Master of Science in Botany

PROGRAMME STRUCTURE AND SYLLABUS 2019-20
ADMISSIONS ONWARDS

BOARD OF STUDIES IN BOTANY (PG)
ST.ALBERT'S COLLEGE (AUTONOMOUS), ERNAKULAM

(AFFILIATED TO MAHATMA GANDHI UNIVERSITY, KOTTAYAM)

(2019)

SYLLABUS FOR POST-GRADUATE PROGRAME

IN

BOTANY

(Biotechnology as Program Elective Subject)

THE RESTRUCTURED CURRICULUM IN CREDIT SEMESTER SYSTEM

(EFFECTIVE FROM 2019 ADMISSIONS)

DEPARTMENT OF BOTANY, ST.ALBERT'S COLLEGE, ERNAKULAM
Board of Studies in Botany (PG)

Sl.No:	Name	Designation	Qualification
1/1	**Dr .J. Jameson, (Chairman)**	**(HOD) Associate Professor**	**Ph. D**
a)	**Entire faculty of each specialization**		
2.	Dr. L. Jose	Associate Professor, SACA	Ph.D
3.	Dr. Siju M. Varghese	Assistant Professor, SACA	Ph.D
4.	Dr. K. Madhusudhanan	Assistant Professor, SACA	M. Phil., Ph.D.
5.	Smt. Drishya K Reghuvaran	Assistant Professor, SACA	M.Sc
6.	Smt. Mary Joseph	Assistant Professor, SACA	M.Sc
7.	Dr. Anna Ancy Antony A	Assistant Professor,SACA	Ph.D
8.	Dr. Anisha S	Assistant Professor, SACA	Ph.D
b)	**Experts in the Subject:** *(two)*		
1.	Dr Cyril E A	Assistant Professor, Dept of Botany,Kerala University.	Ph.D
2.	Dr. Jose Puthoor	Associate Professor, Dept of Botany, Calicut University.	Ph.D
c)	**Nominee of Vice Chancellor (one)**		
1.	Dr. Jomy Augustine	HOD and Associate Professor, St. Thomas College, Pala.	Ph.D
d)	**Placement Representative.**		
	Sri. Jose .P	Corporate Sector (Garden & Nursery)	MD, National nursery, Trichur.
e)	**Meritorious alumnus.**		
	Dr. Stephen Sequeira,	Assistant Professor, Maharaja's College, Ernakulam	Ph.D
f)	**Experts from outside whenever special courses of studies are to be formulated**		
1.	Dr. Vinod Thomas	Scientist ,Rubber Board of India, Kottayam	Scientist
2.	Mr Nikesh R	Agricultural Assistant, Neriamangalam, Kerala	MSc.
g)	**Other Teachers of the Faculty**		
1.	Dr. Krishnakumar KS	Assistant Professor, SACA	PhD
2.	Dr. Bijoy V M	Assistant Professor, SACA	PhD

Preface

In tune with the changing scenario in higher education, Mahatma Gandhi University decided to introduce Credit Semester System in all its regular Post-graduate programmes from 2012-2013 academic year. Regulations for the same were approved by order No. 5386/L/Acad/PGCSS (R)/2011 of Mahatma Gandhi University. In 2016 when St. Albert's college was granted autonomy, we adopted the curriculum and syllabus followed by the Mahatma Gandhi University, Kottayam for the year 2016.

Subsequently, the PG Board of studies in Botany met several times and prepared a draft syllabus conforming to the general guidelines of the curriculum for the post-graduate programmes. The draft syllabus was then subjected to a detailed review in a workshop of teachers in Botany representing all the post-graduate Colleges. Adequate modifications were incorporated into the curriculum based on the views and suggestions came up in the workshop.

St.Albert's College (Autonomous), Ernakulam is affialiated to Mahatma Gandhi University, Kottayam is also felt the importance of the changes made by the University in the New PG curriculam decided to adopt the PG botany syllabus 2019 as such without any modification in its content but decided to follow the exam regulations stipulated by the university for 2012 admission in the Accademic Council Meeting held on 12-06-2019 and which was further approved by the College Governing Council meeting held on 18-06-2019.

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.
- Enabling 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 in Botany St. Albert's College (Autonomous) Ernakulam acknowledges the timely steps taken by MG University Kottayam for conducting workshop in syllabus revision and implementing the syllabus with effect from 2019 and also to all the senior botany teachers whose advice, thoughtful reviews, comments and help have helped in the materialization of the syllabus.

'*A good education is like a savings account. The more you put into it, the richer you are'*.

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Programme objectives and outcome

M.Sc. Botany Programme is a two-year post-graduate programme, which deals with basic and advanced study on plants. It is one of the multi-disciplinary fields with great demand in various fields of research and development. The programme envisages developing understanding and knowledge for applying into sectors like agriculture, horticulture, floriculture, biotechnology, genomics, forest and environment. The programme is divided across 4 semesters of 90 days each.

Assessment of Learning Outcomes

M.Sc. Degrees are designed for students who plan a career in science with an emphasis on plants, especially those intending to pursue an advanced degree Botany/ Life sciences.

Expected Student Learning Outcomes for the Department of Botany

Students who have completed their PG degree in Botany should be competent in the following areas:

- **Specific core discipline knowledge** - Students should have learned core knowledge of the anatomy, morphology, systematics, genetics, physiology and ecology of marine and terrestrial plants, with particular emphasis on Kerala and Kochi's unique flora and ecosystems.
- **Communication skills** - Students should have learned to discuss and analyze problems using oral and written communication skills.
- **Problem solving and research skills** - Students should have learned to make observations and collect data in laboratory and in field courses and to analyze these results, derive conclusions and report their findings.

Department of Botany Program Assessment

Student feedback will be obtained in exit interviews and questionnaires concerning learning outcome objectives, faculty advising, teaching and relevancy of courses in the required curriculum.

THE PROGRAMME STRUCTURE

Course Code	Title of the course	Teaching hours		Credits
		Theory	Practical	
SEMESTER I				
PBT1CRT0119	Microbiology	27	9	4
	Phycology	45	36	
PBT1CRT0219	Mycology	36	36	4
	Crop pathology	36	18	
PBT1CRT0319	Bryophytes	36	18	4
	Pteridophytes	36	36	
PBT1CRT0419	Gymnosperms and Paleobotany	36	27	3
	Evolution	18	--	
PBT1CRPT0119	Microbiology, Phycology, Mycology and Crop Pathology Practical			2
PBT1CRP02119	Bryology, Pteridology, Gymnosperms, and Paleobotany Practical			2
Total		**270**	**180**	**19**
SEMESTER II				
PBT2CRT0119	Anatomy	36	27	
	Developmental Biology	18	9	4
	Horticulture	18	9	
PBT2CRT0219	Cell Biology	27	18	
	Genetics	27	18	4
	Plant Breeding	18	9	
PBT2CRT0319	Plant Physiology	45	36	4
	Biochemistry	27	27	
PBT2CRPT419	Molecular Biology	54	18	3
PBT2CRP0119	Anatomy, Developmental Biology, Horticulture, Cell biology, Genetics and Plant breeding Practical			2
PBT2CRT0219	Plant Physiology, Biochemistry and Molecular biology Practical			2
Total		**270**	**180**	**19**
SEMESTER III				
PBT3CRT0119	Research Methodology	18	9	
	Micro-technique	18	27	4
	Biostatistics	18	9	
	Biophysical Instrumentation	18	18	
PBT3CRT0219	Biotechnology, Bioinformatics and Bio-nanotechnology	72	36	4
PBT3CRT0319	Angiosperm Taxonomy, Economic Botany and Ethanobotany	72	63	4
PBT3CRT04119	Environmental Science	54	18	3

PBT3CRP0119	Research Methodology Micro technique, Biostatistics, Biophysics and Biotechnology and Bioinformatics Practical			2
PBT3CRP0219	Angiosperm Taxonomy, Economic Botany and Environmental Science Practical			2
Total		**270**	**180**	**19**
	SEMESTER IV			
PBT4CRT0119	Elective course IBiotechnology - Plant tissue Culture and Microbial Biotechnology	90	72	4
PBT4CRT0219	Elective course IBiotechnology – Genetic Engineering, Genomics and Immunology	90	54	4
PBT4CRT0319	Elective course IBiotechnology – Genomics, Transcriptomics, Proteomics and Bioinformatics	90	54	4
PBT4CRP0119	Elective course IBiotechnology- Practical Paper I Plant Tissue Culture and Microbial Biotechnology			2
PBT4CRP0219	Elective course I Biotechnology- Practical Paper II Genetic Engineering, Genome Editing, Immunology, Genomics, Transcriptomics, Proteomics and Bioinformatics			2
PBT4CPR0119	Project work			4
PBT4CRV0119	Viva-voce			3
Total		**270**	**180**	**23**

ST.ALBERT'S COLLEGE (AUTONOMOUS) ERNAKULAM
(Affiliated to Mahatma Gandhi University, Kottayam)
POST-GRADUATE PROGRAMME IN BOTANY

REGULATIONS FOR CREDIT AND SEMESTER SYSTEM– 2019 ADMISSION ONWARDS

Salient features

I. These Regulations shall come into force from the Academic Year 2019-2020 onwards.
II. The regulation provided herein shall apply to all regular post-graduate programmes (MSc Botany Programme) conducted by St. Albert's College (Autonomous) Ernakulam for the regular post-graduate programme conducted by the College.
III. Every Programme conducted under Credit Semester System shall be monitored by the College Council.

1. Important definitions
Programme - Tthe entire course of study and examinations.
Duration of Programme - duration of post-graduate programme shall be of 4 semesters.
Semester - 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.
Academic week - a unit of 5 working days in which distribution of work is organized from day 1 to day 5, with 5 contact hours of 1 hour duration in each day. A sequence of 18 such academic week constitutes a semester.
Zero semester - a semester in which a student is permitted to opt out due to unforeseen genuine reasons. **Course** - a segment of subject matter to be covered in a semester. Each Course is designed variously under lectures/tutorials/laboratory or fieldwork/seminar/project/practical training/ assignments/evaluation etc., to meet effective teaching and learning needs.
Credit (Cr) - of a course is a measure of the weekly unit of work assigned for that course in a semester. **Course Credit** - One credit of the course is defined as a minimum of one hour lecture/minimum of 2 hours lab/field work per week for 18 weeks in a Semester. The course will be considered as completed only by conducting the final examination. No regular student shall register for more than 24 credits and less than 16 credits per semester. The total minimum credits, required for completing a PG programme is 80.
Programme Core course - 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. **Programme Elective course** - a course, which can be substituted, by equivalent course from the same subject and a minimum number of courses is required to complete the programme.
Programme Project - 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 research center in order to submit a dissertation on the project work as specified.
Tutorial - a class to provide an opportunity to interact with students at their individual level to identify the strength and weakness of individual students.
Seminar - 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.
Evaluation - every student shall be evaluated by 25% internal assessment and 75% external assessment. **Repeat course** - a course that is repeated by a student for having failed in that course in an earlier registration.
Improvement course - a course registered by a student for improving his performance in that particular course.
Audit Course - a course for which no credits are awarded
Department - any teaching Department offering a course of study approved by the University in a college as per the Act or Statute of the University.
Parent Department - the Department which offers a particular post graduate progrramme.
Department Council - the body of all teachers of a Department in a College.

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

Course Teacher - the teacher who is taking classes on the course.
College Co-ordinator - a teacher from the college nominated by the College Council to look into the matters relating to MGU-CSS-PG System
Letter Grade or simply, **Grade** - in a course is a letter symbol (A, B, C, D, E) which indicates the broad level of performance of a student in a course.
Each letter grade is assigned a **'Grade point' (G)** which is an integer indicating the numerical equivalent of the broad level of performance of a student in a course.
Credit point (P) - of a course is the value obtained by multiplying the grade point (G) by the Credit (Cr) of the course P = G x Cr.
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 decided by the university.
Weight - a numerical measure quantifying the comparative range of an answer or the comparative importance assigned to different components like theory and practical, internal and external examinations, core and elective subjects, project and viva-voce etc.
Weighted Grade Point - is grade points multiplied by weight.
Weighted Grade Point Average (WGPA) - an index of the performance of a student in a course. It is obtained by dividing the sum of the weighted Grade Points by the sum of the weights of the grade points. WGPA shall be obtained for CE (Continuous evaluation) and ESE (End semester evaluation) separately and then the combined WGPA shall be obtained for each course.
Grade Point Average (GPA) - an index of the performance of a student in a course. It is obtained by dividing the sum of the weighted grade point obtained in the course by the sum of the weights of Course. **Semester Grade point average (SGPA)** - the value obtained by dividing the sum of credit points (P) 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.
Cumulative Grade point average (CGPA) - 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.
Grace Grade Points - grade points awarded to course/s, as per the choice of the student, in recognition of meritorious achievements in NCC/NSS/Sports/Arts and cultural activities.

2. Programme structure

10. The programme includes two types of courses, **Program Core (PC)** courses and **Program Elective (PE)** Courses. There shall be a **Program Project (PP)** with dissertation to be undertaken by all students. The Programme also includes **assignments**, **seminars/practical** and **viva**.
11. There are **3 PE courses** for M Sc Botany programme for the choice of students subject to the availability of facility and infrastructure in the institution and the selected one will be the subject of specialization of the programme.
12. Project work shall be completed by working outside the regular teaching hours. Project work shall be carried out under the supervision of a teacher in the concerned department. A candidate may, however, in certain cases be permitted to work on the project in an industrial/Research Organization on the recommendation of the supervisor.
13. There should be an internal assessment and external assessment for the project work. The external evaluation of the Project work is followed by presentation of work including dissertation and Viva-Voce. The title and the credit with grade awarded for the program project should be entered in the grade card issued by the university.

1. **Assignments**: Every student shall submit one assignment as an internal component for every course with a weightage one. The Topic for the assignment shall be allotted within the 6th week of instruction.
2. **Seminar Lectures** - Every student shall deliver one seminar lecture as an internal component for every course with a weightage two. 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.
3. Every student shall undergo at least two class tests as an internal component for every course with a weightage 1 each. The weighted average shall be taken for awarding the grade for class tests.
4. The attendance of students for each course shall be another component of internal assessment as prescribed with weightage one.
5. No course shall have more than 4 credits.
6. Comprehensive Viva-voce shall be conducted at the end semester of the program. Comprehensive Viva-Voce covers questions from all courses in the programme.

3. Attendance

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 University.
2. If a student represents his/her institution, 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 Department and Principal of the College concerned.
3. A student who does not satisfy the requirements of attendance shall not be permitted to take the end semester examinations.

4. Registration/duration

1. The duration of PG programmes shall be 4 semesters. The duration of each semester shall be 90 working days. Odd semesters from June to October and even semesters from December to April. There will be one month semester breaks each in November and May.
2. A student may be permitted to complete the programme, on valid reasons, within a period of 8 continuous semesters from the date of commencement of the first semester of the programmes.

5. Admission

(a)The admission to all PG programmes shall be as per the rules and regulations of the MGUniversity/ St. Albert's College (autonomous). The eligibility criteria for admission shall be as announced by the College/University from time to time. Separate rank lists shall be drawn up for reserved seats as per the existing rules. The college shall make available to all students admitted a prospectus listing all the courses offered, including programme elective during a particular semester. The information provided shall contain title of the course and credits of the course.
(b) There shall be a uniform academic and examination calendar prepared by the University/ college for the conducing the programmes. The University shall ensure that the calendar is strictly followed.

6. Admission requirements

2. Candidates for admission to the first semester of the PG programme through CSS 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 Mahatma Gandhi University as equivalent thereto.
3. The candidate must forward the enrollment form to the Controller of Examinations of the University through the Head of the Institution, in which he/she is currently studying.

1. 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.
2. Students admitted under this programme are governed by the Regulations in force.

7. Promotion

A student who registers for the end semester examination shall be promoted to the next semester.

8. Examinations

1. There shall be University examination at the end of each semester.
2. Practical examinations shall be conducted by the college at the end of each semester.
3. Project evaluation and viva-voce shall be conducted at the end of the programme only.
4. Practical examination shall be conducted by one external examiner and one internal examiner. Specimens for the practical examinations shall be supplied entirely by the external examiner. Valuation of the answer scripts shall be done by both examiners in the centre itself. Project evaluation and viva-voce shall be conducted by two external examiners and one internal examiner.
5. End-Semester Examinations: The examinations shall normally be at the end of each semester. There shall be one end-semester examination of 3 hours duration in each lecture based course and practical course.
6. A question paper may contain short answer type/annotation, short essay type questions/problems and long essay type questions. Different types of questions shall have different weightage to quantify their range. Weightage can vary from course to course depending on their comparative importance, but a general pattern may be followed by the Board of Studies.

9. Evaluation and grading

Evaluation: The evaluation scheme for each course shall contain two parts; (a) **internal evaluation** and

1. **External evaluation**. 25% weightage shall be given to internal evaluation and the remaining 75% to external evaluation and the ratio and weightage between internal and external is 1:3. Both internal and external evaluation shall be carried out using direct grading system.

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

Table 1. Components of Internal Evaluation:

Component	Weightage
(i) Assignment	1
(ii) Seminar	2
(iii) Attendance	1
(iv) Two Test papers	2

Table 2. Grade points:

Letter Grade	Performance	Grade point (G)	Grade Range
A	Excellent	4	3.5 to 4.00
B	Very Good	3	2.5 to 3.49
C	Good	2	1.5 to 2.49
D	Average	1	0.5 to 1.49
E	Poor	0	0.0 to 0.49

Table 3. Grades for Attendance:

% of attendance	Grade
> 90%	A
Between 85 and 90	B
Between 80 and below 85	C
Between 75 and below 80	D
< 75	E

Table 4. Assignment: grading components:

Component	Weight
(i) Punctuality	1
(ii) Review	1
(iii) Content	2
(iv) Conclusion	1
(v) Reference	1

Table 5. Seminar: grading components:

Component	Weight
(i) Area/Topic selected	1
(ii) Review/Reference	1
(iii) Content	2
(iv) Presentation	2
(v) Conclusion	1

Table 6. Practical: Internal assessment components:

Component	Weight
(i) Attendance	1
(ii) Laboratory involvement	2
(iii) Written/Lab test	2
(iv) Record	2
(v) Viva voce/Quiz	1

Table 7. Project evaluation: Internal assessment components:

Component	Weight
(i) Punctuality	1
(ii) Experimentation/Data collection	1
(iii) Compilation	1
(iv) Content	1

Table 8. Project evaluation: External assessment components:

Component	Weight
(i) Area/Topic selected	1
(ii) Objectives	2
(iii) Review	1
(iv) Materials and methods	2
(v) Analysis	2
(vi) Presentation	2
(vii) Conclusion/Application	2

1. To ensure transparency of the evaluation process, the internal assessment grade awarded to the students in each course in a semester shall be published on the notice board at least one

week before the commencement of external examination. There shall not be any chance for improvement for internal grade.

2. 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 University through the college Principal and a copy should be kept in the college for at least two years for verification.

(b) External evaluation: The external examination in theory courses is to be conducted by the University 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.

3. 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 prevailing in the University.

4. 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

Direct Grading System based on a 5-point scale is used to evaluate the performance (External and Internal Examination of students).

Table 9. Direct grading system: Grade points

Letter Grade	Performance	Grade point (G)	Grade Range
A	Excellent	4	3.5 to 4.00
B	Very Good	3	2.5 to 3.49
C	Good	2	1.5 to 2.49
D	Average	1	0.5 to 1.49
E	Poor	0	0.0 to 0.49

1. The overall grade for a programme for certification shall be based on CGPA with a 7-point scale given below:

Table 10. Overall grade: 7-point scale

CGPA	Grade
3.80 to 4.00	A+
3.50 to 3.79	A
3.00 to 3.49	B+
2.50 to 2.99	B
2.00 to 2.49	C+
1.50 to 1.99	C
1.00 to 1.49	D

1. A separate minimum of C Grade for internal and external are required for a pass for a course. For a pass in a programme, a separate minimum grade C is required for all the courses and must score a minimum CGPA of 1.50 or an overall grade of C and above.

2. Each course is evaluated by assigning a letter grade (A, B, C, D or E) to that course by the method of direct grading. The internal (weightage = 1) and external (weightage = 3)

components of a course are separately graded and then combined to get the grade of the course after taking into account of their weightage.

3. A separate minimum of C grade is required for a pass for both internal evaluation and external evaluation for every course.

4. A student who fails to secure a minimum grade for a pass in a course will be permitted to write the examination along with the next batch. There will be no supplementary examination.

5. 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 1.50. However, a student is permitted to move to the next semester irrespective of her/his SGPA. For instance, if a student has registered for 'n' courses of credits C1, C2 ……, Cn in a semester and if she/he has scored credit points P1, P2……., Pn respectively in these courses, then SGPA of the student in that semester is calculated using the formula, SGPA = (P1 + P2 +…….+ Pn)/(C1 + C2 +……+ Cn)

CGPA = [(SGPA)1 x S1 + (SGPA)2 x S2 + (SGPA)3 x S3 + (SGPA)4 x S4]/ (S1+ S2 + S3 + S4) Where S1, S2, S3, and S4 are the total credits in semesters 1, 2, 3 and 4 respectively.

11. Pattern of questions

1. Questions shall be set to assess knowledge acquired, standard 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.

2. Weight: Different types of questions shall be given different weights to quantify their range as follows:

Table 11. Question paper pattern:

Sl. No.	Type of questions	Weight	No. of questions to be answered
1.	Short answer type questions	1	6 out of 8
2.	Short essay (problem solving type questions)	2	7 out of 10
3.	Long essay type questions	5	2 out of 3

12. Grade card

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

3. Name of the University.
4. Name of college.
5. Title of the PG Programme.
6. Name of Semester.
7. Name and Register Number of students.
8. Code number, Title and Credits of each course opted in the semester, Title and Credits of the Project Work.
9. Internal, external and Total grade, Grade Point (G), Letter grade and Credit point (P) in each course opted in the semester.
10. The total credits, total credit points and SGPA in the semester.

The Final Grade Card issued at the end of the final semester shall contain the details of all courses taken during the entire programme including those taken over and above the prescribed

minimum credits for obtaining the degree. The Final Grade Card shall show the CGPA and the overall letter grade of a student for the entire programme.

13. Award of degree

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

14. Monitoring committee

There shall be a Monitoring Committee constituted by the Vice-chancellor to monitor the internal evaluations conducted by institutions. 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.

15. Grievence redressal committee

1. College level: The College shall form a Grievance Redress Committee in each Department comprising of course teacher and one senior teacher as members and the Head of the Department as Chairman. The Committee shall address all grievances relating to the internal assessment grades of the students. There shall be a college level Grievance Redress Committee comprising of Faculty advisor, two senior teachers and two staff council members (one shall be an elected member) and the Principal as Chairman.
2. University level: The University shall form a Grievance Redress Committee as per the existing norms.

Table 12. Programme courses, Teaching hours and Credit distribution: Total credits – 80

Semester	Course	Teaching Hours/Week	Credit	Total credits
I	PC-1	4	4	19
	PC-2	4	4	
	PC-3	4	4	
	PC-4	3	3	
	Practical (Pr. 1 + Pr. 2)	10	4	
II	PC-5	4	4	19
	PC-6	4	4	
	PC-7	4	4	
	PC-8	3	3	
	Practical (Pr. 3 + Pr. 4)	10	4	
III	PC-9	4	4	19
	PC-10	4	4	
	PC-11	4	4	
	PC-12	3	3	
	Practical (Pr. 5 + Pr. 6)	10	4	
IV	PE-1	5	4	23
	PE-2	5	4	
	PE-3	5	4	
	Practical (Pr. 7 + Pr. 8)	10	4	
	Project	-	4	
	Viva-Voce	-	3	

A. Consolidation of grades for internal evaluation

If B, C, B, and A grades are scored by a student for attendance, assignment, seminar and test paper respectively for a particular course, then her/his CE for that course shall be consolidated as follows:

Table 13. Internal evaluation: Consolidation of grades (Theory)

Component	Weight (W)	Grade awarded	Grade point (G)	Weighted Grade Points (W x G)

Attendance	1	B	3	3
Assignment	1	C	2	2
Seminar	2	B	3	6
Test paper	2	A	4	8
Total	6			19

Grade: Total weighted grade points/Total weights = 19/6 = 3.16 = Grade B

The components are defined for internal evaluation of practical work and their weights are given (Table 6). If B, A, C, B and C grades are scored by a student for attendance, Laboratory involvement, Test, Record and Viva-voce respectively for a particular course, then her/his CE for that course shall be consolidated as follows:

Table 14. Internal evaluation: Consolidation of grades (Practical)

Component	Weight (W)	Grade awarded	Grade point (G)	Weighted Grade Points (W x G)
Attendance	1	B	3	3
Laboratory involvement	2	A	4	8
Written/Lab test	2	C	2	4
Record	2	B	3	6
Viva-voce/Quiz	1	C	2	2
Total	8			23

Grade: Total weighted grade points/Total weight = 23/8 = 2.88 = Grade B

The grade of an answer paper (ESE Practical) shall be consolidated by similar procedure discussed above by assigning weights for the various components. (E.g., Procedure, Preparation, Experiment, Identification, Calculation, Accuracy of the reported values, Presentation of results, Diagrams, etc). The components identified and weights assigned for different practical examinations are given in the practical model question papers accompanying this syllabus.

B. Consolidation of grades for external (one answer paper - Theory)

The external evaluation of theory courses shall be consolidated as given below in Table 15 with different grades awarded to various questions.

Table 15. Model evaluation sheet and Grade Calculation:

Type of question	Question Nos.	Grade awarded	Grade points	Weightage	Weighted Grade Points
Short answer	1	B	3	1	3
	2	-	-	-	0
	3	A	4	1	4
	4	D	1	1	1
	5	-	-	-	0
	6	A	4	1	4
	7	B	3	1	3
	8	B	3	1	3
Short essay	9	B	3	2	6
	10	C	2	2	4
	11	-	-	-	0
	12	-	-	-	0
	13	B	3	2	6
	14	A	4	2	8
	15	C	2	2	4
	16	-	-	-	0
	17	C	2	2	4
	18	B	3	2	6
Long essay	19	-	-	-	0
	20	B	3	5	15
	21	D	1	5	5
Total				30	76
Calculation : Overall grade of an answer paper = sum of weighted grade points/ sum of the weightage = 76/30 = 2.53 = Grade B					

C. Consolidation of the grade of a course:

The grade for a course is consolidated by combining the ESE and CE grades taking care of their weights. For a particular course, if the grades scored by a student are C and B respectively for the external and the continuous evaluation, as shown in the above examples, then, the grade for the course shall be consolidated as follows:

Table 16. Consolidation of course grade

Examination	Weight	Grade awarded	Grade points (G)	Weighted Grade point (W x G)
External	3	C	2	6
Internal	1	B	3	3
Total	4			9
Grade of a course (GPA)	**Total weighted grade points/Total weights = 9/4 = 2.25 = Grade C**			

D. Consolidation of SGPA

SGPA is obtained by dividing the sum of credit points (P) obtained in a semester by the sum of credits (C) taken in that semester. After the successful completion of a semester, Semester Grade Point Average (SGPA) of a student in that semester shall be calculated using the formula given. In M Sc Botany programme, a student takes three courses each of 4 credits, one course of 3 credits and 2 practical courses each of 2 credits in the I, II, and III semesters. However, the IV semester has a different combination of courses and credits as explained below. After consolidating the grade for each course as demonstrated above, SGPA is consolidated as follows:

Table 17. Consolidation of SGPA for Semesters I, II, III.

Course code	Title of course	Credit (C)	Grade awarded	Grade points (G)	Credit Points (P = C x G)
01	--	4	A	4	16
02	--	4	C	2	8
03	--	4	B	3	12
04		3	B	3	9
05	--	2	C	2	4
06	--	2	B	3	6
Total		19			55
SGPA	**Total credit points/ Total credits = 55/19 = 2.89 = Grade B**				

Table 18. Consolidation of SGPA for Semester IV.

Course code	Title of course	Credit (C)	Grade awarded	Grade points (G)	Credit Points (P = C x G)
01	--	4	A	4	16
02	--	4	C	2	8
03	--	4	B	3	12
04	--	2	C	2	4
05	--	2	B	3	6
06	Project	4	B	3	12
07	Viva	3	A	4	12
Total		23			70
SGPA	**Total credit points/ Total credits = 70/23 = 3.04 = Grade B**				

E. Consolidation of CGPA

If the candidate is awarded two A grades, one B Grade and one C Grade for the four semesters and has 80 credits, the CGPA is calculated as fallows.

Table 19. Consolidation of CGPA

Semester	Credit taken	Grade	Grade point	Credit points
I	19	A	4	76
II	19	A	4	76
III	19	B	3	57
IV	23	C	2	46
Total	80			255
CGPA	**Total credit points/ Total credits = 255/80 = 3.18 (which is between 3.00 and 3.49 in 7 point scale). The overall grade awarded is B+**			

SEMESTERWISE DISTRIBUTION OF COURSES AND CREDITS

SEMESTER I				
Course	**Title**	**Teaching hrs Theory**	**Teaching hrs Practical**	**Credits**
PC 1	Microbiology + Phycology	27 + 45	9 + 36	4
PC 2	Mycology + Crop Pathology	36 + 36	36 + 18	4
PC 3	Bryology + Pteridology	36 + 36	18 + 36	4
PC 4	Gymnosperms+Paleobotany+Evolution	27+09+18	27	3
Pr. 1	Practicals of PC 1 + PC 2			2
Pr. 2	Practicals of PC 3 + PC 4			2
SEMESTER II				
PC 5	Plant Anatomy + Developmental Biology +Horticulture	36+ 18 + 18	27+ 9+ 9	4
PC 6	Cell Biology+Genetics+Plant Breeding	27+27+18	18+18+9	4
PC 7	Plant Physiology + Biochemistry	45+ 27	36+ 27	4
PC 8	Molecular Biology	54	18	3
Pr. 3	Practicals of PC 5 + PC 6			2
Pr. 4	Practicals of PC 7 + PC 8			2
SEMESTER III				
PC 9	Research Methodology + Microtechnique + Biostatistics +Biophysical instrumentation	18+18+18+18	9 + 27 + 09 +18	4
PC 10	Biotechnology ,Bioinformatics and bionanotechnology	72	36	4
PC 11	Angiosperm Taxonomy, Economic Botany and Ethnobotany	72	36	4
PC 12	Environmental Sciences	54	27	3
Pr. 5	Practicals of PC 9 + 10			2
Pr. 6	Practicals of PC 11 + 12			2
SEMESTER IV				
PE 1	Plant tissue Culture and microbial Biotechnology	90	72	4
PE 2	Genetic engineering, genome editing and immunology	90	72	4
PE 3	Genomics, Transcriptomics, Proteiomics and Bioinformatics	90	72	4
Pr. 7	Practicals of PE 1			4
Pr. 8	Practicals of PE 2 + PE 3			
	Project			4
	Viva			3

SEMESTER I

FIRST SEMESTER COURSES

Course code	*Name of the Course*
PBT1 CRT0119	MICROBIOLOGY AND PHYCOLOGY
PBT1 CRT0219	MYCOLOGY AND CROP PATHOLOGY
PBT1 CRT0319	BRYOLOGY AND PTERIDOLOGY
PBT1 CRT0429	GYMNOSPERMS, PALEOBOTANY AND EVOLUTION
PBT1 CR**P**0119	MICROBIOLOGY, PHYCOLOGY, MYCOLOGY AND CROP PATHOLOGY- **PRACTICAL**
PBT1 CR**P**0219	BRYOLOGY, PTERIDOLOGY, GYMNOSPERMS, AND PALEOBOTANY - **PRACTICAL**

Total Credits: 19
Total Hours: 450

Course-1: PBT1CRT0119- MICROBIOLOGY & PHYCOLOGY

No. of Credits- 4
No. of Contact Hours: Theory 27+ 45= 72 hrs; Practicals 9+36=45hrs)

Course Overview and Context:

This course is designed and visualizes to enables the learner to understand the biodiversity of the lower life forms like microbes and algae. The first six modules of this course deals with the basic aspects of microbiology and aims in studying the classification of microbes especially bacteria and viruses, their diversity and activity in their natural environment, plant microbe interactions, the activity of microbes in their natural environment, their mutual interactions, survival and adaptation strategies with special emphasis on pathogenic microbes. The next four modules deal with the study of algae, their habitats, their ecological and economic importances.

Course objectives and Out come:

(i) To understand and have a comprehensive idea on the major groups of microbes such as bacteria, viruses and algae, their classification, occurrence, reproduction and transmission/ distribution.

(ii) To know the utility (economic importance) of these microbes for human being directly or indirectly and also the role of microbes in ecosystem services (environmental importances).

(iii) The student will be able to acquint with latest developments and practical skills in microbiological techniques and also can take precautionary measures in the case of pathogenic microbes.

(iv) The course will also enables the students in making themselves as amaeuter or professional microbiologist/ phycologist in future and also leads them to research areas.

PBT1CRT0119 : Microbiology and Phycology
(Theory 27+45=72 Hrs; Practical 9+36=45Hrs)Credits-4

MICROBIOLOGY (27 hrs)

Module 1: Introduction to microbiology (2 hrs)

Milestones in microbiology, Microbial taxonomy and phylogeny - Major groups and their characteristics (Five kingdom system and three domain system of classification).

Module 2: Bacteria (7 hrs)

Bacterial morphology. Classification of Bacteria according to Bergey's manual of systematic bacteriology (Brief study up to family). Ultra structure of Gram positive and Gram negative bacteria; cell membrane, cell wall, flagella, pili, fimbriae, capsule and slime, ribosome and endospores. Major groups of Bacteria: Nanobes, VBNC, Spirochetes, Rickettsias, Chlamydias, Mycoplasmas, Actinomycetes, Myxobacteria, Archaebacteria (general account only). Etremophiles - thermophilic, halophilic, acidophilic and alkalophilic bacteria. Nutritional types, Bacterial genome chromosome, plasmids-types of plasmids-R plasmids, Col plasmids and F plasmids

Module 3: Bacterial systematics (4 hrs)

Systematic identification of bacteria: Phenotypic-Morphology, Motility, Colony characters, Biochemical tests (Tests for carbohydrates, proteins and enzymes). Molecular techniques for the identification of bacteria-16S rRNA sequencing. A brief account on metagenome analysis for the identification of non-culturable microbes.

Module 4: Culture of microorganisms (4 hrs)

Sterilization techniques in microbiology-physical and chemical methods (Physical-dry heat and moist heat, radiation, filter sterilization; Chemical-commonly used surface sterilant), Disinfection; Methods of isolation of pure cultures. Types of culture media. Enrichment culturetechniques. Maintenance and preservation of pure cultures.

Module 5: Plant–Microbe interactions (2 hours)
Brief study on endophytes- bacteria and fungi, their role in plant growth promotion and secondary metabolite production.

Module 6: Viruses (8 hrs)
Nomenclature and classification-types of viruses-DNA and RNA Viruses, properties of viruses, morphology (symmetry) of viruses; Capsid and their arrangements; types of envelops and their composition, Viral genome. Structure of bacteriophages belonging to 'T' series- ultra structure of TMV. Viral replication: Lytic and Lysogenic cycles - Lytic cycle in T even phages, and lysogeny in lambda phage. Sub viral particles - prions, viroids, virusoids (brief description only).

Practical (9 hrs)

Preparation and sterilization of microbial culture media -Nutrient broth and nutrient agar
Inoculation of bacteria-stabbing and streaking
Differential staining of bacteria using Gram stain.
Endospore staining
Isolation of Rhizobium from root nodules.
Isolation of microbes from soil: Serial dilution - pour plate/spread plate method.
Streak out a bacterial culture on an agar plate and isolation of colonies –Quadrant streaking method, Antibacterial assay - disc diffusion/agar well method.

References

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(xvii) Willey, Presscot's Microbiology IXth Edition
(xviii) Salle A J (1978). *Fundamentals of Bacteriology*. Asia TMH
(xix) Dubey R C, Maheswari D K (2004). *Microbiology*. S Chand.
(xx) Sharma P D (2003). *Microbiology*. Restogi pub.
(xxi) F H Kayser, K A Bienz, J Eckert, R M Zinkernagel. *Medical Microbiology.*
(xxii) L R Haahelm, J R Pattison, R J Whitley. *Clinical virology.*

(xxiii) Thandavarayan Ramamurthy, Amit Ghosh, Gururaja P. Pazhani, and SumioShinoda Current Perspectives on Viable but Non-Culturable (VBNC) Pathogenic Bacteria. Frontiers in Public Health, 2014; 2: 103.
(xxiv) Nanobes and Nanobacteria -SERC. https://serc.carleton.edu/microbelife/topics/nanobes /index.html

Phycology (45 hrs)

Module 7: Introduction (4 hrs)

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

Module 8: General features of Algae (27 hrs)

Habit, habitat and distribution of Algae. Major characteristics of Cyanophyceae, Chlorophyceae, Xanthophyceae, Bacillariophyceae, Dinophyceae, Phaeophyceae and Rhodophyceae. Range of thallus structure. Algal components: Cell wall, flagella, eye-spot, pigments, pyrenoid, photosynthetic products. Reproduction in algae: Vegetative, asexual and sexual reproduction (development of sex organs not necessary). Major patterns of life cycles in algae and post fertilization stages in Phaeophyceae and Rhodophyceae. Algae and fossil records, special reference to India; a short description on *Rafatazmia chitrakootensis*

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

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

Module 10: Algal biotechnology (5 hrs)

Methods and techniques of collection, preservation and staining of Algae. Algal culture:Importance, methods; Algal culture media (Walne's medium)

Practical (36 hrs)

3. Critical study of diagnostic features and identification of the following genera based onmorphological, anatomical and reproductive parts;

(a) Cyanophyceae - *Gleotrichia, Spirulina, Microcystis, Oscillatoria, Lyngbya, Anabaena, Nostoc, Rivularia, Scytonema*.

(c) Chlorophyceae - *Chlamydomonas, Volvox, Ecballocystopsis, Ulothrix, Microspora, Ulva,Cladophora, Pithophora. Coleochaeta, Chaetophora, Drapernaldia, Trentepohlia, Fritschiella, Cephaleuros, Oedogonium, Bulbochaete, Zygnema, Mougeotia, Sirogonium, Desmedium, Bryopsis, Acetabularia, Codium, Caulerpa, Halimeda, Chara, Nitella*.

(d) Xanthophyceae – *Vaucheria*.

(e) Bacillariophyceae –O*dontella, Navicula*.

(f) Phaeophyceae - *Ectocarpus, Colpomenia, Hydroclathrus, Dictyota, Padina, Sargassum, Turbinaria*.

(g) Rhodophyceac - *Brtrachospermum, Gelidium, Amphiroa, Gracilaria, Polysiphonia*.

4. Students are to collect and identify algae from different habitat. Prepare and submit a report of the field work with sufficient photographs of algal collection.

References

1. Andersen R A (Ed) 2004. *Algal Culturing Techniques*, Elsevier.
2. Bellinger E.G Sigee D C. (2015*). Freshwater Algae Identification, Enumeration and use as Bioindicators.* John Wiley and Sons Ltd.
3. Bold H C, Wynne M J (1978). *Introduction to Algae: Structure and reproduction*. Prentice Hall.
4. Borowitzka M A, Beardall J, Raven J H (2016). The physiology of microalgae. Springer.
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Course-1: PBT1CRT0219- MYCOLOGY & CROP PATHOLOGY

No. of Credits- 4

No. of Contact Hours: Theory 36+ 36= 72 hrs; Practicals 36+18=56hrs)

Course Overview and Context:
This course is designed to learn about the fascinating world of fungi, their biology, importance and impacts they have on humans and natural ecosystems. The modules of crop pathology deal with the biotic and abiotic agents responsible for disease development, their management strategies. Students will have a first hand information on selected plant diseases, their causative agents like bacteria, viruses, fungi and nematodes. This course will help in designing future mycologists and research aptitude in mycological research.

Course objectives and Out come:

1. The course in mycology and crop pathology will help to introduce the history and definition on mycology, crop pathology to the incumbents.
2. To provide students with opportunities to develop basic methods in mycological studies and hands on studies on fungal culture and isolation methods.
3. To develop concise overview of basic concepts and principles in the biology of plant pathogens and pests including disease epidemiology and disease management.

PBT1CRT0219 **MYCOLOGY AND CROP PATHOLOGY**

(Theory 36 + 36 = 72 Hrs; Practical 36 + 18 = 56 Hrs) Credits 4

MYCOLOGY (36 hrs)

Module 1: General introduction (2 hrs)

General characters of Fungi and their significance. Principles of classification of fungi, Classifications by C J Alexopoulos and Mims(1979)

Module 2: Thallus structure and reproduction in Fungi (27 hrs)

Mycelial structure and reproduction of Myxomycota – Acrasiomycetes,(Brief introduction only)Hydromyxomycetes, (Brief introduction only) Myxomycetes, Plasmodiophoromycetes. Mastigomycotina - Chytridiomycetes, (Brief introduction only) Hyphochytridiomycetes(Brief introduction only) 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 Fungal Physiology (5 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 - Mycoparasite, mycoherbicide.

Module 4 : Physiology of Fungi (2hrs)

Fungal Metabolic pathways, Secondary metabolic pathways, Mycotoxins Aflatoxins, Amatoxin, Ergot, Fusarin (general account) Antibiotics (Brief introduction only)

Practical (36 hrs)

1. Critical study of the following types by preparing suitable micropreparations; *Stemonitis, Physarum, Saprolegnia, Phytophthora, Albugo, Rhizopus, Aspergillus, Penicillium, Pilobolous, Saccharomyces, Xylaria, Peziza, Phyllochora, Puccinia, Termitomyces, Pleurotus, Auricularia, Polyporus, Lycoperdon, Dictyophora, Geastrum, Cyathus, Fusarium, Alternaria, Pestalotia, Parmelia,Graphis , Usnea, Cladonia.*
2. Isolation of fungi from soil and water by culture plate technique.
3. Staining and microscopicstudy of mycorrhizal colonization in root
4. Collection and identification of common field macro fungi/lichen (10 types).Submit report with photographs

References

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CROP PATHOLOGY (36 hrs)

Module 1: Introduction to crop pathology (2 hrs)

Classification of plant diseases based on; Major causal agents - biotic and abiotic, General symptoms.

Module 2: Process of infection and pathogenesis (4 hrs)

Penetration and entry of pathogen into host tissue – mechanical, physiological and enzymatic. Host-parasite interaction, enzymes and toxins in pathogenesis.

Module 3: Defense mechanism in plants (4 hrs)

Pre-existing structural and biochemical defense mechanisms, lack of essential nutrients. Induced structural and biochemical defense mechanisms, Inactivation of pathogen enzymes and toxins. Altered biosynthetic pathways. Phytoalexins.

Module 4: Transmission of plant disease (3 hrs)

Spread and transmission of plant diseases by wind, water, seeds and vectors.

Module 5: Plant disease management (8 hrs)

Exclusion, eradication and protection. Chemical means of disease control – common fungicides, antibiotics and nematicides. Biological means of disease control.Biotechnological approaches to disease resistance: Fungi in agricultural biotechnology, control of fungal plant pathogens by mycofungicides. Transgenic approaches to disease resistance.

Module 6: Major diseases in plants (15 hrs)

Cereals: Rice - blast disease, bacterial blight; Wheat - black stem rust disease. Vegetables: Chilly

- leaf spot; Ladies finger - vein clearing disease. Fruits: Banana - bacterial leaf blight, Bunchy top; Mango - Anthracnose; Citrus - bacterial canker; Papaya – mosaic. Spices: Ginger - rhizome rot; Pepper - quick wilt; Cardamom - marble mosaic disease. Oil seeds: Coconut - grey leaf spot, bud rot disease. Rubber yielding: *Hevea braziliensis* - abnormal leaf fall, powdery mildew. Sugar yielding: Sugarcane - red rot; root knot nematode. Cash crops: Arecanut –Mahali disease. Beverages: Tea - blister blight; Red rust; Coffee – leaf rust.

Practical (18 hrs)

1. Identify the diseases mentioned in the syllabus with due emphasis on symptoms and causative organisms by Herbarium/ live specimen.
2. Isolation of pathogens from diseased tissues (leaf, stem, fruit and seed) by blotter / culture methods.
3. Collection and preservation of specimens from infected plants. Submit 5 herbarium sheets/live specimens along with a report.
4. Culture media preparation and sterilization PDA/ Czapek dox’s medium

References

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2. Gareth Johnes. Plant pathology: principles and practice.
3. R S Mehrotra. Plant Pathology.
4. M N Kamat. Practical plant pathology.
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Course-3: PBT1CRT0319- BRYOLOGY & PTERIDOLOGY
No. of Credits- 4
No. of Contact Hours: Theory 36+ 36= 72 hrs; Practicals 18+36=54hrs)

Course Overview and Context:
This course is designed to enable the learner to familiarize the natural habitat and diversity of Bryophytes and Pteridophytes. The first four modules of this course deal with the general characters, thallus organization and classification of Bryophytes, their diversity, ecological and economic importance. The next five modules deal with the study of Pterodophytes, their habitats, life cycle, and their ecological and economic importances.

Course objectives and Out come:

1. The student applies knowledge to identify the various Bryophyte and Pteridophyte specimens belonging to the various groups as mentioned in the syllabus.
2. The student realizes the difference between the life-cycles of homosporous and heterosporous Pteridophytes.
3. The student analyses how heterospory leads to seed habit in the higher plants.
4. The student understands the ecological and economic importance of Bryophytes and Pteridophytes.

PBT1CRT0319 **: BRYOLOGY AND PTERIDOLOGY**

(Theory 36 + 36 = 72 Hrs; Practical 18 + 36= 54 Hrs) Credits: 4

Module 1: Introduction (4hrs)

Diversity in forms habit and habitat. Origin and evolution of bryophytes. Trends in classification of Bryophytes: traditional and modern systems of classification (Rothmaler1951, Goffinet *et al* 2008) Contributions of Indian bryologists (Shiv Ram Kashyap, SK Pande, SC Srivastava). Fossil bryophytes.

Module 2: Ecological significance of bryophytes (3hrs)

Ecological significance of bryophytes with special reference on environmental monitoring. Water relations and regeneration techniques. Symbiotic associations of bryophytes.

Module 3: Economic importance of bryophytes (3hrs)

Economic importance of bryophytes.Cultivation and conservation of bryophytes *with* special note on *In vitro* culture techniques of bryophytes (brief description only).

Module 4: General characters and thallus organization (26 hrs)

General characters and comparative account of sporophyte, gametophyte, their interrelationships, spore dispersal mechanisms of following orders with reference to the types mentioned in the practical (development of sex organs not necessary).Hepaticopsida (Sphaerocarpales, Marchantiales, Jungermanniales and Calobryales)Anthocerotopsida (Anthocerotales).Bryopsida (Sphagnales, Polytrichales and Bryales).

Practical (18 hrs)

1. Detailed study of the structure of gametophytes and sporophytes of the following genera of Bryophytes by suitable micropreparation: *Riccia, Targionia, Cyathodium, Marchantia, Lunularia,Dumortiera, Reboulia, Pallavicinia, Porella, Anthoceros, Notothylas, Sphagnum, Pogonatum*.
2. Students are expected to submit a report of field trip to bryophytes natural habitats to familiarize with the diversity of bryophytes.

References

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PTERIDOLOGY (36hrs)

Module 1: General introduction (2 hrs)

Introduction, general characteristics and origin of Pteridophytes(Anthocerotan theory and algal origin)

Module 2: Classification and evolution of Pteridophytes (9 hrs)

Classification by Smith (1955), Zimmermann (1959) and a brief account of classification by pteridophyte phylogeny Group – PPG-2016 (up to order).Evolution: Telome theory, Stelar evolution in pteridophytes.Heterospory and seed habit in pteridophytes.

Module 3: Structure of the plant body (20 hrs)

Distribution, habitat, morphology,anatomy of sporophytic and gametophytic generation and reproduction of the following classeswith reference to the genera mentioned (development of sex organs is not necessary).
Division: Psilophyta.
Class-Psilophytopsida,
Order – Psilophytales-Rhynia
Class-Psilotopsida,
Order – Psilotales-Psilotum
Division: Lycophyta.
Class- Eligulopsida,
Order lycopodials-Lycopodium
Class- Ligulopsida
Order-Selaginellales-Selaginella
Order – Isoetales-Isoetes,
Order – Pleuromeiales-Pleuromeia
Order – Lepidodendrales-Lepidodendron, Lepidocarpon and Stigmaria
Division: Sphenophyta (Calamophyta)
Class- Sphenophyllopsida.
Order – Sphenophyllales-Sphenophyllum
Class-Calamopsida,
Order – Equisetales-Equisetum.
Division:Filicophyta.
Class- Eusporangiopsida
Order –Ophioglossales-Ophioglossum
Order – Marattiales-Angiopteris
Class- Protoleptosporangiopsida
Order – Osmundales-Osmunda
Class- Leptosporangiopsida
Order – Filicales-Pteris, Adiantum, Gleichenia and Lygodium
Order– Marsileales-Marsilea
Order – Salviniales-Salvinia and Azolla.
Class- Primopteropsida
Order – Cladoxylales-Cladoxylon
Order –Coenopteridiales

Module 4: Developmental studies in Pteridophytes (3 hrs)

Development of sporangium, mechanism of spore dispersal. Apogamy and apospory in pteridophytes.

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Module 5: Ecological and economic importance (2 hrs)

Ecological significances: Diversity of macro and micro habitats of Pteridophytes in the major ecosystems. Ecological roles by pteridophytes: stabilization of disturbed habitats, prevention of soil and nutrient leaching, micro-habitats for seed/spore germination. Economic importance of pteridophytes: General- as garden plants, as food/food supplements, as medicine, as other useful items. Pollution control phyto- remediation by ferns. Biofertilizer- *Azolla-Anabaena*-model.

Practical (36 hrs)

1. Study of morphology and anatomy of vegetative and reproductive organs using clear whole mounts/sections of the following genera:

   Lycopodium, Isoetes, Selaginella, Equisetum, Psilotum, Angiopteris, Ophioglossum, Osmunda, Marsilea, Salvinia, Azolla, Lygodium, Acrostichum, Gleichenia (Dicranopteris), Pteris and *Adiantum.*
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 submit a report.

References

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2. Arnold C R (1977). Introduction to Palaeobotany. McGraw Hill Book Com.
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4. Beddome C R H (1970). Ferns of southern India. Today & Tommorrows Publ.
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Course 4: PBT1CRT0419- GYMNOSPERMS, PALEOBOTANY & EVOLUTION
No. of Credits- 4
No. of Contact Hours: Theory 27+ 09+18= 54 hrs; Practicals 27hrs)

Course Overview and Context:
This course is designed to enable the learner to study the morphology and anatomy of vegetative and reproductive parts of various Gymnosperms. The first four modules of this course deal with the distribution, vegetative, reproductive structures, internal structure and classification of Gymnosperms, their diversity, ecological and economic importance. The next four modules deal with Paleobotany including Geological time scale, fossils their preservation methods. Next six modules discuss Evolution, natural selection, mutation and species concept.

Course objectives and Out come:

1. To enable students to identify Gymnosperms in field.
2. Provide an understanding about fossil Gymnosperms and their evolutionary significance.
3. Student understands the ecological and economic importance of Gymnosperms.
4. Student would be able to prepare suitable micropreparations.

PBT1CRT0419 : GYMNOSPERMS, PALAEOBOTANY AND EVOLUTION

(Theory: 27 + 09 + 18= 54 hrs; Practical: 27 hrs) Credits: 4

GYMNOSPERMS (27 hrs)

Module 1: Introduction (3 hrs)

General characteristics, distribution and classification of gymnosperms (K R Sporne). Brief account of classification by Christenhusz*et al.*, (2011). Distribution of living gymnosperms in India.

Module 2: Vegetative and reproductive structures of Gymnosperms (20 hrs)

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

Class Cycadopsida: *Lyginopteris, Lagenostoma, Glossopteris, Medullosa, Caytonia. Bennettites, Williamsonia, Pentoxylon,Cycas, Zamia.* Class Coniferopsida: General account of families under Coniferales, range of form and structure of stem, leaves. Range of form and structure of female cones in Coniferales -*Pinus*, *Cupressus, Podocarpus, Agathis, Araucaria, Taxus and Ginkgo*.Class Gnetopsida: *Gnetum*. General account of Ephedraceae and Welwitschiaceae

Module 3: Gametophyte development of Gymnosperms (2 hrs)

General account on the male and female gametophyte development in Cycas. Comparative study of male gametophytes of living Coniferales

Module4: Economic importance of Gymnosperms (2 hrs)
Economic importance of gymnosperms; pharmacological importance of *Ginkgo*

Practical (27 hrs)

1. Study the morphology and anatomy of vegetative and reproductive parts of *Cycas, Zamia, Pinus, Cupressus, Agathis, Araucaria, Podocarpus* and *Gnetum.*
   2. Study of fossil gymnosperms through specimens and permanent slides.
3. Conduct field trips to familiarize 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.
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19. Srivastava R C (2006). *Diversity, distribution and economic importance of living gymnosperms of India*. Punjab University Research Journal, 56:45-87.

PALEOBOTANY (Theory: 9 hrs; Practical: 9 hrs)

Module 1: Introduction (1 hr)

Evolutionary Time scale: Eras, Periods and Epochs (Including: Meghalayan, Northgrippian and Greenlandian ages).

Module 2: Fossils (3 hrs)

Fossils-Definition, types.Fossilization: mode of preservation and their importance. Stages in primate evolution-including *Homo*.

Module 3: Techniques and Preservation (3 hrs)

Techniques in Palaeontology: Mega and Micro-fossils, Nanofossils, Ichnofossils-collection.

Reformation and illustration- Binomial Nomenclature. Methods of Plant-fossil studies:

Preservation and preparation, age determination: Carbon dating.

Module 4: Nomenclature and applied aspects (2 hrs)

Fossil record: Systematic, reconstruction and nomenclature. Fossil records from India.
Applied aspects of Paleobotany.

References

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

EVOLUTION: (Theory: 18 hrs)

Module 1: Introduction (3 hrs)

Evolution of biomes. Mixing process, intercontinental connections. Climatic zonations, dispersal opportunities, dispersal availability, sub-climax and climax dispersal. Phylogeny and age of biomes: Interwoven biome phylogeny and biome extension and resurrection.

Module 2: Evidences for evolution (2 hrs)

Morphology, comparative anatomy, embryology, physiology,biochemistry, paleontology and biogeography. Micro and macro-evolution and punctuated equilibrium.

Module3: Natural Selection (3 hrs)

Natural selection and adaptation. Nature of natural selection, limiting factors, origin of races and species, Kins Selectionand Hamilton's Rule. Rate of evolutionary change: Internal and external-factors. Significance of genetic drift in natural selection.

Module 4: Mutation as an Evolutionary Force (3 hrs)

Mutation and genetic divergence. Evolutionary significance of mutations. Genetic assimilations (Baldwin effect). Genetic homoeostasis. Mutation for natural selection. Eugenics and euthenics.

Module 5: Speciation (3 hrs)

Species concept; morphological species, biological species and evolutionary species. Mode of speciation – allopatric, sympatric and parapatric. Types of Speciation-Phyletic and true-speciation. Hybridization (Double cross hybrid of field Corn); Rate of hybridization and introgression in evolution of species. Reproductive isolation: Pre-zygotic and post-zygotic isolation.

Module 6: Co-evolution (2 hrs)

Symbiosis. Plant-animal Co-evolution; mutualism, commensalism.Protective -colouration and shape. Mimicry: Batesian and Mullerian mimicry.Molecular tools in phylogeny.

References

1. Allan C. Hutchinson (2005). *Evolution and the Common Law*. Cambridge University Press.
2. Douglas J. Futuyma (2009). *Evolution*. Sinauer Associates. INC-Publishers. USA.
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4. Gurbachan S. Miglani (2002). *Modern Synthetic theory of evolution*.
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9. Kenneth V. Kardong (2005). *An introduction to Biological Evolution*. McGraw-Hill publications. New York.
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14. Roderic D. M. Page and Edward C. Holmes (1998). *Molecular Evolution: A Phylogenetic approach*. Blackwell Science Ltd.
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16. Victor Rico-Gray, Paulo S. Oliveira (2007). *The Ecology and Evolution of Ant-Plant Interactions*. University of Chicago Press.
17. Volpe E. Peter (1993). *Understanding Evolution*. Universal Book Stall, New Delhi.
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MODEL QUESTION PAPERS - THEORY

M. Sc. Botany Degree (C.S.S) Examination

I Semester

Faculty of Science

PBT1CRT0119 **: Microbiology and Phycology**
(2019 admissions onwards)

Time: Three hours **Max. Weight: 30**

Section- A

(Answer any **six** questions in not less than 50 words. Each question carries a weight of 1)

1. What is metagenomics?
2. Name two parasitic algae
3. Distinguish between valve and girdle of diatoms
4. Comment on nanobes
5. Define Palmelloid stage, cite an example
6. Mention the toxin and causative organism of Amnesic shell fish poisoning
7. Mention major groups and divisions of classification by Lee
8. How will you sterilize bacterial culture medium?

(6 x 1 = 6)

Section B

(Answer any **Seven** questionsin not less than 100 words. Each question carries a weight of 2)

9. Describe the thallus structure of Phaeophyceae
10. Describe the ultrastructure of bacterial flagella
11. Comment on algal symbiosis
12. Describe algal cell components
13. Give an account on various sterilization techniques in microbiology
14. Describe major life cycle patterns in Chlorophyceae
15. Explain allelopathy and microalgae
16. What are endophytes? Explain their role in plant growth promotion
17. Describe single cell proteins with special reference to algae.
18. Explain the methods of isolation of bacterial pure cultures.

(7 x 2 = 14)

Section C

(Answer any **two** questionsin not less than 250words. Each question carries a weight of 5)

19. Give a detailed account on isolation, maintenance and preservation of pure cultures of bacteria
20. Illustrate triphasic life cycle in algae with suitable examples
21. What are algal blooms? describe causative organisms, symptoms and toxins of major toxic algal blooms

(2 x 5 = 10)

MODEL QUESTION PAPERS - THEORY

M. Sc. Botany Degree (C.S.S) Examination

1 Semester

Faculty of Science

PBT1CRT0119**: Microbiology and Phycology**
(2019 admissions onwards)

Time: Three hours **Max. Weight: 30**

Section- A

(Answer any **six** questions in not less than 50 words. Each question carries a weight of 1)

1. What is metagenomics?
2. Name two parasitic algae
3. Distinguish between valve and girdle of diatoms
4. Comment on nanobes
5. Define Palmelloid stage, cite an example
6. Mention the toxin and causative organism of Amnesic shell fish poisoning
7. Mention major groups and divisions of classification by Lee
8. How will you sterilize bacterial culture medium?

(6 x 1 = 6)

Section B

(Answer any **Seven** questionsin not less than 100 words. Each question carries a weight of 2)

9. Describe the thallus structure of Phaeophyceae
10. Describe the ultrastructure of bacterial flagella
11. Comment on algal symbiosis
12. Describe algal cell components
13. Give an account on various sterilization techniques in microbiology
14. Describe major life cycle patterns in Chlorophyceae
15. Explain allelopathy and microalgae
16. What are endophytes? Explain their role in plant growth promotion
17. Describe single cell proteins with special reference to algae.
18. Explain the methods of isolation of bacterial pure cultures.

(7 x 2 = 14)

Section C

(Answer any **two** questionsin not less than 250words. Each question carries a weight of 5)

22. Give a detailed account on isolation, maintenance and preservation of pure cultures of bacteria
23. Illustrate triphasic life cycle in algae with suitable examples
24. What are algal blooms? describe causative organisms, symptoms and toxins of major toxic algal blooms

(2 x 5 = 10)

M. Sc. Botany Degree (C.S.S.) Examination

I Semester

Faculty of Science

PBT1 CRT0219: **Mycology and Crop Pathology**
(2019 admissions onwards)

Time: Three hours **Max. Weight: 30**

Section A

(Answer any **six** questions. Each question carries a weight of 1)

1. What is sclerotium?
2. What is crozier formation? Give example.
3. Describe the structure of basidium.
4. Distinguish between sporangium and conidium
5. Deuteromycetes are also known as fungi imperfecti. Why?
6. What is puckering?
7. What are the disseminating methods of Bacterial Canker in Citrus Spp.?
8. What are the symptoms of Bunchy top Banana?

(6 x 1 = 6)

SectionB

(Answer any **seven** questions. Each question carries a weight of 2)

9. Describe the structure of dolipore septa
10. Write short note on different type of fruiting bodies found in ascomycetes
11. Explain different type of conidial development in Duteromycetes
12. Describe the structure of spermagonium in *Puccinia graminis*
13. Illustrate the life cycle of *Physarum polycephalum*
14. Write short note on the Uredospore survival of *Puccina graminis tritici* in India
15. Writeshort note on the symptoms, causativeorganismand control measures of Mahali disease of Arecanut.
16. What are the resistant verities of paddy against Bacterial blight?
17. What is meant by horizontal resistance?
18. Describe coprophilous fungi with its adaptations? Give any two examples

(7 x 2 = 14)

Section-C

(Answer any **two** questions. Each question carries a weight of 5)

19. Describe the life cycle of *Puccinia graminis tritici*. with illustrations
20. Explain the classification of Fungi by C. J. Alexopoulos and Mims
21. What are the principles of plant disease control? Explain

(2 x 5 = 10)

M Sc Degree (C.S.S) Examination

First semester

Faculty of science

PBT1CRT0319: **Bryology and Pteridology**
(2019 Admission onwards)

Time: Three hours **Max. Weight: 30**

Section A

(Answer any **six** questions. Each question carries a weight of 1)

1. What are endohydric bryophytes?
2. Explain the term synangium.
3. Define apospory.
4. Name two aquatic ferns.
5. What are gemma cups?
6. Write the ecological significance of bryophytes.
7. What are elaters?
8. Write the significance of heterospory.

(6 x 1 = 6)

Section B

(Answer any six questions; each question carries a weight of 2).

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9. Write notes on the evolutionary significance of Psilophytales and Psilotales.
10. Describe *Lepidodendron*
11. Explain the morphological characteristics of *Psilotum.*
12. Describe vegetative reproduction in bryophytes.
13. Explain the morphology of *Ophioglossum.*
14. Write notes on heterospory and seed habit.
15. Describe the reproductive structure in *Osmunda.*
16. Write notes on conservation and cultivation of bryophytes
17. Write an account of the sporophyte of *Sphagnum*.
18. Compare the features of Psilophytales and Psilotales

(2x7= 14)

Section C

(Answer any two questions, each question carries a weight of 5)

19. Describe the origin and habitat diversity of bryophytes.
20. Describe origin, organization and evolution of stele in pteridophytes.
21. Compare the gametophyte and sporophyte of hepaticopsida and bryopsida.

(2x5=10)

M. Sc. Botany Degree (C.S.S) Examination

I Semester

Faculty of Science

PBT1CRT0419**: Gymnosperms, Palaeobotany and Evolution**
(2019 admissions onwards)

Time: Three hours Max. Weight: 30

Section A

(Answer any **six** questions. Each question carries a weight of 1)

1. Mention the orders in class Cycadospsida by Sporne
2. Describe Baldwin effect
3. Name two stem genera of fossil gymnosperms
4. Define mimicry
5. What is yew wood
6. Define copal
7. Write brief note on fossil records from India
8. Define carbon dating

(6 x 1 = 6)

Section B

(Answer any **seven**questions. Each question carries a weight of 2)

9. Mention the similarities and differences of gymnosperms with pteridophytes and angiosperms.
10. Comment on modern coniferales.
11. Distinguish between mutualism and commensalism
12. Comment on the distribution of living gymnosperms in India
13. Describe Kins Selectionand Hamilton's Rule
14. Describe the economic importance of gymnosperms
15. Mention the evolutionary time scale with eras and periods
16. Describe pharmacological importance of *Ginkgo*
17. Significance of genetic drift in natural selection
18. Write note on speciation.

(7 x 2 = 14)

Section C

(Answer any **two** questions. Each question carries a weight of 5)

19. With suitable diagrams, describe the stelar anatomy of Medullosaceae and Pentoxylaceae
20. Describe the evidences of evolution
21. Describe the salient features of Podocarpaceae and Araucariaceae

(2 x 5 = 10)

MODEL QUESTION PAPER FOR PRACTICAL EXAM

ST.ALBERT'S COLLEGE (AUTONOMOUS) ERNAKULAM
MSC BOTANY SEMESTER I - PRACTICAL EXAM
PBT1CRP0119: **MICROBIOLOGY, PHYCOLOGY, MYCOLOGY AND CROP PATHOLOGY**

Time: 4 hours Weightage: 20

1. Make suitable micropreparations of A and B. Draw labeled diagrams and identify giving reasons.
(Total weight 2= Preparation – 0.5, Diagram – 0.5, Identification with reasons – 1.0; 2 x 2 = 4)
2. Write critical notes on C and D.
(Correct identification-0.5 , critical note – 0.5; 1.0 x 2 = 2)
3. Sort out any three algae from the algal mixture E and make separate clear mounts. Identify and draw labeled diagrams.
(Total weight 1.5 = Preparation – 0.5, Identification -0.5 with diagrams – 0.5; 1.5 x 3 = 4.5)
4. Spot at sight F and G.
(Total weight 1 = Identification 0.5, Part displayed = 0.5; 1 x 2 = 2)
5. Identify the disease in H and I and write the causative organism.
(Correct identification of the disease-0.5 and causative organism – 0.5; 1.0 x 2 = 2)
6. Isolate Bacteria from the soil sample J by serial dilution and streak out by quadrate method.
(Total weight 1.5 = Working – 1.0, Procedure – 0.5)= 1.5
7. Practical record
(Weight = 4)

Key to the questions:
1. A, B: Alga, Fungi/Lichen.
2. C, D - Fungi.
3. E – Algal mixture containing five filamentous types.
4. F, G – Macroscopic or microscopic specimens from algae, fungi/lichen with clear and distinguishable identifying characters.
5. H, I – Herbarium or live/dry specimen showing the symptoms of any disease specified in the syllabus
6. J - Supply necessary soil sample.
7. Awarding 'A grade' 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. This also includes field study report(s)/Lab visit report(s), if any.

PBT1CRP0219: BRYOLOGY, PTERIDOLOGY, GYMNOSPERMS AND PALEOBOTANY

Time: 3 hours Weightage: 20

1. Make stained micro-preparations of specimens A, B and C. Draw labeled diagrams for each and identify giving reasons.
   (Total weight 1.5 = Preparation – 0.5, Diagram – 0.5, Identification with reasons – 0.5; 1.5 x 3 = 4.5)
2. Make stained micro-preparations (TS, TLS and RLS) of D. Draw labeled diagram and identify giving reasons.
   (Total weight 3.5 = Preparations – 0.5 (0.5 x 3 = 1.5; Identification with reasons 1.0 and diagrams – 1)
3. Identify at sight E, F, G and H.
   (Total weight 1 = Genus identification - 0.5, Part displayed - 0.5; 1 x 4 = 4)
4. Write critical notes on the reproductive structures I and J.
   (Correct identification-0.5 with critical note – 1.0; 1.5 x 2 = 3)
5. Identify and write a critical note on K.
   (Total weight 1 = Identification – 0.5, Critical note – 0.5) = 1
6. Practical record
   (Weight = 4)

Key to the questions:

1. A, B, C – one each from Bryophytes, Pteridophytes and Gymnosperm leaf.
2. D - Suitable specimen from Coniferales.
3. E, F, G, H – Suitable specimens from Bryophytes, Pteridophytes and Gymnosperms; both reproductiveand/or vegetative structures; should not exceed two specimens from one group.
4. I, J – Specimens from Bryophytes, Pteridophytes or Gymnosperms.
5. K - Fossil slides/specimens/photographs of types specified in the syllabus; both vegetative and
reproductive structures included.
6. Awarding ‘A grade’ for the record of practical work shall be considered only if all the practical worksspecified in the syllabus are done completely and recorded properly. This also includes field studyreport(s)/Lab visit report(s), if any.

SEMESTER II

SECOND SEMESTER COURSES

Course Code	Name of the Course
PBT2CRT0119	Plant Anatomy, Developmental Biology &Horticulture
PBT2CRT0219	Cell Biology, Genetics &Plant Breeding
PBT2CRT0319	Plant Physiology & Biochemistry
PBT2CRT0419	Molecular Biology
PBT2CRP0119	Plant Anatomy, Developmental Biology &Horticulture + Cell Biology, Genetics &Plant Breeding (PRACTICAL)
PBT2CRP0219	Plant Physiology & Biochemistry+ Molecular Biology (PRACTICAL)

Total credits: 19
Total hours: 450

Course 1: PBT2CRT0119- Plant Anatomy, Developmental Biology & Horticulture
No. of Credits- 4
No. of Contact Hours: Theory 36+ 18+18= 72 hrs; Practicals 27+09+09=45hrs)

Course Overview and Context:
This course is focused on revealing the structure and development of plants. It explores the internal tissue organization of higher plants. Laboratory practicals will help the learners to know more about the anatomy practices and methods and will enable them to master the art of sectioning and also the use of microtomes for permanent slide preparation. The learners are getting an opportunity to know more about the embryonic developmental stages of higher plants.

Course objectives and Out come:

1. The student understands anatomical features of various organs and how they function during growth and development.
2. The student will be able to distinguish between the anatomical features of various reproductive organs.
3. The student will be able to apply knowledge in different fields like histotaxonomy and pharmacognosy.
4. The student is able to identify the different types of stomata, nodal patterns, anthers, ovules, embryogeny and endosperm development in various angiosperms.
5. The student understands the developmental stages in the life-cycle of Angiosperms..
6. The student applies knowledge of traditional and modern practices in Horticulture for plant propagation and developing bonsai, terrarium, aquaponics, etc.

PBT2CRT0119: PLANT ANATOMY, DEVELOPMENTAL BIOLOGY AND HORTICULTURE

(Theory: 36 + 18+ 18= 72 Hrs; Practical: 27 + 09 + 09= 45 Hrs) Credits: 4

PLANT ANATOMY (Theory: 36 Hrs; Practical: 27 Hrs)

Module 1: Introduction (1 hr)
Scope and significance of plant anatomy. Role of anatomy in phylogeny.

Module 2: Meristem (4 hrs)
Apical organization: Stages of development of primary meristem and theories of apicalorganization (shoot and root). Origin of branches. Primary Thickening Meristem (PTM) in Monocots. Secretory tissues in plants. Structure and distribution of secretory trichomes (e.g. *Drocera,Nepenthes*), Salt glands, collectors, nectaries, resin ducts and laticifers.

Module 3: Secondary Structure (16 hrs)
Mechanical tissues in plants.Structure and functions. Vascular cambium and cork cambium: Structure and functions.Factors affecting cambial activity. Secondary xylem: ontogeny, structure, components and functions.Origin of vessel in angiosperms and dilation of rays. Axial parenchyma distribution in wood.Secondary phloem: Ontogeny, structure, components and functions. Stelar and extra stelar thickening in angiosperms. Reaction wood, compression wood and tension wood.Factors affecting reaction wood formation. Dendrochronology: Growth rings and their functions.Summer and Spring-wood.Anomalous secondary growth in dicots and monocots. Tyloses: Structure and function. Plant fibers: distribution, structure and commercial importance of coir, jute, and cotton. Root-stem transition in angiosperms.

Module 4: Leaf and Node (4 hrs)

Leaf: ontogeny and structure of leaf. Structure, development and classification of stomata and trichomes. Leaf abscission. Nodal anatomy: unilacunar, trilacunar and multilacunarnodes, nodal evolution; role of nodal anatomy in taxonomy.

Module 5: Reproductive Anatomy (8 hrs)

Floral anatomy: Anatomy of floral parts - sepal, petal, stamen and carpel, vascular anatomy of flower and modifications. Development of epigynous ovary-appendicular and receptacular theory, role of floral anatomy in taxonomy. Fruit and seedanatomy - anatomy of fleshy and dryfruits - follicle, legume and berry. Dehiscence of fruits. Anatomy of seeds.

Module 6: Applied Anatomy (3 hrs)

Research prospects in anatomy. Applications of Anatomy in Systematics (Histotaxonomy) and Pharmacognosy.

Practical (27 Hrs)

1. Study the Anomalous- Primary and Secondary features in: *Bignonia, Amaranthus, Nyctanthes*, *Piper, Bougainvillea* and *Strychnos*.
2. Study of stomatal types (Anomocytic, anisocytic, paracytic and piacytic) and determination of stomatal index.
3. Study of nodal patterns (Unilacunar. Trilacunar and Multilacunar).

References

1. Charles B. Beck (2010). *An Introduction to Plant Structure and Development_ Plant Anatomy for the Twenty-First Century*. Cambridge University Press.
2. David F. Cutler, Ted Botha, Dennis W. M. and Stevenson (2008). *Plant Anatomy: An Applied Approach*.Wiley-Blackwell.
3. Eames A. J, Mc Daniel (1976). *An introduction to plant Anatomy*.
4. Edred John Henry Corner (1976). *The seeds of dicotyledons* (Vol. I & II). Cambridge University Press.
5. Elizabeth G. Cutter (1978). *Applied Plant Anatomy*. Clive and Arnald Ltd.
6. Elizabeth G. Cutter (1978). *Plant anatomy part I & II*. Clive and Arnald Ltd.
7. Ella Werker (1997). *Seed Anatomy*. Borntreager.
8. Esau K. (1965). *Vascular differentiation in plants*. Rirehant and Winston, Inc.
9. Esau K. (1977). *Anatomy of seed plants*. Wiley and sons.
10. Fahn A. (1997). *Plant anatomy*. Aditya Publishers.
11. Foster A. S. *Practical plant Anatomy*.
12. Fritz Hans Schweingruber, Annett Borner and Ernst-Detlef Schulze (2008). *Atlas of Woody Plant Stems. Evolution, Structure, and Environmental Modifications*. Springer.
13. Ingrid Roth (1977). *Fruits of Angiosperm*. Gebruder Borntreager.
14. John A. Romberger, Zygmunt Hejnowicz and Jane F. Hill (2005). *Plant Structure Function and Development. A Treatise on Anatomy and Vegetative Development, with Special Reference to Woody Plants*. Springer-Verlag.
15. Metcalf C. R. and Chalk L. (1950). *Anatomy of Dicotyledons and Monocotyledons*.
16. Metcalf C. R. and Chalk L. (1983). *Anatomy of the dicotyledons: Wood structure and conclusion of the general introduction*. Oxford University press.
17. Pandey B. P. *Plant Anatomy*. S Chand and Co. New Delhi.
18. Paula J. Rudall (2007). *Anatomy of Flowering Plants. An Introduction to Structure and Development*. Cambridge University Press.
19. Ray F. Evert, Susan E. and Eichhorn (2007). *Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body, Their Structure, Function, and Development*.Wiley-Liss.
20. Sherwin John Carlquist (2001). *Comparative wood anatomy: Systematic, ecological, and evolutionary aspects of dicotyledon wood*.
21. Taylor A. Steeves, Vipen K. Sawhney (2017). *Essentials of developmental plant anatomy*.Oxford University Press.

22. Vasishta P. C. (1994). *Plant anatomy*. Pradeep publications.
23. William C. Dickison (2000). *Integrative plant anatomy*. Academic Press.

DEVELOPMENTAL BIOLOGY (Theory: 18 Hrs+ Practical: 9 Hrs)

Module 1: History and Basic Concepts of Development (5hrs)
Overview on the modern era of developmental biology emerged through multidisciplinaryapproaches. Stages of development- zygote, blastula, gastrula, neurula. Cell fate and commitment, potency- concept of embryonic stem cells, differential gene expression, terminal differentiation, lineages of three germ layers, fate map. Mechanisms of differentiation-cytoplasmic determinants, embryonic induction, concept of morphogen, mosaic and regulative development. Pattern formation-axis specification, positional identification (regional specification). Morphogenetic movements. Model organism in developmental biology (Arabidopsis-brief account only)

Module 2: Overview of Plant Development (9 hrs)
Angiosperm life cycle. Anther: microsporogenesis and microgametogenesis. Viability of pollen grains. Pollination, pollen germination, growth and nutrition of pollen tube, pollen morphology, exine sculpturing, pollenkitt NPC formula.Ovule: megasporogenesis and mega gametogenesis. Types of embryosac and development. Fertilization: Double fertilization; embryo development - different types. Endosperm development, types of endosperm, haustorial behavior of endosperm. Xenia and metaxenia. Polyembryony – types and causes. Seed formation, dormancy and germination. Apomixis, parthenogenesis

Module 3: Morphogenesis and Organogenesis in Plants: (4 hrs)
Organogenesis in plants, transition to flowering, floral meristems and floral development. Homeotic genes in plants.

Practical (9hrs)
1. Embryo excision from young seeds.
2. Identification of different types of ovules, embryos, polyembryony, endosperm, pollen grains, anther growth stages.

References

1. Scott F Gilbert (2000). Developmental Bilogy (IX Edn). Sinauer Associates.
2. R M Twyman (2001). Instant notes in Developmental Biology. Viva Books Private Limited.
3. Lincoln Taiz, Eduardo Zeiger (2002). Plant physiology (II Edn). Sinaeur Associates, Inc. Publishers.
4. Robert J Brooker (2009). Genetics: analysis & principles (III Edn.). McGraw Hill
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 Bilogy (VIII Edn). Sinauer Associates.
7. S S Bhojwani, S P Bhatnagar (1999). The Embryology of Angiosperms (IV Edn). Vikas Publishing House Pvt Ltd.
8. Maheswari P (1950). An introduction to the embryology of Angiosperms. McGraw Hill.

HORTICULTURE (Theory: 18 Hrs Practical: 9 Hrs)

Module 1: Introduction (2 hrs)

Introduction to Horticulture; nature and scope. Objectives of horticulture.

Module 2: Principles of Horticulture (4 hrs)

Principles of landscape gardening. Gardening: ornamental and indoor gardens, kids gardens, vertical and roof top gardens. Garden adornments. Propagation methods-layering, budding, grafting, and micropropagation-merits and demerits.

Module 3: Horticulture Applications (6 hrs)

Composting: aerobic, anaerobic and vermicomposting; mist chamber, green house and glass house. Effect of pollution on indoor plants. Commercial products of horticulture. Olericulture: home and market - gardening and truck farming. Seed production.

Module 4: Floriculture (3 hrs)

Introduction, nature and scope. Fresh and dry flower arrangements. Production of Cut flowers, cultivation of orchids, foliage potted plants and bedding plants. Future prospects of floriculture.

Module 5: Modern trends in horticulture (3 hrs)

Bonsai: Selection of plants and making of bonsai. Physical control of plant growth in Bonsai preparation. Preparation of terrarium, aquaponics and arbori culture. Components of high-tech farming.

Practical: (9 Hrs)

1. List out the Garden components in the Photograph.
2. Demonstration of Preparation of a Terrarium.
3. Propagation methods-layering and grafting.

References

1. Adam C.R. (2004). Principles of Horticulture. Elsevier Butterworth-Heinemann.
2. Peter K. V. (2015). *Basics of Horticulture*. New India Publishing Agency, New Delhi.
3. Gupta S.N. (2016). *Instant Horticulture*. Jain Brothers, New Delhi.
4. Tiwari A.K. and R. Kumar (2012). *Fundamentals of Ornamentals, Horticulture and Landscape Gardening*. New India Publishing Agency, New Delhi.

Course 2: PBT2CRT0219- Cell Biology, Genetics & Plant Breeding

No. of Credits- 4

No. of Contact Hours: Theory 27+ 27+18= 72 hrs; Practicals 18+18+9=45hrs)

Course Overview and Context:
This course examines the structure and functions of cells and cell organelles, cell division, cell cycle and cell signaling and communication.The course in genetics aimed to introduce the learner from classical to modern aspects of molecular genetics. It also helps in providing conventional and modern approaches in improving crop plants.

Course objectives and Out come

1. The course will enable the learner to understand the various aspects of cell biology, genetics and plant breeding to critically evaluate the research prospects in the subject area.
2. The learner will understand the structure of various aspects of cell biology and transmission genetics.
3. The learner will be equipped to apply genetics principles and solve problems.
4. The learners will apply the modern as well as conventional methods of crop improvement and will have experiences in conductiong hybridization and plant propagation methods.

PBT2CRT0219: CELL BIOLOGY, GENETICS AND PLANT BREEDING

(Theory: 27+27+18=72Hrs; Practical: 18+18+9=45 Hrs; Credits: 4)

CELL BIOLOGY (Theory: 27 Hrs; Practical: 18 Hrs)

Module 1: Introduction to plant cells (7 hrs)

Structural organization of plant cell. Plasma membrane – chemical composition, organization, membrane fluidity, dynamic nature.Ultrastructure and functions of mitochondria, peroxisomes, glyoxysomes and chloroplast. Endomembrane system – structure and functions of endoplasmic reticulum, Golgi complex, lysosomes and vacuoles. Transport of materials – biosynthetic (secretory) and endocytic pathway. Chromosomes – organization of chromatin and chromosomes

- histones and nonhistone proteins, nucleosomal organization of chromatin, higher levels of chromatin organization in chromosomes. Heterochromatin and Euchromatin, formation of heterochromatin. Molecular structure of the Centromere and Telomere.

Module 2: Cell signaling (6 hrs)

Cell communication - general principles. Signaling molecules and their receptors; external and internal signals that modify metabolism, growth, and development of plants.Receptors: cell surface receptors - ion-channel linked receptors (Voltage-gated ion channels and Ligand-gated ion channels in neurons), G-protein coupled receptors (β-adrenergic receptor), Tyrosine-kinase linked receptors (Insulin receptor), and Steroid hormone receptors (Estrogen receptor). Signal transduction pathways, second messengers, regulation of signaling pathways. Bacterial and plant two-component signaling systems (Brief study).

Module 3: Cell interaction (4 hrs)

Extra cellular matrix, Cell adhesion molecules - cadherins, integrins, selectins, fibronectins, laminin and Immunoglobin superfamily. Cell-cell adhesions (Junctional and non-junctional adhesive mechanisms; occluding junctions, anchoring junctions, communicating junctions (Connexons and plasmodesmata).

Module 4: Cytoskeleton (3 hrs)

Functions of cytoskeleton; Structure, assembly, disassembly and regulation of filaments involved – actin filaments (microfilaments), microtubules, and intermediate filaments. Molecular motors – kinesins, dyneins, and myosins.

Module 5: Cell cycle and its regulation (7 Hrs)

Phases of cell cycle, mitosis and meiosis (Brief study), Spindle formation and its disintegration, Mechanisms of chromosome movement and separation during anaphase, Role of cohesins and condensins. Role of motor proteins. Cell cycle control mechanisms - extracellular an intracellular signals. Cell cycle checkpoints – DNA damage checkpoint, centrosome duplication checkpoint, spindle assembly checkpoint - role of cyclins and cyclin dependent kinases. Apoptosis – process of programmed cell death, extrinsic and intrinsic pathways of apoptosis.

Practical (18 hrs)

1. Identification of different stages of mitosis and study of morphology of metaphase chromosomes from Onion root meristems (Recorded by photomicrographs).
2. Identification of different stages of meiosis from suitable plant material (Recorded by photomicrographs).

3. Microscopic observation (Chloroplast).
5. Study of mitotic index from suitable plant material.

References

1. Gerald Karp (2014). *Cell Biology* (VII Edn). Wiley.
2. Gerald Karp (2008). *Cell and Molecular biology: Concepts and experiments* (V Edn). John Wiley & Sons
3. George Plopper, David Sharp, Eric Sikorski (2015). *Lewin's Cells* (III Edn). Jones and Bartlett Learning.
4. 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.
5. Wayne M Becker, Lewis J Kleinsmith, Jeff Hardin (2007). *The world of the cell* (VI Edn). Pearson.
6. Geoffrey M Cooper, Robert E Hausman (2009). *The Cell: A molecular approach* (V Edn). Sinaeur.
7. 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.
8. Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2010). *Essential Cell Biology*. Garland Science.

9. David E Sadava (2009). Cell biology: Organelle structure and function. CBS.

GENETICS (Theory: 27Hrs; Practical: 18 Hrs)

Module 1: Genetics - From "Factors" to "Genes" and gene interactions (6 hrs)

Introduction to Mendelian genetics and principles of inheritance; Extensions of Mendelism (Brief study).Model organisms in Genetics - *Arabidopsis thaliana*, *Neurospora crassa*, *E. coli*, *Drosophila melanogaster* and *Caenorhabditis elegans* (Brief study).Linkage, crossing over and chromosome mapping in eukaryotes. Cytoplasmic inheritance, multiple alleles,quantitative inheritance, QTL; Penetrance and expressivity, Sex determination in plants and animals, X-chromosome inactivation in mammals – dosage compensation.

Module 2: Human Genetics and Cancer (9 hrs)

Inheritance of traits in Humans - Pedigree analysis(Nail Patella Syndrome and ABO locus) , genetic disorders in humans - autosomal recessive - ADA deficiency, Sickle cell anemia;

autosomal dominant - Huntington's chorea, familial hypercholesterolemia; inborn errors of metabolism - phenylketonuria, Alkaptonuria, Albinism. Cancer - a genetic disease; Cancer and cell cycle, oncogenes, chromosome rearrangements and cancer (Philadelphia Chromosome), Tumour suppressor genes, causes of cancer, properties of cancer cells, types of cancer, Genetic pathways to cancer

Module 3: Mutations (4 hrs)

Classification and types: Chromosomal mutations - changes in structure and number; Gene mutations, Effect of different mutagens on the structure of DNA.

Module 4: Population Genetics (8 hrs)

Emergence of evolutionary theory and population genetics; Concepts in population genetics - Gene pool, Gene frequency, genotype frequency; Hardy Weinberg's Law and its applications; Exceptions to Hardy-Weinberg's Principle; Factors affecting gene frequency - Mutation, selection, migration, natural selection and Genetic drift (Bottle neck effect and Founder effect); Populations in Genetic equilibrium - balancing selection, mutation-selection balance, mutation drift balance. Speciation - pre-zygotic and post-zygotic isolation (Brief account); modes of speciation - Allopatric, sympatric and parapatric.

Practical (18 Hrs)

1. Workout problems related to linkage, crossing over and gene mapping, human pedigree analysis, Cytoplasmic Inheritance, Multiple alleles and quantitative inheritance.
2. Work out problems in population genetics-gene and genotype frequency, Hardy-Weinberg equilibrium.

References

1. Benjamin Lewin (2000). *Genes VII*. Oxford university press.
2. Daniel L Hartl, Elizabeth W Jones (2009). *Genetics: Analysis of genes and genomes* (VII Edn). Jones and Bartlett publishers.
3. Gardner E J, Simmons M J, Snustad D P (1991). *Principles of Genetics* (III Edn). John Wiley and Sons Inc.
4. Klug W.S., Cummings, M.R., Spencer, C.A and Palladino, M.A (2010). *Concepts of Genetics* (10^{th} Edition). Pearson Education Limited.
5. Peter Snustad, Michael J Simmons (2010). *Principles of genetics* (V Edn). John Wiley and Sons.
6. Robert J Brooker (2009). *Genetics: Analysis and principles* (III Edn). McGraw Hill.
7. Strickberger (2005). *Genetics* (III Edn). Prentice Hall of India Pvt. Ltd.
8. William S Klug, Michael R Cummings (1994). *Concepts of Genetics*. Prentice Hall.

PLANT BREEDING (Theory: 18 Hrs; Practical 9 hrs)

Module 1: Introduction (2 hrs)

Objectives of plant breeding, important achievements and future prospects. Domestication and centers of origin of cultivated plants.

Module 2: Hybridization (3 hrs)

Hybridization-role and methods, inter-varietal, inter-specific and inter-generic crosses. Incompatibility and male sterility in plant breeding (brief account). Back-cross breeding. Heterosis, inbreeding depression.

Module 3: Idiotype breeding (2 hrs)

Role and methods, applications of idiotype breeding.

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 (6 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 mutation in plant breeding.

Module 6: Modern breeding methods (2 hrs)

Modern trends in plant breeding: Tissue culture technologies (DNA marker-assisted Selection (MAS) - a brief study only).

Practical: (9 Hrs)

1. Hybridization techniques in self and cross pollinated plants.
2. Estimation of pollen sterility through in-vitro germination/staining-technique.
3. 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. Denis Murphy (2007). Plant Breeding and Biotechnology. Cambridge University Press.
3. Ghahal G. S. and Gosal S. S. (2002). *Principles and procedures of Plant Breeding*. Narosa Publishing House.
4. Izak Bos and Peter Caligari (2007). Selection methods in plant breeding. Springer.
5. Kang M.S. (2002). Quantitative Genetics, Genomics and Plant Breeding. CABI.
6. Langridge P., K. Chalmers, Horst Lörz and Gerhard Wenzel (2005). Molecular Marker Systems in 7. Plant Breeding and Crop Improvement. Springer-Verlag.
8. Sharma J. R. (1994). *Principles and practices of Plant Breeding*. Tata McGraw-Hill Publishers Company Ltd.
9. Shukla.R.S. and P.S.Chandel (1974). Cytogenetics, Evolution, Biostatistics and Plant Breeding. S.Chand and Company Ltd. New Delhi.
10. Singh B. D. (1996). *Plant Breeding: Principles and methods*. Kalyani Publications.

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Course-3: PBT2CRT0319- PLANT PHYSIOLOGY &BIOCHEMISTRY

No. of Credits- 4

No. of Contact Hours: Theory 45+ 27= 72 hrs; Practicals 36+27hrs=63hrs)

Course Overview and Context:

This course will provide the core concepts in plant water relations, absorption of minerals, photosynthesis, respiration, stress physiology and plant growth regulators. The context is to introduce the learner from fundamentals of biochemical process and plant physiological process and also the recent development take place in the subject area

Course objectives and Out come

1. The course will enable the students to understand the various aspects of physic-chemical environment and critically examine its relation to plant life process.
2. The learner will understand various aspects of physiological process related to plant life.
3. The learner will familiarize with the basic skills in experiments related to photosynthesis, respiration and also the biochemical process take place in plants.
4. Learners will have an overview of major biomolecules.
5. Describe the biosynthesis and functions of secondary metabolities.
6. Describe the structure and the mechanism of action of enzymes, learn the kinetics of enzyme catalysed reactions and understand various enzyme inhibitions and regulatory process.

PBT2CRT0319: PLANT PHYSIOLOGY AND BIOCHEMISTRY
(Theory 45+27 =72 Hrs; Practical 36+27=63 Hrs; Credits: 4)

PLANT PHYSIOLOGY (Theory: 45 Hrs; Practical: 63 Hrs)

Module 1: Transport and Translocation of water and solutes (8 hrs)

(a) Absorption and translocation of water, apoplast and symplast, pathways of water uptake and transport, xylem transport, passive and active transport. Aquaporins. Water pathway in the leaf – driving force of transpiration, leaf anatomy for regulating transpiration. Stomatal biology – light dependent stomatal opening. Soil-plant-atmosphere continuum.

(b) Absorption of minerals: Soil characters influencing nutrient availability – size and charge of soil particles, soil pH. Mechanism of entry of minerals into roots.

(c) Transport of ions, solutes and macromolecules: Electrical properties of membranes, Membrane potential. Transport across cell membranes: Passive – diffusion, facilitated diffusion, membrane channels; plasmodesmata, porins, ion channels – gated channels, structure and

working of K^+ ion channels. Active transport: Carrier proteins; P-type H^+ ATPase, ABC transporters.

Module 4: Photosynthesis (12 hrs)

(a) Light harvesting complexes: PS I, PSII; Structure and composition of reaction centers. Basic principles of light absorption, excitation energy transfer, mechanism of electron transport, photooxidation of water, proton electrochemical potential – photophosphorylation.

(b) Structure and function of RuBisco, CO_2 fixation – Calvin cycle. Photorespiration, role of photorespiration in plants. CO_2 concentrating mechanisms – algal and cyanobacterial pumps, C4 cycle, CAM pathway. Synthesis of starch and sucrose, photosynthetic quantum yield and energy conversion efficiency. Transport of photoassimilates – phloem loading and unloading, mechanism of phloem translocation – pressure flow. Thylakoid ET inhibitors, Photoinhibition and its tolerance mechanism.

Module 5: Respiration (10 hrs)

Three stages of respiratory metabolism (brief study only). Plant mitochondrial electron transport and ATP synthesis – organization of electron transfer complexes (complex I – IV). ATPase (Complex V) – detailed structure of F1 and Fo subunits, binding change mechanism of ATP synthesis. Comparison of mitochondrial and chloroplast ATP synthesis. Cyanide resistant pathway - alternative oxidase, its regulation and significance. Rotenone-insensitive pathway in plants.

Module 6: Nitrogen metabolism: (4 hrs)

N cycle. N fixation processes. Biological N fixation – structure of nitrogenase complex, reduction of N. Symbiotic N fixation – nodule formation, nodulin gene and nodulation genes, leghaemoglobin. Nitrate and ammonium assimilation. Transport of amides and ureides.

Module 7: Stress physiology (4 hrs)

Plant stress - biotic and abiotic. Stress sensing mechanisms in plants. Acclimation and adaptation mechanisms in plants.

Module 8: Sensory photobiology (4 hrs)

Plant photoreceptors - phytochromes, cryptochromes and phototropins, their function and mechanism of action. Photoperiodism and biological clocks – circadian rhythms. Floral induction and development.

Module 9: Plant growth regulators (3 hrs)

Physiological effects and mechanism of action of plant growth hormones. Role of elicitors in growth regulation.

Practical (36 hrs)

1. Measurement of Photosynthesis - Hill Reaction.
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 total chlorophyll and study of absorption pattern of chlorophyll solution.
10. Separation and collection of leaf pigments by silica gel column chromatography.
11. Determination of nitrate reductase activity.
12. Extraction and estimation of leghaemoglobin from root nodules.

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BIOCHEMISTRY (Theory: 27 Hrs; Practical 27 Hrs)

Module 1: Introduction (2 hrs)

Acid and Bases, ionisation of water, dissociation of acids, Henderson-Hasselbalch equation, pKa. Buffers - Common buffers (acetate, citrate and phosphate), buffer action, buffer capacity. Measurement of pH.

Module 2: Carbohydrates (4 hrs)

General structure and biological importance of carbohydrates. Monosaccharids and Oligosaccharides: classification and structure with common examples. Polysaccharides: Classification, structure and functions - starch, cellulose. Glycoproteins and glycolipids.

Module 3: Lipids (5 hrs)

(a) Classification, important biological functions. Structure of fatty acids, triglycerides, waxes, Phosphoglycerides and Sterols. Lipids with biological specific activities – steroids and isoprenoids. (b) Lipid metabolism in oilseeds – Oxidation of fatty acids, glyoxylate cycle, gluconeogenesis.

Module 4: Amino acids and proteins (5 hrs)

Classification and structure of aminoacids, peptide bond. Structure and functions of protein – primary, secondary, tertiary and quaternary structure. Ramachandran plot, alpha helix and beta conformations. Protein degradation in cells (brief account).

Module 5: Enzymes (7 hrs)

(a) Classification and naming, IUB system.

(b) Mechanism of enzyme action. Measurement and expression of enzyme activity, factors affecting enzyme activity.

(c) Enzyme kinetics - Michaelis-Menten kinetics, Lineweaver-Burk plot.

(d) Regulation of enzyme activity. Enzyme inhibition

(e) Co-enzymes and co-factors, Ribozymes and Abzymes.

(f) Enzyme technology - isolation and purification of enzymes, modifying enzymes for stability (brief study).

Module 6: Secondary metabolites (4 hrs)
Classification, Biosynthesis and functions of terpenoids, alkaloids and phenolics.

Practical (27 Hrs)
1. Preparation of buffers-Citrate and Phosphate-various strengths.
2. Quantitative estimation of reducing sugar.
3. Separation of amino acids by TLC.
4. Quantitative estimation of protein (Lowry's method).
5. Preparation of Molar, Normal, Percentage and PPM solutions and their dilutions
6. Estimation of total phenolics in plant tissue
7. Isolation and estimation of amylase from germinating seeds.

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10. Sadasivam S and Manickan. Biochemical Methods. New Age International.
11. Satyanarayana U and Chakrapani U Biochemistry (2011).
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Course 4: PBT2CRT0419- MOLECULAR BIOLOGY
No. of Credits- 3
No. of Contact Hours: Theory 54 hrs; Practicals 18hrs)

Course Overview and Context:
The course covers the structure and function of cell organells and chromosomes and DNA. It emphasizes on the DNA and the mechanisms of its replication and repair, gene expression and regulation and helps the students to analyze these mechanisms in the prokaryotic and eukaryotic systems.

Course objectives and Out come

1. Students will be able to understand the molecular diversity of the genetic material
2. Learner will be able to explain the molecular mechanism behind the various steps in gene expression.
3. The students will understand the structure of biomolecules like DNA, RNA and proteins.
4. The students shall be able to understand the formation and functioning of DNA, RNA and protein.
5. The students shall be able to know the regulation of gene expression.
6. The students shall be able to correlate between mode of gene expression and functioning of an organism.

PBT2CRT0419: MOLECULAR BIOLOGY
(Theory 54 hrs; Practical 18 hrs; Credits: 3)

Module 1: Nucleic acids (6 hrs)

(a) Molecular structure of DNA: Watson and Crick model, alternative conformations, DNA triplex and quadruplex, imotif. DNA supercoiling – Topoisomerases.

(b) Structure, Diversity and Versatility of RNA: Primary, secondary, tertiary and quaternary structure of RNA. RNA as genetic material – plus, minus, double stranded RNA. Catalytic RNA: Ribozymes – Discovery, structure, mechanism and functions; HDV ribozyme, hammerhead ribozymes, self-splicing introns, RNaseP, RNase MRP, Peptidyl transferase. Noncoding RNA: Structure and biological roles of rRNA, tRNA, tmRNA, siRNA miRNA, piRNA, lncRNA (Xist, HOTAIR) and circular RNA.

Module 2: Organization of the Genome (4 hrs)

(a) Genome organization in viruses, bacteria, and eucaryotes. Organellar genome – structure and organization, important organellar genes.

(b) Eucaryotic nuclear genome: c-value paradox, DNA renaturation kinetics, Tm, Cot curve. Unique and Repetitive DNA – mini- and microsatellites.

Module 3: Replication of the Genome (6 hrs)

(a) RNA replication: By RNA-dependent RNA polymerase, retroviral RNA replication.

(b) DNA replication: Unit of replication, enzymes and proteins involved in replication (in both procaryotes and eucaryotes). Structure of the replication origin (in both procaryotes and eucaryotes), priming (in both procaryotes and eucaryotes), replication fork, fidelity of replication. Process of replication – initiation, elongation and termination. Replication in the telomere - telomerase.

Module 4: Gene Expression (15 hrs)

(a) Gene: Concept of gene; structural and genetic definitions – complementation test.

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

(c) Transcription in eucaryotes: Types, structure and roles of RNA polymerases. Promoters – important features of class I, II, & III promoters. Enhancers and silencers. General

transcription factors and formation of pre-initiation complex. Elongation factors, structure and function of transcription factors.

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

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

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

(g) Stages in translation: Initiation – formation of initiation complex in procaryotes and eucaryotes, initiation factors in procaryotes and eucaryotes, Kozak sequence. 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) 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 5: Control of Gene Expression (10 hrs)

(a) Viral system: Genetic control of lytic and lysogenic growth in λ phage, lytic cascade.

(b) Procaryotic system: Transcription switches, transcription regulators. Regulation of transcription initiation; Regulatory proteins - activators and repressors. Structure of *Lac* operator, CAP and repressor control of *lac* genes. Regulation after transcription initiation – regulation of amino acid biosynthetic operons - attenuation of trp operon, riboswitches.

(c) Eucaryotic system: Changes in chromatin and DNA structure – chromatin compaction, mechanism of action of activators and repressors, gene amplification, gene rearrangement, alternate splicing, gene silencing by heterochromatization, and DNA methylation. Effect of regulatory transcription factors on transcription. Post-transcriptional control – mRNA stability. Small RNA mediated control.

Module 6: Recombination (5 hrs)

Homologous and nonhomologous recombination, molecular mechanism of homologous recombination. Site-specific recombination, transposition - types of transposons.

Module 7: Epigenetic inheritance (4 hrs)

Genomic imprinting, Cytosine methylation, Histone code, ncRNA and epigenetics

Module 8: Mutation repair (5 hrs)

DNA repair mechanisms: Direct repair, Excision repair – base excision repair and nucleotide excision repair. Mismatch repair, Recombination repair – homologous recombination repair, nonhomologous end joining, SOS response – Transletion DNA polymerase.

Practical (18 hrs)

1. Work out problems based on DNA structure, replication, gene expression and genetic code (Genetic code chart may be brought for reference during examination).

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MODEL QUESTION PAPERS– THEORY

M Sc Botany Degree (CSS) Examination

II Semester Faculty of Science

PBT2CRT0119: PLANT ANATOMY, DEVELOPMENTAL BIOLOGY AND HORTICULTURE

Time: 3 hours **Max. Weight: 30**

Section A

(Answer any **six** questions. Each question carries a weight of 1)

1. What is meant by abiogensis?
2. Write brief notes on
   a) Moleculae clock b) Eras
3. Describe the economic importence of Plant fibers.
4. Describe the structure and fuction of wood parenchyma.
5. Describe the horticultural implement used for weeding.
6. What is double fertilization?
1. What is tension wood?
2. Describe different parts of stem apex.

(6 x 1 = 6)

Section B

(Answer any **Seven** questions. Each question carries a weight of 2)

3. Explain collateral and open vascular bundle with examples?
4. Define hydrophytes. Give morphological and anatomical characters.
11. Write a note on evolutionary time – scale?
12. Describe the structure and development ofstomata.
13. What is Krantz anatomy? Mention its significance.
14. Write a brief note on the following:
    (a) Apomixis (b) Polyembryony (c) Xenia
15. What are the developmental changes in shoot apex leading to floral induction?
16. Write a brief note on different type of gardening.
17. What is meant by genetic drift?
18. What is pagoda?

(7 x 2 = 14)

Section C

Answer any **two** questions. Each question carries a weight of 5)

19. Describe various theories to explain the meachanism of evolution.
20. With suitable example and illustration describe various anomalous primary and secondary structure in the stem of angiosperms.
21. Write an essay on morphogenesis and organogenesis in plants.

(2 x 5 = 10)

M Sc Botany Degree (CSS) Examination
II Semester
Faculty of Science
PBT2CRT0219: CELL BIOLOGY, GENETICS AND PLANT BREEDING
(2019 onwards)

Time: 3 hours **Max. Weight: 30**

Section A

(Answer any **eight** questions. Each question carries a weight of 1)

1. What is apoptosis?
2. Write a brief description on cell adhesion molecules.
3. What are the functions of telomere?
4. What is the genetic significance of the fact that gametes contain half the chromosome complement of somatic cells?
5. Differentiate between heterochromatin and euchromatin.
6. Explain the relationships between the following pairs of genetic terms:

(a) Genotype and phenotype (b) Gene and trait (c) Allele and gene (c) Gene and chromosome 7. What causes phenylketonuria?

8. What is dosage compensation? (6 x 1 = 6)

Section B

(Answer any **Seven** questions. Each question carries a weight of 2)

9. Explain the causes of inbreeding depression?
10. Differentiate between vertical and horizontal resistance with example.
11. Draw the diagram of a bivalent chromosome and label the following parts: centromere, sister chromatids, nonsister chromatids, homologous chromosomes, and chiasma.
12. Describe the self-assembly and the dynamic structure of cytoskeletal filaments.
13. Describe the endosymbiont hypothesis on the origin of chloroplast and mitochondria.
14. Quoting suitable examples, explain genetic drift.
15. Write an account on tumor-suppressor genes.
16. Describe the structure and functions of glyoxysomes and peroxisomes.
17. Explain the concept, “Centres of origin.”
18. Describe the methods used for breeding disease resistance in plants.

(7 x 2 = 14)

Section C

Answer any **two** questions. Each question carries a weight of 5)

19. Describe the chemical composition, structural organization and the dynamic nature of plant cell membrane.
20. What is Hardy-Weiberg equilibrium? Describe the conditions for Hardy-Weinberg equilibrium.
21. Write an account on the modern trends in plant breeding.

(2 x 5 = 10)

M Sc Botany Degree (CSS) Examination
II Semester
Faculty of Science
PBT2CRT0319: PLANT PHYSIOLOGY AND BIOCHEMISTRY
(2019 onwards)

Time: 3 hours **Max. Weight: 30**

Section A
(Answer any **Six** questions. Each question carries a weight of 1)

1. Define the following;
   (a) Km (b) pKa (c) Vmax
   (d) Kw 2. What are
   isozymes?
3. Derive Henderson-Hasselbalch equation
4. Classify monosaccharides based on the number of C atoms.
5. What is RQ? Give the RQ for different substrates
6. Given an account of the role of Gibberellins
7. What is the membrane potential and how is it generated?
8. What is the role of the antenna complex in the light-dependent reactions of photosynthesis?

(6 x 1 = 6)

Section B
(Answer any **seven** questions. Each question carries a weight of 2)

9. Explain the structure and function of leghemoglobin during
nitrogen fixation?
10. Write note on ABC transporters?
11. Write a brief account on the different methods of regulation of enzyme activity
12. Describe the following terms which are related to protein structure;
(a) Quaternary structure (b) α-helix (c) Peptide unit (d) Hydrogen bonds
13. Describe buffer action citing suitable examples
14. Write brief descriptions on;
(a) Aquaporin (b) Active transport (c) Light harvesting complexes (d) Glycolysis
15. Explain the mechanism of electron and proton transport in the thylakoid membrane
16. Write an account on soil-plant-atmosphere continuum.
17. Explain the rotenone-insensitive pathway in plants.
18. Describe the mechanism of entry of minerals into the roots of plants.

(7 x 2 = 14)

Section C
Answer any **two** questions. Each question carries a weight of 5)

19. What is Ramachandran plot? Describe the structural details and principles based on which Ramachandran plots are constructed. Add a note on its applications.
20. With the help of a diagram, describe the detailed structure of ATPase complex. Write the binding change mechanism of ATP synthesis.
21. What are the stresses to which plants are commonly exposed? Describe the stress tolerance mechanisms found in plants.

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(2 x 5 = 10)

M Sc Botany Degree (CSS) Examination
II Semester
Faculty of Science
PBT2CRT0419: MOLECULAR BIOLOGY
(2019 onwards)

Time: 3 hours **Max. Weight: 30**

Section A
(Answer any **six** questions. Each question carries a weight of 1)

1. In what sense does attenuation provide a "fine tuning" mechanism for operons that control amino acid biosynthesis?
2. Describe the function and importance of the 3' to 5' exonuclease activity of DNA polymerases
3. Explain the opposite polarity of the double stranded DNA.
4. What is SRP?
5. What is ARS?
   (a) 6. What is histone code?
7. Explain the function of translation polymerase.
8. Comment on the role of chaperones in protein assembly.

(6 x 1 = 6)

Section B
(Answer any **seven** questions. Each question carries a weight of 2)

9. Explain the role of the following enzymes/proteins;
   a)Rho protein (b) Sigma factor (c) Gyrase (d) Tus protein
10. 'Ribosome is a ribozyme'. Comment.
11. Describe the experimental methods used to crack the complete genetic code.
12. Describe the phenomenon of RNAi? How is RNAi involved in gene regulation?
13. Describe the genetic control of the entry of a Lambda phage into lytic or lysogenic growth.
14. Write briefly on the following;

(a) Shine-Dalgarno sequence (b) Kozak sequence (c) Amber codons (d) DNA quadruplex

15. What are transposons? Write a brief account on the types of transposons.
16. Write a brief account on ribozymes.
17. What are the functions of miRNA?
18. Describe how telomerase help maintain the structure of telomere.

(7 x 2 = 14)

Section C
Answer any **two** questions. Each question carries a weight of 5)

19. Describe the various modifications that the eukaryotic pre-mRNA usually undergoes.
20. Compare the following;
    (a) Eucaryotic and prokaryotic promoters (b) Eucaryotic and prokaryotic Ribosomes (c) Eucaryotic and prokaryotic RNA polymerases (d) Eucaryotic and prokaryotic DNA polymerases
21. Write a comparative account of the molecular events taking place in the 5' – 3' synthesis of RNA during transcription and the 5' – 3' synthesis of DNA during the replication of DNA.

(2 x 5 = 10)

SEMESTER III

THIRD SEMESTER COURSES

Course Code	Name of the Course
PBT3CRT0119	Research Methodology, Microtechnique, Biostatistics and Biophysical Instrumentation
PBT3CRT0219	Biotechnology, Bioinformatics and Bio-nanotechnology
PBT3CRT0319	Angiosperm Taxonomy, Economic Botany and Ethano Botany
PBT3CRT0419	Environmental Sciences
PBT3CRP0119	Research Methodology, Microtechnique, Biostatistics, Biophysics + Biotechnology, Bioinformatics and Bio-nanotechnology (PRACTICAL)
PBT3CRP0219	Angiosperm Taxonomy, Economic Botany+ Environmental Science (PRACTICAL)

Total credits: 19
Total hours: 450

Course-1: PBT3CRT0119- Research methodology, Microtechnique, Bioststistics and Biophysical Instrumentation
No. of Credits- 4
No. of Contact Hours: Theory 18+ 18+18+18= 72 hrs; Practicals 09+27+09+18=63hrs)

Course Overview and Context:
The course provides a deep knowledge regarding the planning, designing and execution of research. The course is designed to enhance the student's ability to identify, analyse and select various research sources and adopt a proper methodology for the future research programmes as well as for project work. The statistical component of the course will enable the student to get deep insights on stastical tools and instrumentation for the conduct and execution of research experiments and its results interpretations.

Course objectives and Out come

1. The student applies knowledge of methods of Biostatistics and tests of significance for statistical inference.
2. The student understands the principles of experimental designs and differentiates between the different types of designs.
3. The student analyses a set of data for correlation/ regression and is able to determine the probability of different events.
4. The student understands the basic principles and applications of microscopy, instrumentation, chromatography, electrophoresis and spectroscopy.
5. Demonstrate competency in using standard laboratory instruments and function successfully in the laboratory.
6. Able to make temporary and permanent slides of plant materials.

PBT3CRT0119: RESEARCH METHODOLOGY, MICROTECHNIQUE, BIOSTATISTICS AND BIOPHYSICAL INSTRUMENTATION

(Theory: 18+18+18+18= 72 Hrs; Practicals: 09+27+09+18 = 63Hrs) Credits:4

RESEARCH METHODOLOGY (Theory: 18 Hrs)

Module 1: Introduction (3 hrs)
Need for research, objectives of research, types of research, stages of research; generation of a research problem, execution of work; interpretation of results: Analysis of data, interpretation and conclusions. Research ethics. Intellectual property rights (IPR): Copy right and patenting-*Brief account*.

Module 2: Review of literature (6 hrs)

Library: Structure of a Scientific Library, Journals (Current and Back-volumes), Books.
Catalogue: Types of catalogues- card catalogue, computerized catalogue.Classification of books (Universal decimal system). Journals: indexing journals, abstracting journals, research journals, review journals, e- journals. Impact factor of journals; h-Index; NCBI, PubMed, Medline. Other sources of references:reprints-acquisition and filing.Internet, open access initiative, INFLIBNET, INSDOC, N-list and Shodhganga. Preparation of index cards: author index and subject index. Open source bibliography. Management system, citation management tools (*E.g.Mendeley, EndNot*).

Module 3: Preparation of project report and Dissertation/Thesis (3 hrs)

Project report. Dissertation/Thesis: Selection of problem and its relevance; available information collected; Execution of experimental programmes; Writing dissertation (*IMRAD-System*): General Format; General principles in writing: Preliminary pages - title page, certificates, acknowledgements, and contents page. Main text of the Dissertation/Thesis: title, introduction, review of literature, material(s) and method(s), heading(s), result(s): table(s) and illustration(s), marginal indicator(s), caption(s), camera ready copy; discussion, summary and conclusion; references, abstract(s) and appendix.

Module 4: Preparation of Project Proposals,Presentation and Publication of Research Outcomes (6 hrs)

(a) Preparation of project proposal:title, introduction, literature review and abstract; aim and scope; present status; location of experiments; materials and methods; justification; expected outcome; date of commencement; estimated date of completion; estimated cost; references; funding agencies.

(b) Presentation and publication of research outcomes:

(i) Statistical analysis by using software (*Eg: - SPSS*).(ii) Preparation of research paper and short communications.(iii) Preparation of review articles.(iv) Proofreading-standard abbreviations for proof correction. (v) Presentation of Research findings in Seminars and Workshops.

Practical (9 Hrs)

1. Visit a scientific library or documentation center and submit a report.
2. Prepare a project proposal.
3. Prepare an outline of dissertation and research paper.
4. Prepare a list of references.

References

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2. Bedekar V. H. (1982). *How to write assignment and research papers, dissertations and thesis*.
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4. Clifford Hawkins and Marco Sorghi. *Research: How to plan and speak about it and write about it*. Narosa Publishing Company.
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10. Victoria E. McMillan (1997). *Writing papers in the biological sciences* (II Edn). Bedford books.
11. Vijay Upadhaya and Arvind Shende (2014). *Research methodology.* S. Chand and Company Pvt.Ltd. Newdelhi.

MICROTECHNIQUE (Theory: 18 Hrs)

Module 1: Killing and Fixing (3 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)

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. Embedding: Paraffin embedding. Sectioning: Free hand sections – Prospects and problems; sectioning in rotary microtome, sledge microtome and cryotome.

Module 3: Staining (5 hrs)

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

Module 4: Whole mounts (5 hrs)

Principles and techniques of whole mounting, TBA/Hygrobutol method, Glycerine-xylol method. Staining of whole mount materials (haematoxylin, fast green or Safranine-fast green combination). Significance of whole mounts. Techniques of smear, squash and maceration.Mounting: Techniques, common mounting media used - DPX, Canada balsam,Glycerin jelly and Lacto phenol. cleaning, labeling and storage of slides.

Practical (27 Hrs)

1. Students are expected to be thorough with the following techniques.
   (a) Preparation of semi-permanent slides.
   (b) Preparation of permanent slides.
   (c) Preparation of whole mounts.
   (d) Maceration.
   (e) Preparation of fixatives (FAA, Carnoys'fluid).
   (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 followingcategories should be included:
   (a) Free hand sections (single/double stained).
   (b) Serial sections (single/double stained).
   (c) Wood sections and whole mounts.

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BIOSTATISTICS (Theory18 Hrs)

Module 1: Introduction to Statistics (4 hrs)
Basic principles and methods of Biostatistics: data collection, Primary and Secondary data. Tools for data collection and presentation. Measures of central tendency and dispersion.
Module 2: Probability, Correlation and Regression (5 hrs)
Probability - Definition, Mutually exclusive and Independent events. Binomial and Normal - distribution.Linear Regression and Correlation (*Simple and Multiple*).
Module 3: Design of experiments (4 hrs)
Experimental Designs: Principles -Replication, Randomization and Local control.Common designs in Biological experiments: Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD), Factorial Design (FD).

Module 4: Tests of Significance (5 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 (9 Hrs)

1. Test the significance of a given data using t-Test, Chi square -test.
2. Analysis of a set of data for Correlation / Regression (Scatter diagram).
3. Determine the probability for different types of events.

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BIOPHYSICAL INSTRUMENTATION (Theory 18 Hrs)

Module 1: Introduction to Microscopy (3 hrs)
Parts of Microscope, Principles of Microscopy.Types of Microscopes- Simple and Compound; Stereo Microscope, Phase contrast Microscope, Fluorescence Microscope. Electron Microscopy (Eg: TEM, SEM, and E-SEM-*Brief account*).

Module 2: Principles and Applications of Instruments (6 hrs)
Micrometry.Basic principles and applications of pH meter, colorimeter,UV–Visible spectrophotometer and centrifuges (E.g. Table top and ultra centrifuge). Flow cytometry.Immunoassay system-RIA and ELISA.Cryobiology- Lyophilisation and its applications.Auto radiography and Liquid Scintillation counter.

Module 3: Basic Principles and Applications of Chromatography (4 hrs)
Types of Chromatography**:** Paper, TLC, Column chromatography, ion exchange chromatography, GCMS, HPLC, HPTLC and LCMS.

Module 4: Basic principles and applications of Electrophoresis and Spectroscopy (5 hrs)

Electrophoresis: Agarose gel Electrophoresis, SDS PAGE, Pulse Field Gel Electrophoresis. Fluorescence, UV, IR, ORD, Visible, NMR, ESR, and Atomic Absorption.

Practical: (18 Hrs)

1. Micrometry; calibrate the ocular and stage micrometre on a light microscope and measure an object.
2. Calibrate the pH meter and measure the pH of different samples.
3. Estimate the concentration of the given sample using colorimeter or spectrophotometer.
4. Separate plant pigments by TLC or Column chromatography.

References

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3. Pesce A J, Rosen C G, Pasty T L. *Fluorescence Spectroscopy: An introduction for Biology and Medicine*. Marcel Dakar.
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Course 2: PBT3CRT0219- Biotechnology, Bioinformatics and Bionanotechnology

No. of Credits- 4
No. of Contact Hours: Theory 72 hrs; Practicals 36hrs)

Course Overview and Context:
The programme and the course provides a sound and firm foundation in the principles underlying modern biotechnology techniques including plant tissue culture, cloning for expression of desired genes and its integration, a sound theoretical understanding with training in bioinstrumentation and bioinformatic tools that find application in biotechnological areas. The course is designed to enhance the student's ability to contribute to the development of scientifically just, ethical and culturally sensitive solutions incorporating biotechnology to solve complex problems for the economic upliftment of the society.

Course objectives and Out come

1. The students shall be able to learn and carry out tissue culture experiments.
2. The students will learn the regulations to be kept in mind while planning and executing biotechnology based research.
3. The students shall learn the tools and techniques of recombinant DNA technology
4. Students gain knowledge and develop skill in plant tissue culture techniques which finds application in the agricultural and environmental sectors.
5. The learner gains an insight into the judicious use of biotechnology for environmental and medical application and he/ she is aware of the ethical principles and issues pertaining to the use of genetic engineering.

PBT3CRT0219: BIOTECHNOLOGY, BIOINFORMATICS AND BIONANOTECHNOLOGY
(Theory 72 Hrs; Practical 36 Hrs; Credits: 4)

BIOTECHNOLOGY (54 hrs)

Module 1: Bioprocess Technology (5 hrs)

(a) Introduction to classical and modern biotechnology. Microbial biotechnology**:** Mode of operation of a bioprocess – basic concepts of batch, fed batch and continuous operation of a bioprocess.

(b) Basic design and construction of various types of bioreactors used in bioprocesses.

(c) Commercialproduction of metabolites using bioreactors. Submerged and solid state fermentation. Microbes in production of enzymes, antibiotics, biopolymers, bioethanol, organic acids, SCP.

Module 2: Plant tissue culture (12 hrs)

(a) Brief history and important milestones in plant tissue culture. Types of cultures: organized structures - meristem, shoot tip, node, embryo, root cultures; unorganized structures - callus, suspension and protoplast cultures. Cellular totipotency. Differentiation of cells in callus - tracheid formation, chloroplast differentiation. Factors influencing vascular differentiation. Organogenic and embryogenic differentiation.

(b) Culture protocol:General composition of the culture media; solid and liquid media – gelling agents. Preparation and standardization of MS medium for shoot and root differentiation. Sterlization of medium, glasswares, instruments, plant material, transfer area. Preparation of explants and inoculation, incubation. Pattern of growth and development, subculturing.

(c) Micropropagation:Methods – shoot tip and nodal segment culture, stages of micropropagation. Advantages and disadvantages of micropropagation. Applications of tissue culture.

Module 3: Genetic engineering (15 hrs)

(a) Important steps in Gene cloning:Basic principles of gene cloning.Isolation and purification of DNA from cells (Brief study). Isolation of DNA fragments of interest, creation of recombinant DNA – introduction into host cells, selection and screening of recombinants, propagation of recombinants.

(b) Tools and techniques: Restriction endonucleases, Ligases. Vectors – necessary properties of a vector, types of vectors based on origin; shuttle vectors, expression vectors.

(c) Plant transformation**:** *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. Plant transformation by direct transfer of DNA (Vectorless methods) - microprojectiles, electroporation, microinjection, chemical, lipofection.

(d) Applications of genetic engineering -in genetic studies, agriculture, and medicine (brief study citing specific examples)

Module 4: Genome editing (3 hrs)

Introduction, scope, methods and applications

Module 5: Advanced tools and techniques in Biotechnology (10 hrs)

(a) cDNA synthesis, artificial DNA synthesis – solid-phase synthesis.

(b) PCR - Procedure and applications, variants of PCR - Real time PCR and reverse transcriptase PCR and their applications.

(c) Automated DNA sequencing.

(d) *In vitro* mutagenesis, site directed mutagenesis.

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

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

(g) Procedure and applications of FISH and GISH

Module 6: Genomics (5 hrs)

Introduction to genome, genomics, transcriptomics and proteomics. Structural genomics - genome sequencing strategies. Genome annotation – structural and functional annotation, gene expression study using microarrays.

Module 7: Societal concerns with biotechnology (4 hrs)

Harm to the environment - potential impact of GMOs on the ecosystem; GM food – effect on health and environment. Misuse of modern molecular biology tools and techniques, bioweapons, bioterrorism. Ethical issues relating to rDNA techniques. Patents – issues relating to patenting living organisms, their genes and other bioresources.

BIOINFORMATICS (13 hrs)

Module 1:Methods, tools and applications of bioinformatics (3 hrs)

(a) Databases: Organization, primary and secondary databases. DNA sequence databases - Genbank, EMBL & DDBJ. Protein databases - SWISS-PROT, PDB. Sequence alignment: Significance; Global Alignment, pair wise analysis, Scoring Matrices (an introduction). Database similarity search – query sequence search; BLAST – Algorithm and different versions. FASTA. Multiple sequence analysis dynamic programming.

(b) Molecular Phylogeny: molecular clock hypothesis. Phylogenetic Trees, Terminology in Phylogenetic tree. Tree drawing Methods. Cladogram and Phylogram. Significance of Molecular Phylogeny.

(c) Structural Bioinformatics: Molecular structure viewing tool – Rasmol; Protein structure prediction – Secondary Structure prediction (Chou Fasman method), Tertiary structure prediction (Homology modeling).

Module 2 Advanced tools and techniques in Biotechnology (10 hrs)

(a) cDNA synthesis, artificial DNA synthesis – solid-phase synthesis. Construction of genomic and cDNA library.

(b) PCR - Procedure and applications, variants of PCR - Real time PCR and reverse transcriptase PCR and their applications.

(c) Automated DNA sequencing.

(d) *In vitro* mutagenesis, site directed mutagenesis.

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

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

(g) Procedure and applications of FISH and GISH

BIONANOTECHNOLOGY (5 Hrs)

Module 1: Introduction to nanoparticles and nanotechnology (3 hrs)

(a) An overview on concepts, strategies and tools. Types of nanoparticles and their relative merits and demerits.

(b) Method of biological synthesis of Zn and Ag nanoparticles – plant extract, bacteria and fungi.

Module 2: Applications of bionanotechnology (2 hrs)

Use of nanoparticles in agriculture, medicine and environment. Impact of NPs on germination and seedling emergence, parameters in various crops. Effect of NPs on gene expression. Translocation and accumulation of NPs in plant tissues and organs.

Practical (36 Hrs)

1. Production of amylase by solid state and submerged fermentation.
2. Preparation of the stock solutions of MS medium.
3. Preparation of MS medium from stock solutions.
4. Isolation, preparation, sterilization and inoculation of different explants like shoot tip, node, anther, embryo and cambium.
5. DNA isolation from coconut/onion/cauliflower and separation using agarose gel.
6. Blast search with Protein Sequence (*Magnolia latahensis*sequence)
7. Blast search with Nucleic Acid Sequence (Neanderthal man's Paleo DNA)
8. Phylogenetic tree creation with the help of CLUSTAL X, W or MUSCLE and tree drawing tools.
9. Creation of phylogentic trees for selected families ofEudicots
10. Molecular docking (using either free or commercialSoftware)

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Course-3: PBT3CRT0319- Angiosperm taxonomy, Economic Botany and Ethnobotany
No. of Credits- 4
No. of Contact Hours: Theory 72 hrs; Practicals 63hrs)

Course Overview and Context:

This course enables the learner to study the morphology, taxonomy of Angiosperms their economic value and ethnobotanical importance. The first seven modules of this course deal with the different classifications, concept of taxa, botanical nomenclature, and various families of Angiosperms as per Bentham and Hookers classification. The eighth modules deal with the importance of economic botany and important Plantation crops of Kerala. Next module discusses aspects like importance, sources and methods in ethnobotany, important tribal people of Kerala and plants used by them.

Course objectives and Out come

1. The student is able to differentiate between the salient features of various angiosperms families.
2. The student is able to identify the local flora using the Flora of the Presidency of Madras (J. S. Gamble).
3. The student applies knowledge to work out nomenclatural problems regarding priority and author citations.
4. The student analyses the economic importance of various plants belonging to different families.
5. The student understands the sources and methods of ethnobotanical studies.

PBT3CRT0319: ANGIOSPERM TAXONOMY, ECONOMIC BOTANYAND ETHNOBOTANY

(Theory - 72 Hrs;Practical - 63 Hrs; Credits: 4)

Module 1:Introduction (6 hrs)

Scope and significance of taxonomy. Major classification systems with emphasis on conceptual basis of classifications of (i) Linnaeus (ii) Bentham & Hooker (iii) Engler & Prantl (iv) Bessey (v) APG (brief synoptic account – current views).

Module 2:Units of classification and Phylogeny of Angiosperms(9hrs)

(a) Taxonomic hierarchy

(b) Concept of taxa: Concept of species: taxonomic, biological & phylogenic species. Concept of genus, family and infraspecific categories - subspecies, variety, forma.

(c) Phylogenetic terms: Premitive and advanced; Homology & Analogy; Parallelism and convergence; monophyly & polyphyly; phylogenetic tree(brief study).

(d) Numerical taxonomy and Cladistics – methodologies of study.

Module 3:Data sources of taxonomy (brief account): **(5hrs)**

(a) Concept of character

(b) Sources of taxonomic characters: Anatomy, cytology, phytochemistry, Molecular taxonomy, DNA barcoding.

Module 4:Methodology of Identification of plants (9 hrs)

(a) Usage of floras; Preperation of indented and bracketed keys

(b) Brief accounts on Flora of the British India, Flora of the Presidency of Madras, Hortus Malabaricus. Important Floras of Kerala

(c) Familiarization of Technical terms associated with the following: Habit, Habitat; Root, Stem, Leaf, Inflorescence; Bract & bracteoles; Flowers; Fruits and Seeds**.**

Module 5: **Tools of Taxonomy (3 hrs)**

Field study, Herbarium and Virtual herbarium, Important Botanical gardens; BSI; Botanical literature (Journals- print and online, Floras, Revisions,Monographs, Indices).

Module 6: Botanical Nomenclature (**4 hrs)**

(a) History of Botanical nomenclature and code

(b) Aims and principles of botanical nomenclature

(c) Study of major provisions of the code (ICN): Typification; Author citation; rule of priority; Effective and valid publication – as per the current code; Retention, rejection and choice of names.

Module 7: Study of angiosperm diversity (**27 hrs**)

Study of following families with reference to tropical flora, as per Bentham and Hooker's concept in detail with economic importance of members:

1.Ranunculaceae 2. Magnoliaceae 3. Annonaceae 4. Polygalaceae 5.Caryophyllaceae 6. Clusiaceae 7. Malvaceae8.Tiliaceae 9. Geraniaceae 10.Rutaceae 11. Vitaceae 12. Sapindaceae 13. Leguminosae 14. Myrtaceae 15.Melastomaceae16. Lythraceae 17. Cucurbitaceae 18. Aizoaceae 19. Apiaceae 20. Rubiaceae 21. Asteraceae 22.Campanulaceae 23. Myrsinaceae 24. Sapotaceae 25. Oleaceae 26. Apocynaceae 27. Asclepiadaceae 28. Boraginaceae 29. Convolvulaceae 30. Solanaceae 31.Scrophulariaceae 32. Acanthaceae 33. Verbenaceae 34. Lamiaceae 35. Polygonaceae 36. Aristolochiaceae 37. Lauraceae 38.Euphorbiaceae 39.Orchidaceae 40. Zingiberaceae 41. Liliaceae 42. Araceae 43. Cyperaceae 44.Poaceae.

Module 8:Economic Botany (6 hrs)

(a) Importance of economic botany. Important Plantation crops of Kerala and brief study on their various products - Rubber, Cardamom, Tea, Coffee, Coconut, Catechu.

(b) Major food plants: **Cereals**: Rice, wheat, maize, oats. **Millets**:Sorgum, Perl millet, Ragi, Italian millet. **Pulses**: Pigeon pea, Garden pea, Black gram, Green gram, Bengal gram. **Sugar**: Sugar cane.**Fruits**: Banana, Mango, Jack fruit, Apple, Pineapple, Orange, Lemon. **Vegetables**: All common vegetables used in traditional Keralakitchen. **Oil plants**: Coconut, Ground nut, Gingelly. **Spices**: Cardamom, Pepper,Ginger, Clove, Cinnamon, Coriander, Fennel, Fenugreek. **Fibre:** Coir, Jute, Cotton.

(c) **Gums and Resins**: White Damar, Gum Arabic, Asafoetida.

(d) **Medicinal plants**: Liquorice, Indian Sarsaparilla, Chitraka(*Plumbago*), Serpntine, Aswagandha, Asafoetida, Greater galanga,Turmeric, Mango ginger, Garlic, Ginger, Asoka tree, Vasaka, Indian Aloe, Holy Basil, Bel, Betel, Pepper, Belleric, Myrobalan, Chebulic myrobalan, Neem, Apple of peru(*Datura*).

Module 9: Ethnobotany (3 hours)

Importance, sources and methods; important tribal people of Kerala; plants used by them such as *Trichopus zeylanicus, Ochlandra travancorica, Dendrocalamus strictus, Gloriosa superba, Emilia sonchifolia, Andrographis paniculata*.

Practical (63 Hrs)

1. Workout a minimum of 2 members from each family with suitable sketches and description in technical terms of locally available plants. Record reasons assigned for Class, subclass, series/order, family and draw at least one species from each family in the record.
2. Identification of local flora using Flora of Presidency of Madras- J. S. Gamble.
3. Conduct study tour for not less than 5 days to study angiosperm diversity and collect plants from diverse habitats belonging to plant families specified above and also visit important botanical gardens and institutions of taxonomic research and submit a report.
4. Preperation of 25 herbarium specimens from the plant families of study and submit.
5. Study of preperation of dendrogram using a suitable software (of a family or Genus of study).
6. Workout nomenclatural problems regarding priority and author citations.
7. Familiarization of morphological terms form live specimens; specimens of economic botany from families of study.

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Course-4: PBT3CRT0419- ENVIRONMENTAL SCIENCE
No. of Credits- 3
No. of Contact Hours: Theory 54 hrs; Practicals 27hrs)

Course Overview and Context:
This course deals with the significance of ecosystems, environment and environmental factors and natural resources, it conservation and sustainable utilization. The impact of anthropological activities on environment and resources is one of the important focuses of the course. The significance of biodiversity in maintaining the balance of Mother Earth and develop strategies for its conservation and proper management is very significant part of this course

Course objectives and Out come

1. Students will be able to understand the concepts in population and community ecology.
2. Enable the student to understand the dynamics of ecosystem.
3. Learner will be able to compare the various ecosystems.
4. The students shall be able to realize the environmental issues of the present day.
5. The students will learn to behave responsibly in order to minimize impact on the environment.
6. The students will be able to devise ways to better interact with nature.

PBT3CRT0419: ENVIRONMENTAL SCIENCE

(Theory 54 Hrs; Practical 27 Hrs; Credits 3)

Module 1: Introduction to Ecological Science (2 hrs)

Definition, history and scope of ecology, Interdisciplinary nature of environmental sciences.

Module 2: Autecological concepts - Population Ecology (5 hrs)

(a) Characteristics of populations - size and density, dispersion, age structure, natality and mortality.

(b) Population growth - factors affecting population growth, environmental resistance, biotic potential, carrying capacity, positive and negative interaction, migration, subsistence density. Ecological consequence of overpopulations.

(c) Genecology - ecological amplitude, ecads, ecotypes, ecospecies, coenospecies,

Module 3: Synecological concepts - Community ecology (5 hrs)

(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, coefficient of communities; Sorenson's Index of similarity.

(c) Dynamic community characteristics - cyclic replacement changes and non-cyclic replacement changes.

Module 4: Dynamic Ecology - Ecological succession (3 hrs)

(a) The concept, definition and reasons of succession. Classification of succession: Changes - autogenic and allogenic, primary and secondary, autotrophic and heterotrophic.

(b) Retrogressive changes or the concept of degradation, concept of climax or stable communities, resilience of communities.

Module 5: Biosphere and Ecosystem (7 hrs)

(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) Comparative study of the major tropical ecosystems: Tropical rain forests, Wetlands and tropical coastal ecosystems. Special emphasis to tropical coastal ecosystems: Conservation and management of tropical coastal ecosystems: The values of coastal ecosystems, issues of coastal ecosystems in the tropics, goals for conservation and management of tropical ecosystems: Providing for resilience, maintain/restore connectivity, protect water quality, conservation and recovery of Species-at-Risk, understanding the socio-economic context.

Module 6: Phytogeography (5 hrs)

(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.

(c) Remote sensing: Definition and data acquisition techniques. Application of remote sensing, geospatial variability and geotagging.

Module 7: Environmental pollution (10 hrs)

(a) Definition and classification.

(b) Water pollution: Water quality parameters and standards, different types of pollutants and their consequences. Types of water pollution, prevention and control - 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.

Module 8: Environmental biotechnology and solid waste management (4 hrs)

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

Module 9: Global environmental problems and climate change (4 hrs)

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

(b) Factors responsible for climate change, *El-Nino* and *La Nina* phenomenon and its consequences.

(c) Effect of climate change on biogeography.

(d) Environmental laws, environmental monitoring and bio indicators, environmental safety provisions in Indian constitution, major environmental laws in India, ISO-14000.

(e) Disaster management; preparedness and planning

Module 10: Biodiversity and its conservation (9 hours)

(a) Biodiversity- definition, the number of known plants in the world (upto groups), current biodiversity loss - concept of endemism, rare, endangered and threatened species (RET), key stone species, IUCN account of biodiversity, red data book and hot spots, reasons to stop extinction, methods to save species.

(b) Principles of conservation - *ex-situ* and *in-situ* conservation techniques. Biodiversity conservation: Species diversity, community diversity, ecosystem diversity. Role of biotechnology in conservation of species.

(c) The natural longevity of species, rain forests as centres of diversity, ecological restoration

(d) Ecotourism - positive and negative impacts.

Practical (27 hrs)

1. Analysis of water quality for; (a) Dissolved CO_2 (b) Dissolved oxygen (c) COD (d) Total dissolved minerals (e) Quantitative estimation of dissolved chloride ions and dissolved sulphate (f) Total alkalinity.

2. Quantitative estimation of dissolved silicate, dissolved sulphate, nitrite and total alkalinity.

2. Physico-chemical analysis of soil: (a) Total water soluble mineral ions (b) estimation of soil organic carbon (Walkey and Black method).

3. Quantitative and qualitative community analysis. Carry out a project on species structure and the frequency, abundance, density of different species and similarity index of different communities in a natural system. Students must be able to explain the structure of vegetation from the given data on the above mentioned characteristics.

4. Phytoplankton counting using Sedgwick Rafter counter.

5. Field visit to natural ecosystem and identification of trophic levels, food webs and food chains, plant diversity (species and community) and submit a report.

6. Students should be aware of the common environmental problems, their consequences and possible solutions.

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MODEL QUESTION PAPERS – THEORY

M Sc Botany Degree (CSS) Examination

III Semester

Faculty of Science

PBT3CRT0119: RESEARCH METHODOLOGY, MICROTECHNIQUE, BIOSTATISTICS AND BIOPHYSICAL INSTRUMENTATION

Time: 3 hours **Max. Weight: 30**

Section A

(Answer any **six** questions. Each question carries a weight of 1)

1. Describe the structure of scientific library.
2. Describe the principle and technic of fixing. Write the composition of FAA.
3. Give brief account of different type of journals.
4. Describe Primary and Secondary data.
5. Describe quantitative and qualitative data.
6. Write the principle and use of Phase contrast microscope.
7. Why is a statistical test necessary to determine the exceptability of an observed set of data?
8. Write the preparation of hematoxylin.

(6 x 1 = 6)

Section B

(Answer any **seven** questions. Each question carries a weight of 2)

9. Explain the principle and working of colorimeter?
10. Explain different type of microtomes used in microtechnique.
11. Write an essary on literature survey and its importance in research.
12. What are a different stages of research?
13. Write note on permanent whole mount preparation.
14. What are histochemical stain? Write its significance.
15. Describe the principles of electron microscopy.
16. How chi-square test is used for the detection of linkages?
17. Describe the basic principles and applications of ELISA.
18. Write a short essay on electrophoresis.

(7 x 2 = 14)

Section C

(Answer any **two** questions. Each question carries a weight of 5)

19. Prepare a sample project proposal on environment problem for submission to UGC. 20.Describe various steps in making permanent serial sections.
21. Describe experimental designing used for different types of study.

(2 x 5 = 10)

M Sc Botany Degree (CSS) Examination
III Semester
Faculty of Science

PBT3CRT0219: ANGIOSPERM TAXONOMY, ECONOMIC BOTANYAND ETHNOBOTANY

Time: 3 hours **Max. Weight: 30**

Section A

(Answer any **six** questions. Each question carries a weight of 1)

1. Describe the primitive characters Magnoliaceae.
2. Explain the pliesiomorphic and apomorphic characters.
3. Write an account on androecium of Orchidaceae.
4. Write the binomials and families of the following:
   (a) Tea (b) Chinese Potato (c) Rose wood (d) Cane
5. With the suitable example describe the medicinal importants of Apocymaceae.
6. Give the family name and economic products of the following plants:
   (a) *Mentha arvelsis* (b) *Lagenaria vulgaris* (c) *Cymbopogon citrates* (d) *Foeniculum vulgare.*
7. What is herbariam? How herbariam is labeled?
8. What is Ethnobotany?

(6 x 1 = 6)

Section B

(Answer any **seven** questions. Each question carries a weight of 2)

9. Give any two plant products used by tribals for stomac ache.
10. What is BSI? Write its functions.
11. Critically evaluate the Engler's system of classification.
12. Compare the families of Verbenaceae and Lamiaceae.
13. Explained different type of keys used for plant identification.
14. Write the economic importance of family Cucurbitaceae.
15. Explain the floral characters of Euphorbiaceae.
16. Comment on the systematic position and effenity of the following genera.
    (a) *Nyctanthes*(b) *Coleus* (c) *Luffa*
17. Describe the advanced floral characters in the families of disciflorae.
18. Comment on the economic importance of the following:
    (a) *Saccharum officinarum* (b) *Dalbergia sissoo* (c) *Adhatoda vasica* (d) *Cinnamomum camphora*

(7 x 2 = 14)

Section C

Answer any **two** questions. Each question carries a weight of 5)

19. Critically evaluate the system of classification of angiosperm by Hutchinsom and compare it with B&H classification.
20. Describe the floral features of Umbelliferae and Guttiferae.
21. Compare and vegetatitve and floral features of the families of Bicarpellatae and write note on its evolutionary trends.

(2 x 5 = 10)

M Sc Botany Degree (CSS) Examination
III Semester
Faculty of Science
PBT3CRT0319: BIOTECHNOLOGY, BIOINFORMATICS AND BIONANOTECHNOLOGY (2019 onwards)

Time: 3 hours **Max. Weight: 30**

Section A

(Answer any **six** questions. Each question carries a weight of 1)

1. Differentiate between stirred tank and airlift bioreactors.
2. What is androgenesis?
3. What are the causes of somaclonal variation?
4. Name four industrial chemicals produced by using microbial activities. Write the names of the microorganisms involved in each.
5. What is enzyme engineering? What are the applications of it?
6. Briefly describe bioaugmentation.
7. How are triploids produced?
8. How do we produce stem cells?

(6 x 1 = 6)

Section B

(Answer any **seven** questions. Each question carries a weight of 2)

9. Describe the importance of using tissue culture in producing secondary metabolites.
10. Define the following;

a)Totipotency (b) Synseeds (c) Haploids (d) Stem cells

11. Write an account on the procedure and applications of hairy root culture.
12. Giving suitable examples, discuss downstream processing.
13. What are cybrids? How are they produced? Discuss the use of cybrids in crop improvement programmes.
14. Citing suitable examples, discuss the importance of GMOs in bioremediation
15. Describe the procedure of plant protoplast isolation and purification.
16. Briefly describe the prospects and future of stem cell research.
17. What is germplasm? Describe the methods of germplasm conservation. Add a note on the importance of tissue culture as a method of germplasm conservation
18. Write an account on the methods and applications of cell immobilization.

(7 x 2 = 14)

Section C

Answer any **two** questions. Each question carries a weight of 5)

19. Describe the procedure and applications of;

(a) Cryopreservation (b) Protoplast culture (c) Microspore culture (d) Cellulase production

20. What is enzyme immobilization? Describe the steps involved and the potential applications. Add a note on enzyme engineering.
21. Write an essay on bioremediation.

(2 x 5 = 10)

M Sc Botany Degree (C.S.S) Examination

III Semester

Faculty of Science

Course Code- **PBT3CRT0419**: Environmental Science

(2019 admissions onwards)

Time: Three hours Max. Weight: 30

Section- A

(Answer any **six** questions. Each question carries a weight of 1)

1. Define the scope of ecology
2. What is biotic potential?
3. Describe ecads and ecotypes
4. Define consociation and formation
5. What is meant by resilience of communities?
6. What is smog?
7. Define phytoremediation
8. Define key stone species

(6 x 1 = 6)

Section B

(Answer any **seven** questions. Each question carries a weight of 2)

9. Define primary production. Explain any two methods of estimating primary productivity.
10. Describe discontinuous distribution with suitable example
11. What is ecotone and edge effect
12. What are wetlands, why they are known as *biological supermarkets* and *kidneys of landscapes*
13. Describe the community classification by Clement
14. Describe geospatial variability and geotagging
15. Mention the factors affecting plant distribution
16. Comment on disaster management
17. Mention the causes and effects of radioactive pollution
18. Distinguish between *El-Nino* and *La Nina* phenomenon

(7x 2 = 14)

Section C

(Answer any **two** questions. Each question carries a weight of 5.)

19. Global warming and its impacts
20. Explain remote sensing and its applications
21. Elaborate biodiversity and principles of conservation

(2 x 5 = 10)

SEMESTER IV

FOURTH SEMESTER COURSES
PROGRAMME ELECTIVE - BIOTECHNOLOGY

Course Code	Name of the Course	Teaching hours		Credits
		Theory	Practical	
PBT4CRT0119	Plant Tissue Culture & Microbial Biotechnology	90	72	4
PBT4CRT0219	Genetic Engineering, Genome Editing & Immunology	90	72	4
PBT4CRT0319	Genomics, Transcriptomics, Proteomics and Bioinformatics	90	72	4
PBT4CRP0119	Plant Tissue Culture & Microbial Biotechnology (PRACTICAL)			2
PBT4CRP0219	Genetic Engineering, Genome Editing, Immunology+ Genomics, Transcriptomics, Proteomics &Bioinformatics (PRACTICAL)			2
PBT4 CPR0119	Project Work			4
PBT4CRV0119	Viva-Voce			3

Total credits: 23
Total hours: 450

Course 1: PBT4CRT0119- Plant Tissue Culture and Microbial Biotechnology

No. of Credits- 4

No. of Contact Hours: Theory 90 hrs; Practicals 72hrs)

Course Overview and Context:

The programme and the course provides a sound and firm foundation in the principles underlying modern biotechnology techniques including plant tissue culture, cloning for expression of desired genes and its integration, a sound theoretical understanding with training in bioinstrumentation and bioinformatic tools that find application in biotechnological areas. The course is designed to enhance the student's ability to contribute to the development of scientifically just, ethical and culturally sensitive solutions incorporating biotechnology to solve complex problems for the economic upliftment of the society.

Course objectives and Out come

1. The students shall be able to learn and carry out tissue culture experiments.
2. The students will learn the regulations to be kept in mind while planning and executing biotechnology based research.
3. The students shall learn the tools and techniques of recombinant DNA technology
4. Students gain knowledge and develop skill in plant tissue culture techniques which finds application in the agricultural and environmental sectors.
5. The learner gains an insight into the judicious use of biotechnology for environmental and medical application and he/ she is aware of the ethical principles and issues pertaining to the use of genetic engineering.

PROGRAMME ELECTIVE - BIOTECHNOLOGY PBT4CRT0119**. PLANT TISSUE CULTURE AND MICROBIAL BIOTECHNOLOGY (Theory 90 hrs; Practical 72 hrs; Credits 4)**

Module 1: Tissue culture regeneration of plants (10 hrs)

(a) Adventitious shoot regeneration: Direct and indirect regeneration; factors influencing adventitious regeneration.

(b) Somatic embryogenesis: Direct and indirect, initiation of embryogenic cultures and regeneration of plants; factors regulating somatic embryogenesis. Synthetic seed production - protocol, types of synthetic seeds. Applications and limitations of synthetic seeds.

Module 2: Somaclonal variation (8 hrs)

Origin of somaclonal variation. Reasons for somaclonal variation – molecular basis. Applications of somaclonal variation.

Module 3: Embryo and meristem culture (3 hrs)

Methodology and applications.

Module 4: Protoplast culture (8 hrs)

(a) Isolation, purification and culture of protoplasts. Regeneration of plants from protoplasts. Significance of protoplast culture.

(b) Protoplast fusion (somatic hybridization) – chemical, mechanical, electrofusion. Isolation and selection of heterokaryons, regeneration and analysis of somatic hybrids; Cybrids. Applications of protoplast culture and somatic hybridization.

Module 5: Production of ploidy variants (12 hrs)

(a) Haploids: In vitro androgenesis – protocol for anther and microspore culture, advantages, applications. **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: In vitro germplasm conservation (6 hrs)

Importance of *in vitro* conservation. Short and medium term storage of germplasm, Cryopreservation technique – importance and methodology of cryopreservation. DNA banking for germplasm conservation.

Module 7: Production of secondary metabolites (6 hrs)

Culture conditions for producing secondary metabolites, selection of high yielding lines, elicitation. Hairy root culture – advantages of using hairy root culture, establishment of hairy root culture and production of secondary metabolites. Biotransformation.

Module 8: Cell and enzyme technology (5 hrs)

(a) Cell immobilization: Methods, advantages and applications.

(b) Enzyme immobilization: Methods and applications. Enzymes as biosensors. Enzyme engineering,

Module 9: Microbial technology (16 hrs)

(a) Screening of microbes for metabolite production - selection of media, strain improvement. Bioreactors – airlift, stirred tank, bubble column, rotary drum. Fermentation process - batch, fed batch, continuous fermentation. Process control during fermentation - pH, aeration, agitation, temperature, foam control. Downstream processing.

(b) Large scale production of antibiotics - penicillin, streptomycin; industrial chemicals - ethanol, acetone, citric acid; SCP – *Spirulina* and *Chlorella*; Biofertilizers – *Azotobacter* and *Rhizobium*; Bioinsecticides – *B. thuringeansis*, NPV. Commercial production of enzymes and their uses - amylase, cellulase, polygalacturonase.

Module 10: Tissue engineering and Stem cell technology (6 hrs)

Regenerative medicine, methods and applications of tissue engineering. Stem cells – embryonic stem cell and adult stem cells – production and applications.

Module 11: Bioremediation (10 hrs)

Importance and advantages of bioremediation, bioleaching, xenobiotics, organisms used for bioremediation. Cleaning strategies for water and soil - *in situ* and *ex situ* technologies. Bioremediation of radioactive wastes. Use of GMOs in bioremediation.

Practical (72 hrs)

1.Isolation of explants, establishment, subculture and maintenance of callus.

2. In vitro morphogenetic studies in any one plant system

3. Study of the morphology of callus cells – callus smear prelaration, histological aspects, microtomy.

4. Isolation and fusion of plant protoplasts.

5. Preparation of synthetic seeds.

6. Preparation of selective medium for drought or salinity resistance. Preparation of MS medium from stock solutions containing auxin and cytokinin, NaCl or PEG, and inoculation.

7. Cell immobilization.

8. Application of immobilized yeast cells for ethanol production.

9. Isolation of microbes producing Organic acids/Enzymes.

10. Find out the uninucleate stage of pollen for anther culture.

11. Dissect out an embryo from any seed and culture it on a suitable solid medium.

12. Cell plating technique.

References

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Course-2: PBT4CRT0219- Genetic Engineering, Genome Editting and Immunology

No. of Credits- 4

No. of Contact Hours: Theory 90 hrs; Practicals 54hrs)

Course Overview and Context:

The present course provides a firm foundation in the principles underlying in modern genetic engineering and cloning techniques. The course also discusses the basic and applied aspects of genetic engineering and it gives an overview of recombinant DNA biosafety guidelines and regulatory mechanisms for their implementation.

Course objectives and Out come

1. Explain and demonstrate the methodology of nucleic acid isolation and its visualization by electrophoresis.
2. To explain the construction and application of cloning vectors from different categories.
3. To explain the construction of DNA libraries and their applications.
4. To explain different strategies for gene silencing.
5. The students will learn the regulations to be kept in mind while planning and executing biotechnology based research.
6. The student understands the basic principles, techniques and strategies involved in immunology.

PROGRAMME ELECTIVE - BIOTECHNOLOGY PBT4CRT0219**: GENETIC ENGINEERING, GENOME EDITING AND IMMUNOLOGY (Theory 90 hrs; Practical 54 hrs; Credits 4)**

Module 1: Important tools and techniques in gene cloning (18 hrs)

(a) DNA cutting and modifying enzymes: restriction endonucleases – types, mode of action; alkaline phosphatase, polynucleotide kinase, S1 nuclease, exonucleases, Ligases.

(b) In vitro DNA ligation strategies: Joining with ligases – adaptors, linkers and homopolymer tailing; topoisomerases, and site-specific recombinase

(c) Vectors: plasmid vectors, phage vectors and artificial chromosomes – BAC, YAC, PAC, HAC – important features, construction and applications of each.

(d) Cloning strategies: Genomic libraries, preparation of DNA fragments for cloning. Bacterial transformation, *in vitro* phage packaging and transfection.

(e) Selection and screening of recombinants: insertional inactivation, complementation of defined mutation, microarray techniques, immunological screening for expressed genes. Reporter systems – *Lac Z* system, GFP.

Module 3: Gene library (10 hrs)

(a) 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 4: Advanced transgenic technology (6 hrs)

Inducible expression systems – trtracycline expression system; site-specific recombination for *in vivo* gene manipulation, gene targeting, gene silencing using antisense RNA and RNAi. RNAi therapy.

Module 5: Applications of rDNA technology (10 hrs)

(a) Uses of GM microbes: Bacteria and yeast– production of useful proteins, basic genetic research. Applications of GM animals: In basic research, producing novel proteins; disease studies, prevention and cure diseases.

(b) Uses of transgenic plants: Herbicide, insect and disease resistance, stress resistance. Genetic engineering for increasing nutritional and other novel qualities in plants, pharming.

Module 6: Genome editing (12 hrs)

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

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

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

Module 7: Gene therapy (8 hrs)

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

Module 8: Protein engineering (5 hrs)

Approaches to protein engineering - protein modification by site-directed mutagenesis, combinatorial methods. Applications of protein engineering.

Module 9: Biosensors (6 hrs)

Design and operation, types. Applications - medical, food and agriculture, industrial, pollution monitoring. GMOs as biosensors.

Module 10: Immunology (14 hrs)

(a) Innate and acquired immunity. Cells and molecules involved in innate and acquired immunity, humoral and cellular immunity, Antigens, Epitopes. Structure, function and types of antibody molecules.

(a) Generation of antibody diversity. Antigen-antibody interactions. Antigen processing and presentation. Activation and differentiation of B cells – formation, role. T cells – types, roles, T cell receptors. 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.

(b) Production and uses of monoclonal antibodies, antibody engineering.

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

Practical (54 hrs)

1. Identification of chemicals/reagents, tools, techniques, and procedures used in genetic engineering.
2. Work out problems based on restriction digestion of DNA, gel separation pattern etc.
3. Isolation of plant genomic DNA and its quantification.
4. Isolation of plasmids and its purification, by minipreparation and midipreparation.
5. Isolation of bacterial genomic DNA and its quantification by using UV spectrophotometer.
6. Separation of DNA by agarose gel electrophoresis.
7. Extraction and quantification of protein by Bradford method.
8. Separation of proteins by PAGE.

9. Conduct PCR.

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Course-3: PBT4CRT0319- Genomics, Transcriptomics, Proteomics and Bioinformatics
No. of Credits- 4
No. of Contact Hours: Theory 90 hrs; Practicals 54hrs)

Course Overview and Context:
The course aims to appraise the students to basic and high throughput techniques in Genomics and Proteomics and their applications.Advances in the technologies and informatics used to generate and process large biological data sets (omics data) are promoting a critical shift in the study of biomedical sciences. While genomics, transcriptomics and proteinomics, coupled with bioinformatics and biostatistics, are gaining momentum, they are still, for the most part, assessed individually with distinct approaches generating monothematic rather than integrated knowledge. As other areas of biomedical sciences, including metabolomics, epigenomics and pharmacogenomics, are moving towards the omics scale, we are witnessing the rise of inter-disciplinary data integration strategies to support a better understanding of biological systems and eventually the development of successful precision medicine. It is therefore felt that this course will helps to target students and researchers seeking knowledge outside of their field of expertise and fosters a leap from the reductionist to the global-integrative analytical approach in research.

Course objectives and Out come

1. Students will be able to understand the basic steps in genome mapping and sequencing and targets students and researchers seeking knowledge in this new area of science.
2. Infer the basic concepts of genomics, transcriptomics and proteomics.
3. List and discuss the use of genomics and proteomics in human health.
4. Suggest and outline solution to theoretical and experimental problems in Genomics and Proteomics fields.

PROGRAMME ELECTIVE - BIOTECHNOLOGY
PBT4CRT0319**: GENOMICS, TRANSCRIPTOMICS, PROTEOMICS AND BIOINFORMATICS**
(Theory 90 hrs; Practical 54 hrs; Credits 4)

Module 1: Genome mapping (12 hrs)
(a) Genome map – definition, types, and significance in genomics.
(b) Cytogenetic map – types (Brief study)

(c) Genetic mapping – basic principles for the construction of linkage maps. Markers for genetic mapping – genes, biochemical markers, molecular markers. Construction of linkage maps using molecular markers - RFLP, RAPD, AFLP, SSLP, SNP.

(d) Physical mapping – restriction mapping, STS mapping, EST.

Module 2: Genome sequencing (14 hrs)

(a) Basic steps in genome sequencing. Shot gun sequencing of small genomes. Hierarchical shot gun sequencing. Whole genome shot gun approach.

(b) Sequence assembly – methods used.

(c) Next generation sequencing strategies: Preparation of sequencing library. Reversible terminator sequencing (Illumina sequencing), Pyrrosequencing, 454 sequencing, ion torrent method, SOLiD. Third and Fourth generation sequencing.

(e) Important findings of the completed genome projects: Human genome project, Rice genome project, Arabidopsis genome project, *E. coli* genome project, Wheat genome project.

Module 3: Genome annotation (11 hrs)

(a) Structural annotation: by computer analysis of sequence data and experimental techniques

(b) Functional annotation: by computer based methods and experimental methods

Module 4: Comparative genomics (5 hrs)

Orthologs and Paralogs, gene identification by comparative genomics, comparative genomics as a tool in evolutionary studies. Metagenomics.

Module 5: Transcriptomics (5 hrs)

Components of the transcriptome. Methods of transcriptome analysis and its importance in genome annotation.

Module 4: Proteomics (8 hrs)

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

Module 5: Bioinformatics (27 hrs)

(a) Internet and WWW. National Centre for Biotechnology Information – SRS. Computational Biology and Bioinformatics. Database organization and function. Types of databases based on the data storage pattern. Submission to and retrieval from databases – BankIt and sequin. Secondary Databases (PROSITE, PRINTS, BLOCKS).

(b) Sequence Analysis: Global Alignment, pairwise analysis, Scoring Matrices (an introduction), Database similarity search – query sequence search; BLAST – Algorithm and different versions; FASTA. Multiple Sequence Analysis dynamic programming for sequence alignment. Tools for multiple sequence alignment – CLUSTAL X/W.

(c) Structural Bioinformatics: Molecular Structure viewing tool – Rasmol; Protein structure prediction, secondary structure prediction - Chou Fasman method and other Bioinformatics tools

for secondary structure prediction; Tertiary structure prediction - comparative modeling, Abinitio prediction, Homology modeling.

(d) Gene prediction strategies, ORF search, gene prediction programs – Grail/Exp, GENSCAN, ORF finder. RNA secondary structure prediction.

(e) Computer assisted drug design - concept, methods and practical approaches. Brief study about Docking tools, AutoDock, molegro virtual docker, GOLD.

(f) Applications of bioinformatics in evolutionary studies, molecular clock hypothesis. Molecular Phylogeny – Gene and Species tree. Molecular evolution and Kimuras theory,

Phylogenetic Trees, Terminology in Phylogenetic tree. Tree drawing Methods. Cladogram and Phylogram, Significance of Molecular Phylogeny.

Module 6: Ethical, legal, and social impact of complete genome analysis (8 hrs)

Genome data availability – Problems with public availability of sequence data, privacy concerns, legal problems, gene and DNA sequence patenting, patenting transgenics.

Practical (54 Hrs)

1.Blast search with Protein sequence (e.g. *Cytochrome C*sequence)

2. Blast search with Nucleic Acid Sequence (e.g *Magnolia latahensis* & Neanderthal man Paleo DNAs)

3. Carry out multiple sequence alignment using the given DNA sequences.

4. Phylogenetic tree creation with CLUSTAL X, W and MUSCLE and tree viewing tools. NJ Plot, Tree View, MEGA

5. Creation of phylogentic trees for selected families of Eudicots

6. Molecular structure viewing - use of Rasmol (supply structure of a few proteins downloaded from PDB).

7. Locate specific sequences like TATA box, promoters, start signals, stop signals etc. in a DNA sequence using computer programmes e.g., *E. coli* promoter, human promoter.

8. Laboratory/Industry visit: Students are expected to conduct a visit to a sophisticated biotechnology laboratory/research centre/biotechnology industry to have an idea on the type of work going on there. A report of the visit should be prepared and submitted.

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MODEL QUESTION PAPERS - THEORY
M Sc Botany Degree (CSS) Examination
IV Semester
Faculty of Science
Programme Elective - Biotechnology
PBT4CRT0119**. PLANT TISSUE CULTURE AND MICROBIAL BIOTECHNOLOGY**
(2019 onwards)

Time: 3 hours **Max. Weight: 30**

Section A

(Answer any **six** questions. Each question carries a weight of 1)

1. Differentiate between stirred tank and airlift bioreactors.
2. Define the following;
   (a) Totipotency (b) Synseeds (c) Haploids (d) Stem cells 3. What is androgenesis?
4. What are the causes of somaclonal variation?
5. Name four industrial chemicals produced by using microbial activities. Write the names of the microorganisms involved in each.
6. Briefly describe bioaugmentation.
9. How are triploids produced?
10. How do we produce stem cells?

(6 x 1 = 1)

Section B

(Answer any **seven** questions. Each question carries a weight of 2)

9. Describe the importance of using tissue culture in producing secondary metabolites
10. What is enzyme engineering? What are the applications of it?
    11. Write an account on the procedure and applications of hairy root culture. 12.Giving suitable examples, discuss downstream processing.
13.What are cybrids? How are they produced? Discuss the use of cybrids in crop improvement programmes.
14.Citing suitable examples, discuss the importance of GMOs in bioremediation
    15. Describe the procedure of plant protoplast isolation and purification. 16.Briefly describe the prospects and future of stem cell research.
17.What is germplasm? Describe the methods of germplasm conservation. Add a note on the importance of tissue culture as a method of germplasm conservation
18. Write an account on the methods and applications of cell immobilization.

(7 x 2 = 14)

Section C

Answer any **two** questions. Each question carries a weight of 5)

19.Describe the procedure and applications of;
(a) Cryopreservation (b) Protoplast culture (c) Microspore culture (d) Cellulase production
    20. What is enzyme immobilization? Describe the steps involved and the potential applications. Add a note on enzyme engineering.
21. Write an essay on bioremediation.
22. Describe the various tissue culture techniques used to produce ploidy variants in plants.

(2 x 5 = 10)

M Sc Botany Degree (CSS) Examination
IV Semester
Faculty of Science
Programme Elective - Biotechnology
PBT4CRT0219**: GENETIC ENGINEERING, GENOME EDITING AND IMMUNOLOGY**
(2019 onwards)

Time: 3 hours **Max. Weight: 30**

Section A
(Answer any **six** questions. Each question carries a weight of 1)

1 Where does T DNA come from, and how is it used in making transgenic plants?
2. Name the key tools for accomplishing the tasks of recombinant DNA technology. Also mention the functions of each tool.
3. Explain the purpose of selectable marker genes in cloning experiments.
4. Explain how edible vaccines work?
5. Distinguish between genomic library and cDNA library
6. What are the advantages of Bt plants?
7. Write the important features in pUC.
8. What is antibody engineering?

(6 x 1 = 6)

Section B
(Answer any **seven** questions. Each question carries a weight of 2)
9. Explain what is meant by the following terms in relation to genetic engineering;
a)Transformation (b) Polylinkers (c) Lipofection (d) Expression
10. Comment on gene augmentation therapy.
11. Describe the following;
(a) BAC (b) DNA probes (c) Electroporation (d) TALEN
12. Highlight any four areas where genetic modification of plants has been useful.
13. What is a recombinant DNA vaccine? Give two examples
14. Explain the gene therapy strategy applied to treat a patient suffering from ADA deficiency.
15. You have identified a useful gene in bacteria. Make a flow chart of the steps that you would follow to transfer this gene to a plant.
16. Describe the important applications of Biosensors.
17. Describe the steps involved in the creation of a genomic library.
18. Comment on RNAi therapy.

(7 x 2 = 14)

Section C
Answer any **two** questions. Each question carries a weight of 5)

19. What is monoclonal antibody? How is monoclonal antibody produced in large scale? What are the uses of it?
20. Describe the following;
(a) Plaque hybridization (b) Biopharming (c) *In vitro* mutagenesis (d) Artificial chromosomes
21. 'Genes could be silenced using RNA'. Explain the methods used with examples.

(2 x 5 = 10)

M Sc Botany Degree (CSS) Examination
IV Semester
Faculty of Science
Programme Elective - Biotechnology
PBT4CRT0319**: GENOMICS, TRANSCRIPTOMICS, PROTEOMICS AND BIOINFORMATICS**
(2019 onwards)

Time: 3 hours **Max. Weight: 30**

Section A
(Answer any **six** questions. Each question carries a weight of 1)

1. What is multiple sequence alignment? Where is it useful?
2. What is a DNA marker? Give two examples.
3. Explain how some of the Restriction enzymes produce "sticky ends" while DNA is cut?
4. Write a brief note on metagenomics.
5. Explain the following terms related to drug design;
   (a) GOLD (b) ORF (c) SOLiD (d) EST 6. What is STS?
7. How is GFP useful for protein localization in a living cell?
8. What is cladogram?

(6 x 1 = 6)

Section B
(Answer any **seven** questions. Each question carries a weight of 2)

9. What are secondary databases? Give examples.
10. Distinguish between a physical map and a genetic map.
11. Describe the major findings of HGP.
12. What is comparative genomics? How is it useful in determining the evolutionary relationships between organisms?
13. Explain the features of GENSCAN.
14. Explain the working and important features of BLAST?
15. What are the applications of genome sequencing?
16. Describe the following;

(a) Microarrays (b) Immunoprecipitation (c) Knock down mutants (d) SNP

17. Describe the different genome sequencing strategies
18. Describe the strategies adopted for sequence assembly.

(7 x 2 = 14)

Section C
Answer any **two** questions. Each question carries a weight of 5)

19. Describe the methods adopted for the annotation of the genome sequence.
20. Write an essay on the ethical, legal, and social issues generated by large-scale sequencing of genomes.
21. Explain the application of bioinformatics in evolutionary studies

(2 x 5 = 10)