DEPARTMENT OF
BOTANY

Curriculum and Syllabus for
Postgraduate Programme in
Botany
Under Credit Semester System
(with effect from 2019 admissions)

St Berchmans College
Founded 1922
AUTONOMOUS | College with Potential for Excellence | Reaccredited by NAAC with A Grade
Affiliated to Mahatma Gandhi University, Kottayam, Kerala
Changanassery, Kottayam, Kerala, India-686101

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Board of Studies

Dr. Scaria K Varghese (Chairman), Associate Professor, Dept. of Botany, St. Berchmans College, Changanassery – 686101

Dr. J G Ray, Professor, School of Biosciences, MG University Priyadarshini Hills P.O Kottayam - 686 560

Dr. Jos T. Puthur, Associate Professor, Dept. of Botany, Calicut University

Dr. Dennis Thomas, Professor and head, Department of Biotechnology, Central University, Kerala

Dr. Anumol Jose, Assistant Professor, UC College, Aluva

Dr. Sunny George, Homegrown Biotech, Kerala

Dr. Soni Scaria, Associate Professor, Dept of Botany, St. Berchmans College
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Dr. Joseph Job, Associate Professor, Dept of Botany, St. Berchmans College
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Mr. Tom Joseph, Assistant Professor, Dept of Botany, St. Berchmans College
Changanassery – 686101

Programme Objectives:-

- To train the students to accomplish mastery in the field of Botany.
- To provide basic principles of biological sciences with special reference to Botany
- To enable the students to explore the intricacies of life forms at cellular and molecular level
- To inspire the students to apply the acquired knowledge to create a better environment
- To develop problem solving skills in students and encourage them to carry out innovative research projects

Programme Outcome:-

- Students will be able to identify the major groups of plants and be able to classify them within a phylogenetic framework.
- Students will be able to compare and contrast the characteristics of different groups of plants and fungi that differentiate them from each other and from other forms of life.
- Students will be able to use the evidence of comparative biology to explain how the theory of evolution offers the only scientific explanation for the unity and diversity of life on earth. They will be able to use specific examples to explicate how descent with modification has shaped plant morphology, physiology, and life history.
- Students will be able to explain how organisms function at the level of the gene, genome, cell, tissue, organ and organ-system. Drawing upon this knowledge, they will be able to give specific examples of the physiological adaptations, development, reproduction and behavior of different forms of life.
- Students will be able to explicate the ecological interconnectedness of life on earth by tracing energy and nutrient flows through the environment. They will be able to relate the physical features of the environment to the structure of populations, communities, and ecosystems.
- Students will be able to demonstrate proficiency in the experimental techniques and methods of analysis appropriate for their area of specialization within biology.
- Students will be able to apply the scientific method to questions in biology by formulating testable hypotheses, gathering data that address these hypotheses, and analyzing those data to assess the degree to which their scientific work supports their hypotheses.

REGULATIONSFOR POSTGRADUATE (PG) PROGRAMMES UNDER CREDIT SEMESTER SYSTEM (SB-CSS-PG) 2019

1. SHORT TITLE

1.1 These Regulations shall be called St. Berchmans College (Autonomous) Regulations (2019) governing postgraduate programmes under Credit Semester System (SB-CSS-PG).

1.2 These Regulations shall come into force with effect from the academic year 2019-20 onwards.

2. SCOPE

2.1 The regulation provided herein shall apply to all regular postgraduate programmes, MA/MSc/MCom, conducted by St. Berchmans College (Autonomous) with effect from the academic year 2019-20.

3. DEFINITIONS

3.1 'University' means Mahatma Gandhi University, Kottayam, Kerala.

3.2 'College' means St. Berchmans College (Autonomous).

3.3 There shall be an Academic Committee nominated by the Principal to look after the matters relating to the SB-CSS-PG system.

3.4 'Academic Council' means the Committee consisting of members as provided under section 107 of the University Act 2014, Government of Kerala.

3.5 'Parent Department' means the Department, which offers a particular postgraduate programme.

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

3.7 'Faculty Mentor' is a teacher nominated by a Department Council to coordinate the continuous evaluation and other academic activities of the Postgraduate programme undertaken in the Department.

3.8 'Programme' means the entire course of study and examinations.

3.9 'Duration of Programme' means the period of time required for the conduct of the programme. The duration of a postgraduate programme shall be four (4) semesters.

3.10 'Semester' means a term consisting of a minimum 90 working days, inclusive of tutorials, examination days and other academic activities within a period of six months.

3.11 'Course' means a segment of subject matter to be covered in a semester. Each Course is to be designed under lectures/tutorials/laboratory or fieldwork/seminar/project/practical/ assignments/evaluation etc., to meet effective teaching and learning needs.

3.12 'Course Teacher' means the teacher who is taking classes on the course.

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

3.14 'Elective Course' means a course, which can be substituted, by equivalent course from the same subject and the number of courses required to complete the programme shall be decided by the respective Board of Studies.

3.15 The elective course shall be either in the fourth semester or be distributed among third and fourth semesters.

3.16 'Audit Course' means a course opted by the students, in addition to the compulsory courses, in order to develop their skills and social responsibility.

3.17 'Extra Credit Course' means a course opted by the students, in addition to the compulsory courses, in order to gain additional credit that would boost the performance level and additional skills.

3.18 Extra credit and audit courses shall be completed by working outside the regular teaching hours.

3.19 There will be optional extra credit courses and mandatory audit courses. The details of the extra credit and audit courses are given below.

Semester	Course	Type
I	Course on Mendeley Reference Management Software	Optional, Extra credit Grades shall be given
	Course on Basic Life Support System and Disaster Management	Compulsory, Audit Grades shall be given
First summer vacation	Internship/Skill Training	Optional, Extra credit Grades shall be given
Any time during the programme	Oral Presentation in National/International seminar	Optional, Extra credit
	Publication in a recognized journal with ISSN number	

3.20 'Project' means a regular research work with stated credits on which the student conducts research under the supervision of a teacher in the parent department/any appropriate research centre in order to submit a report on the project work as specified.

3.21 'Dissertation' means a minor thesis to be submitted at the end of a research work carried out by each student on a specific area.

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

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

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

3.25 'Improvement Examination' is an examination conducted to improve the performance of students in the courses of a particular semester.

3.26 'Supplementary Examination' is an examination conducted for students who fail in the courses of a particular semester.

3.27 The minimum credits, required for completing a postgraduate programme is eighty (80).

3.28 'Credit' (C) of a course is a measure of the weekly unit of work assigned for that course in a semester.

3.29 'Course Credit': One credit of the course is defined as a minimum of one (1) hour lecture/minimum of two (2) hours lab/field work per week for eighteen (18) weeks in a semester. The course will be considered as completed only by conducting the final examination.

3.30 'Grade' means a letter symbol (A,B, C etc.) which indicates the broad level of performance of a student in a course/semester/programme.

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

3.32 'Credit Point' (CP) of a course is the value obtained by multiplying the grade point (GP) by the credit (C) of the course.

3.33 'Semester Grade Point Average' (SGPA) of a semester is calculated by dividing total credit points obtained by the student in a semester by total credits of that semester and shall be rounded off to two decimal places.

3.34 'Cumulative Grade Point Average' (CGPA) is the value obtained by dividing the sum of credit points in all the courses obtained by the student for the entire programme by the total credits of the whole programme and shall be rounded off to two decimal places.

3.35 'Institution average' is the value obtained by dividing the sum of the marks obtained by all students in a particular course by the number of students in respective course.

3.36 'Weighted Average Score' means the score obtained by dividing sum of the products of marks secured and credit of each course by the total credits of that semester/programme and shall be rounded off to two decimal places.

3.37 'Grace Marks' means marks awarded to course/courses, in recognition of meritorious achievements of a student in NCC/NSS/Sports/Arts and cultural activities.

3.38 First, Second and Third position shall be awarded to students who come in the first three places based on the overall CGPA secured in the programme in the first chance itself.

4. PROGRAMME STRUCTURE

4.1 The programme shall include two types of courses; Core Courses and Elective Courses. There shall be a project/research work to be undertaken by all students. The programme will also include assignments, seminars, practical, viva-voce etc., if they are specified in the curriculum.

4.2 Total credits for a programme is eighty (80). No course shall have more than four (4) credits.

4.3 **Project/dissertation**

Project/research work shall be completed by working outside the regular teaching hours except for MSc Computer Science programme. Project/research work shall be carried out under the supervision of a teacher in the concerned department. A student may, however, in certain cases be permitted to work in an industrial/research organization on the recommendation of the supervisor. There shall be an internal assessment and external assessment for the project/dissertation. The external evaluation of the Project/Dissertation shall be based on the individual presentation in front of the expert panel.

4.4 **Evaluations**

The evaluation of each course shall contain two parts.

i Internal or In-Semester Assessment (ISA)

ii External or End-Semester Assessment (ESA)

Both ISA and ESA shall be carried out using indirect grading. The ISA:ESA ratio is 1:3. Marks for ISA is 25 and ESA is 75 for all courses.

4.5 **In-semester assessment of theory courses**

The components for ISA are given below.

Component	Marks
Attendance	2
Viva	3
Assignment	4
Seminar	4
Class test	4
Model Exam	8
Total	**25**

4.6 Attendance evaluation of students for each course shall be as follows:

% of Attendance	Marks
Above 90	2
75 - 90	1

4.7 **Assignments**

Every student shall submit one assignment as an internal component for every course.

4.8 **Seminar**

Every student shall deliver one seminar as an internal component for every course. The seminar is expected to train the student in self-study, collection of relevant matter from the books and internet resources, editing, document writing, typing and presentation.

4.9 **In-semester examination**

Every student shall undergo at least two in-semester examinations one as class test and second as model examination as internal component for every theory course.

4.10 To ensure transparency of the evaluation process, the ISA mark awarded to the students in each course in a semester shall be published on the notice board according to the schedule in the academic calendar published by the College. There shall not be any chance for improvement for ISA. The course teacher and the faculty mentor shall maintain the academic record of each student registered for the course which shall be forwarded to the office of the Controller of Examinations through the Head of the Department and a copy shall be kept in the office of the Head of the Department for at least two years for verification.

4.11 **In-semester assessment of practical courses**

The internal assessment of practical courses shall be conducted either annually or in each semester. There shall be one in-semester examination for practical courses. The examination shall be conducted annually or in each semester. The components for internal assessment is given below.

Component	Marks
Attendance	2
Lab Test	15
Viva-Voce	5
Record	3
Total	**25**

Attendance evaluation of students for each course shall be as follows:

% of Attendance	Marks
Above 90	2
75 - 90	1

4.12 **End-semester assessment**

The end-semester examination in theory and practical courses shall be conducted by the College.

4.13 The end-semester examinations for theory courses shall be conducted at the end of each semester. There shall be one end-semester examination of three (3) hours duration in each lecture based course.

4.14 The question paper should be strictly on the basis of model question paper set by Board of Studies.

4.15 A question paper may contain short answer type/annotation, short essay type questions/problems and long essay type questions. Marks for each type of question can vary from programme to programme, but a general pattern may be followed by the Board of Studies.

4.16 Question Pattern for external theory examination shall be,

Section	Total No. of Questions	Questions to be Answered	Marks	Total Marks for the Section
A	14	10	2	20
B	8	5	5	25
C	4	2	15	30
			Maximum	**75**

4.17 Photocopies of the answer scripts of the external examination shall be made available to the students for scrutiny as per the regulations in the examination manual.

4.18 Practical examination shall be conducted in each semester. Practical examination shall be conducted by one external examiner and one internal examiner. The question paper setting and evaluation of answer scripts shall be done as per the directions in the examination manual of the College. The duration of practical examination shall be decided by the Board of Studies.

4.19 Project/Dissertation evaluation shall be conducted at the end of the programme. Project/Dissertation evaluation shall be conducted by two external examiners. The components and mark division for internal and external assessment shall be decided by the respective Board of Studies.

Components of Project Evaluation	Marks
Internal Evaluation	25
Dissertation (External)	50
Viva-Voce (External)	25
Total	**100**

4.20 Comprehensive viva-voce shall be conducted at the end of the programme. Viva-voce shall be conducted by two external examiners and one internal examiner. The viva-voce shall cover questions from all courses in the programme. There shall be no internal assessment for comprehensive viva-voce. The maximum marks for viva-voce is one hundred (100).

4.21 For all courses (theory and practical) an indirect grading system based on a seven (7) point scale according to the percentage of marks (ISA + ESA) is used to evaluate the performance of the student in that course. The percentage shall be rounded mathematically to the nearest whole number.

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

4.22 **Credit Point**

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

4.23 **Semester Grade Point Average**

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

SGPA = TCP/TCS

where TCP is the total credit point of all the courses in the semester and TCS is the total credits in the semester

GPA shall be rounded off to two decimal places.

4.24 **Cumulative Grade Point Average**

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

CGPA = TCP/TC

where TCP is the total credit point of all the courses in the whole programme and TC is the total credit in the whole programme

GPA shall be rounded off to two decimal places.

Grades for the different courses, semesters, Semester Grade Point Average (SGPA) and grades for overall programme, Cumulative Grade Point Average (CGPA) are given based on the corresponding Grade Point Average (GPA) as shown below:

GPA	Grade	Performance
9.5 and above	S	Outstanding
8.5 to below 9.5	A+	Excellent
7.5 to below 8.5	A	Very Good
6.5 to below 7.5	B+	Good
5.5 to below 6.5	B	Above Average
4.5 to below 5.5	C	Satisfactory
4 to below 4.5	D	Pass
Below 4	F	Failure

4.25 A separate minimum of 40% marks each in ISA and ESA (for theory and practical) and aggregate minimum of 40% are required for a pass in a course. For a pass in a programme, a separate minimum of grade 'D' is required for all the individual courses.

5. SUPPLEMENTARY/IMPROVEMENT EXAMINATION

5.1 There will be supplementary examinations and chance for improvement. Only one chance will be given for improving the marks of a course.

5.2 There shall not be any improvement examination for practical courses and examinations of the final year.

6. ATTENDANCE

6.1 The minimum requirement of aggregate attendance during a semester for appearing the end semester examination shall be 75%. Condonation of shortage of attendance to a maximum of ten (10) days in a semester subject to a maximum of two times during the whole period of postgraduate programme may be granted by the College. This condonation shall not be counted for internal assessment.

6.2 Benefit of attendance may be granted to students representing the College, University, State or Nation in Sports, NCC, NSS or Cultural or any other officially sponsored activities such as College union/University union activities etc., on production of participation/attendance certificates, within one week from competent authorities, for the actual number of days participated, subject to a maximum of ten (10) days in a semester, on the specific recommendations of the Faculty Mentor and Head of the Department.

6.3 A student who does not satisfy the requirements of attendance shall not be permitted to appear in the end-semester examinations.

6.4 Those students who are not eligible even with condonation of shortage of attendance shall repeat the course along with the next batch after readmission.

7. BOARD OF STUDIES AND COURSES

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

7.2 The syllabus of a programme shall contain programme objectives and programme outcome.

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

7.4 Each course shall have an alpha numeric code which includes abbreviation of the course in two letters, semester number, course code and serial number of the course.

7.5 Every programme conducted under Credit Semester System shall be monitored by the Academic Council.

8. REGISTRATION

8.1 A student who registers his/her name for the external exam for a semester will be eligible for promotion to the next semester.

8.2 A student who has completed the entire curriculum requirement, but could not register for the Semester examination can register notionally, for getting eligibility for promotion to the next semester.

8.3 A student may be permitted to complete the programme, on valid reasons, within a period of eight (8) continuous semesters from the date of commencement of the first semester of the programme

9. ADMISSION

9.1 The admission to all PG programmes shall be as per the rules and regulations of the College/University.

9.2 The eligibility criteria for admission shall be as announced by the College/University from time to time.

9.3 Separate rank lists shall be drawn up for seats under reservation quota as per the existing rules.

9.4 There shall be an academic and examination calendar prepared by the College for the conduct of the programmes.

10. ADMISSION REQUIREMENTS

10.1 Candidates for admission to the first semester of the PG programme through SB-CSS-PG shall be required to have passed an appropriate degree examination of Mahatma Gandhi University or any University or authority, duly recognized by the Academic council of Mahatma Gandhi University as equivalent thereto.

11. MARK CUM GRADE CARD

11.1 The College under its seal shall issue to the students, a Mark cum Grade Card on completion of each semester, which shall contain the following information.

i. Name of the Student
ii. Register Number
iii. Photo of the Student
iv. Degree
v. Programme
vi. Semester and Name of the Examination

vii. Month and Year of Examination
viii. Faculty
ix. Course Code, Title and Credits of each course opted in the semester
x. Marks for ISA, ESA, Total Marks (ISA + ESA), Maximum Marks, Letter Grade, Grade Point (GP), Credit Point (CP) and Institution Average in each course opted in the semester
xi. Total Credits, Marks Awarded, Credit Point, SGPA and Letter Grade in the semester
xii. Weighted Average Score
xiii. Result
xiv. Credits/Grade of Extra Credit and Audit Courses

11.2 The final Mark cum Grade Card issued at the end of the final semester shall contain the details of all courses taken during the entire programme including those taken over and above the prescribed minimum credits for obtaining the degree. The final Mark cum Grade Card shall show the CGPA and the overall letter grade of a student for the entire programme.

11.3 A separate grade card shall be issued at the end of the final semester showing the extra credit and audit courses attended by the student, grade and credits acquired.

12. AWARD OF DEGREE

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

13. MONITORING COMMITTEE

There shall be a Monitoring Committee constituted by the Principal to monitor the internal evaluation conducted by the College. The Course Teacher, Faculty Mentor, and the College Coordinator should keep all the records of the continuous evaluation, for at least a period of two years, for verification.

14. GRIEVANCE REDRESS COMMITTEE

14.1 In order to address the grievance of students relating to ISA, a two-level grievance redress mechanism is envisaged.

14.2 A student can approach the upper level only if grievance is not addressed at the lower level.

14.3 Department level: The Principal shall form a Grievance Redress Committee in each Department comprising of course teacher and one senior teacher as members and the Head of the Department as Chairman. The Committee shall address all grievances relating to the internal assessment of the students.

14.4 College level: There shall be a College level Grievance Redress Committee comprising of Faculty Mentor, two senior teachers and two staff council members (one shall be an elected member) and the Principal as Chairman. The Committee shall address all grievances relating to the internal assessment of the students.

15. TRANSITORY PROVISION

Notwithstanding anything contained in these regulations, the Principal shall, for a period of three years 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.

REGULATIONS FOR EXTRACURRICULAR COURSES, INTERNSHIP AND SKILL TRAINING

COURSE ON BASIC LIFE SUPPORT SYSTEM AND DISASTER MANAGEMENT (BLS & DM)

i. The course on BLS & DM shall be conducted by a nodal centre created in the college.
ii. The nodal centre shall include at least one teacher from each department. A teacher shall be nominated as the Director of BLS & DM.
iii. The team of teachers under BLS & DM shall function as the trainers for BLS & DM.
iv. The team of teachers under BLS & DM shall be given intensive training on Basic Life Support System and Disaster Management and the team shall be equipped with adequate numbers of mannequins and kits for imparting the training to students.
v. Each student shall under go five (5) hours of hands on training in BLS & DM organised by the Centre for BLS & DM.
vi. The training sessions shall be organised on weekends/holidays/vacation during the first semester of the programme.
vii. After the completion of the training, the skills acquired shall be evaluated using an online test and grades shall be awarded.
viii. Nodal centre for BLS & DM shall conduct online test and publish the results.
ix. Students who could not complete the requirements of the BLS & DM training shall appear for the same along with the next batch. There shall be two redo opportunity.
x. For redressing the complaints in connection with the conduct of BLS & DM students shall approach the Grievance Redress Committee functioning in the college.

COURSE ON MENDELY REFERENCE MANAGEMENT SOFTWARE

i. College shall arrange workshop with hands on training in Mendely reference management software during the first semester.
ii. Students completing the course can enrol for an evaluation and those who pass the evaluation shall be given one credit.

INTERNSHIP/SKILL TRAINING PROGRAMME

i. Postgraduate student can undergo an internship for a minimum period of five days (25 hours) at a centre identified by the concerned department. In the case of disciplines where internship opportunities are scanty (e.g. Mathematics) special skill training programmes with duration of five days (25 hours) shall be organised.
ii. Each department shall identify a teacher in charge for internship/skill training programme.
iii. The department shall select institutions for internship/organising skill training programme.
iv. Internship/skill training programme shall be carried out preferably during the summer vacation following the second semester or during the Christmas vacation falling in the second semester or holidays falling in the semester.
v. At the end of the stipulated period of internship each student shall produce an internship completion cum attendance certificate and an illustrated report of the training he/she has underwent, duly certified by the tutor and Head of the institution where the internship has been undertaken.
vi. Students undergoing skill training programme shall submit a training completion cum attendance certificate and a report of the training he/she has underwent, duly certified by the trainer, teacher co-ordinator of the programme from the concerned department and the head of the department concerned.
vii. Upon receipt of the internship completion cum attendance certificate and illustrated report of the training or a training completion cum attendance certificate and a report of the training, the teacher in charge of internship/skill training programme shall prepare a list of students who have completed the internship/skill training programme and a list of students who failed to complete the programme. Head of the department shall verify the lists and forward the lists to the Controller of Examinations.

PAPER PRESENTATION

i. During the period of the programme students shall be encouraged to write and publish research/review papers.
ii. One research/review paper published in a UGC approved journal or oral presentation in an international/national seminar which is later published in the proceedings shall fetch one credit.

VIRTUAL LAB EXPERIMENTS/MOOC COURSES

i. During the tenure of the programme, students shall be encouraged to take up Virtual Lab Experiments and/or MOOC Courses.

ii. College shall arrange dedicated infrastructure for taking up Virtual Lab experiments and/or MOOC courses.

iii. There shall be a Nodal Officer and a team of teachers to coordinate the logistics for conducting Virtual Lab experiments and MOOC courses and to authenticate the claims of the students regarding the successful completion of the Virtual Lab experiments and or MOOC courses.

iv. Students who are desirous to do Virtual Lab experiments and or MOOC courses shall register with the Nodal Officer at the beginning of the experiment session/MOOC course. Students also shall submit proof of successful completion of the same to the Nodal officer.

v. Upon receipt of valid proof, the Nodal Officer shall recommend, to the Controller of Examinations, the award of extra credits. In the case of Virtual Lab experiments, 36 hours of virtual experimentation shall equal one credit and in the case of MOOC courses 18 hours of course work shall equal one credit.

Model Mark cum Grade Card

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Changanassery, Kottayam, Kerala, India-686101

MARK CUM GRADE CARD

Date:

Name of the Candidate :

Permanent Register Number (PRN) :

Degree :

Programme :

Name of Examination :

Faculty :

Photo

Course Code	Course Title	Credits (C)	Marks						Grade Awarded (G)	Grade Point (GP)	Credit Point (CP)	Institution Average	Result
			ISA		ESA		Total						
			Awarded	Maximum	Awarded	Maximum	Awarded	Maximum					
	Total SGPA: SG: WAS: ***End of Statement***												

*WAS: Weighted Average Score

Entered by:

Verified by:

Controller of Examinations **Principal**

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E-mail: sbc@sbcollege.org Web: www.sbcollege.ac.in

CONSOLIDATED MARK CUM GRADE CARD

Name of the Candidate :

Permanent Register Number (PRN) :

Degree :

Programme :

Faculty :

Date :

Photo

Course Code	Course Title	Credits (C)	Marks						Grade Awarded (G)	Grade Point (GP)	Credit Point (CP)	Institution Average	Result
			ISA		ESA		Total						
			Awarded	Maximum	Awarded	Maximum	Awarded	Maximum					
SEMESTER I													
SEMESTER II													
SEMESTER III													

SEMESTER IV													
	End of Statement												

PROGRAMME RESULT

Semester	Marks Awarded	Maximum Marks	Credit	Credit Point	SGPA	Grade	WAS	Month & Year of Passing	Result
I II III IV									
Total					**FINAL RESULT: CGPA =**		**; GRADE =**	**;WAS =**	

*** Separate grade card is issued for Audit and Extra Credit courses.**

**** Grace Mark awarded.**

Entered by:

Verified by:

Controller of Examinations **Principal**

Reverse side of the Mark cum Grade Card (COMMON FOR 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 on a seven (7) point scale based on the percentage of Total Marks (ISA + ESA) as given in Table 1. Decimals are corrected to the nearest whole number.

Credit Point and Grade 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

Grade Point Average of a Semester (SGPA) or Cumulative Grade Point Average (CGPA)for a Programme is calculated using the formula

SGPA or CGPA = TCP/TC

where TCP is the Total Credit Point for the semester/programme and TC is the Total Credit for the semester/programme

GPA shall be rounded off to two decimal places.

The percentage of marks is calculated using the formula;

$$\% \text{ Marks} = \left(\frac{\text{total marks obtained}}{\text{maximum marks}}\right) \times 100$$

Weighted Average Score (WAS) is the score obtained by dividing sum of the products of marks secured and credit of each course by the total credits of that semester/programme and shall be rounded off to two decimal places.

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

Table 1

Grades for the different Semesters and overall Programme are given based on the corresponding GPA, as shown in Table 2.

GPA	Grade	Performance
9.5 and above	S	Outstanding
8.5 to below 9.5	A+	Excellent
7.5 to below 8.5	A	Very Good
6.5 to below 7.5	B+	Good
5.5 to below 6.5	B	Above Average
4.5 to below 5.5	C	Satisfactory
4 to below 4.5	D	Pass
Below 4	F	Failure

Table 2

Note: Course title followed by (P) stands for practical course. A separate minimum of 40% marks each for internal and external assessments (for both theory and practical) and an aggregate minimum of 40% marks is required for a pass in each course. For a pass in a programme, a separate minimum of Grade D for all the individual courses and an overall Grade D or above are mandatory. If a candidate secures Grade F for any one of the courses offered in a Semester/Programme, only Grade F will be awarded for that Semester/Programme until the candidate improves this to Grade D or above within the permitted period.

PROGRAMME STRUCTURE

	Course Code	Course Title	Hours /Week	Total Hours	Credit	ISA	ESA	Total
Semester I	BMBO101	Microbiology and Phycology	4	72	4	25	75	100
	BMBO102	Mycology, Lichenology and Crop Pathology	4	72	4	25	75	100
	BMBO103	Bryology and Pteridology	4	72	4	25	75	100
	BMBO104	Gymnosperms and Evolution	3	54	3	25	75	100
	BMBO1P01	Microbiology and Phycology & Mycology, Lichenology and Crop Pathology (P)	5.5	99	2	25	75	100
	BMBO1P02	Bryology and Pteridology & Gymnosperms and Evolution (P)	4.5	81	2	25	75	100
		Total	**25**	**450**	**19**	**150**	**450**	**600**
Semester II	BMBO205	Ecology and Environmental Science	3	54	3	25	75	100
	BMBO206	Genetics and Plant Breeding	4	72	4	25	75	100
	BMBO207	Molecular Biology and Developmental Biology	4	72	4	25	75	100
	BMBO208	Cell Biology and Immunology	4	72	4	25	75	100
	BMBO2P03	Ecology and Environmental Science & Genetics and Plant Breeding (P)	4.5	81	2	25	75	100
	BMBO2P04	Molecular Biology and Developmental Biology & Cell Biology and Immunology (P)	5.5	99	2	25	75	100
		Total	**25**	**450**	**19**	**150**	**450**	**600**
Semester III	BMBO309	Research Methodology, Biophysics, Biostatistics and Microtechnique	4	72	4	25	75	100
	BMBO310	Plant Physiology and Biochemistry	4	72	4	25	75	100
	BMBO311	Angiosperm Anatomy and Embryology	3	54	3	25	75	100
	BMBO312	Angiosperm Morphology and Systematics	4	72	4	25	75	100
	BMBO3P05	Research Methodology, Biophysics, Biostatistics and Microtechnique & Plant Physiology and Biochemistry (P)	5	90	2	25	75	100
	BMBO3P06	Angiosperm Anatomy and Embryology & Angiosperm Morphology and Systematics (P)	5	90	2	25	75	100
		Total	**25**	**450**	**19**	**150**	**450**	**600**
Semester IV	BMBO413	Plant Tissue Culture and Microbial Biotechnology	5	90	4	25	75	100
	BMBO414	Genetic Engineering	5	90	4	25	75	100
	BMBO415	Genomics, Proteomics and Bioinformatics	5	90	4	25	75	100
	BMBO4P07	Plant Tissue Culture and Microbial Biotechnology (P)	4	72	2	25	75	100
	BMBO4P08	Genetic Engineering & Genomics, Proteomics and Bioinformatics (P)	6	108	2	25	75	100
	BMBO4PJ	Project	-	-	4	25	75	100
	BMBO4VV	Viva-Voce	-	-	3	-	100	100
		Total	**25**	**450**	**23**	**150**	**550**	**700**
		Grand Total	**-**	**-**	**80**	**600**	**1900**	**2500**

SEMESTER I

BMBO101: MICROBIOLOGY AND PHYCOLOGY

Credit: 4 **Total Hours: 72**

Course Objectives:-

- To train the students to accomplish mastery in the field of Phycology and Microbiology
- To provide in-depth knowledge of diversity and significance of algae and microbes
- To enable the students to explore the intricacies of life forms at cellular and molecular level
- To inspire the students to apply the acquired knowledge to create a better environment

Course Outcome:-

- Students will be able to identify the major groups of algae and microbes and be able to classify them within a phylogenetic framework.
- Students will be able to compare and contrast the characteristics of different groups of algae and microbes that differentiate them from each other and from other forms of life.
- Students will be able to use the evidence of comparative biology to explain how the theory of evolution offers the only scientific explanation for the unity and diversity of life on earth.
- Students will be able to explain the physiological adaptations, development, reproduction and behavior of different forms of algae and microbes
- Students will be able to explicate the ecological interconnectedness of life on earth.

Microbiology (27 hours)

Module 1: Introduction to microbiology (5 hours)

Microscopy and the discovery of Microbes; Golden age of Microbiology, Contributions of Robert Koch & Louis Pasteur, Germ theory of disease, Vaccination; Members of the Microbial World-Archaebacteria, Non-proteobacterial Gram-Negative Bacteria, Proteobacteria, Firmicutes, Actinobacteria, The Protists, Fungi, and Viruses.

Module 2: Bacteria (10 hours)

Morphology; size, shape and arrangement of bacterial cells ; Detailed structure of bacterial cell wall, structures external to the cell wall (glycocalyx, flagella, axial filament, fimbriae and

pili), structures internal to the cell wall (cytoplasm, nuclear area, ribosomes, inclusions, endospores); Major groups of Bacteria: Spirochetes, Rickettsias, Chlamydias, Mycoplasmas, Actinomycetes, Myxobacteria, Archaebacteria; Bacterial Genetics: Bacterial chromosome and plasmid. Genetic recombination in bacteria - conjugation, transformation and transduction; Microbial Classification: Taxonomic Ranks, Characteristics used for classification, Three domain System and Bergey's Manuals-First and Second Editions; Microbial Growth: Requirements, Culture Media, Growth Curve- Bacterial populations, Division, Generation Time, Phases of Growth, Representation of growth, Measurement of growth- direct and Indirect methods.

Module 3: Viruses (8 hours)

Discovery and General Characteristics; Nomenclature and classification-Principles of Virus Taxonomy, International Committee for Taxonomy of Viruses, Characteristics used for classification; Viral capsids and their arrangements, types of envelops and their composition, Viral genome; Structure of bacteriophages belonging to 'T' series, TMV and HIV; Viral replication (T- even phages and λ phage): Lytic and Lysogenic; DNA oncogenic viruses, RNA oncogenic viruses; Sub viral particles - prions, viroids, virusoid

Module 4: Significance of Microbes (4 hours)

Microbial diversity and habitats, biogeochemical cycles and microbes (brief account only), Aquatic micro organisms, biofilms, role of microbes in water quality ;Industrial Food Canning and Spoilage of foods, Aseptic Packaging, Radiation and Industrial Food Preservation, High-Pressure Food Preservation; Micro organisms in Food Production: Cheese and other dairy products, Non-dairy Fermentations, Alcoholic Beverages and Vinegar.

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4. Pelczar Michael J, Adams M R, Chan E C S, Krieg Noel R. Microbiology. Tata McGraw Hill.
5. Dubey R C, Maheswari D K, Microbiology. S Chand.
6. Dube H C .Fungi, Bacteria and Viruses. Agrobios.
7. Kayser F H, Bienz K A, Eckert J, Zinkernagel R M. *Medical Microbiology*
8. Haahelm L R, Pattison J R, Whitley R J. Clinical virology.

Phycology (45 hours)

Module 1: Algal Cell (5 hours)

Structure of algal cell, cell wall and mucilaginous components, flagella-acronematicflagellum and pantonematic flagellum, flagellar hairs - Non-tubular and tubular; Arrangement of flagella - isokontflagella,anisokont flagella, stephanokontflagella; plastids, pyrenoids, eye spots , algal responses to light- phototaxis, photophobia, and gliding, algal mitochondria and peroxisomes, Contractile vacuoles, storage products - α-1,4 Linked glucans (Floridean starch, Myxophycean starch, Starch), β-1,3 Linked glucans (Laminarin, Chrysolaminarin, Paramylon), Fructosans, Low-molecular-weight compounds (sugars, Glycosides, polyols)

Module 2: Classification of algae (3 hours)

Classification of alga by Linnaeus, F. E. Fritsch, Gene sequencing and algal systematics, fossil algae

Module 3: Cyanophyceae (6 hours)

Morphology, cell structure, cell wall, gliding, pili, sheaths, protoplasmic structures, carboxysomes, cyanophycin, polyphosphate bodies, polyglucan granules, gas vacuoles, pigments, akinetes ; Nitrogen fixation, heterocysts, structure and formation, mechanisms to protect nitrogenase form oxygen – (1) Heterocystous cyanobacteria (2) Non-filamentous cyanobacteria that fix nitrogen in the dark but not in the light (3) filamentous cyanobacteria that fix nitrogen in the light without heterocyst ; Asexual reproduction – hormogonia, baeocytes ; Symbiosis - extracellular associations, intracellular associations ; Habitats - Marine environment (Littoral zone, open ocean), Fresh water, hot springs, terrestrial, anhydrobiotics ; Adaption to silting and salinity ; Cyanotoxins , cyanobacteria as source of food, antibiotics and siderophores; Cyanophages

Module 4: Glaucophyta (1 hour)

Definition, characteristics, cyanelles, cyanome, syncyanosis, examples

Module 5: Rhodophyceae (6 hours)

Cell structure, pit connections between cells, cell wall calcification- calcite and aragonite, Rhodoliths, secretory cells, thallus iridescence ;Photosynthetic pigments, storage products ; Reproductive structures, fertilization, post fertilization changes, asexual spores – monosporangia and parasporangia ; Defense mechanisms of the red algae, Commercial utilization of red algal mucilages – agar, carrageenan

Module 6: Chlorophyceae (6 hours)

Cell structure, phototaxis and eyespots; Thallus variation; Plastids, photosynthetic pigments, storage products; Asexual reproduction, sexual reproduction, Desmids- diversity in thallus, reproduction

Module 7: Bacillariophyceae (3 hours)

Cell structure, cell wall, extracellular mucilage - (1) tubes, (2) pads, (3) stalks, (4) fibrils, and (5) adhering films, biolfouling, and gliding ; Plastids, photosynthetic pigments and storage products ; Resting spores and resting cells , auxosporese ; Asexual reproduction – cell division; sexual reproduction ; Chemical defense against predation ; Fossil diatoms

Module 8: Xanthophyceae (6 hours)

Cell structure, cell wall; Plastids, photosynthetic pigments and storage products; Asexual reproduction and sexual reproduction

Module 9: Phaeophyceae (6 hours)

Cell structure, cell wall; Plastids, photosynthetic pigments and storage products – phlorotannins; Asexual reproduction and sexual reproduction

Module 10: Industrial applications of algae (3 hours)

Common cultivated species in India and production statistics, algal culture: types algal culture media, algal research station in India, algal fuel

References

1. Chapman V J . The Algae. Macmillan & Co. Ltd.
2. Gilbert M Smith. Cryptogamic Botany (Vol. 1): Algae and Fungi. Tata McGraw Hill Edition.
3. F E Fritsch (Vol. I, II) .The structure and reproduction of Algae. Cambridge University Press.
4. Harnold C Bold, Michael J Wynne (1978). Introduction to Algae: Structure and reproduction. Prentice Hall
5. Phycology (Fourth edition), Robert Edward Lee, Cambridge University Press
6. Pringsheim E G. Pure culture of Algae. Cambridge University Press
7. Iyengar M O P and Desikachary T V, ICAR Publication

BMBO102: MYCOLOGY, LICHENOLOGY AND CROP PATHOLOGY

Credit: 4 **Total Hours: 72**

Course Objectives:-

- To train the students to accomplish mastery in the field of Mycology, Lichenology and Crop Pathology
- To provide in-depth knowledge of diversity and significance of fungi , lichens and plant pathogens
- To enable the students to explore the intricacies of life forms at cellular and molecular level
- To inspire the students to apply the acquired knowledge to create a better environment

Course Outcome:-

- Students will be able to identify the major groups of fungi, lichen and plant pathogens and be able to classify them within a phylogenetic framework.
- Students will be able to compare and contrast the characteristics of different groups of fungi and lichens that differentiate them from each other and from other forms of life.
- Students will be able to use the evidence of comparative biology to explain how the theory of evolution offers the only scientific explanation for the unity and diversity of life on earth.
- Students will be able to explain the physiological adaptations, development, reproduction and behavior of different forms of fungi and lichens
- Students will be able to explicate the ecological interconnectedness of life on earth.

Mycology (45 hours)

Module 1: General introduction (4 hours)

General characters of Fungi (Self- study); Ultra structure of fungal cell wall, hyphal growth, polarity of the hypha, Hyphal aggregates – mycelial strands, rhizomorphs, sclerotia – loose type, strand type, terminal type and other types , germination of sclerotia, mantle produced by ectomycorrhiza,Hartig net, Fungal spores – zoospores, sporangiospores, ascospores, basidiospores, zygospores, oospores, chlamydospores, conidia, conidial types thallic and blastic; holoblastic , enteroblastic , anamorphs and teleomorphs, Fungal taxonomy – traditional methods and molecular methods of fungal taxonomy, Classifications by G C Ainsworth (1973), C. J. Alexopoulos, McLaughlin et al., (2001)

Module 2: Thallus structure and reproduction in Fungi (18 hours)

Mycelial structure and reproduction of; Myxomycota–Acrasiomycetes, Hydromyxomycetes, Myxomycetes, Plasmodiophoromycetes; Mastigomycotina- Chytridiomycetes, Hyphochytridiomycetes, Oomycetes; Zygomycotina- Zygomycetes, Trichomycetes ; Ascomycotina - Hemiascomycetes, Pyrenomycetes, Plectomycetes, Discomycetes,Laboulbeniomycetes, Loculoascomycetes; Basidiomycotina - Teliomycetes, Hyphomycetes, Gastromycetes ; Deuteromycotina - Blastomycetes, Hyphomycetes, Coelomycetes.

Module 3: Fungal nutrition (**3 hours**)

Nutrition requirements: carbon energy source, fungal adaptations for nutrient capture - enzymes, mechanism of nutrient uptake.

Module 4: Importance of Fungi (**8 hours**)

Nematophagous fungi, nematode-fungus interactions –stimulation of trap formation, adhesion and the infection process; Mycorrhiza; plant-fungus symbiosis, definition of mycorrhizas, evolution of mycorrhiza; hierarchical classification scheme for mycorrhizal Associations (Brundrett 2004) –arbuscular mycorrhizas, ectomycorrhiza, orchid mycorrhiza, ericoid mycorrhiza , sub-epidermal mycorrhiza; mycorrhizal fungi; molecular mechanism behind mycorrhizal symbiosis; significance of mycorrhiza; threats to mycorrhizal association; experimental methods to study mycorrhizas.

Fungi – insect associations – fungi acting against insects, fungi mutualistic with insects, fungal garden, Industrial applications of fungi, cellulose derived fuels and fungal enzymes

Module 5: Lichens (**12 hours**)

Lichens as a good example of symbiosis, Lichens as self-contained miniature ecosystems, Lichenization: a successful nutritional strategy; Distribution of lichens; Photobionts: Cyanobionts and Phycobionts. Mycobionts; Thallus morphology of lichen. Growth forms: Crustose lichens- endolithic and endophloeodic forms; areolated thallus, effigurate thallus, squamulose thallus, peltate, bullate, suffruticose, lobate forms. Foliose lichens-laciniate and umbilicate forms; Fruticose lichens

Thallus anatomy - homoiomerous thallus and stratified thallus; pseudoparenchymatous and prosoplectenchymatous tissues; cortex, epicortex, and epinecral layers; pruina; photobiont layer, medulla and lower cortex; Attachment organs and appendages- cilia, tomentum, cyphellae and pseudocyphellae, cephalodia; Reproductive structures - teleomorph and anamorph structures, Sexual reproduction- ascoma, Perithecia, Apothecia, Thallinocarpia, Pycnoascocarpia, Hysterothecia, Asci, Basidioma. Asexual and vegetative reproduction-

Conidiomata, Pycnidia, Campylidia, sporodochium, Hyphophores, Thallospores, Hormogonia

Lichen identification- morphological, anatomical and chemical methods ; Lichen substances - intracellular and extracellular products, major categories of lichen, applications of lichen substances –as medicines, dyes, cosmetics, antibacterial, antiviral, antitumour and antioxidant compounds; Ecological significance of lichens

References

1. Alexopoulos C J, Blackwell M, Mims C W. *Introductory Mycology* (IV Edn).
2. Jim Deacon (2006). *Fungal Biology* (IV Edn).Blackwell Publishing.
3. Nair L N (2010). *Methods of microbial and plant biotechnology*. New Central Book agency (P) Ltd.
4. Kanika Sharma. *Manual of microbiology: Tools and techniques*.
5. Ainsworth G C, Sparrow K F, Sussman A S. *The fungi: An advanced treatise*.
6. John Webster and Roland Weber, Mycology - Introduction to Fungi(Third Edition), ,Cambridge University Press
7. Thomas H Nash, Lichen - Lichen Biology (Second Edition), Cambridge University Press

Crop Pathology (27 hours)

Module 1: Introduction to crop pathology

Plant disease-definition- different types of pathogens – transmission of disease- symptoms of plant disease- physical, chemical and biological control measures **(Self Study)**

Module 2: History of crop pathology (2 hours)

A brief history of plant pathology - Potato blight and the Irish famine, Losses caused by plant diseases, examples of severe losses caused by plant diseases

Module 3: Parasitism and disease development (3 hours)

Host range of pathogens, disease cycle- persistence of pathogen between crops and during unfavorable seasons. Effect of pathogens on plant physiological functions, Effect of pathogens the following processes of the host plant – photosynthesis, transpiration, translocation of water and nutrients, respiration, transcription and translation, growth and reproduction

Module 4: Strategies used by pathogens to attack plants (5 hours)

Role of appressorium in disease development, Chemical weapons of pathogens – enzymes, toxins (Tabtoxin, Phaseolotoxin, Tentoxin, Cercosporin, Victorin, T Toxin, HC Toxin), polysaccharides, Role of plant growth regulators in disease

Module 5: Plant defense against pathogens (6 hours)

Horizontal and vertical resistance, Preexisting defense structures and chemical, Defense through lack of essential factors - lack of host receptors and sensitive sites for toxins, lack of essential substances for the pathogen, Induced structural defense – Histological defense structures, Induced biochemical defense –hypersensitive response, plant defense genes, Defense through Production of Secondary Metabolites

Effect of environmental factors on the development of plant diseases-Effect of temperature, moisture, wind, light, soil pH, host plant nutrition on the development of plant diseases

Module 6: Plant disease management (4 hours)

Physical, chemical and biological control, Genetically engineering disease resistant plants – with plant derived genes, with pathogen derived genes, defense through RNA silencing by pathogen derived genes, crop protection plan (CPP)

Module 7: Major diseases in plants (7 hours)

Symptom, causal organism and management of diseases of:

Cereals: Rice - blast disease; Vegetables: Chilly - leaf spot; Ladies finger - vein clearing disease; Fruits: Mango - Anthracnose; Citrus - bacterial canker; Papaya – mosaic; Spices: Ginger - rhizome rot; Pepper - quick wilt; Cardamom - marble mosaic disease; Oil seeds: Coconut - grey leaf spot, bud rot disease; Rubber yielding: *Heveabraziliensis*- powdery mildew; Sugar yielding: Sugarcane - red rot; Beverages: Tea - blister blight; Coffee - rust.

References

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2. Gareth Johnes. Plant pathology: principles and practice.
3. R S Mehrotra. Plant Pathology.
4. M N Kamat. Practical plant pathology.
5. V K Gupta, T S Paul. Fungi and Plant disease.
6. Aneja, K. R. : Experiments in Microbiology, plant pathology and Tissue culture
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PRACTICAL

BMBO1P01: MICROBIOLOGY AND PHYCOLOGY & MYCOLOGY, LICHENOLOGY AND CROP PATHOLOGY

Credit: 2 **Total Hours: 45+54**

Microbiology Practical (18 hours)

1. Preparation and sterilization of various microbial culture media and inoculation.
2. Differential staining of bacteria using Gram stain.
3. Isolation of *Rhizobium* from root nodules.
4. Isolation of microbes from soil: Serial dilution - pour plate/spread plate method.
5. Streak out a bacterial culture on an agar plate and isolation of colonies.
6. Antibacterial assay - disc diffusion/agar well method.

Phycology Practical (27 hours)

1. Study of diagnostic morphological, anatomical features of the following genera *Gleocapsa, Spirulina, Oscillatoria, Lyngbya, Nostoc, Rivularia, ScytonemaChlamydomonas, Pandorina, Volvox, Tetraspora, Ulothrix, Microspora, Ulva, Cladophora, Pithophora, Coleochaete, Drapernaldiopsis, Trentepohlia, Cephaleuros, Oedogonium, Bulbochaete, Zygnema, Mougeotia, Sirogonium, Desmidium, Bryopsis, Acetabularia, Codium, Caulerpa, Halimeda, Chara, Nitella. Vaucheria, Pinnularia, Ectocarpus, Colpomenia, Hydroclathrus, Dictyota,Padina, Sargassum, Turbinaria, Brtrachospermum, Amphiroa, Gracilaria, Polysiphonia.*
2. Students are to collect and identify algae from fresh water and marine habitats and submit a report of the field work

Mycology Practical (45 hours)

1. Critical study of the following types by preparing suitable micropreparations;*Stemonitis, Physarum, Saprolegnia, Phytophthora, Albugo, Mucor, Aspergillus, Penicillium, Pilobolous, Saccharomyces, Xylaria, Peziza, Phyllochora, Puccinia, Termitomyces, Pleurotus, Auricularia, Polyporus, Lycoperdon, Dictyophora, Geastrum, Cyathus, Fusarium, Alternaria, Cercospora, Pestalotia.*
2. Isolation of fungi from rotten vegetables and culturing the same on PDA

3. Slide culture of fungi
4. Fungal spore staining using malachite green and carbol fuchsin
5. Culturing of VAM using maize and vetiver
6. Staining and observing VAM
7. Collection and identification of common field mushrooms (minimum five types)

*8.*Critical study of the following types by preparing suitable micropreparations; *Graphis, Parmelia, Cladonia, Usnea.*

Crop Pathology Practical (**9 hours**)

1. Isolation of pathogens from diseased tissues (leaf, stem and fruit) by serial dilution method.
2. Submit a minimum of three herbarium sheets of diseased plant materials along with a report.
3. Prepare an illustrated report/video report on the prevalence of the diseases and pest in your locality and interview the farmers concerned and collect the details of the control measures used and submit it along with practical record.
4. Demonstrate Koch's postulates using suitable fruits and fungal inoculum. Submit a report with digital photographs.
5. Isolation of pathogens from diseased tissues (leaf, stem and fruit) by serial dilution method

BMBO103: BRYOLOGY AND PTERIDOLOGY

Credit: 4 **Total Hours: 72**

Course Objectives:-

- To train the students to accomplish mastery in the field of Bryology and Pteridology
- To provide in-depth knowledge of diversity and significance of bryophytes and pteridophytes
- To enable the students to explore the intricacies of life forms at cellular and molecular level
- To inspire the students to apply the acquired knowledge to create a better environment

Course Outcome:-

- Students will be able to identify the major groups of bryophytes and pteridophytes and be able to classify them within a phylogenetic framework.
- Students will be able to compare and contrast the characteristics of different groups of bryophytes and pteridophytes that differentiate them from each other and from other forms of life.
- Students will be able to use the evidence of comparative biology to explain how the theory of evolution offers the only scientific explanation for the unity and diversity of life on earth.
- Students will be able to explain the physiological adaptations, development, reproduction and behavior of different forms of bryophytes and pteridophytes
- Students will be able to explicate the ecological interconnectedness of life on earth.

Bryology (36 hours)

Module 1: General introduction (**4 hours**)

Introduction to Bryophytes,General characters of Bryophytes , Classification of Bryophytes, Fossil history and evolution of Bryophytes, Concept of algal and pteridophytic origin of Bryophytes.

Module 2: Ecology and Economic importance of bryophytes (**6 hours**)

Bryophyte habitats -Water relations - absorption and conduction, ectohydric, endohydric and myxohydric Bryophytes; Xerophytic adaptations, drought tolerance, dessication and rehydration; Ecological significance of Bryophytes - role as pollution indicators; Economic importance of Bryophytes.

Module 3: Thallus structure (**26 hours**)

Comparative structural organization of gametophytes and sporophytes in an evolutionary perspective. Asexual and sexual reproductive structures, spore dispersal mechanisms and germination of the following groups with reference to the types mentioned in the practical (development of sex organs not necessary); Hepaticopsida (Sphaerocarpales, Marchantiales, Jungermanniales and Calobryales); Anthocerotopsida (Anthocerotales); Bryopsida (Sphagnales, Polytrichales and Bryales).

Pteridophytes (36 hours)

Module 1: General introduction and classification (**3 hours**)

Introduction, origin, general characteristics and an outline of the classification of Pteridophytes.

Module 2: Structure of the plant body (27 hours)

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

Psilopsida (a) Rhyniales; *Rhynia ;* Psilotopsida (a) Psilotales; *Psilotum ;* Lycopsida (a) Protolepidodendrales; *Protolepidodendron (b)* Lepidodendrales ;*Lepidodendron* (c) Lycopodiales; *Lycopodium* ; (d) Isoetales; *Isoetes*(e) Selaginellales; *Selaginella* ; Sphenopsida (a) Hyeniales (b) Sphenophyllales; *Sphenophyllum*(c) Calamitales; *Calamites ;* (d) Equisetales; *Equisetum* ; Pteropsida (i) Primofilices (a) Cladoxylales; *Cladoxylon*(b) Coenopteridales; (ii) Eusporangiatae (a) Marattiales; *Angiopteris*(b) Ophioglossales; *Ophioglossum* ; (iii) Osmundales; *Osmunda* ; (iv) Leptosporangiatae (a) Marsileales; *Marsilea*(b) Salviniales; *Salvinia, Azolla*(c) Filicales; *Pteris,Lygodium, Acrostichum, Gleichenia, Adiantum. Ceratopteris*

Module 3: Comparative study of Pteridophytes (**4 hours**)

Stelar organization, soral and sporangial characters, gametophytes and sporophytes of Pteridophytesinan evolutionary perspective.

Module 4: Ecology and Economic importance (**2 hours**)

Ecological and economic significance of Pteridophytes.

References

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BMBO104: GYMNOSPERMS AND EVOLUTION

Credit: 3 **Total Hours: 54**

Course Objectives:-

- To train the students to accomplish mastery in the field of Gymnosperms and Evolution
- To provide in-depth knowledge of diversity and significance of gymnosperms
- To enable the students to explore the intricacies of life forms at cellular and molecular level
- To inspire the students to apply the acquired knowledge to create a better environment

Course Outcome:-

- Students will be able to identify the major groups of gymnosperms and be able to classify them within a phylogenetic framework.
- Students will be able to compare and contrast the characteristics of different groups of gymnosperms that differentiate them from each other and from other forms of life.
- Students will be able to use the evidence of comparative biology to explain how the theory of evolution offers the only scientific explanation for the unity and diversity of life on earth.
- Students will be able to explain the physiological adaptations, development, reproduction and behavior of different forms of gymnosperms
- Students will be able to explicate the ecological interconnectedness of life on earth.

Gymnosperms (36 hours)

Module 1: Introduction (**3 hours**)

Origin, general characteristics, distribution and classification of Gymnosperms, Distribution of living gymnosperms in India.

Module 2: Vegetative and reproductive structures of Gymnosperms (**27 hours**)

Detailed study of the vegetative morphology, anatomy (only selected genera) and reproductive structures of genera mentioned.

(a) Class Progymnospermopsida: *Aneurophyton ;*(b) Class Cycadopsida: *Glossopteris, Cycas, Zamia, Pentoxylon*.(Anatomical features of *Cycas, Zamia and Pentoxylon)*(c) Class Coniferopsida: *Pinus, Taxodium, Cupressus, Podocarpus, Agathis, Araucaria, Taxus and Ginkgo*. (Anatomical features of *Pinus, Cupressus,Podocarpus,Agathis and Araucaria) ;*(d) Class Gnetopsida: *Ephedra, Gnetum* and*Welwitschia*(Anatomical features of *Gnetum*)

Module 3: Gametophyte development and economic importance of Gymnosperms (6 hours)

General account on the male and female gametophyte development in Gymnosperms, Evolutionary trends in gymnosperms. Economic significance of Gymnosperms.

Evolution (18 hours)

Module 1: Evidences of Evolution (3 hours)

Evidences of evolution: Palaentology, morphology and comparative anatomy, embryology, rudimentary organs, biogeography, physiology and biochemistry. evolutionary time scale; Eras, Periods and Epochs.

Module 2: Theories of Evolution (3 hours)

Lamarck, Darwin, Weismann, De-Vries and neo- Darwinian synthesis

Module 3: Speciation (6 hours)

Species concept; subspecies, sibling species, semi species, races, demes. Types of speciation- phyletic and true speciation. Mechanism of speciation- Genetic divergences and isolating mechanisms. Patterns of speciation- allopatric, sympatric, quantum and parapatric.

Module 4: Origin of life (**6 hours**)

Abiogenesis, Biogenesis, Theory of Chemical and Organic Evolution- Experimental evidences of Stanley Miller and Sydney Fox. Phylogeny; Important phylogenetic terms and concepts: Plesiomorphic and Apomorphic characters; Homology and Analogy; Parallelism and Convergence; Monophyly, Paraphyly and Polyphyly. Molecular tools in Phylogeny. Molecular evolution, Molecular divergence and Molecular Clocks. Origin and Evolution of Angiosperms.

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PRACTICAL

BMBO1P02: BRYOLOGY AND PTERIDOLOGY & GYMNOSPERMS AND EVOLUTION

Credit: 2 **Total Hours: 54+27**

Bryology Practical (18 hours)

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

Pteridology Practical (36 hours)

1. Study of morphology and anatomy of vegetative and reproductive organs using clear wholemounts/sections of the following genera:
   Psilotum, Lycopodium, Isoetes, Selaginella, Equisetum, Angiopteris, Ophioglossum, OsmundaMarsilea, Salvinia, Azolla, Lygodium, Acrostichum, Gleichenia, Pteris, Adiantum, Ceratopteris.
2. Study of fossil Pteridophytes with the help of specimens and permanent slides.
3. Field trips to familiarize with the diversity of Pteridophytes in natural habitats.

Gymnosperms Practical (27 hours)

1. Study of the anatomy of vegetative parts of *Cycas, Zamia, Pinus, Cupressus, Podocarpus , Araucaria, Agathis and Gnetum.*
2. Study of fossil gymnosperms through specimens and permanent slides.
3. Study the morphology of reproductive parts of all the genus mentioned in the syllabus.
4. study the wood anatomy of conifers using TLS and RLS

Model Question Papers

MSc DEGREE EXAMINATION

First Semester

MSc Botany

Microbiology and Phycology

Time: 3 Hours Maximum: 75 Marks

Part A

*Answer **any ten** questions. Each question has **2 marks**.*

1. What are Microbes? Name the life forms that are studied under microbiology.
2. What are mesosomes? Explain their role in a bacterial cell.
3. Write a short note on prions.
4. Categorize antimicrobial drugs based on their chemical nature.
5. What are biofilms?
6. What is the function of flagellar collar?
7. What is a pyrenoid?
8. What are the stored food in brown algae?
9. What is endosymbiosis?
10. Define cyanophycin and its composition
11. Define anhydrobiotics with an example
12. What are pit connections?
13. List out the commercial uses of red algal mucilages
14. What are hypanospores?

(10×2=20)

Part B

*Answer **any five** questions. Each question has **5 marks**.*

15. Explain the process of sporulation in bacteria.
16. Elaborate the characteristic features of Rickettsias.
17. Make a brief account on fossil diatoms
18. Explain the diversity and complexity of viral genomes.
19. What is specialized or restricted transduction and how does it come about?
20. Describe the pathogenesis of viral diseases
21. Discuss on the intracellular associations of cyanophyceae
22. Enumerate the salient features of Fritsch system of algal classification.

(5×5=25)

Part C

Answer **any two** questions. Each question has **15 marks**.

23. Describe the bacterial cell wall with the help of suitable illustrations.
24. Describe the thallus variation in green algae.
25. Discuss the affinities of blue green algae to bacteria.
26. Describe the salient features Phaeophyceae. Citing suitable examples describe the reproductive startegies in Phaeophyceae

(2×15=30)

MSc DEGREE EXAMINATION

First Semester MSc Botany

Mycology, Lichenology and Crop Pathology

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

Part A

Answer **any ten** questions. Each question has **2 marks**.

1. Describe Dolipore septum.
2. What are water moulds? Give an example.
3. Perfect spore of Zygomycotina.
4. Describe Haustorium and what is its function.
5. Differentiate between ectomycorrhiza and endomycorrhiza
6. Differentiate between photobionts and mycobionts
7. What are the common symptoms of Fungal diseases in plants?
8. Describe host range of pathogens.
9. How pathogen effect on photosynthesis of host palnt?
10. How Gibberellins act as a chemical weapon for pathogen?
11. Define Horizontal resistance
12. Write a note on R- gene.
13. What are the different coloured triangles used in Fungicides? What does it mean?
14. Give any two diseases and causative organism of Vegetables.

(10×2=20)

Part B

Answer **any five** questions. Each question has **5 marks**.

15. What are the different types of asexual reproduction found in Fungi?
16. How fungi are well adapted as decomposers?
17. Write a brief comparative account on the general characters of Blastomycetes, Hyphomycetes, Coelomycetes.
18. Write a note on economic importance of fungi.
19. Explain the life cycle of Lichen.
20. Write a note on initial stages of disease cycle.
21. Explain role of enzyme in disease development.
22. “Lack of essential factors also provide host plant resistance” justify the statement.

(5×5=25)

Part C

Answer **any two** questions. Each question has **15 marks**.

23. Explain Mycelial structure and reproduction of Ascomycotina
24. How Lichen thallus varies in their morphology and Anatomy? What are the major ecological role of lichens?
25. What are the different preexisting defense mechanisms found in plants?
26. Write an essay on biological control of plant diseases.

(2×15=30)

MSc DEGREE EXAMINATION

First Semester MSc Botany

Bryology and Pteridology

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

Part A

Answer **any ten** questions. Each question has **2 marks**.

1. Differentiate between elaters and pseudoelaters.
2. What is meant by a myxohydric bryophyte? Cite one example.
3. What are anacrogynous Bryophytes?
4. What is the function of trabaculae in pogonatum capsule?
5. Discuss the mechanism of nourishment of Anthoceros sporophyte.
6. What is peat moss? Add a note on its economic importance.
7. What are retort cells? What is its function?
8. What is the function of collumella in Pogonatum?
9. Differentiate between eusporangiate and leptosporangiate conditions.
10. Which fern is called as 'walking fern'? Why?
11. Name the different species of Rhynia.
12. Which are the criteria used to divide the genus Selaginella into subgenera Homeophyllumand Heterophyllum?
13. Explain the arrangement of sporangia in Lygodium.
14. Which pteridophyte is nick named as Adder's tongue? Why?

(10×2=20)

Part B

Answer **any five** questions. Each question has **5 marks**.

15. Give a brief account on the classification of Bryophytes.
16. Write an account on the economic importance of Bryophytes.
17. Bring out the salient features of Sphaerocarpales.
18. Describe various views with regard to the evolutionary position of Riccia sporophyte.
19. 'Bryophytes are the amphibians in plant kingdom'. Justify the statement.
20. Compare the salient features of Jungermanniales with that of Marchantiales.
21. Explain the structure of the gametophyte of Psilotum. How it resembles the gametophyte of Ophioglossum?
22. What are Calamostachys and Palaeostachys? With the help of diagrams describe and differentiate their structure. (5×5=25)

Part C

Answer **any two** questions. Each question has **15 marks**.

23. Trace the gradual evolutionary advancement in the sporophytes of Bryophytes you have studied.
24. Compare the male gametophyte development in Selaginella and Isoetes.
25. Explain the development of female gametophyte in Marselia. How it differs from that of Salvinia?
26. Write an essay on the anatomical and morphological variations in the gametophytes of bryophytes

(2×15=30)

MSc DEGREE EXAMINATION
First Semester MSc Botany

Gymnosperms and Evolution

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

Part A

Answer **any ten** questions. Each question has **2 marks**.

1. Briefly comment on the habit and habitat diversity of gymnosperms.
2. Give a brief account on conifer distribution in India.
3. What are the special features seen in coralloid root?
4. What are cypress knees?
5. Comment on the position of cone development in Araucaria and Agathis.
6. Give a brief description about the male flower in Ephedra.
7. Comment on the 'handicapped plant' in gymnosperms.
8. List any four medicinal uses of gymnosperm.
9. What is shower of sulphur?
10. What is sandarc?
11. Describe petrifications with an example.
12. Explain genetic drift.
13. What are races?
14. Explain abrupt speciation.

(10×2=20)

Part B

Answer **any five** questions. Each question has **5 marks**.

15. Why the group gnetales included in the class coniferophyta by Chamberlain?
16. Explain the structure of male and female gametophyte in gymnosperms.
17. Explain the structure of male and female cone in Zamia.
18. Discuss about the affinities of Pentoxylon.
19. Explain the structure of male and female cone of Ginkgo.
20. With suitable diagram explain the structure of ovule in Gnetum.
21. Discuss the nature of archegonia in gymnosperms.
22. Give a brief account on the morphology of Ephedra.

(5×5=25)

Part C

Answer **any two** questions. Each question has **15 marks**.

23. With suitable diagrams explain the lifecycle of Pinus.

24. Discuss about the diversity in the morphological features of gnetopsida members with Ephedra and Welwitschia as an example.
25. Explain molecular evolution and molecular tools in phylogeny analysis.
26. Write an essay on the economic and ecological significance of gymnosperms.

(2×15=30)

SEMESTER II

BMBO205: ECOLOGY AND ENVIRONMENTAL SCIENCE

Credit: 3 **Total Hours: 54**

Course Objectives:-

- To train the students to accomplish mastery in the field of Ecology and Environmental Science
- To provide in-depth knowledge of the significance of ecological balance and significance of environmental science
- To enable the students to explore the interactions of life forms at cellular and molecular level
- To inspire the students to apply the acquired knowledge to create a better environment

Course Outcome:-

- Students will be able to identify the major ecosystems and the components of different types of ecosystems
- Students will be able to compare and contrast the characteristics of different types of ecosystems
- Students will be able identify the major causes of environmental problems
- Students will be able to brainstorm to derive solutions to the major environmental issues
- Students will be able to explicate the ecological interconnectedness of life on earth.

Module 1: Population Ecology (**6 hours**)

Characteristics of populations - size and density, dispersion (distribution), dispersal, age structure, natality, mortality, Survivorship curves ; Population growth –Geometric growth, exponential growth and logistic growth; Population regulation – bottom –up and top –down effects. Maximum sustainable yield (MSY) and effective population size. Metapopulations; Life history strategies - k-selection and r-selection populations., Grimes CSR triangle ; Genecology - ecological amplitude, ecads and ecotypes.

Module 2: Species interactions (**8 hours**)

Mutualism – dispersive, defensive and resource based mutualism. Effect of mutualism on population growth. Commensalism; Competition - different types, Lotka Voltera model, Tilmans R value model, Resource partitioning; Predation – antipredator adaptations, prey-

predator interaction model; Herbivory – different defensive mechanisms (constitutive and induced. Mechanical, chemical, induced. Quantitative and qualitative), C-N balance hypothesis; Parasitism – host – parasite model, microparasites, macroparasites, parasitoids and kleptoparasitism

Module 3: Community ecology (**6 hours**)

Characteristics of plant communities -Quantitative, qualitative and synthetic characteristics. Sorenson's Index of similarity. Ecotone and edge effect; the concept, definition and reasons of succession. Classification of succession: Changes – autogenic and allogenic, primary and secondary, autotrophic and heterotrophic; Retrogressive succession and degradative succession, Concept of climax or stable communities. Resilience of communities.

Module 4: Ecosystem ecology (**8 hours**)

Ecosystem functions - energy flow and nutrient cycles – C, N P and S cycles (Brief study).Ecological efficiency ; Productivity- types, Factors influence primary and secondary productivity in aquatic and terrestrial ecosystems ; Comparative study of biomes: Different biomes(Grasslands, Tundra, Forests, Deserts, salt water biomes and fresh water biomes) with regard to their distribution, climate and soil, major vegetation and environmental concerns.

Module 5: Behavioral ecology (**3 hours**)

Learning – Nonassociative learning and Associative learning (Classical conditioning and Operant conditioning); Genetics of behavior, Communication in social groups; Social behavior – Altruism, reciprocal altruism, kin selection. Foraging behavior, Mating systems, Migratory behavior,

Module 6: Phytogography (**5 hours**)

Climate, vegetation and botanical zones of India; Remote sensing: Definition and data acquisition techniques. Application of remote sensing in vegetation classification, understanding the key environmental issues and ecosystem management; Geographic information system (GIS)

Module 7: Environmental pollution (**8 hours**)

Water pollution: Water quality parameters and standards, different types of pollutants and their consequences. Wastewater treatment; Air pollution: Air quality standards and index, types and sources of air pollutants, air pollution and human health hazards; Noise pollution. Radioactive and thermal pollution: Causes and hazardous effects Bioremediation, Phytoremediation, bioaugmentation and biofilms. Bioindicators

Module 8: Global environmental problems and climate change (**6 hours**)

Greenhouse effect, Global warming, acid rain, ozone depletion; *El-Nino* and *La Nina* phenomenon and its consequences; Effect of climate change on ecosystem, agriculture and human health

Module 9: Conservation biology (**4 hours**)

Biodiversity: Genetic diversity, Species diversity, community diversity (ecosystem diversity); IUCN Red list categories and red data book. Hot spots. Key stone species. Flagship species. Minimum viable population (MVP) and Minimum Dynamic Area (MDA); Methods of conservation - *ex-situ* and *in-situ* conservation techniques; Western Ghats (Brief study)

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BMBO206: GENETICS AND PLANT BREEDING

Credit: 4 **Total Hours: 72**

Course Objectives:-

- To train the students to accomplish mastery in the field of genetics and basic techniques of plant breeding
- To provide in-depth knowledge of the principles of heredity
- To enable the students to explore the intricacies of life forms at the level of chromosomes and genes
- To inspire the students to apply the acquired knowledge to create a better environment

Course Outcome:-

- Students will be able follow the symbols, notations and statistical tools used in classical genetics
- Students will become familiar with the patterns of inheritance of qualitative and quantitative traits
- Students will be able to use the basic knowledge in genetics in solving problems based on various patterns of inheritance
- Students will be able to appreciate the power of inheritance in sustaining various species on earth
- Students will be able to perform simple breeding experiments using plants

Genetics (45hours)

Module 1: Basic principles of heredity (**18 hours**)

Experiment of Mendel with *Pisumsativum*, recessive and dominant traits, alleles, principles of inheritance, pleotropism, anticipation, environmental effects on phenotype; Incomplete dominance and codominance, penetrance and expressivity, Interaction of genes, Epistasis – recessive, duplicate recessive and dominant epistasis, complementary interaction of genes ; Multiple alleles, psuedoalleles, lethal alleles, sex-influenced and sex-limited traits

Quantitative characters: polygenic traits, relation between genotype and phenotype, meristic characteristic and threshold characteristic, heritability, phenotypic variance and genetic variance, calculating heritability, QTL and QTL mapping

Pedigrees - gathering family history; pedigree symbols; construction of pedigrees; Pedigree of single gene disorders in human - autosomal dominant inheritance; Heterozygous affected phenotype, variable expressivity, late onset, high recurrent, incomplete penetrance);

autosomal recessive inheritance; carrier probabilities in a pedigree, effects of consanguinity; X-linked dominant inheritance, X-linked recessive inheritance; genetic counseling, methods of genetic testing

Module 2: Sex determination and sex linked characteristics (6 hours)

Chromosomal , genic and environmental sex determination mechanisms with examples; Sex determination in humans, Turner syndrome, Klinefelter syndrome, Poly-X female, male determining genes in humans, androgen-insensitivity syndrome

Dosage compensation, Lyon hypothesis, mechanism of random X chromosome inactivation ;Sex linked genes, non-disjunction, chromosome theory of inheritance, examples of X-linked traits, Y-linked traits, Z linked traits , evolution of Y chromosome, characteristics of human Y chromosome, use of Y linked genetic markers.

Module 3: Linkage (6 hours)

Notations for crosses with linkage, linkage and crossing over, cytological basis of crossing over; recombination frequency, two point and three point crosses; Interference and coincidence; Construction of linkage map,Haploid mapping (Neurospora) ; conjugation, transformation and transduction mapping in bacteria ; gene mapping in phages; Sex Linkage, eye color in Drosophila, Haemophilia in man.

Module 4: Extrachromosomal Inheritance (6 hours)

Extrachromosomal Inheritance**,** Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast; human diseases caused by mutation in mtDNA, Maternal effects -shell coiling in snail; Infective heredity- Kappa particles in Paramecium.

Module 5: Changes in Chromosome number and structure (3 hours)

Polyploidy, aneuploidy, chromosomal, rearrangements - deletion, duplication, inversion, and translocation. Meiotic consequences in, structural heterozygotes, role in speciation and evolution.

Module 6: **Population Genetics (6 hours)**

Gene pool, allele and genotype frequency. Hardy- Weinberg law and its applications. Factors that alter allelic frequencies; Mutation Genetic drift - Bottleneck effect and Founder effect, migration, selection, non-random mating, inbreeding coefficient.

Plant Breeding (27 hours)

Module 1: Plant genetic resources for plant breeding (5 hours)

Introduction to plant breeding and major objectives of plant breeding; Importance of germplasm to plant breeding, Sources of germplasm for plant breeding –Plant domestication;

concepts of domestication – primary crop and secondary crop, N. Vavilov and centers of diversity, domestication syndrome Domesticated plants (commercial cultivars, landraces, plant introductions, genetic stock) , undomesticated plants, other species and genera; Concept of gene pools of cultivated crops – primary, secondary and tertiary gene pool ; Concept of genetic vulnerability and strategies to overcome genetic vulnerability; Germplasm collection-base collections, back-up collections, active collections, working or breeders' collections ; Germplasm storage technologies – seed storage (orthodox and recalcitrant seeds), field growing, cryopreservation, *in vitro* storage, molecular conservation

Module 2: Classic methods of plant breeding (10 hours)

Types of cultivars - pure-line cultivars, open-pollinated cultivars, hybrid cultivars, clonal cultivars, apomictic cultivars, multiline; Genetic structure of cultivars and its implications-homozygous and homogeneous cultivars, heterozygous and homogeneous cultivars, homozygous and heterogeneous cultivars, clonal cultivar; Breeding self-pollinated species; Mass selection – key features, procedure, advantages and disadvantages, applications; Pure-line selection - key features, procedure, advantages and disadvantages, applications; Pedigree selection - key features, procedure, advantages and disadvantages, applications; Bulk population breeding - key features, procedure, advantages and disadvantages, applications; Single seed descent method - key features, procedure, advantages and disadvantages, applications; Back cross breeding - key features, procedure, advantages and disadvantages, applications, Breeding cross-pollinated species :Recurrent selection – key features, procedure, advantages and disadvantages, applications ; Mass selection – individual plant selection method, family selection method; Breeding vegetatively propagated species :Clonal selection

Module 3: Mutagenesis in plant breeding (3 hours)

Mutation breeding, factors affecting the success of mutagenesis, Limitations of mutagenesis as a plant breeding technique. commonly used physical and chemical mutagens , Gamma chamber; Types of plant materials used for mutagenesis, mutation breeding of seed-bearing plants, mutation breeding of clonally propagated species, examples of successful mutants developed

Module 4: Polyploidy in plant breeding (3 hours)

General effects of polyploidy of plants, autoploids, natural autoploids, induction of autoploidy, autotetraploids and autotriploids; alloploids, breeding alloploids, aneuploids and their application in plant breeding

Module 5: Hybridization (**4 hours**)

Applications of crossing in plant breeding; Definition of hybrid cultivar, heterosis and inbreeding depression, genetic basis of heterosis - dominance theory and over dominance theory ; better parent heterosis and mid parent heterosis; Hybridization procedure - Germplasm procurement, Emasculation, Pollination; Wide crosses: objectives of wide crosses, issue of reproductive isolation barriers – spatial isolation, pre-fertilization reproductive barriers, post-fertilization reproductive barriers ;strategies to overcome the challenges of reproductive barriers , bridge crosses, examples of successful wide crosses; F1 hybrids and their importance

Module 6: Breeding- a case study with rice as example (**2 hours**)

History of rice cultivation, commercial classes of rice, races of rice (Indica, Javanica and Japonica), rice cropping systems - Rainfed lowland rice, Upland rice, Flood-prone rice, Irrigated rice, Pokkali rice ; Hybridization in rice – reproductive biology of rice, emasculation, pollination, seed harvesting

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PRACTICAL

BMBO2P03: ECOLOGY AND ENVIRONMENTAL SCIENCE & GENETICS AND PLANT BREEDING

Credit: 2 **Total Hours: 27+54**

Ecology and Environmental Science Practical (27 hours)

1. Analysis of water quality for; (a) Dissolved CO_2 (b) Dissolved oxygen (c) COD (d) Total dissolved minerals (e) Quantitative estimation of dissolved chloride ions and dissolved sulphate (f) Total alkalinity.
2. Quantitative estimation of dissolved chloride ions, dissolved sulphate, nitrate and total alkalinity.
3. Physico-chemical analysis of soil: (a) Total water soluble mineral ions (b) estimation of soil organic carbon (Walkey and Black method).
4. Work out the problems related to Logistic equation, MSY and effective population size
5. Work out the problems related to frequency, abundance, density and IVI of different species and similarity index of different communities in a natural system.
6. Phytoplankton counting using Sedgwick Rafter counter.
7. Field visit to any natural ecosystem and submit a report on it
8. Students should be aware of the common environmental problems, their consequences and possible solutions.
9. Calculation of biodiversity index – Shannon's index and Simpson index
10. Find out MPN of a given water sample

Genetics Practical (36 hours)

1. Work out problems in:
    a. Monohybrid, dihybrid and back crosses.
    b. All types of modified Mendelian ratios mentioned in the syllabus.
    c. Multiple alleles and their inheritance
    d. Sex linked inheritance
    e. Pedigree analysis
2. Population genetics

3. Raise a population of *Drosophila* and List the contrasting features among the individuals in the *Drosophila* population

Plant Breeding Practicals (**18 hours**)

1. Familiarize the hybridization techniques in self and cross pollinated plants
2. Visit a plant breeding station to familiarize with breeding programmes. Submit a report of the visit.

BMBO207: MOLECULAR BIOLOGY AND DEVELOPMENTAL BIOLOGY

Credit: 4 **Total Hours: 72**

Course Objectives:-

- To train the students to accomplish mastery in the field of molecular biology and to introduce them the recent advances in the field of developmental biology
- To make the students acquainted with the principles of heredity at the molecular level
- To enable the students to explore the intricacies of life forms at the level of nucleic acids and genes

Course Outcome:-

- Students will be familiar with the history and advance of ideas in molecular biology and developmental biology
- Students will become familiar with the molecular level regulations of the central dogma of molecular biology
- Students will be able to use the basic knowledge in molecular biology in solving problems based DNA replication, transcription, translation and gene regulation
- Students will be able to appreciate the power of inheritance in sustaining various species on earth
- Students will be able appreciate the complexities and the perfect regulatory mechanisms operating behind the development of organisms.

Molecular Biology (54 hours)

Module 1: Genetic material (2 hours)

Introduction to heredity and the genetic material, characteristics of genetic material, Early studies on DNA [works of F. Miescher, Albert Kossel, Phoebus Levene, Erwin Chargaff], The discovery of transforming principle [Griffith's experiment], Identification of the transforming principle[Avery, MacLeod and McCarty's experiment]; [Hershey and Chase experiment], Watson and Crick's discovery of the structure of DNA, discovery of RNA as the genetic material in some organisms [Heinz Fraenkal-Conrat's experiment].

Module 2: Structure of DNA (2 hours)

Primary structure; structure of nitrogen bases, structure of nucleotides, formation of polynucleotide strands, secondary structures of DNA; A, B and Z DNA, circular and linear DNA, noncanonical structures, DNA triplex and quadruplex, genetic implications of DNA structure

Module 3: Genome Anatomy (3 hours)

Bacterial chromosome; DNA supercoiling - positive and negative, role of topoisomerase in addition and removal of supercoils

Anatomy of Eukaryotic genome; chromatin, histone proteins, nucleosome, chromatosome, higher order of chromatin structure, structure of eukaryotic chromosome, molecular structure of centromere and telomere, distribution of genes in chromosomes, gene deserts, c-value paradox, Types of DNA sequences in eukaryotes – unique sequence DNA, repetitive DNA, DNA renaturation kinetics, Cot curve,

Module 4: Transposable elements (3 hours)

General characteristics of transposable elements ; transposable elements in bacteria – types; transposable elements in eukaryotes – Ty element in yeast, Ac and Ds elements in maize, transposable elements in Drosophila and humans, transposition- replicative transposition and non-replicative transposition, transposable elements and genome evolution

Module 5: DNA replication (5 hours)

Suspected forms of DNA replication, conservative, dispersive and semi-conservative, Meselson and Stahl's experiment ; Modes of replication- theta replication, rolling circle replication, linear eukaryotic replication, replicon, requirements of replication, direction of replication, continuous and discontinuous replication, Okazaki fragments, experiment by Reiji Okazaki, details of bacterial DNA replication, enzymes and proteins involved, details of eukaryotic DNA replication, enzymes and proteins involved, end replication problem, telomeres and telomerase, fidelity of DNA replication, DNA replication inhibitors

Module 6: Recombination (3 hours)

Recombination; Holiday model, enzymes required for recombination, gene conversion

Module 7: DNA repair (3 hours)

DNA repair, mismatch repair, direct repair, base-excision repair, nucleotide excision repair, photoreactivation, SOS response

Module 8: Transcription (6 hours)

Early RNA world, structure of RNA, types of RNAs and their function, mRNA, tRNA, rRNA, snRNA, snoRNA, miRNA,

Transcription, concept of gene, one gene one enzyme hypothesis, complementation test, requirements for transcription, the template and nontemplate strands of DNA, experiments by Julius Marmur: Promoters; bacterial and eukaryotic RNA polymerase; bacterial and eukaryotic the process of bacterial transcription the process of eukaryotic transcription Transcription inhibitors.

Module 9: RNA processing (4 hours)

RNA processing; addition of 5' cap and 3'polyA tail, RNA splicing, Alternative splicing, exon shuffling, cis and trans splicing, tRNA gene structure and processing, rRNA gene structure and processing, RNA editing,

Module 10: Genetic code (2 hours)

The genetic code, breaking the genetic code, characteristics of the code, Exceptions to the standard code

Module 11: Translation (5 hours)

Structure of tRNA, clover leaf and 'inverted L' models, wobble hypothesis

Structure of mRNA, monocistronic and polycistronic mRNAs

Composition and assembly of prokaryotic and eukaryotic ribosomes, three dimensional structure of ribosome, process of translation in prokaryotes and eukaryotes, polyribosomes, nonribosomal protein synthesis, mRNA surveillance; non-sense mediated mRNA decay, non-stop mRNA decay, stalled ribosome, translation inhibitors

Post translational modifications of proteins, molecular chaperons

Module 12: Organelle genome (3 hours)

mitochondrial genome - gene structure and organization, yeast mtDNA, human mtDNA, plant mtDNA, replication, transcription and translation of mtDNA, non-universal codons in mtDNA, evolution of mtDNA, chloroplast genome - gene structure and organization, replication, transcription and translation of cpDNA, evolution of cpDNA

Module 13: Gene regulation (10 hours)

Importance of gene regulation, Genes and regulatory elements, Levels of gene regulation, gene regulation in bacterial cells; operon structure, negative and positive control, inducible and repressible operons, lac operon of E.coli, lacoperon mutations- structural gene mutations, regulator gene mutations, operator mutations, promoter mutations, positive control and catabolite repression, trpoperon of E.coli,attenuation and antitermination, Antisense RNA and bacterial gene regulation, regulation of ompFgene, riboswitches and bacterial gene regulation.

Gene regulations in eukaryotes; histone modification – methylation and acetylation, control of flowering in Arabidopsis through acetylation of histone, chromatin remodeling, DNA methylation, Transcriptional Control by transcription factors, transcriptional activators and coactivators, GAL4 and galactose metabolism, transcriptional repressors, transcriptional enhancers and insulators, regulation of transcriptional stalling and elongation, gene regulation through RNA splicing, gene regulation through degradation of RNA, mechanism of gene

regulation by RNAi, gene regulation through processes that affect translation or by modification of proteins.

Genetic control of lytic and lysogenic growth in λ phage, lytic cascade

Module 14: Epigenetics (3 hours)

History and development of ideas, genetic maternal effect, genomic imprinting and genetic conflict hypothesis, epigenetic effects – epigenetic changes induced by maternal behavior, epigenetic effects caused by prenatal exposure, molecular mechanism of epigenetic changes, the epigenome, epigenetic cell memory

Developmental Biology (**18 hours**)

Module 1: Basic concepts of developmental biology (**6 hours**)

An overview of plant and animal development, Cell fate and Potency in plants and animals; Levels of cell commitment (Specification and determination). Strategies of specification- Autonomous specification, conditional specification and syncytial specification. Cell lineages and fate map; Mechanisms of developmental commitment - cytoplasmic determinants and cell induction (endocrine signaling, paracrine signaling and juxtacrine signaling. Genomic equivalence. Competency of cells; Stem cells – embryonic stem cells and adult stem cells; Mutants and transgenics in analysis of development; Brief introduction to Model organisms - *Drosophila, Bacillus subtilis, Saccharomyces cerevisiae, Caenorhabditiselegans and Arabidopsis*

Module2: Cellular and molecular mechanisms in the early development of *Drosophila* (**6hours**)

Early development and axis specification in *Drosophila.* Anterior-posterior patterning and Dorsal-ventral patterning; Maternal contribution in development of drosophila larva. Genomic Imprinting; Development of body plan in Drosophila – segmentation genes (gap genes, pair-rule genes and segment polarity genes. Segment identity by homeotic genes – Antennapedia complex, bithorax complex and realisator genes

Module 3: Biochemical and molecular aspects gametogenesis and fertilization (**6 hours**)

Germ cell specification (in Drosophila and mammals), Germ cell migration (In Drosophila and mammals) and gametogenesis (in mammals) Fertilization (biochemical and molecular aspects) - external fertilization (seaurchins) and internal fertilization (mammals). Prevention of Polyspermy. Parthenogenesis.

References

1. Benjamin A. Pierce , Genetics: A Conceptual Approach, ; 5th edition, W. H. Freeman
2. Cooper GM and Hausman, The Cell, a molecular approach , 6th Edition, Sinauer Associates, Sunderland
3. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P., Molecular Biology of the Cell (4th Ed.), Garland Science, New York.
4. Becker, W. M. and Klein smith, L. J., World of the Cell (6th Ed.), Benjamin Cummings.
5. Gupta, P. K., Cell and Molecular Biology (2nd Ed.), Rastogi Publication, Meerut
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8. Scott F Gilbert. *Developmental Bilogy* (IX Edn). Sinauer Associates.
9. R M Twyman, *Instant notes in Developmental Biology*. Viva Books Private Limited.

BMBO208: CELL BIOLOGY AND IMMUNOLOGY

Credit: 4 **Total Hours: 72**

Course Objectives:-

- To train the students to accomplish mastery in the field of cell biology and to introduce them the recent advances in the field of immunology
- To make the students acquainted with the components of living systems at the cellular and sub-cellular levels
- To enable the students to explore the intricacies of life forms at the level of cells

Course Outcome:-

- Students will be familiar with the history and advance of ideas in cell biology and immunology
- Students will become familiar with the regulations of the various processes of life at the cellular level
- Students will be able to use the basic knowledge in cell biology in solving problems based cell division and cell signaling
- Students will be able to appreciate the architecture of life at the cellular level
- Students will be able appreciate the complexities and the perfect regulatory mechanisms operating behind the human immune system

Cell Biology (54 hours)

Module 1 (Self-study)

Basic properties of cell, Prokaryotic cell and eukaryotic cell, structural organization of plant cell and animal cell.

Module 2: Intracellular compartments in eukaryotic cells (3 hours)

Major intracellular compartments in eukaryotic cells (brief study only). Detailed structure of mitochondria, chloroplast, peroxisomes and glyoxysomes with reference to their functional interrelationship. Genetic systems in mitochondria and chloroplast, endosymbiont hypothesis on the evolution of mitochondria and chloroplast.

Module 3: Structural organization of cell membranes (5 hours)

The lipid bilayer: composition and structural organization; Fluid mosaic model of biomembranes; Membrane functions; semi-permeability and hydropathy index, Membrane lipids-Principal classes of membrane lipids, lipid composition and physical properties of membranes; Membrane Proteins- Structure and Basic Functions, Integral membrane proteins, Lipid-anchored membrane proteins, Peripheral membrane proteins ; Lateral movement of

lipids and proteins in Biomembranes ; Membrane carbohydrates: structure and function**.**

Module4: Transmembrane Transport of Ions and Small Molecules (**4 hours**)

Polarity of cell, Overview of Transmembrane Transport, Three Main Classes of Membrane membrane transport proteins, Facilitated Transport of Glucose and Water, ATP-Powered Pumps and the Intracellular Ionic Environment, Nongated Ion Channels and the Resting Membrane Potential, Cotransport by Symporters and Antiporters, Transcellular Transport.

Module 5: Cell organization and movement (**6 hours**)

Components of the cytoskeleton**:**

(a)Microfilaments: G-actin, F- actin Structure, properties and formation, Dynamics of Actin Filaments, Mechanisms of Actin Filament Assembly, Actin Polymerization Powered Intracellular Movements, Function of Microfilaments in Endocytosis, Toxins that affect actin Dynamics, Organization of Actin-Based Cellular Structures, Actin-Based Motor Proteins - Myosins- structure, Myosin-Powered Movements: Myosin-Dependent Mechanisms of muscle Contraction. Cell Migration: Mechanism, Signaling, and Chemotaxis; Functions of cytoskeleton;

(b)Microtubule: Structure and Organization, αβ-Tubulin Dimers, MTOCs, Microtubule Dynamics, Regulation of Microtubule Structure and Dynamics, Microtubule Based Motor Proteins: Kinesins and Dyneins, structure and functions- Kinesins and Dyneins Cooperated Organelle Transport, Cilia and Flagella: Microtubule-Based Surface Structures –structure and movements, Intraflagellar Transport, role of microtubules and its motor proteins in cell division, Reorganization of Microtubules and plant Cell Wall formation in Mitosis

(c)Intermediate Filaments: Structure, assembly and dynamics, Lamins; Coordination and Cooperation Between Cytoskeletal Elements

Module 6: Eukaryotic Cell Cycle (**6 hours**)

Stages of Mitosis emphasis on formation of mitotic chromosomes and mitotic spindle, dissolution of nuclear membrane and organelle partition, chromosome movement in Anaphase. Cytokinesis and formation of cell plate in plant cell. Stages of Meiosis; Significance of meiosis in generating genetic variation.

Cell cycle control system: extracellular and intracellular signals, Extracellular Signals Govern Cell Cycle Entry, Cyclins and Cyclin-dependent kinases. Irreversible Commitment to cell Division and Cell Cycle START/ Restriction Point, S-phase, Entry into Mitosis, Completion of Mitosis, Chromosome Segregation and Exit from Mitosis, Surveillance Mechanisms in Cell Cycle Regulation: checkpoints pathways– DNA damage checkpoint, spindle assembly checkpoint.

Module 7: Integrating cells into tissues (**4 hours**)

Cell-Cell and Cell–Extracellular Matrix Adhesion: An Overview, Cell-Cell and Cell–Extracellular Matrix Junctions and Their Adhesion Molecules, The Extracellular Matrix: The Basal Lamina, Connective Tissue. Adhesive Interactions in Motile and Nonmotile Cells. Integration of Cells in Plant Tissues.

Module 8: Moving proteins into membranes and organelles (**5 hours**)

Targeting Proteins to and Across the ER Membrane, Insertion of Membrane Proteins into the ER, Protein Modifications, Folding, and Quality Control in the ER, Targeting of Proteins to Mitochondria and Chloroplasts, Targeting of Peroxisomal Proteins, Transport Into and Out of the Nucleus

Module 9: Vesicular Traffic, Secretion, and Endocytosis (**5 hours**)

Molecular Mechanisms of Vesicle Budding and Fusion, Early Stages of the Secretory Pathway, Later Stages of the Secretory Pathway, Receptor-Mediated Endocytosis, Directing Membrane Proteins and Cytosolic Materials to the Lysosome.

Module 10: Cell communication and Cell signalling (**7 hours**)

(a) Cell communication: general principles. Signaling molecules and their receptors, external and internal signals that modify metabolism, growth, and development of plants. (b) Receptors: Cell surface receptors – ion-channel linked receptors, G-protein coupled receptors, and Tyrosine-kinase linked receptors (RTK), Steroid hormone receptors. Insulin signaling pathway (c) Signal transduction pathways, Second messengers, Regulation of signaling pathways. Bacterial and plant two-component signaling systems.

Module 11: Cell Death and Its Regulation (**3 hours**)

Programmed cell death, Intrinsic and extrinsic pathway, Proteins Participate in the Apoptotic Pathway, Caspases, Role of Mitochondria in Apoptosis in Vertebrate Cells. Necrosis

Module 12: Molecular biology of cancer (**6 hours**)

Genetic evidence for cancer, Knudson's multistep model of cancer, clonal evolution of tumors, role of environmental factors in cancer, oncogenes and tumor suppressor genes, p53 gene, mutations in cell cycle control and cancer, mutation in DNA-repair genes, enhanced telomerase activity and cancer, genes that promote vascularization and the spread of tumors, microRNAs and cancer, changes in chromosome number and structure associated with cancer, epigenetic changes and cancer, viruses and cancer,

Immunology (18hours)

Module 1: Fundamentals of Immunology (**10 hours**)

Innate and acquired immunity. Cells and molecules involved in innate and acquired

immunity, humoral and cellular immunity, Antigens, Epitopes. Structure, function and types of antibody molecules. Antigen-antibody interactions. Antigen processing and presentation. Activation and differentiation of B cells – formation, role. T cells – types, roles, T cell receptors. Primary and secondary immune modulation, complement system, pattern recognition receptors – toll-like receptors. MHC molecules. Cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity, congenital and acquired immunodeficiencies .Generation of antibody diversity.

Module 2: Applied immunology (8 hours)

Production and uses of monoclonal antibodies; antibody engineering; Vaccines: Basic strategies, inactivated and live attenuated pathogens, subunit vaccines, recombinant vaccines (e.g., Hepatitis B vaccine), DNA vaccines. Modern approaches to vaccine development - edible vaccines; cancer immunotherapy

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10. Peter J Delver, Seamus J Martin, Dennis R Burton, Ivan M Roitt. Roitt's essential immunology (XII Edn). Wiley Blackwell.

PRACTICAL

BMBO2P04: MOLECULAR BIOLOGY AND DEVELOPMENTAL BIOLOGY & CELL BIOLOGY AND IMMUNOLOGY

Credit: 2 **Total Hours: 45+54**

Molecular Biology Practical (45 hours)

1. Work out problems based on DNA structure , replication, transcription and
2. translation
3. Isolation of DNA from plant tissue
4. Agarose Gel Electrophoresis of DNA
5. Spectrophotometric purity analysis and quantification of DNA

Practicals – Cell Biology (27 hours)

1. Study of meiosis in *Rhoeo*/*Chlorophytum* by smear preparation of PMCs
2. Study of mitosis in onion root tips
3. Determination of mitotic index
4. Solve problems related to protein targeting, cell cycle regulation, protein targeting and cell signalling

Practicals – Immunology (27 hours)

1. Perform hemagglutination assay for ABO blood group typing
2. Perform Radial Immunodiffusion (RID) by Mancini's technique.

SEMESTER III

BMBO309: RESEARCH METHODOLOGY, BIOPHYSICS, BIOSTATISTICS AND MICROTECHNIQUE

Credit: 4 **Total Hours: 72**

Course Objectives:-

- To make the students acquainted with the method of research and design of experiments
- To introduce the tools and techniques required for research in life science

Course Outcome:-

- Students will be familiar with the principles of scientific research
- Students will become familiar with the tools and techniques used in research
- Students will be able to design experiments
- Students will be able to interpret the results of research experiments
- Students will be familiar with the tools and techniques required for research in life science

Research methodology (**18 hours**)

Module 1: Objectives and types of research (**3 hours**)

Features of a good research study, Scientific method; Study designs and variations- basic, applied, historical, exploratory, experimental, ex-post-facto, Case study, diagnostic research, Crossover design, case control design, cohort study design, multifactorial design.

Module 2: Research Problem (3 hours)

Research formulation - Observation and Facts, Prediction and explanation, Induction, Deduction. Defining and formulating the research problem, Selecting the problem and necessity of defining the problem. Literature review -Importance of literature reviewing in defining a problem. Hypothesis -Null and alternate hypothesis and testing of hypothesis

Module 3: Preparation of project proposals (**3 hours**)

(a) Title, Introduction, literature review and abstract (b) Aim and scope (c) Present status (d) Location of experiments (e) Materials and methods (f) Justification (g) Expected outcome (h) Date of commencement (g) Estimated date of completion (h) Estimated cost (i) References (j) Funding agencies.

Module 4: Presentation and publication of research outcomes (9 hours)

(a) 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. (b) Preparation of research paper and short communications. (c) Preparation of review articles. (d) Proof reading - standard abbreviations for proof correction. (e) Presentation of research findings in seminars and workshops. Bibliographic management software: Mendely; Research ethics, plagiarism and detection by software- iThenticate and Turniton

Biophysics (18 hours)

Module 1: Microscopy (8 hours)

Parts of microscope, principles of microscopy. Types of microscopes - simple and compound; Stereomicroscope, Phase contrast microscope, Fluorescence microscope, Polarization microscope, Confocal microscope and electron microscope (TEM, SEM and E-SEM).Micrometry, Photomicrography and microphotography.

Module 2: Principles and applications of instruments (10 hours)

(a) Basic principles and applications of; pH meter, Haemocytometer, UV-visible spectrophotometers, Centrifuges (Table top centrifuge and ultra centrifuge); Chromatography- Principles and application, paper, TLC, column chromatography, GC, HPLC, HP-TLC; (c) Immunoassay systems, ELISA ; Electrophoresis: PAGE – native and denaturing; AGE, Capillary electrophoresis ; X-ray crystallography.

Biostatistics (18 hours)

Module 1: Basic principles of statistics (3 hours)

Application of statistics in biosciences, types of statistical data - Primary and secondary data, quantitative and qualitative data, collection and classification of data, frequency distribution; Diagrammatic representation of data - types, significance and utility; Sampling theory and techniques- significance and utility, random sampling, systematic sampling, stratified sampling and multistage sampling.

Module 2: Descriptive statistics (3 hours)

Measures of central tendency- definition, advantages and limitations - mean, median and mode - computation in grouped and ungrouped data; Measures of dispersion - definition and

objectives - range, mean deviation, standard deviation, standard error - computation in grouped and ungrouped data; Skewness and kurtosis - definition, types, graphical representation.

Module 3: Probability (**3 hours**)

Probability - Definition, mutually exclusive events - addition rule, independent events - multiplication rule, conditional probability, applications of probability.

Module 4: Tests of significance (**3 hours**)

Statistical inference - testing of hypothesis - Chi square test (goodness of fit, independence or association, detection of linkages), t-test and F-test, ANOVA.

Module 5: Correlation and Regression (**2 hours**)

Simple linear correlation- definition and utility, types, positive and negative correlation, scatter diagram and correlation graph, coefficient of correlation; Simple linear regression- definition and utility, regression coefficient, comparison of correlation and regression.

Module 6: Design of experiments (**3 hours**)

Experimental designs: Principles - replication and randomization. Common designs in biological experiments- Completely randomized design, randomized block design, Latin square design, and Factorial design,

Module 7: Computer analysis of data (**1 hour**)

Application of computer in statistical data processing, Biostatistics packages, Data base preparation, Graphic applications in biology.

Microtechnique (**18 hours**)

Module 1: Killing and fixing (**2 hours**)

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

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

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

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

Module 3: Staining (**3 hours**)

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, lignin, enzymes and minerals

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

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

Module 5: Whole mounts (**5 hours**)

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

References

1. Chandel R S .A handbook of Agricultural statistics. Achal prakashan Mandir.
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14. Perkampus H, UV-VIS Spectroscopy and its applications. Springer-Verlag.
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BMBO310: PLANT PHYSIOLOGY AND BIOCHEMISTRY

Credit: 4 **Total Hours: 72**

Course Objectives:-

- To train the students to accomplish mastery in the field of Plant physiology and biochemistry
- To make the students acquainted with the biochemical principles of life
- To enable the students to explore the intricacies of metabolic activities going on in plants

Course Outcome:-

- Students will be familiar with the history and advance of ideas in plant physiology and biochemistry
- Students will understand life at the biochemical level
- Students will be able to appreciate the uniformity in the biochemistry in various forms of life
- Students will be able appreciate the complexities and the perfect regulatory mechanisms operating behind plant growth and development

Plant Physiology (45 hours)

Module 1: Plant water relations (4 hours)

Water transport – diffusion, bulk flow, Osmosis – water potential (self study); Water absorption by root , pathways of water uptake and transport; apoplast, symplast and trans membrane pathways; water transport through xylem - pressure driven bulk flow, cohesion-tension theory, physical challenges faced by xylem transport in trees – cavitation, embolism; Water pathway in the leaf – driving force of transpiration- difference in water vapor concentration, Control of stomatal mechanism, transpiration ratio, Soil-plant-atmosphere continuum

Module 2: Mineral nutrition, mineral absorption and transport (5 hours)

Essential nutrients, functions, deficiency disorders (self study) ;Techniques used in nutritional studies - hydroponics, aeroponics, nutrient film growth system and ebb and flow system, determination of mineral deficiency – soil analysis, plant tissue analysis, treating nutritional deficiencies, fertilizers, modes of fertilizer application , factors influencing nutrient uptake – charge of soil particles, soil pH, soil microbes, root growth; Passive and active transport.

Module 3: Photosynthesis; light reactions (6 hours)

General concept of photosynthesis, characteristics of light, photosynthetic pigments and their structure (Self study); History and progress of ideas; Action spectra and absorption spectra,

light harvesting complexes – PSI and PS II, antenna pigment molecules, structure of reaction center, basic principles of light absorption, conversion of light energy to chemical energy, Photosynthetic apparatus; structure of chloroplast, thylakiod and arrangement of photosystem components, Z scheme, water splitting complex; structure and function, Structure and function of D1 protein, Uncouplers and other and other thylakoid electron transport inhibitors , Chemiosmotic hypothesis, photophosphorylation; cyclic and noncyclic , structure and functioning of CF0-CF1 complex, photosynthetic quantum yield and energy conversion efficiency; Bacterial photosynthesis ; Repair and regulation of photosynthetic machinery; excess energy dissipation; non photochemical quenching, photoinhibition, xanthophyll cycle; scavenging system ; role of caroteniods, superoxide dismutase, ascorbate

Module 4: Photosynthesis; carbon reactions (**6 hours**)

Calvin-Benson cycle, structure and function of Rubisco; Regulation of Calvin-Benson cycle; Rubisco activation, ferredoxin –thioredoxin system, ion movement mediated modulation of regulation of Calvin-Benson cycle enzymes, light controlled assembly of chloroplast enzymes into supramolecular complexes; C2 cycle and its significance,C4 pathway, variance and intermediates; CAM pathway; facultative CAMs, Synthesis of starch and sucrose

Module 5: Photosynthesis: physiological and ecological considerations (**2 hours**)

Leaf anatomy in relation to light absorption, plant competition for light, leaf angle and leaf movement in relation to light absorption; Photosynthetic response to temperature and carbon dioxide, Ecological significance of C4 and CAM pathways.

Module 6: Translocation in the phloem (**3 hours**)

Translocation of sugars sieve elements, types of companion cells and their role, source and sink, materials translocated in the phloem, rate of phloem phloem transport – velocity and mass transfer rate, pressure flow model of phloem transport, phloem loading and unloading, transport of signaling molecules through phloem

Module 7: Respiration (**6 hours**)

Glycolysis and citric acid cycle (self study); Gluconeogenesis, Regulation of glycolysis and gluconeogenesis; Mitochondrial electron transport and ATP synthesis – structure of electron transfer complexes (complex I – IV), ATPase – detailed structure of F1 and Fo subunits, binding change mechanism of ATP synthesis, transport of NADH from cytoplasm to mitochondria- malate aspartate shuttle, glycerol-3-phosphate shuttle, Comparison of mitochondrial and chloroplast ATP synthesis, Cyanide resistant pathway – alternative oxidase, its regulation and significance

Module 8: Assimilation of mineral nutrients (5 hours)

Nitrogen fixation, mechanism of biological nitrogen fixation, mechanism of root nodule formation- role of signals and phytohormones; Nitrate assimilation, ammonium assimilation, transported forms of nitrogen ;Sulfur assimilation; Phosphate assimilation; Cation assimilation; Oxygen assimilation; Energetics of nutrient assimilation

Module 9: Sensory photobiology (3 hours)

Structure, function and mechanisms of action of phytochromes, phytochrome mediated plant responses. Photoperiodism and biological clocks – circadian rhythms, Floral induction and development; Blue light response, function and mechanisms of action of cryptochromes, phototropins, zeaxanthine

Module 10: Plant Growth Regulators (3 hours)

Biosynthesis, storage, breakdown, transport, physiological effects, and mechanism of action of plant growth hormones, elicitors

Module 11: Responses and adaptations to abiotic stress (2 hours)

Water stress – deficit and flooding, Salinity stress, high temperature stress, low temperature stress – chilling and freezing, trace element toxicity, air pollution stress, Oxidative stress and antioxidation mechanisms .

Biochemistry (27 hours)

Module 1: Water and its effects on dissolved biomolecules (3 hours)

Structure and properties, unusual properties of water due to hydrogen bonding,

Acids and bases ,strength of acids and bases, ionization of water, Kw, pH, measurement methods, dissociation of acids, pKa, Henderson-Hasselbalch equation, buffers, buffer action, buffer capacity

Module 2: Biomolecules (14 hours)

Carbohydrates - Monosaccharides, classification, structure, isomerism, Disaccharides, structure, Polysaccharides, classification, structure, function, sugar derivatives; Lipids - Classification, properties , function, structure of fatty acids, storage lipids and structural lipids, biosynthesis of lipids, beta oxidation; Aminoacids- Structure and classification, nonstandard aminoacids, titration curve of amino acids, Shikimate pathway ; Proteins- Classification and functions, structural levels, primary structure -peptide bond, secondary structure – Ramachandran plot, α-helix, β-sheets, tertiary structure- forces that stabilize tertiary structure, quaternary structure, domains, motiff and folds, protein sequencing

Module 3: Enzymes (6 hours)

IUB system of enzyme classification and naming, general characters of enzyme, principle of enzyme action, mechanism of enzyme action – formation of Enzyme substrate complex; Formation of ES complex, acid-base catalysis, covalent catalysis, metal ion catalysis, proximity and orientation effect, strain and distortion theory. Factors affecting, enzyme activity; Enzyme Kinetics: Michaelis-Menton kinetics, Lineweaver-Burk plot, Mechanism of multi substrate reaction – Ping Pong, Bi-Bi mechanism, 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; 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

Module 4: Secondary metabolites and plant defense (4 hours)

Classification of secondary metabolites, role in growth, development and defense; terpenes, phenolic compounds, flaveniods- anthocyanins, anthocyanidins, flavons and flavenoids, nitrogen containing compounds - alkaloids, cyanogenic glycosides, glucosiolates, nonprotein amino acids,Plant defense against insect herbivores ; constitutive and induced defense, role of jasmonic acid in plant defense, proteins inhibiting herbivore digestion , Defense against pathogens

References

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2. Bob B Buchanan, Wilhelm Gruissem, Russel L Jones .Biochemistry and molecular biology of plants. L K International Pvt. Ltd.
3. Robert Horton H, Laurence A Moran, Raymond S Ochr, J David Rawn, K Gray Scrimgeour .Principles of Biochemistry (III Edn). Prentice Hall.
4. William H Elliott, Daphne C Elliott. Biochemistry and molecular biology (II Edn). Oxford
5. Sadasivam S, Manickam A .Biochemical methods (II Edn). New age international Publishers.
6. Frank B Salisbury, Cleon W Ross .Plant Physiology (IV Edn). Wadsworth Publishing Company.

PRACTICAL

BMBO3P05: RESEARCH METHODOLOGY, BIOPHYSICS, BIOSTATISTICS AND MICROTECHNIQUE & PLANT PHYSIOLOGY AND BIOCHEMISTRY

Credit: 2 **Total Hours: 45+45**

Research methodology Practicals (9 hours)

1. Visit a scientific library or documentation centre and submit a report.
2. Prepare a project proposal.
3. Prepare an outline of dissertation and research paper.
4. Prepare a list of references in a specific style .
5. Present a small project in the class with the help of LCD projector and submit the CD for evaluation.

Biophysics Practicals (9 hours)

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

Biostatistics Practicals (18 hours)

1. Classify a given data using frequency distribution and represent it graphically.
2. Analysis of data to find the mean, median and mode.
3. Analysis of data for mean deviation, standard deviation and standard error.
4. Test the significance of a given data using χ^2 test, t- test and F-test.
5. Analysis of a set of data for correlation/regression.
6. Determine probability for different types of events.

Microtechnique Practicals (9 hours)

1. Preparation of semi-permanent slides.

2. Preparation of permanent slides.
3. Preparation of whole mounts.
4. Maceration.
5. Histochemical localization of starch, protein, lipid, lignin, enzymes and minerals
6. Preparation of fixatives (FAA, Carnoys' fluid).
7. Preparation of dehydration series (Alcohol, Acetone, TBA).
8. Preparation of paraffin blocks.
9. Preparation of serial sections.
10. Candidates should prepare and submit 10 permanent slides in which the following categories should be included;
11. Free hand sections (single/double stained).
12. Serial sections (single/double stained).
13. Wood sections and whole mounts.

Plant Physiology Practicals (**27 hours**)

1. Demonstration of Hill Reaction.
2. Determination of osmotic potential by tissue weight method.
3. Separation of photosynthetic pigments by TLC/paper chromatography and calculating the Rf value
4. Preparations of normal, molar, ppm, mg/ml solutions
5. Demonstration of amylase activity and GA effect in germinating cereal seeds.
6. Estimation of total chlorophyll and study of absorption pattern of chlorophyll solution
7. Separation and collection of leaf pigments by silica gel column chromatography.
8. Determination of nitrate reductase activity.
9. Extraction and estimation of leghaemoglobin from root nodules.

Biochemistry Practicals (**18 hours**)

1. Estimation of proline in plant tissues under various abiotic stresses
2. Estimation of phenol in plant tissues affected by biotic stress
3. Determination of peroxidase activity in plant tissues affected by biotic/abiotic stresses
4. Estimation of free amino acids in senescing leaves to understand the source to sink transformation phenomenon
5. Flavanoid assay

BMBO311: ANGIOSPERM ANATOMY AND EMBRYOLOGY

Credit: 3 **Total Hours: 54**

Course Objectives:-

- To train the students to accomplish mastery in the field of plant anatomy and embryology
- To make the students acquainted with the plant architecture
- To make the students informed about the sexual reproduction and the associated processes in plants

Course Outcome:-

- Students will be familiar with basic plant architecture
- Students will be familiar with the process of sexual reproduction in plants
- Students will be able appreciate the complexities and the perfect coordination of various tissue systems in plants.

Anatomy (**36 hours**)

Module 1: Introduction (**2 hours**)

Scope and significance of plant anatomy, interdisciplinary relations.

Module 2: Primary plant body (**7 hours**)

Stages of development of primary meristem and theories of apical organization, Origin of branches and lateral roots, Leaf: Initiation, ontogeny and structure, Primary thickening meristem (PTM) in monocots.

Module 3: Secondary plant body (**8 hours**)

Vascular cambium and cork cambium: Structure and function, factors affecting cambial activity, Secondary xylem and phloem: Ontogeny, structure and function, Anomalous secondary growth in dicots and monocots.

Module 4: Identification of woods (**3 hours**)

Wood: Physical, chemical and mechanical properties.

Reaction wood: Compression wood and tension wood. Factors affecting reaction wood formation ; Minute features- Vessels length, width, shape, lateral wall pittings, frequency of distribution per unit area, perforations, wall thickness, inclusions, intervessel pits, tyloses, Rays—classification and types.

Module 5: Specialized structures (**8 hours**)

Structure, development and classification of stomata and trichomes; Nodal anatomy: Unilacunar, trilacunar and multilacunar nodes, nodal evolution; Root-stem transition zone in

angiosperms; Secretory tissues in plants: Structure and distribution of secretory trichomes (*Drocera, Nepenthes*), salt glands, colleters, nectaries, resin ducts and laticifers;

Module 6: Reproductive anatomy (8 hours)

Reproductive apex in angiosperms, Floral Anatomy: Anatomy of floral parts; Floral vasculature (*Aquilegia and Pyrola*). Development of epigynous ovary - appendicular and receptacular theory, Fruit and seed anatomy: Anatomy of fleshy and dry fruits - follicle, legume, berry, Structure of seeds. Anatomical factors responsible for seed dormancy and drought resistance.

Embryology (18 hours)

Module 1: Angiosperm life cycle (6 hours)

Anther: Structure and development, microsporogenesis, male gametophyte development, Viability of pollen grains. Pollination, pollen germination, growth and nutrition of pollen tube; Palynology: Pollen morphology-polarity, symmetry, Apertures; exine stratification and sculpturing, LO Analysis, pollen kit, NPC formula. Applications of palynology – Aeroplalynology, Melittopalynology, Forensic palynology, Palaeopalynologyand palynotaxonomy; Ovule: Structure, ontogeny and types. Megasporogenesis. Embryosac development, types, ultrastructure, and nutrition of embryosac, Female gametophyte development; Fertilization: Double fertilization; embryo development - different types; Endosperm development, types of endosperm, haustorial behaviour of endosperm ; Xenia and metaxenia; Polyembryony – types and causes ;Seed formation, dormancy and germination, Apomixis, Parthenogenesis,

Module 2: Plant development (12 hours)

Introduction to model plants used for development studies in plant system, advantages of each system with special emphasis on model plant Arabidopsis ; Arabidopsis Embryogenesis: Stages in the development of embryo, Origin of polarity- Mechanisms of Auxin transport and developmental effects of auxin, Establishment of polarity in embryogenesis, Genes essential for embryo formation (GURKE, FACKEL, GNOM, MONOPTEROS), Radial patterning in plants and the genes involved in it (ATML1, PDF2, CRE or WOL); Shoot and root development- Establishment of SAM and RAM. Lateral roots, Root hairs-determination of trichoblast and atrichoblast identity; Leaf development and Phyllotaxy; Transition to flowering, floral meristems and floral development; Homeotic genes in plants. Senescence, programmed cell death and hypersensitive response in plants

References

1. Scott F Gilbert .Developmental Bilogy (IX Edn).Sinauer Associates. (available online).
2. R M Twyman .Instant notes in Developmental Biology. Viva Books Private Limited.
3. Lincoln Taiz, Eduardo Zeiger .Plant physiology (IIEdn).Sinaeur Associates, Inc. Publishers.
4. Bob B Buchanan, Wilhelm Gruissem, Russel L Jones). Biochemistry and Molecular biology of Plants. L K International Pvt. Ltd.
5. Scott F Gilbert. Developmental Bilogy (VIII Edn).Sinauer Associates.
6. S SBhojwani, S P Bhatnagar .The Embryology of Angiosperms (IV Edn).Vikas Publishing House Pvt Ltd.
7. Maheswari P .An introduction to the embryology of Angiosperms. McGraw Hill.
8. Eames A J, McDaniel. An introduction to plant Anatomy
9. Elizabeth G Cutter .Plant anatomy part I & II. Clive and Arnald Ltd.
10. Elizabeth G Cutter. Applied Plant Anatomy. Clive and Arnald Ltd.
11. Esau K .Anatomy of seed plants. Wiley and sons.
12. Fahn A. Plant anatomy. Aditya Publishers
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14. Metcalf C R, Chalk L. Anatomy of the dicotyledons: Wood structure and conclusion of the general introduction. Oxford University press.

BMBO312: ANGIOSPERM MORPHOLOGY AND SYSTEMATICS

Credit: 4 **Total Hours: 72**

Course Objectives:-

- To train the students to accomplish mastery in the field of plant systematics
- To make the students acquainted with the plant taxonomy
- To make the students informed about plant wealth of our state

Course Outcome:-

- Students will be familiar with rules and tools of plant taxonomy
- Students will be equipped with the skill of plant identification and documentation
- Students will become aware of the status of plant diversity in the state
- Students will become aware of the importance of conserving plant diversity

Module 1: Morphology of Angiosperms (Self-study)

Habitat and habit; Morphology of root, stem, leaf, bract and bracteoles, inflorescence, flowers, fruits and seeds.

Module 2: History and Systems of Plant Classification (**4 hours**)

Historical background of classification - Major systems of Angiosperm classification- Artificial, Natural and Phylogenetic systems. Significance of plant taxonomy (Self-study). Systems of classifications proposed by (i) Linnaeus (ii) Bentham & Hooker (iii) Engler & Prantl (iv) Bessey and (vi) APG.

Module 3: Botanical Nomenclature (**3 hours**)

Brief history of ICN (formerly ICBN), principles, rules and recommendations: rule of priority, typification, author citation, retention, rejection and changing of names, effective and valid publication.

Module 4: Concepts of Taxonomic Hierarchy (**3 hours**)

Species/Genus/Family and other categories; species concept and intra specific categories - subspecies, varieties and forms.

Module 4: Data sources of Taxonomy (**2 hours**)

Concepts of character. Sources of taxonomic characters - Anatomy, Cytology, Photochemistry and molecular biology.

Module 5: Synthetic approaches to the Systematics of Angiosperms (**3 hours**)

Chemotaxonomy, molecular taxonomy, basic concepts of genome analysis – bar coding.

Module 6: Concept and Principles of Assessing Relationships (**3 hours**)

Phenetic - Numerical Taxonomy - principles and methods; Phenogram. Cladistic - Principles and methods. Phylogenetic tree – Cladogram.

Module 7: Tools of Taxonomy (**3 hours**)

Construction of taxonomic keys – indented and bracketed – their utilization. Floras/Taxonomic literature, field study and GIS, Herbarium.

Module 8: Ethnobotany (**3 hours**)

Ethnobotany: Scope and importance of ethnobotany, sources and methods of ethnobotanical studies.

Module 9: Angiosperm diversity of Kerala (**48 hours**)

Study of the following families (Bentham & Hooker) in detail with special reference to their salient features, interrelationships, evolutionary trends and economic significance.

1. Rununculaceae, 2. Magnoliaceae, 3.Annonaceae, 4. Cruciferae (Brassicaceae), 5. Polygalaceae, 6.Caryophyllaceae, 7. Guttiferae (Clusiaceae), 8. Malvaceae, 9. Tiliaceae, 10. Geraniaceae, 11.Rutaceae, 12.Vitaceae, 13.Sapindaceae, 14.Fabaceae, 15.Caesalpiniaceae, 6.Mimosaceae 17.Rosaceae, 18.Lythraceae, 19.Melastomaceae, 20.Myrtaceae, 21.Cucurbitaceae, 22. Apiaceae (Umbelliferae), 23.Aizoaceae, 24. Rubiaceae, 25. Compositae (Asteraceae), 26.Campanulaceae, 27. Myrsinaceae, 28.Sapotaceae, 29.Loganiaceae, 30.Oleaceae, 31.Apocynaceae, 32. Asclepiadaceae, 33. Boraginaceae, 34.Convolvulaceae, 35.Solanaceae, 36. Scrophulariaceae, 37. Acanthaceae, 38.Verbenaceae, 39. Lamiaceae, 40. Amaranthaceae, 41. Polygonaceae, 42. Loranthaceae, 43. Euphorbiaceae, 44. Orchidaceae, 45.Commelinaceae 46.Zingiberaceae, 47. Arecaceae, 48. Araceae, 49.Cyperaceae, 50.Graminae (Poaceae).

References

1. Jain S K. Dictionary of Indian Folkmedicine and Ethnobotany.
2. Paye G D. 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. Evolution and classification of flowering plants. Thomas & Nelson Co.
6. Cronquist A. An integrated system of classification of flowering plants. Columbia University Press.
7. Heywood V H, Moore D M (Eds). Current concepts in Plant taxonomy.
8. Radiford A E. Fundamentals of plant systematics.Harper& Row.
9. Rendle A E. Classification of flowering plants. Vikas Co.
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13. Takhtajan A L. Diversity and Classification of Flowering Plants. Columbia Univ. Press.
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15. Verma, B K. Introduction to Taxonomy of Angiosperms. PHI Learning Private Limited, New Delhi.
16. Saxena, N B and Saxena S, Plant Taxonomy. Pragati Prakashan Educational Publishers, Meerut.
17. Jain, S K. (Eds), Manual of Ethnobotany. Scientific Publishers, India, Jodhpur.

PRACTICAL

BMBO3P06: ANGIOSPERM ANATOMY AND EMBRYOLOGY & ANGIOSPERM MORPHOLOGY AND SYSTEMATICS

Credit: 2 **Total Hours: 45+45**

Anatomy Practicals (36 hours)

1. Study of cambia - non storied and storied.
2. Study the anomalous primary and secondary features in, *Amaranthus, Boerhaavia, Mirabilis, Nyctanthes, Piper* and *Strychnos.*
3. Study of stomata, trichomes, and laticifers. Determination of stomatal index.
4. Study of nodal patterns.
5. Prepare a histo-taxonomic key.
6. Study the pericarp anatomy of a legume, follicle and berry.
7. Identification of wood - soft wood and hard wood.

Embryology Practicals (9 hours)

1. Study of pollen morphology.
2. Embryo excision from young seeds.
3. Pollen germination study.
4. Identification of different types of embryos, polyembryony, endosperm types, types of pollen grains, anther growth stages and types using permanent slides.

Angiosperm Morphology and Taxonomy Practicals (45 hours)

1. Morphology of leaves, Inflorescences, stamens, carpels and fruits (Self-study)
2. Dissect and describe at least one member from each family with diagnostics and sketches of flower LS, floral diagram and construct the floral formula.
3. Construction of comparison charts and preparation of dichotomous keys.
4. Use of floras (Flora of the Presidency of Madras) in the identification of plant specimens up to species level.
5. Workout nomenclatural problems regarding priority and author citations.
6. Familiarize with all the economically/ethnobotanically/ medicinally important plants of the families mentioned in the syllabus.

7. A field study for not less than 3 days under the guidance and supervision of teachers.
8. Preparation of a minimum of 25 herbarium sheets of the members of the families mentioned in the syllabus along with supporting field book.

SEMESTER IV

BMBO413: PLANT TISSUE CULTURE AND MICROBIAL BIOTECHNOLOGY

Credit: 4 **Total Hours: 90**

Course Objectives:-

- To train the students in the technique of plant micropropagation
- To make the students acquainted with the practical applications of microbes
- To make the students informed about the tools and techniques used in plant micropropagation and fermentation technology

Course Outcome:-

- Students will become trained in plant micropropagation and associated techniques
- Students will become acquainted with the practical applications of microbes

Plant Tissue Culture (54 hours)

Module 1: History and basic concepts (2 hours)

Experiments of Gottlieb Haberlandt, P R White, Gautheret, Nobecourt, Skoog and Steward, Cellular totipotency, *in vitro* differentiation–de differentiation and re-differentiation

Module 2: Tissue culture Media (7 hours)

Basic components of tissue culture media, inorganic nutrients, carbon source, vitamins, organic supplements, chelating agents, plant hormones, gelling agents, adsorbents, pH of medium, general methodology of medium preparation with special reference to MS medium

Module 3: Sterilization techniques (7 hours)

Sterilization of equipments, glasswares, medium end explant. Sterilization using hot air, steam, filter, UV, alcohol and chemicals. Working of hot air oven, glass bead sterilizer, autoclave and laminar air flow chamber, layout of a tissue culture lab

Module 4: Micropropagation (16 hours)

Micropropagation- different methods – axillary bud proliferation, meristem and shoot tip culture, direct and indirect organogenesis, somatic embryogenesis, hardening, transplantation and field evaluation, advantages and disadvantages of micropropagation, somaclonal variation, production of haploids through tissue culture; androgenic methods, gynogenic methods, uses of haploids, thin cell layer culture, triploid plant production, cryopreservation of plant cells

Module 5: Cell suspension culture and secondary metabolite production (12 hours)

Types of suspension cultures; batch culture, continuous culture, measurement of cell growth, synchronization of cells in suspension culture, single cell culture, Bergmann cell plating technique, production of secondary metabolites, medium composition for secondary metabolite production, cell immobilization, biotransformation

Module 6: Protoplast isolation and fusion (10 hours)

Methods; mechanical, enzymatic, use of osmoticum, protoplast purification, protoplast viability testing, protoplast culture techniques and medium, somatic hybridization, spontaneous fusion, induced fusion, selection of hybrids, cybrids, applications of protoplast fusion

Microbial Biotechnology (36 hours)

Module 1: Industrial Microbiology (14 hours)

Isolation of metabolite producing bacteria. Characterization and sterilization of culture media. Types of Bioreactors – airlift, stirred tank, bubble column, rotary drum; Fermentation process - batch, fed batch and continuous fermentation; Process control during fermentation - pH, aeration, agitation, temperature, foam control; Downstream processing. Large scale production of antibiotics - penicillin, streptomycin, industrial chemicals - ethanol, acetone, butanol, lysine.

Module 2: Biotechnological Applications of Enzymes (6 hours)

Enzyme immobilization: Preparation, applications, enzymes as biosensors.

Module 3: Tissue engineering and Stem cell technology (6 hours)

Tissue engineering in medicine, methods and applications of tissue engineering.

Stem cells – embryonic stem cell and adult stem cells – potential applications.

Module 4: Bioremediation and Phytoremediation (10 hours)

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. Bioremediation of radioactive wastes. Phytoremediation - importance. Use of GMOs in bioremediation.

References

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8. In vitro cultivation of plant cells. Biotechnology by open learning. Elsevier.
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20. Barbara M. Reed, Plant Cryopreservation: A Practical Guide. Springer, Heidelberg.

PRACTICAL

BMBO4P07: PLANT TISSUE CULTURE AND MICROBIAL BIOTECHNOLOGY

Credit: 2 **Total Hours: 72**

Plant Tissue Culture and Microbial Biotechnology Practicals

1. Preparation of nutrient medium – Murashige and Skoog medium
2. Establishing shoot tip, axillary bud cultures
3. Establishing single cell culture of any one plant and preparing a growth curve
4. Immobilization of whole cells or tissues in sodium alginate.
5. Determination of appropriate flower bud containing uninucleate pollen for anther culture using cytological techniques
6. Establishment of the axenic culture of any one crop plant
7. Micropropagation of an orchid variety from immature seeds
8. Production of somatic embryos from one plant
9. Visit a well equipped biotechnology lab and submit a report along with the practical record.

BMBO414: GENETIC ENGINEERING

Credit: 4 **Total Hours: 90**

Course Objectives:-

- To train the students in the technique of genetic engineering
- To make the students acquainted with the ethical, legal and social issues associated with genetic engineering
- To make the students informed about the future prospects of genetic engineering

Course Outcome:-

- Students will become trained in basic techniques of gene cloning
- Students will be equipped to brainstorm about the ethical, legal and social issues associated with genetic engineering

Module 1: Methods in molecular biology (38 hours)

Nucleic acid isolation, chemistry and procedure ; Agarose gel electrophoresis and visualization of the nucleic acid bands; Blotting techniques; Southern, Northern and Western blotting and hybridization, Probe preparation via nick translation, random priming, end labeling, radioactive and non radioactive probes; DNA sequencing; Sanger's dideoxy method, working of automated DNA sequencer, pyrosequencing, Nanopore sequencing; Polymerase chain reaction; An Overview ,Components and Conditions for PCR Optimization, Primer Design, Symmetric PCR , Asymmetric PCR ,Inverse PCR, Anchored PCR, Quantitative real time PCR, SYBR Green and TaqMan chemistries, Applications of PCR: RAPD, RFLP, AFLP, DNA finger printing ; DNA foot printing

Module 2: Enzymes used in genetic engineering (16 hours)

Restriction enzymes ,types, properties, nomenclature; DNA methylation systems in *E.coli* (dam, dcm, M *EcoKI*); Phosphatase, polynucleotide kinase, single strand specific nucleases; DNA polymerases (DNA Polymerase I, Klenow fragment, T4DNA Polymerase, T7 DNA Polymerase); RNA Polymerases (T3, T7, SP6); Reverse Transcriptase (AMV, MoMLV), Ligases (T4 DNA ligase, E.coli DNA ligase), TOPO cloning (Vaccinia topoisomerase I), Taq polymerase

Module 3: Cloning vectors (18 hours)

Cloning vectors for *E.coli*, Biology of plasmids (conjugative, nonconjugative, relaxed and stringent control of copy number) Plasmid based vectors, pBR 321, pUC series, Biology of Lambda phage (lytic and lysogenic cycle), λ bacteriophage based vectors (insertional and replacement), in vitro packaging; Biology of M13 bacteriophage, M13 phage based vectors,

phagemids, High capacity vectors: cosmids, P1 phage based vectors, bacterial artificial chromosomes. Advantages of each vector. Bacmids

Cloning vectors for *eukaryotes*, *Agrobacterium tumefaciens* and the biology of crown gall formation, Agrobacterium Ti plasmid based vectors, yeast artificial chromosomes, PACs, pcDNA

Module 4: Covalent linkage of DNA fragments to vector molecules (**2 hours**)

Linkers, adapters, homopolymer tailing

Module 5: Selection and screening of recombinant clones (**8 hours**)

Insertional inactivation, alpha complementation and blue white selection, colony and plaque hybridization, immunological screening

Module 6: Advanced transgenic technology (**4 hours**)

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

Module 7: Generation of genomic and cDNA libraries (**4 hours**)

Genomic library, definition and procedure of construction, cDNA library, definition, advantages and procedure of construction, different methods of first strand and second strand of cDNA synthesis

References

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2. S B Primrose, R M Twyman. Principles of gene manipulation and genomics (VII Edn). Blackwell publishing.
3. T A Brown. Genomes (II Edn). Bios. Leland H Hartwell, Leroy Hood, Michael L Goldberg, Ann E Reynolds, Lee M Silver, Ruth C Veres . Genetics: From genes to genomes (II Edn). McGraw Hill.
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BMBO415: GENOMICS, PROTEOMICS AND BIOINFORMATICS

Credit: 4 **Total Hours: 90**

Course Objectives:-

- To make the students acquainted with recent developments in the fields of genomics, proteomics and bioinformatics
- To make the students informed about the future prospects genomics, proteomics and bioinformatics

Course Outcome:-

- Students will become informed about the recent researches going on in the fields of genomics, proteomics and bioinformatics and their implications
- Students will be equipped to brainstorm about the ethical, legal and social issues associated with the developments in genomics, proteomics and bioinformatics

Genomics (63 hours)

Module 1: Genome mapping and sequencing (9 hours)

Genetic and physical maps, DNA markers for genetic mapping –RFLP, SSLP, SNP, physical mapping – restriction mapping; optical mapping, FISH, STS mapping, The methodology for DNA sequencing- Sanger's chain termination method, automated DNA sequencing, pyrosequencing, nanopore sequencing,

Assembly of contiguous DNA sequence; whole genome shot gun approach, clone contig approach; chromosome walking, clone finger printing , Approaches used in sequencing *Haemophilus influenzae* genome and human genome, Important findings of the completed genome projects: Human genome project, Rice genome project, *Arabidopsis* genome project, *E. coli* genome project, Wheat genome project, Tomato genome project.

Module 2: Understanding a genome sequence (18 hours)

Locating the genes in a genome sequence; orf scanning, applications of codon bias, exon-intron boundaries and upstream regulatory sequences, homology search, experimental techniques for gene location; Determining the functions of individual genes ; computer based techniques –homology analysis , orthologous and paralogous genes , experimental techniques ; analysis by gene inactivation- homologous recombination, transposon tagging, RNAi , site directed mutagenesis; analysis by gene over expression

Module 3: **Transcriptomics (6 hours)**

Transcriptome, Trascriptome analysis through SAGE, DNA micoarray, Chromatin immunoprecipitation

Module 4: **Proteomics** (**6 hours**)

Proteome, Proteome analysis through 2D PAGE, MALDI-TOF, Analysis of protein – protein interaction ; phage display and yeast two hybrid system, tandem affinity purification, protein interaction maps,

Module 5: Comparative genomics (**3 hours**)

Comparative genomics in gene mapping, comparative genomics as a tool in evolutionary studies, metagenomics

Module 6: Synthetic biology (**3 hours**)

Introduction to synthetic biology, synthetic genes and genomes; applications -

Module7: Genome editing (**18 hours**)

Biology of Endonucleases (Zinc-Finger Nuclease, TALENs and CRISPRs), genome editing using Zinc finger nucleases (ZFN), Transcription activator-like effector nucleases (TALEN), Engineered meganucleases and CRISPR/Cas system; genome editing in model organisms , leapfrogging, Therapeutic Genome Editing in Human Hematopoietic Stem and Progenitor Cells , CRISPR/Cas9-based In Vivo Models of Cancer;

Bioinformatics (**27 hours**)

Module 1: Bioinformatics introduction (**4 hours**)

An Introduction to bioinformatics. Scope and relevance of bioinformatics. Elementary commands and Protocols, ftp, telnet, http. Formats: FASTA format, ASN.1 format, PDB flat file format, mmCIF format, Data mining. PERL, programming using PERL, Use of PERL in bioinformatics. Application of Bio Edit.

Module 2: Biological Data bases (12 hours)

Online databases and search tools, data organization, NCBI .Biological databases, structural databases, DNA and RNA sequence databases. Nucleic acid sequence databases : GenBank , ENA, DDBJ ; Protein sequence databases: SWISS-PROT ; Protein structure database : Protein Data Bank ; Bibliographic databases (Finding Scientific Articles) : PubMed ; Miscellaneous : Gene expression Omnibus, OMIM, KEGG, , SCOP, CATH. REBASE

Module 3: Alignment (**11 hours**)

Sequence comparison, Pair wise sequence alignment, Global alignment: Use of ALIGN, Local alignment: Use of BLAST, FASTA .Amino acid substitution matrices PAM and BLOSUM, Multiple sequence alignment: Use of ClustalW, Phylogenetic analysis: Use of PHYLIP, MEGA

References

1. David W Mount .Bioinformatics: sequence and genome analysis. CBS publishers & distributors.
2. Jean-Michel Claverie and Cedric Notredame , Bioinformatics – a beginners guide, Wiley India
3. Robert J Brooker .Genetics: analysis & principles (III Edn). McGraw Hill.
4. David W Mount .Bioinformatics: sequence and genome analysis. CBS publishers & distributors.
5. T A Brown .Genomes (II Edn). Bios
6. S B Primrose, R M Twyman. Principles of gene manipulation and genomics (VII Edn).Blackwell publishing.
7. Robert J Brooker .Genetics: analysis & principles (III Edn). McGraw Hill.
8. James D Watson, Amy A Caudy, Richard M Myers, Jan A Witkowski. Recombinant DNA (IIIEdn). W H Freeman.
9. Leland H Hartwell, Leroy Hood, Michael L Goldberg, Ann E Reynolds, Lee M Silver, Ruth C Veres. Genetics: From genes to genomes (II Edn). McGraw Hill.
10. Jeremy M Berg, John L Tymoczko, Lubert Stryer, Gregory J Gatto Jr. *Biochemistry*. W HFreeman and company.
11. David P Clark, Molecular *biology*. Elsevier.
12. D Peter Snustad, Michael J Simmons .*Principles of genetics* (V Edn).John Wiley and Sons.
13. Brown TA, Genomes , Wiley - Liss
14. Krishnarao Appasani (Editor) Genome Editing and Engineering: From TALENs, ZFNs and CRISPRs to Molecular Surgery, Cambridge University Press

PRACTICAL

BMBO4P08: GENETIC ENGINEERING & GENOMICS, PROTEOMICS AND BIOINFORMATICS

Credit: 2 **Total Hours: 54+54**

Genetic Engineering Practical (54 hours)

1. Isolation of chromosomal and plasmid DNA from bacterium
2. Restriction digestion of DNA and assigning restriction sites
3. Isolation of plant genomic DNA
4. Designing a primer for a well characterized *E.coli* gene
5. PCR amplification of the gene from *E.coli* DNA using the designed primer
6. RAPD analysis of three closely related bacterial strains

Genomics, Proteomics and Bioinformatics Practicals (54 hours)

Hands on training in

1. Retrieving data form various databases mentioned in the syllabus
2. Writing short programmes using PERL
3. Local alignment using BLAST and FASTA
4. Multiple sequence alignment using Clustal W
5. Applications of Bioedit
6. Phylogenetic analysis using PHYLIP and MEGA

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