provided as E | 5 marks |
| 6. Comment on the management strategies of the natural resource F & G | 2X1.5 = 3 marks |
| 7. Report of case study in rural and urban surroundings | 3 marks |
| 8. Report of Green auditing | 2 marks |
| 9. Record | 5 marks |
-

Key to the questions:

1. A - Give appropriate sample
2. B – Give appropriate samples
3. C – Give data
4. D - Give appropriate sample
5. E – Give data
6. F & G Photographs/ Illustrations showing natural resources/ factors affecting their depletion etc
7. Report of case study in rural and urban surroundings
8. Report of Green auditing
9. Record

SEMESTER IV

PROGRAMME ELECTIVE – III : MICROBIAL TECHNOLOGY

Course	Title	Teaching Hrs Theory	Teaching Hrs Practical	Credits
16PE3BOTT13	Clinical Microbial Technology	72	45	4
16PE3BOTT14	Food and Environmental Microbial Technology	72	45	4
16PE3BOTT15	Industrial Microbial Technology	72	45	4
16PE3BOTT16	Agricultural Microbial Technology	54	36	3
16PE3BOTP07	Practicals of 16PE3BOTT13+ 16PE3BOTT14			2
16PE3BOTP08	Practicals of 16PE3BOTT15+ 16PE3BOTT16			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.			

16PE3BOTT13: CLINICAL MICROBIAL TECHNOLOGY
(Theory 72 hrs; Practical 45 hrs Credit 4)

Module 1 (27 hrs)

Systematic and diagnostic bacteriology: morphology, culture, identification, pathogenesis, clinical findings, laboratory diagnosis, epidemiology and pathogenesis of following bacterial infections *Staphylococcus*, *Streptococcus*, *Neisseria*, *Corynebacterium*, *Clostridium*, *Brucella*, *Bordetella*, *Mycobacterium*, *Spirochaetes*, *Escherichia coli*, *Salmonella*, *Klebsiella*, *Proteus*, *Vibrio*. Normal bacterial flora of human beings. Antibiotics in laboratory Medicine. Origin and classification of Antibiotics, chemistry and mode of action, MIC & MBC, *In vitro* susceptibility tests-Different methods Rapid methods of antibiotic susceptibility tests. Antibiotic resistance mechanisms. Detection of methicillin resistant *Staphylococci*. Study of antibiotic sensitivity of common pathogens. Common serological tests for the diagnosis of bacterial infections.

Module 2 (18 hrs)

Isolation and maintenance of viruses, method for detection-isolation, direct detection, serology; assay, phage typing. Common Viral pathogens – Human papilloma virus (HPV), Human Immunodeficiency Virus (HIV), Hepatitis B Virus (HBV), Varicella Zoster Virus (VZV), Polio virus, Dengue virus, Rotavirus. Antiviral strategies-prevention and control of viral diseases, host specific and non-specific defence mechanisms (molecular level) involved in resistance to virus infections and recovery. Role of interferon in viral infections. Viral chemotherapy- Nucleoside analogues, reverse transcriptase inhibitors, protease.

Module 3 (6 hrs)

Fungal and protozoan diseases in humans, epidemiology of common fungal and protozoan diseases in humans.

Module 4 (21 hrs)

Immunology- Types of immunity, Innate and acquired immunity, cellular and humoral immunity. B cells and T cells- types, structure, development and function. Antigen presenting cells. Antigens- Types of antigens. Antibodies- basic structure and classes of antibodies. Antigen-antibody interactions-*in vivo* – toxin neutralization, opsonization, immune complex formation, viral neutralization, adherence inhibition. Antigen antibody interaction *in vitro* - agglutination, complement fixation, ELISA, immunodiffusion, immunoblotting, flow cytometry, immunofluorescence, immunoelectrophoresis, immunoprecipitation, neutralization, radioimmunoassay, serotyping. Immune disorders- Hypersensitivity – acute rheumatic fever, grave's disease, systemic lupus erythematosus, Type 1 Diabetes mellitus, multiple sclerosis, rheumatoid arthritis, transplantation rejection, immune deficiencies – SCID.

Practical (45 hrs)

1. Preparation of bacterial smear and staining – Gram's staining, Staining of bacterial spores, flagella, capsule, lipid granules. Preparation of media, cultivation of bacteria, Biochemical tests for identification of bacteria, Preservation of stock cultures of bacteria
2. Practical Isolation of bacteria from mixed cultures, Study of morphological, cultural and biochemical characters of common bacterial pathogens.
3. Study of antibiotic sensitivity of common bacterial pathogens
4. Common serological tests– Radial ImmunoDiffusion, Agglutination
5. Blood group determination- slide agglutination test
6. Identification of different types of WBC
7. WIDAL Test.

Reference

1. Murray D. (2003) Manual of Clinical Microbiology. American Society Microbiology
2. Ananthanarayanan R and Panicker. (2009). A Text book of Microbiology. Universities Press
3. Prescott LM. (2004) Microbiology. McGraw-Hill Science
4. Atlas RM. (1986) Basic and Practical Microbiology. Macmillan Pub Co
5. Volk (1978). Medical microbiology . Lippincott
6. Topley & Wilsons (2007) – Microbiology & Microbial Infections – 9th Edition. Wiley-Blackwell
7. Douglas E and Bennetts (2014) Principle & Practice of Infectious Diseases – Volume I, II – IV Edn .
8. Koneman F W Colour (2006) atlas of & text book of Diagnosis Microbiology – IV Edn. Wolters Kluwer.
9. Bailey & Scott's (2013). Diagnostic Microbiology – 12th Edn. Elsevier Health Sciences
10. Jawetz Melnick & Adelberg (2013). Medical Microbiology. McGraw Hill Education

16PE3BOTT14: FOOD AND ENVIRONMENTAL MICROBIAL TECHNOLOGY
(Theory 72 hrs; Practical 45 hrs Credit 4)

Module 1 (21 hrs)

Introduction to Food Microbiology: (a) Food as a substrate for microorganisms-factors influencing microbial activity ; (b) Microorganisms important in food microbiology and production of fermented milk -butter milk, cultured butter milk, Yoghurt, Kefir, bread.P(c) Microbial flora of fresh food and theirspoilage—cereals,sugar products,fruits, vegetables, poultry, eggs, fishes, shell fishes, milk, milk products,bread.

General principles of food preservation: (1) aseptic handling (2) high temperature - boiling, steam under pressure, pasteurization and sterilization (3) low temperature – freezing and refrigeration (4) Dehydration (5) Osmotic pressure - in concentrated sugars with brine (6) chemicals, organic acids, smoking (7) radiation - UV and ionization, food additives Food Adulteration : Type of Adulterants –International adulterants, Metallic contamination, Incidental adulterants. Food Law and Standards.

Module 2 (7 hrs)

Food in relation to disease: Salmonellosis, Gastroenteritis, Shigellosis, Listeriosis, Staphylococcal food poisoning, Botulism, Traveller's diarrhoea, Mycotoxins (aflatoxin, patulin, ochratoxin), virus intoxication. Microbial examination of food - Microscopic techniques, culture techniques. Microbiological criteria for food control. Enforcement and control agencies – international agencies, National agencies, state agencies, professional societies, private agencies, processing industry and agency co-operative programmes.

Module 3 (21 hrs)

Environmental Microbial Technology: Nature as a habitat of microbes, microbial diversity in various ecosystems; Isolation and cultivation of microbes from environment - serial dilution and pour plate method, spread plate method, streak plate method, isolation using selective or enrichment media. Methods of culturing anaerobes. Culture characteristics of microbes. Bacterial growth curve, staining techniques. Biochemical tests for bacterial identification - carbohydrate fermentation, triple sugar-Iron agar test, IMVIC test, Litmus Milk reactions, Hydrogen sulphide test, Catalase test, Oxidase test. Uncultivable microbes. Microbiology of Drinking water –Types of test for the purity of drinking water –Bacteriological test –test for quantification of Coliform groups (1) Most Probable Number (M P N) (2) The membrane filter method. Methods for purification of drinking water –Flocculation, Sedimentation, Filtration, sand filtration and disinfection. Detection of coliform bacteria - membrane filtration technique, Colilert defined substrate test.

Module 4 (23 hrs)

Microbial studies of Soil and water bodies: (a) Soil as a habitat for microbes. Factors influencing soil microbial growth; (b) Microbes and their role in fresh water, brackish water and marine environments. Contamination of aquatic environment by pathogenic microbes; (c) Waste water treatment - primary, secondary and tertiary treatment. Role of microbes in environment: Role of microorganisms in Carbon, Nitrogen, Phosphorus, Iron and Sulphur cycles. Microbes – as pollution indicators. Biological magnification. Biodegradation of recalcitrants, paper, paints, textiles, leather, rubber, metal, concrete, wood, radioactive waste. Role of microbes in the disposal of waste and production of organic Compost, biogas. Microbial leaching, Microbial bio-films. Biodeterioration and biodegradation of Petroleum, Hydrocarbons and their derivatives, Xenobiotics, and Heavy metals, Dioxins – sources, bioavailability –toxic and sublethal effects, removal by biodegradation using microbes. -Pesticides- Microbes in Pesticide degradation, pesticide biotic transformation, Enzyme detoxification, factors affecting Pesticide degradation - Microbes in biotechnology: bioremediation - microbial and enzymatic; *in situ* and *ex situ*. Bioaugmentation – principles, enzymes used in bio-augmentation, bio-filtration-bio-filters, microorganisms used in

filters, mechanism of bio-filtration, phyto-extraction and phytotransformation. Genetically modified microbes - benefits and hazards, role of plasmids in bioremediation. Microbial Genetic plasticity, Metagenomics in bioremediation.

Practical (27 hrs)

1. Basic microbiological techniques-sterilization ,preparation of media ,culturing of bacteria, preparation of agar plate, agar slant ,Isolation of bacteria –pour plate method,dilution method,streak plate method .
2. Staining of bacteria –gram stain and spore stain
3. Motility testing (a) using semi solid medium (b) Hanging drop method
- 4 . Multiple tube Fermentation test
5. Quantitative determination of bacteria number in milk- Methylene blue reductase test
6. Measurement of growth –cell count and turbidity
7. Water quality testing –M P N of Coliforms.
8. IMVIC test
9. Identification of different bacteria –E –coli,Salmonella,Bacillus,Vibrios, Pseudomonas,Azatobacter
10. Oxidase test
11. Catalase test
12. Litmus milk test
13. Hydrogen sulphide test.
14. Isolation of bacteria from soil and water by serial dilution.

References

1. Prescott,(2002). Microbiology,MacGraw Hill publishers .
2. Kumar H. D & Kumar .S (2001) .Modern Concepts of Microbiology .
3. William .C .Frazier &Dennis c. Westhoff, 2012.Food Microbiology, Tata MacGraw Hill Education PvtLtd.
4. James M. J. Modern food microbiology. CBS publishers, New Delhi
5. Atlas R .M, Atlas Bartha (i984). Microbial Ecology.-Fundamentals & Applications.
6. Patel.J.H,(2000). Industrial Microbiology ,Macmillan India Ltd.
7. Rajendran. P.&Gunasekharan.P.(2004)Microbial bioremediation
8. Sreelakshmy.B. FoodScience .NewageInternational Publishers ltd.
9. DubeR.C(2006) .Text book of Microbiology
10. Sudeeshjood&Paul.N . K, 2002.Food preservation ,Agrotech Publishers

16PE3BOTT15: INDUSTRIAL MICROBIAL TECHNOLOGY
(Theory 72 hrs; Practical 45 hrs Credit 4)

Module 1 (31 hrs)

Microorganisms in fermentation Industries- isolation of industrially important microorganisms: Screening techniques: Primary and secondary screening; Maintenance and preservation methods- primary and working stock- refrigeration, soil stock, mineral oil, lyophilization.

Bioreactors: Factors involved in fermenter design. Brief study on stirred tank fermenter, air lift fermenter, tower fermenter, packed bed fermenter, fluidized bed fermenter, tray fermenter, rotary drum fermenter. Media for fermentation- crude media: Molasses, cornsteep liquor, sulphite waste liquor; synthetic media. Role of buffers, metabolic regulators, precursors, antifoam agents. Oxidation reduction potential. Sterilization of media- batch sterilization and continuous type, sterilization of fermenter and air. Inoculum preparation- bacterial cells and fungal spores/mycelium, inoculation. Aeration- porous, orifice and nozzle spargers; agitation- different types of agitators; pH and temperature control; foam control.

Module 2 (14 hrs)

Downstream processing: Separation of microbial cells: Flocculation, filtration, precipitation, centrifugation. Cell disruption: physical and chemical methods - liquid shear, solid shear freezing-thawing, ultrasonication, osmotic shock, enzyme treatment, detergents. Concentrating and purifying the products: solvent precipitation, concurrent and countercurrent extraction, two-phase aqueous system, ultrafiltration, crystallization, reverse osmosis, chromatography, drying.

Module 3 (27 hrs)

(A) Production of Industrially Important Products:

- a) Antibiotics- Penicillin, Streptomycin
- b) Amino acids – Lysine, Glutamic acid, Gluconic acid
- c) Enzymes – Amylase, Cellulase, Pectinases, Invertase
- d) Organic acids – Lactic acid, Acetic acid, Citric acid
- e) Solvents – ABE fermentation
- f) Alcoholic beverages – Wine, Beer
- g) Microbial transformation- Steroids
- h) Microbial cells- SCP, Baker's yeast
- I) Dairy products

(B) Immobilization of cells and enzymes: Physical and chemical methods, applications of various immobilized cells and enzymes.

Practical (45 hrs)

1. Screening and isolation of microbes for production of organic acids and enzymes
2. Preparation and fungal spore inoculum and enumeration of spores by Haemocytometer.
3. Preparation of bacterial inoculum by measuring OD and enumeration of bacterial cells by serial dilution and pour plate (or spread plate) method.
4. Solid state and submerged fermentation for amylase production and quantification of product by suitable assay methods.
5. Lab level production of metabolites (Wine, Vinegar).
6. Immobilization of yeast cells and sugar fermentation using immobilized cells.

References

1. Casida .L . E (1968) .Microbial technology, New Age Publishers
2. A .H Patel (2011) .Industrial Microbiology. Macmillan India Limited
3. Stanburry. P .F and Whitaker .A . (1999). Principles of Fermentation Technology. ButterworthHeinemann Publishers
4. Crueger .W and Crueger .A . (1990) Biotechnology: A text book of Industrial Microbiology. SinauerAssociates Inc.
5. Demain AL and Davies J E (2010). Manual of Industrial Microbiology and Biotechnology. AmericanSociety for Microbiology.
6. Demain AL (1985). Biology of industrial microorganisms. Butterworth-Heinemann
7. Prescott S C, Dunn (2004) Industrial Microbiology . CBS Publishers & Distributors
8. Mansi.ME and Bryce CB (2012) Fermentation microbiology and Biotechnology. CRC Press
9. Vogel H CandTodaro CL (2007) Fermentation and biochemical engineering handbook. William Andrew
10. D ‘Souza JI and Killedar S G. (2008) Biotechnology and Fermentation process. NiraliPrakashan

16PE3BOTT16: AGRICULTURAL MICROBIAL TECHNOLOGY
(Theory 54 hrs; Practical 36 hrs Credit 3)

Module 1 (18 hrs)

Soil - as a habitat for microbes. Factors influencing soil microbial populations . Decomposition of organic matter in soil. Microbes and plant growth .Microorganisms and their role in Carbon ,Nitrogen, Phosphorus and Sulphur cycles .Rhizosphere, Rhizobacteria and plant growth promotion, Associative and antagonistic activities in rhizosphere; Micro-organisms as bio-fertilizers, Types of bio-fertilisers; Biological Nitrogen Fixation-Organisms and associations involved in nitrogen fixation. –free living organotrophs , freeliving prototrophs , diazotrophs , Symbiotic nitrogen fixation in legumes and non legumes, Physiology and biochemistry of nitrogen fixation in legumes , Nodulation in Nitrogen fixation, nif- genes, Association with grasses, *Azolla- Anabaena* symbiosis, Nitrogen fixation by free living microorganisms.

Module 2 (18 hrs)

Phosphate solubilizers–Problems in phosphate uptake by plants, P fixation in soils, Bacteria and fungi as phosphate solubilizers, Mechanisms of phosphate solubilisation, Factors affecting phosphate solubilisation, Methodology for isolation and screening of P solubilising micro-organisms. Mycorrhizae –Classification of mycorrhizae.(Ecto- and Endomycorrhiza. Vesicular and Arbuscular mycorrhiza, Ericaceous, Orchidaceous mycorrhizae). Selection and evaluation of mycorrhizae, Physiology and function of mycorrhiza. Beneficial effects of mycorrhizae. Carbon flow in mycorrhizae- plant association. Microbes as Biopesticides-Biological control-definition, Mechanisms of bio-control Microorganisms commonly used in bio-control of insect pests and plant pathogens Entomopathogenic fungi and virus, microbial herbicides ,Bacterial insecticides- use of *Pseudomonas*, *Bacillus*.

Module 3 (9 hrs)

Characteristics of microbial genera, *Azotobacter*, *Bacillus*, *Pseudomonas*, *Beijernkia (Rhizobium)*, *Glomus*, *Trichoderma*. Mass multiplication of micro organisms – Fermentation technology, batch/continuous fermentation, process controls , broth culture, nutrient rich solid media, carrier-based inoculum preparation Edible mushroom culture : Edible mushrooms as source of nutrients, medicine, protein. Characteristics of *Agaricus* , *Pleurotus*, *Volvariella*. Problems in mushroom cultivation. Mass production technique for *Pleurotus*.

Module 4 (9 hrs)

Agro-based Microbial Applications: (a) Micro organisms in energy production and bio remediation: Importance of biogas production as non conventional source of energy; (b) Techniques of bio gas production from: cow dung, waste water from rubber sheet processing, uses of biogas (c) Solid waste management-Cellulolytic and lignolytic micro organisms, Composting of farm waste and urban wastes, Composting of coir waste (d) Bioremediation, micro organisms used for bio remediation, aerobic and anaerobic bio-remediation bio-remediation for land reclamation, oil spills, radio- active wastes.

Practicals (45hrs)

1. Isolation of *Beijernkia (Rhizobium)* from root nodules of legume plants belonging to three different genera and comparison of their characters
2. Isolation of phosphate solubilising bacteria from soil
3. Purification and multiplication of an isolate of *Beijernkia (Rhizobium)* by to develop a biofertilizer sample
4. Isolation of *Azolla* and its multiplication by tank method
5. Isolation and purification of *Bacillus* and *Pseudomonas* isolates and compare their N₂ fixation

PO4solubilisation, HCN and Siderophore production

6. Motility by hanging drop method.

7. Isolation of Azotobacter from soil

8. Isolation of mycorrhizae from rhizosphere soil by wet sieving and identify the genera (Glomus and Gigaspora).

Observe root colonisation of VAM by staining and study the vesicles and arbuscules

9. Isolation of Trichoderma and study the morphology of mycelium, spore bearing structures and spores. Study the inhibition of plant pathogen it causes in dual culture.

10. Mass multiply Trichoderma on wheat bran and rice bran mixed with saw dust at a specific ratio to compare the population on the two media.

11. Isolation of Pleurotus and production of spawn. Production of a bed of mushroom using the spawn.

References

1. Rangaswamy. (1992). Agricultural Microbiology. ASIA Pub. House.

2. James G. Cappucino and Natalie Sherman, Addison Wesley Longman, Inc. (2013) Microbiology – A laboratory manual. Pearson

3. N.S. Subba Rao. (1995). Soil Microorganisms and plant growth. Oxford & IBH Publishing Co., New Delhi, Bombay, Calcutta Delhi .

4. N.S. Subba Rao. (1993). Biofertilizers in Agriculture and forestry –, Oxford & IBH Publishing Co., New Delhi, Bombay, Calcutta

5. Sushil K. Khetan. (2000) Microbial pest control, Marcel Dekkar, Inc. New York. Basel.

6. J.K. Ladha and P.B. Peoples. (1995). Management of biological nitrogen fixation for the development of more productive and sustainable agriculture system. Kluweer Academic Publishers, Dordrecht/Boston/London

7. A.C. Gaur (1990). Phosphate solubilizing micro organisms as biofertilizer , Omega Scientific Publishers, New Delhi

8. HLS Tandon (2003). Recycling of crop, animal, human and industrial wastes in Agriculture, Fertilizer Development and Consultation Organisation, New Delhi

9. Suodh Kumar Dixit (2001). Biofertilizers - A manual on commercial production technology, Omega Scientific Publishers, New Delhi

10. Biofertilizer and organic farming (2012) NIIR Board (National Institute of Industrial Research), Delhi –110 007.

Model Question Paper
SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc.Botany DEGREE EXAMINATION
SEMESTER IV
16PE3BOTT13: CLINICAL MICROBIAL TECHNOLOGY

Time: 3 Hours

Max. Marks: 75

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

1. Write notes on Widal test
2. What is the role of Interferon in viral infections?
3. Explain the term sporadic diseases
4. Differentiate MIC from MBC
5. Critically evaluate the utility of Nucleic acid probes in viral disease diagnosis
6. Explain the concept of autoimmunity disorders
7. Give an account on epidemiology of Cholera
8. What are the various derivatives of penicillin?
9. Explain the term Antiserum
10. What is the science of Vaccination?
11. What are the general features of a virus?
12. Discuss symptoms of bacterial diseases.

(8 x 2 = 16 marks)

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

13. Discuss briefly different types of immunodeficiency diseases
14. Give an account on epidemiology of any one fungal disease of man
15. Explain the pathogenesis and epidemiology of human diseases caused by the genus *Corynebacterium*
16. Explain antibody resistance mechanism in bacteria
17. Explain the different methods used to study *in vitro* susceptibility of antibiotics
18. Briefly describe the technique of phage typing
19. Write notes on Human diseases caused by protozoa
20. Give an account on air borne diseases caused by viruses
21. Explain the epidemiology and pathogenesis of common human virus infections.
22. Describe the classification, chemistry and mode of action of 5 important antibiotics

(5 x 7 = 35 marks)

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

23. Describe the new rapid serological diagnostic methods in disease diagnosis

OR

24. Explain the various methods for detection and assay of viruses.
25. Discuss the common serological tests for the diagnosis of bacterial infections

OR

26. Explain the infections associated with immunodeficiency and immune suppression

(12x2 = 24marks)

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

16PE3BOTT14: FOOD AND ENVIRONMENTAL MICROBIAL TECHNOLOGY

Time: 3 Hours

Max. Marks: 75

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

1. Explain the relevance of smoking of food materials
2. Write notes on Shigellosis
3. Give an account on Mycotoxins
4. What are psychrotrophs?
5. Explain the importance *Lactobacillus*
6. Write notes on Biofilms
7. What do you mean by Biomagnification?
8. Explain the importance of IMViC test
9. Explain the importance of Biofiltration
10. What is activated sludge?
11. What is metagenomics
12. What is a superbug?

(8 x 2 = 16 marks)

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

13. Explain the microbial flora and their spoilage in poultry
14. Comment on the various enforcement and food control agencies.
15. Discuss various methods of culturing anaerobes
16. What are the factors affecting soil microbial growth?
17. Discuss about Microbial leaching
18. Discuss the role of microbes as pollution indicators
19. Describe the chemical changes in food materials caused by micro-organisms.
20. Describe the factors affecting microbial growth in food.
21. Comment on the principles of food preservation by radiation.
22. Describe the various methods for examination of food materials for microbe detection

(5 x 7 = 35 marks)

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

23. Discuss the benefits and hazards of genetically modified microbes

OR

24. Outline the process of wastewater treatment
25. Explain the role of microbes in the disposal of waste

OR

26. Discuss the general principles of food preservation

(12x2 = 24marks)

Model Question Paper
SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc.Botany DEGREE EXAMINATION
SEMESTER IV
16PE3BOTT15: INDUSTRIAL MICROBIAL TECHNOLOGY

Time: 3 Hours

Max. Marks: 75

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

1. Explain the relevance of antifoam agents in industrial microbiology
2. Give an account on the application of Ultrasonication
3. Write the role of pectinase in industrial microbiology
4. Give an account on preservation methods
5. What is meant by Primary Screening ?
6. Mention the methods of isolation of industrially important micro-organisms
7. Narrate the importance of auxotrophic mutant
8. What is Membrane fermentor? Explain its importance
9. What are the applications of SCP?
10. Explain the importance of glutamic acid in industrial microbiology
11. Discuss the production of biopolymers.
12. Write a short note of SmF.

(8 x 2 = 16 marks)

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

13. Explain Transformation process
14. What are the applications of immobilization?
15. Differentiate packed bed fermentor and Fluidised bed fermentor
16. Explain the importance of agitation in microbial fermentation
17. Discuss about strain development.
18. Explain the process of wine production by microbes
19. Discuss the microbial production of streptomycin.
20. Explain the process of amylase production by microbes
21. Give a detailed account of downstream processing
22. Explain the methods of cell and enzyme immobilization

(5 x 7 = 35 marks)

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

23. Describe the process of steroid transformation

OR

24. Write an essay on the production of penicillin at industrial level.
25. Discuss the fermentation technology involved in the production of enzymes that you have studied

OR

26. Explain biotransformation pathway with special reference to biotransformation technology
(12x2 = 24marks)

Model Question Paper
SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc.Botany DEGREE EXAMINATION
SEMESTER IV
16PE3BOTT16: AGRICULTURAL MICROBIOLOGY

Time: 3 Hours

Max. Marks: 75

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

1. What is meant by diazotrophs?
2. Explain the importance of Siderophores
3. Comment on nif genes
4. Write notes on Leghaemoglobin
5. Give an account on Biogas formation
6. Differentiate Batch and continuous fermentation
7. Explain the importance of Azetobacter in agriculture.
8. Give an account on entomopathogenic fungi
9. What is meant by Bioremediation?
10. What are biocontrol agents?
11. Write a short note on agrobacterium
12. What is a mycoherbicide.

(8 x 2 = 16 marks)

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

13. Explain carbon flow in mycorrhizal plant association
14. Mechanism of phosphate solubilization
15. Economic importance of mushrooms
16. Role of microorganisms in energy production
17. Write a short note on carrier based inoculum preparation
18. Briefly describe the methods used for isolation and screening of phosphate solubilizing microbes.
19. Describe the benefits of mycorrhizal association.
20. Short note on viral insecticides
21. Discuss the role of microbes in bioremediation.
22. Explain the role of microbes as biofertilizers

(5 x 7 = 35 marks)

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

23. Give an account on nitrogen fixation.

OR

24. Explain the role of microorganisms in control of plant diseases.
25. Discuss about various micro organisms used for bio remediation and explain the process involed.

OR

26. Expalin various mechanisms of bio-control Micro- organisms commonly used in bio-control of insectpests and plant pathogens.

(12x2 = 24marks)

Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

Semester IV

Practical Course: 16PE3BOTP07

CLINICAL AND INDUSTRIAL MICROBIAL TECHNOLOGY

Time 3 Hours

Max. Marks 40

1. Solid state and submerged fermentation (SSF) for amylase production and quantification of amylase produced (A).
(Procedure – 1 , Working-2, Graph-1, Result & calculation- 2) 6 Marks
 2. Demonstrate the Bacterial types B and C for antibiotic sensitivity.
(Procedure – 2, Petridish preparation, disc placement – 1 +1 = 2, Result interpretation - 2) 6 Marks
 3. Stain Bacterial spores D supplied.
(Procedure – 2, Slide -2, Result-2) 6 Marks
 4. Determine the sample E for WIDAL Test
(Procedure – 2, Working-2, Result -2) 6 Marks
 5. Quantitative determination of bacteria number in milk- Methylene blue reductase test
(Procedure- 2 , Working – 2, Result – 2) 6 Marks
 5. Comment on G &H
(2.5 x 2=5) 5 Marks
 6. Evaluation of Practical Record 5 Marks
-

Key to the questions:

1. A - 4 days old fungal culture (SSF) should be supplied
2. B, C – unknown bacterial cultures are to be given.
3. D – old bacterial culture having spores
4. E – any blood sample
5. F- milk sample
5. G & H– Equipments/Cultures/Reagents/Diagrams related to topics covered in the syllabus.

Model Question Paper**SACRED HEART COLLEGE (AUTONOMOUS), THEVARA****Semester IV****Practical Course: 16PE3BOTP08****FOOD, AGRICULTURAL AND ENVIRONMENTAL MICROBIAL TECHNOLOGY****Time 3 Hours****Max. Marks 40**

- | | |
|--|----------|
| 1. Conduct IMVIC test of Bacteria (A). Any 3 tests.
(Procedure – 2.5 , Working- 3 x2 = 6, Result – 0.5 x 3 = 1.5) | 10 Marks |
| 2. Calculate the percentage of Mycorrhizal colonization in the given sample B.
(Procedure – 2, Slide – 1, calculation & Result– 1) | 5 Marks |
| 3. Demonstrate methylene blue reductase test (C).
(Procedure – 2, Working – 1, Result - 2) | 5 Marks |
| 4. Demonstrate motility of microbes (D) with a hanging drop culture.
(Slide - 5) | 5 Marks |
| 5. Demonstrate Catalase or oxidase activity of the microbes E & F
(Procedure – 2, Working – 1.5 x 2= 3) | 5 Marks |
| 6. Comment on F, G ,
(2.5 x 2 = 5) | 5Marks |
| 7. Evaluation of Practical Record | 5 Marks. |

Key to the questions:

1. A - Bacterial culture is to be supplied.
2. B - supply roots
3. C - supply milk samples
4. D - root nodules or any bacterial culture
5. E and F- 12 hr. old any 2 bacterial cultures to catalase/ oxidase activity
6. F& G - Equipment/Cultures/Reagents/Diagrams etc., belonging to microbiology topics covered in the syllabus

SEMESTER IV

PROGRAMME ELECTIVE - IV : PHYTOCHEMISTRY

Course	Title	Teaching Hrs Theory	Teaching Hrs Practical	Credits
16PE4BOTT13	Conservation And Management of Medicinal and Aromatic Plants	72	45	4
16PE4BOTT14	Pharmacognosy	72	45	4
16PE4BOTT15	Phytochemistry	72	45	4
16PE4BOTT16	Plant Analytical Chemistry and Analytical Techniques	54	36	3
16PE4BOTP07	Practicals of 16PE4BOTT13+ 16PE4BOTT14			2
16PE4BOTP08	Practicals of 16PE4BOTT15+ 16PE4BOTT16			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.			

16PE4BOTT13: CONSERVATION AND MANAGEMENT OF MEDICINAL AND AROMATIC PLANTS

(Theory 72 hrs; Practical 45 hrs Credit 4)

Module 1 (9 hrs)

Important medicinal and aromatic plants of India; Non-angiosperm medicinal and aromatic plants (bacteria, fungi, algae, lichens, bryophytes and gymnosperms); Problems of overexploitation and deforestation; Rare and endangered species of medicinal and aromatic plants; Policies for their conservation, regeneration and sustainable use; Medicinal Plant Specialist Group of Species Survival Commission (IUCN) Methods of collection, process and storage of medicinal and aromatic plants; purification of raw drugs; factors causing drug contamination, methods of storage of drugs.

Module 2 (9 hrs)

Distribution of essential oils in plants – gymnosperms and angiosperms. General survey of plants yielding essential oils. Chemotaxonomy based on the distribution of essential oils and chemistry of oil constituents. Natural essential oils. Application of essential oils. Insect control property. Indian perfumery products – agarbathi, attar and floral and aromatic water. Methods of collection, process and storage of medicinal and aromatic plants; purification of raw drugs; factors causing drug contamination, methods of storage of drugs.

Module 3 (45 Hours)

Essential oils and perfumery chemicals – classification, functions, location in plant body, general structure, isolation and extraction techniques. Essential oils analysis, uses and storage of essential oils and perfumery chemicals. Recent advances of essential oils and perfumery chemical industry in India. Methods of collection, process and storage of medicinal and aromatic plants; purification of raw drugs; factors causing drug contamination, methods of storage of drugs. Detection of adulterants. Aromatherapy.

Morphology, medicinal value, medicinal property, chemical constituents, substitutes, adulterants, collection/cultivation, harvesting, processing, storage and marketing of the following major aromatic and medicinal plants – *Achyranthea aspera*, *Acorus calamus*, *Adhatoda beddomei*, *Aegle marmelos*, *Aervalanata*, *Allium cepa*, *Aloe vera*, *Alstonia venunata*, *Andrographis paniculata*, *Aristolochia indica*, *Asparagus racemosus*, *Azadirachta indica*, *Bacopa monnieri*, *Carthamus tinctorius*, *Cassia senna*, *Cassia fistula*, *Catheranthus roseus*, *Centella asiatica*, *Citrus aurantium*, *Cinchona officinalis*, *Clitoria ternatea*, *Coleus vetiveroides*, *Corriandrum sativum*, *Costus pictus*, *Crocus sativus*, *Cuminum cyminum*, *Curcuma longa*, *Cymbopogon citratus*, *Cyperus rotundus*, *Cynodon dactylon*, *Datura metel*, *Desmodium gangeticum*, *Dioscorea alata*, *Eclipta alba*, *Elettaria cardamomum*, *Emelia sonchifolia*, *Eucalyptus globulus*, *Evolvulus sinoides*, *Ferula asafetida*, *Ficus racemosa*, *Ficus religiosa*, *Ficus benghalensis*, *Foeniculum vulgare*, *Garcinia indica*, *Gloriosa superba*, *Glycosmis pentaphylla*, *Glycyrrhiza glabra*, *Hemidesmis indica*, *Hibiscus rosa-sinensis*, *Holostemma adakodien*, *Indigofera tinctoria*, *Ipomea paniculata*, *Kaempferia galanga*, *Lawsonia alba*, *Mentha piperita*, *Merremia tridentata*, *Moringa oleifera*, *Myristica fragrans*, *Naregamia alata*, *Naravelia zeylanica*, *Nyctanthes arbor-tristis*, *Ocimum sanctum*, *Phyllanthus amarus*, *Phyllanthus emblica*, *Piper longum*, *Piper nigrum*, *Plumbago zeylanica*, *Pogostemon patchouli*, *Pterocarpus santalinus*, *Punicagranatum*, *Rauwolfia serpentina*, *Ricinus communis*, *Rotula aquatic*, *Rutgraveolens*, *Saracca asoka*, *Sidacordifolia*, *Sesamum indicum*, *Solanum nigrum*, *Strobilanthes*, *Syzygium aromaticum*, *Tamarindus indica*, *Terminalia bellerica*, *Terminalia chebula*, *Tinospora cordifolia*, *Tribulus terrestris*, *Trichopus zeylanica*, *Trigonella foenum-graecum*, *Tylophora indica*, *Vanilla fragrans*, *Vernonia cinerea*, *Vetiveria zizanioides*, *Withania somnifera*, *Woodfordia fruticosa*, *Wrightia tinctoria* and *Zingiber officinale*.

Practicals (45 Hours)

1. Field exploration, collection and preservation of plant specimens; Preparation of herbarium (50 sheets).
2. Extraction of phyto-pharmaceuticals with special reference to –
 - a) Isolation of Eugenol from Cinnamon leaf .
 - b) Isolation of Curcumin from Turmeric.
 - c) Extraction of Pectin from orange peels.
 - d) Extraction of Piperin from black Pepper.
 - e) Extraction of oleoresin from Ginger.
 - f) Extraction of flower pigments from *Hibiscus rosa-sinensis*.
 - g) Extraction of essential oils from Patcholi.
 - h) Extraction of essential oils from *Coleus aromaticus*.
 - i) Extraction of essential oils from *Aegle marmelos*.

References

1. Bhattacharjee SK (2004). *Handbook of Medicinal Plants* (4th ed.). Pointer Publishers, Jaipur.
2. Prajapati NS, Purohit SS, Sharma AK and Kumar T (2003). *A Handbook of Medicinal Plants*. AgrobiosIndia.
3. Trivedi PC (2004). *Medicinal Plants: Utilization and Conservation*. Aavishkar Publishers and Distributors, Jaipur.
4. Ambasta SP (ed.) (1988). *The useful plants of India*. CSIR, New Delhi.
5. Chadha KL and Gupta R (1995). *Advance in Horticulture: Vol. II: Medicinal and Aromatic Plants*. Malhotra Pub. House, New Delhi.
6. Dillon BS, Tyagi RK, Lal A and Saxena S (Eds. (2004). *Plant Genetic Resources Management*. Narosa Pub. House, New Delhi
7. Farooqui AA, Khan MM and Sreeramu, BS (1997) *Cultivation of Medicinal and Aromatic Crops in India*. Naya Prakash, Kolkatta.
8. Honda SS and Kaul MK (1996). *Cultivation and Utilization of Medicinal Plants*. RRL, Jamu.
9. Lawless, L (1997). *The Complete Illustrated Guide to Aromatherapy*. Element Books Ltd., Dorset.
10. Sharma R (2004). *Agrotechniques of Medicinal Plants*. Daya Publishing House, Delhi

16PE4BOTT14: PHARMACOGNOSY
(Theory 72 hrs; Practical 45 hrs Credit 4)

Module 1 (9 hrs)

Introduction; aim and scope of Pharmacognosy – approaches to the study of medicinal plants. Plantkingdom as source of drugs. Biologically active compounds from – thallophyta, bryophyta, pteridophyta, gymnosperms and angiosperms. Pharmacopeal and related drugs of biological origin – pharmacological activities of plant derived hydrocarbons, carbohydrates, phenols, cardio active and cynogenetic glycosides, saponins, steroids, alkaloids, tumor inhibitors, vitamins, hormones, pigments, coloring and flavouring agents and phycocolloids.

Module 2 (24 hrs)

Plants in complementary and traditional systems of medicine :herbal medicine, folk medicine, homoeopathic medicine, Asian medicine, Chinese medicine, unani medicine and siddha medicine. Indian health traditions – ayurveda – concept of prakurthi, medicinal plants in ayurveda, ayurvedic parameters on plant properties, ayurvedic preparations – bhasma, choorna, kashaya, lehya, ghrita and taila. Cultivation of medicinal plants and preparation of drugs, sources of drugs, constituents of drugs, extraction and analysis of drugs, drug storage, drug deterioration and drug adulteration. Classification of drugs based on morphological and chemical characters. Microscopical examination of drugs. Non medicinal toxic plants –hallucinogenic, allergenic and teratogenic plants.

Module 3 (21 Hours)

Pharmacognosy: applications in herbal medicine Classification and identification of drugs: Need for classification of drugs; classical (taxonomic, morphological, organoleptic, and therapeutic); microscopy and modern (biogenetic) criteria for classification of powdered drugs, methods for documentation of raw drugs. Single plant drugs and formulations in Ayurveda, Siddha and Unani. Classical and modern means of drug administration. Holistic concept of drug administration. Principles related to commercial production of drugs, standardization of natural products, quality control, standards and regulations of drug export and import, modern techniques in drug improvement and strategies for conservation of drug plants.

Practical (45 hrs)

1. Study of stomatal index, stomatal frequency, vein islet number and vein termination number.
2. Organoleptic evaluation (colour, odour, taste, texture and fibre and other features) of 20 crude samples of interest.
3. Identification and study of vegetative and reproductive characters, morphology of use part and products obtained of important food, medicinal and aromatic plants grown in Kerala.
4. Identification of drug/adulterant based on anatomy.
5. Histochemical tests to identify various plant components – starch, cellulose, protein, lipids, oils, organic acids, mucilage, chitin, suberin, pectin, cutin and crystals in various drug samples.
6. Methods of physical evaluation of drugs: 1) determination of moisture content in crude drugs 2) determination of total ash value, acid insoluble ash value and water soluble ash value of crude drug samples 3) determination of bioactive compounds from alcohol and water soluble extracts of crude drugs.

References

1. Mukherjee B (ed). (1993). *Traditional Medicine*. Oxford & IBH Pub. Co. Pvt. Ltd. New Delhi.
2. Kokate CK, Purohit AP and Gokhala SB (1997). *Pharmacognosy*. NiraliPrakasan Publishers.
3. Kumar NC (1993). *An Introduction to Medical Botany and Pharmacognosy*. Emkay Publications, New Delhi.

4. Trivedi PC (2004). *Medicinal Plants: Utilization and Conservation*. Aavishkar Publishers and Distributors, Jaipur
5. Bannerman RH, Burton J and Wen Chen C. (eds). (1983). *Traditional Medicine and Health Care Coverage*. WHO, Geneva.
6. Chopra RL, Nayar SL and Chopra IC (1956). *Glossary of Indian Medicinal Plants*. CSIR Publications, New Delhi.
7. Gokhale SS, Kokate CK and Purohit AP (1994). *Pharmacognosy*. NiraliPrakashan. Pune.
8. Kirthikar KR and Basu BD (1991). *Indian Medicinal Plants Vol I to IV*.
9. Leavitt D (1974) *Chinese Herbal Medicine*. DHEW Publishers, New York.
10. Lele RD (1986). *Ayurveda and Modern Medicine*. Baratiya Vidya Bhavan, Mumbai.

16PE4BOTT15: PHYTOCHEMISTRY
(Theory 72 hrs; Practical 45 hrs Credit 4)

Module 1 (18 hours)

Introduction and scope of phytochemistry. Plant chemicals in human life. Plant secondary metabolites as drugs. Underutilized and under exploited plants of potential economic value. Phytochemical and histochemical approach to economically important plants with special reference to study of carbohydrate, proteins, vitamins, of cereals, pulses, vegetable, fruit, nuts and oil yielding plants. Chemistry of plant compounds- phenolics, steroids, dyes, tannins, wood, cork, paper, pulp, cellulose derivatives, fibres, latex, gums, resins, mucilage and petroleum substitutes.

Module 2 (27 hours)

Tissue culture techniques for medicinal plants: Types, techniques, nutritional requirements. Preparation and sterilization of media, preparation of explant, measurement of growth parameters. Organogenesis and Embryogenesis. Micropropagation of medicinal and aromatic plants. Secondary metabolism in tissue cultures with emphasis on production of biomedicinals. Immobilization plant cells, techniques and its effect on secondary metabolism. Biotransformation by plant cell culture. Secondary metabolites of medicinal importance involved in biotransformation. Hairy root cultures and their applications.

Module 3 (9hrs)

Commercially and naturally important plant products – phenolic compounds, flavanoids, pigments, betalins, carotenoids, alkaloids, tannins, terpenes, sterols, glycosides, hormones and plant acids. Agronomic practices in the following plants : ajowan, *Canaga*, cardamom, champak, cinnamon, clove, *Citrus*, *Eucalyptus*, fennel, ginger, jasmine, lemon grass, *Murraya*, nut meg, patchouli, palmrosa, pepper, rose, sandal wood, vanilla and vetiver. Plant defense mechanism.

Practical (45 Hours)

1. Estimation of water content, dry matter and ash content of plant tissues.
2. Estimation of total proteins in plant tissues.
3. Estimation of total carbohydrates in plant tissues.
4. Estimation of anthocyanins.
5. Estimation of total alkaloids in tobacco leaves.
6. Estimation of caffeine content in tea leaves.
7. Estimation of vitamin C.
8. Estimation of glucose by iodimetry.
9. Estimation of total tannins in plant tissue.
10. Estimation of cellulose in wood.
11. Determination of iodine value of oils.
12. Determination of acid value of oils.
13. Isolation of starch from potato.
14. Estimation of crude fibres.

References

1. Chatwal Gurdeep R. 1990. *Organic Chemistry of Natural Products* (Vol II) Himalaya Publishing House, Bombay.
2. Daniel Mammen (1991) *Methods in Plant Chemistry and Economic Botany*. Kalyani

Publishers, New Delhi.

3. Sabins SD and Daniel M (1990). *A Phytochemical Approach to Economic Botany*. Kalyani Publishers New Delhi.
5. Bhattacharjee SK (2004). *Handbook of Medicinal Plants* (4th ed.). Pointer Publishers, Jaipur.
6. Bhatia SC (1983). *A Concised Encyclopedia of Oils I and II – Essential Oils and Perfumery Chemicals*. Shree Publishing House, Delhi.2.
7. Chatwal Gurudeep R. (1990). *Organic Chemistry of Natural products* Vol I and II. Himalaya Publishing House, Bombay.
8. Dillon BS, Tyagi RK, Lal A and Saxena S (Eds.). (2004). *Plant Genetic Resources Management*. Narosa Pub. House, New Delhi.
9. Dwivedi JN and Singh RB (1989). *Essentials of Plant Techniques*. Scietific Publishers, Jodhpur.
10. Swain T. (1966). *Comparative Phytochemistry*. Academic Press, London.

16PE4BOTT16: PLANT ANALYTICAL CHEMISTRY AND ANALYTICAL TECHNIQUES
(Theory 54 hrs; Practical 36 hrs Credit 3)

Module 1 (18 hrs)

Extraction techniques: Cold and hot extraction methods, liquid-liquid extraction techniques, liquid-carbondioxide extraction, concentration and evaporation techniques, lyophilisation, Colorimetric and Spectrophotometric analysis of extracts; finger printing of extracts and estimation of bioactive molecules.

Module 2 (9 hrs)

Analytical Methods: Light and electron microscopy, tissue printing, cytochemical localization, Immunological methods (production of monoclonal and polyclonal antibodies, agglutination and precipitation tests, immuno diffusion assays, immuno electrophoresis, radio immunological assay), Radioactive isotopes, Radiometry and Autoradiography.

Module 3 (18 hrs)

Identification of compounds using UV, visible, IR, Mass, NMR spectroscopy, Flame ionization detector, Argon ionization detector, photo ionization detector and reduction gas detector. GC-FID, GC-FTIR and GCMS, LC-MS in the analysis of essential oils and plant extracts. Application of spectroscopic techniques in structural elucidation of secondary metabolites.

Module 4 (13 hrs)

Isolation, separation and detection techniques: Chromatography: TLC, GLC, GC, HPLC and HPTLC. Electrophoretic separation. Detection and determination of elements in plant tissue using atomic absorption spectrometry, atomic emission spectrometry, X-ray fluorescent spectrometry, flame emissionspectrometry, sulphur analysers and nitrogen analysers. Applications: Applications of biomolecular chemistry in plant systematics, plant physiology, medicine and pharmaceuticals, forensic science, environmental science, biotechnology, herbal and modern drug industries, food, flavor and cosmetic industries.

Practicals (45 hrs)

1. Extraction of pigments
2. Extraction of lipids
3. Extraction of proteins
4. Extraction of alkaloids
5. Estimation of different compounds in plant extracts
6. Tests for detection of organic acids from fruits of tamarind, tomato, citrus and apple
7. Histochemical / chemical tests to identify various plant compounds like pectin, tannin, calcium oxalate and calcium carbonate.

References

1. Dey PM and Harborne JB (Eds.) (1997). *Plant Biochemistry*, Academic Press, New York.
2. Harborne JB (1984). *Phytochemical Methods* (2nd ed). Chapman and Hall, London.
3. Schwedt G (1997). *The Essential Guide to Analytical Chemistry*. John Wiley & Sons, New York.
4. Anderson JW and Beardall J (1991). *Molecular Activities of Plant Cells*. Blackwell Scientific Publications, Oxford.
5. Atta-ur-Rahman (1989). *One and Two Dimensional NMR Spectroscopy* (1st ed.). Elsevier, New York.

6. Braithwaite A and Smith FJ (1996). *Chromatographic Methods* (5th ed) Blackie Academic & Professional London.
7. Budzikiewicz H, Djerassi C and Williams DH (1968). *Mass Spectrometry of Organic Compounds*. Holden Day, San Francisco, CA.
8. Derome AE (1987). *Modern NMR Techniques for Chemistry Research* (1st ed.) Pergamon Press, New York.
9. Lea PJ and Leegood RC (1993). *Plant Biochemistry and Molecular Biology*. John Wiley & Sons, West Sussex
10. Silverstein RM, Bassler GC and Morrill TC (1981). *Spectroscopic Identification of Organic Compounds* (4th ed.). John Wiley, New York.

Model Question Paper
SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc.Botany DEGREE EXAMINATION
SEMESTER IV
16PE4BOTT13: CONSERVATION AND MANAGEMENT OF MEDICINAL AND
AROMATIC PLANTS

Time: 3 Hours

Max. Marks: 75

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

1. What are aromatic plants? Give two examples.
2. Describe the concept of IUCN.
3. Describe the botany of two plants used as brain tonic.
4. Enlist the botanical names of two Gymnosperms of medicinal value.
5. Describe chemotaxonomy.
6. Give examples of two endangered medicinal plants.
7. Explain the role of plants having insect control property.
8. Differentiate floral water and aromatic water.
9. Write the botanical names of two plants used as antidote to snake bites.
10. Describe aromatherapy.
11. Write a short note on essential oils.
12. Write a short note on the need of conservation of medicinal plants

(8 x 2 = 16 marks)

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

13. Write down the commercial name, family, morphology of useful part and propagation method of *Saracaasoka* and *Woodfordiafruitcosa* and *Aegle marmelos*.
14. Write an account on the medicinally active properties of *Gloriossasuperba* and *Hemidesmisindica*.
15. Explain the methods of storage of medicinal and aromatic plants.
16. Discuss on the policies evolved for the conservation of medicinal plants.
17. Give an account on the role of essential oils in perfumery industry.
18. Write an account on the botany, cultivation and processing of plants yielding perfumery products.
19. Describe the steps involved in the purification of raw drugs.
20. Enlist the factors causing drug contamination.
21. Give an account on natural essential oils and the role in human health.
22. Discuss on the importance given to the cultivation of medicinal and aromatic plants in India.

(5 x 7 = 35 marks)

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

23. Write an essay on the morphology, cultivation and processing of plants used for anti- dysenteric property.

OR

24. Write an account on the recent advances in essential oils and perfumery chemicals in India.
25. Write an essay on phyto-pharmaceuticals and their significance.

OR

26. Describe with examples the rare and endangered medicinal and aromatic plants. Add a note on their conservation strategies.

(12x2 = 24marks)

Model Question Paper
SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc.Botany DEGREE EXAMINATION
SEMESTER IV
16PE4BOTT14: PHARMACOGNOSY

Time: 3 Hours

Max. Marks: 75

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

1. What are hallucinogenic agents?
2. Describe bhasma and choorna.
3. Describe the methods of drug storage.
4. Explain the concept of Prakurthi.
5. Describe tumor inhibitors.
6. Give an account on organoleptic evaluation.
7. Explain the scope of pharmacognosy.
8. Differentiate single plant drug and formulations.
9. Enlist the steps involved in drug extraction.
10. Describe the term phycocolloids.
11. Write a short note on alkaloids
12. Discuss traditional systems of medicine

(8 x 2 = 16 marks)

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

13. Write on coloring and flavoring agents.
14. Write an account on the cynogenetic and cardiac glycosides.
15. Explain how drugs are classified based on chemical characters.
16. Differentiate drug deterioration and drug adulteration.
17. Give an account on the standard regulations for drug export and import.
18. Explain the parameters of microscopical examination of drugs.
19. Describe the pharmacological activities of plant alkaloids.
20. Bring out the importance of toxic plants with examples.
21. Discuss on the holistic approach of drug administration.
22. Evaluate on the role of plants in traditional systems of medicine

(5 x 7 = 35 marks)

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

23. Write an essay on Ayurvedha as a traditional system of medicine.

OR

24. Give an account on the biologically active compounds from the plant kingdom.
25. Explain the modern techniques employed in drug improvement.

OR

25. Describe with suitable examples th non medicinal toxic plants.

(12x2 = 24marks)

Model Question Paper
SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
M.Sc.Botany DEGREE EXAMINATION
SEMESTER IV
16PE4BOTT15: PHYTOCHEMISTRY

Time: 3 Hours

Max. Marks: 75

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

1. What is biotransformation?
2. Describe the role of sterols.
3. What are plant acids? Give an example.
4. Enlist the plants yielding alkaloids.
5. Describe the importance of *Canaga* and *Jasminum* in perfumery industry.
6. Give an account on flavanoids.
7. Explain biomedicinals.
8. Differentiate organogenesis and embryogenesis.
9. Enlist the significance of pigments.
10. Describe the role of phytochemistry in systematic studies.
11. Write a short note on flavanoides.
12. Discuss the role secondary metabolite in plants.

(8 x 2 = 16 marks)

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

13. Write about the underutilized plants.
14. Write an account on the agronomic practices for cardamom and clove.
15. Explain the various plant defense mechanisms.
16. Give an account on hairy root culture and its significance.
17. Give an account on the nutritional requirements in a culture medium.
18. Explain the cultivation, extraction and importance of lemon grass oil.
19. Describe the various histochemical methods to study plant metabolites.
20. Bring out the role of phenol compounds.
21. Discuss the role of plant secondary metabolites as drugs
22. Explain the various types of bio-reactors and their applications.

(5 x 7 = 35 marks)

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

19. Bring out the role of micro propagation for the improvement of medicinal plants.
20. Give an account on the various plant secondary metabolites.

OR

22. With the help of suitable examples describe the methods involved in the commercial cultivation of plants yielding secondary metabolites.

OR

24. Write an account on the secondary metabolite production by tissue culture technique.

(12x2 = 24marks)

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

16PE4BOTT16: PLANT ANALYTICAL CHEMISTRY AND ANALYTICAL TECHNIQUES

Time: 3 Hours

Max. Marks: 75

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

1. What is finger printing?
2. Describe the term lyophilization.
3. Explain the principle of autoradiography.
4. What are ionization detectors?
5. Describe immunoelectrophoresis.
6. Give an account on bioactive molecules.
7. Explain the term tissue printing.
8. What is radiometry?
9. Enlist the significance of forensic science.
10. Explain herbal drugs.
11. Explain the principle of GC-MS
12. Write a short note on HPLC.

(8 x 2 = 16 marks)

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

13. Describe the various phytohormones.
14. Explain the procedure of spectrophotometric analysis of extracts.
15. Write about the principle and working of sulphur analysers.
16. Write an account on the Xray fluorescent spectrometry.
17. Differentiate iodine value and saponification value.
18. Give an account on cold and hot extraction of plant components.
19. Discuss the procedure and significance of TLC.
20. Explain the protocol of disc diffusion method.
21. Write an account on the applications of biomolecular chemistry in plant systematics
22. Explain the principle and methodology of autoradiography

(5 x 7 = 35 marks)

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

23. Describe the principle, methodology and application of electrophoresis for the separation of plant compounds.

OR

24. Explain the principle, working and applications of a spectrophotometer
25. Give an account on the chromatographic techniques for separation

OR

26. Discuss the various methods of spectroscopic analysis of plant tissues

(12x2 = 24marks)

Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

Semester IV

Practical Course: 16PE4BOTP07

PHARMACOGNOSY AND CONSERVATION AND MANAGEMENT OF MEDICINAL AND AROMATIC PLANTS

Time 3 Hours

Max. Marks 40

- | | |
|--|----------|
| 1. Calculate the stomatal index and stomatal frequency of the given material A .
(Stomatal index - 2 and stomatal frequency - 2) | 4 marks |
| 2. Conduct the organoleptic evaluation of the given sample B and identify the compound | 3 marks |
| 3. Write the botanical name, family and morphology of the useful part of the following materials C, D, E and F .
(Botanical name – 1, Family – ½ and morphology of useful part - ½) | 8 marks |
| 4. Conduct the histochemical localization of the given material G
(Procedure – 2 and Result – 3) | 5 marks |
| 5. Extract floral pigments from the given material H
(Procedure – 3 and Extraction – 7) | 10 marks |
| OR | |
| 5. Extract the active compound from the given sample H
(Procedure – 3 and Extraction – 7) | 10 marks |
| 6. Herbarium | 5 marks |
| 7. Evaluation of practical record | 5 marks |

Key to Specimens

A - Leaves of any one medicinal plant mentioned in the syllabus

B - Powder of the drug from any of the selected 10 plants

C, D, E and F - Any 4 common medicinal plants mentioned in the syllabus

G Histochemical identification of starch, protein, lipid and crystals present in any one of the selected 10 plants

H Extraction of flower pigments or active compounds presents in any of the 5 plant specimens

Model Question Paper

SACRED HEART COLLEGE (AUTONOMOUS), THEVARA

Semester IV

Practical Course: 16PE4BOTP08

**PHYTOCHEMISTRY AND PLANT ANALYTICAL
CHEMISTRY AND ANALYTICAL TECHNIQUES**

Time 3 Hours

Max. Marks 40

- | | |
|--|---------|
| 1. Estimation of water content of A .
(Procedure - 2 and Result - 2) | 4 marks |
| 2. Estimate the protein content in the given plant material B
(Procedure - 2, Conduct of experiment – 6 and Result - 2) | 10 mark |
| 3. Determine the acid value of the given sample C .
(Procedure – 2, Working – 4 and Result - 2) | 8 marks |
| 4. Isolate and identify the nature of starch grain in the material D .
(Procedure–2, Preparation -2, Diagram -1 and Identification with Reasons–2) | 7 marks |
| 5. Extract and separate the pigments present in the given material E .
(Procedure – 2 and Extraction –2 and Separation 2) | 6 marks |
| 6. Evaluation of practical record | 5 marks |
-

Key to Specimens

- A Plant tissue from a selected list of 10 plants
- B Protein rich seeds or plant material
- C Any common vegetable oil sample
- D Starch from rice, wheat or potato
- E Pigments of flowers or leaves from a selected group of 10 medicinal plants.

16PBOTPR: Project Work

Students may carry out the project work in any discipline related to their PG Programme as per the syllabus, either in their parent department or at a recognized Research Institution or University Department with the official permission of the HOD as well as the Head of the Institution where the student wish to carry out the project work.

The dissertation shall be an original work, without any kind of copying or plagiarism, which the supervising teacher shall ensure prior to certification.

The dissertation shall include the following Chapters: (1) Introduction, (2) Review of Literature, (3) Materials & Methods, (4) Results, (5) Discussion followed by Reference. Certificates of the HOD and the Supervisor of the student shall be included prior to the Index/content page in front of the thesis.

In case if the student carry out the project in an outside institution, a teacher of the department shall act as a co-guide for the student and both the supervising experts shall sign the certificate Before the introduction, the student may write a preface including acknowledgement. Total page of the dissertation shall be minimum 25 (typed with 1.5 space between lines and font size 12) Project work shall be presented (oral ppt presentation) in front of the examination board by 20 minutes and the evaluation and mark distribution shall be as per the general norms of the university in this regard.

BO4V44: Comprehensive Viva-Voce:

The viva board shall include two external experts from the Practical Examination Board of the University and each student shall be examined for minimum of 20 minutes (Maximum 30 minutes) regarding the entire topics covered in the PG Programme, excuding the project work.

LIST OF VIRTUAL LAB EXPERIMENTS

Bioinformatics

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

Ecology

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

- 8) Conserving Endangered Species
- 9) Interspecific Competition and Geographic Distributions
- 10) Metapopulation Dynamics
- 11) Parasitoid Host Dynamics
- 12) Spread Pest Population invasion
- 13) Optimal Foraging
- 14) Optimal Foraging Pollinators
- 15) Optimal foraging Sit and wait predators that maximize energy

Biophysics

- 1) Using a light microscope (Remote Trigger)
- 2) Observing an animal cell using a light microscope (Remote Trigger)
- 3) Study of RC Properties of Cell Membrane (Remote Trigger)
- 4) Study of Electrically excitable cells (Remote trigger)
- 5) Bursting phenomenon in biology via RC models (Remote Trigger)
- 6) Micrometry (Remote Trigger)
- 7) 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) Fluorescent Labeling of Antibodies
- 15) Fragmentation of IgG Using Papain
- 16) Fragmentation of IgG using pepsin

Microbiology

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

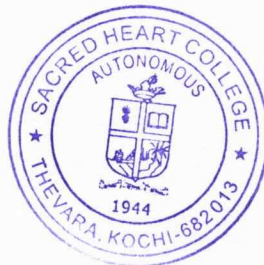
Cell biology

- 1) Cell Organization and Subcellular Structure Studies (Prokaryotic and Eukaryotic)
- 2) Isolation of Mitochondria
- 3) Isolation of Chloroplast
- 4) Isolation of Endoplasmic Reticulum
- 5) Glucose Uptake Assay
- 6) Transfection
- 7) Lignin Staining
- 8) Maintenance of Mammalian Cell Lines
- 9) Cell Attachment

- 10) Cell Migration
- 11) Mitosis in Onion Root Tips
- 12) Cell Proliferation
- 13) Actin Assembly
- 14) Maintenance and Storage of 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) Electroblothing
- 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



Dr. Jose John
 Principal in Charge
 Sacred Heart College (Autonomous)
 Thevara, Kochi-682 013