

ST. JOSEPH'S COLLEGE (AUTONOMOUS)
IRINJALAKUDA, THRISSUR DISTRICT
KERALA - 680121



College with Potential for Excellence (CPE)
NAAC Accredited with 'A' Grade

CURRICULA AND SYLLABI FOR

Post Graduate Programme in Botany

Under Choice Based Credit & Semester System

2021 Admissions





ST. JOSEPH'S COLLEGE (AUTONOMOUS), IRINJALAKUDA DEPARTMENT OF BOTANY

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4	Dr. Jose T. Puthur.	Reader	Department of Botany, University of Calicut.
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FOREWORD

The future of the credibility of the higher education system depends on the success of the implementation of autonomy. The anticipated outcome of the whole exercise depends, in particular, on the mainstay of any educational institution- the curricular aspects. As an autonomous college since 2016, St. Joseph's has the mandate to visualize appropriate curricula for particular programmes, update and revise them periodically, and make sure that the expected outcomes are successfully achieved.

A wide range of course options that are in tune with the emerging national and global trends and relevant to the local needs were considered by the institution prior to the P.G. restructuring exercise. Diversity and flexibility, career orientation, skill acquisition, and research enhancement were considered and a structured feedback system established to gather the opinions and suggestions of all the stakeholders including the students, the faculty, the staff, the industry experts, the alumnae, the parents and the employers.

Curricula evolved also took into account the attainment of program, program specific and course outcomes. Evaluation of the curricular intake and delivery is done at the year end to find suggestions for change.

I Sincerely acknowledge the members on the various Boards of Studies and on the Academic Council for their time and expertise in helping us come to a decision regarding Curricula and Syllabi restructuring and redesigning. Thanks are also due to the team IQAC for their relentless endeavours in enhancing quality of education delivery, and in particular, for their efforts to organize workshops and invited talks to orient the faculty and students towards the necessities implied in the restructuring process. I would also like to thank the Heads of Departments and faculty and staff who co-operated with the same.

PRINCIPAL



ACKNOWLEDGEMENT

As the Chairperson of the Board of Studies of M. Sc. Programme in Botany of St. Joseph's College (Autonomous), Irinjalakuda, I express my sincere thanks to all the well-wishers and stakeholders who have rendered significant suggestions and comments in the preparation of the curriculum and syllabus. My heartfelt gratitude to Dr. Sreekumar V B, Scientist, Department of Forest Botany, Forest Ecology and biodiversity Conservation Division, KFRI, and Dr. Suma Arun Dev, Scientist, Forest Genetics & Biotechnology Division, KFRI, Peechi Thrissur for their sincere effort and contributions in the preparation of this syllabus.

I place on record my sincere thanks to the subject experts, Dr. Asma V. M., Associate Professor, Dept. of Botany, MES Asmabi College, Vemballur, Kodungallur and Dr. Siril E A, Associate Professor, Department of Botany, University of Kerala, Kariyavattam, Trivandrum, for their guidance and remarkable suggestions to restructure various courses of the programme. Thanks to Dr. Jose T Puthur, Associate Professor, Division of Plant Physiology and Biochemistry, Department of Botany, University of Calicut, for his invaluable suggestions.

Department of Botany, St. Joseph's College, gratefully acknowledges the role played by Dr. Najjil George, Assistant Professor and IQAC Coordinator, Department of Biotechnology and other members of the syllabus committee for the guidance and help given to shape the overall frame work and structure of the curriculum and syllabus.

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Dr. Roselin Alex,
Chairperson, Board of Studies.



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**ST. JOSEPH'S COLLEGE, (AUTONOMOUS), IRINJALAKUDA DEPARTMENT OF
BOTANY**

(2024 ADMISSION)

Preface

As an autonomous college under Calicut University, St. Joseph's College has taken conscientious efforts to strengthen the curriculum by retaining all the fundamental stipulations of the University/Higher Education Council, to ensure a well-balanced Curriculum. Within the constraints of a prescribed syllabus, we have resolved to take a collective effort to create an inspiring academic culture in the institution, essential for teachers and students to access deeper knowledge and participate in its expansion and transmission. It is also to re-articulate the almost lost or forgotten fact that production and transmission of Quality Knowledge, essential for the development of students in particular and society in general, are the primary functions of any Educational Institution.

The Syllabus restructuring of 2024 aims to provide the students many opportunities to engage with authentic, real world learning. This has been evident through the significant number of new Programmes introduced at the wake of autonomy in 2016 with their integral placement opportunities. Increasingly, however, opportunities for engagement in work-based learning that can be provided through the curriculum across a range of subject areas are creating new and exciting ways to support student learning.

I acknowledge the efforts taken by the teachers in developing Programme and Course outcomes that focus on cognitive and intellectual skills of the learners, confidence to carry out independent and scholarly research in area of professional interest to them and to position themselves globally effective cross- cultural educators .



ST. JOSEPH'S COLLEGE, (AUTONOMOUS), IRINJALAKUDA

STUDENT ATTRIBUTES



The motto of the institution is “Light, Life, Love”

Light for the illumination of the heart and mind

Life for the fullness of growth – physical, mental, intellectual and spiritual

Love for fellowship with the Supreme & with one another

The motto enshrines the vision of the Founders for the students and constitutes the foundation for the acquisition of the following student attributes envisioned by the institution.

- Empowerment
- Life Long Learning
- Holistic Development
- Value Orientation
- Social Responsibility
- Nation Building Capacity
- Green Thinking
- Creativity & Innovation
- Acquiring Life Skills
- Discipline
- Leadership / Team skills
- Problem solving skills
- Communicability

The above Student Attributes will be attained in the span of their student life at St. Joseph's College through various activities such as

- Curricular, Co-curricular & extra-curricular
- Sports, games, fine arts and cultural
- Enrichment / certificate courses
- Extension / outreach programmes
- Healthy / Best practices



PROGRAMME OUTCOMES

At the end of a postgraduate programme, the student would have :

- Acquired the ability for critical thinking and problemsolving
- Attained life skills and communication skills
- Inculcated moral and ethical values
- Become a promoter of unpolluted environs and proactive society
- Developed a culture of research and lifelong learning
- Become an empowered woman aware of global perspectives and national realities

PROGRAMME SPECIFIC OUTCOME

SL.NO	Program Specific Outcomes
PSO1	Develop a conceptual understanding of principles , importance and evolutionary aspects of plant diversity
PSO2	Obtain Knowledge in the internal structure and functions of various plant components
PSO3	Understand the advanced concepts of physiological ,metabolical,and ecological aspects of plants and microbes
PSO4	Become aware about plant diversity and its conservation for sustainable development
PSO5	Acquire knowledge in problem solving and apply appropriate techniques,tools, resources and modern technology in multidisciplinary way
PSO6	Facilitate students to take-up successful career in Botany



AIMS AND OBJECTIVES

The aim of the Department of Botany is to produce highly qualified botanists who have a broad knowledge of modern and applied plant science and excellent career prospects. The aim of this course is to ensure that the students can achieve an up-to-date level of understanding of plant science.

First Semester

- Understand the general features, external and internal characters of algae, bryophytes, pteridophytes and gymnosperms
- Recognize, compare and distinguish between the thallus structures and reproductive mechanisms in Algae, Bryophyta, Pteridophyta and gymnosperms
- Predict the ecological, economic, evolutionary significance of Algae, Bryophyta, Pteridophyta and gymnosperms in day-to-day life.
- Understand the fungal, microbial, pathological interactions in nature and predict their adaptive strategies and examine the possible applications of microbes and fungus in day-to-day life
- Understand the anatomical, embryological and palynological peculiarities of angiospermic plants.
- Provide concepts and knowledge to make microscopic slides, using different cutting techniques and permanent microscopic slides using paraffin method.

Second Semester

- Learn the concepts on cell organelles, cell cycle, cell differentiation and interactions and acquire practical skill in cytological preparations.
- Impart knowledge on molecular biology and introduce the basic concepts of various instruments in biophysics.
- Familiarize Mendel's Experimental approaches, concepts on linkage, microbial genetics and biochemical genetics.
- To understand mechanism of evolution.
- Provide basic knowledge in plant breeding, biostatistics
- Prepare students to excel in different breeding methods used in crop breeding and apply the statistical methods for data analysis. Provide concepts and knowledge on various ecosystems and environment and create awareness about the significance of genetic resources, biodiversity and its conservation.



Third Semester

- Perceive the knowledge and compare the various aspects of growth and development in plants.
- Understand and evaluate the various aspects, structure, function and metabolism of biomolecules in plants.
- Identify and compare structural differences among different taxa of vascular plants.
- Familiarize and workout nomenclatural problems and author citations.
- Provide training in desk, lab and field based assessment of angiosperm diversity, identifying morphological
- Specialities and writing species description, keys and illustrations.
- make awareness about the Fundamentals of Biotechnology and familiarise the students with the tools and techniques of genetic engineering and gene transfer technologies
- Understand the techniques and applications of plant tissue culture and acquire basic practical skills in Biotechnology.
- Provide the knowledge on Bioinformatics and its applications and to familiarise the students on protein and nucleic acid data bases and genomics & proteomics.

Fourth Semester

- Understand the concept and principles of environment and study various habitats.
- Understand and analyse environmental problems and social issues.
- Build awareness in controlling pollution and apply their knowledge in waste management.
- Acquire an in depth knowledge on genetic engineering and its application.
- Acquire basic practical skills in different genetic engineering techniques.



COURSE DESIGN

The post graduate -programme includes

- Core courses
- Elective Courses
- Project Work / Dissertation
- Comprehensive Viva-voce
- Audit Courses

The PG programme contains 9 compulsory Core courses, 6 core practical papers, 2 Elective and 1 elective practical Courses, 1 Project Work / Dissertation, 1 Comprehensive Viva-voce and 2 Audit Courses. (write about credit distribution of courses) No course carries more than 4 credits. The student can select any choice based elective course offered by the department which offers the core courses, depending on the availability of teachers and infrastructure facilities, in the institution.

Duration of the programme

The minimum duration for completion of a four semester PG Programme is 2 years. The maximum period for completion is 4 years. The duration of each semester will be 90 working days, inclusive of examinations, spread over five months. Odd semesters will be held from June to October and even semesters from November to March subject to the academic calendar of St. Joseph's College (Autonomous) Irinjalakuda.

Programme structure

The post graduate-programme include three types of courses: Core courses, Elective courses and Audit Courses. Project Work and Comprehensive viva-voce are mandatory for all regular programmes and these shall be done in the end semester. Total credit for the postgraduate programme is 80 (eighty), this describes the weightage of the course concerned and the pattern of distribution is as detailed below:

Programme Duration		4 Semester
Core courses	Theory	11
	Practical	7
Elective Courses	Theory	2
	Practical	1
Project Work / Dissertation		1
Comprehensive Viva-voce		1
Minimum attendance required		75%

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Elective courses shall be spread over either in the Third & Fourth Semesters combined or in an one of these Semesters (III / IV). Study Tour / Field visit / Industrial visit / Trip for specimen collection may be conducted as a part of the Programme.

Semester	Course Title	Suggested Area
I	Ability Enhancement Course (AEC)	Internship / Seminar presentation / Publications / Case study analysis / Industrial or Practical Training/Community linkage programme /Book reviews etc.

Courses and Credit distribution

The required number of credits as specified in the syllabus / regulations must be acquired by the student to qualify for the degree. A student shall accumulate a minimum of 80 credits for the successful completion of the post graduate programmes.

Semester	Course	Teaching Hours	Credit
I	Core Courses (Theory +Practical)	108+38=144	15 +5
II	Core Courses (Theory +Practical)	108+38=144	15 +5
III	Core Courses (Theory +Practical)	108+38=144	15 +5
IV	Elective Courses (Theory)	144	10
	Elective Courses (Practical)		2
	Comprehensive Viva-voce (Optional)		3
	Project Work / Dissertation		5
Total credit			80

Audit Courses:

In addition to the above courses there will be two Audit Courses (*Ability Enhancement Course & Professional Competency Course*) with 4 credits each. The college will conduct examinations for these courses in respective semesters and intimate /upload the results of the same to the Controller of Examinations of St. Joseph's College (Autonomous) Irinjalakuda. The College will intimate/upload the results of the same to the University on the stipulated date during the third semester. The credits will not be counted for evaluating the overall SGPA & CGPA. The details of Audit courses are given below.



Semester	Course	Teaching Hours	Credit
I	Audit Course I : <i>Ability Enhancement Course (AEC)</i>	0	4
II	Audit Course II : <i>Professional Competency Course (PCC)</i>	0	4

Project Work / Dissertation & Comprehensive Viva-Voce

There is a Project work with dissertation and Comprehensive Viva- Voce as separate courses relating to the core area under study in the end Semester and included in the Core Courses. Viva-voce related to Project work is one of the criteria for Project Work evaluation. Students have to submit a Project Report / Dissertation in the prescribed structure and format as a part of the Project Work undertaken. There will be External and Internal evaluation for Project Work/ Comprehensive Viva-Voce and these shall be combined in the proportion of 4:1

COURSE CODE FORMAT

The following are the common guidelines for coding various courses in order to get a uniform identification. It is advisable to assign a nine Digit Code (combination of Alpha Numerical) for various courses as detailed below:

First two digits indicate the code of college SJ

Next three digits indicate the Programme/discipline code (ENG for English, MCM for M.Com, CHE for chemistry, PHY for physics, MLM for Malayalam, SKT for Sanskrit, HTY for History etc.)

Sixth digit is the Semester indicator which can be given as 1, 2, 3 & 4 respectively for I, II, III & IV Semester (MCM1, CHE2 Etc).

Seventh digit will be the Course Category indicator as detailed below

Sl. No.	Nature of Course	Course Code
1	Core Courses	C
2	Elective Courses	E
3	Project	P
4	Comprehensive Viva	V
5	Practical / Lab	L
6	Audit Courses	A

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Last two digits indicate the serial number of the respective courses. If there is one digit it should be prefixed by '0'(Zero). (01, 02, etc)

If the number of courses in one category is only one (example: Viva, Project etc.), assign the course serial number as 01.Examples:

Sl. No	Code	Details
1	SJMCM 1C01	M.Com I Sem Core Course No1
2	SJCHE 2 A 02	Chemistry II Sem Audit Course No.2
3	SJENG 4 V01	English IV Sem Viva No. 1
4	SJMLM 3 E02	Malayalam III Sem Elective No. 2
5	SJPHY 4 P 01	Physics IV Sem Project Work No. 1
6	SJ BGY 2 L 02	Biology II Sem Practical No. 2
7	SJPSY 3 C 02	Psychology III Sem Core Course No. 2
8	SJHTR 2 E 01	History II Sem Elective Course No. 1



STRUCTURE OF THE PROGRAMME

SCHEME- CORE COURSE

The following table shows the structure of the programme which indicates course code, course title, instructional hours and credits.

Semester I						
Course Code	Title of the course	Number of hours per week	Total Credits	Total hours/ semester	Marks	
					SA	ESA
SJBOT1 C01	Phycology, Bryology, Pteridology and Gymnosperms	6	5	90	20%	80%
SJBOT1 C02	Mycology and Lichenology, Microbiology and Plant Pathology	6	5	90	20%	80%
SJBOT1 C03	Angiosperm Anatomy, Angiosperm Embryology, Palynology and Lab Techniques	6	5	90	20%	80%
SJBOT1 L01	Practicals of Phycology, Bryology, Pteridology, Gymnosperms, Mycology and Lichenology	3	2.5	45	20%	80%
SJBOT1 L02	Practicals of Microbiology, Plant Pathology, Angiosperm Anatomy, Angiosperm Embryology, Palynology and Lab Techniques.	3	2.5	45	20%	80%
Semester II						
SJBOT2 C04	Cell Biology, Molecular Biology and Biophysics	6	5	90	20%	80%
SJBOT2 C05	Cytogenetics, Genetics, Biostatistics, Plant Breeding and Evolution	6	5	90	20%	80%



SJBOT2 C06	Plant Ecology, Conservation Biology, Phytogeography and Forest Botany	6	5	90	20%	80%
SJBOT2 L03	Practicals of Cell Biology, Molecular Biology, Biophysics and Cytogenetics	3	2.5	45	20%	80%
SJBOT2 L04	Practicals of Genetics, Biostatistics, Plant Breeding, Plant Ecology, Conservation Biology, Phytogeography and Forest Botany	3	2.5	45	20%	80%
Semester III						
SJBOT3 C07	Plant Physiology, Metabolism and Biochemistry	6	5	90	20%	80%
SJBOT3 C08	Angiosperm Morphology, Angiosperm Taxonomy and Plant Resources	6	5	90	20%	80%
SJBOT3 C09	Biotechnology and Bioinformatics	6	5	90	20%	80%
SJBOT3 L05	Practicals of Plant Physiology, Metabolism, Biochemistry, Angiosperm Morphology and Angiosperm Taxonomy	3	2.5	45	20%	80%
SJBOT3 L06	Practicals of Plant Resources, Biotechnology and Bioinformatics	3	2.5	45		80%
Semester IV						
SJBOT4 E01	Elective I- Environmetal Biology and Biodiversity Conservation	6	5		20%	80%
SJBOT4 E02	Elective II- Genetic Engineering	6	5		20%	80%
SJBOT4 L07	Practicals of Electives - Environmetal Biology,	3	2		20%	80%



	Biodiversity Conservation, Genetic Engineering					
SJBOT4 D01	Dissertation	6	5		20%	80%
SJBOT4 V01	Viva voce	-	3	-	20%	80%
			80 Cred its			

Scheme- Project work / Dissertation and Comprehensive Viva-Voce

Semester IV						
Course Code	Title of the course	Number of hours per week	Total Credits	Total hours per semester	Marks	
					SA	ES A
SJBOT4D01	Dissertation	6	5	90	20 %	80 %

EVALUATION AND GRADING

The evaluation scheme for each course will contain two parts; (a) Internal/Continuous Assessment (CA) and (b) External / End Semester Evaluation (ESE). Of the total, 20% weightage will be given to Internal evaluation/Continuous assessment and the remaining 80% to External/ESE and the ratio and weightage between Internal and External is 1:4.

Internal/Continuous Assessment (CA): 20 marks

a) External / End Semester Evaluation (ESE) : 80 marks

Primary evaluation for Internal and External shall be based on 6 letter grades (A+, A, B, C, D and E) with numerical values (Grade Points) of 5, 4, 3, 2, 1 & 0 respectively. Grade Point Average: Internal and External components are separately graded and the combined grade point with weightage 1 for Internal and 4 for external shall be applied to calculate the Grade Point Average (GPA) of each course. Letter grade shall be assigned to each course based on the categorization based on Ten-point Scale. There is no revaluation for PG Programme (due to double valuation)



Evaluation of Audit Courses:

The examination and evaluation will be conducted by the college either in the normal structure or MCQ model from the Question Bank and other guidelines provided by the University/BoS. The Question paper will be for minimum 20 weightage and a minimum of 2-hour duration for the examination. The marks of audit courses one and two will be forwarded to Controller of Examinations of St. Joseph's College (Autonomous) Irinjalakuda in time of respective semesters. The result will be intimated / uploaded to the University during the Third Semester.

Phases for Evaluation:

I Phase: To be done by the concerned Teacher/Examiner based on 6 Point Scale

1. Evaluation of all individual External Theory courses and Internal evaluation
2. Evaluation of Project Work External and Internal
3. Evaluation of External and Internal Practical Courses
4. Evaluation of External and Internal Comprehensive Viva-voce

II Phase - GPA Calculation - To be done by St. Joseph's College (Autonomous)

1. Consolidation of External and Internal for Theory Courses (Calculation of GPA)
2. Consolidation of External and Internal for Project Work (Calculation of GPA)
3. Consolidation of External and Internal for Practical Courses (Calculation of GPA)
4. Consolidation of External and Internal for Comprehensive Viva- voce (Calculation of GPA)

III Phase - SGPA Calculation - To be done by St. Joseph's College (Autonomous) Irinjalakuda

Calculation of Semester Grade Point Average. This is the consolidated net result (Grade) in a particular Semester.

IV Phase - CGPA Calculation - To be done by St. Joseph's College (Autonomous) Irinjalakuda

Calculation of Consolidated Grade Point Average. This is the consolidated net result (Grade) of a Programme.



Internal Evaluation / Continuous Assessment (CA)

Continuous Assessment will be based on a predetermined transparent system involving periodic two written tests, assignments, seminars and attendance in respect of theory courses and based on tests, lab skill and records/viva in respect of practical courses. The criteria and percentage of weightage assigned to various components for internal evaluation are as follows:

(a) Theory:			
Sl. No	Component	Percentage	Weightage
1	Examination /Test	40%	2
2	Seminars / Presentation	20%	1
3	Assignment	20%	1
4	Attendance	20%	1
(b) Practical:			
1	Lab Skill	40%	4
2	Records/viva	30%	3
3	Practical Test	30%	3

Attendance weightage 1 can be distributed as follows

Attendance	Internal weightage	Marks
Above 90%	1	5
85–89%	0.8	4
80–84%	0.6	3
76–79%	0.4	2
75%	0.2	1

Grades given for the internal evaluation are based on the grades A+, A, B, C, D & E with grade points 5, 4, 3, 2, 1 & 0 respectively. The overall grades will be as per the Ten Point scale. There shall be no separate minimum Grade Point for internal evaluation. To ensure transparency of the evaluation process, the internal assessment marks awarded to the students in each course in a semester will be published on the notice board before 5 days of commencement of external examination. There will not be any chance for improvement of internal marks. The course



teacher will maintain the academic record of each student registered for the course.

Examination /Test: For each course there shall be class test/during a semester. Grades should be displayed on the notice board. Valued answer scripts shall be made available to the students for perusal.

Seminars / Presentation: Every student should deliver Seminar/Presentation as an internal built – in component of the curriculum transaction for every course and must be evaluated by the respective course teacher in terms of structure, content, presentation and interaction. The soft and hard copies of the seminar report are to be submitted to the course teacher.

Assignment: Each student will be required to do assignment/s as an internal built – in component of the curriculum transaction for each course. Assignments after valuation must be returned to the students. The teacher shall define the expected quality of the above in terms of structure, content, presentation etc. and inform the same to the students. Punctuality in submission is to be considered.

Lab Skill: Students in the science stream are required to combine their classroom methods with hands on practical sessions in the laboratories. The teacher shall assess the skills of the student and the quality of application of theoretical knowledge.

Records/viva: Records are submitted by science students for documenting the textual and classroom knowledge along with their practical lab skills. Neatness, accuracy and precision are also evaluated here. Viva voce is conducted to assess the grasp of knowledge gained by the student and to test their communication skills in the translation of the knowledge.

Practical Test: It is conducted for students in the science stream to assess their scientific temper and application of theoretical knowledge. The sense of precision and accuracy is also taken into account.

External / End Semester Evaluation (ESE)

The semester-end examinations in theory courses will be conducted by the Controller of Examination St. Joseph's College (Autonomous) Irinjalakuda with question papers set by external experts. The evaluation of the answer scripts will be done by examiners based on a well-defined scheme of valuation. The external evaluation will be done immediately after the internal valuation. The language of writing the examination should be English.

Pattern of Questions For External/ESE:

Questions will be set to assess the knowledge acquired, standard, and application of knowledge, application of knowledge in new situations, critical evaluation of knowledge and the ability to synthesize knowledge. Due weightage will be given to each module based on content/teaching hours allotted to each module. The question will be prepared in such a way that the answers can be awarded A+, A, B, C,D, E Grades. Different types of questions shall be given different weightages to quantify their range given in the following model:



Sl. No.	Type of Questions	Individual weightage	Total Weightage	Number of questions to be answered
1	Short Answer type questions	2	$2 \times 4 = 8$	4 out of 7
2	Short essay/ problem solving type	3	$3 \times 4 = 12$	4 out of 7
3	Long Essay type questions	5	$5 \times 2 = 10$	2 out of 4
Total			30	18

End Semester Evaluation in Practical Courses will be conducted and evaluated by both Internal and External Examiners. Practical examinations shall be conducted at the end of each semester of the particular Programme. The number of examiners and other aspects of the practical examination shall be prescribed by the concerned Board of Studies of the programmes. There shall be one end-semester examination of 3 hours duration for each practical course.

Sl. No.	Type of Questions	Total No. Of Questions	Individual Weightage
1	Major Experiment / Problems	3	$3 \times 5 = 15$
2	Minor Experiment/ Problems	3	$3 \times 2 = 6$
3	Identification / Spotters	5	$5 \times 1 = 5$
4	Lab records	1	$1 \times 2 = 2$
5	Submissions /Tour reports	1	$1 \times 2 = 2$
Total		13	30

Evaluation of project work / dissertation

There will be External and Internal evaluation with the same criteria for Project Work done and the grading system shall be followed. One component among the Project Work evaluation criteria will be Viva- voce (Project Work related) and the respective weightage will be 40%. Consolidated Grade for Project Work is calculated by combining both the External and Internal in the Ratio of 4:1 (80% & 20%). For a pass in Project Work, a student has to secure a minimum of P Grade in External and Internal examination combined. If the students could not secure



minimum P Grade in the Project work, they will be treated as failed in that attempt and the students may be allowed to rework and resubmit the same in accordance with the University exam stipulations. There shall be no improvement chance for Project Work. The External and Internal evaluation of the Project Work shall be done based on the following criteria and weightages as detailed below:

Sl. No	Criteria	Percentage of weightage	Weightge External	Weightage Internal
1	Relevance of the topic and Statement of problem	10	3	2
2	Methodology & Analysis	30	9	2
3	Discussion	10	3	2
3	Quality of Report & Presentation	20	6	2
4	Viva-Voce	30	9	2
Total Weightage		100	30	10

Conduct of comprehensive viva-voce

There will be External and Internal Comprehensive Viva-voce; the External Conduct and internal Conduct of the Viva-voce are mandatory.

Evaluation Component Mark	No. Of Questions	Weightage Internal in %
UG level questions	10	20
PG syllabus level questions	15	30
Subject of interest based questions	15	30
Advanced level questions	10	20
TOTAL WEIGHTAGE	30	

For a pass in Comprehensive viva-voce, a student has to secure a minimum of P Grade in External and Internal examination combined. If the students could not secure minimum P Grade



inthe Comprehensive viva-voce, they will be treated as failed in that attempt and the student may reappear for the same next time in accordance with the University exam stipulations. There shall be no improvement chance for Comprehensive viva-voce.

DIRECT GRADING SYSTEM

Direct Grading System based on a 10 – Point scale is used to evaluate the performance (External and Internal Examination of students). For all courses (Theory & Practical)/Semester/Overall Programme, Letter grades and **GPA/SGPA/CGPA** are given on the following way:

First Stage Evaluation for both Internal and External done by the Teachers concerned in the following Scale :

Grade	Grade Points
A+	5
A	4
B	3
C	2
D	1
E	0

The Grade Range for both Internal & External shall be :

Letter Grade	Grade Range	Range of Percentage (%)	Merit / Indicator
O	4.25 – 5.00	85.00 – 100.00	Outstanding
A+	3.75 – 4.24	75.00 – 84.99	Excellent
A	3.25 – 3.74	65.00 – 74.99	Very Good
B+	2.75 – 3.24	55.00 – 64.99	Good
B	2.50 – 2.74	50.00 – 54.99	Above Average
C	2.25 – 2.49	45.00 – 49.99	Average
P	2.00 -2.24	40.00 – 44.99	Pass
F	< 2.00	Below 40	Fail
I	0	-	Incomplete
Ab	0	-	Absent



No separate minimum is required for internal evaluation for a pass, but a minimum P Grade is required for a pass in the external evaluation. However, a minimum P grade is required for pass in a course. 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.

Improvement of Course—The candidates who wish to improve the grade / grade point of the external examination of a course/s they have passed already can do the same by appearing in the external examination of the concerned semester along with the immediate junior batch.

Betterment Programme One time- A candidate will be permitted to improve the CGPA of the Programme within a continuous period of four semesters immediately following the completion of the programme allowing only once for a particular semester. The CGPA for the betterment appearance will be computed based on the SGPA secured in the original or betterment appearance of each semester whichever is higher.

Semester Grade Point Average (SGPA) – Calculation

The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses taken by a student. 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.

Where 'S_j' is the jth semester, 'G_i' is the grade point scored by the student in the ith course 'c_i' is the credit of the ithcourse, 'Cr' is the total credits of the semester.

Cumulative Grade Point Average (CGPA) – Calculation

$$\text{Cumulative Grade Point Average (CGPA)} = \frac{\sum(C_i \times S_i)}{\text{Cr}} \text{ (CGPA = Total Credit points awarded in all semesters / Total credits of the programme)}$$

Where C₁ is the credit of the Ist semester S₁ is the SGPA of the Ist semester and Cr is the total number of credits in the programme. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme. The SGPA and CGPA shall be rounded off to 2 decimal points. For the successful completion of a semester, a student should pass all courses and score a minimum SGPA of 2.0. However, the students are permitted to move to the next semester irrespective of their SGPA

$$\text{Semester Grade Point Average - SGPA (S}_j\text{)} = \frac{\sum(C_i \times G_i)}{\text{Cr}} \text{ (SGPA = Total Credit Points awarded in a semester / Total credits of the semester)}$$



CONSOLIDATED SCHEME FOR I TO IV SEMESTERS PROGRAMME STRUCTURE
SEMESTER I

COURSE CODE	COURSE TITLE	HOURS	CREDIT
SJBOT1C01	Phycology, Bryology, Pteridology and Gymnosperms	90	5
SJBOT1C02	Mycology and Lichenology, Microbiology and Plant Pathology	90	5
SJBOT1C03	Angiosperm Anatomy, Angiosperm Embryology, Palynology and Lab Techniques	90	5
SJBOT1L01	Practicals of Phycology, Bryology, Pteridology, Gymnosperms, Mycology and Lichenology	45	2.5
SJBOT1L02	Practicals of Microbiology, Plant Pathology, Angiosperm Anatomy, Angiosperm Embryology, Palynology and Lab Techniques.	45	2.5

SEMESTER II

COURSE CODE	COURSE TITLE	HOURS	CREDIT
SJBOT2C04	Cell Biology, Molecular Biology and Biophysics	90	5
SJBOT2C05	Cytogenetics, Genetics, Biostatistics, Plant Breeding and Evolution	90	5
SJBOT2C06	Plant Ecology, Conservation Biology, Phytogeography and Forest Botany	90	5
SJBOT2L03	Practicals of Cell Biology, Molecular Biology, Biophysics and Cytogenetics	45	2.5
SJBOT2L04	Practicals of Genetics, Biostatistics, Plant Breeding, Plant Ecology, Conservation Biology, Phytogeography and Forest Botany	45	2.5



SEMESTER III

COURSE CODE	COURSE TITLE	HOURS	CREDIT
SJBOT3C07	Plant Physiology, Metabolism and Biochemistry	90	5
SJBOT3C08	Angiosperm Morphology, Angiosperm Taxonomy and Plant Resources	90	5
SJBOT3C09	Biotechnology and Bioinformatics	90	5
SJBOT3L05	Practicals of Plant Physiology, Metabolism, Biochemistry, Angiosperm Morphology and Angiosperm Taxonomy	45	2.5
SJBOT3L06	Practicals of Plant Resources, Biotechnology and Bioinformatics	45	2.5

SEMESTER IV

SJBOT4E01	Elective I- Environmental Biology and biodiversity conservation	90	5
SJBOT4E02	Elective II-Genetic engineering	90	5
SJBOT4L07	Practicals of Electives- Environmental Biology and biodiversity conservation and Genetic engineering	45	2
SJBOT4D01	Dissertation	90	5
SJBOT4V01	Viva voce		3



SYLLABUS FOR CORE COURSES

SEMESTER I

COURSE CODE: SJBOT1C01

NAME OF THE COURSE: PHYCOLOGY, BRYOLOGY, PTERIDOLOGY AND GYMNOSPERMS

(1.5+1+2+1.5 = 6 Hours Per Week)

SL. NO	COURSE OUT COME	PSOs	PO	CL	KC	Class sections
CO1	Understand the general features, habitats, and life cycles of algae, bryophytes, pteridophytes and gymnosperms	1	5	U	C	10
CO2	Understand the geological time scale and Familiarize the fossil members	1	5	U	C	20
CO3	Discuss the evolutionary affinities among the lower groups and gymnosperms	1	5	A	C	20
CO4	Recognize and distinguish between the reproductive organs and mechanisms	2	5	Z	F	5
CO5	Predict the ecological and economic significance in day today life	1	4	E		5
CO6	Identify the plant groups based on the internal structure	2	1	A		10
Total						90



Phycology

Module 1

13 hr

1. Classification of Algae – comparative Survey of important systems-Fritsch-Smith-Round. Criteria for algal classification- Phylogenetic considerations.
2. Algal cytology- Basic ideas of cell features- Electron microscopic studies of algal cell, cell wall, flagella, chloroplast, pyrenoid, eyespot- their importance in classification.
3. Reproduction-Different types of life cycles in algae.
4. General account of energy sources and pigments in algae.

Module 2

14hr

1. Biological importance of Planktons and water blooms.
2. Economic importance of algae-Role of algae in soil fertility, algae in industry.
3. Algal Ecology – Ecological importance of algae, Algae in symbiotic association, algae in polluted habitat, Algal indicators.
4. General account of thallus structure, cell ultra-structure, reproduction, relationships and evolutionary trends in the following groups: Chlorophyta, Xanthophyta, Bacillariophyta, Phaeophyta, Rhodophyta.

References:

1. Fritsch, F.E. The structure and Reproduction of Algae.
2. Smith, G.M. Manual of Phycology
3. Round, F.E, The Biology of Algae.
4. Pold and Wyane. Introduction of Algae.

Bryology

Module 3

19 hrs

1. General characters and systems of classifications of Bryophytes.
2. General account of the anatomy, reproduction, life history and phylogeny of Sphaerocarpaceae, Marchantiales, Jungermanniales, Calobryales, Anthocerotales, Sphagnales, Andreales, Funariales and Polytrichales.
3. Origin and evolution of Bryophytes-Concept of algal and pteridophytic origin of bryophytes, gametophytic and sporophytic.
4. A general account of fossil Bryophytes and their affinities.
5. Economic importance of Bryophytes.

References

1. Watson E.V. The structure and life of Bryophytes. Hutchinson Univ. Press, London.
2. Cavers F. The interrelationship of Bryophytes. New Phytologist.
3. Kashyap S.R., the Liverworts of Western Himalaya and the Punjab Plains, Vol.I &II. Chronica Botanica

4. Smith G.M. Cryptogamic Botany. Mc Graw Hill Book Co., N.Y.
5. Parihar N.S. An introduction of Embryophyta: Bryophyta. General Book House, Allahabad.
6. Verdoon, F.M. Manual of Bryology. Ashor & Co., Amsterdam.
7. Shaw, J. and Goffinet, B. Bryophyte Biology. Cambridge University Press.
8. Manju C. Nair, K.P. Rajesh and Madhusoodanan P.V. Bryophytes of Wayanad in Western Ghats. Malabar Natural History Society, Kozhikode.

Pteridology

Module 4

10hr

1. General characters and life history of Pteridophytes.
2. Cytology of Pteridophytes- Chromosome number and polyploidy.
3. Structure and evolution of stele in Pteridophytes.

Module 5

10 hr

1. Origin and evolution of Sporangium. Soral and sporangial characters.
2. Heterospory and seed habit.
3. Development and evolutionary trends in the Gametophytes of Pteridophytes.
4. Apogamy, Apospory and Parthenogenesis.

Module 6

12hr

1. Classification of Pteridophytes: Holttum, Pichi-Sermolli.
2. Comparative morphology, ecology and phylogeny of the following:
 - a. Psilopsida : Rhyniales, Psilophytales and Psilotales
 - b. Lycopsida : Lycopodiales and Isoetales, Sphenopsida: Hyeniales, Pseudobomiales, Sphenophyllales, Calamitales and Equisetales.
 - c. Sphenopsida : Hyeniales, seudoborniales, Sphenophyllales, Equisetales and Calamitales
 - d. Filicopsida: Primofilicales, Ophioglossales, Marattiales, Osmundales, Schizaeales, Cyatheales, Gleicheniales, Marsileales and Salviniiales

Module 7

4 hr

1. Economic importance of Pteridophytes- Medicinal, Horticulture, Biofertilizer, weeds.
2. General account of the contribution of Indian Pteridologists

References:

1. Bierhost, D.W. Morphology of Vascular Plants. Mac Miilan Co., NewYork.
2. Dyer, A.C. The Experimental Biology of Ferns. Academic Press, London.
3. Jermy, A.C. (Ed.): The phylogeny and Classification of Ferns.
4. Kramer, K.U. and Green, P.S. The Families and Genera of Vascular Plants. Narosa, NewDelhi.
5. Nampy, S. and Madhusoodanan, P.V. Fern Flora of South India-Taxonomic Revision Polypodioid Ferns. Daya Publishing House, NewDelhi.
6. Abdul Hameed C., Rajesh K.P. and Madhusoodanan P.V. Filmy Ferns of South India. Penta

MSc. Botany St. Joseph's College (Autonomous),

Book Publishers & Distributors, Calicut.

7. Azeez K., Venugopalakrishna Kurup V. and P.V. Madhusoodanan. Spleenworts (Aspleniaceae) of South India. Malabar Natural History Society, Calicut.
8. Venugopalakrishna Kurup V., Azeez K. and P.V. Madhusoodanan. Primitive Ferns of South India. 'V'Publishers, Kottayam.

Gymnosperms

Module 8

12hr

1. Geological time scale and correlated predominant Gymnospermflora. Classification of Gymnosperms- Chamberlain's system.
2. Phylogenetic relationship of Gymnosperms.
3. Economic importance of Gymnosperms

Module 9

15hr

1. Geological horizons. Distribution, morphology, anatomy, reproduction and interrelationship of the following orders (Study of families and types not required)
 - a) Pteridospermales; b) Glossopteridales; c) Caytoniales; d) Cycadaeoidales; e) Pentoxylales; f) Cycadales, g) Ginkgoales; h) Cordaitales; i) Coniferales; j) Taxales; k) Ephedrales; l) Welwitschiales; m) Gnetales

References:

1. Andrews, H.N. Studies in Paleobotany, Wiley, N.Y.
2. Banks, H.P. Evolution and plants of the past. Wadsworth.
3. Bierhost, D.W. Morphology of Vascular Plants. Macmillan.
4. Bower, F.O. Primitive Plants. Macmillan.
5. Chamberlain, C.J. Gymnosperms- Structure and Evolution. Univ. of Chicago Press.
6. Foster, A.S. & E.M. Gifford. Comparative morphology of vascular plants. Freeman.
7. Maheshwari, P & V. Vasil. Gnetum. CSIR, New Delhi.
8. Ramanujam, C.G.K. Indian Gymnosperms in time and space. Today & Tomorrow, DehraDun.
9. Sewart, W.N. Paleo botany and the Evolution of Plants. Cambridge Univ. Press.
10. Stockey, R.S. Some comments on the origin and evolution of conifers. Canadian J. Bot. 59: 75-82.
11. Taylor, T.N. Reproductive biology in early seed plants. Bioscience 32: 23-28.
12. Walton. An Introduction to the Study of Fossil plants



NAME OF THE COURSE: MYCOLOGY & LICHENOLOGY, MICROBIOLOGY AND PLANT PATHOLOGY

(2.5+2.5+1 = 6 Hours Per Week)

SL NO.	COURSE OUT COME	PSOs	PO	CL	KC	Class sections
CO1	Understand the classification and characteristic features and of fungi, lichens, and microbes and examine the role of fungal interactions	1	1	U	C	20
CO2	Examine the possible applications of role microbes and fungi in Agricultural, Environmental and industry in day to day life	4	6	A	C	15
CO3	Understand the principles of plant pathology and disease management.	6	4, 6	U	C	20
CO4	Apply the skill to identify the major diseases of crop plants and propose their control measures	3	1, 5	A	C	10
CO5	Develop basic skill and Examine the Morphology, anatomical, reproductive structures of different fungus, microbes and Lichens	2	1,	A	C	10
CO6	Identify different types of fungi and microbes through field collection, micro preparation and herbarium and apply the skill to identify plant diseases based on symptoms.	5	2	A	P	15
Total						90



Mycology

Module 1

10hr

1. General characters of Fungi: cell-ultra structure, unicellular and multi cellular organization, hyphal growth, cell wall composition, nutrition (saprobic, biotrophic, symbiotic, predacious) reproduction (vegetative, asexual, sexual), heterothallism, parasexuality.

Module 2

15hr

1. Classification of fungi by Ainsworth & Bisby (1983), Alexopoulos et al. (1996)- Phylogeny of fungi- Characters used in classification.
2. General account of Myxomycota, Mastigomycota, Zygomycota, Ascomycota, Basidiomycota and mitosporic fungi. Different kinds of spores and their dispersal.

Module 3

10hr

1. Fungi as saprophytes: Details of the fungal decomposition of organic matter, coprophilous fungi, lignin degrading fungi, role of fungi in degradation of pesticides.
2. Fungi as symbionts: Mycorrhiza – ectotrophic, orchidaceous and Ericoid mycorrhiza, Vesicular Arbuscular Mycorrhiza - their distribution and significance. Endophytes.

Module 4

10hr

1. Lichenology: General account and systematics of lichens, thallus structure, reproductive bodies, ecological significance and economic importance of lichens.

References:

1. Alexopoulos C.J., Mims, C.W. & Blackwell, M. Introductory Mycology. 4th edition. John Wiley & Sons Inc.
2. Ainsworth, G.C., Sparrow, K.F. & Susmann, A.S. (Eds.). The Fungi - An Advanced Treatise. Vol 1-4. Academic Press.
3. Burnett, J.H. Fundamentals of Mycology. Edward Arnold.
4. Carile, M. J. & Watkinson S.C. The Fungi. Academic Press.
5. Deacon, J.W. Introduction to Modern Mycology. Blackwell.
6. Dubey, H.C. An Introduction to Fungi. Vikas Publishers, New Delhi.
7. Hale Mason, E. The Biology of Lichens. 3rd Ed. Edward Arnold, London.
8. Jennigs, D.H. & Lysek, G. Fungal Biology. Bios Scientific Publishers.
9. Mehrotra, R.S. & Aneja, K.R. An Introduction to Mycology. New Age International Publishers.
10. Landecker, Elizabeth Moore. Fundamentals of Fungi. 4th Ed. Prentice Hall.
11. Nair, M.C. & Balakrishnan, S. Beneficial fungi and their utilization. Scientific Publishers, Jodhpur.
12. Nash, T.H. Lichen Biology. Cambridge University Press.
13. Webster, John. Introduction to Fungi. Cambridge University Press.



Microbiology

Module 5

22hr

1. Introduction - main groups of microorganisms and their characteristics -prions, viroids, viruses, bacteria, mycoplasmas and actinomycetes.
2. Bacteria - classification based on Bergey's Manuel. Archaeobacteria and Eubacteria. Morphology, ultra-structure, nutrition, Genetics
3. Plasmids and their characterization.
4. Cyanobacteria- salient features, morphology, ultrastructure, classification and economic importance.
5. Viruses- General account of plant and animal viruses, bacteriophages and their classification. Isolation, purification, infection, replication and transmission of plant viruses. Detailed study of TMV and T4Phage.

Module 6

20hr

1. Microbial ecology- microbiology of rhizosphere and phylloplane. Sewage disposal, bioremediation and water purification. Detection of microbes in air and water
2. Agricultural microbiology - management of agricultural soils, bio fertilizers, bio pesticides.
3. Food Microbiology - Food spoilage and preservation methods. Microbiology of fermented food - dairy products, bread and other fermented plant products. Microorganisms as source of food- single cell protein.
4. Industrial Microbiology - Production of alcohol, vinegar, antibiotics, vitamins, steroids, vaccines, organic acids, amino acids.

References:

1. Adams, M R & Moss, M.O. Food Microbiology. New Age International Publishing Ltd., New Delhi.
2. Brock, T. D. Biology of Microorganisms. Prentice Hall.
3. Campbell, R. Microbiology. ELBS-Edward Arnold London. Carpenter, P.L. Microbiology. W.B. Saunders & Company, Philadelphia.
4. Dubey, R.C. & Maheswari, D.K. A text book of Microbiology. S. Chand. Desikachary.
5. Cyanophyta- Monograph Goodfellow, M. et.al. The Biology of Actinomyces. Academic press.
6. Kumar, H.D. & Swati Kumar. Modern Concepts of Microbiology. Mathew, R.E.F. Plant Virology, Academic press.
7. Pelozar, M.J., Chan, E.C.S. & Krieg, N.R. Microbiology. Tata Mc GraHill.
8. Sharma, P.D. Microbiology & Plant Pathology. Rastogi Publishers, Meerut.

Plant Pathology

Module 7

10hr

1. Principles of Plant Pathology- Causal agents of plant diseases - Biotic causes (fungi, bacteria, virus, mycoplasma, nematodes, angiospermic parasites. Abiotic causes (nutrient and mineral deficiencies, effect of pollution). Koch's postulates. Iatrogenic diseases.



2. Details of different symptoms of plant diseases.
3. Process of infection- mechanical, physiological and enzymatic action. Penetration and entry of pathogens in to host tissue.
4. Host- parasite interaction. Enzymes and toxins in pathogenesis. Defense mechanisms in plants (structural and biochemical).
5. Details of different ways of spread and transmission of plant diseases- wind and water-mediated, seed borne and vector borne.
6. Plant disease management- exclusion, eradication and protection .Different pesticides and fungicides and their application. Biocides in plant protection.

Module 8

8hr

1. Study of the following diseases with reference to the symptoms, causal organisms, disease cycle and control measures:

Bunchy top of banana, Bacterial blight of paddy, Bud rot of coconut, Mahali of Arecanut, Powdery mildew of rubber, Abnormal leaf fall of rubber, tikka disease of Ground nut, Late blight of potato, Blister blight of tea, wheat rust, coffee rust, grey leaf spot of coconut, Phytophthora foot rot of pepper, rhizome rot of ginger and turmeric, angiospermic parasites- Viscum, Dendrothoe.

References:

1. Agrios, G.N. Plant pathology. 4th Ed., Academic Press.
2. Bilgrami, K.H. & Dube, H C. A Text Book of Modern Plant Pathology. Vikas Publishers, New Delhi.
3. Chaube, H.S. & Ramji Singh. Introductory Plant Pathology. International .Book Distributing Co., Lucknow.
4. Gareth-Jones, D. Plant Pathology: Principles and Practice. Open University Press.
5. Horsfall J.G. & Cowling E. B. (Ed.). Plant Disease: An Advanced Treatise
6. Academic Press. Lucas, J. A.. Plant Pathology and Plant pathogens. Blackwell.
7. Manners, J.G. Principles of Plant Pathology. Cambridge Univ Press. Mehrotra, R.S. Plant Pathology. Tata Mc Graw Hill.
8. Pandey, B. P. Plant Pathology -pathogen and plant disease. S. Chand & Co.
9. Pathak, V.N., Khatri, N.K. & Pathak, M. Fundamentals of Plant Pathology. Agro-bios India. Rangaswami, G. Diseases of Crop Plants of India. Prentice Hall India.
10. Tarr, S.A.J.The Principles of Plant Pathology. Winchester Press. Wheeler, H. Plant Pathogenesis. Springer Verlag.



CODE: SJBOT1C03

NAME OF THE COURSE: ANGIOSPERM ANATOMY, ANGIOSPERM EMBRYOLOGY,
PALYNOLOGY & MICROTECHNIQUES

(2+2+1+1= 6 hours per week)

SL.NO	COURSE OUT COME	PSOs	PO	CL	KC	Class sections
CO1	Understand the anatomical Peculiarities of plant parts, to identify anomalous growth and correlate anatomical features to taxonomy.	2	5	Z	C	20
CO2	Percieve the knowledge about Morphology and development of Reproductive Parts and to impart knowledge about its future applications	1	5	A	C	20
CO3	Develop the knowledge on how to make temporary microscopic slides, using different cutting techniques and permanent microscopic slides using paraffin method.	5	5,6	Z	F	30
CO4	To familiarize the techniques for the preservation and processing of tissues, to get practical experience in micro macro preparations, histochemistry and staining procedure	5,6	5	U	P	20
Total						90



Angiosperm Anatomy

Module 1

12hr

1. Cell wall and its development. Chemistry of cell wall- cellulose, hemicellulose, polysaccharides, cell wall proteins, water. Organisation of primary wall. Cytokinesis and growth. Plasmodesmata. Secondary wall chemical constituents- lignin, suberin, callose; organisation of secondary wall
2. Node- nodal patterns: Unilacunar, trilacunar, multilacunar and split lateral. Phylogenetic considerations. Leaf trace and branch trace- origin, departure; effect on stele and pith. Secondary growth in leaf traces.
3. Cambium: Development of vascular cambium and cork cambium in root and stem; cell types in vascular cambium, infected vascular cambia, seasonal variations in cambial activity; role of cambium in wound healing and grafting. Conversion of fusiform initials into ray initials; cambium in arborescent monocotyledons (Liliiflorae).

Module 2

12 hr

1. Development and differentiation: The structure of specialized cells. Vascular differentiation (procambium, residual meristem, interfascicular and intrafascicular cambia); acropetal and basipetal differentiation in leaves, stem and roots. Sieve tube differentiation. Control of phloem differentiation. Tracheary elements differentiation. Ultra structure of phloem and xylem, brief account of transfer cells. Secondary wall thickening, cytoplasmic changes and autolysis. Control of differentiation. Genetic aspects- Induction of vessel elements. Induction of secondary xylem structure in relation to function in water conduction.
2. Anomalous secondary growth: Concepts; modification of the common type of vascular cambium, unequal activity of the vascular cambium. Successive cambia. Anomalous placement of vascular cambium. Discontinuous, unidirectional and bidirectional activity of cambium. Anomalous secondary growth in storage roots (Beet root, sweet potato).

Module 3

12 hr

1. Seedling anatomy: Concepts: anatomy of cotyledons, hypocotyl, seedling root, Mesocotyl differentiation
2. Leaf anatomy: Unifacial, bifacial and centric leaf (onion); structure of epidermis, stomata types; foliar scleroids; oil cells; crystals idioblasts. Anatomy of Petiole.
3. Anatomy in relation to taxonomy.
4. Wood anatomy- general account.

References

1. Easu, K. Plant Anatomy - Wiley Eastern Limited.
2. Fahn, A. Plant Anatomy. Pergamon Press.
3. Cutter, E.G. & Edward, E. Plant Anatomy: Experiment and Interpretations Part I and II.
4. Mauseth, J.D. Plant Anatomy - The Benjamin Cummings Publishing Co.
5. Forester, A.S. Practical Plant Anatomy. D. Van Nostrand Company Inc.
6. Roberts, L.W. Cyto differentiation in Plants - Cambridge University Press, Cambridge.



**MSc. Botany St. Joseph's College (Autonomous),
Angiosperm Embryology**

Module 4

8 hr

1. Introduction to angiosperm embryology - structure of ditheous and monotheous anther.
2. Microsporogenesis: Structure and function of wall layers, role of tapetum in Pollen development
3. Male gametophyte: Pollen mitosis, division of generative cells, heterospory.
4. Megasporogenesis: Megaspore triad, dyad, coenomegaspore.

Module

20 hr

1. Embryo sac- different types- ultra-structure of components- synergid and antipodal. Theories of the morphological nature of embryo sac
2. Pollination-Artificial pollination - ultra-structural and dis-ultrastructural and histo-chemical stigma. Significance of pollen - pistil interaction. Role of pollen wall proteins and stigma. In vitro pollination and fertilization.
3. Fertilization: Role of synergids - filiform apparatus, heterospermy and triple fusion.
4. Structure and development of typical dicot and monocot embryos- structure and function of suspensor.
5. Endosperm: classification and type- ruminant endosperm- mosaic endosperm- endosperm haustoria- physiology and cytology of endosperm.

Module 6

8hr

1. Polyembryony - classification – practical value.
2. Apomixis - general account, genetics of apomixis.
3. Parthenocarpy -seedless fruits
4. Seed- Development, structure, classification of seed, importance, seed dispersal and seed dormancy. Seed storage.
5. Experimental embryology- embryo culture, anther culture, ovule culture.
6. Embryology in relation to taxonomy.

References:

1. Bouman F. Ovule initiation, ovule development and seed coat astructure in angiosperms. Today and Tomarrow Publishers, NewDelhi.
2. Bhojwani S.S. and Bhatnagar S.S. The embryology of Angiosperms. Vikas Publication, NewDelhi.
3. Davis C.L. Systematic embryology of Angiosperms. JohnWiley.
4. Eames A.J. Morphology of Angiosperms. Mc GrawHill.
5. Johanson D. Plant Embryology. Waltham, Massachusetts.
6. John B.D. (Ed.). Embryology of Angiosperms. SpringerVerlag.
7. Maheswari P. An introduction to the Embryology of Angiosperms. Mc GrawHill.



9. Raghavan V. Experimental embryogenesis in plants. Academic Press.
10. Wardlaw C.W. Embryogenesis in Plants. Methusen, London.

Palynology

Module 7

18hrs

1. Introduction- contributions of Erdtman and P K KNair.
2. Development and structure of pollen wall. Pollen morphology and its application. Pollen evolution
3. Aero-palynology- methods of aerospore survey and analysis
4. Melitto palynology- nutritional and medical value of honey- unifloral and multifloral honey.
5. Recent advances in palynological studies- forensic-pollen allergy-oil exploration-paleo palynology.
6. Palynology in relation to taxonomy- eurypalynous and stenopalynous taxa.

References:

1. Sripad N. Agashe. Palynology and its Application.
2. Kahinath Bhattacharya et. al. A Text Book of Palynology.

MicroTechniques

Module 8

18 hrs

1. Study of the following instruments - their uses and principles:
Microscope : microscopic measurements - camera lucida, micrometry.
Microtomes- Sledge, Rocking, Rotary
2. Killing, fixing and staining of plant tissues:
 - a. Important reagents and chemicals used in the preparation of fixatives and their properties.
 - b. Fixatives - FAA, Carnoy's fluid, chrome acetic, Nawaschins fluid, Craf, Flemings- composition, preparation and specific uses.
 - c. Dehydrating agents, clearing agents, mounting media. Examples and brief description.
 - d. Stains - classification, composition and specific uses - safranin, crystal violet, cotton blue, fast green, Orange - G, hematoxylin, carmine.
 - e. Staining techniques –single staining, Double staining (Saffranin - Fastgreen, Crystal violet – OrangeG), progressive staining, retrogressive staining, counter staining. Brief account of vital staining.
 - f. Methods of embedding plant materials in paraffin wax - TBA method ; embedding for Electron microscopy.
3. Sectioning of embedded paraffin wax materials using Rotary Microtome.
Double staining of microtome serial sections embedding in paraffin wax - Saffranin - fast



green; Crystal violet - Orange G /Erythrosin.

4. General account on Whole mounts, Maceration, smears
5. Histo chemical tests – (a.) PAS Test – insoluble polysaccharides. (b.) Sudan black-lipids (c) Fuelgen reaction – Nucleic Acids.

References:

1. Peter Gray. Hand book of Basic microtechnique. Mcgraw – Hill.
2. John E. Sass. Botanical Microtechnique, Oxford & IBH PublishingCo.
3. John R. Baker. Principles of Biological Microtechnique– A guide book to microscopical methods. A. V. Grimstone and R.J. Saker, Cambridge Univ. press.
4. K.V. Krishnamurthy. Methods in Plant Histo chemistry-A guide book to microscopical methods. A. V. Grimstone and R.J. Saker, Cambridge Univ.press.



COURSE CODE: SJBOT1L01

**COURSE NAME: PRACTICALS OF PHYCOLOGY, BRYOLOGY, PTERIDOLOGY,
GYMNOSPERMS, MYCOLOGY AND LICHENOLOGY**

(0.5x6= 3 Hours)

SL. NO	COURSE OUT COME	PSOs	PO	CL	K C	Lab (hrs)
CO1	Identify the external morphology, internal Structure and reproduction of different types of algae, bryophytes, Pteridophytes and Gymnosperms	2	1,5	A	P	25
CO2	Understand the structural details of various types of Fungi and lichens and develop basic skills and techniques for the isolation and Culturing of fungi and pathogens	2	5	A	P	20
Total						45



Phycology

6hrs

1. Collection, preparation and submission of algal herbarium (2 numbers).
2. Collection and study of the types mentioned below and their identification up to generic level using algal monographs:
Chlorophyta: Pediastrum, Scenedesmus, Hydrodictyon, Ulva, Cladophora, Pithophora, Bulbochaeta, Cephaleuros, Draparnaldiopsis, Bryopsis, Codium, Caulerpa, Halimeda, Desmids (Closterium, Cosmarium), Nitella. Xanthophyta: Botrydium. Bacillariophyta: Biddulphia, Coscinodiscus, Cymbella. Phaeophyta: Ectocarpus, Dictyota, Padina, Turbinaria. Rhodophyta: Batrachospermum, Gracilaria, Champia.

Bryology

6hrs

1. Morphological and structural study of representative members of the following groups using whole mount preparations, dissections and transactions:
Asterella, Targionia, Cyathodium, Lunularia, Pallavicinia, Dumortiera, Porella, Anthoceros, Sphagnum and Bryum.

Pteridology

6hrs

1. Collection, preparation and submission of five herbarium sheets of pteridophytes.
2. Study of vegetative and reproductive features of Lycopodium, Ophioglossum, Angiopteris, Osmunda, Lygodium, Ceratopteris, Pteris, Asplenium, Blechnum, Cyathea, Gleichenia, Trichomanes, Salvinia and Azolla.
3. Study of the following fossils: Rhynia, Lepidodendron, Sphenophyllum, Calamites, Calamostachys, Zygopteris and Anachoropteris.
4. Spore germination and development of prothallus in Knop's Agar medium.

Gymnosperms

6hrs

1. Identification of petrifications, compressions, impressions: Lyginopteris, Heterangium, Medullosa, Trignocarpus, Glossopteris, Caytonia, Pentaxylon and Cordaites.
2. Study of vegetative and reproductive structures of Zamia, Ginkgo, Pinus, Cryptomeria, Cupressus, Araucaria, Agathis, Podocarpus, Cephalotaxus, Ephedra and Gnetum.

Mycology & Lichenology

12hrs

1. Critical study of the following types with the help of fresh/preserved materials by making suitable micropreparations giving emphasis on systematic position, details of vegetative and reproductive structures:
Stemonitis, Saprolegnia, Phytophthora, Albugo, Mucor, Pilobolus, Saccharomyces, Xylaria, Chaetomium, Peziza, Puccinia, Auricularia, Polyporus, Ganoderma, Lycoperdon, Dictyophora, Geastrum, Cyathus, Aspergillus, Curvularia, Alternaria, Fusarium, Colletotrichum, Parmelia, Usnea.



Practical records:

- Submission of certified record of practicals at the time of terminal evaluation.

Field work:

- 2 days of field work for the in situ study of the types of the above areas of study and submission of a field report.



COURSE CODE: SJBOT1L02

**COURSE NAME: PRACTICALS OF MICROBIOLOGY, PLANT PATHOLOGY,
ANGIOSPERM ANATOMY, ANGIOSPERM EMBRYOLOGY, PALYNOLOGY AND
MICRO TECHNIQUES**

(0.5X6= 3 Hours)

SL.NO	COURSE OUT COME	PSOs	POs	CL	K C	Lab (hrs)
CO1	Develop basic skills and techniques in inoculation and isolation of microbes and its various assays.	5	1,5	A	P	10
CO2	Apprehend the pathological importance of Fungi and identify common plant diseases and device control measures.	1,5	4	A	P	5
CO3	Examine the anatomical peculiarities of types mentioned in the syllabus	2	1	A	P	10
CO4	Build the basic concepts of development, organogenesis and morphogenesis in plants	5	5	A	P	5
CO5	Develop skill in preparing Permanent slides.	5	5,6	A	P	15
Total						45



Microbiology

6hrs

1. Test for the presence of coliform bacteria in contaminated water.
2. Isolation of Eubacteria and Cyanobacteria from soil by dilution plate method.
3. Isolation of pure bacterial culture by streak plate method.
4. Staining of bacteria (negative staining, Gram staining and spore staining).
5. Demonstration of bacterial motility by hanging drop method.
6. Morphological studies on Scytonema, Aphanocapsa, Spirulina, Oscillatoria, Anabaena.

Plant Pathology

6hrs

1. Submission of five herbarium sheets of pathological specimens.
2. Detailed lab study of the following diseases:
Bud rot of coconut, Powdery mildew of rubber tikka disease of Ground nut, Late blight of potato, Blister blight of tea, wheat rust, coffee rust, grey leaf spot of coconut, Phytophthora foot rot of pepper, rhizome rot of ginger and turmeric.
3. Technique of isolation and pure culture of pathogens.

Angiosperm Anatomy

12hrs

1. Study of anomalous secondary growth in roots and stems of Aristolochia, Strychnos, Amaranthaceae, Nyctaginaceae, Bignoniaceae and Agavaceae.
2. Nodal anatomy of different types.
3. Leaf anatomy: epidermal peels and TS of Lamina.

Embryology

3hrs

1. Study of anther development of Datura.
2. Preparation of dissected whole mounts of microsporangium.
3. Study of megaspore mother cell, megaspore and embryo sac.
4. Study of the receptivity of stigma and in situ germination of pollen.
5. Dissection of stages in the development of embryo and endosperm.
6. Pollen germination using hanging drop technique.
7. Demonstration of intra ovarian pollination.

Palynology

3hrs

1. Analysis of honey for microscopic examination of pollen.
2. Calculation of percentage of viable pollen by using T Z test.
3. Study of pollen wall by acetolysis.

Lab Techniques

6hrs

1. Measurement of microscopic objects -Micrometry.
2. Camera lucida drawing - calculation of magnification
3. Double stained permanent sections - free hand section, Microtome serial Sections.



4. Preparation of whole mounts, macerations and smears.
5. Submission of 5 permanent slides - which should include microtome serial sections, free hand sections, macerations, whole mounts and smears.

Practical records:

- Submission of certified record of practicals at the time of terminal evaluation.
- **Field work:** 2 days of field work for the in situ study of the types of the above areas of **study and submission of a field report**



SEMESTER II

COURSE CODE: SJBOT2C04

NAME OF THE COURSE: CELL BIOLOGY, MOLECULAR BIOLOGY AND BIOPHYSICS

(2.5 + 2.5 + 1 = 6 hours)

SL.NO	COURSE OUT COME	PSOs	POs	CL	KC	Class sections
CO1	Understand the structure of cell organelle, intracellular compartments, cell communication and signalling, life cycle and cytoskeleton of the cell	1	5	U	C	20
CO2	Build the knowledge about DNA replication, compare and distinguish the processes and mechanisms involved in Transcription and Translation repair and recombination	6	5	Z	C	20
CO3	Analyse and assess the regulation of gene expression in Viral, Prokaryotic and Eukaryotic Systems	1	5	Z	C	20
CO4	Acquire practical skill in cytological preparations and molecular biology problems	5	1,5,6	Z	P	15
CO5	Understand principles and applications of instruments.	5	5	A	C	15
						90



Cell Biology

Module 1

16 hrs

1. The nucleus. Interphase nucleus- Chromatin organization- nucleosomes, scaffold. Organization of eukaryotic chromosome. Heterochromatin- constitutive, facultative and condensed. Euchromatin. Satellite DNA. Chromosome banding and its significance.
2. Cell reproduction: Cell cycle. Specific events G1, S, G2 and M phases. Significance of G0. Control of cell cycle. Significance. Gene expression during cell cycle. Mitotic Inducers.
3. Meiosis: types, synaptonemal complex, significance of meiosis. Genetic control and consequences of meiosis. Restriction points and check points. Cell cycle regulation of meiotic events- behaviour of sex chromosomes in meiosis- suppression of DNA replication between Meiosis I and II. Meiotic defects and human diseases.

Module 2

17 hrs

1. Programmed cell death- necessity, classes, signals. Genetic analysis of cell death. Proteins regulating apoptosis. Pathways leading to cell death- significance. Aging- cellular and extracellular. Cell signaling.
2. Cell interactions-communication, recognition and adhesion.Application.

Module 3

11 hrs

1. Cellular differentiation and specialization. General characteristics, intrinsic interactions- Nucleo-cytoplasmic. Extrinsic interactions. Molecular mechanisms of cellular differentiations.
2. Cancer- carcinogenic agents. Phenotype of the transformed cell. Genetic basis of malignant transformation- oncogenes. Tumour suppressor genes. Cancer and cell cycle. Metastasis. Interaction of cancer cells with normal cells.

References:

1. Cooper Jeffrey M. The Cell- A Molecular Approach. ASM, Washington.
2. Karp Gerald. Cell Biology. John Wiley and Sons.
3. Derobertis. Cell and Molecular Biology.
4. Sadava R.
5. Pollard T.D. and Earn Shaw W.C. Cell Biology.Saunders

Molecular Biology

Module 4

13 hrs

1. Molecular biology of gene: Structure of DNA: Different forms of DNA (A, B, C, D, E, Z): Repetitive DNA; c-value paradox.
2. Replication of DNA: Enzymology of replication. Replication in prokaryotes and eukaryotes. Primosomes and replisomes. Telomerase and its function.



Module 5

20 hrs

1. Gene expression: regulation of gene expression- Operon concept- Gene regulation in prokaryotes and eukaryotes- enhancers and silencers.
2. Protein synthesis: Transcription, post-transcriptional events. Introns and their significance. Translation. Post translational events. Role of chaperons.

Module 6

12 hrs

1. Mutation: Spontaneous and induced. Physical and chemical mutagens. Molecular mechanism of mutation. Mutation and cancer. Mutator and antimutator genes. DNA repairing mechanisms.
2. Molecular evolution: The origin of genomes. Evolution of new genes. Origin of eukaryotic genomes. Phylogenetics. Application of molecular phylogenetics.

References

1. Lewin Benjamin. Genes. Oxford University press.
2. Brown TA. Genomes. John Willey and Sons.
3. Snustad, Simmons and Jenkins. Principles of Genetics. John Willey and Sons.
4. Weaver and Hendrick. Genetics. Wm. C. Brown Publishers.
5. Hawkins J.D. Gene Structure and Expression. Cambridge University Press.

Biophysics

Module 7

10hrs

1. pH and buffer solutions- hydrogen ion concentrations and pH, dissociation of acids and bases. Measurement of pH using organic indicator molecule and potentiometric method. Functions of buffers in a biological system. Use of buffers in biological and biochemical research. pH and life. Henderson and Hasselbalch equation.
2. Chromatography: Principles of chromatography. Types of chromatography (Brief account).
3. Electrophoresis: Electrophoretic mobility, principles, PAGE, Agarose gel electrophoresis. Separation and detection of macromolecules by electrophoresis. Electrophoretic apparatus, technique and procedure.
4. Centrifugation - Theory of centrifugation. Centrifuge- Types, Methodology of centrifugation, applications.

Module 8

8 hrs

1. Colorimetry and spectrophotometry: Beer-Lamberts law. Measurement of extinction. Colorimeters and spectrophotometers. Techniques and applications in biological and biochemical research. Comparison between colorimetry and spectrophotometry.
2. Radiobiology: Autoradiography. principles, types. Methods and applications in biological research.



3. Immunochemistry: Immune response. Antigens- Antibodies. Histo-incompatibility antigens; Structure of IgG. Immunochemical assays-RIA, ELISA.
4. Cryobiology: Freeze drying (lyophilization)-applications.

References:

1. Hoppe, W. (Ed.). Biophysics. Springer Verlag.
2. Rogers, A.W. Techniques of Autoradiography. Elsevier.
3. Roy, R.N. A Text Book of Biophysics. New Central Book Agency Pvt. Ltd, Calcutta.
4. Sasidharan, A. Selected Topics of Biophysics. Frontier Area Publishers.
5. Slayter, E.M. Optical methods in Biology. Wiley Inter sciences.
6. Wong, C.H. Radiation Tracer Methodology in Biophysical Sciences.
7. Prentice Hall. Plummer, D. An introduction to Practical Biochemistry. Tata Mc Graw Hill, New Delhi.



COURSE CODE: SJBOT2C05

NAME OF THE COURSE: CYTOGENETICS, GENETICS, BIostatISTICS, PLANT BREEDING AND EVOLUTION

(1+1.5+1.5+1+1= 6 hours)

SL. NO	COURSE OUT COME	POs	PSOs	CL	KC	Class sections
CO1	Understand the basics of gene interactions and linkage	1,5	5,6	U	C	10
CO2	Impart the knowledge of Cytogenetics, human genetics and population genetics	1,5	5,6	U	C	25
CO3	Familiarize the students with different conventional aspects and modern approaches of Plant Breeding used in crop improvement	5	6	A	F	20
CO4	Introduce relevance of Biometrical techniques and IPR in plant breeding	5	6	A	P	5
CO5	Understand basic concepts and mechanisms of Evolution	3	1	U	C	15
CO6	Recognize, compare and apply the statistical methods used for data analysis and biological experiments	1,5	5,6	A	C	15
						90



Cytogenetics

Module 1

18 hrs

1. Cytogenetics of aneuploids, euploids and structural heterozygotes: Effect of aneuploidy on phenotype. Transmission of monosomics and trisomics and their uses. Breeding behaviour and genetics of structural heterozygotes; translocation heterozygotes; Robertsonian translocation; B-A translocation. Karyotype- concepts and its importance. Structural chromosome aberrations- types and significance in evolution. Heteroploidy, aneuploidy, monosomy, trisomy (primary, secondary, tertiary and compensating). Nullisomy. Uses of aneuploidy in cytogenetics. Euploidy- autopolyploidy, allopolyploidy and segmental allopolyploidic diploidization. Role of aneuploidy and euploidy in evolution.
2. Molecular cytogenetics: Multigenic families and their evolution; in situ hybridization- concept. Computer assisted chromosome analysis, chromosome micro-dissection and micro- cloning; flow cytometry.
3. Polytene and lampbrush chromosomes- cytogenetic importance.
4. Supernumerary chromosomes: B-chromosomes.

References:

1. Alberts B., D. Bray, J. Lewis, K. Roberts and J.D. Watson. Molecular Biology of the Cell Gartand Publishing Inc. New York.
2. Atherly A.G., J.R. Girton and J.F. McDonald. The Science of Genetics. Saunders College Publishing, Fort Worth, USA.
3. Burnharm C.R. Discussions in Cytogenetics. Burgess Publishing Co., Minnesota.
4. De Robertis E.D.P. and De Robertis E.M.F. Cell and Molecular Biology ISBN, Hong Kong.
5. Dupraw E.J. DNA and Chromosomes. Holt, Rinehart and Winston Inc. New York.
6. Hart D.L and E.W. Jones. Genetics: Principles and Analysis. Jones & Bartlett publishers, Massachusetts, USA.
7. Khush, G.S. Cytogenetics of Aneuploids. Academic Press.
8. Karp G. Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons, Inc. USA.
9. Lewin B. Gene. Oxford University Press, New York, USA.
10. Lewis R. Human Genetics: Concepts and Applications. WCB Mc Graw Hill, USA.
11. Malacinski G. and D. Freifelder. Essentials of Molecular Biology. Jones and Bartlett Publishers Inc., London
12. Rieger R., A. Michaelis and M.M. Green Glossary of Genetics and Cytogenetics - Classical and Molecular. Springer-Verlag, New York.
13. Swanson C.P., T. Merz, and J.W. Young. Cytogenetics. Prentice Hall.



Genetics

Module 2

12hrs

1. Relevance of Mendelism in modern genetics. A critical evaluation of Mendelism on the basis of modern concept of genes.
2. Linkage and gene mapping. Three- point test cross; linkage map; interference; tetrad analysis and centromere mapping. Linkage in humans. Pedigree analysis. Genetic recombination and mapping of genes in bacteria and bacteriophages.

Module 3

8 hrs

1. Mobile genetic elements: Transposable elements in bacteria. IS elements. Tn elements. Cmp site transposon. Cepia and P elements in Drosophila. Ac, DS and Mu elements in maize. Retrotransposons- Molecular characteristics and significance in development and evolution.
2. Extranuclear inheritance: Analysis of mitochondrial and chloroplast genomes and their utility. Cytoplasmic male sterility.
3. Quantitative genetics: Polygenic inheritance, heritability and its measurements. QTL mapping.

Module 4

7 hrs

1. Population genetics: Systems of mating. The Hardy-Weinberg principle. Estimation of gene frequencies. Factors affecting equilibrium: natural selection, mutation, migration and genetic drift.
2. Human genetics: Human pedigree analysis, Lod score for linkage testing. Karyotype; genetic disorders.

References:

1. Snustad, Simmons and Jenkins. Principles of Genetics. John Willey and Sons.
2. Weaver and Hendrick. Genetics. Wm. C Brown Publishers.
3. Good enough. Genetics. Saunders College Publishing. Stansfield. Theory and Problems of Genetics. Mc Grow Hills. Strickberger. Genetics. Macmillan
4. Burnet L. Essential Genetics. Cambridge University Press. Friefelder. Microbial Genetics. Narosa Publishing House.
5. Gardner, Simmons and Snustad. Principles of Genetics. John Wiley and Sons, New York, USA.
6. Singh B.D. Fundamental of Genetics. Kalyani Publishers, New Delhi.



Biostatistics

Module 5

12hr

1. The science of statistics and its applications in biological research. Types and collection of data- Census and sampling- theory and methods.
3. Tabulation and presentation of data- diagrammatic and graphic presentation.
4. Analysis of data- central tendencies.
5. Measures of dispersion - Range, quartile deviation, mean deviation,
6. Standard deviation and standard error. Relative measures of dispersion - coefficient of variation.
7. Tests of significance- formulation and testing of hypothesis- testing the probability of committing type 1 and type 2 errors. z test, t test, chi-square test.
8. Analysis of variance- one way classification and two way classification, F test, F value calculation, F table.

Module 6

15 hr

1. Correlation and Regression analysis- coefficient of correlation- significance testing. Rank correlation. Lines of regression- coefficient of regression.
2. Experimental designs- designing an experiment- CRD, RBD, LSD. Factorial experiments.
3. Probability- application of the principles of probability- theorems of probability- applications- Probability distributions- binomial, multinomial, normal and poisson distributions.
4. Statistical softwares- SPSS, SPAR, MINITAB.

References:

1. Chandal S.R.S. A Handbook of Agricultural Statistics. Achal Prakashan Mandir, Kanpur, India.
2. Das M.N. and N.C. Giri. Designs and Analysis of Experiments. Wiley Eastern Ltd.
3. Elhance and Elhance. Fundamentals of Mathematical Statistics. Kithab Mahal, New Delhi, India.
4. Gupta S.K and V.K. Kapoor. Fundamentals of Mathematical Statistics. Sultan Chand & Sons, New Delhi.
5. Gupta C.B. An Introduction to Statistical Methods. Vikas Publishing House Pvt.Ltd.
6. Kempthorne, O. An Introduction to Genetic statistics. John Wiley and Sons Inc. New York.
7. Mather K. and J.L. Links. Biometrical Genetics. Chapman and Hall, London.
8. Panse, V.G and P..Sukatme. Statistical Methods for Agricultural Workers. ICAR, New Delhi.
9. Rao C.A. Advanced Statistical Methods in Biometrical Research. Wiley and Sons, New York.
10. Singh P. and S.S. Narayanan. Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi.
11. Singh R.K. and Chaudhary B.D. Biometrical Methods in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi.
12. Daniel W.W. Biostatistics- A foundation for Analysis in Health Sciences.



Plant Breeding

Module 7

18 hrs

1. Introduction and objectives.
2. Organizations involved in plant breeding.
3. Breeding systems in sexually propagated plants- Floral Biology and its significance in plant breeding. Sterility and incompatibility systems.
4. Genetic resources- centers of crop genetic diversity. In situ and ex situ conservation; cryopreservation of germplasm.
5. Conventional methods of plant breeding: Domestication of wild plants- changes under domestication.
 - a. Plant introduction- history, types, principles, plant introduction agencies in India- rules and regulations. Major achievements.
 - b. Selection-selection methods in sexually and vegetatively propagated species.. Major achievements.
 - c. Hybridization- history, objectives, techniques, consequences and major achievements. Heterosis breeding- genetic basis of heterosis and inbreeding depression.
6. Modern methods of plant breeding:
 - a) Mutation breeding- history, methodology, applications, merits, demerits and achievements.
 - b) Polyploidy breeding- methodology, applications, merits, demerits and achievements.
 - c) Biotechnological approaches in plant breeding- Molecular markers and their uses- Transgenic plants- critical evaluation.
7. Breeding for special purposes: Resistance breeding- a brief account of disease resistance, pest resistance, stress resistance- achievements. Quality breeding- objectives and achievements.
8. Biometrical techniques in Plant Breeding- analysis of variability, heritability, genetic advance and combining ability.
9. IPR- Protection of plant variety and farmers' right act.

References:

1. Allard R.W. Principles of Plant Breeding. John Wiley and Sons, New Delhi.
2. Chahal G.S. and Gosal S.S. Principles and Procedure of Plant Breeding. Narosa Publishing House, New Delhi.
3. Jain H.K. and Kharkwal M.C. Plant Breeding- Mendelian to Molecular Approaches. Narosa Publishing House, New Delhi.
4. Roy D. Plant Breeding- Analysis and Exploitation of Variation. Narosa Publishing House.



5. Hayward M.D., Bosemark N.O. and Romagasa I. Plant Breeding- Principles and Prospects. Chapman &Hall.
6. Gupta S.K. Plant Breeding- Theory and Techniques. Agrobios (India), Jodhpur.
7. Khan M.A. Plant Breeding. Biotech Books, New Delhi.
8. Stoskopf N.C. Plant Breeding- Theory and Practice. Scientific Publishers (India), Jodhpur.
9. Sharma J.R. Principles and Practices of Plant Breeding. Tata Mc GrawHill.
10. Chopra V.L. Breeding Field Crops.Oxford &IBH.
11. Mohanan K.V. Essentials of Plant Breeding. PHI Ltd., New Delhi.
12. MohananK.V. Essentials of Plantation Science. Penta Book Publishers, Calicut, Kerala.

Evolution

Module 8

18hrs

1. The concept of evolution geological time scale and evolution.
2. Origin of life- theories and experimental evidences.
3. Evidences of evolution: chemical evolution and biological evolution.
4. Theories of evolution.- Pre-Darwinian, Darwinian and Post Darwinian theories.- Modern synthetic theory of evolution.
5. Reproductive isolation and the origin of species.
6. Evolution at the molecular level.

References

1. Charlesworth B. & Charlesworth D. 2017. Evolution: A Very Short Introduction, 2nd Edition Oxford University Press.
2. Willis K. & McElwain M. C. 2014. The Evolution of Plants. Oxford University Press.
3. Herron, J. C., Freeman, S.m Hodin, J., Miner, B. & Sidor, C. 2014. Evolutionary Analysis.5th Edition. Pearson Education, Inc.
4. Futuyma D. J. 2013 Evolution. 3rd edition Sinauer Associates, Inc.
5. Shapiro, J. A. 2011. Evolution- A view from the 21st Century. Publishing as FT Press Science.
6. Barton N.H., Briggs E.G.,Eisen J. A. Goldstein D. B. & Patel N.H. 2007 Evolution Cold Spring Harbor Laboratory Press; 1st edition (June 26,)
7. Sproule, A. 1998. Charles Darwin: Scientist who have Changed the World. Orient Longman, New Delhi.
8. Strickberger, M. W. 1996. Evolution, Jones and Bartlett Publishers, New York.



COURSE CODE: SJBOT2C06

**NAME OF THE COURSE: PLANT ECOLOGY, CONSERVATION BIOLOGY,
PHYTOGEOGRAPHY AND FOREST BOTANY**

(2.5+1.5+1+1= 6 hours)

SL.NO	COURSE OUT COME	PSOs	POs	CL	KC	Class sections
CO1	Understand the concept and principles of ecosystem productivity, energy flow and biodiversity.	6	1	U	F	15
CO2	Impart knowledge on phytogeography and recognize the different forest types and products for sustainable utilization of bioresources.	4	3	U	F	15
CO3	Build awareness in controlling pollution and apply their knowledge in waste management	5	6	A	C	15
CO4	Understand and analyse environmental problems and social issues which need immediate attention.	4	4	U	C	20
CO5	Examine the biodiversity loss and create an awareness about the significance of genetic resources and its conservation	5	5	U	C	15
CO6	Evaluate conservation ventures at local/national and global levels	5	2	E	P	10
						90



Plant Ecology & Conservation Biology

Module 1

12hr

1. Habitat Ecology: Salient features of terrestrial (Biomes), fresh water (Limnology), wet land and marine habitats.
2. Productivity and Energy flow: Concepts, limits and process of primary production; methods of productivity measurements: global trends in primary productivity, energy flow models.

Module 2

12hr

1. Population characteristics: density, natality, mortality, distribution, biotic potential, carrying capacity, aggregation and dispersal, ecotone and edge effect, eco type, ecophene, ecocline.
2. The environment and its pollution- types (land, air and water). Effect on living organisms. Control with emphasis on biological methods. Environmental hazards.

Module 3

12hr

1. Threats to the global environment- green house effect, ozone depletion, El-Nino and La Nina effects.
2. Environment impact assessment (EIA) and assessment of environmental hazards-remotesensing.
3. Problems of conservation; causes of threat to environment- human interference, deforestation, habitat destruction, over exploitation of resources.

Module 4

12hr

1. Identification of threatened plants; red list categories- extinct, endangered, vulnerable, rare and out of danger. Extinction process. Hot spots, keystone species and flagship species.
2. Strategies for conservation: in situ and ex situ conservation, biosphere reserve, national parks, wildlife sanctuaries. Gene banks, cryopreservation, seed banks.

Module 5

24hr

1. Afforestation- social forestry, agroforestry. International biological programme (IBP), Man and biosphere programme (MAB), IUCN, world environment day, wild life preservation act (1972), Indian forest (conservation) act (1980) and United Nations Environment Programme. Environment Protection Acts.
2. Environmental awareness- role of government and NGOs- Gaia hypothesis.
3. Biodiversity- significance at Local, National and Global levels. Deep ecology (Paradigm shift from anthropocentric ecology to ecocentric ecology. National heritages.

References:

1. Negi, S.S. Hand book of National Parks and Sanctuaries in India.
2. M.P. Nair and P.K Sastry - Red data book of Indian plants.
3. Mehrotra and B.K Suri - Remote sensing for environment and forest management.
4. Negi S.S - Biosphere reserves in India.



5. Lucas and Syngé - IUCN Red data book. IUCN, Stockholm
6. Dasman R.F – Environmental Conservation.
7. Odum E.P. Fundamentals of ecology
8. Odum E.P. Basic principles of ecology
9. Misra K.R. Ecology workbook
10. Puri G.S. - Indian Forest Ecology Volumes I and II. Oxford & IBH.
11. Clarke G.L - Elements of Ecology.
12. Chhatwal G.L. Encyclopedia of environmental biology.
13. Ray P.K. - Pollution and Health. Willey-Eastern Ltd, New Delhi
14. Michael P.-Ecological methods for field and laboratory investigations. Tata McGraw Hill, New Delhi
15. Kershaw K.A. Quantitative and Dynamic Plant Ecology. ELBS.

Phytogeography

Module 6

18 hr

1. Patterns of plant distribution: continuous distribution: circumpolar, circumboreal, circum austral, pan tropical.
2. Discontinuous distribution: Theory of land bridges, theory of continental drift, theory of glaciation.
3. Endemic distribution (neoendemic, paleoendemic), age and area hypothesis.
4. Phytochoria of world and India.

References:

1. Ronald Good. The geography of flowering plants. Lcngmans.
2. Bharucha F.R. A text book of plant geography of India. Oxford University Press.
3. Puri G.S. Indian Forest Ecology, Vol I, II. Oxford, New-Delhi.

Forest Botany

Module7

18 hr

1. Forest- Definitions. Study of various types of forests in the world and in India.
2. Forest products-Major and minor with special reference to Kerala.
3. Influence of forests on environment. Consequence of deforestation and industrialization-sustainable utilization of bioresources.

References

1. Agarwal A.P. Forests in India. Oxford & IBH.

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2. Gregorv G.R. Forest products, production, trade and consumption, quantity and value of rawmaterials requirements. Ford foundation, New-Delhi.
3. Puri G.S. Indian Forest Ecology Vol. I& II. Oxford &IBH.
4. Champion G.H. and Seth S.K. A revised survey of the forest types of India.



COURSE: SJBOT2L03.

**COURSE NAME: PRACTICALS OF CELL BIOLOGY, MOLECULAR BIOLOGY,
BIOPHYSICS, CYTOGENETICS**

(0.5+1+ 0.5+1= 3 hours)

SL.NO	COURSE OUT COME	PSOs	POs	CL	K C	Lab (hrs)
CO1	Understand and observe the various stages of mitosis and meiosis and to get the skill for induction of polyploidy	5,6	5	U	P	10
CO2	Workout problems based on molecular biology	5,6	1	A	P	15
CO3	Assess the basic function and work in of analytical instruments used in research	6	1,5	U	P	10
CO4	Understand the features of chromosome for the Preparation of ideogram	6	1	A	P	10
						45



Cell Biology

10hr

1. Study of Mitosis in root tip cells.
2. Pre-treatment of root tips with colchicine / hydroxy quinoline / paradichlorobenzene and study of chromosomes in Chlorophytum, / Zea mays Crotalaria / Cyanotis.
3. Isolation of plastids and mitochondria.
4. Chromosome banding

Molecular Biology

10 hr

1. Working out problems from molecular genetics.
2. Isolation of nucleic acid and identification of histones by SDS-PAGE.
3. Isolation of plant DNA and its quantification by spectrophotometric/ calorimetric method.
4. Immunological techniques: ELISA and Western Blot.

Biophysics

9 hr

1. Preparation of buffers and measurement of pH using pHmeter.
2. Determination of isoelectric pH.
3. Paper chromatography: Separation of sugars.
4. Thin layer chromatography- separation of amino acid mixtures.
5. Calorimetric and spectrophotometric estimation of proteins by Biuret / Lowry's method.
6. Estimation of amino acid by Ninhydrin method (colorimetric).

Cytogenetics

9 hr

1. Induction of polyploidy using colchicine; different methods of the application of colchicine.
 2. Effect of induced and spontaneous polyploidy on plant phenotype, meiosis, pollen and seed fertility and fruit set.
 3. Preparation of karyotype and ideogram of plant meristematic cells.
 4. Cytological studies in callus tissues.
 5. Study of meiosis in translocation heterozygotes (Rheo discolor)
 6. Study of polytene chromosomes.
- Preparation of lab record and submission for valuation.
 - **Visit to a reputed molecular biology lab and submission of a report.**

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COURSE CODE : SJBOT2L04

COURSE NAME: PRACTICALS OF GENETICS, BIostatISTICS, PLANT BREEDING, PLANT ECOLOGY, CONSERVATION BIOLOGY, PHYTOGEOGRAPHY AND FOREST BOTANY (0.5+0.5+0.5+0.5+0.5+0.5=3 hours)

SL.NO	COURSE OUT COME	PSOs	CL	K C	Lab(hrs)
CO1	Understand and workout problems related to genetics	2	A	P	7.5
CO2	Develop the skills to analyse the water quality using different parameters	2,3,4	Z	P	15
CO3	Devise methods and tests to improve the basic skills and techniques related to plant breeding	2,4	C	P	7.5
CO4	Explain basic software skills necessary for the conduct of research.	2,4	A	P	7.5
CO5	Understand the vegetative patterns	2,4	Z	P	7.5
					45

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SYLLABUS

Genetics (7.5hrs)

1. Problems from linkage, tetrad analysis, quantitative genetics and population genetics.

Biostatistics (7.5 hrs)

1. Problems from Mean, standard deviation, Coefficient of variation, tests of significance and correlation analysis.
2. Use of computer programmes for statistical analysis.

Plant Breeding (7.5hrs)

1. Study of floral morphology and flower structure in crop plants-rice, cashew, pulses, Solanum, Capsicum.
2. Practice of hybridization technique in self and cross pollinated plants mentioned in 1.
3. Biometrical techniques in Plant Breeding- analysis of variability.

Ecology and Conservation biology (7.5hrs)

1. Determination of food chains and food web in aquatic ecosystem.
2. Determination of the minimum size of the quadrat suitable for an area using species area curve method.
3. Determination of the Importance Value Index (IVI) of plant species in the community by quadrat, line and belt transect methods.
4. Comparative study of polluted and non-polluted aquatic ecosystems.



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5. Visit to a meteorological station, national park or wild life sanctuary, sewage treatment unit and major construction site.
6. Estimation of dissolved oxygen content in the water sample by Winkler's method.
7. Determination of primary production in water samples by light and dark bottle method (Winkler's method).
8. Determination of dissolved carbon dioxide content in water samples.
9. Determination of frequency of plant species of an area and heterogeneity of vegetation using transect method.

Phytogeography (7.5hrs)

1. Identification of the various floristic and vegetational regions of the world and India in maps.

Forest Botany (7.5 hrs)

1. Study of the major and minor forest products of Kerala and their uses.
2. Preparation and submission of lab record
3. Visit to one plant breeding station and one ecologically sensitive area and submission of reports

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SEMESTER III

COURSE CODE: SJBOT3C07

NAME OF THE COURSE: PLANT PHYSIOLOGY, METABOLISM AND BIOCHEMISTRY

(2+2+2+=6hours)

SL.NO	COURSE OUT COME	PSOs	POs	CL	KC	Class (hrs)
CO1	Understand the water relations, absorption and transport of minerals in plants	3	1	U	F	10
CO2	Understand and evaluate the role of growth hormones in plant development and external factors in plant development and stress induction	3	1	U	F	15
CO3	Discuss the various secondary metabolic pathways and their physiological ecological, phylogenetic importance	3	1	A	C	15
CO4	Understand the structure, function, mechanism of action, synthesis regulation of biomolecules in plants.	3	1	U	C	15
CO5	Discuss the different photoreceptive pigments and photosynthetic and metabolic pathways	3	1	U	C	20
CO6	Develop basic skills and techniques for qualitative and quantitative analysis of Physiological and biochemical parameters	5	5	A	P	15
						90



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Plant Physiology

Module 1

12hr

1. Water and plant cells: Properties of water, hydrogen bonding, polarity, cohesion and adhesion. The concept of water potential. Water movements in cells and tissues. Soil-plant atmosphere continuum. Transpiration, stomatal movement, modern theories of stomatal mechanism. The ascent of xylem water and the up-take of water by roots. Absorption of mineral ions- solute absorption.
2. Plants and nitrogen: Nitrogen cycle , Biological nitrogen fixation, symbiotic nitrogen fixation in leguminous plants. Biochemistry of nitrogen fixation. Export of fixed nitrogen from nodules. Genetics of nitrogen fixation. Nitrogen assimilation, assimilation of nitrate. Nitrogen nutrition - agricultural and ecological aspects. Biosynthesis of amino acids- reductive amination and transamination. GDH and GS/ GOGAT pathway.

Module 2

12hr

1. Photosynthesis: Absorption and fate of light energy, absorption and action spectra. Photoreceptors-chlorophylls, carotenoids, phycobilins. Bioenergetics and the light dependent reactions of photosynthesis. Photosynthetic electron transport and photophosphorylation. The two pigment systems, Z-scheme, water oxidizing clock. The photosynthetic carbon reduction cycle, C3, C2, C4 and CAM metabolism and ecological significance.
2. Translocation and distribution of photo assimilates. Phloem transport, Sources and sinks, mechanism of translocation. Phloem loading and unloading, distribution of assimilates. Translocation of xenobiotic chemicals.

Module 3

12hr

1. Patterns in plant development: Growth, differentiation, and development. Genetic control and hormonal regulation of development. Seed germination- physiology of hormones in plant development- auxins, gibberellins, cytokinins, abscisic acid and ethylene. Role of vitamins and nutrients.
2. Photomorphogenesis : Phytochrome: chemistry and physiological effects. Mechanism of phytochrome and gene action. Cryptochromes and blue light effect.
3. Stress Physiology: Types of stress- water, temperature, salt, stresses caused by pests and pathogens and pollutants.



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References:

1. William G. Hopkins. Introduction to Plant Physiology. John Wiley & Sons Inc.
2. Lincoln Taiz and Eduardo Zeiger. Benjamin/Cumming Publishing Company Inc. New York.

Metabolism

Module 4

9hr

1. Enzymes: General aspect, classification, Michaelis-Menton equation and its significance. Mechanism of enzyme action, co-enzymes, inhibition, regulation, allosteric enzymes, covalently modulated enzymes. Kinetics of enzyme catalysis. Isoenzymes.
2. Intermediary metabolism: Anabolism, catabolism, amphibolic pathways and anapleurotic reactions. Link between primary metabolism and secondary metabolism. Bioenergetics and thermodynamics.

Module 5

13hr

1. Catabolism of hexoses: Glycolysis- two phases, overall balance sheet, regulation; fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway-multifunctional pathway (significance). Tricarboxylic acid cycle: Formation of acetate, reaction of citric acid cycle, anapleurotic reactions of citric acid cycle. Regulation of citric acid cycle. Glyoxylate cycle. Amphibolic nature of TCA cycle.
2. Oxidation of fatty acids. Activation and entry of fatty acids, Beta oxidation of saturated and unsaturated fatty acids. Regulation.
3. Oxidation of amino acids and entry to TCA cycle.

Module 6

14hr

1. Oxidative phosphorylation: Electron transfer reactions in mitochondria. Electron carriers, multienzyme complexes, ATP synthesis. Regulation of oxidative phosphorylation. Shuttle systems- Alternate pathways, Thermogenesis.
2. Carbohydrate biosynthesis: Gluconeogenesis, biosynthesis of starch, glucose and other carbohydrates. Involvement of NDP- sugars. Regulation.
3. Lipid biosynthesis: Biosynthesis of fatty acids. Triacyl glycerols, phospholipids and isoprenoids. Regulation.
4. Biosynthesis of nucleotides: PRPP and its significance. Purine and pyrimidine biosynthesis. Precursors and regulation. Conversion of NMP to NTP. Biosynthesis of Deoxy ribonucleotides.
5. Secondary metabolism: Main pathways and their relation to primary-metabolism.

References

1. Lehninger. Principles of Biochemistry, Macmillan,



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2. Geoffrey Zubay. Biochemistry. Macmillan Publishing Company, New York.
3. Trevor Palmer. Enzymes- Biochemistry, Biotechnology and Clinical Chemistry. Norwood Publishing, Chichester.

Biochemistry

Module 5

18hr

1. The molecular logic of life.
2. The chemical unity of diverse living organisms.
3. Weak interactions in aqueous systems and the fitness of the aqueous environment for living organisms.

Module 6

18 hrs

1. Biomolecules: (a) Carbohydrates- Classification, structure and functions of simple sugars and compound carbohydrates. Sugar derivatives of biological importance. (b) Lipids. Classification- storage and structural lipids; lipids in membranes; the supramolecular architecture of membranes. (c) Amino acids, peptides and proteins. Amino acids: classification based on polarity; properties. Covalent structure of proteins. Three dimensional structure of proteins. Protein- tertiary and quaternary structures. Denaturation and renaturation. Functions of protein. (d) Nucleotides and nucleic acids. Chemistry- structure of nucleotides- Other functions of nucleotides.
2. Secondary metabolites: Secondary metabolites, their physiological roles. Significance- ecological and phylogenetic importance.

References:

1. Lehninger. Principles of Biochemistry, Macmillan, U.K.
2. Geoffrey Zubay. Biochemistry. Macmillan Publishing company, New York.
3. Sadasivam and Manickam. Biochemical Methods. New Age International Publishers. New Delhi.
4. David T. Plummer, An Introduction to Practical Biochemistry. Tata McGraw Hill



COURSE CODE: SJBOT3C08

**NAME OF THE COURSE: ANGIOSPERM MORPHOLOGY, ANGIOSPERM
TAXONOMY AND PLANT RESOURCES**

(1+4+1=6 hours)

SL.NO	COURSE OUTCOME	PSOs	POs	CL	KC	Class Sections
CO1	Understand the evolutionary pattern of angiosperms and their floral parts through various theories and co-evolution of pollinators	1	3,5	U	F	15
CO2	Understand the conceptual basis and history of development of systems of classifications in taxonomy	4	5	U	C	20
CO3	Understand various rules, principles and recommendations of plant nomenclature emphasizing on ICN.	4	5	U	C	15
CO4	Familiarize the concept of character and literature in plant taxonomy	4	5	U	C	10
CO5	Perceive the knowledge about modern trends in taxonomy	4	5	U	C	15
CO6	Familiarize and categorize various plant resources	4	5	U	C	15
						90



Angiosperm Morphology

Module 1

18 hr

1. A critical study of the current ideas on the origin of Angiosperms with special reference to their ancestral stock, time and place of origin.
2. The concept of primitive angiosperm flower. Origin and evolution of flower, co-evolution of flowers vis-à-vis pollinators.
3. Origin and evolution of structure and morphology of stamens, nectarines and nectar.
4. Origin and evolution of carpels: different types- concept of foliar origin of carpels; types of ovary; evolution of placentation types- inferior ovary- foliar and axial concepts.
5. Role of floral anatomy in interpreting the origin and evolution of flower and floral parts

References:

1. Eames, E.J. Morphology of Angiosperms. Mc Graw Hills Book Co. NewYork.
2. Bamard, C. The interpretation of Angiosperm flower. Aust. J. Sci.24:64-72.(1961).
3. Manilal, K.S. Vascularization of corolla in Compositae. J.Indian Bot. Soc.59:189-196
4. Meeuse, A.D.J. Some fundamental principles of interpretive floral morphology. Intenational Sci. Publ. Hissar.
5. Melville, R. New theory of Angiosperm flower. Nature 188: 14-18.(1960).
6. Puri, V. Inferior ovary. Phytomorpholgy 2:122.(1952).
7. Sporne, K.R. The Morphology of Angiosperms. Hutchinsons Uni. Press, London.

Angiosperm Taxonomy

Module 2

14 hr

1. Principles of Taxonomy- Scope and importance of Taxonomy; systems of classification- artificial, natural and phylogenetic systems; phonetic versus phylogenetic systems; cladistics in taxonomy; APG system of classification.
2. Conceptual basis of classification- essentialism, nominalism, empiricism, phenetics and cladistics. Phylogenetic and alternative; concept of genus; concept of family; infraspecific categories.

Module 3

14 hr

1. Definitions and terms: primitive and advanced; homology and analogy; parallelism and convergence; monophyly and polyphyly.
2. Taxonomic hierarchy- concept of taxa- species, genus and family- infra specific categories.

Module 4

14 hr



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1. Plant nomenclature: history of nomenclature; polynomial and binomial systems; detailed study of salient features and major provisions of the International Code of Botanical Nomenclature. Effective and valid publication, rank of taxa, rule of priority and its limitations, typification, author citation, rejection of names and names of hybrids. A brief account of International Code of Nomenclature of Cultivated Plants.

Module 5

14 hr

1. Concepts of Character: definition, classification of characters- analytical and synthetic, qualitative and quantitative; unit and multiple, good and bad; correlation of characters; character weighting.
2. Modern trends in Taxonomy: cytotaxonomy, chemotaxonomy, biosystematics and numerical taxonomy. Molecular taxonomy- DNA bar coding in plants.

Module 6

16 hr

1. History and development of taxonomy in India. Classification of taxonomic literature- general indices, floras, icons, monographs, reviews-and journals; Herbarium- definition, steps involved in the development of herbarium- utility of herbarium and its maintenance- general account of regional and national herbaria with special reference to central National herbarium, Calcutta (CAL) and Madras Herbarium (MH). Botanical survey of India; Botanical gardens- types of gardens and importance of gardens in taxonomic studies- important national and international Botanical Gardens- Royal Botanical Garden, Kew; Indian Botanical Garden, Calcutta, National Botanical Garden, Lucknow, Tropical Botanic Garden, Trivandrum

References:

1. Cronquist A. Evolution and classification of flowering plants. Thomas and Nelson Co.
2. Cronquist. A. An integrated system of classification of flowering plants. New York.
3. Graf A.B. Tropica. Roehrs Company Publ. NJ, USA.
4. Harborne J.B. & Turner B.L. Plant chemosystematics. A.P., London.
5. Haywood W.H. & Moore D.M. Current concepts in plant taxonomy.
6. Rendle A.E. Classification of flowering plants.
7. Lawrance. G.H.M. Taxonomy of vascular plants. Oxford and IBH.
8. Sneeth P.H.A. Numerical taxonomy. W.H. Freeman Co., San Francisco.
9. Sporne. K.R. The Morphology of Angiosperms. Hutchinson University Press, London.
10. Sivarajan V.V. Introduction to principles of plant taxonomy. Oxford and IBH.
11. Smith P.M. The Chemotaxonomy of plants. Edward Arnold, London.



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12. Stace, C.A. Plant Taxonomy and Biosystematics. Edward Arnold, London.
13. Takhtajan, A. L. Diversity and classification of flowering plants. Columbia University Press, New York.
14. Woodland, D.W. Contemporary plant systematics. Prentice Hal, New Jersey.
15. Simpson M.G. Plant Systematics. Elsevier, Amsterdam.
16. Stebbins, G.L. Flowering Plants- Evolution above species level. Edward Arnold, London.

Plant Resources

Module 7

12 hr

1. A study of history, occurrence, morphology of useful part and overall chemical composition of the following:
 - a. Cereals & millets: Rice, Wheat, Maize, Sorghum, Finger Millet, Pearl millet.
 - b. Pulses: Bengal gram, Cluster Bean, Common Bean, Horse Gram, Cowpea.
 - c. Sugar yielding plants: Sugar Cane, Beet Root.
 - d. Starch yielding tubers: Potato, Tapioca, Arrow Root, Yam, Taro.
 - e. Fats & Oils: Ground Nut, Coconut, Castor, Gingelly, Mustard, Oil.
 - f. Beverages: Tea, Coffee, Cocoa.
 - g. Spices and Condiments: Pepper, Ginger, Turmeric, Coriander, Cumin, Fennel, Fenu-Greek, Cardamom, Nutmeg, Cloves, Cinnamon.
 - h. Fibre yielding plants: Cotton, Jute, Coir.
 - i. Rubber yielding plants: Pararubber.
 - j. Timber yielding plants: Teak, Rose Wood, Artocarpus, Ailanthus, Xylia.

Module 8

6hr

1. A study of the following medicinal plants with reference to the chemical and pharmacognosic properties: Neem, Turmeric, Adhatoda, Rauwolfia, Catharanthes, Bacopa, Nux-Vomica, Sweet Flag, Saraca, Wood Apple, Indian Myrobalans, Liquorize.

References:

1. Arora R.K. & Nayar, E.K. Wild relatives of crop plants in India. NBPGR Sci. Monograph No.7.
2. Bole, P.V. & Vaghani, Y. Field guide to common Indian trees. Oxford Uni. Press.
3. Chandel, K.P.S., Shukla, G. & Sharma, N. Biodiversity in medicinal and aromatic plants in India- conservation and utilization.. NBPGR. New Delhi.
4. Chripeels, M.J. & Sadava, D. Plants, food and people. W.Freeman & Co. San Francisco.



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5. ConwqyG. The doubly green revoluioon: food for all in the 21st century. Penguin Books
6. CS1R. The useful plants óf India. Publication and Information directorate, CSIR, New Delhi.
7. Kochar S.L. Economic Botany of the Tropics. Macmillon India Ltd.
8. Nàir M.N.B. et al. (eds.) Sustainãble management of non wood forest products. Faculty of Forestry, Uni. Putra, Malaysia.
9. Padora R.S. and Arora R.K. Plant genetic resources and management. IPGRI Publication, South Asia office, NBPGR, Pusa Campus, New Delhi.
10. Indian Science Academy. Plant wealth in India.Special issue of proceedings, 1997.
11. Sahni, K.C. The Book of Indian Trees. Oxford Uni. Press, Mumbai.
12. Sharma, O.P. Hill's Economic Botany. Tata Mc Graw Hill Co., New Delhi. _
13. Swaminathan M.S. & Kochar, S.L..(eds.) . Plants and society. Macmillan Publication, London.
14. Thakur, R.S., Puri, H.S. & Husain, A. Major medicinal plants of India. Central Institute of Medicinal and Aromatic Plants, CSIR, Lucknow.



COURSE CODE: SJBOT3C09

NAME OF THE COURSE: BIOTECHNOLOGY AND BIOINFORMATICS

(3+3 = 6 hours)

SL.NO	COURSE OUT COME	PSOs	POs	CL	KC	Class sections
CO1	Understand the mechanism of tissue culture and regeneration of plants, and production of metabolites from plants.	5	5	U	C	20
CO2	Evaluate the different methods and process involved in plant tissue culture.	5	5	U	C	15
CO3	Identify various culture methods.	5	5	U	F	10
CO4	Investigate the societal issues in biotechnology.	4	3, 4	Z	F	10
CO5	Examine the role of bioinformatics in biotechnology and provide the knowledge on Bioinformatics and its applications, and different types of data bases	5	5	A	F	10
C06	Explain the methods involved in Tissue Culture and molecular techniques.	5	5	U	C	10
C07	Acquire basic practical skills in Biotechnology.	5,6	5	A	P	10
C08	Acquire the skill in various software applications.	5,6	5	A	P	5
						90



Biotechnology

Plant Tissue Culture

Module 1

10 hr

1. Basic concepts and history.
2. General account of laboratory facilities and management.
3. Media for in vitro culture, composition and their preparation.
4. Callus culture- selection of explants and medium- types of callus- growth profile of callus.
5. Cell culture - isolation of single cells- mechanical and enzymatic methods- measurement of growth of cells in suspension culture- viability tests.

Module 2

7 hr

1. Large scale cultivation of cells using bioreactors for secondary metabolite production.
2. Organogenesis- direct and indirect- factors affecting organogenesis.
3. Organ culture – apical/ axillary meristems, embryo, ovary, ovule, endosperm, anther, pollen and root cultures.
4. Applications of plant tissue culture - clonal propagation, somaclones, somatic hybrids, synthetic seeds, secondary metabolites, germplasm conservation –cryopreservation.
5. Environmental biotechnology (Brief study only)

Genetic Engineering

Module 3

13 hr

1. Molecular analysis of gene and gene products: southern, northern and western blot ,restriction maps- RAPD and RFLP. Chromosome walking and jumping. FISH. PCR and its applications. DNA finger printing. DNA chips.
2. DNA sequencing: Enzymatic methods. Gilbert and Maxam method. Messing's shot gun method. Fluorescent detection and automation.
3. Recombinant DNA Technology- Enzymes, vectors, gene-cloning strategies, construction and screening of gene and cDNA Libraries. Expression of cloned genes in bacteria and mammalian cells. Prospects and achievements.

Module 4

14hr

1. Transgenic plants. Gene cloning strategies in plants. Vector dependent and vector independent methods. Identification and selection of transformed plants; the reporter enzyme technology. Objectives and achievements- engineering for secondary metabolites; resistance against herbicides, pests, pathogens, stress - improved nutritional and status changes in plants. Plants as bioreactors; phytopolymers and biodegradable plastics; antisense RNA technology; transgene inactivation. Terminator and traitor technologies.
2. Cloning: objectives. Creation of transgenic animals- other developments in cloning. Human cloning.



Ethics of cloning.

3. Patenting of genes and GMOs. Gene piracy. Ethical, ecological and legal issues, and biosafety aspects, recDNA safety; Forms of protections- Patents, Copyrights, Trade secrets, Trademarks; WIPO, GATT, TRIPs, IPR, biosafety protocols, Significance of patents in India.

4 References:

1. Walker J.M. and R. Rapley. Molecular Biology and Biotechnology: Panima Publishing Corporation.
2. Bernard R. Glick and Jack J. Pasternack. Molecular Biotechnology Principles and Applications of Recombinant DNA.; ASM Press Washington
3. Brown T.A. Gene Cloning and DNA Analysis Blackwell Science Pub:
4. Primrose S.B. Molecular Biotechnology. Panima Publishing Corporation.
5. Maarten J. Chrispeels and D.E.Sadava. Plants, Genes and Agriculture. Jones and Bartlett Publishers.
6. Robert de la Pemere and Franck Seuret. Brave New Seeds: The threat of GM crops to farmers. Global Issues Series.

Bioinformatics

Computer application

Module 5

7 hr

1. Computer in Science with special reference to biology, the scope and prospects.
2. Information super highway (Internet)- Web browsers, HTTP, HTML and URLs. Biological networks,
3. Online publications with special reference to biology, -electronic journals, books, Open Archive Initiative (www.openarchives.org), biomedcentral, pubmedcentral, freedom of scientific information access, e-access debate- concepts and implications, Free Software Movement, Free Software Foundation, GNU/Linux, etc. Online archives, databases, the Public Library of Science (www.publiclibraryofscience.org).

References

1. Online resources freely available at Internet sites such as www.
2. Publiclibraryofscience. org www.openarchives.org
3. [www.pubmedcentral](http://www.pubmedcentral.gov) gov .
4. [www.biomedcentral](http://www.biomedcentral.com). com
5. www.nature.com/nature/debates/e-access/index.html

Bioinformatics

Module

20 hr

1. Introduction: Importance and scope.
2. Biological Databases



- a. Nucleic acid databases: EMBL, Gen Bank- structure of Gen Bank entries. Specialized genomic resources, UniGene.
- b. Protein sequence databases: PIR, SWISS-PROT, TrEMBL. Composite protein databases: NRDB, OWL.
- c. Secondary databases: PROSITE, PRINTS, BLOCKS, IDENTIFY.
- d. Structure classification databases- SCOP, CATH.

Module 7

10 hr

1. Database searching
 - a. Sequence database searching. EST searches. Different to EST analysis. Merck/IMAGE, Incyte, TIGR. EST analytical tools. Sequence similarity, sequence assembly and sequence clustering.
 - b. Pair wise alignment technique: Comparison of sequences and sub-sequences. Identity and similarity. Substitution matrices, BLOSUM, DOTPLOT and BLAST.
 - c. Multiple alignment technique: Objective, Manual, simultaneous and progressive methods. Databases of multiple alignments. PSI-BLAST, CLUSTAL-W.

Module 8

10 hr

1. Protein structure Prediction:
 - a. Secondary structure prediction. Chou-Fasman, JPred.
 - b. Tertiary structure prediction: Comparative modelling - Modeller, RasMol.

Module9

7hr

1. Emerging areas of Bioinformatics: DNA Microarrays, functional genomics, comparative genomics, pharmacogenomics, chemoinformatics, Medicalinformatics.

References:

1. Attwood T.K. and D.J. Arny-smith. Introduction to Bioinformatics. Pearson Education.
2. Sundararajan S. and R. Balaji, Introduction to Bioinformatics. Himalaya Publishing House
3. Choudhuri S (2014). Bioinformatics for Beginners (I Edn). Academic Press
4. S. B. Primrose, R. M. Twyman (2006). Principles of gene manipulation and genomics (VII Edn). Blackwell publishing.



COURSE CODE: SJBOT3L05.

COURSE NAME: PRACTICALS OF PLANT PHYSIOLOGY, METABOLISM, BIOCHEMISTRY, ANGIOSPERM MORPHOLOGY, ANGIOSPERM MORPHOLOGY AND TAXONOMY

(0.5+0.5+0.5+0.5+1=3 hours)

SL.N O	COURSE OUT COME	PSOs	POs	CL	KC	Lab (hrs)
CO1	Familiarize and identify various plants through field study and Herbarium techniques	4	4	A	P	10
CO2	Devise methods and tests to improve basic skills and techniques related to biochemistry and apply the quantitative and qualitative analysis of plant metabolites.	3	1,5	Z	P	5
CO3	Explain and demonstrate various physiological parameters through experiments.	3	1,5	A	P	10
CO4	Identify the various parameters related to water quality and quantify them.	3	4,5	Z	P	10
CO5	Identify and categorize plant members into their specific families using floras and keys	4	4,5	A	P	10
						45



Plant Physiology

6hr

1. Determination of water potential by tissue weight change method.
2. Extraction of leaf pigments and preparation of absorption spectra of chlorophylls and carotenoids.
3. Demonstration of Hill reaction.
4. Separation of leaf pigments by paper chromatography and column chromatography.
5. Effects of light intensity on photosynthesis by Wilmot's bubbler.
6. Determination of sugars and amino acids in germinating seed by TLC.
7. Extraction of seed proteins based on solubility.
8. Biochemical analyses of leakages from seeds during germination.
9. Analyses of proline in water stressed plants.
10. Testing of seed viability by NBT test.
11. Changes in the reserve proteins during germination.

Metabolism

6hr

1. Extraction of enzyme: Any enzyme.
2. Effect of substrate on enzyme and determination of its K_m value.
3. pH dependent activity profile of enzymes.
4. Ammonium sulphate precipitation of enzymes.
5. Desalting of proteins by gel filtration using Sephadex G25/ dialysis
6. Separation of isoenzymes by native PAGE.
7. Determination of enzyme / protein sub units by SDS-PAGE.
8. Metabolism of germinating seeds - changes in metabolizable carbohydrates.

Biochemistry

6hr

1. Qualitative tests for monosaccharides, reducing and non reducing oligosaccharides, starch, amino acids and protein.
2. Quantitative estimation of reducing sugars and starch.
3. Qualitative tests for lipids. Emulsification, saponification, acrolein test, Boundouin's test.
4. Quantitative estimation of amino acids.
5. Quantitative estimation of protein by Biuret / Bradford's / Lowry et al method.
6. Quantitative estimation of DNA and RNA (colorimetric/spectrophotometric)
7. Quantitative estimation of total phenolics.

Angiosperm Morphology

6hr

1. Preparation of cleared whole mounts of floral parts to show vasculature.
2. Examination of the following with the help of dissections and hand sections: Transmitting tissues/canals in style and stigma; Different types of ovaries; Different types of placentation, vasculature of androecium and gynoecium in special types of flowers.



Angiosperm Taxonomy

8hr

1. Familiarization with local flora and construction of keys – use of floras in identification up to species.
2. Study of diagnostic features of the families studied in the theory paper with special reference to their economic aspects.
3. Study of the following families with special reference to morphology of modified parts, economic importance, interrelationships and evolutionary trends: Magnoliaceae, Ranunculaceae, Menispermaceae, Nymphaeace, Polygalaceae, Caryophyllaceae, Clusiaceae, Sterculiaceae, Meliaceae, Sapindaceae, Rosaceae, Melastomaceae, Rhizophoraceae, Aizoaceae, Rubiaceae, Sapotaceae, Gentianaceae, Boraginaceae, Convolvulaceae, Scrophulariaceae, Pedaliaceae, Verbenaceae, Nyctaginaceae, Euphorbiaceae, Urticaceae, Casuarinaceae, Orchidaceae, Zingiberaceae, Amaryllidaceae, Commelinaceae, Araceae, Cyperaceae and Poaceae.
4. Dissection of at least two members of each family in the laboratory, making suitable sketches, describing them in technical terms and identifying them constructing appropriate floral diagrams.
5. Field study of three days under the guidance and supervision of teachers at an ecologically different locality and submission of a field study report certified by the teacher concerned. The report should contain ecology of flora of the area studied.
6. Collection of plant specimens following the standard means of plant collection for preparation of herbarium. Each student shall submit a minimum of 25 such herbarium specimens with QR code along with the field book for the Practical examination.
7. Problems in Bar Coding



COURSE CODE: SJBOT3L06.

COURSE NAME: PRACTICALS OF PLANT RESOURCES, BIOTECHNOLOGY AND BIOINFORMATICS

(0.5+1.5+1=3 hours)

SL.N O	COURSE OUT COME	PSOs	POs	CL	K C	Lab (hrs)
CO1	Identify members of the major plants of economic importance	4	5	A	P	10
CO2	Understand the basic concepts and advanced techniques of plant tissue culture and develop skill in micropropagation and to establish commercial tissue culture ventures	6	6	C	P	10
CO3	Develop basic skills and techniques involved in isolation and quantification of DNA	5	5	Z	P	10
CO4	Familiarize the techniques involved in Bioinformatics and analyze the data available in databases	5	1, 5	Z	P	10
CO5	Acquire knowledge in the usage of biological networks	5	5	U	P	5
						45



Plant Resources

2hr

1. Morphological study of the source plants mentioned in the theory syllabus and identification of the plants and plant products.

Biotechnology- A. Tissue Culture

9hr

1. Preparation and sterilization of culture media- MS medium
2. Culturing of Carrot/Tobacco/Datura.
3. Estimation of cell growth in callus culture by fresh wt. and dry wt.
4. Induction of multiple shoots using axillary and apical meristems as explants.
5. Plantlet regeneration from callus.
6. Identification of secondary metabolites in cultures.
7. Synthetic seed preparation

Biotechnology- B. Genetic Engineering

10hr

1. Isolation and Electrophoresis of DNA.
2. Working out problems in genetic engineering.
3. Construction of coding sequence of DNA using amino acid sequence.
4. Visit to a genetic engineering lab and submission of a report.

Bioinformatics-

Computer Application

4hr

1. Acquiring basic computer operation and internet browsing skills in Windows and Linux platforms.
2. Acquiring basic word processing/ data entry skills using popular (both commercial and open source) packages such as MS-Word, K-Word, Open Word, PageMaker.
3. Acquire graphic processing skills using popular packages such as Photo Shop, Corel Draw, Chem Draw.
4. Preparation of scientific presentations using packages such as MS-PowerPoint.
5. Use of statistical packages such as SPSS, Biostat, Origin, MS-Excel.

Bioinformatics

13hr

1. Acquisition of basic skills in Internet browsing
 2. Use of web browsers and search engines.
 3. Compare the protein sequence using CLUSTAL/ BLAST tool.
 4. Use of biological and bioinformatic websites Agris, Agricola, BIOSIS, CABWeb.
 5. Visit to Bioinformatics websites: NCBI, SWISS PROT, PIR, PDB.
 6. Submission of lab record
- **Submission of 10 plant products directly collected by the student from the field with a note on the source plant and plant part.**



SEMESTER IV

E01: To be selected by the board of studies from the list appended as Elective I,

E02: To be selected by the center from the list appended as Elective II.

L07: Practicals of Electives.

(The centers are advised to select relevant and related electives so that the centers can be developed to centers of excellence in the specialization area.)

A. Elective I

1. Advanced Angiosperm Taxonomy
2. Environmental Biology and Biodiversity Conservation
3. Plant Tissue Culture
4. Plant Physiology
5. Plant Cell and Molecular Biology
6. Genetics and Crop Improvement

B. Elective II

1. Molecular Plant Taxonomy
2. Pathology of Plantation crops and Spices
3. Genetic Engineering
4. Genomics and Proteomics
5. Genetic Engineering and Bioinformatics
6. Biotechnology in Crop Improvement

The board of studies selected the following Electives

1. Environmental Biology and Biodiversity Conservation
2. Genetic Engineering



ELECTIVE-1

COURSE CODE: SJBOT4E01

**NAME OF THE COURSE: ENVIRONMENTAL BIOLOGY, AND
BIODIVERSITY CONSERVATION**

(6hr)

SL.NO	COURSE OUT COME	PSOs	POs	CL	KC	Class sections
CO1	Understand familiarize the fundamentals of the concept of ecosystem along with its structural and functional attributes.	1	1,3,5	U	F	15
CO2	Identify the different components and their interrelationships in the Ecosystem	3	4	U	C	15
CO3	Classify different types of ecosystems and give and awareness to its conservation plants for sustainable development	4	6	A	C	15
CO4	To create an attitude in conserving plants for sustainable development.	1,2	1,3	U	C	15
CO5	Build awareness in environmental problems and social issues, and apply their knowledge in waste management	4	6	A	C	10
CO6	Asses the biodiversity loss and understand the need to conserve it, understand global climatic change.	4	6	A	C	8
CO7	Familiarize various types of natural resources, vegetations, and different conservation strategies..	5	5,6	Z	C	8
CO8	Acquire skills for water analysis to estimate phosphate and nitrate content, major elements, and to get experience in quadrat study.	2,6	1,5	A	P	4
						90



Module 1

20 hr

1. Population ecology: Properties (concepts of rate, intrinsic rate of natural increase, carrying capacity, population fluctuations and cyclic oscillations, density independent and density dependent mechanisms of population regulation, patterns of dispersion, Allee's principle of aggregation and refuting, home range and territoriality, energy partitioning and optimization, *r* and *K* selection.
2. Community ecology: Types of interaction between two species, coevolution, evolution of cooperation, group selection, interspecific competition and coexistence, positive and negative interactions, concepts of habitat, ecological niche and guild. Niche Modeling.

Module2

20 hr

1. Major global environmental challenges: Acid rain, Ozone depletion, climate disruption, deforestation, land degradation and desertification, freshwater degradation and shortage, marine fisheries decline, loss of biological diversity and excess nitrogen.
2. Global initiatives: Stockholm conference (1972), Rio (1992), Ramsar convention (1971), Kyoto (1997), Johannesburg (2002), Stockholm (2011).
3. Environmental Law- International and National: The Environment Protection Act & Rules 1986; Water (Prevention & Control of Pollution) Act 1974; Biodiversity Act (2002).

Module 3

11hr

1. Thoughts on ecology: Contributions of Buddha, Rabindranatha Tagore, Mahatma Gandhi, Rachel Carson, Gro Herlem Brundtland, Vandana Siva, Edward O Wilson, Aldo Leopald.

Module 4

20 hr

1. Biodiversity: a). Genetic diversity, agrobiodiversity and cultivated taxa, causes of decline, value of wild species, conservation practices- traditional (*upavana vinoda*, sacred groves, *sthalavrikshas*) b). Biodiversity information management and communication- libraries, databases (taxonomic database working groups for plant sciences, data bases on biodiversity); distribution of biodiversity information, metadatabases, virtual libraries.

Module 5

7hr

1. Ecosystem capital- use and restoration: Global perspective on biological systems; conservation, preservation and restoration. Biomes and ecosystems under pressure (forest biomes, ocean ecosystems).

Module 6

12 hr

1. Habitat studies: Wetlands (Ramsar sites), mangroves



2. Brief study of the following: Cybernetics, ecological foot print, sustainable development, deep ecology, conservation ethics, peoples' movements for biodiversity conservation, role of NGOs and educational institutions in biodiversity conservation, trade related IPR, ecotourism.

Module 7

12 hr

1. Climate change and its impacts- brief study.
2. Disaster management- basic aspects.
3. Composting techniques: Open air composting(hot composting),Direct composting(in ground composting),tumbler composting, worm Farm Composting, EMO composting, Combination composting, Commercial Composting, Mechanical composting

References

1. Champion H.G. and Seth S.K. A Revised Classification of Forest Types of India. Govt.of India, New Delhi.
2. Gadgil Madhav. Ecological Journeys. Permanent Black, Delhi
3. Jaiswal P.C. Soil Plant and Water Analysis. Kalyani Publishers, Ludhiana.
4. Krishnamurthy K.V. An Advanced Text Book on Biodiversity Principles and Practice. Oxford IBH.
5. Misra R. Ecology Workbook. Oxford IBH
6. Odum E.P. and Barrett G.W. Fundamentals of Ecology.Thomson Books, Bangalore.
7. Palmer J.A. Fifty Thinkers on the Environment. Routledge, London.
8. Puri G.S. Indian Forest Ecology.Oxford IBH.
9. Pushpangadan P. and Nair K.S.S. Biodiversity and Tropical Forests- The Kerala Scenario. STEC, Thiruvananthapuram.
10. Sarngdharacharyar. (Translated by Vishnu B.).*Vruksha ayurvedam* Janapriya Pusthakasala, Kottayam.
11. Sivadasan M. and Mohanan K.V. Biodiversity and Ecology: Concepts and Facts. Department of Botany, University of Calicut, Kerala.
12. Speth Gustave, James and Haas M. Peter.Global Environmental Governance. Pearson Longman, New Delhi.



ELECTIVE-2

COURSE CODE: SJBOT4E02

NAME OF THE COURSE: GENETIC ENGINEERING

(6hr)

SL.NO	COURSE OUT COME	PSOs	PO	CL	KC	Class sections
CO1	Awareness about the fundamentals of Genetic engineering	5	5	U	F	20
CO2	To evaluate and familiarise with the tools and techniques of genetic engineering and gene transfer technologies.	5	5	A	C	20
CO3	To utilize various plant transformation techniques and in creating transgenic plants.	5	5	A	C	15
CO4	Acquire an in depth knowledge on plant biotechnology and its application	5	1,5	A	C	15
CO5	Discuss the important applications of genetic engineering in day to day life	5	5	A	C	20
CO6	Bestow practical skill in isolation of DNA, RNA and Protein	6	5	A	P	
CO7	Discuss the applications of biotechnology by visiting A biotechnology laboratory. Submit a report of the visit.	6	5	A	P	
						90



Module 1

21 hr

1. Structure of genes in prokaryotes and eukaryotes. Genetic code and codons. Gene expression.
2. Recombinant DNA technology: Tools of rDNA technology, methods of creating r DNA molecules, restriction mapping
3. Gene transfer techniques in plants- Agrobacterium mediated transfer, gene gun method, electroporation, microinjection, chemical methods.

Module 2

25hr

1. Molecular markers- RAMPO, SSCP, RFLP, RAPD, AFLP, EST markers, Repetitive DNA, Microsatellite and Minisatellite,
2. DNA sequencing- chemical and enzymatic methods. Importance of DNA sequencing. Next Gen Sequencing (NGS).
3. Gel electrophoresis- techniques for visualization and reading sequences

Module 3

20 hr

1. Polymerase Chain Reaction - History, methodology of PCR. Variations from Basic PCR- reverse transcriptase PCR, inverse PCR, nested PCR, Anchored PCR Quantitative real time PCR - applications of PCR.
2. DNA profiling- history, methodology of genetic fingerprinting- applications.

Module 4

22hr.

1. Genetic engineering for crop improvement – transgenic plants.
2. Cloning of genes and production of vaccines, drugs, growth hormones and chemicals.
3. Gene therapy- types of gene therapy. Getting transgenes in to patients- viral and nonviral approaches. Success of gene therapy.

Module 5

20 hr

1. Abatement of pollution through genetically engineered microorganisms- an emerging approach towards environmental cleanup programmes.
2. Nanotechnology and its applications in genetic engineering.

References

1. Hartl D.L. and Jones E.W. Genetics- Analysis of genes and genome. Jones and Bartlett Publishers.
2. Nicholl Desmond S.T. An Introduction to Genetic Engineering. Cambridge Pub.
3. Brown T.A. Gene Cloning and and DNA Analysis. B lackwell Science Pub.
4. Dubey R.C. A Text Book of Biotechnology. Chand Pub.
5. Singh B.D. Biotechnology. Kalyani Publishers.



6. Walker and Rapley. Molecular Biology and Biotechnology. Panima Pub.
7. Chrispeels M.J. and Sadava D.E. Plants, Genes and Agriculture.
8. Lewin B. Genes. Oxford University Press.
9. Mason A.C. Principles of Gene Manipulation and Genomics.
10. Rissler J. and Mellon M. The Ecological Risks of Engineered Crops. MIT Press, Cambridge.
11. Avise, John C. The Hope, Hype and Reality of Genetic Engineering.
12. McYYan R.P. Genetics and Genetic Engineering. Saras Publications.
13. Narayana L.M. Molecular Biology and Genetic Engineering.
14. Khadpekar N.R. The Age of Nanotechnology. ICFAI University Press, Hyderabad. Nalwa H.R. Encyclopedia of Nanoscience and Technology.



MSc. Botany St Joseph's College (Autonomous), Irinjalakuda

COURSE CODE: SJBOT4L07

COURSE NAME: PRACTICALS OF ELECTIVE

(3 hr)

SL.N O	COURSE OUT COME	PSOs	POs	CL	K L	Lab (hrs)
CO1	Analysis of vegetation type by Quadrat method	2, 3,4	1,5	Z	P	10
CO2	Develop basic skills and techniques involved in isolation and quantification of DNA, RNA, protein	2,3	5	A	P	15
CO3	Acquire skills for water analysis to estimate carbon calcium and carbon etc.	2, 3,4	5	Z	P	10
CO4	Acquire skill in waste management	3,4	4,6	Z	P	10
						45



MSc. Botany St Joseph's College (Autonomous), Irinjalakuda

I. Environmental Biology and Biodiversity Conservation- Practicals 19hr

1. Studies on the following and submission of reports: Waste water treatment plant, local environmental peculiarities (such as hillocks and forest patches), wet land ecosystem, alien invasive plants, degraded ecosystem, different forest types, effluent treatment system).
2. Physical and chemical analysis of soil and water: Particle size analysis of soil, estimation of particle density using relative density or volumetric flask; Air capacity analysis of soil by field method; Soil pH analysis of soil using pH meter. Water analysis for pH using pH meter, estimation of BOD by Winkler's method (dark and light bottles).
3. Study of community structure: Charting and mapping of vegetation, Raunkiaer's life forms, biological spectrum, profile diagram (soil).
4. Study of ecological succession: Different types of ecological successions.
5. Preparation of any compost.
6. Visit to an ecological sensitive area and submission of a report.

II. Genetic engineering – Practicals

19 hr

1. Working out problems in genetic engineering.
2. Isolation of plant DNA and its quantification by spectrophotometer.
3. Isolation of plasmid DNA from E.coli.
4. Gel electrophoresis- gel preparation, casting, elution and staining.
5. Visualization of DNA by agarose gel electrophoresis and gel reading.
6. Construction of coding sequence of DNA using aminoacid sequence.
7. Visit to a genetic engineering lab and submission of a report.



COURSE CODE: SJBOT4D01

COURSE NAME: DISSERTATION

SL.N O	COURSE OUT COME	PSOs	POs	CL	K L
CO1	Plan, and engage in ,an independent and sustained critical investigation and evaluation of a chosen research topic relevant to the environment and society	1,4	1,4, 5	U	C
CO2	Describe a relevant area of career development or work related area	6	5	U	P
CO3	Critically analyze and evaluate the knowledge and understanding in relation to the agreed area of study	1,6	1,5	Z	P
CO4	Communicate research concepts and contexts clearly and effectively both in writing and orally	1,5	1,2	A	P

CODE: SJBOT4 VV01

COURSE NAME: VIVA VOCE

SL.N O	COURSE OUT COME	PSOs	POs	CL	K L
CO1	Demonstrate knowledge in programme domain	1	1,2	Z	C
CO2	Exhibit professional etiquette suitable for career progression	6	5	A	C
CO3	Explain views cogently and precisely	1	2	Z	C

MODEL QUESTION PAPER

**FIRST SEMESTER M.Sc. (CBCSS) DEGREE EXAMINATION
SJBOT1C01- PHYCOLOGY, BRYOLOGY, PTERIDOLOGY AND
GYMNOSPERMS**

Time: 3 Hours

Max. Weightage: 30

PART A -Give short answers to any four of the following: (4×2=8 weightage)

1. Give an account on flagellar apparatus in algae.
2. Enumerate the criteria for classification in algae.
3. Compare the Sporophytic generation in Sphagnales and Polytrichales.
4. Enumerate the primitive characters of Rhynia.
5. Summarize the characters of Pteridospermales.
6. Give a detailed account on biological importance of Phytoplanktons.
7. Explain the angiospermic characters of gymnosperms.

PART B - Answer any four of the following in paragraph: (4×3=12 weightage)

8. Give a detailed account on different life cycles in algae.
9. Discuss the ancestral characters of Gnetum
10. Pentoxylales considered as an enigmatic group.Why?
11. Evaluate the origin and evolution of sporangium in Pteridophytes.
12. Discuss the affinities of fossil bryophytes.
13. Evaluate the role of heterospory in evolution of seed habit in pteridophytes.
14. Evaluate the thallus organization and evolutionary trends in chlorophyceae..

PART C - Write essay on any two of the following: (2×5=10 weightage)

15. Give a detailed account on fossil Pteridophytes.
16. Generalize the evolution of gymnosperms.
17. Give a detailed account on general characters and classification of bryophytes..
18. Give a detailed account on the economic importance of algae.



MODEL QUESTION PAPER

FIRST SEMESTER M.Sc. (CBCSS) DEGREE EXAMINATION

SJBOT1C02 -MYCOLOGY, MICROBIOLOGY, LICHENOLOGY AND PLANT PATHOLOGY

Time: 3 Hours

Max. Weightage: 30

PART A - Give short answers to any four of the following: (4×2=8 weightage)

1. Enumerate the mode of transmission of diseases.
2. Give the enumeration methods of microbes.
3. Enumerate the ecological and economic importance of lichens.
4. Discuss the characteristics of Mitosporic fungi.
5. Explain heterothallism.
6. What are VAM fungi ? Give their importance.
7. Distinguish between biofertilizers and biopesticides.

PART B - Answer any four of the following in paragraph: (4×3=12 weightage)

8. Give a detailed account on bacteriophages with special reference to its classification.
9. List the distinguishing characters of basidiomycetes.
10. Explain the symptoms, control measure, disease cycle of tikka disease of groundnut.
11. Endospores are structures meant for survival than structures of reproduction. Substantiate.
12. Discriminate the role of Toxins and enzymes in host –parasite interaction.
13. Discriminate the various symptoms appeared in plants after infection.
14. Briefly explain the characters of TMV

PART C - Write essay on any two of the following: (2×5=10 weightage)

15. Discuss different characteristics used in the classification of Bacteria . How prokaryotes are classified according to Bergey's manual of systemic bacteriology, second edition.
16. What are lichens ? Give the structure, classification , reproductive methods in lichens. Add a note on economic importance of lichens.
17. Demonstrate how the structural peculiarities or modifications of plants help in defense mechanism.
18. Discuss fungi as symbionts with special reference to mycorrhizal association and their significance



MODEL QUESTION PAPER

**FIRST SEMESTER M.Sc. (CBCSS) DEGREE EXAMINATION
SJBOTC03-ANGIOSPERMANATOMY, ANGIOSPERM MORPHOLOGY,
PALYNOLOGY AND LAB TECHNIQUES**

TIME:3HOURS

WEIGHTAGE: 30

PART A -Give short answers to any four of the following: (4×2=8 weightage)

1. Explain plasmodesmata.
2. Explain how the spore studies has distinct role in taxonomy.
3. Why is palynology important in today's life.
4. With the help of suitable diagram, explain the structure of mature anther.
5. What are the contributions of Erdtman in Palynology
6. Write down the significance of leaf gaps and leaf traces.
7. Discuss killing and fixing with example .Write down the significance of killing and fixing.

PART B - Answer any four of the following in paragraph: (4×3=12 weightage)

8. Write an essay on cambium.
9. Give an account on the development of male gametophyte
10. Polyembryony has great significance in horticulture, Explain.
11. Write down the major reasons of anomaly in dicot plants with suitable examples.
12. With the help of a diagram, explain the structure of embryosac..
13. Differentiate between mounting and mountant. Briefly explain different mounting Medias.
14. Give an account on self incompatibility

PART C -Write essay on any two of the following: (2×5=10 weightage)

15. How does pistil recognize the pollen grain of the right type.
16. Describe the development of endosperm in angiosperms with suitable examples.
17. Write down the application of embryology in tissue culture.
18. Categorize the different types of stains and staining techniques used in lab techniques.



MODEL QUESTION PAPER

**SECOND SEMESTER M.Sc. (CBCSS) DEGREE EXAMINATION
SJBOT2C04- CELL BIOLOGY, MOLECULAR BIOLOGY AND
BIOPHYSICS**

TIME:3HOURS

WEIGHTAGE: 30

PART A -Give short answers to any four of the following: (4×2=8 weightage)

1. What are the different types of DNA?
2. Elaborate on One gene- One enzyme concept
3. What is the principle of lyophilization.
4. Explain synaptonemal complex and its function.
5. Briefly explain the following.(a) Chargaff's rule (b) C-Value Paradox..
6. Give an account on the structural difference between purines and pyrimidines.
7. Differentiate between Euchromatin and Heterochromatin

PART B - Answer any four of the following in paragraph: (4×3=12 weightage)

8. Describe the properties of genetic code.
9. How is cell cycle regulated?
10. Discuss the structural organization of proteins.
11. How are amino acids are classified.
12. Brief account on ion exchange chromatography.
13. Explain cell signaling path ways.
14. Explain briefly different banding techniques.

PART C --Write essay on any two of the following: (2×5=10 weightage)

15. Describe the different phases of cell cycle with diagram.
16. What is the genetic basis of malignant transformation? Explain the mechanisms involved in Cancer.
17. Briefly explain the application and principles of chromatography.
18. Define mutation. Explain the role of mutator and anti mutator genes.



MODEL QUESTION PAPER

**SECOND SEMESTER M.Sc. (CBCSS) DEGREE EXAMINATION
SJBOT2C05 - CYTOGENETICS, GENETICS, BIostatITICS, PLANT
BREEDING AND EVOLUTION**

Time: 3 Hours

Max. Weightage: 30

PART A - Give short answers to any four of the following: (4×2=8 weightage)

1. Distinguish between Tetrad analysis and Centromere mapping.
2. Describe the cytogenetic importance of Lamp brush chromosomes and Polytene chromosomes.
3. Briefly explain heterosis breeding and inbreeding depression.
4. Enumerate the computer assisted molecular cytogenetics.
5. Comment Darwinism after a critical analysis.
6. Critically evaluate the roles of aneuploidy and euploidy in evolution.
7. Write a note on IPR.

PART B - Answer any four of the following in paragraph: (4×3=12 weightage)

8. Explain the different types of designs in biological experiments.
9. Enumerate Structural chromosome aberrations and their significance.
10. Explain Hardy- Weinberg principle. Evaluate the factors which affecting the equilibrium.
11. Write an account on biological evolution.
12. Write an account of probability distributions.
13. Describe genetic recombination and mapping of genes in Bacteria.
14. Briefly explain biometrical techniques in Plant Breeding.

PART C - Write essay on any two of the following: (2×5=10 weightage)

15. Give a detailed account on theories of evolution.
16. Write an account of modern methods of plant breeding.
17. What are mobile genetic elements? Explain Cepia & P elements in Drosophila and Ac, DS& Mu elements in Maize.
18. Describe Measure of dispersion.



MODEL QUESTION PAPER

**SECOND SEMESTER M.Sc. (CBCSS) DEGREE EXAMINATION
SJBOT2C06- PLANT ECOLOGY, CONSERVATION BIOLOGY,
PHYTOGEOGRAPHY AND FOREST BOTANY**

TIME:3HOURS

WEIGHTAGE: 30

PART A -Give short answers to any four of the following: (4×2=8 weightage)

1. Briefly describe deforestation, afforestation, agroforestry, social forestry
2. Briefly describe the wetland ecosystem.
3. Write briefly on the following.(a) Food web(b) Biomagnification
(c) Ecological pyramid (d) Niche
4. Describe el nina and La nina phenomena.
5. Explain gaia hypothesis.
6. Briefly explain red data book
7. Briefly explain theory of glaciation and theory of land bridges.

PART B - Answer any four of the following in paragraph (4×3=12 weightage)

8. Briefly explain plant distribution patterns.
9. What are the various methods for conservation of natural resources.
10. Briefly explain the role of NGOs.
11. Give an account on EIA.
12. Briefly explain the different causes of threat to environment.
13. Briefly explain the major forest products.
14. Discuss various reasons for biodiversity loss.

PART C -Write essay on any two of the following: (2×5=10 weightage)

15. Write an essay on population characteristics.
16. Discuss about major biomes.
17. Explain different types of forest found in kerala.
18. Describe the major global environmental problems and its Consequences.



MODEL QUESTION PAPER

**THIRD SEMESTER M.Sc. (CBCSS) DEGREE EXAMINATION
SJBOT3C07: PLANT PHYSIOLOGY, METABOLISM AND
BIOCHEMISTRY**

TIME:3HOURS

WEIGHTAGE: 30

PART A -Give short answers to any four of the following: (4×2=8 weightage)

1. Enumerate the nitrogen reduction in plants.
2. Significance of Gibberellins.
3. List the properties of Zwitter ions.
4. Elucidate carbon reduction cycle.
5. Explain Gluconeogenesis
6. Discuss oxidative phosphorylation.
7. Explain saponification of lipids.

PART B - Answer any four of the following in paragraph: (4×3=12 weightage)

8. Give an account on Enzyme kinetics.
9. Give a brief account on classification of lipids.
10. Define photomorphogenesis. Give an account on phytochrome.
11. Write an account on transamination of aminoacids.
12. Give an account of stomatal mechanism in plants.
13. Discuss the biochemistry of nitrogen fixation.
14. Point out IUB system of enzyme classification.

PART C -Write essay on any two of the following: (2×5=10 weightage)

- 15) Give an account on secondary metabolites. Add a note on their physiological role and significance.
- 16) Give detailed account on the EMP Path way. Explain the anaerobic break down of pyruvic acid.
- 17) Give a detailed account on the photophosphorylation in plants.
- 18) Write an essay on stress in plants.



MODEL QUESTION PAPER

THIRD SEMESTER M.Sc. (CBCSS) DEGREE EXAMINATION

**SJBOT3C08- ANGIOSPERM MORPHOLOGY, ANGIOSPERM ANATOMY
AND PLANT RESOURCES**

Time: 3 Hours

Max. Weightage: 30

PART A -Give short answers to any four of the following: (4×2=8 weightage)

1. Write a note on relevance of molecular taxonomy.
2. Explain infra specific categories.
3. Give the binomial, family, and morphology of useful parts of plants yielding fats and oils.
4. Explain Cladistics.
5. Briefly explain types of Botanical gardens and their importance.
6. Give an account on the coevolution of flowers vis a vis pollinators.
7. Give the binomial, family, and morphology of useful parts of cereals and millets.

PART B - Answer any four of the following in paragraph: (4×3=12 weightage)

8. Point out the characters of primitive flowers. Mention the origin and evolution of nectaries.
9. Write a note on typification.
10. Give a detailed account on salient features and major provisions of ICBN.
11. Give a detailed account on taxonomic literature.
12. Explain the concept of character with special reference to correlation of characters and character weighting.
13. Write a note on herbarium techniques.
14. Give the binomial, family, and morphology of useful parts of spices and condiments

PART C -Write essay on any two of the following: (2×5=10 weightage)

15. Give a detailed account on medicinal plants you have studied with special reference to their chemical and pharmacognostic properties.
16. Explain the evolution of placentation types.
17. Explain modern trends in taxonomy.
18. Give a detailed account on various species concept used in taxonomy



MODEL QUESTION PAPER

**THIRD SEMESTER M.Sc. (CBCSS) DEGREE EXAMINATION
SJBOT3C09- BIOTECHNOLOGY AND BIOINFORMATICS**

TIME:3 HOURS

WEIGHTAGE: 30

PART A -Give short answers to any four of the following: (4×2=8 weightage)

1. Explain callus culture.
2. List out the applications of plant tissue culture.
3. Write gene cloning strategies.
4. Give an account on the enzymology of recombinant DNA technology.
5. What are reporter genes?
6. Differentiate SCOP and CATH.
7. Explain major Bioinformatics resources.

PART B - Answer any four of the following in paragraph: (4×3=12 weightage)

8. Write a note on pharmacogenomics and chemoinformatics.
9. Give an account on bioreactors.
10. Briefly explain database search.
11. Differentiate antisense RNA technology with that of Terminator seed technology.
12. Write about internet and its prospects.
13. Briefly explain about vectors used in gene transfer techniques.
14. Comment your views on human cloning.

PART C -Write essay on any two of the following: (2×5=10 weightage)

15. Write an account on gene piracy.
16. Explain the scope of Bioinformatics.
17. Give an account on the objectives and achievements of genetic engineering.
18. Explain various methods in DNA sequencing.



MODEL QUESTION PAPER

**FOURTH SEMESTER M.Sc. (CBCSS) DEGREE EXAMINATION
SJBOT4E01- ELECTIVE I ENVIRONMENTAL BIOLOGY AND
BIODIVERSITY CONSERVATION.**

TIME: 3 HOURS

WEIGHTAGE: 30

PART A -Give short answers to any four of the following: (4×2=8 weightage)

1. What are greenhouse gases?What are the consequences of green house effect.
2. Give an account on population fluctuation
3. Write a note on gaia hypothesis.
4. Briefly explain the followings: (a)ecological guild (b) ecological footprints.
5. Briefly explain the forest types of Kerala
6. Write a note on 'Silent Spring'.
7. Describe the impacts of climatic change.

PART B - Answer any four of the following in paragraph: (4×3=12 weightage)

8. Give an account on Stockholm conference 1972.
9. Differentiate between the traditional and modern practices of biodiversity conservation
10. Citing suitable examples, describe the role of NGOs in biodiversity conservation.
11. How can people restore a damaged ecosystem?
12. Write a short note on the contributions of Buddha.
13. Briefly describe the interspecific competition.
14. Give an account on Cairo conference

PART C -Write essay on any two of the following: (2×5=10 weightage)

15. Give an account on population characteristics.
16. Give a detailed account on human population expansion and its consequences.
17. What is International Environmental Law? What are the major National Environmental Laws?Give a detailed account on disaster management.
18. Explain different types of pollution that affdect the environment



MODEL QUESTION PAPER

**FOURTH SEMESTER M.Sc. (CBCSS) DEGREE EXAMINATION
SJBOT4E02- ELECTIVE PAPER II- GENETIC ENGINEERING**

TIME: 3 HOURS

WEIGHTAGE: 30

PART A -Give short answers to any four of the following: (4×2=8 weightage)

1. Briefly describe nanotechnology.
2. Explain Okazaki fragments.
3. Differentiate linkers with that of adaptors.
4. Give an account on DNA vaccines.
5. What is meant by Genetic counseling?
6. Explain southern blotting techniques.
7. Write a short note on Golden rice.

PART B - Answer any four of the following in paragraph: (4×3=12 weightage)

8. Explain electrophoresis techniques involved in genetic engineering.
9. Briefly describe polymerase chain reaction.
10. What are the important steps involved in translation.
11. Explain about genetic codes and codons.
12. Briefly describe the various DNA sequencing methods.
13. Give an account on molecular markers.
14. What are direct gene transfer methods.

PART C -Write essay on any two of the following: (2×5=10 weightage)

15. How we can control pollution by genetic engineering? Explain.
16. Discuss the gene expression in Eukaryotes.
17. Give an account on the tools used in recombinant DNA technology.
18. Give an account on gene therapy.



AUDIT COURSE SYLLABUS

SIACIAEC: Ability Enhancement Course: Scientific Documentation and Report writing

1. Collection of scientific literature from secondary and primary sources. Preparation of literature reviews and review papers- structure and components Preparation of research papers- structure and components
2. Scientific conduct, ethics, authorship issues, plagiarism, citation and acknowledgement. Importance of language and effective communication.
3. Presenting a paper in a scientific seminar- oral and poster presentation Preparation of oral presentations
4. Preparation of scientific posters

SIAC2PCC: Professional Competency Course: Intellectual Property Rights

1. Introduction to intellectual property right (IPR) - Concept and kinds. Economic importance. IPR in India and world. IPR and WTO (TRIPS, WIPO).
2. Patents- Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents- Working of patents. Infringement.
3. Copyrights- Introduction. Works protected under copyright law. Transfer of Copyright. Infringement. Trademarks- Objectives, Types, Rights. Protection of goodwill. Infringement.
4. Geographical Indications- Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian position.
5. Protection of Traditional Knowledge- Objective, Concept, Holders, Issues concerning, Bio-Prospecting and Bio- Piracy, Alternative ways, Protectability, Traditional knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library.
6. Protection of Plant Varieties- Plant Varieties Protection-Objectives, Justification, International Position, Plant varieties protection in India. Rights of farmers, Breeders and Researchers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.
7. Biotechnology and Intellectual Property Rights Patenting Biotech Inventions: Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting Biotechnological inventions.