CMS COLLEGE KOTTAYAM
(AUTONOMOUS)

Affiliated to the Mahatma Gandhi University
Kottayam, Kerala

CURRICULUM FOR POST GRADUATE PROGRAMME

MASTER OF SCIENCE IN BOTANY

UNDER CREDIT AND SEMESTER SYSTEM (CSS)
(With effect from 2019 Admissions)

Approved by the Board of Studies on 13th May 2019

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ACKNOWLEDGEMENTS

The designing of the M. Sc. Programme curriculum of the Department of Botany CMS College Kottayam (Autonomous)was a year long process, since it involved the purposeful, deliberate and systematic organization of the curricula. Care is taken to align the learning goals and outcome of the courses with the programme specific outcome that in turn is set in line with the Post graduate programme outcome and vision and mission of the Institution. The ultimate goal of the curriculum design is to improve student learning and also aid teachers in planning out the methods that they would adopt for transacting the syllabus and identifying what will be done, when and by whom.

On behalf of the Botany Department, I thank the Management, Principal and IQAC, CMS College for organizing umpteen sessions by experts and advisors from the National Educational arena to train us teachers in the science and art of Curriculum design.

Dr. T. P. Sasikumar, educationalist, writer, science communicator, motivational speaker, life skills trainer and founder of "Shiksha" that promotes learning from all quarters needs a special mention amongst our galaxy of resource persons, since he conveyed to us the need for redefining the learning pattern in today's generation.

We extend our heart felt thanks to Prof. N. J. Rao, former Professor, Indian Institute of Science and advisor to University Grants Commission for giving us an insight into the current UGC requirements in curriculum design.

Our heart goes out to Dr. C. James, Convenor of the curriculum design committee, Scott Christian College, Nagercoil, Kanyakumari and Dr. David Saji, Chairman, Board of Studies, M G University for helping us give the final shape to our Curriculum.Their experiences in this field as resource persons to various institutions and their commitment to this cause requires special mention.

We owe our gratitude to members of the Board of studies of Botany Dr. Dennis Thomas T, Professor & Head, Department of Botany, Central University, Kasargod, Dr. Radhamany P.M, Professor, Department of Botany, Kerala University,Dr. K. Jayachandran, Associate Professor, School of Biosciences, M G University, Kottayam, Bijeshmon PP, Botanist, Sreedhareeyam Ayurvedic Research and Development Institute, Centre of Excellence, Accredited by Dept. of AYUSH, Nelliakkattumana and Mr. Robert Raju, Assistant Professor, Department of Botany, Bishop Moore College, Mavelikkarafor their constructive and valuable inputs towards the design of the present curriculum. Thanks are due to the members of the Board of studies, Botany and all my collegues of the Depatment of Botany for their whole hearted support in the design of the M.Sc. Botany Curriculum.

Dr. Mini Chacko
Chairman
Board of Studies

13.05.2019
Kottayam

PREFACE

The Botany Curriculum is a guide to both students and teachers to explore each one's talents and abilitiesduring the course of its progress from the beginning to the end of the second year. This programme concerns much more than simply the content of the course as presented here. It concerns the lifelong process of personal growth from the student – teacher interactions that every student acquires from here. It is on this process that I would like to reflect on.

Each student comes to this course from different backgrounds with different personal interests, skills, and styles. Each will therefore, in very subtle ways, get something very different from this course. We will come together during the class hours to discuss and involve ourselves with a variety of ideas and exercises. We hope that the common thread among these diverse learning experiences will be an appreciation of the effective "two-way" communication between the teacher and the taught. This indeed is a skill that must be developed and continually refined by the student. We the teachers of the Botany department hope that during their time in the department, the students will recognize some ways in which to refine their knowledge base in the subject, ethical values, communication skills and ways in which theywould continue this process even after their programme here ends.Although, it might be easy to think of a set of behaviors that we want our students to have so that we can get on with the curriculum that we need to cover, it becomes apparent that we teachers, need to provide specific opportunities for students to practice these habits. Habits are formed only through continuous practice. And to practice the habits, the transaction of the curriculum and its assessments must provide generative and rich opportunities for using them. For example, when we are concerned about persistence, we need to provide the kinds of problems and tasks that engage students and hold their attention long enough for persistence to be important. When we are concerned with the habit of metacognition, we need to provide opportunities for students to plan for, monitor, thoughtfully reflect upon, and become explicitly aware of how they are thinking. We, as teachers, need to interact with their metacognitive thinking so that we understand better how to reach each student and motivate learning. We need to continuously be asking, what have we done today that creates the opportunity for expressing wonderment and awe? Has there been a problem, an event, an observation that really deserves the exclamation "Awesome!"?

REGULATIONS FOR POST GRADUATE PROGRAMMES UNDER CREDIT SEMESTER SYSTEM 2019

Preamble

CMS College Kottayam (Autonomous) was conferred with the Autonomous status as per UGC No.F.22-1/2016(AC) Dtd. 9th March 2016 and Mahatma Gandhi U.O.No.2732/VII/2016/Acad. Dtd.12th May 2016.

REGULATIONS

CMS College Kottayam (Autonomous) follows Credit Semester System (CSS) for the Post Graduate programmes from the Academic year 2019-20. The Post Graduate programmes of the college are being redesigned and revised in tune with the modifications effected at the UGC Curriculum Framework. This will be reflected in the scheme, course content and mode of examination and Evaluation system. The scheme and syllabus of all the programmes are being revised accordingly. The revisions were effected based on the recommendations made at the Curriculum Revision workshops conducted for the purpose besides several sittings of the Curriculum Revision Committee.

1. TITLE

1.1. These regulations shall be called **"CMS COLLEGE KOTTAYAM (AUTONOMOUS) REGULATIONS FOR POST GRADUATE PROGRAMMES UNDER CREDIT AND SEMESTER SYSTEM 2019"**

2. SCOPE

2.1 Applicable to all regular Postgraduate Programmes conducted by the CMS College Kottayam (Autonomous) with effect from 2019 admissions.

2.2 Medium of instruction is English unless otherwise stated therein.

3. DEFINITIONS

3.1. **Academic Week** is a unit of five working days in which the distribution of work is organized from day one to day five, with five contact hours of one hour duration on each day.

3.2. **Semester** means a term consisting of **90** working days, within **18** five-day academic weeks for teaching, learning and evaluation.

3.3. **Programme** means a two year programme of study and examinations, spread over four semesters, with a set of courses, the successful completion of which would lead to the award of a degree.

3.4. **Course** comprises a set of classes or a plan of study on a particular subject which will be taught and evaluated within a semester of a study programme.

3.5. **Core course** means a course which should compulsorily be studied by a student as requirement in the subject of specialization within a degree programme.

3.6. **Elective Course** means an elective course chosen from the discipline/ subject, in an advanced area.

3.7. **Credit** is the numerical value assigned to a course according to the duration of the classes or volume of the syllabus of the course**.**

3.8. **Department** means any teaching department in the college.

3.9. **Dean of Academic Affairs** is a teacher nominated by the Academic Council to coordinate the academic affairs of the college relating to academic planning, curriculum implementation and review.

3.10. **Dean of Student Affairs** is a teacher nominated by the Academic Council to coordinate the admissions, grievances and other student related services.

3.11. **Department Council** means the body of all teachers of a department in the college.

3.12. **Department Coordinator** is a teacher nominated by a Department Council to co-ordinate the ^{In}-Semester examination of the PG programme in that department.

3.13. **Faculty Advisor** means a teacher from the parent department nominated by the Department Council, who will advise the students of a class on academic matters.

3.14. **Course Teacher** means a teacher who is in charge of a course. If a course is taught by more than one teacher, one teacher should be assigned as course teacher, nominated by the HOD. The course teacher shall be responsible for the valuation of answer scripts of examinations and other continuous assessments.

3.15. **In-Semester Assessment (ISA)** means assessment consisting of Attendance, Assignment/Seminar/Viva voce and Examination (theory and practical).

3.16. **End Semester Assessment (ESA)** means Examination conducted at the end of each semester for all courses (theory and practical).

3.17. **Internal Examiner** means a teacher working in the college.

3.18. **External Examiner** means a teacher from outside the college.

3.19. **Grace Marks** shall be awarded to candidates as per the orders issued by Mahatma Gandhi University.

3.20. **Grade** means a letter symbol (A, B, C, etc.), which indicates the broad level of performance of a student in a Course/ Semester/Programme.

3.21. **Grade Point** (GP) is the numerical indicator of the percentage of marks awarded to a student in a course.

3.22. **College Average (CA)** means average mark secured (ISA+ESA) for a course at the college level.

3.23. Words and expressions used and not defined in this regulation shall have the same meaning assigned to them in the Act and Statutes of the University, UGC Regulations and the Constitution of the CMS College Kottayam (Autonomous)

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4. ELIGIBILITY FOR ADMISSION AND RESERVATION OF SEATS

Eligibility for admission, norms for admission and reservation of seats for various Postgraduate Programmes shall be according to the regulations framed/orders issued by Govt. of Kerala, Mahatma Gandhi University and CMS College Kottayam in this regard.

5. PROGRAMME STRUCTURE

5.1 The nomenclature of all PG programmes shall be as per the specifications of University Grants Commission and the Mahatma Gandhi University.

5.2 Credit Semester System (CSS) will be followed for all PG Programmes from the academic year 2019– 2020.

5.3 All the PG Programmes will be of two-year duration with four Semesters. A student may be permitted to complete the Programme, on valid reasons, within a period of 8 continuous semesters from the date of commencement of the first semester of the programme.

5.4 There will be three/four/five courses in each semester and one viva voce and dissertation at the end of the fourth semester.

5.5 There will be three components for the programme viz. core course, elective course and project spread over four semesters.

5.6 The total credits required for completing a PG Programme is **80**.

5.7 The Syllabus for all courses in each semester has been divided into five modules based on certain thematic commonalities.

6. EVALUATION SYSTEM

i. The evaluation scheme for each course shall contain two parts:
(a) In-Semester Assessment (ISA)
(b) End-Semester Assessment (ESA)

ii. The proportion of ISA to ESA will be 1:3.

iii. The marks secured for each course shall be converted as grades. The grades for different semesters and overall programme are assigned based on the corresponding semester grade point average and cumulative grade point average respectively.

iv. A separate minimum of 40% is mandatory for both ISA and ESA to pass for every course.

6.1 EVALUATION OF THEORY COURSES

The marks allotted for theory courses in End-Semester Assessment shall be 120 and that for the In-Semester Assessment will be 40.

IN-SEMESTER ASSESSMENT

The In-semester assessment for theory is based on the marks obtained for Attendance, Assignment, Major Seminar and two Test Papers for a particular course.

(i) Attendance

Percentage of attendance	Mark
90 and above	6
85 – 89	5
80 – 84	4
76 – 79	3
75	0

Maximum marks = 6

(ii) Assignment (One assignment per course)

Evaluation Component	Mark
Review of related literature	2
Content	3
Reference	2
Punctuality	1

Maximum marks = 8

(iii) Major Seminar

A student should present one Major Seminar in a Semester. The faculty advisor should allot students to the respective course teacher in a semester. The seminar topics shall be incorporated in the syllabus for each course/ declared in the beginning of each semester. The student shall prepare the seminar paper with the guidance of the course teacher. The student is expected to make a detailed presentation in a common session in the department, with students and all course teachers. The student shall also make a brief conclusion including the future scope of studying the topic. The teacher in charge of the particular course has to act as the moderator for the seminar.

The course teachers of that semester shall evaluate the seminar and give marks for their course or the average mark of all the evaluators shall be taken as the seminar mark for each course of a semester.

Evaluation Component	Mark
Involvement/punctuality	1
Review of related literature	1
Content	3
Presentation	3
Interactions/ justification	1
Conclusion	1

Maximum marks = 10

(iv) Test paper

For each course, two In-Semester examinations of total 16 marks shall be conducted. One of the test paper will be centralized examination of 8 marks and the remaining 8 marks will be awarded with one or more class tests conducted by the course teacher.

A. END -SEMESTER ASSESSMENT

End-Semester examinations for each course are conducted at the end of every semester with a maximum marks of 120. The examination for each course will have two components viz., descriptive test and an objective type test. Questions shall be set to evaluate the attainment of course outcomes. The question paper for each course will be generated from the Question Bank which is prepared by due mapping of Course outcomes and Program Specific Outcomes.

(i) Descriptive Test

A written examination with a maximum marks of 100 and of three hours duration will be conducted.

PATTERN OF QUESTIONS

A question paper shall be a judicious mix of short answer type, short essay/problem solving type and long essay type questions.

No.	Section	Type of questions	Total Questions	Number of questions to be answered	Mark for each question	Total Marks
1	Section A	Short answer type	8	5	4	20
2	Section B (One pair should be from each module)	Short essay/problem solving type	10 (Either/or)	5	8	40
3	Section C	Long essay type	4	2	20	40
	Total		**22**	**12**	**-**	**100**

(ii) Objective Test

A Multiple Choice Objective type Test shall be a component of the End-semester examination which will be conducted in the online mode for each course. The marks obtained shall be converted into 20. The objective type examination for all courses in a semester shall be conducted in a session of one hour. The number of questions in Arts stream will be 50 and that of Science and Mathematics stream will be 40.Questions should be equally distributed among the courses in a semester. There will be four choices for each question. Each question carries 4 marks for correct answer, zero marks for no answer and -1 marks for wrong answer.

6.2 EVALUATION OF PRACTICAL COURSES

Practical examination will be conducted at the end of each semester/ end of an academic year. The time of conduct of the practical examination will be decided by the respective BOS.

A. IN-SEMESTER ASSESSMENT

Evaluation Component	Mark
Attendance	6
Lab Involvement	8
Test	12
Record	8
Viva	6

Maximum Marks = 40

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

B. END- SEMESTER ASSESSMENT

Evaluation Component	Mark
Attendance	18
Lab Involvement	24
Test	36
Record	24
Viva	18

Maximum Marks = 120

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

6.3 EVALUATION OF PROJECT

An academic project work shall be done and a dissertation shall be submitted in the final semester of the programme. There will be both In semester and End semester assessment for the project work.

A. **IN- SEMESTER ASSESSMENT**

Evaluation Component	Mark
Relevance of the topic	5
Project content and report	15
Presentation	15
Project viva	10
Paper presentation* in Seminar/Conference or publications with ISBN/ISSN (*valid certificate to be submitted)	5

Maximum marks = 50

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

B. **END -SEMESTER ASSESSMENT**

The dissertation at the end of final Semester will be evaluated by a panel of one internal evaluator assigned by HOD and one external evaluator / a panel of two external evaluators, as may be decided by the respective BOS.

Evaluation Component	Mark
Relevance of the topic	15
Project content and report	45
Presentation	45
Project viva	30
Paper presentation* in Seminar/Conference or publications with ISBN/ISSN (*valid certificate to be submitted)	15

Maximum marks = 150

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

6.4 EVALUATION OF COMPREHENSIVE VIVA VOCE

A comprehensive viva voce shall be done at the end of the final semester. There will be both In-semester and End-semester assessment for the viva voce examination.

A. IN - SEMESTER ASSESSMENT

Evaluation Component	Mark
+2/ UG level questions	4
PG syllabus level questions	10
Subject of interest based questions	8
Advanced level questions	3

Maximum marks = 25

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

B. END- SEMESTER ASSESSMENT

The comprehensive Viva Voce Examination at the end of final Semester will be evaluated by a panel of one internal evaluator assigned by HOD and one external evaluator / a panel of two external evaluators, as may be decided by the respective BOS.

Evaluation Component	Mark
+2/ UG level questions	12
PG syllabus level questions	30
Subject of interest based questions	24
Advanced level questions	9

Maximum marks = 75

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

7. Grievance Redressal Mechanism

In order to address the grievance of students regarding In-Semester assessment, a two-level Grievance Redressal mechanism is established.

Level 1: Department Level: The Department cell is chaired by the HOD, Department Coordinator as member secretary and Course teacher in-charge as member. If the grievance is not redressed at the Department level, the student shall report the grievance to the College Level Grievance Redressal Cell.
Level 2: **College level**: College Level Grievance Redressal Cell has the Vice-Principal as the Chairman, Dean of Student Affairs as the Member Secretary and HOD of concerned Department as member.

8. Eligibility for End Semester Examination

A minimum of 75% average attendance for all the courses is mandatory to register for the examination. Condonation of shortage of attendance to a maximum of 10 days in a semester subject to a maximum of 2 times during the whole period of the programme may be granted by the College on valid grounds. Attendance may be granted to students attending University/College union/Co-curricular activities for the days of absence, on production of participation/attendance certificates, within one week, from the teacher in charge of the activity and endorsed by the Dean of Student Affairs. This is limited to a maximum of 10 days per semester. Monthly Attendance report will be published in the college website on or before the 10^{th} of every month. Those students who are not eligible even with condonation of shortage of attendance shall repeat the semester along with the next batch after obtaining readmission.

9. Promotion to the next Semester

Those students who possess the required minimum attendance and have registered for the End Semester Examination during an academic semester are promoted to the next semester.

Those students who possess the required minimum attendance and progress during an academic semester and could not register for the semester examination are permitted to apply for Notional Registration to the examinations concerned enabling them to get promoted to the next semester.

10. Eligibility for Readmissions

An additional chance of readmission will be given to those students who could not register for the examination due to shortage of attendance. Readmitted students shall continue their studies with the subsequent batch of students. If an applicant for readmission is found to have indulged in ragging or any other misconduct in the past, readmissions shall be denied.

11. MARK CUM GRADE CARD

The College under its seal shall issue to the student a MARK CUM GRADE CARD on completion of each semester/programme, which shall contain the following information:

(a) Name of the College
(b) Title of the Postgraduate Programme
(c) Name of the Semester
(d) Name and Register Number of the student
(e) Date of publication of result
(f) Code, Title, Credits and Maximum Marks (ISA, ESA & Total) of each course opted in the semester.
(g) ISA, ESA and Total Marks awarded, Grade, Grade point and Credit point in each course opted in the semester
(h) College average (CA) of the marks of all courses
(i) The total credits, total marks (Maximum & Awarded) and total credit points in the semester
(j) Semester Grade Point Average (SGPA) and corresponding Grade.
(k) Cumulative Grade Point Average (CGPA) and corresponding Grade.

The final Mark cum Grade Card issued at the end of the final semester shall contain the details of all courses taken during the study programme and the overall mark/grade for the total programme.

There shall be a College Level Monitoring Committee comprising Principal, Vice Principal as member-secretary, Dean of Academic Affairs, Controller of Examinations, IQAC Director and Administrative Assistant as members for the successful conduct of the scheme.

12. CREDIT POINT AND CREDIT POINT AVERAGE

Credit Point (CP) of a course is calculated using the formula:-

CP = C × GP, where C is the Credit and GP is the Grade point

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

SGPA = TCP/TC, where TCP is the Total Credit Point of that semester,ie, $\sum_1^n$ CPi*; TC is the Total Credit of that semesterie,* $\sum_1^n$ Ci*, where n is the number of courses in that semester*

Cumulative Grade Point Average (CGPA) is calculated using the formula:-
CGPA = TCP/TC, where TCP is the Total Credit Point of that programmeie, $\sum_1^n$ CPi*; TC is the Total Credit of that programme, ie,* $\sum_1^n$ Ci *, where n is the number of courses in that programme*

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

CPA	Grade with Indicator
4.5 to 5.0	A+ Outstanding
4.0 to 4.49	A Excellent
3.5 to 3.99	B+ Very Good
3.0 to 3.49	B Good (Average)
2.5 to 2.99	C+ Fair
2.0 to 2.49	C Marginal
Up to 1.99	D Deficient (Fail)

13. TRANSITORY PROVISION

Notwithstanding anything contained in these regulations, the Principal shall, for a period of six months from the date of coming into force of these regulations, have the power to provide by order that these regulations shall be applied to any programme with such modifications as may be necessary.

The Principal is also authorized to issue orders for the perfect realization of the regulations.

Annexure I

(Model Mark Cum Grade Card)

CMS COLLEGE KOTTAYAM (AUTONOMOUS)

Affiliated to Mahatma Gandhi University Kottayam

(Autonomous College as per UGC order no.F.22-1/216(AC)dated 9th March 2016)

MARK CUM GRADE CARD

Section :
Name of the Candidate :
Unique Permanent Registration Number :
Degree :
Programme :
Stream :
Name of the Examination :
Date of Publication of Result :

Course Code	Course Title	Credits (c)	Marks						Grade Awarded (G)	Grade Point (GP)	Credit Point (C x GP)	College Average	Result
			ISA		ESA		TOTAL						
			Awarded	Maximum	Awarded	Maximum	Awarded	Maximum					

ISA - In - Semester Assessment, ESA – End - Semester Assessment

SGPA: **SG:**

Checked by **Section Officer** **Controller of Examinations**

Date:

Annexure II

CMS COLLEGE KOTTAYAM (AUTONOMOUS)
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Affiliated to Mahatma Gandhi University Kottayam, Kerala
(Autonomous College as per UGC Order No.F.22-1/216 (AC) dated 9th March 2016)

CONSOLIDATED MARK CUM GRADE CARD

Name of the Candidate:

Unique Permanent Register Number (UPRN):

Degree:

Programme:

Stream:

Date of Birth:

Date of Eligibility for the Degree:

PHOTO

CMS COLLEGE KOTTAYAM (AUTONOMOUS)

Name: UPRN:

Course Code	Course Title	Credits (C)	Marks						Grade Awarded (G)	Grade Point	Credit Point (CxGP)	College Average (CA)	Result
			ESA		ISA		Total						
			Awarded	Maximum	Awarded	Maximum	Awarded	Maximum					

Final Result

Cumulative Grade Point Average CGPA :

Semester Summary

Sl.No	Semester	Credit	SGPA	Grade	Month/year	Result
	Semester 1 Semester 2 Semester 3 Semester 4					

Date: **Controller of Examinations**

Annexure III

(Reverse side of the Mark cum Grade Card (COMMON TO ALL SEMESTERS))

Description of the Evaluation Process

Grade and Grade Point

The Evaluation of each Course comprises of Internal and External Components in the ratio 1:3 for all Courses.

Grades and Grade Points are given based on the percentage of Total Marks (Internal + External) as given in Table 1

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

Table 1

% Marks	Grade	GP
Equal to 88 and above	A+ Outstanding	5
Equal to 76 and < 88	A Excellent	4
Equal to64 and < 76	B+ Very Good	3
Equal to 52 and < 64	B Good(Average)	2
Equal to 40 and below 52	C Marginal	1
Below 40	D Deficient (Fail)	0
	Ab Absent	

Credit point and Credit point average Grades for the different Semesters and overall Programme are given on a 7-point Scale based on the corresponding CPA, as shown in Table 2.

Table 2

CPA	Grade with Indicator
4.5 to 5.0	A+ Outstanding
4.0 to 4.49	A Excellent
3.5 to 3.99	B+ Very Good
3.0 to 3.49	B Good (Average)
2.5 to 2.99	C+ Fair
2.0 to 2.49	C Marginal
Up to 1.99	D Deficient (Fail)

Credit point (**CP**) of a paper is calculated using the formula $\boldsymbol{CP = C \times GP}$**,where C is the Credit; GP is the Grade Point**

Semester or Programme (cumulative) Grade Point Average of a Course/Programme is calculated using the formula

SGPA/CGPA = $\frac{\boldsymbol{TCP}}{\boldsymbol{TC}}$**, where TCP is the Total Credit Point; TC is the Total Credit**

NOTE

A separate minimum of 40% marks each for internal and external (for both theory and practical) are required for a pass for a course. For a pass in a programme, a separate minimum of **Grade C** is required for all the individual courses. If a candidate secures **D Grade** for any one of the course offered in a Semester/Programme **only D grade** will be awarded for that Semester/Programme until he/she improves this to **C GRADE** or above within the permitted period.

CURRICULUM

GRADUATE PROGRAMME OUTCOMES (GPO) – POST GRADUATE PROGRAMMES

At the completion of the Post Graduate Programme, the student will be able to accomplish the following programme outcomes.

GPO No.	Graduate Programme Outcomes
GPO.1	**Critical Thinking**: Ability to engage in independent and reflective thinking in order to understand logic connections between ideas.
GPO.2	**Effective Communication:** Development of communication skills for effectively transmitting and receiving information that focuses on acquiring knowledge, problem solving, improving on arguments and theories thereby paving the way for better employability and entrepreneurship.
GPO.3	**Social Consciousness:** Acquire awareness towards gender, environment, sustainability, human values and professional ethics and understand the difference between acting, responding and reacting to various social issues.
GPO.4	**Multidisciplinary Approach:** Combining various academic disciplines and professional specializations to cross borders and redefine problems in order to explore solutions based on the new understanding of complex situations.
GPO.5	**Subject Knowledge:** Acquiring knowledge at a higher level that would help develop the necessary skills, fuel the desire to learn and contribute to the field of expertise thereby providing valuable insights into learning and professional networking with the aim of catering to the local, national and global developmental needs.
GPO.6	**Lifelong Learning**: Understanding the necessity of being a lifelong learner for personal enrichment, professional advancement and effective participation in social and political life in a rapidly changing world.

PROGRAMME SPECIFIC OUTCOMES

PSO No.	Programme Specific Outcomes Upon completion of the M.Sc. Botany Programme, the graduates will be able to:	GPO
PSO-1	Identify the different groups of botany and appreciate plant diversity	1,4,5,6
PSO-2	Understand the current developments in the different areas of botany	1,2,3,4,5,6
PSO-3	Analyze and apply the methodologies and techniques learnt during the course of studying botany	1,4,5,6
PSO-4	Integrate the knowledge acquired in botany to solve problem, take real time decisions and innovate, while working with plants	2,4,5,6
PSO-5	Share social, environmental and ethical concerns with fellow citizens	1,2,3, 4,5,6
PSO-6	Keep abreast with concepts, tools and techniques that have a multidisciplinary dimension	1,2,3,4,5,6

PROGRAMME DESIGN

The Post graduate programme in botanyis a two year programme of four semesters. There are four components for the programme namely, the core course(Theory and Practical) elective course,viva voce and the project spread over four semesters. There are Six courses in each semester(Four Theory and Two Practicals). In the fourth semester, there are four elective courses, two practical courses, a major project and a comprehensive viva-voce.The last four courses in the fourth semester are Elective courses. The total credits for completing a PG programme is 80.
The Course Design is given below:

Sl No	**Course Type**		**No of Courses**	**Total Credits**
1.	Core courses	Theory	12	45
		Practical	6	12
2.	Elective course	Theory	4	15
		Practical	2	4
3	Viva voce		-	2
4.	Dissertation		-	2
	TOTAL		**24**	**80**

PROGRAMME STRUCTURE

	Course Code	Course	Teaching hours per week	Credit	Total credits
Semester 1	BY1921101	Microbiology and Phycology	4	4	19
	BY1921102	Mycology and Crop Pathology	4	4	
	BY1921103	Bryology and Pteridology	4	4	
	BY1921104	Environmental Science	3	3	
	BY1921601	Practicals of PC 1 + PC 2- Microbiology and Phycology & Mycology and Crop pathology	5	2	
	BY1921602	Practicals of PC 3 + PC 4- Bryology and Pteridology & Environmental Science	5	2	
Semester 2	BY1922105	Gymnosperms, Evolution and Developmental Biology	4	4	19
	BY1922106	Cell and Molecular Biology	4	4	
	BY1922107	Plant anatomy and Principles of Angiosperm systematics	4	4	
	BY1922108	Genetics and Biochemistry	3	3	
	BY1922603	Practicals of PC 5 + PC 6- Gymnosperms, Evolution and Developmental Biology & Cell and Molecular Biology	5	2	
	BY1922604	Practicals of PC 7 + PC 8- Plant anatomy and Principles of Angiosperm systematics & Genetics and Biochemistry	5	2	
Semester 3	BY1923109	Research Methodology, Biophysical instrumentation, Biostatistics and Microtechnique	4	4	19
	BY1923110	Plant Physiology and Plant Breeding	4	4	
	BY1923111	Biotechnology	4	4	
	BY1923112	Taxonomy of Angiosperms	3	3	
	BY1923605	Practicals of PC 9 + PC 10- Research methodology, Biophysical instrumentation, Biostatistics and Microtechnique & Plant	6	2	

		physiology and Plant breeding			
	BY1923606	Practicals of PC 11 + PC 12- Biotechnology & Taxonomy of Angiosperms	4	2	
Semester 4	BY1924301	Tissue culture and Microbial Biotechnology	4	4	23
	BY1924302	Genetic Engineering	4	4	
	BY1924303	Genomics, Proteomics and Bioinformatics	4	4	
	BY1924304	Nanobiotechnology	3	3	
	BY1924701	Practicals of PE 1- Tissue culture and Microbial biotechnology&Applied Biotechnology And Bioethics	5	2	
	BY1924702	Practicals of PE 2 + 3- Genetic engineering & Genomics,proteomics and Bioinformatics	5	2	
	BY1924801	Project	-	2	
	BY1924901	Viva	-	2	
		TOTAL			**80**

DETAILED SYLLABUS OF ALL COURSES

SEMESTER I

Course	Details				
Code	BY1921101				
Title	**MICROBIOLOGY AND PHYCOLOGY**				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	1/I				
Type	Core Course				
Credits	4	**Hrs/Week**	4	**Total Hours**	72

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the general features of Microbes	U	1
2	Identify the external morphology, internal structure and reproduction of different types of algae and microbes	Ap	2
3	Examine the possible applications of microbes and algae	Ap	3
4	Predict the economic and ecological significance of algae and microbes	C	5
5	Differentiate different groups of algae and microbes, its Isolation and culturing.	An	6
6	Formulate new methods for culturing of microbes and algae	C	4
7	Determine the use of microbes and algae in day-to-day life	E	5

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Introduction to microbiology**	**9**	
1.1	Milestones in Microbiology	1	1
1.2	Microbial taxonomy and phylogeny - Major groups and their characteristics (Five kingdom system and three domain system of classification).	1	2,5
1.3	Sterilization techniques in microbiology-physical and chemical methods(Physical-dry heat and moist heat, radiation, filter sterilization; Chemical-commonly used surface sterilants), Disinfection;	2	3,4
1.4	Methods of isolation of pure cultures	1	5
1.5	Types of culture media	1	5,6
1.6	Enrichment culture techniques	1	5,6
1.7	Maintenance and preservation of pure cultures.	1	5,6
1.8	A brief account on endophytes- bacteria and fungi, their role in plant growth promotion and secondary metabolite production.	1	5,6

2.0	**Bacteria and Viruses**	**19**	
2.1	Bacterial morphology ,Major groups of Bacteria: Nanobes, VBNC, Spirochetes, Rickettsias, Chlamydias, Mycoplasmas, Actinomycetes, Myxobacteria, Archaebacteria (general account only). Extremophiles - thermophilic, halophilic, acidophilic and alkalophilic bacteria.	2	1
2.2	Ultra structure of Gram positive and Gram negative bacteria; cell membrane, cell wall, flagella, pili, fimbriae, capsule and slime, ribosome and endospores.	2	2
2.3	Bacterial Nutrition	1	1,2
2.4	Bacterial genome-chromosome, plasmids-types of Plasmids-R plasmids, Col plasmids and F plasmids	2	1,2
2.5	Classification of Bacteria according to Bergey's manual of systematic bacteriology (Brief study up to family).	2	2
2.6	Systematic identification of bacteria: Phenotypic-Morphology, Motility, Colony characters, Biochemical tests (Tests for carbohydrates, proteins and enzymes).	2	2,5
2.7	Molecular techniques for the identification of bacteria-16 S r RNA sequencing.	1	2,5
2.8	A brief account on metagenome analysis for the identification of non-culturable microbes.	1	2
2.9	Nomenclature and classification-types of viruses-DNA and RNA Viruses, properties of viruses, morphology (symmetry) of viruses; Capsid and their arrangements; types of envelops and their composition, Viral genome.	2	2,4
2.10	Structure of bacteriophages belonging to 'T' series-Ultra structure of TMV.	1	2
2.11	Viral replication: Lytic and Lysogenic cycles - Lytic cycle in T even phages, and lysogeny in lambda phage.	2	2
2.12	Sub viral particles - prions, viroids, virusoid (brief description only).	1	2
3.0	**Introductionto Phycology**	**4**	
3.1	History of algal classification.	1	4
3.2	Detailed study of the classification by F. E. Fritsch. Brief account on the classification (Upto groups and divisions) by Edward Lee (2008).	1	2,3
3.3	Gene sequencing and algal systematics (Brief study only).	1	3
3.4	Centers of algal research in India. Contributions of Indian phycologists – M O P Iyengar, G.S. Venkataraman, T V Desikachary.	1	4
4.0	**General features of Algae**	**26**	

4.1	Habit, habitat and distribution of Algae.	3	5
4.2	Major characteristics of Cyanophyceae, Chlorophyceae, Xanthophyceae,	3	2,4,5
4.3	Major characteristics ofBacillariophyceae, Dinophyceae,	2	2,4,5
4.4	Major characteristics of Phaeophyceae and Rhodophyceae	2	2,4,5
4.5	Range of thallus structure in algae	2	2
4.6	Algal components: Cell wall, flagella	2	2,4
4.7	Algal components: eye-spot, pigments	2	2,4
4.8	Algal components: pyrenoid, photosynthetic products.	2	2,4
4.9	Reproduction in algae: Vegetative, asexual and sexual reproduction (development of sex organs not necessary).	3	2
4.10	Major patterns of life cycles in algae	1	2
4.11	Post fertilization stages in Rhodophyceae	2	2
4.12	Fossil algae(Chlorophyceae, Cyanophyceae, Phaeophyceae, Rhodophyceae, Bacillariophyceae)	2	1,4
5.0	**Ecological and Economic importance of Algae**	**14**	
5.1	Ecological importance of Algae. Primary productivity. Algae in symbiotic association, Ultraviolet radiation absorption by algae.	2	4
5.2	Algae as food, fodder, biofertilizer, medicine, industrial uses and other useful.	2	4
5.3	Cyanophages	1	4
5.4	Algae in experimental studies. (SCP, Biofuel, Live feeds, EPS.).	2	4,6
5.5	Chemically mediated interactions in microalgae: Allelopathy (brief account only).	1	4,6
5.6	Harmful effects of algae: Algal blooms, causative organisms, symptoms and toxins of major toxic algal blooms (Amnesic Shellfish Poisoning [ASP], Paralytic Shellfish Poisoning [PSP] and Cyanophycean toxins).	2	7
5.7	Methods and techniques of collection, preservation and staining of Algae.	2	5,6
5.8	Algal culture: Importance, methods for culturing macroalgae and microalgae; Algal culture media (Walnes medium and BG 11)	2	4,6,7

Text Books for Reference

1. Ananthanarayan and Panicker. Text Book of Microbiology, Sterling Publications
2. Dube H C (2008). *Fungi, Bacteria and Viruses*. Agrobios.
3. Bilgrami, Sinha. *Essentials of Microbiology*.
4. Andersen R A (Ed) 2004. *Algal Culturing Techniques*, Elsevier.

5. Bellinger E.G Sigee D C. (2015*). Freshwater Algae Identification, Enumeration and use as Bioindicators*. John Wiley and Sons Ltd.
6. Bold H C, Wynne M J (1978). *Introduction to Algae: Structure and reproduction*. Prentice Hall.

Text Books for Enrichment

1. Dube H C (2008). *Fungi, Bacteria and Viruses*. Agrobios.
2. Kanika Sharma (2005). *Manual of Microbiology: Tools and Techniques*. Ane Books.
3. Kumar H D (1990). *Modern concepts of Microbiology*. Vikas public. Delhi.
4. Lansing M Prescott, Harley, Klein (1999). *Microbiology*.
5. Monica Cheesbrough. Medical Laboratory Manual for tropical countries. Elsevier, London, UK.
6. Pelczar Michael J, Adams M R, Chan E C S, Krieg Noel R (2000). *Microbiology*. Tata McGraw Hill.
7. Pelczar (1990). *Microbiology*. T M H.
8. Purohit S S (1997). *Microbiology: Fundamentals and application*. Agrobotanical.
9. Powar C B, Daginawala H F (1991). *General Microbiology* Vol II. Himalaya Publishing House.
10. Willey, Presscot's Microbiology IXth Edition
11. Salle A J (1978). *Fundamentals of Bacteriology*. Asia TMH
12. Dubey R C, Maheswari D K (2004). *Microbiology*. S Chand.
13. Sharma P D (2003). *Microbiology*. Restogi pub.
14. F H Kayser, K A Bienz, J Eckert, R M Zinkernagel. *Medical Microbiology.*
15. L R Haahelm, J R Pattison, R J Whitley. *Clinical virology.*
16. Thandavarayan Ramamurthy, AmitGhosh, Gururaja P. Pazhani, and SumioShinoda Current Perspectives on Viable but Non-Culturable (VBNC) Pathogenic Bacteria. Frontiers in Public Health, 2014; 2: 103.
17. Nanobes and Nanobacteria -SERC. https://serc.carleton.edu/microbelife/topics/nanobes/index.html
18. Borowitzka M A, Beardall J, Raven J H (2016). The physiology of microalgae. Springer.
19. Chapman V J (1962). *The Algae*. Macmillan & Co. Ltd.
20. D'Silva M.S, Anil, A C Naik R K, D'Costa P M (2012). *Algal blooms: a perspective from the coasts of India. Nat Hazards,* 63:1225–1253 DOI 10.1007/s11069-012-0190-9
21. Das S K, Adhikary S B (2014). *Freshwater Algae of Eastern India*. Astral Inernational
22. Desikachary, T.V. 1959. *Cyanophyta.* Indian Council of Agricultural Research.
23. Fritsch F E (Vol. I, II) (1977). *The structure and reproduction of Algae*. Cambridge University Press.
24. Hallegraeff, G.M, Anderson D.M, Cembella A D (2004). *Manual on Harmful Marine Microalgae* UNESCO.
25. ICAR Publications: *Algal monographs*

26. Jha B, Reddy C R K, Rao M R (2009). Seaweeds of India: The diversity and distribution of seaweeds of Gujarat coast. Springer.
27. Kundal P, Mude S M (2009). *Geniculate coralline algae from the Neogene-quaternary sediments in and around Porbandar, southwest coast of India*. Journal geological society of India 74:267-274.
28. Kundal P, Mude S M (2012). *Additional coralline algae from the lower Miocene to late Holocene sediments of the Porbandar group, Gujarat*. Journal geological society of India 79:69-76.
29. Lee R E (2012). *Phycology* 4th edition. Cambridge University Press.
30. Perumal S, Thirunavukkarasu A R, Pachiappan P (2015), *Advances in marine and brackish water aquaculture,* Springer
31. Reynolds C S (2006). Ecology of phytoplankton, Cambridge University Press
32. Richardson, K. (1997). Harmful or exceptional phytoplankton blooms in the marine ecosystems. In. Blaxter and Southward (Eds) *Advances in Marine Biology,* 31:301-385. Academic Press
33. Smith G M (1971). *Cryptogamic Botany (Vol. 1): Algae and Fungi*. Tata McGraw Hill Edition.
34. Tomas, C.R. 1997 *Identifying Marine Phytoplankton*. Academic press.
35. Bengtson S Sallstedt T Belivanova V Whitehouse M (2017). *Three-dimensional preservation of cellular and sub cellular structure suggest 1.6 billion year old crown group red algae,* PLOS Biology, DOI: 10.1371/journal.pbio.2000735, March 14.

Course	Details				
Code	BY1921102				
Title	**MYCOLOGY AND CROP PATHOLOGY**				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	1/I				
Type	Core Course				
Credits	4	**Hrs/Week**	4	**Total Hours**	72

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the different fungal groups with examples	U	1
2	Examine the fungal interactions in nature and predict their adaptive strategies.	C	2,4
3	Understand the economic importance of fungi and assess their useful and harmful nature	E	2
4	Recognize, compare and distinguish the processes and mechanisms involved in pathogenesis by various microbes	An	3,4,6
5	Identify and interpret the major diseases of crop plants and propose their control measures	C	1,4,5

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
	MYCOLOGY	**36 hrs**	
1.0	**General introduction**	**3**	**1**
1.1	General characters of Fungi and their significance.	1	1
1.2	Principles of classification of fungi Classifications by G C Ainsworth (1973) and C. J. Alexopoulos	2	1
2.0	**Thallus structure and reproduction in Fungi**	**24**	**1**
2.1	**Mycelial structure and reproduction of** : **Myxomycota** – Acrasiomycetes, Hydromyxomycetes, Myxomycetes, Plasmodiophoromycetes.	3	1
2.2	**Mastigomycotina** - Chytridiomycetes, Hyphochytridiomycetes, Oomycetes.	3	1
2.3	**Zygomycotina** - Zygomycetes, Trichomycetes.	3	1
2.4	**Ascomycotina** - Hemiascomycetes,	3	1

	Pyrenomycetes, Plectomycetes,		
	Discomycetes, Laboulbeniomycetes, Loculoascomycetes.	3	1
2.5	**Basidiomycotina** - Teliomycetes, Hyphomycetes, Gastromycetes	3	1
2.6	**Deuteromycotina** - Blastomycetes, Hyphomycetes, Coelomycetes	3	1
2.7	.Types of fruiting bodies in fungi	3	1
3.0	**Fungal associations and their significance**	**9**	**2,3**
3.1	**Symbionts** - Lichens, Mycorrhiza, Fungus-insect mutualism	2	2,3
3.2	**Parasites** - Common fungal parasites of plants, humans, insects and nematodes.	2	2,3
3.3	**Saprophytes** - Fungal decomposition of organic matter, coprophilous fungi, cellulolytic fungi, lignolytic fungi.	3	2,3
3.4	**Agricultural significance of Fungi** - Mycoparasite, mycoherbicide.	2	2,3
	CROP PATHOLOGY	**36 hrs**	
4.0	**Introduction to crop pathology**	**21**	**4**
4.1	**Process of infection and pathogenesis:** Penetration and entry of pathogen into host tissue – mechanical, physiological and enzymatic.	3	4
	Host-parasite interaction,enzymes and toxins in pathogenesis.	2	4
4.2	**Defense mechanism in plants:** Pre-existing structural and biochemical defense mechanisms, lack of essential nutrients.	2	4
	Induced structural and biochemical defense mechanisms, inactivation of pathogen enzymes and toxins, altered biosynthetic pathways.	3	4
4.3	**Transmission of plant disease** Spread and transmission of plant diseases by wind, water, seeds and vectors.	3	4
4.4	**Plant disease management** Exclusion, eradication and protection.	1	4
	Chemical means of disease control – common fungicides, antibiotics and nematicides.	2	4
	Biological means of disease control. Biotechnological approaches to disease resistance:	2	4
	Fungi in agricultural biotechnology, control of fungal plant pathogens by mycofungicides.	2	4
	Transgenic approaches to disease resistance	1	4
5.0	**Major diseases in plants**	**15**	**5**
5.1	**Cereals**: Rice - blast disease, bacterial blight;	2	5

	Wheat - black rust disease.		
5.2	**Vegetables**: Chilly - leaf spot; Ladies finger - vein clearing disease.	1	5
5.3	**Fruits**: Banana - bacterial leaf blight, leaf spot; Mango - Anthracnose; Citrus - bacterial canker; Papaya – mosaic.	3	5
5.4	**Spices**: Ginger - rhizome rot; Pepper - quick wilt; Cardamom - marble mosaic disease.	3	5
5.5	**Oil seeds**: Coconut - grey leaf spot, bud rot disease.	1	5
5.6	**Rubber yielding**: *Hevea braziliensis* - abnormal leaf fall, powdery mildew.	2	5
5.7	**Sugar yielding**: Sugarcane - red rot; root knot nematode.	1	5
5.8	**Cash crops**: Arecanut - nut fall disease.	1	5
5.9	**Beverages**: Tea - blister blight; Coffee - rust.	1	5

References – Mycology

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

References – Crop Pathology

1. K S Bilgrami, H C Dube. *A text book of modern plant pathology*.
2. Gareth Johnes. *Plant pathology: principles and practice.*
3. R S Mehrotra. *Plant Pathology*.
4. M N Kamat. *Practical plant pathology*.
5. V K Gupta, T S Paul. *Fungi and Plant disease.*
6. Malhotra, Aggarwal Ashok. *Plant Pathology*.
7. Rangaswamy, A Mahadevan. *Diseases of crop plants in India*.
8. B P Pandey. *Plant Pathology*.
9. George N Agrios (2006). *Plant pathology* (V Edn). Elsevier Academic Press

Course	Details				
Code	BY1921103				
Title	**BRYOLOGY AND PTERIDOLOGY**				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	1/I				
Type	Core Course				
Credits	4	**Hrs/Week**	4	**Total Hours**	72

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the different groups in Bryophyta and Pteridophyta with examples	R	1
2	Understand the ecological and economic importance of Bryophytes and Pteridophytes	E	2
3	Recognize, compare and distinguish between the thallus structures and reproductive mechanisms in Bryophyta and Pteridophyta.	An	3,4,6
4	Compare and study the structural characteristics of Pteridophyta	C	1,4,5
5	Predict the ecological and economic significance of Pteridophyta	C	5

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
	BRYOLOGY	**36Hrs**	
1.0	**Introduction to Bryophytes**	**10**	**1**
1.1	**General introduction** Introduction to Bryophytes, their fossil history and evolution.	1	1
	Concept of algal and pteridophytic origin of Bryophytes.	1	1
	General characters of Bryophytes.	1	1
	History of classification of Bryophytes.	1	1
1.2	**Ecology and Economic importance of bryophytes:** Bryophyte habitats.	1	1
	Water relations - absorption and conduction, xerophytic adaptations, drought tolerance, dessication and rehydration, ectohydric, endohydric and myxohydric Bryophytes.	3	1
	Ecological significance of Bryophytes - role as pollution indicators.	1	1
	Economic importance of Bryophytes.	1	1

2.0	**Thallus structure**	**26**	**2**
2.1	Comparative structural organization of gametophytes and sporophytes in an evolutionary perspective.	3	2
2.2	Asexual and sexual reproductive structures, spore dispersal mechanisms and germination of the following groups with reference to the types mentioned in the practical (development of sex organs not necessary).		2
	(a) Hepaticopsida: Sphaerocarpales	3	2
	Marchantiales	3	2
	Jungermanniales	3	2
	Calobryales	3	2
	(b) Anthocerotopsida (Anthocerotales).	2	2
	(c) Bryopsida: Sphagnales,	3	2
	Polytrichales	3	2
	Bryales	3	2
	PTERIDOLOGY	**36 Hrs**	
3.0	**General introduction and classification of Pteridophytes**	**3**	**3**
3.1	Introduction, origin, general characteristics	2	3
3.2	outline of the classification of Pteridophytes	1	3
4.0	**Structure of the plant body**	**27**	**4**
4.1	Distribution, habitat, range, external and internal morphology of sporophytes, spores, mechanism of spore dispersal, gametophytic generation, sexuality, embryogeny of the following classes of Pteridophytes with reference to the genera mentioned (development of sex organs is not necessary): (I) Psilopsida (a) Rhyniales; *Rhynia*	1	4
4.2	(II) Psilotopsida (a) Psilotales; *Psilotum*	1	4
4.3	(II) Lycopsida (a) Protolepidodendrales; *Protolepidodendron* (b) Lycopodiales; *Lycopodium*,	2	4
4.4	(c) Isoetales; *Isoetes* (d) Selaginellales; *Selaginella*.	2	4
4.5	(IV) Sphenopsida (a) Hyeniales (b) Sphenophyllales; *Sphenophyllum* (c) Calamitales; *Calamites*	3	4
4.6	(d) Equisetales; *Equisetum*.	2	4
4.7	(V) Pteropsida (i) Primofilices (a) Cladoxylales; *Cladoxylon* (b) Coenopteridales.	3	4
4.7	(ii) Eusporangiatae (a) Marattiales; *Angiopteris* (b)	3	4

	Ophioglossales; *Ophioglossum*. iii) Osmundales; *Osmunda*		
4.8	(iv) Leptosporangiatae (a) Marsileales; *Marsilea* (b) Salviniales; *Salvinia, Azolla*	3	4
	(c) Filicales; *Pteris*, *Lygodium, Acrostichum, Gleichenia, Adiantum*.	3	4
4.9	**Comparative study of Pteridophytes:**		
	Stelar organization, soral and sporangial characters	2	4
	Gametophytes and sporophytes of Pteridophytes in an evolutionary perspective.	2	4
5.0	**Ecology and Economic importance** Ecological and economic significance of Pteridophytes.	2	5

References - Bryology

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

References – Pteridology

1. Agashe S N (1995). *Palaeobotany*. Oxford and IBH publishing House.
2. Arnold C R (1977*). Introduction to Palaeobotany*. McGraw Hill Book Com.
3. Chandra S, Srivastava M (Eds) (2003). *Pteridology in the New Millennium*. Khuwar Acad. Publishers.
4. Beddome C R H (1970). *Ferns of south India*. Today & Tommorrows Publ.
5. Dyer A F (1979). *The experimental biology of ferns*. Academic Press.
6. Gifford E M, A S Foster (1989). *Morphology and evolution of Vascular plants* (III Edn). W H Freeman & Co.
7. Khullar S P (2000). *An illustrated fern flora of West Himalayas* (Vol I, II). International Book Distributers.

8. Kubitzki K (1976). *The families and Genera of Vascular plants: Vol. I Pteridophytes*. Vikas publishing house.
9. Rashid A (1976). *An introduction to Pteridophytes*. Vikas Publishing House.
10. Sporne K R (1982). *Morphology of Pteridophytes*. Hutchinson university Press.
11. Surange K R (1964). *Indian Fossil Pteridophytes*. CSIR.
12. Louis J D (1977). *Evolutionary patterns and processes in ferns: Advances in Botanical Research*.
13. Scott. *Studies in Fossil Botany*. Haffner publications.
14. Smith, Gilbert (1972). *Cryptogamic Botany* (Vol. II). Tata McGraw Hill publications.
15. Nayar B K, S Kaur (1971). *Gametophytes of homosporous ferns*. Bot. Rev.

Course	Details				
Code	BY1921104				
Title	**ENVIRONMENTAL SCIENCE**				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	1/I				
Type	Core Course				
Credits	3	**Hrs/Week**	3	**Total Hours**	54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the concept and principles of ecology	U	1,2
2	Identify the different components and their interrelationships in the ecosystem	E	1,2
3	Classify different types of ecosystems and discover those which need immediate attention	An	3, 4
4	To identify and analyse the distribution of vegetation in different zones	An	2,3
5	Understand and analyse environmental problems and social issues	An	5
6	Build awareness in controlling pollution and apply their knowledge in waste management	C	3,4
7	Asses the biodiversity loss and understand the need to conserve it	E	4

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Ecology and Environment**	**14**	
1.1	Introduction to ecology - Definition, history and scope of ecology, Interdisciplinary nature of environmental science.	1	1
1.2	Autecological concepts:- Population Ecology - (a) Characteristics of populations - size and density, dispersion, age structure, natality and mortality.	1	1,2
	(b) Population growth - factors affecting population growth, environmental resistance, biotic potential, carrying capacity, positive and negative interaction, migration, subsistence density, security and optional density. Ecological consequence of overpopulations.	2	1,2
	(c) Genecology - ecological amplitude, ecads, ecotypes, ecospecies, coenospecies, k-selection and rselection populations.	1	1,2
1.3	Synecologicalconcepts : Community ecology - (a) Ecological processes of community formation,	2	1,2

	ecotone, edge effect. Classification of communities - criteria of classification, dynamic system of classification by Clement.		
	(b) Special plant communities - quantitative, qualitative and synthetic characteristics of plant communities, Sorenson's Index of similarity, coefficient of communities.	2	1,2
	(c) Dynamic community characteristics - cyclic replacement changes and cyclic no-replacement changes.	1	1,2
1.4	Dynamic Ecology: Ecological succession – (a) The concept, definition and reasons of succession. Classification of succession: Changes – autogenic and allogenic, primary and secondary, autotrophic and heterotrophic.	2	1,2
	(b) retrogressive changes or the concept of degradation, concept of climax or stable communities, resilience of communities.	2	1,2
2.0	**Biosphere and Ecosystem**	**9**	1,2
2.1	Significance of habitat, biodiversity, ecological niche, trophic level, primary and secondaryproductivity, food chains, food webs, ecological pyramids, energy flow and nutrient cycles.	3	2
2.2	Comparative study of the major tropical ecosystems: Tropical rain forests, Wetlands and tropical coastal ecosystems, Significance of wetlands, mangroves and coastal ecosystem and their conservation	2	3
2.3	Phytogeography : Definition, principles governing plant distribution, factors affecting plant distribution, theories of distribution, different types of distribution of vegetations on the earth, continuous and discontinuous distribution., Climate, vegetation and botanical zones of India.	3	4
2.4	Remote sensing: Definition and data acquisition techniques. Application of remote sensing in environmental studies - geospatial variability and geotagging.	1	4
3.0	**Global environmental problems and climate change**	**15**	
3.1	Pollution - Definition and classification, Types of pollution	1	5
3.2	Water pollution: Water quality parameters and standards, different types of pollutants and theirconsequences. Types of water pollution, prevention and control- water shed management	3	5
3.3	Air pollution: Air quality standards and index,	2	5

	ambient air monitoring using high volume airsampler,		
	Types and sources of air pollutants, air pollution and human health hazards, control of airpollution.	2	5
3.4	Noise pollution, Radioactive pollution, thermal pollution: Causes and hazardous effects, effective management.	3	5
3.5	Global warming, green house gases, acid rain, ozone depletion. Stockholm conference, Montreal protocol, Kyoto protocol,	2	5
3.6	Factors responsible for climate change, *El-Nino* and *La Nina* phenomenon and its consequences.	1	5
3.7	Disaster management; preparedness and planning	1	5
4.0	**Environmental management**	**8**	
4.1	Solid waste management: Concept of waste, types and sources of solid wastes including e-waste, methods of solid waste management – Recycling, landfill, incineration, pyrolysis, biological methods – aerobic and anaerobic, composting	3	6
4.2	Bioremediation, bioaugmentation, Phytoremediation, biofilms, biofilters, bioscrubbers, wastewater treatment - bioreactors, trickling filters. Role of aquatic macrophytes in waste water treatment.	2	6
4.3	Major environmental laws in India, environmental safety provisions in Indian constitution, Role of MoEF, Govt. of India, Environmental Management System, Environmental Impact Assessment, environmental standards, ISO-14000, environmental monitoring and bio indicators	3	6
5.0	**Biodiversity and its conservation**	**8**	
5.1	Basic principles of resource management, definition and classification of resources, problems ofresource depletion, preservation, conservation and restoration, patterns of resource depletion.	1	7
5.2	Current biodiversity loss - concept of endemism, rare, endangered and threatened species (RET), keystone species, IUCN account of biodiversity, red data book and hot spots, reasons to stop extinction,methods to save species, Ecotourism - positive and negative impacts.	3	7
5.3	Principles of conservation - *ex-situ* and *in-situ* conservation techniques. Biodiversity conservation:Species diversity, community diversity, ecosystem diversity, Rain forests as centres of diversity, ecological restoration, Role of biotechnology in conservation of species.	3	7
5.4	Students should be aware of the common environmental problems, their consequences and possible solutions.	1	7

References

1. Ahmedullah M, Nayar M P (1987). *Endemic plants of India*.
2. APHA, Awwa, Wep. *Standard methods for the examination of water and waste water*.
3. Barbour M D, et. al., (1980). *Terrestrial Plant Ecology.* The Benjamin-Cammings Pub. Com.
4. Benton A H, Werner W E (1976). *Field Biology and Ecology*. Tata McGraw Hill.
5. Christenhusz M J M, Byng J W (2016). *The number of known plants species in the world and its annual increase*. Phytotaxa, 261 (3): 201-217. http://dx.doi.org/10.11646/phytotaxa.261.3.1.
6. Clarke G L (1954). *Elements of Ecology.* John Wiley Pub.
7. Dash M C (1993). *Fundamentals of Ecology*. Tata McGraw Hill.
8. *Ecological Guidelines for tropical coastal developments*. UNESCO.
9. Eldon D, Enger, Bradley, Smith F (1995). *Environmental Science*. W C Brown publications.
10. Emery W, Camps A (2017). *Introduction to satellite remote sensing*. Elsevier.
11. Furley P A et. al., (1983). *Geography of the biosphere: An introduction to the nature, distribution and evolution of the world life zones*. Butterworths.
12. IUCN (2000). *The IUCN red list category*. IUCN England.
13. IUCN (2007). *The 2000 IUCN red list of threatened species*. IUCN. England.
14. Jain S K, Sastry A R K (1984). *The Indian plant red data book*. BSI, Calcutta.
15. Jones H G, Vaugham R A. *Remote sensing of vegetation*. Oxford university press.
16. Jorgensson S E. (2009). *Ecosystem Ecology*, Elsevier.
17. Kormondy E J (Ed) (1965). *Reading in ecology*. Prentice Hall.
18. Kormondy E J (Ed) (1999). *Concept of ecology*. Prentice Hall.
19. Kumar H D (1977). *Modern concept of ecology*. Vikas Publication.
20. Michael P (1984). *Ecological methods of field and laboratory investigations*. Tata McGraw Hill.
21. Misra K C. *Manual of plant ecology*. Oxford and IBH Pub. Com. P. Ltd.
22. Misra S P &Pandey S N *Essential Environmental Studies*, Ann Books Pvt. Ltd
23. Nagelkerker, I. (2009*). Ecological connectivity among tropical coastal ecosystems*, Springer.
24. Odum E P (III Edn) (1991). *Fundamentals of ecology*. Saunders and Com.
25. Odum E P, Barrett G W (2005). *Fundamentals of Ecology*- 5th Edition. Brooks/Cole Publishing Co.

26. Osborne P L (2012). *Tropical Ecosystems and Ecological Concepts,* 2nd edition. Cambridge University Press
27. Pearcy R W et. al., (1989). *Plant physiological Ecology: Field methods and instrumentation*. Chapman and Hall.
28. Ramade F (1981). *Ecology of natural resources*. John Wiley and sons.
29. Schowengerdt R (2012). *Remote sensing* 2nd edition, Academic Press.
30. Sharma P D (1999). *Ecology and Environment*. Rastogy Pub.
31. Simons I G (1981). *Ecology of natural resources*. Edwin-Arnold Ltd.
32. Smith T M Smith R L. (2012). *Elements of ecology*, 8th edition, Benjamin Cummins.
33. Trivedi R K. *Practical methods in Ecology and Environmental sciences*. Envt. pub.
34. Trivedi R. *International encyclopedia of ecology and environment* (Vol.1). IIEE, New Delhi.
35. Uberoi N K*Environmental Management,*Excel Books
36. Varma P S, Agarwal V K. *Principles of Ecology*. S Chand and Co.
37. Walter (1987). *Vegetation of the earth*. Springer Verlag.
38. Wilson E O (1988). *Biodiversity.* The national academic press.
39. Wilson E O (1999). *The diversity of life.* W.W. Norton and Company.

Course	Details				
Code	BY1921601				
Title	**Microbiology And Phycology & Mycology And Crop Pathology**				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	1/I				
Type	Core Practical				
Credits	4	**Hrs/Week**	5	**Total Hours**	99

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the world of microbes and algae in order to appreciate their adaptive strategies.	E	1,2,3
2	Develop basic skills and techniques in inoculation and isolation of microbes and its various assays.	C	4,6
3	Identify the external morphology, internal structure and reproduction reproduction of different types of algae	An	3
4	Examine the possible applications in phycology	Ap	3
5	Understand the structural details of various types of fungi and lichens.	E	1,3
6	Apprehend the pathological importance of Fungi and identify common plant diseases and device control measures.	C	2,4
7	Develop basic skills and techniques for the isolation and culturing of fungi and pathogens	Ap	4, 6

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Microbiology**	**9**	
1.1	Preparation and sterilization of microbial culture media - Nutrient broth and nutrient agar	2	2
1.2	Inoculation of bacteria-stabbing and streaking	1	2
1.3	Differential staining of bacteria using Gram stain.	1	2
1.4	Endospore staining	1	2
1.5	Isolation of Rhizobium from root nodules.	1	2
1.6	Isolation of microbes from soil: Serial dilution - pour plate/spread plate method.	1	2
1.7	Streak out a bacterial culture on an agar plate and isolation of colonies –Quadrant streaking method	1	2
1.8	Antibacterial assay - disc diffusion/agar well method.	1	2
2.0	**Phycology**	**30**	
2.1	Critical study of diagnostic features and identification of	8	3

	the following genera based on morphological, anatomical and reproductive parts; Cyanophyceae - *Gleotrichia, Spirulina, Microcystis, Oscillatoria, Lyngbya, Anabaena, Nostoc, Rivularia, Scytonema*.		
2.2	Critical study of diagnostic features and identification of the following genera based on morphological, anatomical and reproductive parts; Chlorophyceae - *Chlamydomonas, Volvox, Ecballocystopsis, Ulothrix, Microspora, Ulva, Cladophora, Pithophora. Coleochaete, Chaetophora, Drapernaldia, Trentepohlia, Fritschiella, Cephaleuros, Oedogonium, Bulbochaete, Zygnema, Mougeotia, Sirogonium, Desmedium, Bryopsis, Acetabularia, Codium, Caulerpa, Halimeda, Chara, Nitella*.	8	3
2.3	Critical study of diagnostic features and identification of the following genera based on morphological, anatomical and reproductive parts; : Xanthophyceae – *Vaucheria*.	2	3
2.4	Critical study of diagnostic features and identification of the following genera based on morphological, anatomical and reproductive parts; : Bacillariophyceae –O*dontella ,Navicula*.	2	3
2.5	Critical study of diagnostic features and identification of the following genera based on morphological, anatomical and reproductive parts; Phaeophyceae - *Ectocarpus, Colpomenia, Dictyota, Padina, Sargassum, Turbinaria*.	5	3
2.6	Critical study of diagnostic features and identification of the following genera based on morphological, anatomical and reproductive parts; Rhodophyceac - *Batrachospermum, Gelidium, Amphiroa, Gracilaria, Polysiphonia*.	5	3
3.0	**Algae Culturing**	**6**	
3.1	Students have to collect and identify algae from different habitat.	2	1
3.2	Preparation of any one of the algal culture media and isolation of algae	2	4
3.3	Prepare and submit a report of the field work on algal collection.	2	1
4.0	**MYCOLOGY**	**36 Hrs**	
4.1	Critical study of the following types by preparing suitable micropreparations; Stemonitis, Physarum,Saprolegnia,	3	5
4.2	Critical study of the following types by preparing suitable micropreparations; Phytophthora, Albugo, Mucor,	3	

4.3	Critical study of the following types by preparing suitable micropreparations; Aspergillus, Penicillium, Pilobolous, Saccharomyces, Xylaria,	3	
4.4	Critical study of the following types by preparing suitable micropreparations; Peziza, Phyllochora, Puccinia,	3	
4.5	Critical study of the following types by preparing suitable micropreparations; Termitomyces, Pleurotus, Auricularia,	3	
4.6	Critical study of the following types by preparing suitable micropreparations; Polyporus, Lycoperdon, Dictyophora,	3	
4.7	Critical study of the following types by preparing suitable micropreparations; Geastrum ,Cyathus, Fusarium	3	
4.8	Critical study of the following types by preparing suitable micropreparations; Alternaria, Cladosporium, Pestalotia,	3	
4.9	Critical study of the following types by preparing suitable micropreparations; Graphis, Parmelia, Cladonia, Usnea.	3	
4.10	Isolation of fungi from soil and water by culture plate technique	3	7
4.11	Estimation of mycorrhizal colonization in root.	3	
4.12	Collection and identification of common field mushrooms (5 types).	3	
5.0	**CROP PATHOLOGY**	**18**	6,7
5.1	Make suitable micropreparations and identify the diseases mentioned with due emphasis on symptoms and causative organisms.	3	
5.2	Isolation of pathogens from diseased tissues (leaf, stem and fruit) by serial dilution method.	3	
5.3	Collection and preservation of specimens from infected plants.	3	
5.4	Submit 5 herbarium sheets/live specimens along with a report.	3	
5.5	Tests for seed pathology – seed purity test.	3	
5.6	Calculation of Spore load on seeds using Haemocytometer.	3	

Course	Details				
Code	BY1921602				
Title	**BRYOLOGY AND PTERIDOLOGY &ENVIRONMENTAL SCIENCE**				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	1/I				
Type	Core Practical				
Credits	4	Hrs/Week	5	Total Hours	81

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the unique and general features of Bryophytes and pteridophytes and familiarize it	U	1
2	Identify the external morphology, internal structure and reproduction of different types of bryophytes	C	2,4
3	Examine the classification, distribution, morphology, anatomy, reproduction and life cycle of pteridophyte types mentioned in the syllabus	U	1
4	Identify the various parameters related to water quality and quantify them.	An	3,4,5
5	Familiarize various types of natural resources and plant diversity.	An	3,4

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
	PRACTICALS		
1.0	**BRYOLOGY**	**18**	1,2
1.1	Detailed study of the structure of gametophytes and sporophytes of the following genera of bryophytes by suitable micropreparation: *Riccia, Targionia, Cyathodium, Marchantia*	3	2
1.2	Detailed study of the structure of gametophytes and sporophytes of the following genera of bryophytes by suitable micropreparation*Lunularia,Dumortiera,*	3	2
1.3	Detailed study of the structure of gametophytes and sporophytes of the following genera of bryophytes	3	2

	by suitable micropreparation*Reboulia, Pallavicinia, Aneura*		
1.4	Detailed study of the structure of gametophytes and sporophytes of the following genera of bryophytes by suitable micropreparation *Fossombronia, Porella, Anthoceros,*	3	2
1.5	Detailed study of the structure of gametophytes and sporophytes of the following genera of bryophytes by suitable micropreparation*Notothylas, Sphagnum, Pogonatum*.	3	2
1.6	Students are expected to submit a report of field trip to bryophyte's natural habitats to familiarize with the diversity of Bryophytes.	3	1
2.0	**PTERIDOLOGY**	**36**	
2.1	Study of morphology and anatomy of vegetative and reproductive organs using clear whole mounts/sections of the following genera: *Psilotum, Lycopodium, Isoetes, Selaginella, Equisetum, Angiopteris, Ophioglossum, Osmunda, Marsilea, Salvinia, Azolla, Lygodium, Acrostichum, Gleichenia, Pteris, Adiantum, Polypodium and Asplenium*.	30	3
2.2	Study of fossil Pteridophytes with the help of specimens and permanent slides.	3	3
2.3	Field trips to familiarize with the diversity of Pteridophytes in natural habitats.	3	1
3.0	**ENVIRONMENTAL SCIENCE**	**27**	
3.1	Analysis of water quality for; (a) Dissolved CO2 (b) Dissolved oxygen (c) COD (d) Total dissolvedminerals (e) Quantitative estimation of dissolved chloride ions and dissolved sulphate (f) Totalalkalinity.	7	4
3.2	Quantitative estimation of dissolved silicate, dissolved sulphate and nitrite	3	4
3.3	Physico-chemical analysis of soil: (a) Total water soluble mineral ions (b) estimation of soil organiccarbon (Walkey and Black method).	2	4
3.4	Quantitative and qualitative community analysis. Carry out a project on species structure and thefrequency, abundance, density of different species and similarity index of different communities in anatural system. Students must be able to explain the structure of vegetation from the given data on theabove mentioned characteristics.	5	5
3.5	Phytoplankton counting using Sedgwick Rafter counter.	2	4,5
3.6	Field visit to natural ecosystem and identification of trophic levels, food webs and food chains, plant diversity (species and community) and submit a report.	8	5

SEMESTER II

Course	Details				
Code	BY1922105				
Title	**GYMNOSPERMS, EVOLUTION AND DEVELOPMENTAL BIOLOGY**				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	1/II				
Type	Core Course				
Credits	4	**Hrs/Week**	4	**Total Hours**	72

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the general characteristics, distribution and classification of Gymnosperms	U	1
2	Compare the structure and development of gymnosperms and understand its economic importance	An	1,5
3	Summarize on the various concepts of evolution and speciation	An	2,4,5
4	Discuss and interpret the various theories explaining evolution	Ap	3,4
5	Build the basic concepts of development, organogenesis and morphogenesis in plants	An	3,4

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO No.
	GYMNOSPERMS	**27**	
1.0	**Introduction to Gymnosperms:**	**3**	**1**
1.1	Origin, general characteristics, distribution and classification of Gymnosperms (K R Sporneand C J Chamberlain).	2	1
1.2	Distribution of living gymnosperms in India	1	1
2.0	**Structure, Development and Economic Importance of Gymnosperms**	**24**	**2**
2.1	**Vegetative and reproductive structures of Gymnosperms** Detailed study of the vegetative morphology, internal structure, reproductive structures, and evolution of the orders and families (with reference to the genera mentioned). Class Progymnospermopsida: *Aneurophyton*	3	2

2.2	Detailed study of the vegetative morphology, internal structure, reproductive structures, and evolution of the orders and families (with reference to the genera mentioned). Class Cycadopsida: *Heterangium, Lyginopteris, Lagenostoma, Glossopteris, Medullosa, Caytonia*	3	2
2.3	Detailed study of the vegetative morphology, internal structure, reproductive structures, and evolution of the orders and families (with reference to the genera mentioned). *Bennettites, Williamsoniella, Nilsonia, Cycas, Zamia, Pentoxylon*.	3	2
2.4	Class Coniferopsida: General account of families under Coniferales, range of form and structure of stem, leaves; range of form, structure and evolution of female cones in coniferales such as *Pinus*, *Taxodium, Cupressus, Podocarpus,*	3	2
	Detailed study of the vegetative morphology, internal structure, reproductive structures, and evolution of the orders and families (with reference to the genera mentioned). *Agathis, Araucaria,Taxus and Ginkgo*.	3	2
2.5	Detailed study of the vegetative morphology, internal structure, reproductive structures, and evolution of the orders and families (with reference to the genera mentioned). Class Gnetopsida: *Gnetum*.	3	2
2.6	**Gametophyte development and economic importance of Gymnosperms** General account on the male and female gametophyte development in Gymnosperms (Cycas).	3	2
2.7	Economic significance of Gymnosperms.	3	2
	EVOLUTION	**27**	
3.0	**Introduction to Evolution**	**22**	**3**
3.1	The Concept of evolution, preformation theory, Baer's law, biogenetic law,	2	3
	theoryof catastrophism, natural selection, artificial selection, sexual selection, mutation theory,isolation theory.	2	3

3.2	**Origin of life** Abiogenesis, Biogenesis experiment of Miller (1953).	2	3
	Theory of Organic evolution – Biochemical origin of life, place and time of origin and experimental evidences. Concept of Oparin and Haldane	2	3
3.3	**Evidences for evolution** Morphology and Comparative anatomy – Embryology, Physiology and Biochemistry, Palaentology, Biogeography.	3	3
	Evolutionary time scale: eras, periods and epochs.	2	3
	Stages in primate evolution including *Homo*.	1	3
3.4	**Mutation as an evolutionary force** Mutation and genetic divergence; Evolutionary significance of mutations, genetic assimilations (Baldwin effect), genetic homoeostasis.	3	3
3.5	**Speciation** Genetic drift - Salient features; species concept; subspecies, sibling species, semi species, demes. Types of speciation - Phyletic speciation and True speciation. Mechanism of speciation - Genetic divergences and isolating mechanisms.	3	3
	Patternsof speciation – allopatric, sympatric, quantum and parapatric speciation.	2	3
4.0	**Theories of Evolution**	**5**	**4**
4.1	Lamarckism and Neo-Lamarckism, Darwinism and Neo-Darwinism; Mutation theory of De-Vries and the modern mutation theory.	2	4
4.2	**Modern theories of evolution** Modern synthetic theory of evolution, molecular evolution, concepts of natural evolution, molecular divergence and molecular clocks; molecular tools in phylogeny, Plant evolution.	3	4
5.0	**Developmental Biology**	**18**	**5**
5.1	**Basic concepts of developmental Biology:** An overview of plant and animal development, Potency, Commitment, Specification, Induction, Competence, Determination and Differentiation; Morphogenetic gradients, Cell-fate and Cell lineages, Stem cells,	2	5
	Genomic equivalence and the cytoplasmic determinants, Imprinting. Mutants and transgenics in analysis of development .	1	5
5.2	**Development in flowering plants:** Angiosperm life cycle. Anther: Structure and development, microsporogenesis, male gametophyte development.	2	5

	Palynology: Pollen morphology, exine sculpturing, pollen kit, NPC formula. Applications of palynology - palynology in relation to taxonomy. Viability of pollen grains.Pollination, pollen germination, growth and nutrition of pollen tube.	2	5
	Ovule: Structure, ontogeny and types. Megasporogenesis. Embryosac– development, types, ultrastructure, and nutrition of embryosac. Female gametophyte development. Fertilization: Double fertilization; embryo development - different types .	3	5
	Endosperm development, types of endosperm, haustorial behavior of endosperm . Xenia and metaxenia.	2	5
	Polyembryony – types and causes . Seed formation, dormancy and germination. Apomixis, Parthenogenesis.	2	5
5.3	**Morphogenesis and organogenesis in plants:** Shoot and root development. Leaf development and Phyllotaxy. Transition to flowering, floral meristems and floral development	2	5
	Homeotic genes in plants. Senescence, programmed cell death and hypersensitive response in plants.	2	5

References – Gymnosperms

1. Andrews H N Jr (1961). *Studies in Palaeobotany*. John Wiley and sons.
2. Arnold C A (1947). *An introduction to Palaeobotany*. John Wiley and sons.
3. Beck C E (1995). *Gymnosperm Phylogeny*. Bot. Rev. 51-176.
4. Bhatnagar S P, Moitra A (2000). *Gymnosperms*. New Age International Ltd.
5. Chamberlain C J (1935). *Gymnosperms: Structure and Evolution*. University of Chicago Press.
6. Meyen S V (1984). *Basic features of Gymnosperms' Systematics and Phylogeny as evidenced by theFossil Record*. Bot. Rev.
7. Sharma O P, S Dixit (2002). *Gymnosperms*. Pragati Prakashan.
8. Sporne A R (1974). *The morphology of gymnosperms*. Hutchinson Univ. Library.
9. Biswas C. *The Gymnosperms*. Today and Tomorrows print.
10. Coulter J M, Chamberlain C J (1977). *Morphology of Gymnosperms*. University
of Chicago Press.

11. Dallimore W, A B Jackson (1964). *A Handbook of Coniferae and Ginkgoaceae* (IV Edn). Edward Arnold & Co.
12. Delevoryas T (1962). *Morphology and evolution of Fossil Plants*. Holt, Rinehart
and Winston.

References – Evolution

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

References – Developmental Biology

1. Scott F Gilbert (2000). *Developmental Bilogy* (IX Edn). Sinauer Associates. (available online).
2. R M Twyman (2001). *Instant notes in Developmental Biology*. Viva Books Private Limited.
3. Lincoln Taiz, Eduardo Zeiger (2002). *Plant physiology* (II Edn). Sinaeur Associates, Inc. Publishers.
4. Robert J Brooker (2009). *Genetics: analysis & principles* (III Edn.). McGraw Hill
5. Bob B Buchanan, Wilhelm Gruissem, Russel L Jones (2000). *Biochemistry and Molecular biology ofPlants*. L K International Pvt. Ltd.
6. Scott F Gilbert (2000). *Developmental Bilogy* (VIII Edn). Sinauer Associates.
7. S S Bhojwani, S P Bhatnagar (1999). *The Embryology of Angiosperms* (IV Edn).
Vikas Publishing House Pvt Ltd.
8. Maheswari P (1950). *An introduction to the embryology of Angiosperms*. McGraw
Hill.

Course	Details				
Code	BY1922106				
Title	**CELL AND MOLECULAR BIOLOGY**				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	1/II				
Type	Core Course				
Credits	4	Hrs/Week	4	Total Hours	72

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the structure of intracellular compartments, cell communication and signalling, life cycle and cytoskeleton of the cell	U	1,2
2	Explain the structure of nucleic acids and chromosomes.	U	2
3	Build the knowledge about DNA replication, repair and recombination	Ap	2,4
4	Recognize, compare and distinguish the processes and mechanisms involved in Transcription and Translation.	E	2,4
5	Analyse and assess the regulation of gene expression in Viral, Prokaryotic and Eukaryotic systems.	C	3,5,6

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Cell Biology**	**21**	**1**
1.1	**Intracellular compartments in eukaryotic cells** Major intracellular compartments in eukaryotic cells (brief study only) . Genetic systems in mitochondria and chloroplast, endosymbiont hypothesison the evolution of mitochondria and chloroplast	3	1
	Structural organization of cell membranes:Chemical composition; structure and function of membrane	3	1

1.2	**Cell communication and Cell signaling** Cell communication: general principles. Signaling molecules and their receptors . Receptors: Cell surface receptors – ion-channel linked receptors, G-protein coupled receptors,	3	1
	Tyrosine-kinase linked receptors (RTK), Steroid hormone receptors. Signal transduction pathways ,Second messengers, Regulation of signaling pathways .	3	1
1.3	**Life cycle of the cell** Cell growth and division. Phases of cell cycle, cell cycle control system; extracellular and intracellular signals. Cell cycle checkpoints – DNA damage checkpoint, centrosome duplication checkpoint, spindle assembly checkpoint. Cyclins and Cyclin-dependent kinases. Regulation of plant cellcycle.	3	1
	Cell division – mitosis and meiosis (brief study only). Significance of meiosis in generating genetic variation. Programmed cell death – molecular mechanism and control .	3	1
1.4	**Cytoskeleton** Functions of cytoskeleton; Structure, assembly, disassembly and regulation of filaments involved – actin filaments (microfilaments), microtubules, and intermediate filaments. Molecular motors– kinesins, dyneins, myosins .	3	1
2.0	**Genetic material and Molecular structure.**	**11**	**2**
2.1	**Genetic material and its molecular structure** Identification of DNA as genetic material: Transformation experiment, Hershey Chase experiment. RNA as the genetic material in some viruses. Important features of Watson and Crick model of DNA structure, Chargaff's rules, preferred tautomeric forms of bases.	3	2
	Alternative conformations of DNA – type(s) of right handed and left handed helices , circular and linear DNA, single-stranded DNA. Structure and function of different types of RNA - mRNA, tRNA, rRNA, SnRNA, and Micro RNA. Ribozymes – Hammerhead ribozyme	3	2
2.2	**Genome and chromosome organization in eucaryotes** c-value paradox, DNA renaturation kinetics, Tm, Cot curve. Unique and Repetitive DNA – mini- and microsatellites. Structure of chromatin and chromosomes - histones and nonhistone proteins , nucleosomal organization of chromatin, higher levels of chromatin structure.	3	2
	Heterochromatin and Euchromatin, formation of heterochromatin . Chromosomal packing andstructure of metaphase chromosome. Molecular structure of the Centromere and Telomere	2	2
3.0	**DNA replication, Repair and Recombination**	**10**	**3**

3.1	**DNA replication** Unit of replication, enzymes and proteins involved in replication (in both procaryotes and eucaryotes). Structure of the replication origin (in both procaryotes and eucaryotes), priming (in both procaryotes and eucaryotes), replication fork, fidelity of replication .	3	3
	Process of replication – initiation, elongation and termination. Replication in the telomere – telomerase	2	3
3.2	**DNA repair mechanisms**: Direct repair, excision repair – base excision repair and nucleotide excision repair (NER), Mismatch repair,Recombination repair – homologous recombination repair, non homologous end joining, SOS response –Transletion DNA polymerase	3	3
3.3	**Recombination**: Homologous and nonhomologous recombination, molecular mechanism of homologous recombination. Site-specific recombination, transposition – types of transposons.	2	3
4.0	**Gene Expresssion**	**20**	**4**
4.1	**Gene**: Concept of gene; structural and genetic definitions – complementation test.Transcription in procaryotes: Initiation – promoter structure, structure of RNA polymerase, structure and role of sigma factors. Elongation – elongation complex, process of RNA synthesis. Termination – rho-dependent and rho-independent termination .	3	4
4.2	**Transcription in eucaryotes**: Types, structure and roles of RNA polymerases. Promoters – important features of class I, II, & III promoters. Enhancers and silencers. General transcription factors and formation of pre-initiation complex. Elongation factors, structure and function of transcription factors	3	4
4.3	**Post-transcriptional events:** Split genes, splicing signals, splicing mechanisms of group I, II, III, and tRNA introns. Alternative splicing, exon shuffling,*cis*and*trans*splicing. Structure, formation and functions of 5' cap and 3' tail of mRNA, RNA editing, mRNA export.	3	4
4.4	**Translation**: Important features of mRNA – ORF, RBS. Fine structure, composition and assembly of procaryotic and eukaryotic ribosomes. tRNA charging, initiator tRNA.	3	4
4.5	**Stages in translation**: Initiation – formation of initiation complex in procaryotes and eucaryotes, initiation factors in procaryotes and eucaryotes, Kozak sequence. Elongation – process of polypeptide synthesis, active centers in ribosome - 3-site model, peptidyl	3	4

	transferase, elongation factors. Termination – process of termination, release factors, ribosome recycling.		
4.6	**Genetic code**: Cracking the genetic code – simulation synthetic polynucleotides and mixed copolymers, synthetic triplets. Important features of the genetic code, proof for the triplet code, Exceptions to the standard code.	2	4
4.7	**Protein sorting and translocation**: Cotranslational and posttranslational – signal sequences, SRP, translocon. Membrane insertion of proteins. Post-translational modification of proteins. Protein folding – self assembly, role of chaperones in protein assembly.	3	4
5.0	**Control of Gene expression**	**10**	**5**
5.1	**Viral system**: Genetic control of lytic and lysogenic growth in λ phage, lytic cascade.	2	5
5.2	**Procaryotic system**: Transcription switches, transcription regulators. Regulation of transcription initiation; Regulatory proteins - activators and repressors. Structure of *Lac* operator, CAP and repressor control of *lac* genes. Regulation after transcription initiation – regulation of amino acid biosynthetic operons - attenuation of trp operon, riboswitches.	3	5
5.3	**Eucaryotic system:** Changes in chromatin and DNA structure – chromatin compaction, transcriptional activators and repressors involved in chromatin remodelling, gene amplification, gene rearrangement, alternate splicing, gene silencing by heterochromatization, and DNA methylation.	3	5
	Effect of regulatory transcription factors on transcription. Post-transcriptional control – mRNA stability, RNA interference, microRNA. Role of small RNA in heterochromatization and gene silencing	2	5

Text Books for Reference

1. Wayne M Becker, Lewis J Kleinsmith, Jeff Hardin (2007). *The world of the cell* (VI Edn). Pearson.
2. Geoffrey M Cooper, Robert E Hausman (2009). *The Cell: A molecular approach* (V Edn). Sinaeur.
3. Gerald Karp (2008). *Cell and Molecular biology: Concepts and experiments* (V Edn). John Wiley & Sons.
4. Harvey Lodish, Arnold Berk, Lawrence Zipursky, Paul Matsudaira, David Baltimore, James Darnell (2000). *Molecular cell biology* (IV Edn). W H Freeman & Company.
5. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2002). *Molecular biology of the cell* (IV Edn). Garland Science, Taylor and Francis group.
6. Robert J Brooker (2009). *Genetics: analysis and principles* (III Edn). McGraw Hill.

7. Jocelyn E Krebs, Elliott S Goldstein, Stephen T Kilpatrick (2011). *Lewin's Genes X*. Jones and Bartlett Publishers.
8. Bob B Buchanan, Wilhelm Gruissem, Russel L Jones (2000). *Biochemistry and Molecular biology ofplants*. I K International Pvt. Ltd.
9. Daniel L Hartl, Elizabeth W Jones (2012). *Genetics: Analysis of genes and genomes* (VII Edn). Jones and Bartlett publishers.
10. James D Watson, Tania A Baker, Stephen P Bell, Alexander Gann, Michael Levine, Richard Losick (2009). *Molecular biology of the gene* (V Edn). Pearson.
11. William S Klug, Michael R Cummings (2004). *Concepts of Genetics* (VII Edn). Pearson.
12. Daniel J Fairbanks, W Ralph Anderson (1999). *Genetics: The continuity of life*. Brooks/Cole publishing company.
13. Robert F Weaver (2002). *Molecular biology* (II Edn). McGraw Hill.
14. Bruce Alberts, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2010). *Essential Cell Biology*. Garland Science.
15. Leland H Hartwell, Leroy Hood, Michael L Goldberg, Ann E Reynolds, Lee M Silver, Ruth C Veres (2004). *Genetics from genes to genomes* (II Edn). McGraw Hill.
16. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira (2007). *Molecular cell biology* (VI Edn). W H Freeman & Company.
17. James D. Watson, Amy A. Caudy, Richard M. Myers, Jan A. Witkowski (2007). *Recombinant DNA* (III Edn). W H Freeman.
18. William H Elliott, Daphne C Elliott (2001). *Biochemistry and molecular biology* (II Edn). Oxford.
19. Jeremy M Berg, John L Tymoczko, Lubert Stryer, Gregory J Gatto Jr. (2007). *Biochemistry*. W H Freeman & company.
20. David P Clark (2010). *Molecular biology*. Elsevier.
21. David R Hyde (2010). *Genetics and molecular biology*. Tata McGraw Hill.
22. D Peter Snustad, Michael J Simmons (2010). *Principles of genetics* (V Edn). John Wiley and Sons.
23. David A Micklos, Greg A Freyer with David A Crotty (2003). *DNA Science: A first course* (II Edn). L K Inter.
24. Benjamin A Pierce (2008). *Genetics: A conceptual approach* (IV Edn). W H Freeman and Company.
25. Anthony J F Griffiths, Susan R Wesler, Sean B Carroll, John Doebley (2012). *Introduction togenetic analysis*. W H Freeman & Company.
26. T A Brown (2002). *Genomes* (II Edn). Bios.
27. Robert H Tamarin (2002). *Principles of genetics*. McGraw Hill.
28. David E Sadava (2009). *Cell biology: Organelle structure and function*. CBS.
29. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2010). *Essential Cell Biology* (III Edn.). Garland Science.
30. Pranav Kumar, Usha Mina (2011). *Biotechnology: A problem approach*. Pathfinder Academy.
31. Burton E Tropp (2012). *Molecular biology: Genes to Proteins* (IV Edn). Jones and Bartlett Learning.
32. Lynne Cassimeris, Viswanath R Lingappa, George Plopper (Eds) (2011). *Lewin's Cells* (II Edn). Jones and Bartlett Publishers.

Course	Details				
Code	BY1922107				
Title	**PLANT ANATOMY AND PRINCIPLES OF ANGIOSPERM SYSTEMATIC**				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	1/II				
Type	Core Course				
Credits	4	**Hrs/Week**	4	**Total Hours**	72

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the scope & importance of Anatomy and make connections between plant anatomy and the other major disciplines of biology.	An	1,2
2	Identify and compare structural differences among different taxa of vascular plants.	An	2,3
3	Illustrate the role of anatomy, cytology, Phytochemistry and molecular Taxonomy.	Ap	4,5,6
4	Trace the history of development of systems of classification emphasizing angiospermic taxa.	E	4
5	Understand various rules, principles and recommendations of plant nomenclature.	E	2,3,4

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
	PLANT ANATOMY	**36**	
1.0	**Introduction to anatomy**	**8**	
1.1	Scope and significance of plant anatomy, interdisciplinary relations.	1	1,2
1.2	Apical organization: Stages of development of primary meristem and theories of apical organization, origin of branches and lateral roots.	2	2,3
1.3	Primary thickening meristem (PTM) in monocots. Reproductive apex in angiosperms.	2	1,2
1.4	Secretory tissues in plants: Structure and distribution of secretory trichomes (*Drocera, Nepenthes*), salt glands, colleters, nectaries, resin ducts and laticifers.	2	1,2
1.5	Structure of bark and distribution pattern of laticifers in *Hevea brasiliensis.*	1	1,2
2.0	**Secondary structure development and characters**	**16**	
2.1	Vascular cambium and cork cambium: Structure and function, factors affecting cambial activity.	2	2

2.2	Secondary xylem and phloem: Ontogeny, structure and function. Lignification patterns of xylem.	2	2
2.3	Reaction wood: Compression wood and tension wood. Factors affecting reaction wood formation.	1	3
2.4	Anomalous secondary growth in dicots and monocots.	2	3
2.5	Wood: Physical, chemical and mechanical properties.	1	3
2.6	Plant fibers: Distribution, structure and commercial importance of coir, jute, and cotton.	2	3
2.7	Leaf: Initiation, plastochronic changes, ontogeny and structure of leaf. Structure, development and classification of stomata and trichomes. Krantz anatomy, anatomical peculiarities in CAM plants. Leaf abscission.	2	3
2.8	Nodal anatomy: Unilacunar, trilacunar and multilacunar nodes, nodal evolution.	2	3
2.9	Root-stem transition in angiosperms.	2	3
3.0	**Reproductive anatomy**	**12**	**1,3,4**
3.1	Floral Anatomy: Anatomy of floral parts - sepal, petal, stamen and carpel	1	1,3,4
3.2	Floral vasculature (*Aquilegia and Pyrola*). Vascular anatomy. Development of epigynous ovary - appendicular and receptacular theory.	2	,1,3,4
3.3	Fruit and seed anatomy: Anatomy of fleshy and dry fruits - follicle, legume, berry.	2	1,2,3
3.4	Dehiscence of fruits. Structure of seeds. Anatomical factors responsible for seed dormancy and drought resistance.	2	1,3,4
3.5	**Ecological anatomy** Morphological and structural adaptations in different ecological groups - hydrophytes, xerophytes, epiphytes and halophytes.	3	1,3,4
3.6	**Applied anatomy** Applications of anatomy in systematics (histotaxonomy) and Pharmacognosy.	1	1,3,4
	Research prospects in anatomy.	1	1
	PRINCIPLES OF ANGIOSPERM SYSTEMATICS	**36**	**3,4**
4.0	**Basic Concepts of Taxonomy and Phylogeny of Angiosperms**	**10**	**3,4**
4.1	**Scope and significance of Taxonomy** Historical background of classification - Artificial, natural and phylogenetic systems.	1	3,4
	Importance of taxonomy.	1	3,4

4.2	**Concepts of Taxonomic hierarchy** Species/Genus/Family and other categories; species concept and intraspecific categories - subspecies, varieties and forms.	2	3
4.3	**Phylogeny of Angiosperms** Important phylogenetic terms and concepts: Plesiomorphic and Apomorphic characters	2	3
	Homology and Analogy; Parallelism and Convergence; Monophyly, Paraphyly and Polyphyly	2	3
	Phylogenetic tree - Cladogram and Phenogram.	2	3
5.0	**Data sources of Taxonomy**	**26**	**2,3,4**
5.1	Concepts of character	2	2,3,4
	Sources of taxonomic characters - Anatomy, Cytology, Phytochemistry and molecular taxonomy.	2	2,3,4
5.2	**Concept and principles of assessing relationships** Phenetic - Numerical Taxonomy - principles and methods	2	2,4
	Cladistic - Principles and methods.	2	2,3,4
5.3	**Botanical nomenclature** History of ICBN, Aims and principles	3	2,3,4
	Rules and recommendations: rule of priority, typification, author citation, retention, rejection and changing of names, effective and valid publication.	3	2,3,4
5.4	**Synthetic approaches to the systematics of angiosperms** Chemotaxonomy	2	2,3,4
	Basic concepts of genome analysis – bar coding.	2	2,3,4,
5.5	**Morphology of Angiosperms** Habitat and habit	2	2,3,4
	Morphology of root, stem, leaf, bract and bracteoles	3	2,3,4
	Inflorescence, flowers, fruits and seeds.	3	2,3,4

References- Plant Anatomy

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

13. Kuriachen P M, Dave P Thomas V, Mercymol Sebastian (1992). *SEM studies on seed surface ofsome Asclepiadaceae with taxonomic significance*. Geophytology.
14. Metcalf C R, Chalk L (1950). *Anatomy of Dicotyledons and Monocotyledons*.
15. Metcalf C R, Chalk L (1983). *Anatomy of the dicotyledons: Wood structure and conclusion of thegeneral introduction*. Oxford University press.
16. Pandey B P. *Plant Anatomy*. S Chand and Co.
17. Reghu C P (2002). *Structural features of Rubber wood*. Rubberwood Processing and utilization in India.Ganesh Publications, Bangalore.
18. Reghu C P, George B P, YA Varghese (2007). *Screening of Hevea germplasm for wood qualityusing Cinnamyl Alcohol Dehydrogenase (CAD) activity and lignifications pattern*. Natural RubberResearch, 20 (1&2): 1-7.
19. Sherwin John Carlquist (2001). *Comparative wood anatomy: Systematic, ecological, andevolutionary aspects of dicotyledon wood*.
20. Tharian George K, Reghu C P, Nehru CR (2000). *By-products and ancillary sources of income*. Natural Rubber: Agro management and Crop Processing, Rubber Research Institute of India, Kottayam. 507-510
21. Vasishta P C (1994). *Plant anatomy*. Pradeep publications.
22. Wardrop A B (1961). *The structure and formation of reaction wood in Angiosperm: Problems oftree physiology*. Recent advances in Botany (Vol II). University of Toronto press.
23. Wardrop A B (1964). *Reaction wood Anatomy in Arborescent angiosperms*. Formation of wood in forest trees (Ed, Zimmerman). Academic press, New York.

Reference- Principles of Angiosperm Systematics

1. Lawrence George H M (1951). *Taxonomy of vascular plants*. Oxford and IBH Publ. Co. Pvt. Ltd.
2. Jeffrey C (1968). *An Introduction to principles of Plant Taxonomy*.
3. Cole A J (1969). *Numerical Taxonomy*. Academic Press.
4. Davis P H, Heywood V M (1973). *Principles of Angiosperm Taxonomy*. Robert E Kereiger Publ.
5. Harrison H J (1971). *New Concepts in Flowering Plant Taxonomy*. Heiman Educational Books Ltd.
6. Cronquist A (1981). *An Integrated system of classifications of flowering plants*. Columbia University Press.
7. Heywood V H, D M Moore (Eds) (1984). *Current concept in Plant Taxonomy*.
8. Naik V V (1984). *Taxonomy of Angiosperms*. Tata McGraw Hill Publ. Co. Ltd.
9. Radford A E (1986). *Fundamentals of Plant Systematics*. Harper & Row Publ.
10. Davis P H, V H Heywood (1991). *Principles of Angiosperm Taxonomy*. Today and Tomorrow Publications.
11. Stace C A (1989). *Plant Taxonomy and Biosystematics*. Etwaed Arnold.
12. Woodland D W (1991). *Contemporary Plant Systematics*. Prentice Hall.
13. Sivarajan V V (1991*). Introduction to Principles of Plant Taxonomy*. Oxford IBH.
14. Takhtajan A L (1997). *Diversity and Classification of Flowering Plants*. Columbia Univ. Pres

Course	Details				
Code	BY1922108				
Title	**GENETICS AND BIOCHEMISTRY**				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	1/II				
Type	Core Course				
Credits	3	**Hrs/Week**	3	**Total Hours**	54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the basics of gene interactions and linkage	U	1,2
2	Impart the knowledge of human genetics and cancer	E	2,4,5
3	Comprehend the concepts involved in population genetics	E	2,3,4
4	Understand the structure, function and metabolism of biomolecules in plants	E	1,2,3
5	Understand the various aspects of enzymes and its mechanism of action	E	4,5,6

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
	GENETICS	**18**	
1.0	**Genetics - From "Factors" to "Genes" and gene interactions**	**4**	**1**
1.1	Introduction to Mendelian genetics and principles of inheritance; Extensions of Mendelism (Brief study).	1	1
1.2	Linkage, crossing over and Chromosome mapping in eukaryotes	2	1
1.3	Cytoplasmic inheritance, Multiple alleles,quantitative inheritance, QTL; Sex determination in plants and animals, X-chromosome inactivation in mammals – dosage compensation	1	1
2.0	**Human Genetics and Cancer**	**9**	**2**
2.1	Inheritance of traits in Humans - Pedigree analysis,	2	2

	Genetic disorders in humans - autosomal recessive - ADA deficiency, Sickle cell anemia; autosomal dominant - Huntington's chorea, familial hypercholesterolemia; inborn errors of metabolism - phenylketonuria, Alkaptonuria, Albinism.	3	2
2.2	Cancer - a genetic disease; Cancer and cell cycle, oncogenes, chromosome rearrangements and cancer,	2	2
	Tumour suppressor genes, causes of cancer, properties of cancer cells, types of cancer	2	2
3.0	**Population Genetics**	**5**	**3**
3.1	Emergence of evolutionary theory and population genetics; Concepts in population genetics - Gene pool, Gene frequency, genotype frequency	2	3
	Hardy Weinberg's Law and its applications; Exceptions to Hardy-Weinberg's Principle; Factors affecting gene frequency - Mutation, selection, migration, natural selection and Genetic drift (Bottle neck effect and Founder effect).	3	3
	BIOCHEMISTRY	**36**	
4.0	**Structure, function and synthesis of biomolecules**	**22**	**4**
4.1	**Introduction** Acid and Bases, ionisation of water, dissociation of acids, Henderson-Hasselbalch equation, pKa. Buffers - Common buffers (acetate, citrate and phosphate), buffer action, buffer capacity. Measurement of pH.	2	4
4.2	**Carbohydrates** General structure and biological importance of carbohydrates. Monosaccharids and Oligosaccharides - classification and structure with common examples.	2	4
	Polysaccharides: Classification, structure and functions - starch, cellulose. Glycoproteins and glycolipids.	2	4
4.3	**Lipids** Classification, important biological functions. Structure of fatty acids, triglycerides, waxes, Phosphoglycerides and Sterols. Lipids with biological specific activities – steroids and isoprenoids.	3	4
	Lipid metabolism in oilseeds – Oxidation of fatty acids, glyoxylate cycle, gluconeogenesis.	2	4
4.4	**Amino acids and proteins** Classification and structure of aminoacids, peptide bond. Structure and functions of protein – primary, secondary, tertiary and quaternary structure.	3	4
	Ramachandran plot, alpha helix and beta conformations. Protein degradation in cells (brief account).	2	4
4.5	**Nucleic acid and nucleotide metabolism**	2	4

	Functions of nucleotides, nucleotide biosynthesis by *de novo* pathways and salvage pathways		
4.6	**Secondary metabolites** Classification	2	4
	Biosynthesis and functions of terpenoids, alkaloids and phenolics.	2	4
5.0	**Enzymes**	**14**	**5**
5.1	Principles of catalysis: Activation energy of a reaction General characters of enzymes - specificity, catalytic power, regulation. IUB system of enzyme classification and naming.	2	5
5.2	Mechanism of enzyme activity: Formation of ES complex, acid-base catalysis, covalent catalysis, metal ion catalysis, proximity and orientation effect, strain and distortion theory Factors affecting enzyme activity	2	5
5.3	Enzyme Kinetics: Michaelis-Menton kinetics, Lineweaver-Burk plot Mechanism of multi substrate reaction – Ping Pong, Bi-Bi mechanism	2	5
5.4	Regulation of enzyme activity: Allosteric effect, control proteins, reversible covalent modification, proteolytic activation Enzyme inhibition – reversible and irreversible inhibition, competitive, non-competitive, uncompetitive inhibition , dixon plot	3	5
5.5	Cofactors and coenzymes: Essential ions, Coenzymes; structure and role of metabolite coenzymes – ATP; structure and role of vitamin derived coenzymes – NAD^+, $NADP^+$, FAD, FMN, TPP, PLP, Biotin , Isozymes (2)..Abzymes.	3	5
5.6	Enzyme technology - isolation and purification of enzymesmodifying enzymes for stability (brief study)	2	5

Text Books for Reference

1. Benjamin Lewin (2000). *Genes VII*. Oxford university press.
2. Gardner E J, Simmons M J, Snustad D P (1991). *Principles of Genetics* (III Edn). John Wiley and Sons Inc.
3. Strickberger (2005). *Genetics* (III Edn). Prentice Hall of India Pvt. Ltd.
4. William S Klug, Michael R Cummings (1994). *Concepts of Genetics*. Prentice Hall.
5. Robert J Brooker (2009). *Genetics: Analysis and principles* (III Edn). McGraw Hill.

6. Daniel L Hartl, Elizabeth W Jones (2009). *Genetics: Analysis of genes and genomes* (VII Edn). Jones and Bartlett publishers.
7. D Peter Snustad, Michael J Simmons (2010). *Principles of genetics* (V Edn). John Wiley and Sons.
8. Arti Nigam, ArchnaAyyagari. Lab Manual in Biochemistry Immunology and Biotechnology (2007) Tata McGraw Hill Pvt. Ltd.
9. Bob B Buchanan, Wilhelm Gruissen and Russel L. Jones (2000). Biochemistry and Molecular Biology of plants. IK International Pvt. Ltd.
10. Donald Voet, Judith Voet (2011) Biochemistry. John Wiley and sons Inc.
11. David L Nelson and Michael M Cox. Principles of Biochemistry
12. David T Plummer (1998) An Introduction to practical Biochemistry
13. Keshav Trehan Biochemistry. New Age International.
14. Sadasivam S and Manickan. Biochemical Methods. New Age International.
15. Satyanarayana U and Chakrapani U Biochemistry (2011).
16. Rastogi S C Biochemistry (2010) Tata McGraw Hill

Course	Details				
Code	BY1922603				
Title	GYMNOSPERMS, EVOLUTION AND DEVELOPMENTAL BIOLOGY & CELL AND MOLECULAR BIOLOGY				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	1/II				
Type	Core Practical				
Credits	4	Hrs/Week	5	Total Hours	81

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Examine the classification, distribution, morphology, anatomy, reproduction and life cycle of Gymnosperms types mentioned in the syllabus	Ap	1
2	Build knowledge about basic concepts of Developmental Biology	U	3
3	Understand and observe the various stages of meiosis	An	3
4	Understand the types of giant chromosomes	U	3
5	Workout problems based on molecular biology	C	4

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
	PRACTICALS		
1.0	**GYMNOSPERMS**	**27**	**1**
1.1	Study of the morphology and anatomy of vegetative and reproductive parts of Cycas, Zamia, Pinus, Cupressus, Agathis, Araucaria and Gnetum.	21	1
1.2	Study of fossil gymnosperms through specimens and permanent slides.	3	1
1.3	Conduct field trips to familiarise various gymnosperms in nature and field identification of Indian gymnosperms and submit a report.	3	1
	PRACTICALS		
2.0	**DEVELOPMENTAL BIOLOGY**	**18**	**2**
2.1	Study of pollen morphology.	3	2
2.2	Embryo excision from young seeds.	3	2
2.3	Pollen germination study.	3	2
2.4	Identification of different types of embryos,	9	2

	polyembryony, endosperm types,types of pollen grains, anther growth stages and types using permanent slides.		
3.0	**CELL AND MOLECULAR BIOLOGY**	**36**	
3.1	Study of meiosis in *Rhoeo*/*Chlorophytum* by smear preparation of PMCs.	14	3
3.2	Study of giant chromosomes in Drosophila/Chironomus.	4	4
3.3	Work out problems based on DNA structure, replication, gene expression and genetic code	18	5

Course	Details				
Code	BY1922604				
Title	**PLANT ANATOMY AND PRINCIPLES OF ANGIOSPERM SYSTEMATICS & GENETICS AND BIOCHEMISTRY**				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	1/II				
Type	Core Practical				
Credits	4	**Hrs/Week**	5	**Total Hours**	99

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the anatomical peculiarities of plants	U	1
2	Percieve the knowledge about Morphology and Development of Reproductive Parts.	An	1,3
3	Familiarize and workout nomenclatural problems and author citations.	C	3,4,6
4	Understand and workout problems related to genetics	Ap	3, 4
5	Devise methods and tests to improve basic skills and techniques related to biochemistry	An	3, 6
6	Understand and apply the quantitative and qualitative analysis of biochemicals	C	4, 6

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

	PRACTICALS		**CO.No.**
1.0	**PLANT ANATOMY**	**36**	1
1.1	Study of cambia - non storied and storied.	2	1
1.2	Study the anomalous primary and secondary features in, *Amaranthus, Boerhaavia,Mirabilis*, *Nyctanthes*, *Piper* and *Strychnos.*	10	1
1.3	Study of stomata, trichomes, and laticifers. Determination of stomatal index.	4	1
1.4	Study the anatomical peculiarities of C4 and CAM plants (Leaf/Stem).	4	1
1.5	Study of nodal patterns.	4	1
1.6	Prepare a histotaxonomic key.	4	1
1.7	Study the pericarp anatomy of a legume, follicle and	4	1

	berry.		
1.8	Identification of wood - soft wood and hard wood	4	1
2.0	**PRINCIPLES OF ANGIOSPERM SYSTEMATICS**	**27**	
2.1	Morphology of leaf: Leaf attachment, Stipules, Patterns of leaf, Phyllotaxy, Shapes of leaf lamina, bases, margins and tips, Venation.	2	3
2.2	Inflorescence: Racemose - Simple raceme, Compound raceme, Spike, Spikelet, Catkin, Spadix, Corymb, Simple umbel, Compound umbel, Panicle, Capitulum. Cymose - Solitary cyme, Mono-, Di-and polychasial cyme. Special types - Cyathium, Verticillaster, Hypanthodium, Coenanthium.	2	2
2.3	Morphology of stamens: Mono-, Di- and Polyadelphous; Epipetalous, Syngenesious, Synandrous, Polyandrous, Didynamous, Tetradynamous, Basifixed, Dorsifixed, Versatile.	2	2
2.4	Morphology of carpels: Apocarpous, Syncarpous, Gynostegium. Placentation - Marginal, Parietal, Axile, Free central, Basal and Pendulous.	2	2
2.5	Morphology of fruits: Berry, Drupe, Hesperidium, Pepo, Balausta, Amphisarca, Achene, Follicle, Capsule, Legume, Lomentum, Nut, Caryopsis, Cypsela, Samara, Cremocarp, Siliqua, Carcerule, Regma. Aggregate fruits; Composite fruits - Sorosis and Syconus; Pome.	2	2
2.6	Workout plant specimens collected locally for vegetative and reproductive characters.	10	2
2.7	Workout nomenclatural problems regarding priority and author citations.	7	3
3.0	**GENETICS**:	**18**	
3.1	Workout problems related to linkage, crossing over and gene mapping, human pedigree analysis, Cytoplasmic Inheritance, Multiple alleles and quantitative inheritance.	9	4
3.2	Work out problems in population genetics-gene and genotype frequency, Hardy-Weinberg equilibrium.	9	4
4.0	**BIOCHEMISTRY**:	**18**	
4.1	Preparation of buffers-Citrate and phosphate-various strengths.	2	5
4.2	Quantitative estimation of reducing sugar.	2	6
4.3	Separation of amino acids by TLC.	2	6
4.4	Quantitative estimation of protein (Lowry's method).	2	6
4.5	Preparation of Molar, Normal, Percentage and PPM solutions and their dilutions.	2	5
4.6	Estimation of peroxidase activity.	2	6
4.7	Estimation of catalase activity.	2	6
4.8	Estimation of total phenolics in plant tissue	2	6
4.9	Isolation and estimation of amylase from germinating seeds.	2	6

SEMESTER III

Course	Details				
Code	BY1923109				
Title	**RESEARCH METHODOLOGY, BIOPHYSICAL INSTRUMENTATION, BIOSTATISTICS AND MICROTECHNIQUE**				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	2/III				
Type	Core Course				
Credits	4	Hrs/Week	4	Total Hours	72

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand basic concepts of research and its methodologies	C	1,2,3
2	Organize and conduct research (advanced project) in a more appropriate manner	C	4,5
3	Understand principles and applications of instruments.	Ap	3,6
4	Recognize, compare and explain the correlation and regression & application of different methods, analysis of data and also learn how to write dissertation, thesis and research paper.	U	4,5,6
5	Able to make temporary microscopic slides, using different cutting techniques and permanent microscopic slides using paraffin method.	An	6

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
	RESEARCH METHODOLOGY	**18**	
1.0	**RESEARCH AND REVIEW OF LITERATURE**	**10**	**1,2,3**
1.1	**Introduction** Need for research, stages of research	1	1,2,3
1.2	Generation of a research problem, execution of work, interpretation of results.	1	1,2,3
1.3	**Review of literature** (a) Library: (i) Structure of a scientific library, journals (current and back volumes), books.	1	1,2,3
	(ii) Catalogue: Types of catalogues - Card catalogue, computerized catalogue	1	1,2,3
	(iii) Classification of books (Universal Decimal System).	1	1,2,3
	Journals: Indexing journals, abstracting journals, research journals, review journals, e-journals. Impact	2	1,2,3

	factor of journals, NCBI-Pub Med.		
	Other sources of references: (i) Reprints - acquisition and filing (ii) Secondary storage devices - pen drive, external hard drive, DVD and CD ROM (iii) Internet, open access initiative, INFLIBNET, INSDOC.	2	1,2,3
	Preparation of index cards: Author index and subject index; Open source bibliography management system.	1	1,2,3
2.0	**PREPARATION AND PRESENTATION OF RESEACH WORK**	**8**	**4,5**
2.1	**Preparation of project proposals** Title, Introduction, literature review and abstract (b) Aim and scope (c) Present status (d) Location of experiments (e) Materials and methods (f) Justification (g) Expected outcome (h) Date of commencement (g) Estimated date of completion (h) Estimated cost (i) References (j) Funding agencies.	2	4,5
2.2	**Presentation and publication of research outcomes** Preparation of a dissertation: (i) Consolidation and analysis of data, photographs, illustration, tables and graphs (ii) Preparation of the outline (iii) Preparation of manuscript - introduction, review of literature, materials and methods, results, discussion, bibliography (methods of citing references, arrangement of references), summary (iv) Preliminary pages - title page, certificates, acknowledgements, and contents page.	2	4,5
2.3	Preparation of research paper and short communications.	1	4,5
2.4	Preparation of review articles.	1	4,5
2.5	Proof reading - standard abbreviations for proof correction.	1	4,5
2.6	Presentation of research findings in seminars and workshops.	1	4,5
3.0	**BIOPHYSICAL INSTRUMENTATION:**	**18**	
3.1	**Microscopy** Parts of microscope, principles of microscopy.	2	3,6
3.2	Types of microscopes - simple and compound	2	3,6
	Stereo microscope, Phase contrast microscope, Fluorescence microscope, Polarization microscope, Confocal microscope and electron microscope (TEM, SEM and E-SEM).	3	3,6
	Micrometry, Photomicrography and microphotography.	1	3,6
3.3	**Principles and applications of instruments (10 hrs)** Basic principles and applications of; (i) pH meter (ii) UV-visible spectrophotometers (iii) Centrifuges (Table top centrifuge and ultra centrifuge).	3	3,6
3.4	Chromatography: Principles and application; paper, TLC, Column chromatography, GC, HPLC.	3	3,6
3.5	Immunoassay systems, ELISA - ELISA reader.	1	3,6
3.6	Electrophoresis: SDS PAGE.	1	3,6
3.7	X-ray crystallography.	1	3,6

3.8	Haemocytometer.	1	3,6
4.0	**BIOSTATISTICS**	**18**	**4,5,6**
4.1	**Basic principles of Biostatistics** Methods of collection and classification of data; Primary and secondary data, qualitative and quantitative data.	1	4,5,6
	Frequency distribution, graphical representation, normal distribution.	1	4,5,6
4.2	**Measures of central tendency** Mean, Median, Mode	3	4,5,6
4.3	**Measures of dispersion** Mean deviation, Standard deviation, variance, standard error, co-efficient of variation.	3	4,5,6
4.4 4.5	**Probability** Probability - Definition, mutually exclusive events – sum rule, independent events – product rule. Probability of unordered combination of events. **Tests of significance** Statistical inference – estimation - testing of hypothesis - t-test, Chi square test (goodness of fit, independence or association, detection of linkages), F-test, ANOVA.	2 3	4,5,6
4.6	**Correlation and Regression** Linear regression and correlation (simple and multiple).	2	4,5,6
4.7	**Design of experiments** Experimental designs: Principles - replication and randomization.	1	4,5,6
	Common designs in biological experiments: Completely randomized design, randomized block design, Latin square design, Factorial design.	2	4,5,6
5.0	**MICROTECHNIQUE**	**18**	**6**
5.1	**Killing and fixing** Principles and techniques of killing and fixing; properties of reagents, fixation images; properties and composition of important fixatives - Carnoy's Fluid, FAA, FPA, Chrome acetic acid fluids, Zirkle-Erliki fluid.	2	6
5.2	**Dehydration, clearing, embedding and sectioning**	1	6
	Dehydration: Principles of dehydration, properties and uses of important dehydrating and clearing agents - alcohols, acetone, xylol, glycerol, chloroform, dioxan.	2	6
	Dehydration Methods: (i) Tertiary-butyl alcohol method (ii) Alcohol-xylol method.	1	6
	Embedding: Paraffin embedding. Sectioning: Free hand sections – Prospects and problems; Sectioning in rotary microtome - sledge microtome and cryotome.	1	6

5.3	**Staining** Principles of staining; classification of stains, protocol for preparation of; (i) Natural stains - Haematoxylin and Carmine (ii) Coal tar dyes – Fast green, Orange G, Safranine, Crystal violet, Cotton Blue and Oil Red O. Techniques of staining: (i) Single staining; Staining with Safranine or crystal violet (ii) Double staining; Safranine-Fast green method, Safranine-Crystal violet method (iii) Triple staining; Safranine-Crystal violet-Orange G method.Histochemical localization of starch, protein, lipid and lignin.	3	6
5.4	**Specimen preparation for transmission electron microscopy** Material collection, fixing, dehydration, embedding, sectioning (glass knife preparation, grid preparation, ultra microtome) and staining.	3	6
5.5	**Whole mounts** Principles and techniques of whole mounting, TBA/Hygrobutol method, Glycerine-xylol method.	1	6
	Staining of whole mount materials (haematoxylin, fast green or Safranine-fast green combination). Significance of whole mounts.	2	6
	Techniques of smear, squash and maceration. Mounting: Techniques, common mounting media used - DPX, Canada balsam, Glycerine jelly and Lactophenol. Cleaning, labeling and storage of slides.	2	6

References- Research methodology

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

Reference- Principles of Biophysical Instrumentation

1. Ackerman E A, Ellis L E E, Williams L E (1979). *Biophysical Science*. Prentice-Hall Inc.
2. Chang R (1971). *Basic principles of spectroscopy*. McGraw Hill.
3. Pesce A J, Rosen C G, Pasty T L. *Fluorescence Spectroscopy: An introduction for Biology andMedicine*. Marcel Dakar.
4. Stanford J R (1975). *Foundation of Biophysics*. Academic press.
5. Henry B Bull (1971). *An Introduction to physical biochemistry*. F A Devis Co.
6. Perkampus H (1992). *UV-VIS Spectroscopy and its applications*. Springer-Verlag.
7. Garry D Christian, James E O'reilvy (1986). *Instrumentation analysis*. Alien and Bacon, Inc.
8. Friefelder D. *Physical Biochemistry*. W H Freeman and Co.
9. Mahadevan A, Sridhar R (1996). *Methods in Physiological Plant Pathology*. Sivakmi Publications.
10. Salle A J (1974). *Fundamental principles of Bacteriology*. McGraw Hill.

Reference- Principles of Biostatistics.

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

Reference- Principles of Microtechnique.

1. Johanson D A (1940). *Plant microtechnique*. McGraw Hill co.
2. John E Sass (1967). *Botanical Microtechnique*. Oxford IBH Publ. Company.
3. Gray (1964). *Handbook of Basic Microtechnique*. McGraw Hill co.
4. Prasad M K, M Krishna Prasad (1983). *Outlines of Microtechnique*. Emkay Publications.
5. Geoffrey A Meek (1976). *Practical electron microscopy*. John Willey and sons.
6. Krishnamurthy K V (1987). *Methods in Plant Histochemistry*. S Viswanathan printers, Anand book depot, Madras.
7. Toji Thomas (2005). *Essentials of botanical microtechnique* (II Edn). Apex infotech publishing company.

Course	Details				
Code	BY1923110				
Title	**PLANT PHYSIOLOGY AND PLANT BREEDING**				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	2/III				
Type	Core Course				
Credits	4	Hrs/Week	4	Total Hours	72

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the water relations, absorption and transport of minerals in plants	U	2
2	Perceive and compare the various aspects of plant metabolism	E	3,4
3	Understand and evaluate the various aspects of growth and development in plants	E	2,3,4
4	Familiarize the students with different aspects of plant breeding	E	1,2,3
5	Developing and designing the various methods of crop improvement	C	4,5,6
6	Develop basic skills and techniques for qualitative and qualitative analysis of physiological parameters	C	4,6

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Transport and translocation of water and solutes**	**13**	**1**
1.1	**Plant water relations** Water absorption by root, pathways of water uptake and transport, xylem and phloem transport, passive and active transport. Aquaporins.	3	1
	Water pathway in the leaf – driving force of transpiration, leaf anatomy for regulating transpiration. Control of stomatal mechanism. Soil-plant-atmosphere continuum	3	1
1.2	**Absorption of minerals** Soil characters influencing nutrient availability – size and charge of soil particles, soil pH. Mechanism of entry of minerals into roots;Role of Mycorrhizae in nutrient uptake.	2	1

1.3	**Transport of ions, solutes and macromolecules** Electrical properties of membranes, Membrane potential. Transport across cell membranes: Passive diffusion, facilitated diffusion, membrane channels; gap junctions, porins, ion channels – gated channels, structure and working of K^+ ion channels.	3	1
	Active transport: Carrier proteins; Na^+K^+ pump, ABC transporters.	2	1
2.0	**Plant Metabolism:**	**27**	**2**
2.1	**Photosynthesis:** Light harvesting complexes: PS I, PSII; Basic principles of light absorption, excitation energy transfer, mechanism of electron transport, photooxidation of water, proton electrochemical potential – photophosphorylation.	3	2
	Structure and function of RuBisco, CO_2 fixation – Calvin cycle, C4 cycle, CAM pathway.	3	2
	Synthesis of starch and sucrose, photosynthetic quantum yield and energy conversion efficiency. Photorespiration, role of photorespiration in plants.	3	2
	Transport of photoassimilates – phloem loading and unloading, mechanism of phloem translocation – pressure flow, Photoinhibition and its tolerance mechanism.	3	2
2.2	**Respiration:** Three stages of respiratory metabolism (brief study only).	3	2
	Plant mitochondrial electron transport and ATP synthesis – organization of electron transfer complexes (complex I – IV). ATPase (complex 5) – detailed structure of F1 and Fo subunits, binding change mechanism of ATP synthesis.	3	2
	Comparison of mitochondrial and chloroplast ATP synthesis.	2	2
	Cyanide resistant pathway - alternative oxidase, its regulation and significance. Rotenone insensitive pathway in plants.	2	2
2.3	**Nitrogen metabolism:** N cycle. N fixation processes. Biological N fixation – structure of nitrogenase complex, reduction of N. Symbiotic N fixation – nodule formation, nodulin gene and nodulation gene, leghaemoglobin.	3	2
	Nitrate and ammonium assimilation. Transport of amides and ureides.	2	2
3.0	**PLANT GROWTH AND DEVELOPMENT**	**14**	**3**
3.1	**Stress physiology** Response of plants to biotic (pathogen and insects) and abiotic (water, temperature – low and high, salt, oxygen deficiency) stresses.	3	3
	Mechanisms of resistance to biotic stress and tolerance to abiotic stress.	2	3
3.2	**Sensory photobiology** Plant photoreceptors: phytochromes, cryptochromes and phototropins.	2	3
	Photoperiodism and biological clocks – circadian rhythms. Floral induction and development	2	3
3.3	**Plant growth regulators** Physiological effects, and mechanism of action of auxin, gibberlin and cytokinnin	3	3

	Physiological effects, and mechanism of action of ethylene and abscissic acid	2	3
4.0	**INTRODUCTION TO PLANT BREEDING**	**9**	**4**
4.1	**Introduction** Objectives of plant breeding, important achievements and future prospects. Genetic variability and its role in plant breeding. Domestication and centres of origin of cultivated plants.	3	4
4.2	**Systems of reproduction in plants** Reproductive systems and pollination control mechanisms; Sexual reproduction - Cross and self pollination; asexual reproduction, Incompatibility and Male sterility, their types.	3	4
4.3	**Hybridization** Hybridization - role and methods, Inter-varietal, inter specific and inter generic crosses. Back-cross breeding. Heterosis, Inbreeding depression.	3	4
5.0	**METHODS OF CROP IMPROVEMENT**	**9**	**5**
5.1	**Breeding for resistance** Breeding for biotic (disease) and abiotic (drought) stresses; loss due to diseases, disease development, disease escape, disease resistance, vertical and horizontal resistances of biotic stress; methods of breeding for disease resistance.	3	5
5.2	**Mutation breeding** Mutagens and crop improvement. Spontaneous and induced mutations, effects of mutation. Physical and chemical mutagens; principles and working of Gamma gardens, methods of mutation breeding, mutations in oligogenic traits, mutations in polygenic traits	2	5
	Limitations of mutation breeding, achievements of mutation breeding. Role of mutation in Plant Breeding.	2	5
5.3	**Modern breeding methods** Modern trends in plant breeding: Tissue culture technologies; DNA – marked assisted selection (brief study only)	2	5

Text Books for Reference

1. Lincoln Taiz, Eduardo Zeiger (2002). *Plant physiology* (II Edn). Sinaeur Associates, Inc. Publishers.
2. Bob B Buchanan, Wilhelm Gruissem, Russel L Jones (2000). *Biochemistry and molecular biology ofplants*. L K International Pvt. Ltd
3. Reginald H Garrett, Charles M Grisham (2005). *Biochemistry*. Thomson Brooks/Cole
4. H Robert Horton, Laurence A Moran, Raymond S Ochr, J David Rawn, K Gray Scrimgeour (2002). *Principles of Biochemistry* (III Edn). Prentice Hall.
5. Frank B Salisbury, Cleon W Ross (1992). *Plant Physiology* (IV Edn). Wadsworth Publishing Company.
6. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2002). *Molecular biology of the cell* (IV Edn). Garland Science, Taylor and Francis group.

7. Gerald Karp (2008). *Cell and Molecular biology: Concepts and experiments* (V Edn). John Wiley & Sons.
8. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher, HiddePloegh, Paul Matsudaira (2007). *Molecular cell biology* (VI Edn). W H Freeman & Company.
9. William H Elliott, Daphne C Elliott (2001). *Biochemistry and molecular biology* (II Edn). Oxford
10. Jeremy M Berg, John L Tymoczko, LubertStryer, Gregory J Gatto Jr. (2007). *Biochemistry*. W H Freeman and company.
11. David E Sadava (2009). *Cell biology: Organelle structure and function*. CBS
12. S Sadasivam, A Manickam (1996). *Biochemical methods* (II Edn). New age international Publishers.

13. Allard R W (1995). *Principles of Plant Breeding*. John Wiley and Sons, Inc.
14. Ghahal G S and Gosal S S (2002). *Principles and procedures of Plant Breeding*. Narosa Publishing House.
15. Sharma J R (1994). *Principles and practices of Plant Breeding*. Tata McGraw-Hill Publishers Company Ltd.
16. Singh B D (1996). *Plant Breeding: Principles and methods*. Kalyani Publications.

Course	Details				
Code	BY1923111				
Title	**BIOTECHNOLOGY**				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	2/III				
Type	Core Course				
Credits	4	**Hrs/Week**	4	**Total Hours**	72

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the mechanism of production of metabolites from microorganisms	U	1,2
2	Evaluate the different methods and process involved in plant tissue culture	E	3,4
3	Design genetically modified organisms	C	4,5
4	Examine the role of bioinformatics in genomics and proteomics	Ap	4,6
5	Investigate the different processes involved in immune system	An	2,6
6	Investigate the societal issues in biotechnology and genetic engineering	An	2,5

Module	Course Description	Hrs	CO.No.
1.0	**Introduction to biotechnology**	**10**	
1.1	Introduction to classical and modern biotechnology.	1	1
1.2	**Microbial biotechnology :**Commercial production of metabolites using bioreactors. Submerged and solid state fermentation .	2	1
1.3	Microbes in production of enzymes , antibiotics , biopolymers, bioethanol, organic acids , SCP .	2	1
1.4	Microbial oxidative transformations .	1	1
1.5	**Societal issues in biotechnology :**Need for regulation, regulatory agency in India – GEAE. Patents – issues relating to patenting living organisms, their genes and other bioresources.	2	6
1.6	Potential impact of GMOs on the ecosystem . GM food – effect on health and environment . Ethical problems of rDNA technology .Economic issues . Potential misuse of modern molecular biology tools and techniques, bioweapons, bioterrorism .	2	6
2.0	**Plant tissue culture**	**13**	
2.1	Brief history and important milestones in plant tissue culture. Types of cultures: organized structures - meristem, shoot tip, node, embryo, root cultures ; unorganized structures - callus, suspension and protoplast cultures	2	2
2.2	General composition of the culture medium . Solid and	2	2

	liquid media – gelling agents.		
2.3	Preparation and standardization of MS medium for shoot and root differentiation.	1	2
2.4	Sterlization of medium, glasswares, instruments, plant material, transfer area.	1	2
2.5	Preparation of explants and inoculation, incubation. Pattern of growth and development, subculturing and hardening.	1	2
2.6	**Cytodifferentiation and morphogenesis :**Cellular totipotency. Differentiation of cells in callus - tracheid formation, chloroplast differentiation.	2	2
2.7	Factors influencing vascular differentiation. Organogenic differentiation: factors influencing shoot bud differentiation, induction of organogenic differentiation.	2	2
2.8	Techniques and stages of micropropagation . Advantages and disadvantages of micropropagation. Applications of tissue culture.	2	2
3.0	**Genetic engineering**	**30**	
3.1	Basic principles, tools and techniques;	1	3
3.2	Restriction endonucleases – naming, types and reaction. Ligases – reaction, methods of blunt end joining - linkers and adaptors .	2	3
3.3	Vectors – necessary properties of a vector , shuttle vectors, expression vectors . Construction and specific uses of plasmid, phage, cosmid, and artificial chromosomes .	2	3
3.4	Creation of recombinant DNA. Methods of screening and selection of recombinant cells – selectable markers, reporter systems – *Lac Z* system, GFP	2	3
3.5	**Procedure of gene cloning (in bacteria using pBR322 vector system):** Isolation and purification of vector and the DNA to be cloned , creation of recombinant vector, introduction of recombinant DNA into host cell – preparation of competent host cells, transformation..	2	3
3.6	**Procedure of gene cloning (in bacteria using pBR322 vector system):** Selection of transformed cells, identification of recombinant cells – insertional inactivation	2	3
3.7	**Procedure of gene cloning (in bacteria using pBR322 vector system):** Expression of foreign genes in host cells .	1	3
3.8	Applications of genetic engineering – in genetic studies, agriculture, and medicine (brief study citing specific examples)	2	3,6
3.9	cDNA synthesis, artificial DNA synthesis (brief study). Construction of genomic and cDNA library.	2	3
3.10	PCR - Procedure and applications, variants of PCR - Real time PCR and its applications.	2	3
3.11	Automated DNA sequencing.	2	3
3.12	Blotting techniques - procedure and applications of southern, northern, western, and dot blotting.	2	3
3.13	Microarray (gene chip) technology , mass spectrometry .	2	3
3.14	*In vitro* mutagenesis and its application.	2	3
3.15	Procedure and applications of DNA profiling,	2	3

	Footprinting.		
3.16	Procedure and applications of ELISA, RIA, Immunoprecipitation, flow cytometry, FISH , GISH, PFGE .	2	3
4.0	**Genomics and Bioinformatics**	**13**	
4.1	Genome, genomics, and proteomics.	1	4
4.2	Structural genomics - genome sequencing	2	4
4.3	Functional genomics – genome annotation, gene expression study using microarrays annotation of genes.	2	4
4.4	Introduction, aim and importance of bioinformatics	1	4
4.5	Databases: primary and secondary databases . DNA sequence databases - Genbank, DNA databank, Nucleotide sequence databank (EMBI Bank). Specialized databases.	2	4
4.6	Protein databases - SWISS-PROT, PDB.	2	4
4.7	Sequence alignment: Significance; local sequence alignment, BLAST, FASTA.	2	4
4.8	Global sequence alignment - MILAGAN,	1	4
5.0	**Immunology**	**6**	
5.1	Innate and acquired immunity.	1	5
5.2	Cells and molecules involved in innate and acquired immunity, humoral and cellular immunity, Antigens, Epitopes.	1	5
5.3	Structure, function and types of antibody molecules.	1	5
5.4	Antigen-antibody interactions. Antigen processing and presentation. Activation and differentiation of B cells – formation, role. T cells – types, roles, T cell receptors.	1	5
5.5	Primary and secondary immune modulation, complement system, pattern recognition receptors – toll-like receptors. MHC molecules.	1	5
5.6	Cell-mediated effect or functions, inflammation, hypersensitivity and autoimmunity, congenital and acquired immune deficiencies.	1	5

Text Books for Reference

1. James D. Watson, Amy A. Caudy, Richard M. Myers, Jan A. Witkowski (2007). *Recombinant DNA* (III Edn). W H Freeman.
2. S. B. Primrose, R. M. Twyman (2006). *Principles of gene manipulation and genomics* (VII Edn). Blackwell publishing.
3. Smita Rastogi, Neelam Pathak (2010). *Genetic engineering*. Oxford.
4. T A Brown (2002). *Genomes* (II Edn). Bios.

Text Books for Enrichment

1. Robert J Brooker (2009). *Genetics: Analysis & principles* (III Edn.). McGraw Hill.
2. Leland H Hartwell, Leroy Hood, Michael L Goldberg, Ann E Reynolds, Lee M Silver, Ruth C Veres (2004). *Genetics: From genes to genomes* (II Edn). McGraw Hill.
3. Robert F Weaver (2002). *Molecular biology* (II Edn). McGraw Hill.

4. William J Thieman, Michael A Palladino (2009). *Introduction to biotechnology* (II Edn). Pearson.
5. 10.David W Mount (2001). *Bioinformatics: Sequence and genome analysis*. CBS publishers & distributors.
6. Jeremy W Dale, Malcolm von Schantz (2002). *From genes to genomes*. John Wiley & Sons Ltd.
7. David P Clark (2010). *Molecular biology*. Elsevier.
8. Jeremy M Berg, John L Tymoczko, Lubert Stryer, Gregory J Gatto Jr. (2007). *Biochemistry*. W H Freeman and company.
9. D Peter Snustad, Michael J Simmons (2010). *Principles of genetics* (V Edn). John Wiley and Sons.
10. Benjamin A Pierce (2008). *Genetics: A conceptual approach* (IV Edn). W H Freeman and Company.
11. Peter J Delver, Seamus J Martin, Dennis R Burton, Ivan M Roitt (2011). *Roitt's essentialimmunology* (XII Edn). Wiley Blackwell.
12. Jocelyn E Krebs, Elliott S Goldstein, Stephen T Kilpatrick (2011). *Lewin's Genes X* . Jones and Bartlett Publishers.
13. Paul G Higgs, Teresa K Attwood (2005). *Bioinformatics and molecular evolution*. Blackwell publishing.
14. John L Ingraham, Catherine A Ingraham (2000). *Introduction to microbiology* (II Edn). Brooks/Cole.
15. Kathleen Park Talaro, Arthur Talaro (2002). *Foundations in microbiology*. McGraw Hill.
16. Hamish A Collin, Sue Edwards (1998). *Plant tissue culture*. Bios scientific publishers.
17. C W Sensen (2002). *Genomics and Bioinformatics*. Wiley – VCH.
18. Richard A Goldsby, Thomas J Kindt, Barbara A Osborne, Janis Kuby (2003). *Immunology* (V Edn). W H Freeman and Company.
19. Zhumur Ghosh, Bibekanand Mallik (2008). *Bioinformatics: principles and applications*. Oxford University press.
20. Orpita Bosu, Simminder Kaur Thukral (2007). *Bioinformatics: Databases tools and algorithms*. Oxford University press.
21. R A Dixon, R A Gonzales (2004). *Plant cell culture, a practical approach* (II Edn). Oxford University Press.
22. S S Bhojwani, M K Razdan (1996*). Plant tissue culture: Theory and Practice*. Elsevier.
23. Teresa K Attwood, David J Parry-Smith, Simiron Phukan (2007). *Introduction to Bioinformatics*. Pearson Education.
24. T A Brown (1995). *Gene cloning: an introduction* (III Edn). Stanley Thomas (Publishers) Ltd.
25. S B Primrose (1999). *Molecular biotechnology* (II Edn). Panima Publishing Corporation.
26. Nicholas C Price, Lewis Stevens (1999). *Fundamentals of enzymology* (III Edn). Oxford University press.
27. Trever Palmer (2004). *Enzymes: Biochemistry, Biotechnology, Clinical chemistry*. T. Palmer/ Harwood Publishing Limited.
28. E M T El-Mansi, C F A Bryce, A L Demain, A R Allman (2007). *Fermentation Microbiology andBiotechnology* (II Edn). Taylor & Francis.
29. Colin Ratledge, Bjorn Kristianson (2001). *Basic biotechnology*. Cambridge University press.
30. O L Gamborg, G C Philips (Eds.) (2005). *Plant cell, tissue and organ culture: Fundamentalmethods*. Narosa Publishing House.
31. *In vitro cultivation of plant cells*. Biotechnology by open learning. Elsevier.

32. D E Evans, J O D Coleman, A Kearns (2003). *Plant Cell Culture*. BIOS Scientific Publishers.
33. Bernard R Glick, Jack J Pasternak, Cheryl L Pattein (2010). *Molecular biotechnology, principlesand applications of recombinant DNA*. ASM press.
34. Burton E Tropp (2012). *Molecular biology: Genes to Proteins* (IV Edn). Jones and Bartlett Learning.
35. Anthony J F Griffiths, Susan R Wesler, Sean B Carroll, John Doebley (2012). *Introduction togenetic analysis*. W H Freeman and Company.
36. Alexander N Glazer, Hiroshi Nikaido (2007). *Microbial Biotechnology: Fundamentals of appliedmicrobiology*. Cambridge University Press.
37. Edwin F George, Michael A Hall, Geert-Jan De Klerk (2008). *Plant Propagation by Tissue Culture:The Background* (Vol I). Springer.
38. L E Casida (2005). *Industrial Microbiology.* New Age International Limited.
39. Peter F Stanbury and Allan Whitaker (1999). *Principles of Fermentation technology.* Butterworth-Heinemann.
40. S C Prescott and Cecil Gordon Dunn (2004). *Industrial Microbiology.* CBS publishers and distributors.
41. A H Patel (2000). *Industrial Microbiology*. Macmillan Publishers.
Ashok Pandey (2001). *Solid state fermentation in biotechnology.* Asiatech publishers

Course	Details				
Code	BY1923112				
Title	**TAXONOMY OF ANGIOSPERMS**				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	2/III				
Type	Core Course				
Credits	3	Hrs/Week	3	Total Hours	54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Critically analyze the methods and principles of classification.	An	1
2	Understand and utilize the tools of taxonomy	U	2
3	Provide training in desk, lab and field based assessment of angiosperm diversity, identifying morphological specialities and writing species description,keys and illustrations.	Ap	3,4
4	Recognize members of the major angiosperm families by identifying their economic importance.	R	4
5	Evaluate the contributions of ethnobotany, and traditional botanical knowledge to the advancement of plant taxonomy.	E	5

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Classification**	**5**	1
1.1	Major systems of angiosperm classification with special emphasis on the conceptual basis of the classifications of; (i) Linnaeus (ii) Bentham & Hooker (iii) Engler & Prantl (iv) Takhtajan	3	1
	(v) APG (synoptic versions of APG,APG II,APG III,APG IV).	2	1
2.0	**Tools of taxonomy**	**4**	**2**
2.1	Field study, herbarium, virtual herbarium, botanical gardens, BSI.	2	2
2.2	Floras/Taxonomic literature and GIS (Geographic Information System).	1	2
2.3	Construction of taxonomic keys – indented and bracketed - their utilization.	1	2
3.0	**Angiosperm diversity with special reference to Tropical flora** *Study of the following families (Bentham & Hooker) in detail with special reference to their salient*	**34**	**3**

	features, interrelationships and economic significance.		
	1. Runnunculaceae 2. Magnoliaceae	2	3
	3. Annonaceae 4. Polygalaceae	2	3
	5.Caryophyllaceae 6. Guttiferae (Clusiaceae)	2	3
	7. Malvaceae 8. Tiliaceae9. Rutaceae 10.Vitaceae.	2	3
	11. Sapindaceae 12. Fabaceae, 13. Caesalpiniaceae 14. Mimosaceae	3	3
	15. Rosaceae 16.Lythraceae	2	3
	17. Melastomaceae 18. Myrtaceae	1	3
	19. Cucurbitaceae 20. Apiaceae	2	3
	21. Aizoaceae 22.Rubiaceae	1	3
	23. Compositae (Asteraceae) 24. Myrsinaceae	2	3
	25. Sapotaceae 26.Loganiaceae	1	3
	27. Oleaceae 28.. Apocynaceae 29. Asclepiadaceae 30. Boraginaceae	2	3
	31.Convolvulaceae 32. Solanaceae	2	3
	33. Scrophulariaceae 34. Acanthaceae	2	3
	35. Verbenaceae 36.Lamiaceae	1	3
	37. Polygonaceae 38. Aristolochiaceae	2	3
	39. Lauraceae 40.Euphorbiaceae	2	3
	41. Orchidaceae 42. Dioscoriaceae 43. Zingiberaceae, 44.Cyperaceae 45.Poaceae	3	3
4.0	**Economic Botany**	**5**	**4**
4.1	Importance of economic botany.	2	4
4.2	Economic importance of the families: Malvaceae, Rutaceae,Fabaceae,Caesalpiniaceae,Mimosaceae,Myrtaceae, Cucurbitaceae, Apiaceae, Rubiaceae, Asteraceae,Apocynaceae,Solanaceae,Scrophulariaceae,Verbenaceae,Lamiaceae,Euphorbiaceae,Orchidaceae,Poaceae.	3	4
5.0	**Ethnobotany**	**6**	**5**
5.1	Scope and importance of ethnobotany.	1	5
5.2	Sources and methods of ethnobotanical studies.	2	
5.3	Traditional botanical knowledge of important tribal communities in Kerala such as Kanis,Mannans,Mala Arayans,Ulladars,Muthuvas and Kurichiyas.	3	5

References

1. Jain S K (1991). *Dictionary of Indian Folkmedicine and Ethnobotany*.

2. Paye G D (2000). *Cultural Uses of Plants: A Guide to Learning about Ethnobotany*.
The New York Botanical Garden Press.

3. Hooker J D. *The flora of British India* (Vol. I – VII).

4. Gamble J S. *Flora of the Presidency of Madras*. (Vol. I – III).

5. Cronquist A (1960). *Evolution and classification of flowering plants*. Thomas & Nelson

6. Cronquist A (1981). *An integrated system of classification of flowering plants*. Columbia
University Press.

7.Heywood V H, Moore D M (Eds) (1984). *Current concepts in Plant taxonomy*.
8.Radiford A E (1986). *Fundamentals of plant systematics*. Harper & Row.
9. Rendle A E (1970). *Classification of flowering plants*. Vikas Co.
10.Stace C A (1989). *Plant Taxonomy and Biosystematics* (II Edn). CBS Publ.
11.Woodland D W (1991). *Contemporary Plant Systematics*. Prentice Hall.
12. Sivarajan V V (1991*). Introduction to Principles of Plant Taxonomy*. Oxford IBH.
13.Takhtajan A L (1997). *Diversity and Classification of Flowering Plants*. Columbia Univ. Press.

Course	Details				
Code	BY1923605				
Title	**RESEARCH METHODOLOGY, BIOPHYSICAL INSTRUMENTATION, BIOSTATISTICS AND MICROTECHNIQUE &PLANT PHYSIOLOGY AND PLANT BREEDING**				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	2/III				
Type	Core Practical				
Credits	4	**Hrs/Week**	6	**Total Hours**	117

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Discuss different methodologies and techniques used in research work.	U	1,2
2	Explain basic computer skills necessary for the conduct of research.	An	1,2,3
3	Assess the basic function and working of analytical instruments used in research	E	2,3
4	Propose the required numerical skills necessary to carry out research.	C	3,6
5	Devise techniques to preserve and study plant materials.	C	3
6	Demonstrate and explain the various physiological parameters through experiments.	An	3, 4, 6
7	Devise methods and tests to improve the basic skills and techniques related to plant breeding	C	3, 6
8	Understand and apply the concepts and skills involved in plant breeding through plant breeding station visit.	Ap	3, 4, 6

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

	Practical	**Hours**	**CO. No.**
1.0	**RESEARCH METHODOLOGY**	**9**	**1,2**
1.1	Visit a scientific library or documentation centre and submit a report.	3	1
1.2	Prepare a project proposal.	1	1
1.3	Prepare an outline of dissertation and research paper.	1	1
1.4	Prepare a list of references.	2	1
1.5	Present a small project in the class with the help of LCD projector and submit the CD for evaluation.	2	2
2.0	**BIOPHYSICAL INSTRUMENTATION**	**18**	**2,3**
2.1	Micrometry: Calibrate the ocular micrometer stage micrometer on a light microscope and measure the size of an object (e.g., diameter of spore/pollen grains, width of algal filaments).	3	3
2.2	Calibrate the pH meter and test the pH of different sample solutions.	3	3
2.3	Estimate the concentration of the given sample using calorimeter or spectrophotometer.	3	3

2.4	Prepare a plant extract and perform TLC.	6	3
3.0	**BIOSTATISTICS**	**18**	**4**
3.1	Analysis of data to find the mean, median and mode.	3	4
3.2	Analysis of a given data for mean deviation and standard deviation.	3	4
3.3	Test the significance of a given data using t test, X^2 test, F-test and ANOVA.	6	4
3.4	Analysis of a set of data for correlation/regression.	3	4
3.5	Determine probability for different types of events.	3	4
4.0	**MICROTECHNIQUE**	**27**	**5**
4.1	Students are expected to be thorough with the following techniques. (a) Preparation of semi-permanent slides.	3	5
4.2	(b) Preparation of permanent slides.	3	5
4.3	(c) Preparation of whole mounts.	3	5
4.4	(d) Maceration.	3	5
4.5	(e) Preparation of fixatives (FAA, Carnoys'fluid).	3	5
4.6	(f) Preparation of dehydration series (Alcohol, Acetone, TBA).	3	5
4.7	(g) Preparation of paraffin blocks.	3	5
4.8	(h) Preparation of serial sections.	3	5
4.9	Candidates should prepare and submit 10 permanent slides in which the following categories should be included; (a) Free hand sections (single/double stained). (b) Serial sections (single/double stained). (c) Wood sections and whole mounts.	3	5
5.0	**PLANT PHYSIOLOGY**	**36**	**6**
5.1	Measurement of Photosynthesis - Hill Reaction.	3	6
5.2	Estimation of proline in plant tissues under various abiotic stresses.	3	6
5.3	Estimation of phenol in plant tissues affected by biotic stress.	3	6
5.4	Determination of peroxidase activity in plant tissues affected by biotic/abiotic stresses.	3	6
5.5	Estimation of free amino acids in senescing leaves to understand the source to sink transformation phenomenon.	3	6
5.6	Determination of osmotic potential by tissue weight method.	3	6
5.7	Separation of photosynthetic pigments by TLC/paper chromatography and calculating the Rf value	3	6
5.8	Demonstration of amylase activity and GA effect in germinating cereal seeds.	3	6
5.9	Estimation of total chlorophyll and study of absorption pattern of chlorophyll solution.	3	6
5.10	Separation and collection of leaf pigments by silica gel column chromatography.	3	6
5.11	Determination of nitrate reductase activity.	3	6
5.12	Extraction and estimation of leghaemoglobin from root nodules.	3	6
6.0	**PLANT BREEDING**	**9**	**7,8**

6.1	Hybridization techniques in Self and Cross pollinated plants.	2	7
6.2	Estimation of pollen sterility through in-vitro germination/staining-technique.	3	7
6.3	Visit a Plant Breeding station to familiarize with breeding programmes. Submit a report of the visit	4	8

Course	Details				
Code	BY1923606				
Title	**BIOTECHNOLOGY & TAXONOMY OF ANGIOSPERMS**				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	2/III				
Type	Core Practical				
Credits	4	**Hrs/Week**	4	**Total Hours**	63

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the history and current developments in the field of Biotechnology and Bioinformatics	U	2
2	Explain the methods involved in Tissue Culture and Molecular techniques	An	3
3	Understand the repositories of Biological Data Knowledge and construction of Phylogenetic trees	Ap	2
4	Plan desk, lab and field based studies of angiosperm diversity, identifying morphological specialties and writing short species descriptions and illustrations.	C	3
5	Identify members of the major angiosperm families by observing their diagnostic features.	An	3
6	Identify members of the major plants of economic importance	Ap	3

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

	Practicals		**CO No.**
1.0	**Biotechnology**	**27**	
1.1	Preparation of the stock solutions of MS medium.	4	1,2
1.2	Preparation of MS medium from stock solutions.	4	2
1.3	Isolation, preparation, sterilization and inoculation of different explants like shoot tip, node, anther, embryo and cambium	4	2
1.4	DNA isolation from coconut/onion/cauliflower and separation using agarose gel.	7	1,2
1.5	Multiple sequence alignment and creation of phylogenetic trees using MEGA.	4	1,3
1.6	Production of amylase by solid state and submerged fermentation.	4	1
2.0	**Taxonomy of Angiosperms**	**36**	
2.1	Work out a minimum of two members from each family and record at least one with suitable sketches and	20	4

	description in technical terms.		
2.2	Study of local flora and campus flora, construction of keys and use of floras in the identification up to species.	3	5
2.3	Preparation of dichotomous keys based on 4 sample plant materials from the same family.	3	5
2.4	Students should familiarize with the economic importance of the families mentioned in the economic botany section of the syllabus.	3	6
2.5	Field study: A field study for not less than 5 days under the guidance and supervision of teachers andpreparation of a minimum of 25 herbarium specimens of different categories with supporting field book.	7	5

SEMESTER 4

Course	Details				
Code	BY1924301				
Title	**TISSUE CULTURE AND MICROBIAL BIOTECHNOLOGY**				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	2/IV				
Type	Elective Course				
Credits	4	Hrs/Week	4	Total Hours	72

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand tissue culture and regeneration of plants	U	2
2	Identify various culture methods	Ap	1
3	Analyse the somaclonal and ploidy variants	An	3
4	Make use of cell cultures for the production of secondary metabolites	Ap	4
5	Identify the techniques for conservation and preservation	Ap	1,4
6	To evaluate use ofvarious microbes in industrial field	E	3,4,5

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Tissue cultureand regeneration of plants**	**11**	**1**
1.1	(a) Adventitious shoot regeneration: Direct and indirect regeneration. Factors influencingadventitious regeneration.	3	1
1.2	(b) Somatic embryogenesis: General aspects, initiation of embryogenic cultures and regeneration of plants, factors regulating somatic embryogenesis, differences between somatic and zygotic embryos.	3	1
	Encapsulation of somatic embryos, synthetic seed production - protocol, types of synthetic seeds.-desiccated and hydrated types.	3	1
	Applications and limitations of synthetic seeds.	2	1
2.0	**Culture methods and variants**	**28**	**2**
2.1	Embryo and meristem culture - Methodology and applications.	3	2
2.2	Protoplast culture: (a) Isolation, purification and culture of protoplasts. Regeneration of plants from protoplasts. Significance of protoplast culture.	3	2
	(b) Protoplast fusion (somatic hybridization) – chemical, mechanical, electrofusion.	3	2
	Isolation and selection of heterokaryons, regeneration and	2	2

	analysis of somatic hybrids; Cybrids. Applications of protoplast culture and somatic hybridization.		
2.3	Somaclonal variation: Origin of somaclonal variation. Reasons for somaclonal variation – molecular basis.	3	2
	Applications of somaclonal variation	2	2
2.4	Production of ploidy variants: (a) Haploids: In vitro androgenesis – protocol for anther and microspore culture, advantages, applications.	3	2
	(b) Gynogenesis: Developmental stage at inoculation, *in vitro* maturation of embryo sacs, origin of embryos, triggering factors – pretreatment, medium.	3	2
	Uses and limitations of haploid plants	3	2
	(c) Triploids: importance of triploid plants, conventional production of triploid plants, endosperm culture - advantages and limitations .	3	2
3.0	**Production of secondary metabolites**	**6**	**3**
3.1	Culture conditions for producing secondary metabolites, selection of high yielding lines,elicitation, immobilization of cells.	3	3
3.2	Hairy root culture – advantages of using hairy root culture, establishment of hairy root culture and production of secondary metabolites, Biotransformation.	3	3
4.0	**Germplasm conservation**	**6**	4
4.1	Importance of *in vitro* conservation. Short and medium term storage of germplasm	3	4
	Cryopreservation technique – importance and methodology of cryopreservation. DNA banking for germplasm conservation.	3	4
5.0	**Microbial technology**	**21**	**5**
5.1	Screening of microbes for metabolite production. Selection of media, sterilization of media.	2	5
	Bioreactors – airlift, stirred tank, bubble column, rotary drum.	1	
	Fermentation process - batch, fed batch, continuous fermentation. Process control during fermentation - pH, aeration, agitation, temperature, foam control. Downstream processing.	3	5
5.2	Large scale production of antibiotics - penicillin, streptomycin	2	5
	industrial chemicals - ethanol, acetone, butanol, citric acid;	2	
	SCP – *Spirulina* and *Chlorella*	1	5
	Biofertilizers – *Azotobacter* and *Rhizobium* Bioinsecticides – *B. thuringeansis*, NPV	3	5
	Commercial production of enzymes and their uses - amylase, cellulase, polygalacturonase.	2	5
5.3	Cell and enzyme technology:Cell immobilization: Methods, advantages and applications.	3	5
	Enzyme immobilization: Preparation, applications, Enzyme engineering.	2	5

References

1. Hamish A Collin, Sue Edwards (1998). *Plant tissue culture*.Bios scientific publishers.
2. R A Dixon, R A Gonzales (2004). *Plant cell culture, a practical approach* (II Edn).Oxford University Press.
3. S SBhojwani, M K Razdan (1996). *Plant tissue culture: Theory and Practice*. Elsevier.
4. Susan R. Barnum (1998). *Biotechnology an introduction*.Thomson Brooks/cole.
5. Nicholas C Price, Lewis Stevens (1999). *Fundamentals of enzymology* (III Edn).Oxford university press.
6. Trever Palmer (2004). *Enzymes: Biochemistry, Biotechnology, Clinical chemistry*. T Palmer/Harwood Publishing Limited.
7. E M T El-Mansi, C F A Bryce, A L Demain, A R Allman (2007). *Fermentation Microbiology and Biotechnology* (II Edn).Taylor & Francis.
8. O L Gamborg, G C Philips (Eds.) (2005). *Plant cell, tissue and organ culture: Fundamental methods*. NarosaPublishinh House.
9. *In vitro cultivation of plant cells*. Biotechnology by open learning.Elsevier.
10. John L Ingraham, Catherine A Ingraham (2000). *Introduction to microbiology* (II Edn). Brooks/Cole
11. Kathleen Park Talaro, Arthur Talaro (2002).*Foundations in microbiology*.McGraw Hill.
12. Colin Ratledge, Bjorn Kristianson (2001). *Basic biotechnology*.Cambridge University press.
13. William J Thieman, Michael A Palladino (2009). *Introduction to biotechnology* (II Edn). Pearson.
14. D E Evans, J O D Coleman, A Kearns (2003). *Plant Cell Culture*.BIOS Scientific Publishers.
15. Bernard R Glick, Jack J Pasternak, Cheryl L Pattein (2010). *Molecular biotechnology, principles and applications of recombinant DNA*.ASM press.
16. Alexander N Glazer, Hiroshi Nikaido (2007). *Microbial Biotechnology: Fundamentals of applied microbiology*. Cambridge University Press.
17. Anne KathrineHvoslef-Fide, Walter Preil (Eds) (2005). *Liquid Culture Systems for in vitro Plant Propagation*. Springer.
18. Edwin F. George, Michael A. Hall, Geert-Jan De Klerk (2008). *Plant Propagation by Tissue Culture (Vol I): The Background*. Springer.
19. Michael R. Davey, Paul Anthony (2010). *Plant Cell Culture: Essential Methods*. Wiley-Blackwell A John Wiley & Sons, Ltd.
20. Trevor A. Thorpe and Edward C. Yeung (Eds) (2011).*Plant Embryo Culture: Methods and Protocols*. Springer, Heidelberg.
21. Barbara M. Reed (2008). *Plant Cryopreservation: A Practical Guide*. Springer, Heidelberg.
22. Erica E. Benson (1999). *Plant Conservation Biotechnology*.Taylor and Francis.
23. Pritchard H W (2004). *Modern methods in orchid conservation: The role of Physiology, Ecology and Management*. Cambridge University Press.
24. Wen-Huei Chen, Hong-HwaChe (2007). *Orchid Biotechnology*.World Scientific Publishing Co. Pvt. Ltd.
25. Joseph Arditti (2008). *Micropropagation of Orchids* (Vol.I). Blackwell

publishing.

26. AlisherTouraev, Brian P. Forster, S. Mohan Jain (Eds) (2009). *Advances in Haploid Production in Higher Plants*.Springer, Heidelberg.
27. S Mohan Jain, H. Häggman (Eds) (2007). *Protocols for Micropropagation of Woody Trees and Fruits*.Springer, Heidelberg.
28. L E Casida.(2005) *Industrial Microbiology.* New Age international limited.
29. Peter F Stanbury, Allan Whitaker (1999). *Principles of Fermentation technology.*Butterworth-Heinemann.
30. S C Prescott, Cecil Gordon Dunn (2004). *Industrial Microbiology.*CBS publishers and distributors.
31. A H Patel (2000). *Industrial Microbiology*.Macmillan Publishers.
32. Ashok Pandey (2001). *Solid state fermentation in biotechnology.*Asiatech publishers.
33. Pauline M. Doran (1995). *Bioprocess Engineering Principles*. Academic Press Ltd.
34. M L Srivasthava (2007). *Fermentation technology*. Alpha Science Intl Ltd.
35. Gary Walsh (2002). *Proteins:Biochemistry and Biotechnology*. John Wiley and Sons.
36. Ronald M Atlas, Jim Philip (2005). *Applied Microbial solutions for real-world environment clean up*. Amer Society for Microbiology.
37. Martin Alexander (1999). *Biodegradation and Bioremediation.*Academic Press.
38. Dennis Thomas, Rakhichaturvedi (2008). *Endosperm culture: A novel method for triploid plant production*. Plant cell and organ culture, Springer science.

Course	Details				
Code	BY1924302				
Title	**GENETIC ENGINEERING**				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	2/IV				
Type	Elective Course				
Credits	4	**Hrs/Week**	4	**Total Hours**	72

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand, Remember and Analyze various tools and techniques in Gene cloning.	An	2,3
2	To evaluate and apply various techniques of genetic engineering.	E	2,3,4,6
3	To utilize various plant transformation techniques techniques in creating transgenic plants.	C	3,5,6
4	Applying the techniques in rDNA technology.	C	2,3,4,5,6
5	Understanding and application of immunological techniques.	Ap	2,3,5

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Tools and techniques in Gene Cloning**	**32**	**1**
1.1	**Working with Nucleic acids** Isolation and purification of DNA (genomic and plasmid) and RNA	2	1
1.2	**Chemical synthesis of DNA** Phosphodiester, phosphotriester, and phosphite-triester method of DNA synthesis (Brief study only)	3	1
	Phosphoramidite method, automated DNA synthesis	3	1
	Artificial genome synthesis	2	1
	Procedure of cDNA synthesis, reverse transcriptase PCR	2	1
1.3	**Modern cloning vectors** M13	3	1
	Puc	2	1
	artificial chromosomes – YAC, BAC, PAC, HAC, – important features, construction and applications of each	3	1
1.4	**Gene library** Genomic and cDNA library	3	1
	Procedure for the construction of a genomic library	3	1

	using phage λ system		
	Identification of desirable clones from library – hybridization probing, colony and plaque hybridization probing, immunological screening.	3	1
	Locating and isolating a gene - *in situ* hybridization, positional cloning, chromosome walking and jumping	3	1
2.0	**Advanced transgenic technology**	**10**	**2**
2.1	Inducible expression systems – examples, site-specific recombination for *in vivo* gene manipulation, gene targeting, gene silencing using antisense RNA and RNAi *In vitro* mutagenesis - site-directed mutagenesis	5	2
2.2	**Protein engineering** Applications of protein engineering	2	2
	protein modification by site-directed mutagenesis, combinatorial methods	3	
3.0	**Plant transformation**	**10**	**3**
3.1	**Plant transformation** *Agrobacterium tumefaciens* mediated gene transfer in plants - details of vector system based on *A. tumefaciens*, binary vector and cointegrate vector	3	3
	Steps involved in *Agrobacterium* mediated genetransfer to plants	2	
3.2	Plant transformation by direct transfer of DNA (Vectorless methods) - microprojectiles, electroporation, microinjection, chemical, lipofection	3	3
3.3	Details of the creation of Bt plants, Golden rice, *Flavr Savr* Tomato.	2	3
4.0	**Applications of rDNA technology**	**10**	**4**
4.1	Uses of GM microbes: Bacteria and yeast - producing useful proteins, basic genetic research	3	4
	Applications of GM animals: In basic research, producing novel proteins; disease studies, prevention and cure diseases	2	4
	Uses of transgenic plants: Herbicide, insect and disease resistance, stress resistance.	3	4
	Genetic engineering for increasing nutritional and other novel qualities in plants	2	4
5.0	**Immunology**	**10**	**5**
5.1	Generation of antibody diversity	2	5
	Production and uses of monoclonal antibodies, antibody engineering	3	5
5.2	Vaccines: Basic strategies, inactivated and live attenuated pathogens, subunit vaccines, recombinant vaccines (e.g., Hepatitis B vaccine), DNA vaccines	3	5
	Modern approaches to vaccine development - edible vaccines	2	5

Text Books for Reference

1. James D Watson, Amy A Caudy, Richard M Myers, Jan A Witkowski (2007). *Recombinant DNA* (III Edn). W H Freeman.
2. S B Primrose, R M Twyman (2006). *Principles of gene manipulation and genomics* (VII Edn). Blackwell publishing.
3. Robert J Brooker (2009). *Genetics: Analysis & principles* (III Edn). McGraw Hill.
4. T A Brown (2002). *Genomes* (II Edn). Bios.
5. Leland H Hartwell, Leroy Hood, Michael L Goldberg, Ann E Reynolds, Lee M Silver, Ruth C Veres (2004). *Genetics: From genes to genomes* (II Edn). McGraw Hill.
6. Abul K Abbas, Andrew H Lichtmay, Shiv Pillai (2007). *Cellular and molecular immunology* (IV Edn). Elsevier.
7. Charles A Janeway Jr., Paul Travers, Mark Walport, Mark J Schiomchik (2007). *Immunobiology*. Garland science, Churchill Livingstone
8. Richard A Goldsby, Thomas J Kindt, Barbara A Osborne, Janis Kuby (2003). *Immunology* (V Edn). W H Freeman and Company.
9. Smita Rastogi, Neelam Pathak (2010). *Genetic engineering*. Oxford.
10. Bernard R Glick, Jack J Pasternak, Cheryl L Pattein (2010). *Molecular biotechnology: Principlesand applications of recombinant DNA*. ASM press.
11. S B Primrose, R M Twyman, R W Old (2001). *Principles of gene manipulation* (VI Edn). Blackwell Science.
12. Jeremy W Dale, Malcolm von Schantz (2002). *From genes to genomes*. John Wiley & Sons Ltd.
13. Daniel L Hartl, Elizabeth W Jones (2009). *Genetics: analysis of genes and genomes* (VII Edn). Jones and Bartlett publisher
14. P Nagarajan, N Senthilkumar (2002). *Molecular biology: Principles and methods*. Sree Narmatha printers, Coimbatore.
15. Joseph Sambrook, David W Russell (2001). *Molecular cloning: A laboratory manual*. Cold spring harbor laboratory press.
16. David P Clark (2010). *Molecular biology*. Elsevier.
17. Jeremy M Berg, John L Tymoczko, Lubert Stryer, Gregory J Gatto Jr. (2007). *Biochemistry*. W H Freeman and company.
18. Desmond S T Nicholl (2010). *An introduction to genetic engineering* (III Edn). Cambridge.
19. D Peter Snustad, Michael J Simmons (2010). *Principles of genetics* (V Edn). John Wiley and Sons.
20. David A Micklos, Greg A Freyer with David A Crotty (2003). *DNA Science: A first course* (II Edn). L K Inter.
21. Benjamin A Pierce (2008). *Genetics: A conceptual approach* (IV Edn). W H Freeman and Company
22. Anthony J F Griffiths, Susan R Wesler, Sean B Carroll, John Doebley (2008). *Introduction togenetic analysis* (X Edn). W H Freeman and Company.
23. Benjamin Lewin (2006) *Genes IX*. Jones and Bartlett.
24. Kathleen Park Talaro, Arthur Talaro (2002). *Foundations in microbiology*. McGraw Hill.
25. William J Thieman, Michael A Palladino (2009*). Introduction to biotechnology* (II Edn). Pearson.
26. Carl Branden, John Tooze (1999). *Introduction to protein structure* (II Edn). Garland Publishing.
27. *Science* August 3, 2007:Vol. 317 no. 5838 pp.

28. *Science,* May 20, 2010.
29. E M T El-Mansi, C F A Bryce, A L Demain, A R Allman (2007). *Fermentation Microbiology andBiotechnology* (II Edn). Taylor & Francis.
30. T A Brown (1995). *Gene cloning: An introduction* (III Edn). Stanley Thomas (Publishers) Ltd.
31. S B Primrose (1999). *Molecular biotechnology* (II Edn). Panima Publishing Corporation.
32. Alexander N Glazer, Hiroshi Nikaido (2007). *Microbial Biotechnology: Fundamentals of appliedmicrobiology*. Cambridge University Press.
33. Alan Fersht (1999). *Structure and Mechanism in Protein Science*. W H Freeman and Comp

Course	Details				
Code	BY1924303				
Title	**GENOMICS, PROTEOMICS AND BIOINFORMATICS**				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	2/IV				
Type	Elective Course				
Credits	4	Hrs/Week	4	Total Hours	72

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Critically analyze the methods and principles of genome sequencing and genome mapping.	An	2,4
2	Understand the structure and function of genome and proteome.	U	4
3	Creating new informations by applying skills in computer based approaches in biological processes.	C	3
4	Identify the concepts of genomics as a tool in evolutionary studies.	R	6

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
1.0	**Structural genomics**	**23**	**1**
1.1	Basic steps in genome sequencing .	1	1
	Shot gun sequencing of small genomes. Map based sequencing: Hierarchial shot gun sequencing (clone-by-clone approach) - steps involved	2	1
	Whole genome shot gun approach - steps involved.	2	1
1.2	Genome mapping: Genetic mapping and physical mapping.	2	1
	Cytogenetic and linkage map (brief study only)	1	1
	Molecular markers – RFLP, RAPD, AFLP, SSLP, SNP. Physical mapping – restriction mapping, STS, SNP, EST.	2	1
	Next generation sequencing strategies - Pyrrosequencing. Third and fourth generation sequencing (brief study only).	2	1
1.3	Important findings of the completed genome projects: Human genome project	3	1
	Rice genome project	2	1
	Arabidopsis genome project	2	1
	Wheat genome project	2	1
	Tomato genome project.	2	1
2.0	**Functional genomics**	**10**	**2**
2.1	Transcriptome, expression profiling (mRNA profiling).	2	2
	Gene expression analysis using dot blotting and	2	2

	microarrays.		
2.2	Fabrication of microarrays – spotted arrays, *in situ* synthesis.	2	2
	Chromatin immunoprecipitation (ChIP) and its applications.	1	2
2.3	Determination of gene functions - knock out and knock down mutants	2	2
	Antisense RNAand RNAi, gene overexpression.	1	2
3.0	**Comparative genomics**	**6**	**4**
3.1	Orthologs and Paralogs,	2	4
	Gene identification by comparative genomics, comparative genomics as a tool in evolutionary studies.	3	4
	Metagenomics .	1	4
4.0	**Proteomics**	**8**	**2**
4.1	Proteome, proteomics.	2	2
4.2	Separation and identification of cellular proteins by 2D gel electrophoresis and mass spectrometry.	2	2
4.3	Protein expression analysis using Protein microarray	2	2
4.4	protein localization using GFP, other applications of GFP.	2	2
5.0	**Bioinformatics**	**25**	**3**
5.1	Submission and retrieval of databases – BankIt, ENTREZ.	1	3
5.2	Sequence analysis – significance. Methods of sequence alignment – paired sequence alignment, multiple sequence alignment, scoring matrices.	3	3
	Sequence comparison – dot matrix method, dynamic programming for sequence alignment; Global - Needleman Wunch algorithm; Local - Smith Waterman algorithms.	3	3
	Database similarity search – query sequence search; BLAST - different versions; FASTA - different versions.	3	3
	Tools for multiple sequence alignment – CLUSTAL X/W.	1	3
5.3	Gene prediction strategies, ORF search, gene prediction programs – Grail/Exp, GENSCAN, ORF finder.	3	3
	RNA secondary structure prediction; Protein structure and function prediction - tools used.	3	3
	Protein visualization tool - Rasmol.	1	3
5.4	Applications of bioinformatics in evolutionary studies – molecular phylogenetics, molecular clock.	3	3
	Construction of phylogenetic trees - tool Phylip, MEGA .	2	2
5.5	Bioinformatics for enzyme and protein design.	2	2

References

1. S B Primrose, R M Twyman (2006). *Principles of gene manipulation and genomics* (VII Edn). Blackwell publishing.

2. Robert J Brooker (2009). *Genetics: analysis & principles* (III Edn). McGraw Hill.

3. James D Watson, Amy A Caudy, Richard M Myers, Jan A Witkowski (2007). *Recombinant DNA* (III Edn).

W H Freeman.
4. T A Brown (2002). *Genomes* (II Edn). Bios.
5. Leland H Hartwell, Leroy Hood, Michael L Goldberg, Ann E Reynolds, Lee M Silver, Ruth C Veres (2004). *Genetics:From genes to genomes* (II Edn). McGraw Hill.
6. *Science*, 16 february 2001, Vol. 291.
7. David W Mount (2001). *Bioinformatics: sequence and genome analysis*. CBS publishers & distributors.
8. Jeremy M Berg, John L Tymoczko, Lubert Stryer, Gregory J Gatto Jr. (2007). *Biochemistry*. W H Freeman and company.
9. David P Clark (2010). *Molecular biology*. Elsevier.
10. D Peter Snustad, Michael J Simmons (2010). *Principles of genetics* (V Edn). John Wiley and Sons.
11. David A Micklos, Greg A Freyer with David A Crotty (2003). *DNA Science: A first course* (II Edn). L K Inter.
12. Benjamin A Pierce (2008). *Genetics: A conceptual approach* (IV Edn). W H Freeman and Company.

13. Anthony J F Griffiths, Susan R Wesler, Sean B Carroll, John Doebley (2008). *Introduction togenetic analysis* (X Edn). W H Freeman and Company.
14. Benjamin A Pierce (2008). *Genetics: A conceptual approach* (IV Edn). W H Freeman and Company
15. Paul G Higgs, Teresa K Attwood (2005). *Bioinformatics and molecular evolution*. Blackwell publishing.
16. C W Sensen (2002). *Genomics and Bioinformatics*. Wiley – VCH.
17. T A Brown (2002). *Genomes* (II Edn). Bios.
18. William J Thieman, Michael A Palladino (2009). *Introduction to biotechnology* (II Edn). Pearson
19. George Acquaah (2005). *Understanding biotechnology*. Pearson.
20. Teresa K Attwood, David J Parry-Smith, Simiron Phukan (2007). *Introduction to Bioinformatics*. Pearson Education.
21. Zhumur Ghosh, Bibekanand Mallik (2008). *Bioinformatics: principles and applications*. Oxford University press.
22. Orpita Bosu, Simminder Kaur Thukral (2007). *Bioinformatics: Databases tools and algorithms*. Oxford University press.
23. Robert H Tamarin (2002). *Principles of genetics*. McGraw Hill.
24. Robert K Murray, David A Bender, Kathleen M Botham, Peter J Kennelly, Victor W Rodwell, P Anthony Weil (2009). *Harper's Illustrated Biochemistry* (XXVIII Edn). Mc Graw Hill.
25. *Nature*, 409 (6822): 860-921, 2001.
26. S R Pennington, M J Dunn (Edts) (2002). *Proteomics: From protein sequence to function*. Viva Books Private Limited.
27. Bernard R Glick, Jack J Pasternak, Cheryl L Pattein (2010). *Molecular biotechnology, principlesand applications of recombinant DNA*. ASM press.
28. Burton E Tropp (2012). *Molecular biology: Genes to Proteins* (IV Edn). Jones and Bartlett Learning.
29. Jocelyn E Krebs, Elliott S Goldstein, Stephen T Kilpatrick (2011). *Lewin's Genes X* . Jones and Bartlett Publishers.

Course	Details				
Code	BY1924304				
Title	**APPLIED BIOTECHNOLOGY AND BIOETHICS**				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	2/IV				
Type	Elective Course				
Credits	3	**Hrs/Week**	3	**Total Hours**	54

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Discuss the important applications of Biotechnology	Ap	2
2	Analyse and evaluate the processes involved in the Biotechnological applications	E	3,4
3	Assess the social concerns of Applied biotechnology and predict its short and long term effects	C	4,5
4	Apply ethical Principles to the biotechnological applications and justify their use	E	4,5,6

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO.No.
	Applied Biotechnology	**39**	
1.0	**Bioremediation and Phytoremediation**	**10**	
1.1	Importance and advantages of bioremediation, bioaugmentation, pollutants that can be cleaned. Cleaning reactions - aerobic and anaerobic biodegradation, organisms used for bioremediation, cleaning strategies for water and soil - *in situ* and *ex situ* technologies.	3	1,2
1.2	Bioremediation of radioactive wastes	2	1,2
1.3	Phytoremediation - importance	3	1,2
1.4	Use of GMO's in bioremediation	2	2,3,4
2.0	**Tissue engineering and Stem cell technology**	**18**	
2.1	Regenerative medicine, methods	3	1,2
	Applications of tissue engineering.	2	
	Stem cells – embryonic stem cell and adult stem cells – potential applications	3	

2.2	**Gene therapy** Approaches to gene therapy - somatic cell and germline therapy	3	1,2,3
	vectors used in gene therapy.*In vivo* and *ex vivo* therapy.	2	
	Gene therapy of SCID, Cystic fibrosis, gene augmentation therapy.	2	
	Problems and fears associated with gene therapy.	3	
3.0	**Biosensors**	**8**	
3.1	Design operation and types.	3	1,2
3.2	Applications - medical, food and agriculture, industrial, pollution monitoring.	3	3
3.3	Enzymes as biosensors	2	3,4
4.0	**Nanobiotechnology**	**3**	
4.1	Nanoparticles and nanotechnology: an overview on concepts, strategies and tools. Types of nanoparticles and their relative merits and demerits.	1	1,2
4.2	Method of biological synthesis of Zn and Ag nanoparticles – plant extract, bacteria and fungi.	1	1,2
4.3	Use of nanoparticles in agriculture, medicine and environment. Impact of NPs on germination and seedling emergence, parameters in various crops. Effect of NPs on gene expression. Translocation and accumulation of NPs in plant tissues and organs.	1	3,4
5.0	**BIOETHICS**	**15**	
5.1	**Societal concerns with biotechnology** Harm to the environment - potential impact of GMOs on the ecosystem;	1	3,4
	GM food – effect on health and environment. Misuse of modern molecular biology tools and techniques, bioweapons, bioterrorism.	1	
	Ethical issues relating to rDNA techniques. Patents – issues relating to patenting living organisms, their genes and other bioresources.	2	
5.3	**Ethical, legal, and social impact of modern biotechnology** Genome data availability – Problems with public availability of sequence data, privacy concerns, legal problems,	3	3,4
	Gene and DNA sequence patenting, patenting transgenics,	3	
	stem cell research - EST, gene therapy – problems and concern over germline gene therapy.	3	
	Biosafety.	2	

References

1. Alexander N Glazer, Hiroshi Nikaido (2007). *Microbial Biotechnology: Fundamentals of appliedmicrobiology*. Cambridge University Press.

2. Benjamin A Pierce (2008). *Genetics: A conceptual approach* (IV Edn). W H Freeman and Company
3. Bernard R Glick, Jack J Pasternak, Cheryl L Pattein (2010). *Molecular biotechnology: Principlesand applications of recombinant DNA*. ASM press.

4. Burton E Tropp (2012). *Molecular biology: Genes to Proteins* (IV Edn). Jones and Bartlett Learning.

5. Nicholas C Price, Lewis Stevens (1999). *Fundamentals of enzymology* (III Edn). Oxford university press.

6. Orpita Bosu, Simminder Kaur Thukral (2007). *Bioinformatics: Databases tools and algorithms*. Oxford University press.

7. Paul G Higgs, Teresa K Attwood (2005). *Bioinformatics and molecular evolution*. Blackwell publishing.

8. S B Primrose, R M Twyman (2006). *Principles of gene manipulation and genomics* (VII Edn). Blackwell publishing.

9. Trever Palmer (2004). *Enzymes: Biochemistry, Biotechnology, Clinical chemistry*. T Palmer/Harwood Publishing Limited.

10. Alok Dhawan (Editor), Sanjay Singh (Editor), Ashutosh Kumar (Editor), Rishi Shanker (Editor) Nanobiotechnology: Human Health and the Environment 1st Edition

11. Clive Jarvis (Editor) ,Nanobiotechnology: An Introduction

Course	Details				
Code	BY1924701				
Title	NATURAL RESOURCES AND THEIR MANAGEMENT				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	2/IV				
Type	Elective Course				
Credits	4	Hrs/Week	4	Total Hours	72

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the various types of Natural resources and their management	U	2,6
2	Explain the various Principles of resource management	U	2,3
3	Discuss the theories related to Environmental economics	An	3
4	Relate the importance of ethics with society and environment	An	5,6

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

Module	Course Description	Hrs	CO. No.
1.0	**Natural resources and their management**	**10**	1
1.1	Natural resources – renewable and nonrenewable. Preservation, conservation, and restoration of resources. Recycling, reuse, and substitution.	3	
1.2	Distribution of water resources, threats to water resources. Principles and approaches to surface water management, watershed management – catchment infiltration models	3	
1.3	Rainwater harvesting and storage, recharging of ground water.	2	
1.4	Management of degraded water resources. Drinking water quality and water treatment - desalination, ion-exchange, reverse osmosis, and disinfection of water.	2	
2.0	**Principles of resource management – Energy resources, Food resources & Mineral resources**	**20**	2
2.1	Energy sources – resource and reserves. Current national and global energy scenario. Fossil fuels: Oil, Coal, Natural gas, Shale – sources, exploration, exploitation; environmental consequences of overexploitation.	2	
2.2	Nuclear energy: Nuclear fission and fusion, nuclear minerals, nuclear fuel cycle, nuclear fuel production, nuclear reactors. Advantages and disadvantages of nuclear power.	2	

	Environmental consequences – safety, terrorism, waste disposal and management.		
2.3	Renewable and alternate energy sources – solar energy and isolation, photovoltaic cells; hydropower; tidal power; wind power; geothermal energy; ocean energy; fuel cells – advantages and disadvantages, environmental consequences.	2	
2.4	Bio-energy: biomass as energy source, biomass production, energy farming, biomass conversion processes – thermochemical and biochemical. Biodiesel. Environmental consequences of biomass resource harnessing.	2	
2.5	Land as a resource, land degradation and its causes, desertification – causes and prevention	2	
2.6	Food sources, effect of agriculture on the environment.	2	
2.	World food problems, methods and strategies to alleviate food problems.	3	
2.8	Mineral resources: Formation of mineral deposits. Types of mineral resources, environmental impact of mineral exploration, mining, processing and utilization.	3	
2.9	Conservation of mineral resources.	2	
3.0	**Principles of resource management – Biological resources**	**24**	
3.1	(a) Forests as biological resources – importance, types of forests, deforestation, reforestation, conservation of forests.	1	
3.2	(b) Biodiversity and its importance: Types of biodiversity - wild biodiversity, agro-biodiversity, domesticated biodiversity. Values of biodiversity, ecosystem functions and biodiversity, mobile links and valuating ecosystem services. Drivers of biodiversity loss. Tools and techniques for biodiversity estimation: Biodiversity indices; methods of biodiversity monitoring.	3	
3.3	(c) Uses of biodiversity – source of food, medicine, raw material, aesthetic and cultural values.	2	2
	Threats to biodiversity; natural and anthropogenic, species extinctions, IUCN threat categories, red data book. Extinction: Types, Causes – population growth, overconsumption, pollution, climate change. Ecological extinction, biological extinction.	2	
	Principles and strategies for biodiversity conservation - *In-situ* conservation: sanctuaries, biosphere reserves, national parks, nature reserves, preservation plots.	2	
	Ex-situ conservation: botanical gardens, zoos, aquaria, homestead garden; herbarium; *In-vitro* Conservation: germplasm and gene Bank; tissue culture: pollen and spore bank, DNA bank. GEF-World Bank initiatives.	2	

	Biodiversity hotspots and their characteristics, global distribution. National and international programmes for biodiversity conservation.CITES and TRAFFIC, Indian Biodiversity Act 2002 and Rules.	2	
3.4	(d) Biological Invasions: Introduction -Elton's hypothesis – Invasion patterns and process -biological attributes for invasion: Reproductive potential, Allelopathy -Phenotypic plasticity -fitness to the new environment.	3	
	Hypotheses for invasion success: Natural enemy hypothesis -evolution of invasiveness hypothesis, empty niche hypothesis, novel weapon hypothesis, disturbance hypothesis and Propagule pressure hypothesis. Invasive alien species of India (plants and animals).	3	
3.5	(e) Impacts and management of invasions: Impacts of exotics on biodiversity, productivity, nutrient cycling.	2	
	Management: Bio-control programmes, mechanical and chemical control -Positive utilization.Quarantine and EIA of biological invasion.	2	
4.0	**Environmental economics**	**9**	
4.1	(a) Definition, scope and basic theories of environmental economics; sustainable growth. (b) Economics of natural resources, environment cost-benefit analysis.	2	
4.2	(c) Agricultural development and environment: Modern agriculture and its impact on environment – monoculture plantations, use of insecticides, pesticides, chemical fertilizers, hybrid seeds, water consumption, desertification, watershed problem, soil erosion, deforestation, depletion of biodiversity	3	3
	Sustainable agriculture – alternate methods in agriculture	1	
4.3	(d) Industrial development and environment: impact of modern large scale industries on environment, problems related to modernization and urbanization. Green policies of industrialization.	2	
5.0	**Society and Environment**	**9**	
5.1	Social perspectives of environment – Global and Indian issues.	1	
5.2	Social impacts of growing human population and affluence, production and distribution of food, hunger, poverty, malnutrition, famine	2	4
5.3	Social impacts of water crisis, global climate change, ozone depletion, nuclear accidents, acid rain, consumerism and waste products.	2	
5.4	Problems related to major dams and other	2	

	developmental projects, resettlement and rehabilitation. Environment and human health – epidemiological issues.		
5.5	Importance and need of environmental ethics. Moral relation among humans, nonhumans, and natural environment. Position of humans in the world, human responsibility to care the world, animal rights.	2	

References

1. APHA-AWWA-WPCF (1990). *Standard Methods for the Examination of water and Waste water.*
(XX Edn). American Public Health Association.
2. Butter G C (1988). *Principles of Ecotoxicology.* John Wiley and Sons.
3. Cockerham G L, Shane B S (Eds) (1994). *Basic Environmental Toxicology*. CRC Press.
4. Eisenbude M (1998). *Environmental Radioactivity*. Academic Press.
5. Fellenberg G (1999). *Chemistry of Pollution*. John Wiley and Sons.
6. Hayes W A (2001). *Principles and Methods of Toxicology*. CRC Press.
7. James P, Lodge J R (1971). *Methods of Air sampling and Analysis.* ISc Lewis Pub. Inc.
8. Klaassen C D, J B W Alkins (2003). *Essentials of Toxicology*. McGraw-Hill Professional.
9. Khopkar S M (2004). *Environmental Pollution: Monitoring and Control.* New Age International.
10. Lutgens F K, Tarbuek J E (1992). *The Atmosphere*. Prentice Hall.
11. Michael L McKinney, Robert M Schoch (2002). *Environmental science: Systems and Solutions*.
West publishing company.
12. Niesink R J M, De Vries J, Hollinger M A (Eds) (1996). *Toxicology: Priniples and Applications.*
CRC Press.
13. Oehme W F (1989). *Toxicity of Heavy Metals in Environment.* Marcel Dakkar Inc.
14. Purnima B B, A Janin, Arun K Jain (2011). *Waste Water Engineering Including Air Pollution*.
Laxmi Publications (P) Ltd.
15. Samuel G (1990). *Nuclear Engineering.* Academic Press.

16. Wilber C G (1989). *Biological aspects of Water pollution.* Charles C Thomas Publishers.

Course	Details				
Code	BY1924702				
Title	TISSUE CULTURE AND MICROBIAL BIOTECHNOLOGY & APPLIED BIOTECHNOLOGY AND BIOETHICS				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	2/IV				
Type	ElectivePractical				
Credits	4	Hrs/Week	5	Total Hours	90

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Explain the methods involved in Tissue Culture	An	3,4
2	Understand the applications of microbial biotechnology.	C	2,3,6
3	Discuss theapplications of biotechnology by visiting abiotechnologylaboratory. Submit a report of the visit	An	2,3,4

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

	PRACTICALS	90 hrs	CO No.
	TISSUE CULTURE AND MICROBIAL BIOTECHNOLOGY		
1.0	**Plant tissue culture**	**59**	1
1.1	In vitro morphogenetic studies in any one plant system, Isolation of explants, establishment, subculture and maintenance of callus.	7	
1.2	Study of the morphology of callus cells – callus smear preparation, histological aspects, microtomy.	7	
1.3	Isolation and fusion of plant protoplasts	4	
1.4	Preparation of synthetic seeds.	6	
1.5	Preparation of selective medium for drought or salinity resistance.	6	
1.6	Preparation of MS soild medium from stock solutions containing auxin and cytokinin, NaCl or PEG, and inoculation.	10	
1.7	Find out the uninucleate stage of anther and anther culture.	6	
1.8	Dissect out an embryo from any seed and culture it on a suitable solid medium.	6	
1.9	Cell plating technique.	7	
2.0	**Microbial Biotechnology**	**21**	2
2.1	Cell immobilization.	7	
2.2	Application of immobilized yeast cells for ethanol production.	7	

2.3	Isolation of microbes producing organic acids.	7	
3.0	**APPLIED BIOTECHNOLOGY AND BIOETHICS**		
3.1	**Laboratory/Industry visit:** Students are expected to conduct a visit to a sophisticated biotechnologylaboratory/biotechnology industry to have an idea on the type of work going on there. A report of the visit should be prepared and submitted.	**10**	3

Course	Details				
Code	BY1924801				
Title	**GENETIC ENGINEERING&GENOMICS, PROTEOMICS AND BIOINFORMATICS**				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	2/IV				
Type	Elective Practical				
Credits	4	**Hrs/Week**	5	**Total Hours**	90

CO No.	***Expected Course Outcomes*** *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Develop basic skills and techniques involved in isolation and quantification of DNA and plasmids	An	3, 4
2	Understand and build skills for separation and amplification of DNA	Ap	4
3	Understand and demonstrate the extraction and quantification of proteins	An	4, 6
4	Understand the repositories of Biological Data Knowledge	U	2
5	Analyze the data available in databases	An	3
6	Familiarize the techniques involved in Bioinformatics related to Phylogeny	C	4,6

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

	Practicals		
1.0	**GENETIC ENGINEERING**	**40 Hrs**	
1.1	Isolation of plant genomic DNA and its quantification [14].	6	1
1.2	Isolation of plasmids and its purification [14], by minipreparation and midipreparation[15].	8	1
1.3	Isolation of bacterial genomic DNA and its quantification by using UV spectrophotometer [14].	6	1
1.4	Separation of DNA by agarose gel electrophoresis [14].	6	2
1.5	Extraction and quantification of protein by Bradford method [14].	6	1
1.6	Separation of proteins by PAGE	6	2
1.7	PCR	2	2
2.0	**GENOMICS, PROTEOMICS AND BIOINFORMATICS**	**50 Hrs**	
2.1	Protein visualization using Rasmol (supply structure of a few proteins downloaded from PDB).	9	4,5
2.2	Multiple sequence alignment using CLUSTAL X (give DNA or protein sequence).	9	6

2.3	Phylogenetic analysis by Phylip/MEGA (give some protein or DNA sequence data).	9	6
2.4	Locate specific sequences like TATA box, promoters, start signals, stop signals etc. in a DNA sequence using computer programmes (22) e.g., E. coli promoter, human promoter.	9	4,5
2.5	Multiple sequence alignment and ontology based database searches on selected plant cytoskeletal genes to decipher the molecular phylogeny of cytoskeleton genes – record the results.	9	6
2.6	Laboratory/Industry visit: Students are expected to conduct a visit to a sophisticated biotechnologylaboratory/research centre/biotechnology industry to have an idea on the type of work going on there. A report of the visit should be prepared and submitted.	5	1,2,3

Course	Details				
Code	BY1924901				
Title	NATURAL RESOURCES AND THEIR MANAGEMENT				
Degree	M.Sc.				
Branch(s)	Botany				
Year/Semester	2/IV				
Type	Elective Practical				
Credits	4	Hrs/Week	5	Total Hours	72

CO No.	*Expected Course Outcomes* *Upon completion of this course, the students will be able to*:	Cognitive Level	PSO No.
1	Understand the various natural resources and their important parameters.	U	2
2	Evaluate and assess the various parameters related to Water Quality	An	3,4

PSO – Programme Specific Outcome CO-Course Outcome; Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create.

	PRACTICALS	72 Hrs	
1.0	Water Quality Analysis: a. Determination pH, Electrical conductivity, Alkalinity, Salinity, Hardness, Nitrate, Phosphate and Silica.	37	1
2.0	b. Determination of total dissolved salts (TDS). 2. Toxicity Analysis of Water: For Chlorine, H2S, Ammonia, Copper and Chromium.	35	2