KANNUR UNIVERSITY

(Abstract)

M.Sc. Plant Science with Bioinformatics Programme - Scheme & Syllabus, - under Choice Based Credit and Semester System (in Outcome Based Education System-OBE) in Affiliated Colleges - Implemented with effect from 2024 Admission - Orders issued

ACADEMIC C SECTION

Acad/C2/6474/NGC/2021 (I) Dated: 26.11.2024

Read:-1. U.O No Acad C1/21246/2019 dtd: 09/08/2023 and 15/10/2024

2. The Minutes of the meeting of BoS in Botany (PG) dtd: 08/08/2024

3. E-mail dtd: 09/10/2024 received from Chairperson, BoS Botany

4. E-mail dtd 15/10/2024 received from Dean, Faculty of Science

5. The Orders of Vice Chancellor dtd.28.10.2024

6. The Minutes of the meeting of the Standing Committee of Academic Council held on 13/11/2024

7. The Orders of Vice Chancellor dtd.25.11.2024

ORDER

1.The revised Regulations for Post Graduate Programmes under Choice Based Credit and Which semester system (In OBE- Outcome Based Education system) in Affiliated Colleges under the University was approved and implemented w.e.f.2023 admission and certain modifications were effected thereafter vide paper read (1) above.

2.In the circumstance of nonexistence of Board of Studies at that time, the Syllabus of New Generation Programme viz, M.Sc. Plant Science with Bioinformatics, implemented in the University w.e.f.2021 admission were not revised in line with new PG Regulations implemented w.e.f.2023 admission.

3. Subsequently, after the formation of the Board of Studies(BoS), the Board of Studies in Botany (PG) finalized the Draft Scheme and Syllabus of the M.Sc. Plant Science with Bioinformatics programme and the Chairperson vide paper read (3) above submitted the same for approval and implementation w.e.f.2024 admission, along with the BoS Minutes in this regard.

4.The Syllabus, submitted by the Chairperson was forwarded to the Dean, Faculty of Science for verification. The Dean after vetting the Syllabus, recommended to approve the same vide paper read (4) above.

5.Considering the matter, the Vice Chancellor ordered to place the Draft Syllabus, before the Standing Committee of Academic Council.

6.The Standing Committee of the Academic Council, vide paper read (6) above, recommended to approve the Draft Scheme and Syllabus of the M.Sc.Plant Science with Bioinformatics progaramme.

7.The Vice Chancellor, after considering the Recommendation of the Standing Committee of

the Academic Council and in exercise of the powers of the Academic Council conferred under Section 11(1), Chapter III of the Kannur University Act 1996, ***approved the Scheme & Syllabus of the M.Sc. Plant Science with Bioinformatics programme under Choice Based Credit and Semester system (in OBE- outcome Based Education system) and accorded sanction to implement the same in Affiliated Colleges under the University w.e.f. 2024 Admission, subject to reporting to the Academic Council.***

8.The Scheme & Syllabus of the M.Sc. Plant Science with Bioinformatics programme under Choice Based Credit and Semester System (in OBE- Outcome Based Education System) in Affiliated Colleges under the University with effect from 2024 Admission are appended with this U.O. and uploaded in the University website.

Orders are issued accordingly.

Sd/-
ANIL CHANDRAN R
DEPUTY REGISTRAR (ACADEMIC)
For REGISTRAR

To: The Principals of Affiliated College offering M.Sc. Plant Science with Bioinformatics programme

Copy To: 1.The Examination Branch (Through PA to CE)
2. PS to VC/PA to R
3. DR/AR (Acad)
4. EXCI/ EG I/ AR II/ AR I/ JR II (Exam)
5.The IT Cell, Computer Programmer (for uploading in the website)
6. Chairperson BoS in Botany (PG)
7. SF/DF/FC

Forwarded / By Order
SECTION OFFICER

KV

KANNUR UNIVERSITY * CIVIL STATION P.O. KANNUR Pin-670 002 * THAVAKKARA *

KANNUR UNIVERSITY
കണ്ണൂർ സർവകലാശാല

(Abstract)

Modified syllabus of M.Sc. Plant Science with Bioinformatics Programme (Under Choice Based Credit and Semester System -OBE) in Affiliated colleges w.e.f.2024 admission- Approved - Orders issued

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ACADEMIC C SECTION

Acad/C2/6474/NGC/2021 Dated: 02.03.2026

Read:-1. U.Os No Acad/C2/6474/NGC/2021(I) dtd: 26.11.2024 and 02.12.2024

2. U.O Note no. EXC I/EXC I-IV/29267/2025 dtd:24.10.2025

3. Minutes of the meeting of the Board of Studies in Botany (PG) held on 14.11.2025

4. Remarks received from the Dean- Faculty of Science via e-mail dtd: 04.12.2025

5. Minutes of the meeting of the Standing Committee of the Academic Council held on 21.02.2026

6. Orders of the Vice Chancellor in the file of even number dtd: 02.03.2026

ORDER

1. The Scheme, Syllabus, Pattern of question paper and Model question papers of M.Sc. Plant Science with Bioinformatics Programme (Under Choice Based Credit and Semester System-OBE) in Affiliated colleges was approved and implemented w.e.f.2024 admission vide paper read (1) above.

2. Subsequently, vide paper read (2) above, the Examination Branch requested to clarify the discrepancy occurred in the title of the course, viz MSPSB01C04, between Scheme part and detailed part of the above mentioned programme.

3. The matter was intimated to the Chairperson, BoS in Botany (PG) and later the meeting of BoS in Botany (PG) held on 14/11/2025 considered the matter in detail, and forwarded the modified Syllabus after clearing discrepancy occurred in the title of the course. The content of the fourth semester course viz, MSPSB04C15- STRUCTURAL BIOINFORMATICS was also modified w.e.f 2024 admission.

4. The modified syllabus was forwarded to the Dean Faculty of Science for remarks, and the Dean after vetting the syllabus recommended to approve the same

5.Considering the matter in detail, the Vice Chancellor has ordered to place the modified syllabus of M.Sc Plant Science with Bioinformatics programme in affiliated colleges, before the Standing Committee of the Academic Council for consideration.

6.The Standing Committee of the Academic Council, vide paper read (5) above recommended to approve the modified syllabus of M.Sc Plant Science with Bioinformatics programme in affiliated colleges w.e.f 2024 admission

7.The Vice Chancellor, after considering the recommendation of Standing Committee of the Academic Council and in exercise of the powers of the Academic Council, conferred under the Section 11 (1) Chapter III of Kannur University Act, 1996 and all other enabling provisions read together with, ***approved the modified syllabus of M.Sc Plant Science with Bioinformatics programme, and accorded sanction to implement the same, w.e.f. 2024 admission in Affiliated Colleges under the University,*** subject to reporting to the Academic Council

8. The modified syllabus of M.Sc Plant Science with Bioinformatics programme in affiliated

colleges w.e.f 2024 admission, is appended with this U.O. and uploaded in the University website. Orders are issued accordingly.

Sd/-
Bindu K P G
DEPUTY REGISTRAR (ACADEMIC)
For REGISTRAR

To: 1 . The Principals of Arts and Science Colleges affiliated to Kannur University
2. The Controller of Examinations (Through PA)

Copy To: 1. Chairperson, Board of Studies in Botany (PG)
2. PS to VC/PA to R
3. EX C I/EG I/AR-II/AR-I
4. DR/AR (Academic)
5. IT Cell/Computer Programmer
6. Web Manager (to upload on the website)
7. SF/DF/FC

Forwarded / By Order

SECTION OFFICER

KANNUR UNIVERSITY
കണ്ണൂർ സർവകലാശാല
Re-accredited by NAAC with 'B++' Grade

Scheme and Syllabus

M.Sc. Plant Science with Bioinformatics

2024 Admission onwards

(As per CBCSS Regulations 2023)

KANNUR UNIVERSITY
THAVAKKARA, CIVIL STATION P.O., KANNUR DISTRICT
KERALA 670 002, INDIA.

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Preface

Higher education in Kerala is witnessing drastic changes in the last few years with the introduction of a number of programmes, introduction of Outcome Based Education (OBE) system, introduction of Four Year Undergraduate Programme (FYUGP) and subsequent changes in the Post Graduate Curricula. The MSc Plant Science with Bioinformatics programme was introduced in Kannur University following a policy of the Government of Kerala to introduce more modern and new generation programmes in the higher education sector of Kerala. The syllabus of the programme was prepared based on Kannur University PG Regulations 2014, when the programme was first introduced in 2021. Now Kannur University has amended its regulation for post graduate programmes (Regulations for Choice Based Credit and Semester System for Postgraduate Programme in Affiliated Colleges – 2023), with the introduction of Outcome Based Education (OBE) system in the curriculum. In outcome based education, the focus is shifted from what is taught to what is learned. OBE is an approach to education in which decisions about the curriculum and instruction are driven by the exit learning outcomes that the students should display at the end of a program. This shift to student centric approach calls for important changes to the existing beliefs and practices of teaching and learning, such as, how the syllabus of course is communicated to the learners, the way instruction needs to be done, how the assessment of learning is done, and how the attainment of learning outcomes is determined. The adoption of the student centric approach in this programme is expected to attract more and diverse learners from different states of India and also international students. The syllabus is a concerted effort of all members of the Board od Studies, teachers and experts in this field. The board acknowledge the contributions of each, which gave way in the culmination in this document.

Dr. Pramod C.
Chairperson
Board of Studies in Botany (PG)
Kannur University

Members:

Dr. C. Kunhikannan

Dr. Tajo Abraham

Dr. Prasanth K.P.

Dr. Sreeja P.

Dr. Harikrishnan E.

Dr. Josekutty E.J.

Dr. Tomson Mani

Dr. Gayathri R. Nambiar

Dr. Resmi M.S.

Dr. Subrahmanya Prasad K.

KANNUR UNIVERSITY

Regulations for Choice Based Credit and Semester System for Postgraduate Programme in Affiliated Colleges – 2023

(OBE – Outcome Based Education System)

1. TITLE, APPLICATION AND COMMENCEMENT

1.1 These regulations may be called "Kannur University Regulations for Choice Based Credit and Semester System for Postgraduate Programme 2023" (in OBE – Outcome Based Education – system) (KUCBCSSPG 2023).

1.2 The regulations provided herein shall apply to all regular Post Graduate programmes conducted in colleges and institutions affiliated to the Kannur University, coming under the Faculties of Science, Technology, Humanities, Social Sciences, Language & Literature, Commerce and Management Studies, Fine Arts, Communication, and such other faculties as decided by the University from time to time .

1.3 These regulations shall come into force with effect from 2023 admission onwards.

1.4 The provisions herein shall supersede all the existing regulations for the regular Postgraduate programmes of affiliated colleges and institutions to the extent herein prescribed.

2. DEFINITIONS: In these regulations, unless the context otherwise requires:

2.1 'Programme' means a programme of study comprising of Core Course, Elective Course, Open Course and MOOC course as applicable.

2.2 'Duration of Programme' means the time period required for the conduct of the programme. The duration of a Post Graduate degree programme shall be four semesters with 18 weeks in a semester distributed over a period of two academic years in compliance with hours of instruction stipulated by UGC.

2.3 'Semester' means a term consisting of 90 working days including examination days.

2.4 'Academic Week' is a unit of five working days in which the distribution of work is organised from day one to day five (normally, Monday to Friday), with five contact hours of one-hour duration on each day. A sequence of 18 such academic weeks constitutes a semester.

2.5 'Course' means a segment of a programme limited to one semester in a subject.

2.6 'Core Course' means a compulsory course in a subject related to a particular postgraduate programme.

2.7 'Elective Course' means an optional course to be selected by a student out of such courses offered in the same Department.

2.8 'Open Elective Course (Multidisciplinary)' means an elective course which is available for students of all departments including students of the same department. Students of other departments may opt for these courses subject to fulfilling eligibility criteria as laid down by the department offering the course.

2.9 'MOOC Course' means Massive Open Online Course.

2.10 'Improvement Course' is a course registered by a student for improving her/his performance in that particular course.

2.11 'Credit' means the value assigned to a course which indicates the level of instruction. It is the measure of the total number of hours of training received in a course during a week.

2.12 'Credit Point' (CP) of a Course is the value obtained by multiplying the grade point (GP) by the credit (C) of the course: CP = GP x C.

2.13 'Credit Point' (CP) of a Semester is the sum of credit points obtained by a student in various courses taken in a semester.

2.14 'Semester Grade Point Average' (SGPA) is the value obtained by dividing the sum of credit points obtained by a student in various courses taken in a semester by the total number of credits in that semester. SGPA shall be rounded off to three decimal places. SGPA determines the overall performance of a student at the end of a semester.

2.15 'Cumulative Grade Point Average' (CGPA) is the value obtained by dividing the sum of credit points in all the courses taken by the student for the completed semesters by the total number of credits acquired so far and shall be rounded off to three decimal places.

CGPA = Sum of the Credit Points secured in completed semesters/ Total Credit for the completed semesters

2.16 'Overall Grade Point Average' (OGPA) is the value obtained by dividing the sum of credit points in all the semesters taken by the student for the entire programme by the total number of credits in the entire programme and shall be rounded off to three decimal places. OGPA is the final grade point average after completing four semesters.

2.17 'Grade Card' means the official record of a student's performance, awarded to her/him. Each letter grade is assigned a 'Grade Point' (GP) which indicates the numerical equivalent of the broad level of performance of a student in a course. "Grade Point" means a point given to a grade on the scale as provided under clause 7.2.

2.18 'Letter Grade' or simply 'Grade' in a course is a letter symbol (A^+, A, B, C, D, E, and F). Grade means the prescribed alphabetical grade awarded to a student based on her/his performance in various examinations.

2.19 'Repeat course' is a course that is repeated by a student in a semester for want of sufficient attendance. She/He can repeat the course whenever it is offered again. The student registered for repeat course need not attend the classes if she/he has satisfied the requirements regarding attendance.

2.20 'Strike off the roll': means removing a student who is continuously absent for 14 days without sufficient reason and proper intimation to the Principal of the college from the roll after following the procedure prescribed.

2.21 'College Council' means the body of all Heads of the Departments and elected members among teachers as per the Kannur University Statutes.

2.22 'College Co-ordinator' is a teacher nominated by the college council to coordinate the effective running of CBCSS and the process of continuous evaluation undertaken by various departments within the college. She/he shall be nominated to the College level Grievance Redressal Cell.

2.23 'Department' means any teaching department in a college offering a programme/course of study approved by the University, as per the Statutes and Act of the University.

2.24 'Parent Department' means the Department that offers a particular degree programme.

2.25 'Department Council' means the body of all teachers of a department in a college.

2.26 'Department Co-ordinator' is a teacher nominated by the Department Council to co-ordinate the continuous evaluation process undertaken in that department.

2.27 'Faculty Adviser' means a teacher from the parent department nominated by the Department Council, who will advise the students in academic matters and in the choice of Generic Elective course.

2.28 Words and expressions used and not defined in these regulations, but defined in the Kannur University Act, Statutes and Ordinances shall have the meaning respectively assigned to them in the Act, the Statutes and the Ordinances.

3. PROGRAMME STRUCTURE

3.1 Duration: The duration of a Postgraduate programme shall be four semesters inclusive of days of examinations distributed over a period of two academic years. The odd semesters (1, 3) shall be from June to October and the even semesters (2, 4) shall be from October/November to March. Each semester shall have 90 working days inclusive of days of all examinations. The minimum duration for completion of a two-year Postgraduate programme in any subject is four semesters and the maximum period for completion is eight semesters from the date of registration. No student shall register for more than 24 credits and less than 16 credits per semester subject to the provisions of the programmes concerned.

3.2 Admission: Eligibility for admissions and reservation of seats for various First semester (Postgraduate) programmes shall be according to the rules framed by the University from time to time. There shall be a uniform Academic cum Examinations Calendar approved by the University for the registration, conduct and scheduling of examinations, and publication of results. The Academic cum Examinations Calendar shall be complied with by all colleges and offices, and the Vice Chancellor shall have all powers necessary for this purpose.

3.3 Courses: The Post graduate programme shall include three types of courses, viz., Core Courses, Elective Courses and Open Elective Courses (including MOOC courses). The

Parent Department shall offer appropriate elective courses for a specific programme. Open Elective Courses are offered either by the parent department or by any other Department or via MOOC. Open Elective courses can be opted in the third semester preferably having multidisciplinary nature. A course offered may have different components associated with the teaching-learning process of the course; namely 1. Lecture (L), 2. Tutorials (T) and 3. Practicals (P). 'L' stands for lecture session and every one-hour lecture session per week of a semester amounts to 1 credit. 'T' stands for tutorial session consisting of participatory discussion/self-study/desk work/brief seminar presentation by students. 'P' stands for practical session and it consists to acquire the much-required skill of applying the theoretically learnt concepts. A minimum two-hour session of Tutorial or Practical amounts to 1 credit per semester. Maximum hours allotted for 1 credit practical course/tutorial course/seminar course shall not exceed 4 hours.

3.4. Project/Project and internship/Industry visit: There shall be a project work with dissertation (credit of which shall be decided by the concerned Board of Studies/Ad hoc committee) to be undertaken by all students. Project and dissertation work is a special course involving application of knowledge in solving/analysing/exploring a real-life situation/problem. The dissertation entails field work, lab work, report, presentation and viva voce. Project with dissertation shall be done under the supervision of a faculty member of the department as per the curriculum design. A candidate may, however, in certain cases be permitted to work on the project in an industrial/research organisation on the recommendation of the Head of the Department. In such cases, one of the teachers from the department concerned shall be the supervisor/internal guide and an expert from the industry/research organisation concerned shall act as co-supervisor/external guide. Project dissertation shall be submitted in the last week of February in the fourth semester. Belated and incomplete project reports will not be entertained. Dissertation on the project shall be prepared as per the guidelines given as Annexure 1. Board of studies/Ad hoc committee of each programme shall frame guidelines for internship/industry/academy/library visit or such items designed by the BOS/Ad hoc committee.

3.5 Course code: Every course offered is identified by a unique course code; where, first two letters to denote programme name (MA for Master of Arts, MS for Master of Science, MB for Master of Business Administration, MC for Master of Computer Application, CM for Master of Commerce, MW for Master of Social Work and MT for Master of Tourism and Travel Management). Next three letters denote the subject. This is followed by semester numbers such as 01, 02, 03 and 04. After the semester numbers, the single alphabet stands for Core (C) Elective (E) and Open Elective (O). The last two digits denote the serial number of the course in that category (C, E or O) in that programme.

Illustration:

MAENG01C02

MA = Master of Arts

ENG = English

01 = First semester

C = Core

02 = Serial number of the core course in the programme.

3.6 Credits: Each course shall have a specified number of credits. The total credits required for the successful completion of a four-semester programme will be 80 but for MSW the total credits will be 100 and for MBA and MCA, 120 credits each. Minimum credits for core course shall be 64. The number of credits from Elective course/Open Elective course shall vary between 12 and 16. No course shall have more than 5 credits and for dissertation and General Viva Voce, the maximum credits shall be 10.

3.7 Attendance: A student shall be permitted to appear for the semester examination, only if the candidate secures not less than 75% attendance in all courses of a semester put together. Female students can avail 2% menstrual leave and require only 73% of attendance. Maternity leave for 60 days shall also be granted to girls above 18 years as per U.O. No. Acad/C2/24654/2019 dated 25-03-2023.

Records of attendance shall be maintained by the concerned Department for a period of six years and the attendance register shall be made available for verification, as and when required by the University.

3.8 Eligibility to register for examination: Only those students who are registered for the University examination with eligible attendance (including those under condonable limit) alone are eligible to be promoted to next semester. Students who have attendance in the prescribed limit but could not register for examination are eligible to move to the next semester after availing token registration. The candidates shall apply for token registration within two weeks of the commencement of the next semester. Token registration is allowed only once during the entire programme. It shall be the duty of the principal to ensure that only eligible candidates are promoted to the next semester. The Vice Chancellor shall be competent to cancel the ineligible promotion and impose penalty on the Principal.

3.9 Condonation: Students are eligible for the condonation of shortage of attendance for a maximum of 14 days in a semester subject to a maximum two times during the whole period of Postgraduate Programme. Condonation of shortage of attendance may be granted by the Vice Chancellor on production of the medical certificate from a registered medical practitioner for the days absent. Students who attend, with prior concurrence from the Head of the department/institution, the approved co-curricular activities of College/University/higher level/other agencies approved by the Principal are eligible to get their lost days treated as 'Present' on submission of an application to the Principal through the Head of the Department with a certificate of participation/attendance certificate in such

activities, provided the student concerned must receive the required course of instruction in lieu of the days/ hours lost as may be decided by the Head of the Department/ Principal.

A student who is not eligible for condonation of shortage of attendance shall repeat the semester along with the subsequent batch, in the same institution by availing re-admission.

3.10 For re-admission additional seats shall be allocated, if there is no vacancy in the batch concerned, with a maximum limit of 10% of the total seats, over and above the sanctioned strength.

3.11 Absence from classes: If a student registered in the first semester of a Postgraduate programme is continuously absent from the classes for more than 14 days at the beginning of the first semester without intimation to the Principal, the matter shall immediately be brought to the notice of the Registrar of the University, by the Principal. The names of such students shall be removed from the rolls. A student who is continuously absent for 14 days during a semester without sufficient reason and proper intimation to the Principal of the College shall be removed from the roll provided before removing the student from the roll, the Principal shall consult the College Council and shall communicate the student the decision of the College Council giving the student a reasonable time to file appeals/complaints, if any, to the Principal before the date of strike off the roll. Such appeals/complaints shall be considered by the College Council for further proceedings.

3.12 Grace marks: Grace marks shall be awarded to eligible candidates as per the University orders in this regard from time to time.

4. BOARD OF STUDIES AND COURSES

4.1 The programme/course under these Regulations shall be designed to include the title of the programme/course, Programme Specific Outcome (PSO)/Course Outcome (CO), the number of credits, maximum marks for End Semester Evaluation and Continuous Evaluation and the distribution there of, duration of examination hours and reference materials. Maximum efforts shall be made to maintain a uniform pattern while designing the courses, project, viva, practical etc. in the scheme and syllabus of various programmes coming under the same faculty. The Vision and Mission Statements of the University and Programme Outcomes, as given in Annexure (i) and (ii) shall be given in all syllabi. The concerned PG Boards of Studies/ Ad hoc committees shall design all the courses offered in the Postgraduate programmes. The Boards/Ad hoc committees shall design and introduce new courses, modify or re-design existing courses and replace any existing courses with new/modified/re-designed courses to facilitate better exposures and training for the students.

4.2 Each course shall have an alpha-numeric code and title of the course. The code gives information on the subject, the semester number and the serial number of the course.

4.3 The syllabus of each course shall be prepared module (unit)-wise. Number of instructional hours and reference materials are also to be mentioned against each module.

4.4 The scheme of examination and model question papers are to be prepared by the Board of Studies/Ad hoc committee.

4.5 Board of Studies/Ad hoc committees should analyse the question papers of previous examinations.

4.6 The Board of Studies/Ad hoc committee should make the changes in the syllabi and textbooks in consultation with the teachers concerned.

4.7 At least two meetings of teachers may be held in every department in every College, one in the mid-year and one towards the year end to discuss the academic and general activities of the Department. The recommendations of these meetings should be sent to the Boards of Studies/Ad hoc committee.

4.8 Boards of Studies/Ad hoc committees have to be constantly in touch with other Universities. Subject experts are to be identified in all major fields of study and endeavour, and consulted frequently.

4.9 Different types of questions shall possess different marks to quantify their required analysis. Maximum marks can vary from course to course depending on their comparative importance.

5. EXAMINATION

5.1 There shall be university examinations at the end of each semester. A candidate who fails to register for the University Examination shall not be permitted to move to the next semester. However, token registration is possible as per clause 3.8.

5.2 Practical examinations shall be conducted by the University at the end of the semester. If necessary, it shall be conducted before the End Semester Evaluation.

5.3 External Viva-voce, if any, shall be conducted along with the practical examination/project evaluation.

5.4 Project/Dissertation evaluation shall be conducted at the end of the fourth semester. 20% of marks are to be awarded through continuous evaluation.

5.5 Improvement: Improvement of courses in a particular semester can be done only once. The student shall avail the improvement chance in the succeeding year along with the subsequent batch. If the candidate fails to appear for the improvement examination after registration, or if there is no change in the results of the improvement examination, the mark/grade obtained in the first appearance will be retained. Candidates may be permitted to cancel their improvement registration/appearance if applied before the publication of results, and after that application for cancellation shall not be permitted. To avoid a situation of undergoing two courses of study during the same academic year, those candidates who intend to avail improvement chance after successful completion of the programme, shall surrender their Grade Cards and submit their Transfer Certificate to the University along with application for registration for examination. Transfer Certificate shall be returned to the students after releasing the hall tickets and fresh Grade Card shall be issued incorporating the improvement results. There shall be no improvement chance for continuous evaluation, project/viva voce/practical. The internal marks already obtained will be carried forward to determine the new grade/mark in the improvement examination.

5.6 There shall be no supplementary examinations. For reappearance/improvement the students shall appear along with the students of subsequent admissions as and when the examinations are conducted by the University.

6. EVALUATION

6.1 Course Evaluation:

The evaluation scheme for each course shall contain two parts

a) Continuous Evaluation (CE)

b) End Semester Evaluation (ESE)

20% Weightage shall be given to the Continuous Evaluation (CE) and 80% Weightage shall be for the End Semester Evaluation (ESE)

6.2 Continuous Evaluation (CE):

a. 20% of the total marks in each course are for continuous assessment. The continuous evaluation shall be based on a pre-determined transparent system involving two or more of the following components:

   For theory course: written test, assignments, seminars, viva, book/article review etc.

   For practical courses: lab involvement, records, written tests, etc.

b. Two components and their respective weightages shall be as prescribed in the scheme and syllabus by the Board of Studies/Ad hoc committee concerned.

c. Attendance *shall not be* a component for Continuous Evaluation (CE).

d. There is no pass minimum insistence on Continuous Evaluation marks.

6.3 To ensure transparency in the evaluation process, the Continuous Evaluation marks awarded to the students in each component of each course in a semester shall be displayed on the notice board at least three days before the commencement of the End Semester Evaluation. There shall not be any chance for the improvement of Continuous Evaluation. Only the total CE marks awarded to a candidate in each course need be sent to university by the principal of colleges concerned. The College shall maintain the academic record of each student registered for the course, with the details of the marks awarded to each component of Continuous Evaluation of courses with the signatures of the students, course teacher and HoD which shall be preserved in the college for a period of six years from the last date of the End Semester Examination of the semester concerned and shall be made available to the University for inspection as and when required. Complaints, if any, with regard to the Continuous Evaluation shall be submitted by the student to the Course Teacher. If the student feels that justice is denied, she/he can submit an appeal to the Head of the Department and thereafter to the Principal of the College. The Department Council/ College Council shall consider the complaint and ensure that assessments are done by the teacher in a just and fair manner. In case the student is not satisfied with the decision at the college level, further appeal/complaints may be submitted by the student to the Controller of

Examinations, Kannur University for being placed before the University Level Committee for consideration.

6.4 End Semester Evaluation (ESE): End Semester Evaluation carries 80% of the total marks. The End Semester Evaluation in theory courses are to be conducted with the question papers set by external experts. The evaluation of the answer scripts shall be done by examiners appointed by the University based on a well-defined Scheme of valuation and answer keys provided by the University. After the End Semester Evaluation marks are to be entered in the answer scripts. Marks secured for End Semester Evaluation only need to be communicated to the University. All other calculations including grading are to be done by the University by the Chairperson of the Board of Examiners. The End Semester Evaluation in the practical courses shall be conducted by two examiners (one internal and one external) appointed by the University. End Semester Evaluation of all semesters will be conducted in centralised valuation camps immediately after the examination. All question papers shall be set by the University.

6.5 Project Evaluation: Project evaluation shall be conducted at the end of the fourth semester as per the following general guidelines or by the guidelines framed by the Board of Studies/Ad hoc committee concerned:

a. Evaluation of the Project Report shall be done under Mark System.

b. The evaluation of the project will be done at two stages:

   i) Continuous Evaluation (supervising teacher/s will assess the project and award Continuous Evaluation Marks)

   ii) End Semester Evaluation (external examiner appointed by the University)

c. Marks secured for the project will be awarded to candidates, combining the Continuous Evaluation and End Semester Evaluation marks.

d. The Continuous Evaluation to End Semester Evaluation components are to be taken in the ratio 1:4. Assessment of different components may be taken as follows:

e. Components of Continuous Evaluation and End Semester Evaluation of Project other than the following can be decided by the concerned Board of Studies/Ad hoc committee.

f. For internship/industry/academy/library visit, BOS/Ad hoc committee shall frame suitable evaluation methods including records presentation, etc.

Continuous Evaluation (20% of total)	
Components	**Percentage**
Punctuality	20
Use of Data	20
Scheme/Organization of Report	40
Viva voce	20

End Semester Evaluation (80% of total)	
Components	**Percentage**
Relevance of the Topic	5
Statement of Objectives	10
Methodology/Reference/Bibliography	15
Presentation of facts/figures/language style/diagrams, etc.	20
Quality of Analysis/Use of Statistical tools	15
Findings and recommendations	10
Viva-Voce	25

g. External Examiners will be appointed by the University from the list of IV semester Board of Examiners in consultation with the Chairperson of the Board.

h. The chairman of the IV semester examination should form and coordinate the evaluation teams and their work.

i. Continuous Evaluation should be completed 2 weeks before the last working day of the IV semester.

j. Continuous Evaluation marks should be published in the department.

k. In the case of courses with practical examination, project evaluation shall be done along with practical examinations.

l. Chairperson Board of Examinations, may at his/her discretion, on urgent requirements, make certain exceptions in the guidelines for the smooth conduct of the evaluation of the project.

m. Submission of the Project Report and presence of the student for viva are compulsory for Continuous Evaluation. No marks shall be awarded to a candidate if she/he fails to submit the Project Report for End Semester Evaluation.

n. The student should get a minimum of 40% marks of the aggregate and 40% separately for ESE and 10% CE for a pass in the project.

o. There shall be no improvement chance for the Marks obtained in the Project Report.

p . In an instance of inability to obtain a minimum pass mark as required under clause 6.5 n, the project work shall be re-done and the report may be re-submitted along with subsequent exams through the parent department.

6.6 Viva Voce: There shall be a comprehensive viva voce at the end of the programmes covering questions from all courses of the programme including project work. The candidate shall present one copy of the dissertation on the project before the Viva voce board. The viva voce shall be conducted by two external examiners.

7. GRADING

7.1 Indirect Grading System based on the scale specified in clause 7.2 is used to evaluate the performance of students.

7.2 Indirect grading system shall be adopted for the assessment of a student's performance in a course (both CE and ESE) Each course is evaluated by assigning marks with a letter grade (A^+, A, B, C, D, E and F) to that course by the method of indirect grading. Mark system is followed instead of direct grading for each question. For each course in the semester, letter grade, grade point and percentage of marks are introduced in the indirect grading system with scale as per guidelines given below:

% of Marks (CE+ESE)	Grade	Interpretation	Range of Grade Points
90 and above	A+	Outstanding	9-10
80 to below 90	A	Excellent	8-8.99
70 to below 80	B	Very Good	7-7.99
60 to below 70	C	Good	6-6.99
50 to below 60	D	Satisfactory	5-5.99
40 to below 50	E	Pass	4-4.99
Below 40	F	Failure	0-3.99

7.3 Evaluation (both CE and ESE) is carried out using mark system. The grading on the basis of a total CE and ESE marks will be indicated for each course. Each letter grade is assigned a 'Grade point' (GP) which is a point given to a grade on the scale as envisaged under clause 7.2 and is obtained using the formula:

Grade Point = (Total marks awarded / Total Maximum marks) x 10.

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

CP = GP x C

A minimum of grade point 4 is needed for the successful completion of a course.

7.5 A candidate securing not less than 40% of aggregate marks of a course [both ESE and CE put together) with not less than 40% in End Semester Examination [ESE] shall be declared to have passed in that course. A minimum of grade point 4 with letter grade E is needed for the successful completion of a course.

7.6 Appearance for Continuous Evaluation (CE) and End Semester Evaluation (ESE) are compulsory and no grade shall be awarded to a candidate if she/he is absent for CE/ESE or both.

7.7 After the successful completion of a semester, Semester Grade Point Average (SGPA) of a student in that semester is calculated using the formula given below.

SGPA = Sum of the Credit Points of all courses in a semester / Total Credits in that semester

Semester Grade Point Average' (SGPA) is the value obtained by dividing the sum of credit points obtained by a student in the various courses taken in a semester by the total number of credits in that semester. SGPA determines the overall performance of a student at the end of a semester.

For the successful completion of a semester, a student should pass all the courses in that semester. However, a student is permitted to move to the next semester irrespective of the SGPA obtained.

SGPA shall be rounded off to three decimal places.

7.8 The Cumulative Grade Point Average (CGPA) of the student is calculated at the end of each semester. The CGPA of a student determines the overall academic level of the student in each stage of the programme. CGPA can be calculated by the following formula:

CGPA = Sum of Credit Points of all completed semesters / Total Credits acquired

CGPA shall be rounded off to three decimal places.

7.9 At the end of the programme, the overall performance of a candidate is indicated by the Overall Grade Point Average. Overall Grade Point Average (OGPA) of the student is calculated at the end of the programme. The OGPA of a student determines the overall academic level of the student in a programme and is the criterion for classification and ranking the students. OGPA can be calculated by the following formula.

OGPA = Sum of Credit Points obtained in all semesters of the programme / Total Credits (80)

OGPA shall be rounded off to three decimal places.

An overall letter grade for OGPA for the entire programme shall be awarded to a student after completing the entire programme successfully. Overall letter grade based on OGPA and conversion of Grades into classification shall be in the following way.

Grade range OGPA	Overall Letter Grade	Classification
9 - 10	A+	First class with Distinction
8 - 8.999	A	
7 - 7.999	B	First class
6 - 6.999	C	
5 - 5.999	D	Second class
4 - 4.999	E	Pass
Below 4	F	Fail

7.10 The Percentage of marks based on OGPA is calculated by multiplying them by 10. Percentage in two decimal places = [OGPA in three decimal places] x 10

7.11 Those candidates who pass all the courses prescribed for a programme shall be declared to have successfully completed the programme and eligible for the degree. Minimum OGPA

required for the successful completion of the degree programme is 4. In the event a candidate fails to secure a pass in any course in a semester, consolidation of SGPA and CGPA will be made only after obtaining a pass in the failed course in the subsequent appearance, as envisaged in clause 7.5.

7.12 A student who fails to secure a minimum mark for a pass in a course is permitted to write the examination along with the subsequent batch.

7.13 Moderation: Moderation shall be decided by the concerned Board of examiners subject to the Statistics of marks made available from the Examination branch and as per the prescribed guidelines.

7.14 Revaluation: In the new system revaluation is permissible. The prevailing rules and regulations of revaluation are applicable to KUCBCSSPG2023.

8. GRADE CARD

8.1 The University shall issue to the student's grade/marks card (by online) on completion of each semester, which shall contain the following information:

a) Name of University

b) Name of College

c) Month and year of examination

d) Title of Postgraduate Programme

e) Semester concerned

f) Name and Register Number of the student.

g) Course Code, Title and Credits of each course opted in the semester

h) Continuous Evaluation marks, End Semester Evaluation marks, total marks, Grade point (G), Credit point and Letter grade in each course in the semester

i) Total credits, total credit points and SGPA in the semester (corrected to three decimal places)

j) Semester percentage = SGPA X 10 and CGPA separately.

8.2 The final Grade/mark Card issued at the end of the final semester shall contain the details of all courses taken during the entire programme including those taken over and above the prescribed minimum credits for obtaining the degree. The final grade card shall show OGPA (corrected to three decimal places) and the overall letter grade of a student for the entire programme. If the students are in need of a separate grade card of each semester for the purpose of higher studies, the same shall be issued on attestation by the Controller of Examinations/Joint Registrar/Deputy Registrar/Assistant Registrar after levying the prescribed fee.

9. AWARD OF DEGREE

9.1 For the successful completion of all the courses [core, elective and open elective (multidisciplinary)] a candidate has to secure minimum E grade as provided in clause 7. Satisfying the minimum credit 80 and securing minimum OGPA 4 shall be the minimum requirement for the award of degree.

9.2 Rank certificates up to third rank shall be issued, instead of Position Certificates, on the basis of highest OGPA secured for the programme.

10. MONITORING OF THE PROGRAMME AND GRIEVANCE REDRESSAL MECHANISM

10.1 College level: Every programme conducted under the Choice Based Credit and Semester System in a College shall be monitored by the College Council. The College shall form a Grievance Redressal Committee in each department comprising of course teacher and one senior teacher as members and the Head of the department as chairperson. This committee shall address all grievances relating to the continuous evaluation marks of the students. There shall be a college level Grievance Redressal Committee comprising of staff advisor of College Union as Convenor, Chairperson of College Union, General Secretary of College Union, two senior teachers and two members elected by the College Council from among the teachers of the College as members and Principal as Chairperson.

10.2 University level: The University shall form a Grievance Redressal Committee under the chairmanship of Pro-Vice Chancellor as the Chairperson with Convenors of Standing Committees on Examinations, and Student Welfare, Controller of Examinations as Convenor, One Senior officer in Examination branch not below the rank of Joint Registrar/Deputy Registrar, Director of Student Services, University Union Chairperson, University Union General Secretary as members to consider the complaints/appeal from students with regard to Continuous Evaluation or any other matter coming under the purview of these regulations.

11. TRANSITORY PROVISION

Notwithstanding anything contained in these regulations, the Vice-Chancellor shall, for a period of three year from the date of coming into force of these regulations, have the power to make provisions by order to address any issues arising out of the implementation of these regulations for solution of which no provisions are explicitly provided in these regulations. All such decisions taken by the Vice Chancellor shall be reported to the Academic Council and the Syndicate.

12. REPEAL

The Regulations now in force insofar as they are applicable to Post Graduate programmes offered by the University and to the extent they are inconsistent with these regulations stand repealed. In the case of any inconsistency between any other existing regulations and these regulations in their application to any programme offered in a College, the latter shall prevail.

Annexure 1:

Guidelines for the preparation of dissertation on project

1. Arrangement of contents shall be as follows:

    1. Cover page and title page
    2. *Bonafide* certificate
    3. Declaration by the student
    4. Acknowledgements
    5. Table of contents
    6. List of tables
    7. List of figures
    8. List of symbols, Abbreviations and Nomenclature
    9. Chapters
    10. Appendices
    11. References

2. Page dimension and typing instruction

The dimension of the dissertation on the project should be in A4 size. The dissertation should be typed in bond paper and bound using a flexible cover of the thick white art paper or spiral binding. The general text shall be typed in the font style 'Times New Roman' and font size 12. For major headings font size may be 16 and minor heading 14. Paragraphs should be arranged in justified with margin 1.25 each on top. Portrait orientation shall be there on the left and right of the page. The content of the report shall be around 40 pages.

3. *Bonafide* certificate shall be in the following format

CERTIFICATE

This is to certify that the project entitled ..... (title) submitted to the Kannur University in partial fulfilment of the requirements of Post Graduate Degree in ..... (subject), is a *Bonafide* record of studies and work carried out by ..... (Name of the student) under my supervision and guidance.

Office seal — Signature, name, designation and official address of the

Date: — Supervisor.

4. Declaration by the student shall be in the following format

DECLARATION

I ..... (Name of the candidate) hereby declare that this project titled ..... (title) is a *bonafide* record of studies and work carried out by me under the supervision of ..... (Name, designation and official address of the supervisor), and that no part of this project, except the materials gathered from scholarly writings, has been presented earlier for the award of any degree or diploma or other similar title or recognition.

Date: Signature and name of the student

KANNUR UNIVERSITY

Curriculum for Choice Based Credit and Semester System for Postgraduate Programme in Affiliated Colleges -2023

(OBE – Outcome Based Education – system)

Kannur University introduced Outcome Based Education (OBE) in the curriculum for undergraduate students in 2019. Expanding OBE to the Postgraduate curriculum and syllabus from the academic year 2023 onwards demonstrates the university's commitment to further improving the learning experience for its students across different academic levels. This move is to enhance the academic rigour and relevance of the Postgraduate programmes, better preparing the students for their future careers and challenges.

Outcome based education is an educational methodology where each aspect of education is organised around a set of goals (outcomes). Students should achieve their goal by the end of the educational process. Throughout the educational experience, all students should be able to achieve their goals. It focuses on measuring student performance through outcomes. The OBE model aims to maximise student learning outcomes by developing their knowledge & skills.

The key to success in outcome-based education is clarity, for both teachers and students to understand what's expected of them. Outcome-based education aims to create a clear expectation of results that students must achieve. Here, the outcome includes skills, knowledge and attitude. In addition to understanding what's expected, outcome-based education also encourages transparency. The basic principle of outcome-based education is that students must meet a specific standard to graduate. Hence, no curve grading is used in outcome-based education, and instead, teachers are free to experiment with any methodology they feel is best.

Mission statements

To produce and disseminate new knowledge and to find novel avenues for application of such knowledge.

To adopt critical pedagogic practices which uphold scientific temper, the uncompromised spirit of enquiry and the right to dissent.

To uphold democratic, multicultural, secular, environmental and gender sensitive values as the foundational principles of higher education and to cater to the modern notions of equity, social justice and merit in all educational endeavours.

To affiliate colleges and other institutions of higher learning and to monitor academic, ethical, administrative and infrastructural standards in such institutions.

To build stronger community networks based on the values and principles of higher education and to ensure the region's intellectual integration with national vision and international standards.

To associate with the local self-governing bodies and other statutory as well as non-governmental organisations for continuing education and also for building public awareness on important social, cultural and other policy issues.

Establishing the Programme Outcomes (POs)

Programme Outcomes (POs): Programme outcomes can be defined as the objectives achieved at the end of any specialisation or discipline. These attributes are mapped while a student is doing graduation and determined when they get a degree.

Establishing the Course Outcomes

Course Outcomes (COs) are the objectives that are achieved at the end of any semester/year. For instance, if a student is studying a particular course, then, the outcomes would be concluded on the basis of the marks or grades achieved in theory and practical lessons. Each programme shall define the COs according to the outcome set at the beginning of the study of the course.

Automated Question Bank System

The evaluation process shall be based on the revised Bloom's Taxonomy. Hence the syllabus shall be defined and designed in view of the scheme of the said taxonomy.

Modules

The syllabus shall be prepared in four Modules to reflect the spirit of revised Bloom's Taxonomy and the evaluation system based on the six cognitive levels.

Evaluation process using Revised Bloom's Taxonomy

There are six levels of cognitive learning according to the revised version of Bloom's Taxonomy. Each level is conceptually different. The six levels are remembering, understanding, applying, analysing, evaluating, and creating. These levels can be helpful in developing learning outcomes.

Remember

Definition: retrieve, recall, or recognize relevant knowledge from long-term memory. Appropriate learning outcome verbs for this level include: cite, define, describe, identify, label, list, match, name, outline, quote, recall, report, reproduce, retrieve, show, state, tabulate, and tell.

Understand

Definition: demonstrate comprehension through one or more forms of explanation. Appropriate learning outcome verbs for this level include: abstract, arrange, articulate, associate, categorise, clarify, classify, compare, compute, conclude, contrast, defend, diagram, differentiate, discuss, distinguish, estimate, exemplify, explain, extend, extrapolate, generalise, give examples of, illustrate, infer, interpolate, interpret, match, outline, paraphrase, predict, rearrange, reorder, rephrase, represent, restate, summarise, transform and translate.

Apply

Definition: Use information or a skill in a new situation. Appropriate learning outcome verb for this level include: apply, calculate, carry out, classify, complete, compute, demonstrate, dramatise, employ, examine, execute, experiment, generalise, illustrate, implement, infer, interpret, manipulate, modify, operate, organise, outline, predict, solve, transfer, translate, and use.

Analyze

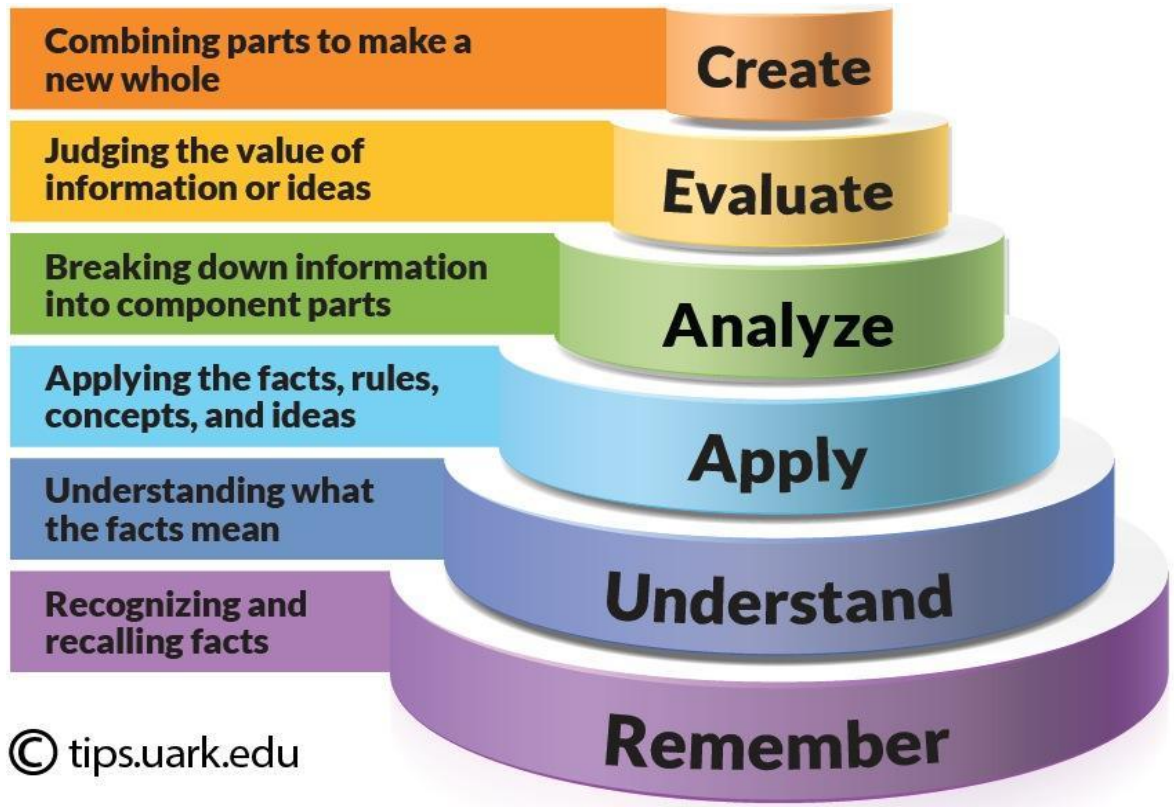
Definition: break material into its constituent parts and determine how the parts relate to one another and/or to an overall structure or purpose Appropriate learning outcome verbs for this level include: analyse, arrange, break down, categorise, classify, compare, connect, contrast, deconstruct, detect, diagram, differentiate, discriminate, distinguish, divide, explain, identify, integrate, inventory, order, organise, relate, separate, and structure.

Evaluate

Definition: make judgments based on criteria and standards Appropriate learning outcome verbs for this level include: appraise, apprise, argue, assess, compare, conclude, consider, contrast, convince, criticise, critique, decide, determine, discriminate, evaluate, grade, judge, justify, measure, rank, rate, recommend, review, score, select, standardise, support, test, and validate.

Create

Definition: put elements together to form a new coherent or functional whole; reorganise elements into a new pattern or structure. Appropriate learning outcome verbs for this level include: arrange, assemble, build, collect, combine, compile, compose, constitute, construct, create, design, develop, devise, formulate, generate, hypothesise, integrate, invent, make, manage, modify, organise, perform, plan, prepare, produce, propose, rearrange, reconstruct, reorganise, revise, rewrite, specify, synthesise, and write.



Levels in the Revised Bloom's Taxonomy of Cognitive Development

Programme Outcomes (POs)

PO1. Advanced Knowledge and Skills: Postgraduate courses aim to provide students with in-depth knowledge and advanced skills related to their chosen field. The best outcome would be to acquire a comprehensive understanding of the subject matter and develop specialised expertise.

PO2. Research and Analytical Abilities: Postgraduate programmes often emphasise research and analytical thinking. The ability to conduct independent research, analyse complex problems, and propose innovative solutions is highly valued.

PO3. Critical Thinking and Problem-Solving Skills: Developing critical thinking skills is crucial for postgraduate students. Being able to evaluate information critically, identify patterns, and solve problems creatively are important outcomes of these programs.

PO4. Effective Communication Skills: Strong communication skills, both written and verbal, are essential in various professional settings. Postgraduate programs should focus on enhancing communication abilities to effectively convey ideas, present research findings, and engage in academic discussions.

PO5. Ethical and Professional Standards: Graduates should uphold ethical and professional standards relevant to their field. Understanding and adhering to professional ethics and practices are important outcomes of postgraduate education.

PO6. Career Readiness: Postgraduate programs should equip students with the necessary skills and knowledge to succeed in their chosen careers. This includes practical skills, industry-specific knowledge, and an understanding of the job market and its requirements.

PO7. Networking and Collaboration: Building a professional network and collaborating with peers and experts in the field are valuable outcomes. These connections can lead to opportunities for research collaborations, internships, and employment prospects.

PO8. Lifelong Learning: Postgraduate education should instil a passion for lifelong learning. The ability to adapt to new developments in the field, pursue further education, and stay updated with emerging trends is a desirable outcome.

KANNUR UNIVERSITY
M.Sc. PLANT SCIENCE WITH BIOINFORMATICS
(Effective from 2024 admission onwards)

Programme Specific Outcomes (PSOs)

PSO1: Attain a comprehensive understanding of varied life forms such as cyanobacteria, bacteria, algae, fungi, lichens, bryophytes, pteridophytes, gymnosperms and angiosperms with an understanding of the distribution, pattern of evolution within and between groups.

PSO2: Able to apply morphological, anatomical, palynological, embryological, physiological, ecological, biophysical, biochemical, and molecular processes and methods for understanding the growth and development of diverse groups of plants under varied growth conditions.

PSO3: Develop skills and expertise in herbarium techniques, nursery and garden techniques, indoor farming, agriculture and horticulture techniques, cell biology, tissue culture, plant breeding, genetics, biotechnology and bioinformatics.

PSO4: Equip with logical reasoning ability for analysing the floristics composition, phytosociology, adaptive mechanisms, phytogeography and ecosystem services of habitats from an ecological, economic and conservation perspective.

PSO5: Develop professional skill and expertise to design and undertake independent research in priority areas of plant sciences, develop analytical proficiency using statistical and computational tools and techniques, and evaluate the findings as per the objectives set in the scientific investigation.

PSO6: Acquire the basic and advanced aspects of bioinformatics and skill and expertise in analysing and establishment of databases in bioinformatics.

SCHEME AND CREDIT DISTRIBUTION CHART OF COURSES FOR THE M.Sc. PLANT SCIENCE WITH BIOINFORMATICS PROGRAMME

SEM	COURSE CODE	COURSE	MARKS			CREDIT	Hours/week	
			CE	ESE	Total		L	P
I	MSPSB01C01	MICROBIOLOGY, MYCOLOGY AND PLANT PATHOLOGY	15	60	75	4	4	2
	MSPSB01C02	PHYCOLOGY, BRYOLOGY AND PTERIDOLOGY	15	60	75	4	4	3
	MSPSB01C03	GYMNOSPERMS, ANGIOSPERM ANATOMY AND EMBRYOLOGY	15	60	75	4	4	3
	MSPSB01C04	EVOLUTION, MICROTECHNIQUE AND BIOINSTRUMENTATION	15	60	75	4	3	2
	MSPSB01C05	PRACTICAL I	15	60	75	4		
TOTAL FOR FIRST SEMESTER			**75**	**300**	**375**	**20**	**15**	**10**
II	MSPSB02C06	ENVIRONMENTAL SCIENCE, FOREST BOTANY AND PHYTOGEOGRAPHY	15	60	75	4	3	3
	MSPSB02C07	GENETICS, PLANT BREEDING AND BIOSTATISTICS	15	60	75	4	4	3
	MSPSB02C08	CELL AND MOLECULAR BIOLOGY	15	60	75	4	4	2
	MSPSB02C09	MICROBIAL AND PLANT BIOTECHNOLOGY	15	60	75	4	4	2
	MSPSB02C10	PRACTICAL II	15	60	75	4		
TOTAL FOR SECOND SEMESTER			**75**	**300**	**375**	**20**	**15**	**10**
III	MSPSB03C11	PLANT PHYSIOLOGY AND BIOCHEMISTRY	15	60	75	4	4	2
	MSPSB03C12	ANGIOSPERM SYSTEMATICS	15	60	75	4	4	4
	MSPSB03C13	BASIC BIOINFORMATICS	15	60	75	4	4	2
	MSPSB03O 01/02/03/04/05	OPEN ELECTIVE (Multi-Disciplinary)/MOOC	15	60	75	4	3	2
	MSPSB03C14	PRACTICAL III	15	60	60	4		
TOTAL FOR THIRD SEMESTER			**75**	**300**	**375**	**20**	**15**	**10**
IV	MSPSB04C15	STRUCTURAL BIOINFORMATICS	15	60	75	4	4	3
	MSPSB04 E01/02/03/04	ELECTIVE I	15	60	75	4	4	2
	MSPSB04 E05/06/07/08	ELECTIVE II	15	60	75	4	4	2
	MSPSB04C16	PRACTICAL IV	15	60	75	4		
	MSPSB04C17	PROJECT/DISSERTATION	15	60	75	4		6
TOTAL FOR FOURTH SEMESTER			**75**	**300**	**375**	**20**	**12**	**13**
TOTAL			**300**	**1200**	**1500**	**80**		

OPEN ELECTIVE COURSES

Open Elective Courses are elective courses offered in the third semester of the programme, available for students of all departments including the students of the same department. Open Elective Courses for a programme can be offered either by the parent department or by any other PG Department. The student can opt the open elective course from the bunch of courses offered by the department from MSPSB03O01 to MSPSB03O04. Students are also free to opt Massive Open Online Course (MOOC - MSPSB03O05) instead of the open elective courses offered by the departments of the college. Only internal examinations shall be conducted for the practical of Open Elective Courses.

List of Open Elective Courses

Sl. No.	Course Code	Course
1	MSPSB03O01	ARTIFICIAL INTELLIGENCE FOR LIFE SCIENCE STUDIES
2	MSPSB03O02	FORENSIC BOTANY
3	MSPSB03O03	MARINE BOTANY
4	MSPSB03O04	BIODIVERSITY AND CONSERVATION
5	MSPSB03O05	MOOC (Suggested by the Department Council)

ELECTIVE COURSES

The elective courses are offered in the fourth semester of the programme. The student shall select two elective courses offered by the department from the list of elective courses given. The first course (Elective I) should be selected from the bunch of courses from MSPSB03E01 to MSPSB03E04 and the second course (Elective II) should be selected from the bunch of courses from MSPSB03E05 to MSPSB03E08 from the list. The model question for the elective course will be in the same pattern as that of other core theory courses.

List of Elective Courses

ELECTIVE I		
Sl. No.	**Course Code**	**Course**
1	MSPSB04E01	MICROBIOME AND METAGENOMICS
2	MSPSB04E02	ADVANCED BIOINFORMATICS
3	MSPSB04E03	SPECTROSCOPY AND PROTEIN STRUCTURE PREDICTION
4	MSPSB04E04	PROGRAMMING FOR BIOINFORMATICS
ELECTIVE II		
1	MSPSB04E05	REMOTE SENSING, GIS AND ECOSYSTEM MODELLING
2	MSPSB04E06	WETLAND ECOLOGY
3	MSPSB04E07	HORTICULTURE AND MUSHROOM CULTIVATION
4	MSPSB04E08	ETHNOBOTANY AND BIOPROSPECTING

MOOC COURSES

The students are free to opt Massive Open Online Courses (MOOC) for the requirement of Open Elective Courses in the third semester of the programme, under intimation to the Head of the Department. The department shall advise the students regarding the selection of MOOC. Total credits for MOOC are 4. The Department will conduct internal assessment (CE) of MOOC based on a presentation, viva voce, etc. The student shall submit the course completion certificate to the parent department. A report of the MOOC with the grade/mark obtained (converted as per course requirement) shall be sent to the university by the parent department.

PRACTICAL EXAMINATION

The external evaluation of four Practical courses is carried out through an examination for each course at the end of each semester. Each question paper has maximum marks of 60, of which 12 marks should be for the records/submissions related to that course. All the records and submissions should be certified *bona fide* before the external practical examination. The scheme of the question paper for practical examination and the ratio/components of Records & Submissions (CE/ESE) shall be finalised by the Board of Examiners sufficiently prior to the practical examination. The Board of Examiners has the flexibility to make necessary changes in the practical question paper, if required. The split up of the total marks shall be as follows.

Component	CE (Internal)	ESE (External)	Total
Examination	12	48	60
Records & Submissions	3	12	15
Total	15	60	75

CONTINUOUS EVALUATION (CE)

This assessment shall be based on a predetermined transparent system involving periodic written tests, assignments, seminars and regularity/punctuality in respect of theory courses and based on tests, lab skill, records/viva and regularity/punctuality in respect of practical courses.

The percentage of marks assigned to various components for internal evaluation is as follows:

Theory Component	% of internal marks
Two test papers (preferably one model exam and one test paper on self-study module)	40
Review of any Publication or Book/ Debates/Assignment	20
Seminar/Presentation of case study	20
Regularity/Punctuality of activities	20

Practical Component	% of internal marks
Test Papers	40
Lab skill	20
Records/Viva	20
Regularity/Punctuality of activities	20

END SEMESTER EVALUATION (EXTERNAL) OF THEORY COURSES (ESE)

The End Semester Evaluation (ESE) of each theory course is done through a question paper for 60 marks with 16 questions belonging to Long Essay, Short Essay and Paragraph type questions, covering the cognitive levels Remember, Understand, Apply, Analyse, Evaluate and Create; out of which 11 questions are to be answered. The model question paper for the core theory courses, with weightage per module is appended.

CONTINUOUS EVALUATION (INTERNAL) EVALUATION (CE)

To ensure transparency of the evaluation process, the internal assessment (CE) marks awarded to the students in each course in a semester shall be published on the notice board at least one week before the commencement of the external examination. There will not be any chance for improvement for internal marks. The course teacher shall maintain the academic record of each student registered for the course, which shall be forwarded to the University, through the college Principal, after endorsed by the Head of the Department.

Tests: For each course there shall be at least two class tests during a semester. The probable dates of the tests shall be announced at the beginning of each semester. More weightage in the internal tests shall be given for self-study modules of the course syllabus content. Marks should be displayed on the notice board. Valued answer scripts shall be made available to the students for perusal within 10 working days from the date of the tests.

Assignments: Each student shall be required to do Assignments/Publication/Book review for each course. Publication /Book review after valuation must be returned to the students. The teacher shall define the expected quality of the above in terms of structure, content, presentation, etc. and inform the same to the students. Punctuality in submission is to be considered.

Seminar: Every student shall deliver one seminar as an internal assessment component for every course and must be evaluated by the respective course teacher/s in terms of structure, content, presentation and interaction. The soft and/or hard copies of the seminar report are to be submitted to the teacher in charge.

PROJECT

In the fourth semester, each student has to undertake a research project and to submit a dissertation. The topic of dissertation may be chosen from any area of Plant Science and may be laboratory-based, field-based or both or computational, with emphasis on originality of approach. The students may be advised to start the project during early semesters, preferably second or third semester of the programme and shall be completed by the end of the fourth semester. The Dissertation should be prepared in a Science Thesis Model. Along with the submission of project dissertation, there shall be a Viva voce and presentation as components of evaluation.

The project work shall be carried out under the supervision of a teacher in the parent department concerned or prescribed by the department coordinator. The project report shall be prepared according to the guidelines approved by the university. Two typed copies of the project report shall be submitted to the Head of the Department, two weeks before the commencement of the ESE of the final semester. The external evaluation of the project work shall be carried out at the end of the

programme. Every student has to do the project work independently. Each project should be unique with respect to title, project content and project layout.

Project Evaluation

Submission of the Project report and presence of the student for viva are compulsory for external evaluation. No marks shall be awarded to a candidate if she/he fails to submit the Project report for external evaluation. A student shall be declared pass in the Project Report Course if she/he secures minimum 40% marks of the aggregate and 40% separately for external. In an instance of inability to obtain a minimum of 40% marks, the Project work may be redone and the report may be resubmitted along with subsequent examinations through the parent department. There shall be no improvement chance for the Marks obtained in the Project Report.

The ESE of the project work shall be conducted by two external examiners. The evaluation of the project will be done at two stages: Continuous Evaluation (CE) (supervising teacher/s will assess the project and award Internal Marks) and External Evaluation (by external examiners appointed by the University). Marks secured for the project will be awarded to candidates, combining the internal and external Marks. The internal (CE) to external component (ESE) is to be taken in the ratio 1:4. Assessment of different components of the project may be taken as below.

Continuous Evaluation (Internal) (20% of total)

Component	**% of mark**
Punctuality	20
Use of data	20
Scheme/Organization of Report	40
Viva-voce	20

(End Semester Evaluation (External) (80% of total)

Component	**% of mark**
Relevance of the Topic	5
Statement of objectives	10
Methodology/Reference/Bibliography	15
Presentation of Facts/Figures/Language style/Diagrams, etc.	20
Quality of Analysis/Use of Statistical tools	15
Findings and recommendations	10
Viva-voce	25

The Chairperson of the Board of Examinations, may at his discretion, on urgent requirements, shall make certain exceptions in the guidelines for the smooth conduct of the evaluation of the project.

RECORD OF PRACTICAL WORK

A certified record of practical work done by the student should be submitted at the time of each practical examination. The submissions/documentation prescribed in each course are also considered as the record of practical work. All of these also shall be submitted for the external evaluation.

INTERNSHIP

The students are advised to undertake internship programmes in institutions especially related to plant science research, preferably in the summer vacation. The internship shall be done with the prior permission of the Head of the parent Department.

Semester I

MSPSB01C01 MICROBIOLOGY, MYCOLOGY AND PLANT PATHOLOGY

Course Code	MSPSB01C01			
Course	MICROBIOLOGY, MYCOLOGY AND PLANT PATHOLOGY			
Type of Course	Core Course			
Semester	I			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	4	2	72 + 36
Pre-requisites	Basic introductory knowledge on microbes and its types and ecology			
Course summary	Students will be introduced to the microbial world, its diversity and functions with suitable examples. Course will help to comprehend the different aspects of the living world at the microscopic level. Host-microbe interaction both at the beneficial and harmful levels will be discussed. Applications of the microbial potentialities are also discussed with suitable examples.			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Ability to describe the microbes using technical terms.	R, U	F	Quiz Test paper
CO2	Ability to differentiate different types of microbes based on its features	R, U	F	Test paper
CO3	Ability to comprehend the different functions carried out by microbes at the ecosystem levels and also at the individual interaction with its respective host	U, An, E	F, C	Test paper Assignment Seminar Viva Voce
CO4	Ability to explore the microbial diversity using suitable tools and techniques	An, E	P	Practical Exam
CO5	Ability to appreciate the potentialities of the microbe and its beneficial application in industry	Ap, An, E, C	F, P	Test paper Assignment Viva voce
CO6	Ability to recognise the negative impacts of microbes on its host	An, E	F, C	Test paper Assignment Viva voce
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	**MICROBIOLOGY** **Methods in Microbiology**: Microscopy and related techniques. Culture methods - Media preparation and sterilisation techniques - different types. isolation of pure cultures, cultivation of anaerobic bacteria, maintenance of microbial cultures, estimation of microbial number and biomass, bacterial staining.	18

	Bacteria: Classification of Bacteria according to Bergey's manual of systematic bacteriology (up to family). Systematic identification of bacteria: Phenotypic and biochemical characters. Molecular techniques used in bacterial identification. Genomes based classification of Microbes (Bacteria) and their phylogeny. Major groups of Bacteria: Spirochetes, Rickettsias, Chlamydias, Mycoplasmas, Actinomycetes. Myxobacteria, Archaebacteria: - extremophiles, thermophilic, halophilic, acidophilic, alkalophilic bacteria and methanogenic bacteria General outline on Nutrition, cultivation, growth of Bacteria. Use of DNA Barcoding in bacteria **Viruses:** General account of plant and animal viruses and bacteriophages; classification of viruses - ICTV; Viral cryptogram. Basic virology methods for the study of morphology and structure, Techniques for isolation, purification, cultivation and assay. General outline of virus life cycle-infection, replication and transmission. Viroids and Prions. Virus and Cancer **Applications of Microbial Fermentation and Agricultural microbiology**: Industrial microorganisms - types and products. Introduction to Fermentation technology - fermenter design and operation, upstream and downstream processes. production of alcohol, vinegar, antibiotics, vitamins, steroids, vaccines, organic acids, enzymes.	
Module II	**MYCOLOGY** **Classification and Salient features of Fungi**: Characters used in fungal classification, Kingdoms of fungi: Fungi, Chromista, Protozoa; phylum-level classification Alexopoulos *et al.* 1996, and Kirk *et al.* (2008); DNA Barcoding in fungi. General characters, habit and importance of asexual fungi, somatic structures, and reproductive structures in Myxomycota, Oomycota, Chytridiomycota, Zygomycota, Glomeromycota, Ascomycota and Basidiomycota. Asexual fungi (Deuteromycetes). **General Topics on Fungi:** Growth of fungal thallus, fungal tip growth, vegetative incompatibility and sexual compatibility, parasexuality. Types of fruiting bodies in fungi. Fungal metabolic pathways, secondary metabolic pathways. Mycotoxins- Aflatoxins, Amatoxin, Amanitarin, Ergot, Fusarin and antibiotics.	18
Module III	**PLANT PATHOLOGY** **Basic Plant pathology:** Plant diseases causes and classification; Common agents of plant diseases, Common Symptoms of plant diseases. Koch postulates. Disease development: Host parasite interaction - infection- progress of disease. Role of enzymes and toxins. Défense mechanisms in plants (both pre-existing and induced) - structural and biochemical. Phytoalexins and Second messengers. Effect of environment on plant disease development. Concept of Disease triangle. **Plant disease management**: control measures - exclusion or eradication exclude or eradicate pathogens, biological control and chemical control, types of chemicals used for plant disease control, regulatory methods,	18

	control through use of transgenic plants, integrated control of plant diseases. Gene for gene, protein for protein and immunisation basis and management of resistant gene. **Major Diseases of plants in India:** Major crops and their diseases relevant to South India. Cereals: Rice **–** blast disease, bacterial blight and Brown spot Vegetables: Tomato - Bacterial wilt; Chilli - seedling wilt; *Abelmoschus* - Yellow vein mosaic/*Cercospora*. Fruits: Banana – bunchy top; Papaya **–** mosaic. Spices: Ginger **–** rhizome rot; Pepper **–** quick wilt; Oil seeds: Coconut **–** grey leaf spot, bud rot disease. Rubber yielding crops: *Hevea brasiliensis.* Abnormal leaf fall and powdery mildew. Beverage crops: Tea **–** blister blight and Red rust. Tuber crops: Tapioca - mosaic virus	
Module IV (Self-Study)	**Basics in Microbiology**: Antonie Van Leuwenhoek and History of Microbiology, Major Milestones in Microbiology. General classification of microbes. Ultrastructure of Gram positive and Gram-negative bacteria; cell membrane, cell wall, flagella, pili, fimbriae, capsule and slime, ribosome and endospores. Bacterial genetics and plasmids. Fungi: General characteristics of fungi - thallus organisation, modes of nutrition, structure of fungal cell wall. **Lichens**: Classification, Habitat ecology, thallus structure, nutrition, reproduction, mutualistic interaction, ecological and economic significance. **Indian Microbiology**: Contribution of Indian Microbiologists – J.V. Bhat, M.K. Patel and Jay Vakil. Contribution of Indian Mycologists – E.J. Butler, Kirtikar and Subramanian C.V. Contribution by Indian phytopathologists – K.C. Mehta, B.B. Mundkar. Major Institutes and their achievements. **Economic and Ecological significance of Microbes - Bacteria and Fungi:** Microbes as symbionts: Nitrogen fixation, mycorrhizae, endophytes, insect–symbionts; Role of microbes in decomposition of cellulose and lignin, mechanism of decomposition by fungi. Role of microbes in management of agricultural soils, biofertilizers and biopesticides, Bioremediation and Biogeochemical cycling. **Emerging infectious diseases:** Zoonotic and Anthroponotic diseases. Case study of HIV, SARS, EBOLA, NIPAH and CoVID-19.	18

PRACTICAL (36 Hours)

1. Isolation of bacteria from soil: Serial dilution - pour plate/spread plate method.
2. Staining of bacteria and their spores.
3. Isolation of *Rhizobium* from root nodules and its Gram staining.
4. Demonstration of bacterial motility by hanging drop method.
5. Using appropriate mycological methods and techniques the students shall collect and study the morphology and anatomy of the reproductive structures of the following genera of fungi *Stemonites, Saprolegnia, Albugo, Pilobolus, Mucor, Ascobolus, Xylaria, Geoglossum, Drechslera, Aspergillus, Alternaria, Cercospora, Fusarium, Pleurotus, Auricularia,*

Ganoderma, Lycoperdon, Geastrum, Dictyophora, Cyathus. Lichens: *Parmelia/Usnea.*

6. Study of the following diseases with reference to signs and symptoms in the laboratory of locally available plant disease specimens: Blast disease of Rice, Chilly – seedling wilt; *Abelmoschus – Cercospora*, Banana – bunchy top; Ginger – rhizome rot; Pepper – quick wilt; Coconut – grey leaf spot, bud rot disease. *Hevea brasiliensis* – abnormal leaf fall, powdery mildew, cassava mosaic, Tea - blister blight.
7. Submit at least 5 preserved specimens belonging to Fungi/Lichen/Plant Pathology.
8. Visit any research institute to familiarise with Mycology/Microbiology/Plant Pathology techniques.

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Mapping of COs with POs and PSOs*

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	2	2	1	2	1		3			1	1	2
CO2	3	3	3	2	1	3	1		3	2	1	2	2	
CO3	3	3	3	3	2	3	1		2	3		3	2	
CO4	3	3	3	2	2	3	3	2	2	1	2	3	3	
CO5	3	3	3	2	2	3	2	3	1	1	1	3	3	
CO6	3	3	2	2	3	2	2	2	1		2	3	2	

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics

	Quiz / Discussion / Seminar	Internal Theory / Practical Exam.	Assignment / Viva	End Semester Exam.
CO 1	✓	✓		✓
CO 2		✓		✓
CO 3	✓	✓	✓	✓
CO 4		✓		
CO 5		✓	✓	
CO 6		✓	✓	✓

MSPSB01C02 PHYCOLOGY, BRYOLOGY AND PTERIDOLOGY

Course Code	MSPSB01C02			
Course	PHYCOLOGY, BRYOLOGY AND PTERIDOLOGY			
Type of Course	Core Course			
Semester	I			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	4	3	72 + 54 = 126
Pre-requisites	Basic understanding of algae, bryophytes and pteridophytes			
Course summary	This course covers the fundamental aspects of algae, bryophytes and pteridophytes, including their structure, reproduction, classification, and their role in the environment.			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Comprehend the General Features of Algae, Bryophytes and Pteridophytes	U	F	Unit Test, Seminar
CO2	Analyse the Reproductive Strategies and Life Cycles	An	P	Practical Test
CO3	Understand the Evolutionary Role	U, An	C	Unit Test, Assignment
CO4	Assess the Ecological Importance	E	F	Unit Test, Seminar
CO5	Apply Practical Methods and Techniques	Ap	P	Practical Exam
CO6	Gain Historical Perspectives	U	F	Unit Test, Assignment
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	**PHYCOLOGY** **Basics in Phycology:** Diversity in thallus and cell structure, pigments and stored food materials in algae, various asexual, vegetative and sexual methods of reproduction in algae, Life cycles in algae. Contributions of Indian Phycologists: M.O.P. Iyengar, T.V. Desikachary, V.K. Krishnamurthy, M.S. Balakrishnan, G.S. Venkataraman. **Classification and general characters of Algae**: Comparison of systems	20

	of classification of F. E. Fritsch and van den Hoek *et al*. (1995) system and Lee (2008). Modern trends in algal classification-DNA barcoding in algae. Habit, Habitat, Thallus structure, cell structure, reproduction and Lifecycle in Cyanophyta, Chlorophyta, Xanthophyta, Bacillariophyta, Phaeophyta, Rhodophyta, Euglenophyta, Dinophyta, Chrysophyta and Cryptophyta. **General Topics on Algae:** Comparative study on thallus structure, Pigmentation and stored food materials, types of nutrition- autotrophic, mixotrophic, heterotrophic and parasitic. Evolution of Algae. Theories and hypotheses on the origin of higher plant groups from algae. Significance of algae in budgeting of elements and biogeochemical cycles. Algal Toxicity - ASP, NSP, PSP and Cyanobacterial toxins. Methods and techniques of collection, preservation and staining of Algae. Algal culture: Importance, various methods and media.	
Module II	**BRYOLOGY** **Classification and general features of Bryophytes:** Comparison of classifications of Rothmaler, 1951 and Goffinet *et al.,* 2008. Modern trends in classification - DNA barcoding. Anatomy, reproduction, life history and phylogeny of Spherocarpales, Marchantiales, Jungermaniales, Anthocerotales, Funariales and Polytricales. **General topics in Bryology**: Thallus diversity, Different types of reproduction, life history patterns, dehiscence of capsule and spore dispersal. Origin and evolution of Bryophytes. Contributions of Indian bryologists: S.R. Kashyap, S.K. Pande and Ram Udar. Methods and techniques in bryophyte Studies.	14
Module III	**PTERIDOLOGY** **Classification and general features of Pteridophytes:** Classification and phylogeny of Pteridophytes. Comparison of various systems of classification. Modern trends in classification (PPG-2016). DNA barcoding. Anatomy, reproduction, life history and phylogeny of Psilopsida, Lycopsida, Sphenopsida and Pterospida; with special reference to South Indian species. Fossil Pteridophytes, Psilophytales, Lepidodendrales Calamitales, and Primofilicales	20

	General topics in Pteridology: Types of reproduction, life history patterns, Origin and evolution of Pteridophytes. Origin and evolution of sporangium – heterospory and seed habit. Development and evolutionary trends in the gametophytes of Pteridophytes. Evolution of vascular tissue - theories and concepts. Pteridophyte herbarium preparation, cultivation techniques and spore staining and spore germination. Contributions of Indian Pteridologists: R.H. Beddome, B.K. Nair and V.S. Manickam.	
Module IV (Self-Study)	**Phycology:** General features of algae and comparison with other plant groups especially bryophytes. Economic and ecological importance of algae. Ecology of freshwater forms and marine forms. Algae and pollution, Algae as indicators. Algal bloom. **Bryology**: General features of Bryophytes, Comparison with other groups, History of Bryology, Ecological and Economic importance of bryophytes. **Pteridology**: General features of Pteridophytes in comparison with algae, bryophytes and gymnosperms. Ecological and economic importance of Pteridophytes. Habitat ecology of Pteridophytes - epiphytes, lithophytes, climbers, halophytes, sciophytes, xerophytes, rheophytes, hydrophytes. Pteridophytes as weeds - *Salvinia* (Aquatic), *Pteridium* (Terrestrial). Weed problem, weed control: impact and management - Biological control. Ornamental and medicinal Pteridophytes. Pteridophytes as ecological indicators. Nitrogen fixation by Pteridophytes.	18

PRACTICAL (54 Hours)

1. Collection, preservation and identification up to generic level.

   Cyanophyta: *Gloeocapsa, Oscillatoria, Microcoleus, Anabaena, Nostoc, Scytonema, Stigonema* (Any 3).

   Chlorophyta: *Chlorella, Hydrodictyon, Scenedesmus, Enteromorpha, Ulva, Pithophora, Bulbochaete, Cephaleurous, Chaetophora, Acetabularia, Bryopsis, Codium, Caulerpa, Halimeda, Desmids - Closterium, Cosmarium, Mougetia* and *Nitella* (Any 8).

   Xanthophyta: *Botrydium*.

   Bacillariophyta: *Coscinodiscus, Odontella.*

   Phaeophyta: *Ectocarpus, Dictyota, Padina, Porphyra* (Any 2).

   Rhodophyta: *Batrachospermum, Gracilaria, Gelidium* (Any 2).

2. Staining Techniques for permanent mounts.

3. Algal culture practice
4. Morphological and structural study of representation members of following groups using cleared whole mount preparations, dissections and sections: *Cyathodium, Lunularia, Targionia, Porella, Sphagnum, Bryum* and *Polytrichum.*
5. Field trip to observe bryophyte diversity.
6. Morphological, anatomical and reproductive features of *Lycopodium, Angiopteris, Osmunda, Lygodium, Ceratopteris, Blechnum, Asplenium, Acrostichum, Azolla* and *Salvinia.*
7. Fossils – *Rhynia, Lepidodendron, Calamites, Sphenophyllum.*
8. Field trips to familiarise with the diversity of Algae/Byophytes/Pteridophytes in natural habitats and submit a report along with 10 preserved specimens/photographs for practical examination.

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Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	1	3			2			3	2				
CO2	3	2	3	1		2			3	2		2	2	
CO3	3	3	3						2	2				
CO4	3	2	2		2	3		1	2	1		3		
CO5	3	3	3		3	3	1	2	2	3	3	2	3	1
CO6	3	2	1	2					2					

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics

	Quiz / Discussion / Seminar	Internal Theory / Practical Exam.	Assignment / Viva	End Semester Exam.
CO 1	✓	✓		
CO 2		✓		
CO 3		✓	✓	✓
CO 4	✓	✓		
CO 5		✓		
CO 6		✓	✓	✓

MSPSB01C03 GYMNOSPERMS, ANGIOSPERM ANATOMY AND EMBRYOLOGY

Course Code	MSPSB01C03			
Course	GYMNOSPERMS, ANGIOSPERM ANATOMY AND EMBRYOLOGY			
Type of Course	Core Course			
Semester	I			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	4	3	72 + 54 =126
Pre-requisites	Basic understanding of gymnosperms and angiosperms			
Course summary	This course covers the general features of gymnosperms and anatomical and embryological features of angiosperms. It also deals with the modern trends in respective areas.			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Comprehend the general features of gymnosperms and anatomical and embryological features of angiosperms.	U	F	Unit Test, Seminar
CO2	Analyse the relationship between structure and function	An	P	Practical Exam
CO3	Understand the evolutionary trends	U, An	C	Unit Test, Assignment
CO4	Assessment of the ecological significance of higher plants	E	F	Unit Test, Seminar
CO5	Skill in Practical Methods and Techniques	Ap	P	Practical Exam
CO6	Enthusiasm for higher studies in this field	U	F	Viva Voce, Seminar
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	**GYMNOSPERMS** **Classification and general features of Gymnosperms**: Classification (Sporne, 1965) and modern trends including molecular phylogeny. Distribution, morphology, anatomy and reproductive biology and phylogenetic trends in the following orders of gymnosperms: Pteridospermales, Glossopteridales, Caytoniales, Cycadoideales, Pentoxylales, Cycadales, Ginkgoales, Coniferales, Taxales, Ephedrales, Welwitschiales and Gnetales.	15

	Gymnosperm studies in India: Distribution of living and fossil gymnosperms in India. Contributions of Indian gymnosperm botanists - Birbal Sahni and R.C. Srivastava.	
Module II	**ANGIOSPERM ANATOMY** **Major concepts and theories in Anatomy**: History of plant anatomy: Scope and significance, interdisciplinary relations. Differentiation and its significance in developmental studies. Dedifferentiation and redifferentiation. Recent theories on organisation of root and shoot apical meristems. Origin of lateral root. Leaf and bud development. Plastochronic stage, experimental studies on meristems, vegetative to reproductive apex. Reversion from reproductive to vegetative apex. Environmental factors influencing differentiation of the divergent tissue systems, experimental studies, and their economic importance. **Origin, structure and function of cambia and its derivatives:** Concept and classification. Cambium in wound healing and grafting, factors influencing cambial differentiation and activity. Cork cambium - origin, types, derivatives and function. Abnormal Cambium: Classification, origin and function, experimental studies. Anomalous Secondary thickening - Types with examples. Xylem and Phloem: Origin and trends of specialization. Taxonomic significance, factors affecting xylem and phloem differentiation. **Anatomy of seedlings:** Root Stem transition - features and types; Nodal anatomy - features and types; Controversies on phylogenetic trends in nodal anatomy and root stem transition. **Development of Organs:** Roots: Initiation and development of specialized roots. Leaf: Origin and development of lamina – general pattern and phyllotaxy. Flower: Floral development in *Antirrhinum* and *Arabidopsis*. Fruit and seeds: General anatomy of fleshy and dry fruits; Anatomy of seeds in general, development dormancy and drought resistance from anatomical point of view. **Applied anatomy**: Wood anatomy of economically important plants - Teak, Jack, *Dalbergia, Ailanthus* and *Alstonia*. Applications of anatomy in systematics (histotaxonomy) and Pharmacognosy. Research prospects in anatomy.	21
Module III	**ANGIOSPERM EMBRYOLOGY** **Pollen development**: Role and ultra-structural changes of tapetum in pollen development. Male gametophyte: Microspore/pollen mitosis, division of generative cell heterogeneity in sperms, pollen fertility and sterility, pollen storage, viability and germination. **Palynology**: Pollen morphology, ultrastructure of pollen wall, palynogram, evolution of pollen types. Contributions of G. Erdtman, P.K.K. Nair. Applied palynology - Mellito Palynology, Aeropalynology, Paleopalynology and Forensic Palynology. Application of Palynology in Taxonomy. Economic and ecological importance of pollen grains - pollen biology, pollen allergy and productivity. **Ovule and megasporogenesis**: Ovular Ontogeny, types and evolution, reduction, nutrition. Sub-cellular features of archesporial and megaspore mother cells, megaspore tetrad, dyad and coeno megaspore, termination of	26

	functional megaspore. Female gametophyte - Embryo sac: Classification and types, ultra-structure of components; synergids and antipodal haustoria, nutrition of embryo sac. **Pollination**: Primary and secondary attractants of pollination. Ultrastructural histochemical details of style and stigma, significance of pollen-pistil interaction, role of pollen wall proteins and stigma surface proteins, intra - ovarian pollination and in vitro fertilization. Coevolution of Pollinators and flowers with special emphasis on major pollination mechanisms. **Fertilization and post-fertilization development**: Role of synergids, filiform apparatus, heterospermy, differential behaviour of male gametes, syngamy and triple fusion, post fertilization metabolic and structural change in embryo sac. **Endosperm**: Classification and types, ultrastructure, cellularization in nuclear endosperm, endosperm haustoria, their extension and persistence, function, storage metabolites. **Embryo**: Polarity in relation to development, classification and types, Histogenesis and organogenesis of monocot and dicot embryos, delayed differentiation of embryo structure, cytology and function of suspensor, physiological and morphogenetic relationship of endosperm and embryo. **Polyembryony and Apomixis**: Classification and types of polyembryony and Apomixis. Factors affecting polyembryony and apomixis. Diplospory, Apospory, Adventive Embryony, Agamospermy and parthenogenesis of embryos. **Fruit and seed**: Fruit and seed development: morphological, anatomical and biochemical changes. Parthenocarpy - induction of seedless fruits.	
Module IV (Self-Study)	**Gymnosperms**: General features of the gymnosperms and comparison to angiosperms and pteridophytes. Ecological significance and Economic importance of gymnosperms **Basics in Angiosperm Anatomy**: Structure and Functions of Tissues - meristems; permanent Tissues - simple (parenchyma, collenchyma and sclerenchyma) and complex tissues (xylem and phloem). Tissue systems (Epidermis, ground and Vascular) of primary root, stem and leaf - types and variations tissue **Basics in Angiosperms Embryology**: Basic structure of sex organs in a flower, Structure and function of wall layers in the anther; structure and development pattern in microsporangium and megasporangium, double fertilisation and triple fusion; post fertilisation changes and endosperm development.	10

PRACTICAL (54 Hours)

1. Morphological, anatomical and reproductive features of *Zamia, Cryptomeria, Cupressus, Podocarpus, Agathis, Ephedra, Podocarpus.*
2. Fossils - *Medullosa, Heterangium, Williamsonia.*
3. Variations in Epidermis – Trichomes, stomatal types; estimation of stomatal index.
4. Types of Nodal anatomy and Root - stem transition
5. Abnormal secondary growth – different patterns: *Cyclea, Aristolochia, Amaranthus, Nyctanthes, Aerva, Mirabilis, Bougainvillea* and *Strychnos*.
6. Preparation of dissected whole mounts of micro and mega sporangium; pollinia and embryos.

7. Pollen germination - *in vitro* and *in vivo* viability tests.
8. Acetolysis of pollen grains to study the different types of exine ornamentation.
9. Developmental stages of anther, ovule, embryo and endosperm.

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Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3			1					3	1	3	2		
CO2	3	2	3			2			2		2	3	2	1
CO3	3	3	2						2	2		1		
CO4	3	2	2		3				3	2		3	2	
CO5	3	3		2	3	3	2	1	3	3	3	2	3	2
CO6	3				2	3	2	3	2			1		

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics

	Quiz / Discussion / Seminar	Internal Theory / Practical Exam.	Assignment / Viva	End Semester Exam.
CO 1	✓	✓		✓
CO 2		✓		
CO 3		✓	✓	✓
CO 4	✓	✓		
CO 5		✓		
CO 6	✓		✓	

MSPSB01C04 EVOLUTION, MICROTECHNIQUE AND BIOINSTRUMENTATION

Course Code	MSPSB01C04			
Course	EVOLUTION, MICROTECHNIQUE AND BIOINSTRUMENTATION			
Type of Course	Core Course			
Semester	I			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	3	2	54 + 36 = 108
Pre-requisites	Knowledge in Evolution, Microtechnique and Bioinstrumentation			
Course summary	This course gives an idea on modern concepts of evolution, various types of botanical microtechniques and advanced bio-instrumentation techniques.			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Use the appropriate terms to describe the concepts in evolution, microtechnique and bioinstrumentation	R	F	Quiz, Assignment, Seminar
CO2	Understand the advancement in molecular and phylogenetic evidences of evolution, especially after Darwin	U	C	Unit test
CO3	Understand the principles and methods of plant microtechnique	U, Ap	C, P	Unit test, Practical Examination
CO4	Understand the principles and methods of bioinstrumentation	U, Ap	C, P	Unit test and Practical Examination
CO5	Apply the theoretical knowledge gained in evolution, microtechnique and bio-instrumentation in new contexts of daily life and in the areas of research	Ap	P, M	Viva voce, Evaluation
CO6	Evaluate the concepts in new knowledge areas related to evolution, microtechnique and instrumentation	E	F, C, P	Assignment
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	**EVOLUTION** **Concepts on Evolution**: Evolution of biomes. Mixing process, intercontinental connections. Climatic zonation, dispersal opportunities, dispersal availability, sub-climax and climax dispersal. Phylogeny and age of biomes: Interwoven biome phylogeny and biome extension and resurrection. Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; origin of new genes and proteins; Gene duplication and divergence. Micro and macro-evolution and punctuated equilibrium. **Origin and evolution of life**: General outline on classical and synthetic hypotheses and theories of evolution. Chemical evolution - Oparin-Haldane theory, Miller Urey experiment, Path of Chemical evolution. Biological Evolution - Coacervate theory. The first cell; evolution of prokaryotes; origin of eukaryotic cells; evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism. Endosymbiotic theory. **Natural selection, Speciation and Coevolution:** Natural selection and adaptation. Nature of natural selection, limiting factors, origin of races and species, Kin's selection and Hamilton's Rule. Rate of evolutionary change: Internal and external factors. Significance of genetic drift in natural selection. Hardy-Weinberg Law; concepts and rate of change in gene frequency through natural selection. Evolutionary significance of mutations. Genetic assimilations (Baldwin effect). Genetic homoeostasis. Coevolution: Origin and evolution of flower, nectaries and coevolution of flowers **Concept of Species and Speciation:** Species concept - morphological species, biological species and evolutionary species. Mode of speciation – allopatric, sympatric and parapatric. Types of speciation - phyletic and true-speciation. Reproductive isolation: Pre-zygotic and post-zygotic isolation.	18
Module II	**PLANT MICROTECHNIQUE** **Killing and Fixing:** Principles and techniques of killing and fixing; properties of reagents; properties and composition of important fixatives - Carnoy's Fluid, FAA, FPA, Chrome acetic acid fluids, Zirkle-Erliki fluid. **Dehydration, Clearing, Embedding and Sectioning:** (a) Dehydration: Principles of dehydration, properties and uses of important dehydrating and clearing agents - alcohols, acetone, xylol, glycerol, chloroform, dioxan. (b) Dehydration Methods: (i) Tertiary-butyl alcohol method. (ii) Alcohol-xylol method. (c) Embedding: Paraffin embedding. (d) sectioning in rotary microtome, sledge microtome and cryotome. **Staining:** Double staining; Safranin-Fast green method, Safranin-Crystal violet method. Triple staining; Safranin-Crystal Violet-Orange G method. (c) Histochemical localization of starch, lipid and lignin. **Mounting techniques:** (a) Mounting: Techniques, common mounting	10

	media used - DPX, Canada balsam, Glycerin jelly and Lacto phenol (b) Whole mounts: Principles and techniques of whole mounting, TBA/Hygrobutol method, Glycerine xylol method. Staining of whole mount materials (haematoxylin, fast green or Safranin-fast green combination). Significance of whole mounts. (c) Techniques of smear, squash and maceration (d) Cleaning, labelling and storage of slides.	
Module III	**BIOINSTRUMENTATION** **Electron Microscopy**: Principles, components and applications of Electron microscopy TEM, SEM, ESEM, Cryo EM and AFM. **Modern Spectroscopy:** Principle and applications of FT-IR Spectroscopy, Raman Spectroscopy, Spectrofluorometry, Mass Spectroscopy, AAS and NMR. Brief study on MS and MALDI-TOF**.** **Modern Chromatography and Electrophoresis**: Ion exchange chromatography, GCMS, HPLC, HPTLC and LCMS. Electrophoresis: Agarose gel Electrophoresis, SDS PAGE, Pulse Field Gel Electrophoresis. Isoelectric focussing. **Methods for Nucleic Acid Study**: Detecting DNA Polymorphism: Principle, methods and applications of RFLP, AFLP, RAPD. Nucleic Acid Hybridization**:** Principle of Hybridization, Blotting Techniques (Southern blotting, Northern blotting, South-Western blotting, Western blotting). *In situ* localization by techniques - FISH and GISH	15
Module IV (Self-Study)	**Evolution:** Evidence of evolution - Morphology, comparative anatomy, embryology, physiology, biochemistry, palaeontology and biogeography. Evolution of Plant animal interactions - Symbiosis, mutualism, commensalism. Mimicry: Batesian and Mullerian mimicry. Case studies on plant-animal coevolution. **Paleobotany**: Geological time scale, Geological evidence of evolution: Major groups of plants and animals in different eras and epochs. The fossil record - Types of Fossils and Mechanism of fossilisation. Geological fundamentals. Phylogeny and the fossil record. **Basic Bioinstrumentation:** Types of microscopes - simple and compound; stereo microscope, phase contrast microscope, fluorescence microscope. Micrometry. Photomicrography, Camera Lucida. Centrifugation**:** Rotors, Bench top, Low speed, High speed, Cooling and Ultracentrifuge**.** Principle and applications of UV, Visible spectroscopy. Types of Chromatography: Paper, TLC, Column chromatography, Nucleic Acid Sequencing**:** Maxam Gilbert method, Sanger method. Polymerase Chain Reaction**:** Principle, Procedure, Variations and Applications. **Basic Microtechnique**: Sectioning: Free hand sections – prospects and problems. Principles of staining; classification of stains, protocol for preparation of: Natural stains - Haematoxylin and Carmine; Coal tar dyes – Fast green, Orange G, Safranin, Crystal violet, Cotton Blue and Oil Red O; Techniques of staining: (i) Single staining; Staining with Safranine or crystal violet.	11

PRACTICAL (36 hours)

1. Demonstration of Evolutionary Principles through computer exercises.
2. Phylogenetic tree preparation.
3. Floral evolution and MADS-box.
4. Case studies on biological diversity through intraspecific variation in morphological

characters and submit a report.

5. Students are expected to be thorough with the following techniques. (a) Preparation of semi-permanent slides. (b) Preparation of permanent slides. (c) Preparation of whole mounts. (d) Maceration. (e) Preparation of fixatives (FAA, Carnoy's fluid). (f) Preparation of dehydration series (Alcohol, Acetone, TBA). (g) Preparation of paraffin blocks. (h) Preparation of serial sections.
6. Candidates should prepare and submit 5 permanent slides in which the following categories should be included: (a) Free hand sections (single/double stained). (b) Serial sections (single/double stained). (c) whole mounts.
7. Micrometry.
8. Electrical conductivity and pH measurements.
9. Preparation of Buffers: Phosphate, Carbonate and Tris HCl.
10. Quantitative estimation of chlorophyll content using spectrophotometer.
11. Absorption spectra of BSA/DNA and determination of absorption maxima.
12. Gel filtration.
13. Use of Camera Lucida/drawing tube.
14. Separation of leaf pigments by paper chromatography and TLC.
15. Immunodiffusion technique for testing of antigens and antibodies.
16. Rocket immunoelectrophoresis.
17. Histochemical localization of Polysaccharides, Total proteins, DNA.

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Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3			1					1					1
CO2	3	3	1		2	2			2	3	2	1		3
CO3	3		2			1				3	2			
CO4	3	2								3	2			
CO5	3	3	3		3	3	2		1	3	3	2	3	2
CO6	3	3	3	2	3	1	2	1	2	2	2	3	3	2

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics

	Quiz / Discussion / Seminar	Internal Theory / Practical Exam.	Assignment / Viva	End Semester Exam.
CO 1	✓		✓	
CO 2		✓		✓
CO 3		✓		✓
CO 4		✓		✓
CO 5			✓	✓
CO 6			✓	

Semester II

MSPSB02C06 ENVIRONMENTAL SCIENCE, FOREST BOTANY AND PHYTOGEOGRAPHY

Course Code	MSPSB02C06			
Course	ENVIRONMENTAL SCIENCE, FOREST BOTANY AND PHYTOGEOGRAPHY			
Type of Course	Core Course			
Semester	II			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	3	3	108
Pre-requisites	Basic knowledge in Environmental Biology and Phytogeography			
Course summary	This is a course designed for post graduate students that deals with the basic and advanced topics of ecology in relation to human beings.			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Understand the basic structure and function of ecosystem	U	F	Unit test, Assignment
CO2	Students were able to apply the knowledge in conservation	R, A	M	Unit test, Assignment, Quiz
CO3	Able to analyse and differentiate the major floristic regions and forest types of India	U	F, C	Unit test, Assignment
CO4	To apply the techniques and tools in the study of environment like remote sensing, water analysis etc.	U, A	P, M	Practical Exam, Unit test, Assignment
CO5	To explore the major centres of biodiversity	U, A	F, P	Unit test, Assignment
CO6	To acquire basic knowledge in theories of phytogeography	U, R	F	Unit test, Quiz
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	**ENVIRONMENTAL SCIENCE** **Autecological concepts - Population Ecology:** (a) Characteristics of populations - size and density, dispersion, age structure, natality and mortality. (b) Population growth, factors affecting population growth, environmental resistance, biotic potential, carrying capacity, positive and negative interaction, migration, subsistence density. Ecological consequence of over populations. (c) Gene-ecology - ecological amplitude, ecads, ecotypes, ecospecies, coenospecies. **Synecological concepts - Community ecology:** (a) Ecological processes of community formation, ecotone, edge effect. Classification of communities - criteria of classification, dynamic system of classification by Clement. (b) Special plant communities - quantitative, qualitative and synthetic characteristics of plant communities, coefficient of communities; Sorenson's Index of similarity. (c) Dynamic community characteristics - cyclic replacement changes and non-cyclic replacement changes. **Dynamic Ecology:** The concept, definition and reasons of succession. Classification of succession: changes - autogenic and allogenic, primary and secondary, autotrophic and heterotrophic. Retrogressive changes or the concept of degradation, concept of climax or stable communities, resilience of communities. **Pollution Ecology:** Effects of pollution on Ecosystem, Biodiversity and Health issues related to humans and plants. Methods to control pollution: Bioremediation, Phytoremediation, bioaugmentation, biofilms, biofilters, bioscrubbers and trickling filters. **Conservation Ecology:** Concept of endemism, rare, endangered and threatened (RET) species, key stone species, IUCN account of biodiversity, red data book and hot spots, reasons to stop extinction, methods to save species. Biodiversity conservation: Principles of conservation – *ex situ* and *in situ* conservation techniques. Species diversity, community diversity, ecosystem diversity and landscape preservation. UN decade on ecosystem restoration. Role of biotechnology in conservation of species. Ecotourism and its significance	20
Module II	**FOREST BOTANY** Definition of forests. Different types of Forest in the world and India. Major problems related to Forests - deforestation and invasion of weeds and pests. Joint forest management strategies. Plants to reduce forest	8

	related disasters. Forests and livelihood. Forests and Aesthetics: Major influencing factors - tree density and size, ground cover and species makeup. Tree architecture - Definition, Types, Factors influencing tree architecture. Forests and Remote Sensing.	
Module III	**PHYTOGEOGRAPHY** **Basics in Phytogeography**: Definition of Phytogeography; Plant distribution - Principles governing plant distribution, Factors affecting plant distribution, Theories on distribution and different types of distribution of vegetations on the earth. Continuous distribution - cosmopolitan, circumpolar, circumboreal or circum-austral, pantropical; Discontinuous distribution. Endemic distribution - Neo and paleo endemism. Factors influencing plant distribution; Migration of floras, and Evolution of floras. **Major theories in Phytogeography**: Theory of land bridge, theory of continental drift, theory of polar oscillations or Shifting of poles, glaciations. Centres of origin and diversity of plants. Methods of dispersal, migrations and isolation; Theory of area and theory of tolerance. Age and area hypothesis. **Floristic regions of the world**: Vegetation Zones in relation to latitudes and altitudes; a brief account of the phytochoria of the Indian subcontinent - climate, vegetation and botanical zones of India. **Remote Sensing & GIS**: Definition, data acquisition techniques and various tools used for remote sensing. GIS: definition, fundamental concepts and components of GIS; developments and future trends in GIS. Applications of remote sensing and GIS. Geospatial variability and geotagging.	15
Module IV (Self Study)	**Basic concepts in Ecology**: Structure and Function of Ecosystem – Structural components, relationship between structural and function; trophic structures, Significance of habitat, ecological niche. Functions of Ecosystems: Biogeochemical cycles; Productivity and energy flow**.** Ecological Succession, climax and stability – concepts, characteristics of pioneer and climax species. Major Concepts in Ecology: Ecosystem Equilibrium and Nature's Balance. **Pollution Ecology:** Types of Pollutants, Concept of Pollutant and waste. Types of pollutants and wastes in Land pollution, Water pollution and Air pollution. Noise, Radioactivity, Temperature, Light and Electromagnetic waves as pollutants. **Forest Products:** Major and minor forest products with special reference to Kerala. Forest based industries in Kerala.	11

PRACTICAL (54 Hours)

1. Analysis of water quality for: (a) Dissolved CO_2 (b) Dissolved oxygen (c) Quantitative estimation of dissolved chloride ions (d) Dissolved sulphate (f) Total alkalinity.
2. Physico-chemical analysis of soil: (a) Total water-soluble mineral ions (b) estimation of soil organic carbon (Walkey and Black method).
3. Quantitative and qualitative community analysis: study of species structure and the frequency, abundance, density of different species, IVI and similarity index of different communities in a natural system. Students must be able to explain the structure of vegetation from the given data on the above-mentioned characteristics.
4. Phytoplankton counting using Sedgwick Rafter counter/Haemocytometer/Any other counting chambers.
5. Field visit to natural ecosystems and identification of trophic levels, food webs and food chains, plant diversity (species and community).
6. Conduct case studies on common environmental problems, their consequences and possible solutions.
7. GPS Mapping.
8. Visit to a wildlife sanctuary/National Park.
9. Collection of 5 Minor Forest products in Kerala.
10. Construction of a map showing Forest types of India.

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Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3					1			1	2		2		
CO2	3	2	2			2			1	2		1		
CO3	3	3	2		1	2			2	2		3	2	1
CO4	3	3	3		2	3	1		2	3	3	3	3	
CO5	3	3				2	3	1	3	2		3	3	
CO6	3	1	2		1	3			3			2		

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics

	Quiz / Discussion / Seminar	Internal Theory / Practical Exam.	Assignment / Viva	End Semester Exam.
CO 1	✓	✓	✓	✓
CO 2		✓	✓	✓
CO 3		✓	✓	✓
CO 4		✓	✓	✓
CO 5		✓	✓	✓
CO 6	✓	✓		✓

MSPSB02C07 GENETICS, PLANT BREEDING AND BIOSTATISTICS

Course Code	MSPSB02C07			
Course	GENETICS, PLANT BREEDING AND BIOSTATISTICS			
Type of Course	Core Course			
Semester	II			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	4	3	72 + 54 = 126
Pre-requisites	Knowledge in basic statistical tools, genetics concept and problem solving and basic plant breeding techniques.			
Course summary	This course is aimed at developing analytical, quantitative and problem-solving ability of students and to inculcate theoretical and practical knowledge on various breeding techniques for crop improvement.			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Understand the variation in the inheritance pattern with phenotypic traits	U	F	Seminar/Assignment/Quiz
CO2	Students were able to interpret basic genetics of crop plants	U	F	Unit Test, Seminar/Assignment
CO3	Understand and Apply statistical tools for collection, analysis, interpretation and visualisation of data	U, Ap	F, P	Practical Exam
CO4	Solve problems in quantitative, population and molecular genetics	Ap & An	P, C	Practical Exam
CO5	Acquired the knowledge required to design, execute, and analyze the results of genetic experimentation in plant breeding systems	Ap & An	P, M	Practical Exam, Assignment
CO6	Apply and evaluate the genetic principles for crop improvement	Ap & An	P, M	Practical Exam, Unit Test
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	**GENETICS** **Basic Genetics:** Chromosomal theory of inheritance and its modifications by the concept of Jumping genes, Pleiotropic genes and advances in Molecular Genetics. Model organisms in Genetics - *Arabidopsis thaliana, Neurospora crassa,*	25

	Escherichia coli, *Drosophila melanogaster* and *Caenorhabditis elegans* (brief study). **Plasmagenes:** Cytoplasmic inheritance - chloroplast gene, *Mirabilis jalapa* and *Zea mays* and mitochondrial genes - petite, cytoplasmic male sterility in plants, maternal effect in inheritance in *Limnaea peregra.* **Quantitative genetics:** inheritance of quantitative traits, corolla length in *Nicotiana*, cob length in *Zea mays*, Multiple factors - continuous variation - continuous and threshold traits – QTL - Heritability- transgressive variation. **Linkage and Crossing Over:** Bateson's concept, Stern's hypothesis, Creighton and McClintock's experiments, single crossover, multiple crossover, two-point cross, three-point cross, map distances, gene order, interference and coefficient of coincidence. Haploid mapping (*Neurospora*), Mapping in bacteria and bacteriophages. **Behavioural genetic**s: Genetics of biorhythms - genetics of mammalian clock - genetics of behaviour. **Human genetics**: Inheritance of traits in humans; pedigree analysis, determination of human genetic diseases by pedigree analysis (ABO Locus), genetic mapping in human pedigrees. Autosomal recessive and dominant diseases: Sickle cell anaemia, Huntington's chorea, familial hypercholesterolemia; inborn errors of Metabolism in Man – Phenylketonuria, Alkaptonuria, Albinism, Tyrosinosis, Goitrous Cretinism. Concept of eugenics, euphenics and euthenics. **Genetic basis of cancer:** Proto-oncogenes, oncogenes, conversion of proto-oncogenes to oncogenes. Tumour suppressor genes – functions, role of p53. Viral oncogenes. **Population Genetics**: Systems of mating and their genetic effects. Genetic structure of populations and its change - Hardy–Weinberg equilibrium – Sewall Wright effect. Factors that alter allelic frequencies: (i) mutation (ii) genetic drift - bottleneck effect and founder effect (iii) migration (iv) selection (v) nonrandom mating; inbreeding coefficient.	
Module II	**PLANT BREEDING** **Basic Plant Breeding**: Objectives of Plant breeding, Floral Biology in relation to selfing and crossing techniques. Biological foundations of Plant breeding - Role of heredity and environment in character expression - Systems of reproduction in plants - Mating systems in sexually reproduced plants. Conventional methods of plant breeding Domestication of Plants. Plant introduction: Types and procedures. National and international agencies for plant introduction. Certification, quarantine and Acclimatization. Selection: principles, genetic basis and methods. Mass selection, Pureline selection and Clonal selection **Conventional hybridization**: Objectives, principle and methods of hybridization. Interspecific, intraspecific and distant hybridisation. Selection of Hybrids by Bulk method and Pedigree method. **Sources of plant germplasm:** Centres of genetic diversity. Concepts of de-Candolle and Vavilov, Primary, secondary and microcenters. Preservation and utilization of germplasm, Gene banks, NBPGR, International exchanges of germplasm.	22

	Methods of Crop improvement: In vegetatively propagating plants, sexually reproducing with unisexual and bisexual, autogamic and heterogamic plants. **Back-cross breeding**: Inbreeding consequences. Heterosis theories – genetic and physiologic basis – Applications in plant breeding – steps in the production of single cross, double cross, three way cross and synthetic cross. **Genetics and Plant Breeding**: Genetics of Incompatibility and Sterility - male sterility, somatoplastic sterility - cytoplasmic and genetic sterility. Methods to overcome incompatibility. Genetic erosion – causes threatened species. Plant genetic conservation – (*in situ* and *ex situ*). **Polyploidy breeding**: induction of autopolyploidy and allopolyploidy, role of chromosome manipulation – chromosome addition and substitution lines achievements. **Mutation breeding:** Situations suitable for mutation breeding. Materials needed for treatment. Physical and chemical mutagens. Handling of mutants. Evaluation of mutants in M1, M2 and M3 generations.	
Module III	**BIOSTATISTICS** **Basics in Biostatistics**: Introduction and scope of biostatistics. Measures of central tendencies - mean, median and mode. Skewness and kurtosis. Measures of variations - range, quartile deviation, mean deviation, variance and standard deviation. Standard error and Coefficient of variation. **Advanced Biostatistics**: Tests of significance - z, t and χ^2 tests. Analysis of variance (ANOVA) - one way, two way and multiple. Correlation (Pearson's correlation coefficient, Spearman's rho) and Regression (Linear regression, Least Square method) analysis; Factor and cluster analysis. Introduction to R programming and SPSS. **Study Designs and Experimental designs in Biology**: Classification of study design, observational studies and experimental studies (uncontrolled studies, trials with external controls, crossover studies, trials with self-controls, trials with independent concurrent controls). Experimental Designs: Randomised Block Design, Split plot design and Latin Square **Sampling, Data Collection and Data Tabulation methods**: Sampling: Reasons for sampling, methods of sampling, SRS, Systematic, Stratified, Cluster, NPS. Methods of data collection - primary and secondary data - census and sampling methods. Tabulation and presentation of numerical data - diagrammatic and graphical presentation. Graphs, Histograms, Box and Whisker plots, Frequency polygon, Scatter Plots. **Biometrical genetics:** Probability and genetics - prediction of genetic behaviour - statistical tools in genetic analysis.	17
Module IV (Self-Study)	**Basic Genetics:** History of Genetics; concept of genes. Mendelism - critical evaluation on Mendel's work and Mendelian Principles based on recent advances in genetics. Sex determination -XX-XY, XX- XO and other mechanisms. Sex-linked and Sex influenced traits. Mendelian inherited disorders in man. **Basic Biostatistics**: Measures of central tendency- mean, median, mode. Measures of dispersion. Need of Biostatistics in Biological research. **Basic Plant Breeding**: Centre of origin - Vavilov's centre of origin.	8

	Major plant breeding research institutes of India with special emphasis to Kerala and their achievements.	

PRACTICAL (54 Hours)

1. Workout problems related to linkage, crossing over and gene mapping, human pedigree analysis, cytoplasmic inheritance, multiple alleles and quantitative inheritance.
2. Work out problems in population genetics - gene and genotype frequency, Hardy-Weinberg equilibrium.
3. Budding (T Budding, Patch Budding), Layering (Air and Serpentine) and Grafting (Whip and Crown).
4. Report of Breeding between any two varieties of one garden/crop plant with digital documentation.
5. Diagrammatic and graphical representation of data using programmes like MS Excel, Open Office Calc or Statistics.
6. Analysis of numerical data for mean, median, mode, variance, standard deviation, standard error and coefficient of variation.
7. Analysis of variance between data from different samples using MS Excel one way, two way and multiple.
8. Calculation of correlation coefficient between groups of data and calculation of critical difference.
9. Demonstration of statistical analysis using the softwares - R Programming and SPSS, using a given data set.

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Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3		1		1				2					
CO2	3	2	3			2		1		3		2	2	2
CO3	3	3	3		1	3				3	3		3	3
CO4	3	3	3			3				3	3		3	
CO5	3	3	3		2	3	2			3	3		3	
CO6	3	3	3	1	2	3		2		3	2		3	1

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics

	Quiz / Discussion / Seminar	Internal Theory / Practical Exam.	Assignment / Viva	End Semester Exam.
CO 1	✓		✓	
CO 2	✓	✓	✓	✓
CO 3		✓		
CO 4		✓	✓	
CO 5	✓	✓		✓
CO 6		✓		✓

MSPSB02C08 CELL AND MOLECULAR BIOLOGY

Course Code	MSPSB02C08			
Course	CELL AND MOLECULAR BIOLOGY			
Type of Course	Core Course			
Semester	II			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	4	2	72 + 36
Pre-requisites	Basic Knowledge in Cell biology and molecular genetics			
Course summary	This is a theory course that deals with the functioning of cell at cellular level, without the basic cell structure			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Elucidate organelle structure and function, know cell structure, function, and reproduction, and to analyze chromosomal aberrations.	R, U	C	Test paper, Assignments, Seminar
CO2	Analyze cell adhesion and extracellular matrix, understand cellular transport and communication.	U, An	C, M	Test paper, Assignments, Seminar
CO3	Understand cell cycle regulation, reproduction and apoptosis.	An, E	C, M	Test paper, Assignments, Seminar
CO4	Understand the fundamental structures of genetic material, explore DNA topology and variants, examine DNA replication mechanisms.	R, U	C	Test paper, Assignments, Seminar
CO5	Analyze gene expression and its regulation, identify mutations, DNA repair, and genetic disorders.	An, E	C, M	Test paper, Assignments
CO6	Develop Proficiency in Cytogenetic and Molecular Techniques.	An, C	P	Practical Exam, Viva Voce, Assignment
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	**CELL BIOLOGY** **Cells & their environment**: Transport of materials - biosynthetic (secretory) and endocytic pathway. Cell communication - general principles. Signalling molecules and their receptors; external and internal signals that modify metabolism, growth and development of plants. Extracellular matrix, Cell adhesion molecules - cadherins, integrins,	27

	selectins, fibronectins, laminin and immunoglobulin superfamily. Cell-cell adhesions - junctional and non-junctional adhesion mechanisms; occluding junctions, anchoring junctions, communicating junctions (connexons and plasmodesmata). **Ultra-structure, composition & functions of Nucleus, Mitochondria and Plastids - Nucleus**: Nuclear Membrane, Nuclear Pore Complex, Nucleolus (NOR), Nuclear Matrix, Nuclear Lamina & Chromatin Assembly Factor (CAF). Nuclear cytoplasmic transport. **Mitochondria**: Structure of ATP Synthase, Chaperones & Chaperonins, Kinetoplast; Mitochondrial Heterosis, Mitochondrial Abnormalities of Plants & Mitochondrial diseases. **Plastids**: Chloroplast Import, Photosynthetic Domains, Chlorophyll Binding Proteins; Chlorosomes & Chromatophores. **Chromosomes: Structure, Chemistry and Organization**: Kinetochore, Satellites, Chromomeres, Chromosome Knobs, Structure and organisation of chromatin - Euchromatin, Heterochromatin, prochromatin and anti-chromatin. Packaging of DNA into chromosomes. structure and role of centromere and telomere. Mitochondrial and plastid genome organisation. Molecular Cytogenetics: FISH, GISH, FIBER-FISH, Flow Cytogenetics, Flow karyotyping, Applications of molecular cytogenetics. **Cell cycle and its regulation**: Stages of cell cycle (mitosis and meiosis). Spindle formation and its disintegration; Role of cohesins and condensins. Molecular Motors, Microfilaments & Microtubules, Actins & Tubulins, Microtubule Associated proteins (MAP) - Dynein, Dynactin, Kinesin, Kinectin. Regulation of cell cycle: Role of cyclins, cyclin dependent kinases, cdk activating kinases, CDK inhibitory proteins. Apoptosis: Regulatory proteins, extrinsic and intrinsic pathways of apoptosis. Cell signalling for apoptosis.	
Module II	**MOLECULAR GENETICS** **Gene Expression**: Transcription in Prokaryotes, Transcription & RNA Processing in Eukaryotes, RNA Splicing & Spliceosomes, Introns, Intron Homing, Exons, Exon Shuffling, RNA Editing; Structure & Composition of RNA - rRNA, mRNA, tRNA (Clover Leaf Model & 'L'- Shaped Tertiary Conformation) & snRNA; Genetic Code; Protein Synthesis & Protein Synthesis Inhibitors. **Gene regulation**: Prokaryotes - Operon Concept (lac Operon, trp Operon.) Positive and negative control attenuation, anti-termination. Gene Expression in Eukaryotes - heterochromatinization and DNA methylation (DNA methylases, DNA rearrangements). Transcriptional regulation (signal transduction – upstream and downstream, regulatory sequences and transacting factors, activators and enhancers). DNA binding by transcription factors. Britten and Davidson Model for eukaryotic gene regulation. Post transcriptional regulation (RNA processing, split genes, hnRNA, introns and exons, capping, polyadenylation, splicing, snRNAs and spliceosomes, Post transcriptional silencing micro RNAs and RNA inhibition). Translational regulation and post translational regulation (Cleavage and processing of Proteins, Genomic imprinting) Environmental regulation and the concept of epigenetics.	20

Module III	**Mutation & DNA Repair Mechanisms**: Somatic & Germinal Mutations, Spontaneous & Induced Mutations, Environmental Mutagens, Molecular Basis of Mutation, DNA Repair Mechanisms (Light-Dependant-, Excision-, Mismatch-, Post Replication- & SOS Repair). Methods to detect mutation (ClB method, attached X method, Ames test). **Molecular genetics of Human and Cancer**: Major Human Genetic Abnormalities, Syndromes and Diseases (ADA deficiency, Nail Patella Syndrome, Blooms Syndrome, *Xeroderma pigmentosum*, retinoblastoma, Sickle Cell Anemia), HGP and its relevance in Human Welfare. Cancer - Tumour suppressor genes, Genetic basis of malignant transformation, oncogenes, cancer and cell cycle, chromosome rearrangements and cancer, Pathways of Cancer.	8
Module IV (Self - Study)	**Basic cell structure and cell reproduction**: Prokaryotes and eukaryotes; structural organisation and functions of cell organelles (Cell wall, Plasma membrane, Nucleus, Mitochondria, chloroplast, nucleus, Golgi body, Endoplasmic reticulum, Micro bodies - Glyoxysomes, Peroxisomes, Oxalosomes, Glycosomes, Hydrogenosome and vacuoles). Ribosomes: Different Types (Prokaryotic, Eukaryotic, Cytoplasmic, Organellar, etc.), Polysomes. Cell Reproduction - Mitosis and Meiosis. **Chromosomal aberrations**: Duplications, deficiencies/deletions, inversions, interchanges/ translocations; Role of chromosomal aberrations in crop evolution; Ploidy changes: Haploids, polyploids and aneuploids. **Basics in Molecular Biology and Genetics**: Structure of DNA and RNA - Purines and Pyrimidines, Nucleosides, Nucleotides, Watson and Crick Model of DNA. **Molecular Structure of DNA:** Topology of DNA, Forms & types of DNA (Super Helical - Circular, Nicked-Circular, Linear, Satellite, selfish), Types of DNA - A, B, C, D, E, H, Z, RL Helix & Triple Helix; Organellar DNA (ct DNA & mt DNA) Replication of DNA: DNA Replication *in vivo*, Types of DNA Replication (Conservative, semi-conservative & dispersive), Enzymology of replication. Replication of ΦX174. Comparison of Eukaryotic and prokaryotic replication.	17

PRACTICAL (36 Hours)

1. Preparation of mitotic spreads and analysis of various stages of cell division (*Allium*) with special emphasis on Metaphase and Anaphase.
2. Study of mitotic index in different conditions given for onion root growth
3. Study of meiosis in *Datura/Rhoeo/Chlorophytum/Crotalaria* by smear preparation of PMCs.
4. Camera Lucida/drawing tube drawings of Karyotype from a permanent slide.
5. Demonstration of Karyotyping using common/crop plants (Onion, *Rheo*)
6. Study of giant chromosomes in *Drosophila*.
7. Colorimetric estimation of DNA by Diphenylamine method.
8. Colorimetric estimation of RNA by Orcinol method.
9. Extraction, isolation and staining of nucleic acid DNA from plant tissues (leaf/fruit tissue) (CTAB).

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Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3		2						1					
CO2	3		3							2				
CO3	3		2											
CO4	3		3					2			2		3	3
CO5	3	3	3		3					3	3	2	3	3
CO6	3	3	3		2	3				3	3	1	3	3

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics:

	Quiz / Discussion / Seminar	Internal Theory / Practical Exam.	Assignment / Viva	End Semester Exam.
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5		✓	✓	✓
CO 6		✓	✓	✓

MSPSB02C09 MICROBIAL AND PLANT BIOTECHNOLOGY

Course Code	MSPSB02C09			
Course	MICROBIAL AND PLANT BIOTECHNOLOGY			
Type of Course	Core Course			
Semester	II			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	4	2	72+ 36 = 108
Pre-requisites	Basics of Microbiology and Biotechnology			
Course summary	This course gives basic and applied aspects of biotechnology with special reference to the application of microbes.			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Understand genetic engineering tools, Apply genetic engineering techniques.	U, Ap	C, P	Test paper, Assignments, Seminar
CO2	Analyse bioprocesses and Biotechnology applications and utilise microbial inoculants.	Ap, E	C, P, M	Test paper, Assignments, Seminar
CO3	Evaluate plant genetic engineering and Genome editing technology.	An, E	P, M	Test paper, Assignments, Seminar
CO4	Understanding of general techniques in plant tissue culture including laboratory setup and equipment, in vitro production and plant improvement techniques.	R, Ap	P, M	Test paper, Assignments, seminar, Practical Exam
CO5	Understand nanobiotechnology, apply biosensors and miniaturised devices. Evaluate applications and address ethical issues.	R, U	F, C	Test paper, Assignments, Seminar
CO6	Develop Proficiency in Genetics Engineering and Molecular Techniques.	Ap, An	P, M	Practical Exam, Viva Voce, Assignments
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	**MICROBIAL BIOTECHNOLOGY** a. Genetic Engineering: Tools used in genetic engineering: i. Cloning vectors (plasmid and bacteriophage vectors, cosmids BAC and YACs. ii. Enzyme (Restriction endonucleases, exonucleases, polymerases,	25

	reverse transcriptase, alkaline phosphatase, polynucleotide kinase, Ligases, terminal transferases, topoisomerase, DNA methylase) iii. DNA cloning, preparation of plasmid DNA, Restriction and electrophoresis, ligation, transformation and analysis of recombinants. b. Techniques of Genetic Engineering**:** Principles and methods of Genetic Engineering, Gene libraries and cDNA libraries. Restriction mapping. c. Microbial inoculants: bacterial inoculants - Rhizobacterial inoculants (Nitrogen-fixing bacteria and Phosphate-solubilising bacteria), Fungal inoculants (mycorrhizae and endophytes), Composite inoculants. d. Microbial biotechnology: Mode of operation of a bioprocess – basic concepts of batch, fed batch and continuous operation of a bioprocess. Basic design and construction of various types of bioreactors used in bioprocesses. Commercial production of metabolites using bioreactors. Submerged and solid-state fermentation. Microbes in production of enzymes, antibiotics, biopolymers, bioethanol, organic acids, SCP. Ethics and Safety in biotechnology. e. CRISPR technology: Methods and applications.	
Module II	**GENETIC ENGINEERING OF PLANTS** a. Plant Genetic Engineering**:** Methods of direct and indirect gene transfer in plants, *Agrobacterium*, Ti and Ri plasmids, application of genetic engineering, transgenic plants for insect, fungal and bacterial disease resistance, lignin, modification, abiotic stress tolerance, production of useful products. b. *Agrobacterium* and Plant Genetic Engineering: *Agrobacterium*-mediated gene transfer and cloning. Types of plant vectors and their use in gene manipulation. Selectable markers for plant transformation, molecular mechanism of T-DNA transfer - based on vector and Ti plasmid; protocol for *Agrobacterium*-mediated genetic transformation of plants; its success in monocots and dicots with specific examples. c. GMMs, GMOs and GMPs: Major successful organisms and their production details- pest resistant, stress resistant, nutrient enhanced varieties. Pros and cons of GMOs in biosafety, IPR and other related aspects.	20
Module III	**PLANT TISSUE CULTURE** a. *In vitro* Production: Micropropagation, cloning, various stages, applications, pathogen indexing, meristem culture, advantages, Haploids - androgenesis, pathways, factors affecting, advantages – applications, gynogenesis, Phytochemicals, large scale cultures, bioreactors, improvement – elicitors, hairy root cultures, biotransformation and applications. b. Plant Improvement**:** Somatic hybridization, protoplast isolation, culture, fusion, advantages. Somaclonal variation, origin, advantages. c. Complementary Techniques: Germplasm conservation, slow growth, cryopreservation (freezing – thawing), cryoprotectants and applications. Distant hybridization, *in vitro* pollination/fertilization, embryo culture, embryo rescue, applications.	15

Module IV (Self - Study)	**PLANT TISSUE CULTURE** a. Plant Tissue Culture: General technique, Laboratory and equipment, aseptic techniques, nutrient medium. Morphogenesis, Plant regeneration, Callus, induction, transfer – subcultures, growth kinetics, cell suspension, somatic embryogenesis, advantages, synthetic seeds - application. **NANOBIOTECHNOLOGY** a. History, development and branches of nanobiotechnology. Nanomaterials in nature. Nanomaterials used in biotechnology - nanoparticles, quantum dots, nanotubes and nanowires. Method of biological synthesis of 'Zn' and 'Ag' nanoparticles – plant extract, bacteria and fungi. b. Biosensors; different types - molecular recognition elements, transducing elements; applications of Nano biosensors. Miniaturised devices: types and applications, lab on a chip concept. c. Nanobiotechnological applications in health care and disease diagnosis and treatment; applications in environment and food - detection and mitigation. Bioethics and Biosafety of Nanobiotechnology.	12

PRACTICALS (36 Hrs)

1. Preparation of culture medium (MS, N & N, SH, B5 and Whites), sterilisation and inoculation methods.
2. Shoot multiplication, Callus culture and organogenesis of important crops/medicinal plants/ornamentals.
3. In vitro fertilisation.
4. Demonstration of Agarose gel electrophoresis.
5. Encapsulation of seeds/embryos in calcium alginate.
6. Estimation of DNA/RNA concentration by Spectrophotometric method.

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Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2				2					3		2	2
CO2	3	2	2	1	1	3						3		
CO3	3	2	3	2		3		2			3		3	3
CO4	3	3				3				2	3		3	
CO5	3	3	3		2	3		1		2	2		2	
CO6	3	3			2	3	3	3		3	3	2	3	3

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics

	Quiz / Discussion / Seminar	Internal Theory / Practical Exam.	Assignment / Viva	End Semester Exam.
CO 1	✓	✓	✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5	✓	✓	✓	✓
CO 6		✓	✓	✓

Semester III

MSPSB03C11 PLANT PHYSIOLOGY AND BIOCHEMISTRY

Course Code	MSPSB03C11			
Course	PLANT PHYSIOLOGY AND BIOCHEMISTRY			
Type of Course	Core Course			
Semester	III			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	4	2	72 + 36 = 108
Pre-requisites	Knowledge in fundamental biological concepts and basic chemistry			
Course summary	This course offers a comprehensive study of plant physiology, exploring the fundamental processes that govern plant growth, development, and response to the environment. The course integrates classical concepts with modern advances in plant physiology and biochemistry, emphasising the molecular mechanisms underlying the physiological processes.			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Comprehend the processes of water absorption and translocation in plants, including the apoplastic, symplastic, and trans-membrane pathways.	U	F	Assignment, Seminar
CO2	Compare different CO_2 fixation pathways (C3, C4, CAM) and their physiological and environmental implications.	An	F	Unit Test
CO3	Analyse the hormonal balance concept and the role of elicitors in growth regulation	An	F	Unit Test, Assignment
CO4	Understand the properties and functions of photoreceptors in regulating plant responses to light.	U	C	Assignment, Unit Test
CO5	Analyse plant responses to various abiotic stresses	An	C	Viva, Assignment
CO6	Gain a foundational understanding of biochemistry, enzyme kinetics, regulation, and the role of enzymes in plant physiological processes.	E	P	Practical exam
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	**PLANT PHYSIOLOGY I** **Absorption and translocation of water:** Aquaporins. Water pathway in the leaf – driving force of transpiration, leaf anatomy for regulating transpiration. Cavitation and Embolism. Soil-plant-atmosphere continuum. Stomatal biology – light dependent stomatal opening. **Absorption of minerals:** Soil characters influencing nutrient availability – size and charge of soil particles, soil pH, interaction between roots and microbes. Mechanism of entry of minerals into roots. Transport of ions, solutes and macromolecules: Electrical properties of membranes, membrane potential. Transport across cell membranes: Passive – diffusion, facilitated diffusion. Membrane channels and pumps: Plasmodesmata, porins, ion channels – gated channels, Voltage dependent K^+ channels, voltage gated channels, Calcium channels, Vacuolar malate channels. ATPase activity and electrogenic pumps. ABC transporters. Patch clamp studies. Active transport and electrochemical potential gradients. **Photosynthesis:** Light harvesting complexes: PS I, PS II; mechanism of electron transport, photo-oxidation of water, proton electrochemical potential – photophosphorylation. Structure and function of Rubisco, CO_2 fixation - C3, C4 and CAM metabolism. Significance.Thylakoid ET inhibitors, Photoinhibition and its tolerance mechanism CO_2 concentrating mechanisms: Algal and cyanobacterial pumps, Photosynthetic quantum yield and energy conversion efficiency. Transport of photoassimilates – phloem loading and unloading, Starch and sucrose synthesis. Allocation and partitioning mechanism of phloem translocation – pressure flow of plasmodesmata in symplastic transport. **Respiration:** Glycolytic reactions: Pyruvate entry into mitochondria and citric acid cycle. Electron transfer system and ATP synthesis. Transporters involved in the pathway. Detailed structure of F1 and Fo subunits, binding change mechanism of ATP synthesis. Comparison of mitochondrial and chloroplast ATP synthesis. Cyanide resistant pathway, Rotenone - insensitive pathway in plants and Pentose Phosphate Pathway (PPP). Interaction between mitochondrial and other cellular components. Metabolites and specific transporters. **Nitrogen metabolism:** Nitrate and ammonium assimilation. Assimilation of ammonia; pathways and enzymes - GS, GOGAT and GDH. Energetics and Importance of phosphorus, iron, magnesium, calcium and potassium assimilation. Transport of amides and ureides. **Growth, differentiation and development:** Analysis of plant growth: production of cells, growth velocity profile. Cytological and biochemical events. Differentiation: secondary cell wall formations, multinet growth hypothesis of cell wall. Development: initiation and regulation of development, genes involved in the control of development, role of protein kinases. Types of development: *Flowering* - floral induction, evocation and morphogenesis. Floral organ	32

	identity genes. Biochemical signalling: Theories of flowering. Control of flowering - phytochrome, cryptochrome and biological clock. Factors affecting flowering: Photoperiodism and thermoperiodism. *Fruit development and ripening*: physiology of ripening - cell wall architecture and softening, enzymes involved in biochemical changes. *Seed development*: deposition of reserves during seed development, desiccation of seeds: hormones involved, desiccation tolerance.	
Module II	**PLANT PHYSIOLOGY II** **Photoreceptors:** Phytochromes - photochemical and biochemical properties, localisation in cells and tissues, phytochrome induced whole plant responses, ecological functions. Mechanisms of phytochrome regulated differentiation. Signal transduction pathways, role in gene expression. Cryptochromes: blue light hormones photophysiology, effect on stem elongation, gene expression, stomatal opening, proton pumps, phototropism, role of carotenoids. **Senescence and programmed cell death:** Apoptosis and necrosis. Programmed cell death in relation to reproductive development, and stress response. Genes associated with senescence, metabolism during senescence. **Stress physiology:** Water deficit and drought resistance, heat stress and heat shock, chilling and frost, salinity stress, oxygen deficiency stress and heavy-metal pollution stress. Acclimation and adaptation mechanisms in plants.	10
Module III	**BIOCHEMISTRY** **Introduction:** Acid and Bases, ionisation of water, dissociation of acids, Henderson - Hasselbalch equation, pKa. Buffers - Common buffers (acetate, citrate and phosphate), buffer action, buffer capacity. **Carbohydrate:** Metabolism of starch, cellulose and glycogen. glycoproteins and proteoglycans, biosynthesis of peptidoglycan, metabolic mill. **Proteins:** Conformation proteins, Ramachandran plot. Structure, function, mechanism and allosteric regulation of haemoglobin, abnormal haemoglobin, structure and function of leghaemoblobin, brief account of the biosynthesis and degradation of protein. **Enzymology:** Regulation of enzyme activity, enzyme kinetics, Michaelis-Menten constant, Lineweaver-Burk plot. Active sites, substrate specificity, inhibitors, allosteric enzymes, negative and positive cooperativity. Detailed study of FAS and Rubisco. **Lipids:** Biosynthesis of fatty acids (microbes, plants and animals), alpha, beta and omega oxidation of fatty acids, omega fatty acid and functional food, trans- fatty acids and their dangers, detailed study of coconut oil. **Secondary metabolites:** Classification, biosynthesis and functions of terpenoids, alkaloids and phenolics. **Signal transduction:** Classes of signals; receptors, signal perception, signal amplification and transduction reactions, role of Ca^{++} as second messengers, role of Calmodulin. Cross regulations in signal transduction pathways.	18

Module IV (Self-Study)	**History and significance of Plant Physiology and Biochemistry:** Contribution of Indian Plant Physiologists – J.C. Bose and V.S. Ramadas. Indian contributors in Biochemistry – G.N. Ramachandran, P.M. Bhargava. **Transport in plants:** Apoplastic, symplastic and trans-membrane pathways. Mechanism and theories of xylem transport, passive and active transport. **N fixation processes:** N cycle. Biological N fixation – structure of nitrogenase complex, reduction of N. Symbiotic N fixation – nodule formation, nodulin gene and nodulation genes, leghaemoglobin. **Plant growth regulators:** Biosynthesis, transport, physiological roles and role in signal transduction pathways of Auxin Gibberellin, Cytokinin, Ethylene and Abscissic acid. Hormonal balance concept. Role of elicitors in growth regulation. Germination physiology: Classification of seeds, seed dormancy. Imbibition, germination and reserve mobilisation - metabolism of carbohydrates, lipids, proteins and phytins, physiology of seed dormancy. **Biomolecules:** Mono-, di-, oligo- and polysaccharides, linear and ring structures, homo- and heteroglycans, artificial sweeteners, structure and function of major homo- and heteropolysaccharides. Amino acids: Classification, properties, optical activity, unusual amino acids. Lipids: Classification, brief account on compound and derived lipids with examples, classification of fatty acids, **Enzymes:** Classification and Structure, function and classification of enzymes, Coenzymes, multienzyme, isoenzymes, ribozyme, abzyme.	12

PRACTICAL (36 Hours)

1. Preparation of molal, molar, normal and percentage solutions and their dilutions.
2. Determination of moisture content of plant materials.
3. Determination of osmotic potential by plasmolytic method.
4. Separation of plant pigments by paper chromatography.
5. Measurement of Photosynthesis - Hill Reaction.
6. Measurement of Light Intensity and Light Transmission Ratio.
7. Demonstration of Amylase activity and gibberellic acid effect in germinating cereal seeds.
8. Preparation of standard solutions of BSA, Glucose and Catechol.
9. Detection of non-reducing sugar in the presence of reducing sugar.
10. Quantitative estimation of reducing sugar from plant tissue by any suitable method.
11. Extraction and estimation of starch from plant tissue by a suitable method.
12. Colorimetric estimation of protein by Biuret method and soluble proteins by Bradford method.
13. Colorimetric estimation of protein by Lowry et al. method.
14. Measurement of amylase/invertase/protease from any suitable plant/microbial source using suitable method.
15. Isolation and quantification of plant lipids by dry and lipid methods.
16. Extraction and estimation of total phenols.

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Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3		1							1				
CO2	3	2	3						1	2		3		
CO3	3	2	2					2		3			1	
CO4	3	1	2							2		1		
CO5	3	3	3		1	3	2	2		3		3	2	
CO6	3	2	3	1	2	2				3		2	3	

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics

	Quiz / Discussion / Seminar	Internal Theory / Practical Exam.	Assignment / Viva	End Semester Exam.
CO 1	✓		✓	✓
CO 2		✓		
CO 3		✓	✓	✓
CO 4		✓	✓	✓
CO 5			✓	✓
CO 6		✓		

MSPSB03C12 ANGIOSPERM SYSTEMATICS

Course Code	MSPSB03C12			
Course	ANGIOSPERM SYSTEMATICS			
Type of Course	Core Course			
Semester	III			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	4	4	72 + 72 = 144
Pre-requisites	Knowledge in the basics of Angiosperm morphology and systematics.			
Course summary	The course is designed to develop sound knowledge about origin, evolution and distribution of angiosperms. It provides advanced level knowledge in the classification, identification and nomenclature of angiosperms.			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Acquire Knowledge about primitive angiosperms and their evolution	R	F	Exam
CO2	Acquire Knowledge about taxonomic, categories, taxonomic literatures and nomenclature of flowering plants	U	F	Exam, Assignment
CO3	Understanding taxonomic characters and procedure for phylogenetic systematics	U, Ap	C, P	Examination, Quiz
CO4	Application of concepts in taxonomy for the identification of families and preparation of keys	An	M	Practical Examination
CO5	Developing skill in the Preparation of herbarium sheets and field identification of flowering plants	An, C	M	Practical Exam, Assignment
CO6	Developing skills in taxonomic illustrations and for describing a new taxon	An, C	P, M	Practical Exam, Assignment
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	a. General concepts of morphology: Origin and evolution of flower; coevolution of flowers viz-a-viz pollinators. Stamens: origin and evolution in structure and morphology. Morphology of Nectaries.	15

	Evolution of carpels: Different types of carpels, concepts of foliar origin of carpels. Evolutionary trends in pollination mechanisms. b. A critical study of the current ideas of the origin of Angiosperms with special reference to their ancestral stocks and time of origin. The recent concepts on primitive angiosperms. Fossil angiosperms. c. Evolution of APG system of classification with a detailed account on APG IV. Historical development of plant taxonomy in India with special reference to the contribution by William Roxburgh, J.D. Hooker, J.S. Gamble and K.S. Manilal. d. Taxonomic structure: Taxon, taxonomic category and taxonomic rank. Taxonomic hierarchy; major and minor categories used in taxonomy. Concept of species, genus and family; supraspecific categories and infraspecific categories; cladistics, cladogram and Adansonian Principles.	
Module II	**Methods of Plant exploration and identification** a. Practical identification of plants: Different kinds of Identification keys, construction of dichotomous keys – Indented and bracketed keys. Various kinds of Taxonomic literature: General indices, Floras, Revisions, Manuals, Icons, Monographs, Reviews, Periodicals and Journals; online databases, eFlora. Usage of floras and brief account on Flora of the British India, Flora of the Presidency of Madras, *Hortus Malabaricus*. Important Floras of Kerala. b. Plant nomenclature: Brief history on the origin and development of botanical nomenclature; detailed study of the major provisions of the International Code of Nomenclature for Algae, Fungi and Plants (ICN); effective and valid publication, ranks of taxa, rule of priority and its limitations; typification, author citation, rejection and retention of names, conserved names; valid and invalid names, *nomen nudum*, conserved names. Names of hybrids; nomenclature of cultivated plants. c. Taxonomic character, character variations and their taxonomic implications; concept of primitive and advanced characters. Sources of taxonomic characters: Morphology, anatomy, palynology, cytology, phytochemistry and embryology. Modern trends in taxonomy: Cytotaxonomy, chemotaxonomy, biosystematics and numerical taxonomy. d. Expression of relationship: monophyly, polyphyly, homology, analogy, parallelism, divergence, convergence. Plant speciation: Allopatric, sympatric, abrupt, hybrid, apomictic speciation; isolation mechanisms. e. Principles and procedure of phylogenetic systematics, classification of tree building methods: Maximum Likelihood and Bayesian analysis. Cladogram analysis. Brief account of DNA barcoding in plants.	15
Module III	**Method of describing a plant species using morphological characters.** a. Study of the following families with special reference to their phylogenetic relationship and economic importance: Ranunculaceae, Magnoliaceae, Menispermaceae, Polygalaceae, Caryophyllaceae, Capparidaceae, Sterculiaceae, Geraniaceae (Oxalidaceae and Balsaminaceae), Sapindaceae, Rhizophoraceae, Melastomataceae, Aizoaceae, Gentianaceae, Boraginaceae, Convolvulaceae, Oleaceae, Lentibulariaceae, Pedaliaceae, Lauraceae, Loranthaceae,	30

	Amaryllidaceae, Commelinaceae, Araceae, Cyperaceae.	
Module IV (Self-Study)	a. Systematics and Taxonomy. Objectives, scope and importance of taxonomy. Major centres of taxonomy in the world and India. b. Historical development of theories and concepts of plant classification and classificatory systems. Detailed study of classification proposed by Bentham and Hooker. c. Familiarisation of technical terms associated with the following: habit, habitat; root, stem, leaf, inflorescence; bract and bracteoles, flowers, fruits and seeds. d. Herbarium and virtual herbarium: Field study; Herbaria - definition and techniques involved in the preparation of Herbarium. Management of Herbaria; Major Herbaria in India (CAL, MH, BSI) and the World (K, NY); Role of Herbaria in taxonomy. Floristic studies in India; Major centers of taxonomic and floristic studies in India; Organization and functions of the Botanical Survey of India. e. Botanical Gardens: Role in taxonomy and biodiversity conservation. History and major Botanical gardens of India (Indian Botanical Garden, Calcutta; National Botanical Garden, Lucknow and JNTBGRI, Thiruvananthapuram) and World (Royal Botanical Garden, Kew; Kirstenbosch Botanical Garden, Cape town. South Africa).	12

PRACTICAL (72 Hours)

1. During the course of study, the students shall get familiar with local flora, construction of keys, use of floras for the identification up to the species level.
2. Study of the diagnostic features of the families included in the syllabus (Plants not included in the Flora of the Presidency of Madras are not expected to be given for practical examination).
3. Work out 2 species each (at least one) from the families mentioned in the syllabus, draw line diagrams, describe in technical terms and identify by constructing a key up to species level.
4. Each student shall undertake a field study for at least five days under the guidance and supervision of the teacher at a place ecologically different from the respective college and submit a field study report certified by the concerned teacher.
5. Each student shall submit at least 25 herbarium sheets of different families (need not be from the families mentioned in the syllabus) along with a field note book for practical examination.
6. Each student shall solve nomenclatural problems involving the identification of legitimate name, invalid names, basionyms and synonyms and must be familiar with common terminologies in botanical citations.
7. Construction of a phylogenetic tree using any online software available free of cost.
8. Dissection of flowers for the identification of primitive flowers (*Clematis, Magnolia, Nymphaea, Nelumbium*), transitional stamens (*Nymphaea, Nelumbium*) and their evolution.

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Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3		1	1				1	3	3				2
CO2	3							2	3	2		1		
CO3	3		2				1		3	3		2	1	
CO4	3		2			2			3	3		3	1	
CO5	3	2			3	3				1	3	3	2	
CO6	3	2			3	3				3	3	3	2	

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics

	Quiz / Discussion / Seminar	Internal Theory / Practical Exam.	Assignment / Viva	End Semester Exam.
CO 1		✓		✓
CO 2		✓	✓	✓
CO 3	✓	✓		
CO 4		✓		
CO 5		✓	✓	✓
CO 6		✓	✓	✓

MSPSB03C13 BASIC BIOINFORMATICS

Course Code	MSPSB03C13			
Course	BASIC BIOINFORMATICS			
Type of Course	Core Course			
Semester	III			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	4	2	72 + 36 =108
Pre-requisites	Basic knowledge about the concept of genome and applications of computer.			
Course summary	The main content of the course is based on the application and analysis of basic genomic knowledge and *in vitro* biology of plants.			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Students will be able to understand the scope of usage of computers in biological sciences	R, U	F	Quiz, Discussion
CO2	Students will be able to identify the types of biological information or data and its significance in biology	R, U, E	F, C	Quiz, Viva, Practical exam
CO3	Students will be able to comprehend the methodology of biological data analysis	U, E, An	F, C, P	Exam, Assignment,
CO4	Students will be able to recognise the potential of the emerging field of bioinformatics	U, E	F, C	Quiz, Exam, Assignment
CO5	Students will be introduced to the general and specialized biological data and bioinformatics tools to analyse the data	U,	F, C, P	Viva, Practical Exam, ESE
CO6	Students will understand the use of bioinformatics in deriving new knowledge or information which will redefine or fortify the conventional method scientific investigation.	U, Ap, An, E	F, C, P	Exam, Assignment, Quiz, Seminar
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	**Basic Informatics:** Introduction to Operating Systems: Definition and functions of O.S. Types of O.S. – Single user, Multi-user (Windows and Linux), Graphical User interface. Disk Operating System (DOS): DOS internal and external commands.	18

	Networking of Computers: Basic principles, tools and techniques used in Computer Networking. Hardwares in networking: Network Cables, Distributors, Routers, Internal Network Cards, External Network Cards. Softwares in networking: SDN framework. Major types of Network softwares. Types of Computer networks: Internet and intranet. Introduction to Internet: TPC/IP, WWW, FTP, registration with ISP, Internet connection wizard, URL, http, internet access methods: Dial-up, DSL, Cable, ISDN, Wi-Fi.	
Module II	**Basics in Bioinformatics:** Bioinformatic Resources: NCBI, EBI, ExPASy, RCSB. Nucleotide sequence Databases: GenBank, EMBL, DDBJ; Protein sequences Databases: Swiss-Prot, TrEMBL, UniProt, UniProtKB, UniParc, UniRef, UniMES; Sequence motifs Databases: Prosite, ProDom, Pfam, InterPro, Gene Ontology; Sequence file formats: GenBank, FASTA, PIR, ALN/ClustalW2. Patent databases, TAIR, PDB, ATIDB, OMIM; Medical databases, KEGG, EST databases, Chemical Databases: ZINC, Pubchem, Chembl. Fundamentals of computer programming, common languages in Bioinformatics - PERL. C++ and Python - Python Data Types, Python variables, Operators, Lists in Python, operations, methods, parameters, Iterators, Generators, Comprehensions and Expressions – Tuples, Python Dictionaries and Sets. Advanced Concepts in Python Programming – Files reading and writing, command line arguments, Exception handling, Modules and Packages, Control Statements and Regular Expression, string functions and methods, Using Databases in Python - Introduction to Biopython - Sequence objects - Database search using Biopython, Python for Data Analysis. Genomes and proteomes. Eukaryotic genome with special references to model organisms (Yeast, *Drosophila*, *Caenorhabditis elegans*, Rat and Mouse), human, plants such as *Arabidopsis thaliana* and Rice. Transcriptomics: transcriptome analysis - micro-arrays, NGS- RNA seq, Types of non-coding RNA's-lncRNAs, miRNAs, piRNAs, siRNAs ceRNAs etc. RNA databases, RNAi, RNA structure prediction tools, RNA sequence analysis, RNA regulatory networks; Transcriptome assembly, Comparative transcriptomics; short ORFs, encodeproject.	18
Module III	**Basics in Sequence Analysis** a. Various biomolecular sequences - DNA, RNA, Proteins and their significance and interrelationship. b. Basic concept of sequence similarity, identity and homology, definition of homologous, paralogous, orthologous and xenologous sequences. c. Various file format for Bio-molecular Sequences: GenBank, FASTA, GCG, MS, NBRF-PIR, ALN/ClustalW2**.** d. Scoring matrices: Basic concept of scoring matrix, matrices for nucleic acid and protein sequences, PAM and BLOSOM series, principles based on which these matrices are derived. Differences between distance & similarity matrix. e. Sequence based database search: Tools and techniques used in	18

	sequence analysis. Pair wise and Multiple Sequence Alignments. Tools for local, global and MSA: Muscle, T-Coffee, and ClustalW. f. Basic concept of sequence alignment: Algorithms - Needleman and Wunch, Smith waterman. Sequence analysis of Nucleic acid and Protein sequences and interpretation of the results. Applications of Sequence Analysis. g. Sequence patterns and Evolution: Molecular evolution, Diversity, Evolution and Concept of sequence patterns, motifs, profiles, various types of pattern representation viz. consensus, regular expression and profiles. Phylogenetic analysis by PHYLIP, MEGA. h. Nature of data used in Taxonomy and Phylogeny, Description of phylogenetic trees and types of dendrograms. Analysis, interpretation and significance of dendrograms.	
Module IV (Self-study)	**Basic Informatics:** a. Introduction to Computer: Definition, Salient features, limitations and capabilities of Computers. Evolution of Computers - generations of Computers. Types of Computers - based on size and purpose. Applications of computers in various fields b. Major Computer components and peripherals – ALU, Memory Unit, Control Unit, motherboard, SMPS, Expansion Slots, Serial and Parallel ports, USB. Concept of Memory: Primary Memory – RAM, ROM, EPROM, PROM. Secondary Storage devices: - Magnetic disk, Magnetic tape, Floppy disk, Pendrive, DVD/CD ROM, Cache memory RAM, ROM, PROM, EPROM, Input and Output Devices. **Basics in Bioinformatics:** a. Bioinformatics: History, branches and significance of bioinformatics. b. Types of Biological data: Biodiversity data, Molecular data - DNA, RNA and Protein sequences.	18

PRACTICAL (36 Hours)

1. Exercises on Windows/Linux/UNIX in Documentation, Networking, Internet search & Graphics.
2. Usage of Software for identification of species to authenticate biodiversity.
3. Accessing existing five databases on the World-wide Web - PubMed/DDBJ/GENBANK/ PDB/EMBL/SCOP/etc.
4. Usage of similarity, homology and alignment software; Software for Microarray analysis – design, processing and analysis. Various versions of BLAST and CLUSTAL
5. Phylogenetic analysis using MEGA
6. Evaluation of Gene Prediction methods. Tools - GENSCAN, GENEFINDER.
7. Programming in python (Data interpretation/visualization).

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Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3													3
CO2	3	2								1				3
CO3	3	3	3	1						2				3
CO4	3	2	3			3					2		1	3
CO5	3	3	2		2	3	2				3		3	3
CO6	3	3	3		1	2	3	2			2	2	3	3

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics

	Quiz / Discussion / Seminar	Internal Theory / Practical Exam.	Assignment / Viva	End Semester Exam.
CO 1	✓			
CO 2	✓	✓	✓	✓
CO 3		✓	✓	✓
CO 4	✓	✓	✓	✓
CO 5		✓	✓	✓
CO 6	✓	✓	✓	✓

MSPSB03O01 ARTIFICIAL INTELLIGENCE FOR LIFE SCIENCE STUDIES

Course Code	MSPSB03O01			
Course	ARTIFICIAL INTELLIGENCE FOR LIFE SCIENCE STUDIES			
Type of Course	Open Elective Course			
Semester	III			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	3	2	54 + 36 = 90
Pre-requisites	Basic knowledge in information technology and a general awareness of all fields of life sciences.			
Course summary	The course will enable the students to understand the fundamental concepts of Artificial Intelligence and its applications in life sciences. They will gain practical knowledge for applying AI techniques to various areas of life sciences, including genomics, botany, and ecological conservation.			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Understand the basic principles of Artificial Intelligence.	U	F	Quiz
CO2	Able to apply the knowledge of AI in various fields of Life Sciences.	Ap	P	Quiz, Unit test
CO3	Apply AI in Genomics, medicine and healthcare.	Ap	P	Assignment, Unit test
CO4	Use AI for practical plant identification.	Ap	P	Assignment, Practical Exam
CO5	Able to integrate AI for modern agriculture and biodiversity monitoring and conservation.	An	P	Assignment, Practical Exam
CO6	Utilise AI for research and publication of scientific publications.	Ap	P	Assignment, Practical Exam, Unit test
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	**Introduction to Artificial Intelligence:** Definition and brief history. Types of AI: Narrow AI vs. General AI, Applications of AI in various fields. Machine learning fundamentals: supervised, unsupervised, and reinforcement learning. Basic algorithms: Linear regression, logistic regression, decision trees, etc. Deep learning basics: Neural networks architecture, Convolutional Neural Networks (CNNs) for image data, Recurrent Neural Networks (RNNs) for sequential data. Ethical	12

	Considerations in AI: Bias and fairness in AI algorithms, Privacy concerns, AI and its impact on society.	
Module II	**AI for Life Science Studies:** Introduction to AI in Life Sciences; overview of biology, genetics, and bioinformatics. Importance of data in life sciences research. Applications of AI in Genomics: Genome sequencing and analysis, predictive modelling for genetic diseases, Personalized medicine and precision healthcare. AI in drug discovery and development: Drug-target interactions prediction, drug repurposing using AI, Clinical trial optimization with machine learning. AI for healthcare management: Predictive analytics in healthcare, medical imaging analysis using AI, Electronic Health Records (EHR) management with AI.	15
Module III	**AI for Botanical Studies:** Introduction to AI in Botany; plant anatomy and physiology, importance of botanical research in agriculture and ecology. AI Applications in Plant Identification: Image-based plant species recognition, plant disease detection using machine learning, remote sensing for vegetation analysis. AI for crop improvement: Genomic selection for crop breeding, precision agriculture and AI-driven farming techniques, Climate change modelling and its impact on plant ecosystems. AI for ecological conservation: Biodiversity monitoring using AI, habitat modelling and species distribution prediction, AI-enabled conservation planning.	15
Module IV (Self Study)	**AI for Research and Publication:** Literature review automation; introduction to literature review in research, text mining techniques for automated literature search; citation network analysis and literature clustering; tools and platforms for literature review automation. AI-assisted experimental design, data analysis and visualization using AI, AI for manuscript writing and editing; grammar and style correction using AI-based writing assistants, automated summarization and abstraction of research findings. Reference management software and tools.	12

PRACTICAL (36 Hours)

1. Practical identification of flowering plants using image-based AI tools.
2. Design an experiment using an AI tool.
3. Case study of AI application in healthcare.
4. Demonstration of basic algorithms used in AI.

References:

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Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3													
CO2	3	2				3								
CO3	3	2	3			3								2
CO4	3	1				3					1		3	
CO5	3	3	3		2	3					2		3	
CO6	3	3	3	2	3	3	2	2			2		3	

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics

	Quiz / Discussion / Seminar	Internal Theory / Practical Exam.	Assignment / Viva	End Semester Exam.
CO 1	✓			
CO 2	✓	✓		✓
CO 3		✓	✓	✓
CO 4		✓	✓	✓
CO 5		✓	✓	✓
CO 6		✓	✓	✓

MSPSB03O02 FORENSIC BOTANY

Course Code	MSPSB03O02			
Course	FORENSIC BOTANY			
Type of Course	Open Elective Course			
Semester	III			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	3	2	54 + 36 = 90
Pre-requisites	Knowledge in various fields of biology which are utilised in forensic science.			
Course summary	The course explains the basic principles and modern techniques utilised in forensic investigations; and the utilisation of the principles, tools and data utilised in forensic procedures and criminal investigation.			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Understand the basics of forensic science and forensic botany	U	F	Quiz, Assignment
CO2	Familiarise the modern techniques utilised in forensic investigations.	U	F	Quiz, Unit test
CO3	Identify available botanical evidence and apply appropriate techniques for their identification in forensic investigations.	Ap	P	Assignment, Unit test, Practical Exam
CO4	Familiarise common poisonous plants available locally.	U	F	Assignment, Practical Exam
CO5	Explain the legal and ethical aspects of forensic procedures.	An	M	Assignment, Practical Exam
CO6	Apply their understanding of forensic science principles in criminal investigations.	E	M	Assignment, Practical Exam, Unit test
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	**Introduction to Forensic Science:** Definition, history, development and scope; forensic science in India. Basic principles of forensic science and its significance, organization and functioning of Forensic Science Laboratories, forensic laboratories in Kerala. Legal and ethical considerations in forensic science: adherence to legal procedures; respect	12

	for rights and privacy; chain of custody; impartiality and objectivity; confidentiality and data protection.	
Module II	**Introduction to forensic botany:** Scope and importance of Botany in forensic science. ecology of plants. Various types of woods, components of wood and their forensic significance. Types of fibres; forensic aspects of fibre examination, fluorescent, optical properties, refractive index, birefringence and dye analysis; identification and comparison of man-made and natural fibres. Aquatic microscopic algae; planktons and diatoms and their forensic importance. Diatom types, morphology, methods of isolation from different tissues. Forensic palynology, study and identification of pollen grains, pollen morphology; identification of starch grains, powder and stains of spices. Paper and paper pulp identification, microscopic and biochemical examination of pulp material. Standards and guidelines for forensic botany data collection; samples of botanical origin; collection protocols; preservation of data; outdoor crime scene investigation. Samples analysis and interpretation; quality assurance; documentation and reporting data. Modern tools used in Forensic Botany: molecular techniques; DNA analysis and barcoding; high-resolution imaging techniques.	26
Module III	**Common poisonous plants:** Locally available poisonous plants belonging to the families Anacardiaceae, Fabaceae, Apocynaceae, Euphorbiaceae, Liliaceae and Loganiaceae. Plants yielding drugs of abuse: *Opium*, *Cannabis*, *Coca*, Tobacco, *Datura*. Common poisonous fungi; fungal toxins.	10
Module IV (Self-Study)	**Collection and preservation of botanical evidence for forensic investigations:** Plant identification; classification of plants; characters used for identification and classification; morphology, anatomy, phytochemistry and palynology; Classic forensic botany case studies: Case histories by using plant anatomy and systematics, palynology, plant ecology, limnology, plant molecular biology and drug enforcement.	6

PRACTICAL (36 Hours)

1. Collection and submission of classic forensic botany cases: Case histories by using plant anatomy and systematics, palynology, plant ecology, limnology, plant molecular biology and drug enforcement.
2. Collection and study of samples containing diatoms, planktons, pollen grains and fibres.
3. Common methods used in blood stain and other sample collection in forensic investigations.

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Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3													
CO2	3	3				2		2			3	2	3	2
CO3	3	3	3		2	3	1			2			1	
CO4	3	2							2					
CO5	3	1	2	2	3	3	2	2				3	2	
CO6	3	3	3	1	3	3	3	2		1		3	3	

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics

	Quiz / Discussion / Seminar	Internal Theory / Practical Exam.	Assignment / Viva	End Semester Exam.
CO 1	✓		✓	
CO 2	✓	✓		✓
CO 3		✓	✓	✓
CO 4		✓	✓	✓
CO 5		✓	✓	✓
CO 6		✓	✓	✓

MSPSB03O03 MARINE BOTANY

Course Code	MSPSB03O03			
Course	MARINE BOTANY			
Type of Course	Open Elective Course			
Semester	III			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	3	2	54 + 36 = 90
Pre-requisites	Detailed knowledge on the diversity of plants and a basic understanding of the structure of marine ecosystems.			
Course summary	This course gives basic knowledge in the components of marine ecosystems including mangroves and the consequences of environmental pollution on marine ecosystems.			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Develop a basic knowledge in the components of marine ecosystems.	U	F	Quiz, Unit test
CO2	Understand the diversity, structure and importance of mangroves.	U	F	Quiz, Unit test
CO3	Analyse the floristic diversity of mangroves and appraise the diversity of associated fauna.	An	M	Assignment, Unit test, Quiz
CO4	Understand the floristic diversity and ecology of marine ecosystems	U	F	Assignment, Quiz
CO5	Understand marine pollution and various other phenomena in marine ecosystems as a result of human interventions.	U	F	Assignment, Practical Exam
CO6	Apply the knowledge gained in tackling the problems related with the pollution of marine ecosystems.	An	M	Assignment, Practical Exam, Unit test
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	**Marine Plant Diversity** Introduction; major aquatic biomes of the world; marine ecosystems - introduction and types, zonation, environment. Marine organisms; marine plants. Marine algae: macroscopic and microscopic; major groups of marine microscopic algae; algal blooms; Planktons, Nektons, Benthos. Marine Phytoplanktons: Dino-flagellates, Nano-plankton, ultra-plankton,	15

	coccoliths. Marine fungi, lichens and marine microbiome. Macroalgae and their distribution. Seagrasses and their distribution.	
Module II	**Mangroves and their Biodiversity** Introduction to creek, estuary, lagoon and delta formations. Coastal plants and Mangroves, ecology and vegetation of mangroves; Adaptations of true mangroves: anatomical, physiological, morphological, vivipary. Mangrove families in Kerala – taxonomy and diversity, major mangrove species of Kerala; Mangrove associates and their diversity in Kerala. Regeneration in Mangroves; methods of natural and artificial regeneration in mangroves. Conservation of mangroves; mangrove conservation initiatives in Kerala.	15
Module III	**Marine Ecology** Detailed account of the physical and chemical parameters of ocean water. Ocean water movements; *El Nino*, *La Nina*. Microbial ecology of coastal ecosystem; mycorrhizal relations, coastal vegetation. Microbial ecology of coral reefs: occurrence, distribution and types. Calcification, reef algae, natural and anthropogenic stress, restoration and conservation of coral ecosystem. Cultivation of marine algae; *in vitro* cultivation of algae. **Pollution and Conservation of Marine Ecosystem** Marine pollution: Types of pollutants, sources and effects. Toxic metals, oil spill, sewage, fertilisers and pesticides, radioactive pollutants; disposal of waste in oceans; biomagnification. Conservation of marine and mangrove ecosystems; importance of conservation; major conservation initiatives in India.	16
Module IV (Self-Study)	Vegetative and reproductive account of Cyanophyceae, Bacillariophyceae, Chlorophyceae, Rhodophyceae and Phaeophyceae. Collection, preservation and herbarium preparation of marine macroscopic algae. Economic importance of marine algae: food, fodder, medicine, industry, etc. Mangrove vegetation: Diversity, ecological significance. Distribution of mangroves in India. Mangroves of Kerala; Mangrove diversity of Northern Kerala.	8

PRACTICAL (36 Hours)

1. Field visit to a nearest coast and submit a report on the floristic diversity (microaglae/ macroalgae/ tracheophytes).
2. Conduct a field visit to nearby mangrove areas and submit a report on the floristic diversity and ecology.
3. Identify the presence of pollutants in sea water.
4. Conduct water quality parameters of sea water.

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Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	1							3					
CO2	3	1	3						3			3	2	
CO3	3	2			2				3	2	2	3	2	
CO4	3	2				2			3	2	2	3	2	
CO5	3	2	2						3		3	3	3	
CO6	3	3	3	2	3	3	2	1	3		3	3	3	

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics:

	Quiz / Discussion / Seminar	Internal Theory / Practical Exam.	Assignment / Viva	End Semester Exam.
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓	✓	✓
CO 4	✓		✓	
CO 5		✓	✓	
CO 6		✓	✓	✓

MSPSB03O04 BIODIVERSITY AND CONSERVATION

Course Code	MSPSB03O04			
Course	BIODIVERSITY AND CONSERVATION			
Type of Course	Open Elective Course			
Semester	III			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	3	2	54 + 36 = 90
Pre-requisites	Basics of environmental science and taxonomy.			
Course summary	This course covers the principles of and components of biodiversity, its significance and values, various threats and strategies adopted for their conservation.			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Understand the concept and components of biodiversity, and its significance and values.	U	F	Unit test, Quiz
CO2	Understand various threats and strategies adopted for their conservation.	U	F	Quiz, Unit test
CO3	Familiarise the RED Data Book and IUCN Red list categories.	U	F	Assignment, Unit test
CO4	Differentiate various methods for *in situ* and *ex situ* conservation of biodiversity.	U	F	Assignment, Unit test
CO5	Understand various protocols and national and international efforts adopted for the conservation of biodiversity.	U	F	Assignment, Seminar
CO6	Attain skill in the process of red listing of plants based on the latest IUCN criteria.	Ap	P	Assignment, Practical Exam, Unit test
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	**Biodiversity:** Definition; alpha, beta and gamma diversity - global and Indian scenario. Levels of biodiversity: *Genetic diversity* - types and sources methods for measuring genetic diversity; *Species Diversity* - Measurement of species diversity, concepts on keystone species, flagship species. Endemism and endemic species. Threatened and endangered species. Extinction risk; *Ecosystem diversity* - concept of Megadiversity Nations and Hotspots; Biodiversity Hotspots, Biodiversity hotspots of	12

	India. Threats to biodiversity. Significance and applications of biodiversity. Values of biodiversity.	
Module II	**Conservation Biology:** Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy: Conservation Projects, Sanctuaries, National Parks and Biosphere reserves. What to conserve; why to conserve; overview of genetic variability: population biology of endangered species, conservation genetics, wildlife biology. Conservation and management of biodiversity: Indian forest conservation act, Biological Diversity Act (2002). Role of ethnic groups in conservation of plant genetic resources. Threatened taxa and forest management (participatory forest management). Organizations: IUCN Historical background of IUCN; RED Data Book, IUCN Red List, IUCN Red List categories. Detailed study of IUCN criteria and assessment process. Supporting information for Red List assessments. National Red Lists UNEP and WWF; NBPGR, Kerala State Biodiversity Board (KSBB), National Biodiversity Authority (NBA); PBR.	22
Module III	*In-situ* conservation: Assessment of adequate areas, design and management of protected areas; problems in protected areas of India, connectivity and corridors, sustainable use of biodiversity, conservation and society, conservation networks. Biosphere reserves, National parks, Sanctuaries, Sacred grooves, wetlands and mangroves. *Ex-situ* conservation: Facilities, establishment of new populations, captive breeding, reintroduction, discussion of advantages and disadvantages. Concept of germplasm preservation and gene banks. Botanical gardens, field gene banks, seed banks, cryo-banks, pollen banks, culture-collections.	12
Module IV (Self-Study)	Concepts of Conservation: *Ex situ* and *in situ*; Major conservation methods. Major Biosphere Reserves, National parks and Wildlife sanctuaries of India. World Heritage centres of India. Geotagged species of India. Case studies on Impact Ecological /conservation activities.	8

PRACTICAL (36 Hours)

1. Assessment of species listed in IUCN categories and their present distribution.
2. Conservation of red listed species by raising seedlings and planting in the field.
3. Visit a nearby forest area/sacred grove/laterite/wetland ecosystem and identify IUCN red listed species.
4. Assessment of species distribution, their density and abundance using quadrats, line transects or waypoints.
5. Visit a seed bank or gene bank and record the methods of conservation followed.

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Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2		2					3					
CO2	3				3				1			3		
CO3	3		2											
CO4	3		2		1									
CO5	3	3	3		1	3					3	3	3	
CO6	3	3	3		1	3	3	2		2	3	3	3	

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics

	Quiz / Discussion / Seminar	Internal Theory / Practical Exam.	Assignment / Viva	End Semester Exam.
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3		✓	✓	✓
CO 4		✓	✓	
CO 5	✓		✓	
CO 6	✓	✓	✓	✓

Semester IV

MSPSB04C15 STRUCTURAL BIOINFORMATICS

Course Code	MSPSB04C15			
Course	STRUCTURAL BIOINFORMATICS			
Type of Course	Core Course			
Semester	IV			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	4	3	72 + 54 = 126
Pre-requisites	Basic knowledge in bioinformatics.			
Course summary	Students will be introduced to the world of languages, sequencing methods and structure prediction methods used in bioinformatics. Course will help to comprehend the different aspects of structural bioinformatics at an advanced level. Applications of these tools in human life also will be discussed during the theory session. During the experiential learning sessions, a hands-on training will be given to the students on various tools used in structural bioinformatics.			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

COs	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Basic understanding of various terms related to bioinformatics, especially to structural bioinformatics.	R, U	F	Quiz
CO2	Understanding of various steps in the use of languages and programmes related to bioinformatics.	U	C, P	Test paper
CO3	Application of the knowledge on various types of structural bioinformatic tools during experiential learning sessions.	Ap, An	C, P	Practical examination
CO4	Enthusiasm to develop various methods for structural biology.	C	M	Viva Voce, Group discussion
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	**Introduction to Structural Bioinformatics, Programming Languages and AI:** Overview of Structural Bioinformatics: Definition, scope, and significance. Importance of biomolecular sequences in structural bioinformatics. Applications in drug design, protein engineering, systems biology, and functional annotation. Programming and Scripting Languages: Compiled languages: C, C++, Java. Scripting languages: Python, Perl. Statistical and analytical languages: R, MATLAB, Octave. Fundamentals of Artificial Intelligence: Types of AI (narrow AI, general AI), Basic AI	15

	workflow, Overview of machine learning, deep learning, and neural networks.	
Module II	**Structural Determination Methods and Prediction Approaches:** Protein Structure Fundamentals: Ramachandran plot and conformational analysis. Bond lengths, bond angles, torsion angles. B-factors, active sites, and binding pocket identification. X-ray Crystallography: Components of crystallographic experiments. Data collection, structure solution, refinement, and validation. Crystal systems, Bragg's law, diffraction principles. Structure factor, atomic scattering factor. Fundamentals of crystallisation. Spectroscopic Approaches to Structure Determination: NMR spectroscopy. Shielding constants, chemical shift, multidimensional NMR, applications in protein structure. Structural insights from UV–Visible, IR, and other spectroscopic techniques. Cryo-Electron Microscopy. Basic principles. Image acquisition and 3D reconstruction. Structure Prediction Methods: Chou–Fasman method. GOR method. Ab initio prediction methods. Accuracy measurements: Q3, RMSD-based evaluation. Homology modelling: principles, templates, modelling steps, validation.	20
Module III	**Tools in Structural Bioinformatics**: Molecular Dynamics (MD): Force fields (e.g., CHARMM, AMBER, GROMACS). Energy minimization, solvation models. Trajectory analysis and structural evaluation. Stability checks (RMSF, Rg, H-bonds, SASA). Structural Prediction Concepts: TM-score, and structure superposition. Inferring protein function from three-dimensional structure. Applications: functional annotation, domain prediction. Scoring Matrices and Sequence Comparison: Concepts of scoring matrices. PAM and BLOSUM series. Distance vs. similarity matrices. Structure formats: PDB, mmCIF, DSN6. Format conversion tools: Open Babel, PDB2PQR. Structure Prediction and Molecular Docking: Structure prediction workflows. Docking methodology: preparation, docking algorithms, scoring and post-processing. Visualization Tools: Swiss-PDB Viewer (SPDBV), VMD, PyMol, ChimeraX, NGL. Brief account on AI Tools in Structural Bioinformatics: DeepAccNet, AlphaFold2, AlphaFold-Multimer, ProteinMPNN, AI-driven molecular docking and drug design: DiffDock, GNINA (CNN-based docking), Generative models for ligand design, QSAR using ML/DL.	25
Module IV (Self- Study)	**General introduction to biological data and Bioinformatics Databases: Major Structural and Sequence Databases:** PDB, RCSB. SCOP, CATH. PDBsum, MMDB. UniProt. **Sequence and Structural Data Formats: Sequence formats:** GCG, MSF, NBRF-PIR, ALN/ClustalW2, FASTA. **Taxonomy and Phylogeny:** Nature of data used in phylogenetic inference. Phylogenetic trees and dendrograms: Types, construction, interpretation, and significance. **Sequence Similarity and Evolutionary Relationships:** Concepts of similarity, identity, and homology. Homologous sequence types: paralogues, orthologues, xenologues.	12

PRACTICAL (54 Hours)

1. Retrieve nucleotide sequences from NCBI/PDB.
2. Retrieve protein sequence from protein database.
3. Similarity search using BLAST.
4. Multiple sequence alignment using Muscle, T-Coffee and CLUSTAL-W.

5. Secondary structure prediction of proteins.
6. PDB structure retrieval and molecular visualization.
7. Restriction mapping.
8. Construct a Phylogenetic tree by PHYLIP/MEGA.
9. Prediction and annotation of protein functions using AI tools

References

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Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3								1		3			3
CO2	3	2			2					2	3		3	3
CO3	3	3	3		2	3	2			2	3		3	3
CO4	3		2	2			2	3			3		1	3

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics

	Quiz / Discussion / Seminar	Internal Theory / Practical Exam.	Assignment / Viva	End Semester Exam.
CO 1	✓			
CO 2		✓		✓
CO 3		✓		✓
CO 4	✓		✓	

MSPSB04E01 MICROBIOME AND METAGENOMICS

Course Code	MSPSB04E01			
Course	MICROBIOME AND METAGENOMICS			
Type of Course	Elective Course			
Semester	IV			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	4	2	72 + 36 = 108
Pre-requisites	Knowledge in microbiology and molecular biology.			
Course summary	This course covers the concept of microbiome and its implications and different microbiomes and their functions and significance in human health.			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Understand the concept of microbiome.	U	F	Quiz
CO2	Understand the implications and functions of different microbiomes.	U	F	Quiz, Unit test
CO3	Create awareness on human microbiome and their impact on human health.	U	F	Assignment, Unit test
CO4	Understand genomes and metagenomes and their significance.	U	F	Assignment, Practical Exam
CO5	Attain skill in various techniques related microbiomes and metagenomics.	Ap	P	Assignment, Practical Exam
CO6	Apply the knowledge of metagenomics on human life.	Ap	P	Assignment, Practical Exam, Unit test
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	**Techniques in microbiome research:** DNA sequencing technologies, 16S rRNA gene sequencing, Shotgun metagenomics, Bioinformatics in microbiome analysis. Human Microbiome: Composition and diversity of the human microbiome, microbiome-host interactions, role of the microbiome in health and disease, Gut-brain axis and other microbiome-related phenomena.	12
Module II	**Environmental microbiomes:** Microbiomes in soil, water and air.	22

	Extremophiles and their adaptations; impact of environmental microbiomes on ecosystems. Microbiome and disease; microbiome dysbiosis in various diseases, infectious diseases and the microbiome, therapeutic interventions targeting the microbiome.	
Module III	**Metagenomics applications**: Functional metagenomics, comparative metagenomics, metatranscriptomics and metaproteomics, single-cell genomics in microbiome research. Basic techniques for metagenomics study: gene sequencing and single-cell analyses and identification of genes. Applications of metagenomics: Human microbiome, bio-prospecting novel genes, industrial bioproducts and bioremediation. Biosafety and IPR issues in metagenomics. Ethics and challenges in microbiome research: Ethical considerations in microbiome studies, challenges in sample collection and data interpretation, future directions and emerging trends in the field.	28
Module IV (Self-Study)	Overview of microbiome and metagenomics, importance of microbiome in health and disease. Factors influencing microbial diversity. Plant microbiome. Principles of microbial ecology; types of microbial interactions, microbial niches and habitats; host-microbe interactions. Earth microbiome project.	10

PRACTICAL (36 Hours)

1. Isolation of DNA from Environmental samples (soil microbes) or microbes (culture dependent or independent).
2. Amplification of 16SrDNA/ITS/ Universal gene and sequence analysis.
3. Comparative analysis of amplicon sequences and phylogenetic analysis.
4. Analysis of metagenomes: A practical introduction to bioinformatic tools for metagenome analysis (eg: DOTUR, MGRAST, DMAP, FMAP, QIIME, MOTHUR).

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Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3								3					1
CO2	3											2		
CO3	3		3		3			2	3			3		
CO4	3	2							1	2				3
CO5	3	3	3			3				3	3		3	3
CO6	3	3		1	2	3	2			3	3	3	3	3

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics

	Quiz Discussion/ Seminar	Internal Theory/ Practical Exam.	Assignment / Viva	End Semester Exam
CO 1	✓			
CO 2	✓	✓		✓
CO 3	✓	✓	✓	✓
CO 4		✓	✓	
CO 5		✓	✓	✓
CO 6		✓	✓	✓

MSPSB04E02 ADVANCED BIOINFORMATICS

Course Code	MSPSB04E02			
Course	ADVANCED BIOINFORMATICS			
Type of Course	Elective Course			
Semester	IV			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	4	2	72 + 36 = 108
Pre-requisites	Detailed knowledge in molecular biology and basics of information technology.			
Course summary	The course aims to develop knowledge in the advanced fields of bioinformatics and its recent developments; structure prediction and application of the data derived from bioinformatics.			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Develop knowledge in the fundamentals of bioinformatics and its recent developments	U	F	Quiz, Assignments
CO2	Understand the theoretical knowledge on various resources of bioinformatics	U	F	Quiz, Unit test
CO3	Knowledge on programme languages in bioinformatics, sequence analysis and phylogeny of various groups of organisms	U	F	Assignment, Unit test
CO4	Develop updated knowledge about recent advances in structure prediction and bioinformatics tools used for structure prediction and to interrelate bioinformatics with other branches of biology	U	F	Assignment, Seminar
CO5	Application of various tools for phylogenetic analysis.	Ap	P	Assignment, Practical Exam
CO6	Apply the data derived from bioinformatics.	Ap	P	Assignment, Practical Exam, Unit test
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	**Introduction to Bioinformatics:** types of data; concept of databases in Bioinformatics. Common Languages in Bioinformatics: PERL, C++ and Python. Python data types, Python variables, Operators, Lists in Python, Operations, Methods, Parameters, Iterators, Generators, Comprehensions and Expressions. Tuples, Python Dictionaries and Sets.	22
Module II	**Basics in sequence analysis:** Basic concept of sequence similarity, identity and homology; definition of homologous, paralogous, orthologous and xenologous sequences. Various file formats for Bio-molecular Sequences: GenBank, FASTA, GCG, MS, NBRF-PIR, ALN/ClustalW2. Scoring matrices: Basic concept of scoring matrix, matrices for nucleic acid and protein sequences, PAM and BLOSOM series, principles based on which these matrices are derived. Differences between distance and similarity matrix. Sequence based database search: Tools and techniques used in sequence analysis. Pairwise and Multiple Sequence Alignments. Tools for local, global and MSA: Muscle, T-Coffee, and Clustal-W. Basic concept of sequence alignment: Algorithms - Needleman and Wunch, Smith waterman. Sequence analysis of nucleic acid and protein sequences and interpretation of the results. Applications of sequence analysis. Phylogenetic analysis by PHYLIP, MEGA. Nature of data used in Taxonomy and Phylogeny, description of phylogenetic trees and types of dendrograms. Analysis, interpretation and significance of dendrograms. Transcriptomics: transcriptome analysis: micro-arrays and NGS-RNA seq.	25
Module III	**Basic principles and methods used for structure prediction:** Wave properties. X-ray crystallography: Basic principle-s, X-rays, crystal systems, Bragg's law, diffraction of crystals, structure factor, atomic scattering factor, crystallisation. Components and applications of X-ray crystallography in Bioinformatics: Data collection, structure solution and refinement, structure validation. Spectroscopic methods for structure determination. NMR spectroscopy: shielding constant, chemical shift, application of NMR in protein structure determination. Structural information from UV, Visible, IR spectroscopy, Cryo-electron microscopy.	15
Module IV (Self Study)	**Methods and tools used in structure prediction and visualisation:** Methods in structure prediction: Chou-fasman method, GOR method, *Ab initio* method and measuring the accuracy of predictions using Q3, homology modelling, different steps in homology modelling. Structure visualisation tools: Rasmol, SPDBV, WEBMOL, Cn3D, VMD, molmol, chime.	10

PRACTICAL (36 Hours)

1. Retrieve nucleotide sequences from NCBI.
2. Retrieve protein sequence from protein database.
3. Similarity search using BLAST.
4. Multiple sequence alignment using Muscle, T-Coffee and CLUSTAL-W.
5. Secondary structure prediction of proteins.
6. PDB structure retrieval and molecular visualisation.
7. Restriction mapping
8. Construct a Phylogenetic tree by PHYLIP/MEGA.

References

Attwood, T.K. & Parry-Smith, D.J. (2003). *Introduction to bioinformatics*. Prentice Hall.

Baldi, P. & Hatfield, G.W. (2011). *DNA microarrays and gene expression: From experiments to data analysis and modeling*. Cambridge University Press.

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Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	1									1		2	3
CO2	3	1				1					1		2	3
CO3	3	2						2			2		2	3
CO4	3	3			2	3					2		2	3
CO5	3	3	3								3		3	3
CO6	3	3	3	2	3	3	2				3		3	3

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics

	Quiz / Discussion / Seminar	Internal Theory / Practical Exam.	Assignment / Viva	End Semester Exam.
CO 1	✓		✓	
CO 2	✓	✓		
CO 3	✓		✓	
CO 4		✓	✓	✓
CO 5		✓	✓	✓
CO 6		✓	✓	✓

MSPSB04E03 SPECTROSCOPY AND PROTEIN STRUCTURE PREDICTION

Course Code	MSPSB04E03			
Course	SPECTROSCOPY AND PROTEIN STRUCTURE PREDICTION			
Type of Course	Elective Course			
Semester	IV			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	4	2	72 + 36 = 108
Pre-requisites	Detailed knowledge of molecular biology and a basic idea of the principles of physics.			
Course summary	The course analyses the principles and application of spectroscopy in studying and predicting the structure of macromolecules.			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Familiarise the principles, procedures and applications of spectroscopy.	Ap	P	Quiz, Unit test
CO2	Analyse the primary, secondary, tertiary, and quaternary structures of proteins and their functions	U	F	Quiz, Unit test, Assignment
CO3	Explore protein engineering and design methods for various biotechnological and medical purposes	Ap	P	Assignment, Unit test
CO4	Compare and contrast biological and recombinant protein synthesis processes	An	P	Assignment, Practical Exam
CO5	Utilise molecular graphics for the analysis of protein structure	Ap	P	Assignment, Practical Exam
CO6	Explore protein bioinformatics tools and methods for sequence and structural analysis.	Ap	P	Assignment, Practical Exam, Unit test
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	**Introduction to Spectroscopy:** basic principles of spectroscopy, electromagnetic spectrum and its significance, interaction of light with matter: absorption, emission and scattering. Types of spectroscopies and their applications. Introduction to UV-Visible Spectroscopy, Beer-Lambert Law and its applications, instrumentation, applications in chemistry, biology, and environmental science. Introduction to IR spectroscopy, vibrational transitions and molecular vibrations, modes of vibration and selection rules, instrumentation and sample preparation,	28

	interpretation of IR spectra and applications. Introduction to Nuclear Magnetic Resonance (NMR) spectroscopy, nuclear spin and magnetic resonance, chemical shift, coupling and relaxation, NMR instrumentation and data interpretation, applications in organic and inorganic chemistry, biochemistry, and medicine. Other spectroscopic techniques (brief account only): Fluorescence spectroscopy, Raman spectroscopy, X-ray spectroscopy and Mass spectrometry.	
Module II	**Introduction to Protein Structure:** Protein structure hierarchy, amino acids, peptide bonds, protein function and structure-function relationships. Protein folding: Primary, secondary, tertiary and quaternary protein structures, thermodynamics of protein folding, secondary structure elements (α-helix, β-sheet), forces stabilising protein structures, chaperone proteins and their role in protein folding.	12
Module III	**Structural databases and tools:** PDB (Protein Data Bank) and other structural databases, Software tools for protein structure analysis, visualisation and analysis of protein structures. Protein structure prediction: Homology modelling, Ab initio protein structure prediction, CASP (Critical Assessment of Structure Prediction). Analysis of protein structure using molecular graphics. Introduction to databases for protein sequences, structures and functions. Protein bioinformatics tools and methods. Protein sequence databases: Uniprot-KB: SWISS-PROT, TrEMBL, PIR-PSD, Protein-Protein interaction database: STRING.	16
Module IV (Self-Study)	Enzyme structure and catalysis, protein-ligand interactions, signalling proteins and their role in cell communications, structural basis of membrane proteins. Protein structure in drug discovery: drug design and target identification, antibody engineering, protein engineering and design. Recent advances and emerging trends: Recent breakthroughs in protein structure determination, structural genomics and proteomics, emerging technologies and biotechnological applications of protein structure. Use of proteins in biotechnological, medical research and development. Importance of proteins in the development of different types of drugs. Antibody engineering, Protein engineering and design.	16

PRACTICAL (36 Hours)

1. Exploring NCBI and UniProt databases.
2. Software for viewing protein structures.
3. Protein Phylogenetic analysis using software tools.
4. Exploring protein interactions using STRING.

References

Branden, C. I. & Tooze, J. (2012). *Introduction to protein structure*. Garland Science.

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Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3									1				3
CO2	3	3	2		1					1			2	3
CO3	3	3	2		3	2				3	2		3	3
CO4	3	1	3							2			1	3
CO5	3	3	3		2	3				3	3		3	3
CO6	3	3	3		2	3	2	1		3	3		3	3

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics

	Quiz / Discussion / Seminar	Internal Theory / Practical Exam.	Assignment / Viva	End Semester Exam.
CO 1	✓	✓		✓
CO 2	✓	✓	✓	✓
CO 3		✓	✓	✓
CO 4		✓	✓	
CO 5		✓	✓	✓
CO 6		✓	✓	✓

MSPSB04E04 PROGRAMMING FOR BIOINFORMATICS

Course Code	MSPSB04E04			
Course	PROGRAMMING FOR BIOINFORMATICS			
Type of Course	Elective Course			
Semester	4			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	4	2	72 + 36 = 108
Pre-requisites	Basic knowledge in Informatics, Programming and Bioinformatics			
Course summary	This course deals with programming required for bioinformatics. In this course, a preliminary knowledge-both theoretically and practically, on programming languages used in bioinformatics are given. A depth knowledge on programmes such as HTML, SQL, PERL and C is also envisaged by this course.			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Basic understanding of various terms related to programming for bioinformatics	R, U	F	Quiz
CO2	Understanding of various steps in the use of languages and programmes related to bioinformatics.	U	C, P	Test paper
CO3	Application of the knowledge on various types of languages and programmes during experiential learning sessions.	Ap, An	C, P	Practical examination
CO4	Enthusiasm to develop and use more programmes and languages in bioinformatics	C	M	Viva Voce, Group discussion
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	Common programming languages used in Bioinformatics and their specific uses in Bioinformatics. **HTML (HyperText Markup Language):** Overview of HTML and its role in web development. Basic structure of an HTML document (tags, elements, attributes). Text formatting and basic styling with HTML. Creating forms for user input in bioinformatics applications. Different input types (text fields, checkboxes, radio buttons, etc.). Semantic Elements for structuring content. Creating Tables and Lists. Creating Hyperlinks and Anchors. Embedding images and multimedia content (videos, audio files) in HTML pages. The method of computer	18

	programming using HTML and its application in Bioinformatics.	
Module II	**SQL:** Overview of SQL and its role in managing relational databases. SQL syntax- Select, Insert, Update, Delete. SQL commands – alter, create, drop, update, delete, order by, distinct, rename, inbuilt functions. RDBMS platforms commonly used in bioinformatics -MySQL, PostgreSQL. SQL constraints - check unique not null, default, primary key, foreign key. Introduction to index and types of index. The method of computer programming using SQL and its application in Bioinformatics.	12
Module III	**General Account on Languages:** uses of Python, PERL, R, C/C++, Java, Julia, MATLAB and Bash (Shell scripting) in bioinformatics. **PERL - General Introduction**: PERL's benefits. Installing Perl and basic setup.Writing and executing Perl scripts. Variables, data types, and operators. Control structures (if-else, loops). Arrays and hashes (associative arrays). Subroutines and modules. **Text processing in PERL:** Regular expressions in Perl; File handling (reading and writing files); Parsing file formats commonly used in bioinformatics (e.g., FASTA, GenBank). **Bioinformatics Applications:** Sequence analysis- DNA sequence manipulation (e.g., reverse complement, translation); Sequence alignment algorithms (e.g., pairwise alignment); Data extraction and manipulation from biological databases (e.g., NCBI). **C LANGUAGE - Basic Concepts:** Overview of C/C++ programming languages; History and relevance of C/C++ in bioinformatics; Setting up development environments (IDEs, compilers). Variables, data types, and operators; Control structures (if-else, loops, switch-case); Arrays, strings, and pointers. **Functions and Modular Programming:** Writing and using functions; Header files and function prototypes; Modular programming practices in C/C++. Reading from and writing to files; Handling different file formats in bioinformatics (e.g., FASTA, GenBank); Implementing data structures (e.g., arrays, linked lists, trees); Basic algorithms (e.g., sorting, searching); Algorithmic complexity and efficiency considerations. **Applications of C language in Bioinformatics**: Sequence analysis; Implementing sequence alignment algorithms (e.g., pairwise alignment, dynamic programming); DNA sequence manipulation (e.g., reverse complement, translation).	28
Module IV (Self-Study)	**BASICS IN PROGRAMMING**: Definition and steps involved in problem solving. Definition of problem, algorithm, charts, definition, symbol, running and debugging and computer languages. Computer basics – Components of Computers, Generations of Computers, Types of Softwares used in Computers- Types of Computer Languages - Low, Assembly, High level, Compiler and Interpreter. Operating systems – Definitions, GUI (graphical user interface) – Unix - Linux – basics and commands. Biological Databases – Uses and significance in Health care, medicine and agriculture.	14

PRACTICAL (36 Hours)

1. Sequence analysis using programming languages.
2. Develop programmes for sequence analysis and diversity studies.
3. Database creation and utilisation using the programmes

References

Mount D. W. (2004). *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor Laboratory Press, U.S.A.

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Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3													3
CO2	3	1								1				3
CO3	3	3	3		1	3					3		3	3
CO4	3						2	2						3

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics

	Quiz / Discussion / Seminar	Internal Theory / Practical Exam.	Assignment / Viva	End Semester Exam.
CO 1	✓			
CO 2		✓		✓
CO 3		✓		✓
CO 4	✓			

MSPSB04E05 REMOTE SENSING, GIS AND ECOSYSTEM MODELLING

Course Code	MSPSB04E05			
Course	REMOTE SENSING, GIS AND ECOSYSTEM MODELLING			
Type of Course	Elective Course			
Semester	IV Semester			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	4	2	72 + 36 = 108
Pre-requisites	Knowledge in the basic principles of physics, environmental science and skill in information technology.			
Course summary	The course provides the principles of Remote Sensing, GIS, web GIS, mobile GIS and various applications of these technologies.			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Understand the basic principles of Remote Sensing and various techniques used in it.	U	C	Quiz, Unit test
CO2	Familiarise the energy sources, various platforms and sensing units used for Remote Sensing.	U	C	Quiz, Unit test, Assignment
CO3	Acquainted with the latest technologies in GIS and GPS.	U	C	Assignment, Unit test
CO4	Able to apply the technologies in GIS and GPS in various fields.	Ap	P	Assignment, Unit test
CO5	Understand the basics of webGIS, mobile GIS and their applications.	Ap	P	Assignment, Practical Exam
CO6	Acquire skill in ecosystem modelling utilising latest technologies in IT, remote sensing, GIS and GPS.	An	M	Assignment, Practical Exam, Unit test
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge (F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	**Remote Sensing:** History and development, definition, concept and principles in Remote Sensing. Energy resources, radiation principles, EM Radiation and EM Spectrum. Stages of Remote Sensing; data acquisition; process of Remote Sensing data analysis. Types of Remote Sensing: active and passive remote sensing. Platforms used in Remote Sensing:	25

	Flight platforms - space, satellites, space station, high-altitude, (balloons; aircraft-fixed wing, copters, drones, fixed wing, VTOL); terrestrial. Satellites and their characteristics: geostationary and sun-synchronous. Earth Resources Satellite: LANDSAT, SPOT, IRS, IKONOS satellite series. Sensors: types and their characteristics. Concept of resolution: spatial, spectral, temporal, radiometric. Basic principles, types, steps and elements of image interpretation. Instruments for visual interpretation. Advantages and limitations of Remote Sensing.	
Module II	**GIS and Earth's Positioning System:** Introduction to GIS; components of GIS; recent trends and applications of GIS; data structure and formats. Data management using MS-Excel, SQL. Spatial data models: Raster and vector. Database design; editing and topology creation in GIS, linkage between spatial and non-spatial data; data inputting in GIS. Rectification, transformation methods; Root Mean Square (RMS) Error. Concepts and principles of Web GIS; definition and history of Web GIS; significance of Web GIS. Concepts and principles of GIS model, types of GIS models, modelling process. Application of GIS Modelling. Mobile GIS: Characteristics of mobile GIS; benefits of mobile GIS. Introduction to Navigation and Positioning; Objectives, types of Earth's, Positioning System and comparative account: GPS, GALILEO, GLONASS and GAGAN.	22
Module III	**Ecosystem Modelling:** History, context and key concepts of ecosystem modelling. Differences between models and modelling activities. Ecosystem Modelling: principles, methods and tools to define, parameterize, evaluate and apply models and the visualization and interpretation of their results. Model classification: deterministic models, stochastic models, steady state models, dynamic models. Different stages involved in model building. Ecosystem stability, cybernetics and ecosystem regulation. Ecoinformatics: a brief account and scope in environmental analysis. General account of major ecosystem models. Applications of ecosystem modelling in research, administration and in other sectors.	15
Module IV (Self-Study)	**Applications:** Major applications of Remote Sensing: in conservation biology, human presence monitoring, plant health, fire dynamics, terrain analysis, pollution detection and monitoring, Ocean Colour Applications. Applications of GPS in route navigation, forestry and natural resources, GPS tracking, utility, mapping. Applications of GIS, web GIS, mobile GIS and GIS modelling in biological studies. Applications of Environmental informatics and importance of taxonomy in environmental informatics.	10

PRACTICAL (36 Hours)

1. Map/classify vegetation based on aerial imagery.
2. Prepare local land use maps using aerial imagery/GIS tools, and verify with land survey.
3. Visit A laboratory undertaking activities involving remote sensing and GIS, and submit a report.
4. Internship/training in remote sensing/GIS, Agroinformatics, Environmental informatics, Ecosystem modelling.

References

Bolstad, P. (2008). *GIS fundamentals, a first text on geographic information systems* (3rd ed.). Eider Press.

Burrough, P.A. & McDonnell, R.A. (2000). *Principles of geographical information systems*. Oxford University Press.

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Gunther, O. (2001). *Environmental information systems*. Springer.

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Jorgensen, S.E. & Bendoricchio, G. (2001). *Fundamentals of ecological modelling* (Chapter 1). Elsevier.

Joshi, P.K., Pani, P., Mohapartra, S.N. & Singh, T.P. (Eds.). (2010). *Geoinformatics for natural resource management*. Nova Publishers.

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Ormsby, T., Napoleon, E., Burke, R., Groessl, C. & Bowden, L. (2010). *Getting to know ArcGIS desktop*. Esri Press.

Smith, J. & Smith, P. (2007). *Introduction to environmental modelling*. Oxford University Press.

Srivastava, P., Pandey, P.C., Kumar, P., Raghubansi, A.S. & Han D. (2015). *Geospatial technology for water resource development*. CRC Press, Taylor and Francis.

Steede-Terry, K. (2002). *Integrating GIS and the global positioning system*. ESRI.

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3											1		
CO2	3											2		
CO3	3	2				2						3	2	
CO4	3	2	2		1	3						3	3	
CO5	3	2	2		1	3	2					3	3	
CO6	3	3	3			3	2	1				3	3	

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics

	Quiz / Discussion / Seminar	Internal Theory / Practical Exam.	Assignment / Viva	End Semester Exam.
CO 1	✓	✓		✓
CO 2	✓	✓	✓	✓
CO 3		✓	✓	✓
CO 4		✓	✓	
CO 5		✓	✓	✓
CO 6		✓	✓	✓

MSPSB04E06 WETLAND ECOLOGY

Course Code	MSPSB04E06			
Course	WETLAND ECOLOGY			
Type of Course	Elective Course			
Semester	IV			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	4	2	72 + 36 = 108
Pre-requisites	Knowledge in the principles of environmental science and plant taxonomy.			
Course summary	The course covers the concepts and components of wetlands and their significance, various threats faced by them and strategies for their conservation.			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Understand the concept and components of wetlands.	U	C	Quiz, Unit test
CO2	Analyse the significance of wetland ecosystems.	U	C	Quiz, Assignment
CO3	Classify the types of wetland ecosystems and identify the ecological significance and biodiversity components of each type.	An	M	Assignment, Unit test
CO4	Familiarise the ecology, biodiversity and ecosystem values and services of mangrove ecosystems.	U	C	Assignment, Discussion
CO5	Identify various threats faced by the wetland ecosystems.	An	C	Assignment, Seminar
CO6	Suggest strategies and protocols for the conservation of wetland ecosystems.	An	P	Assignment, Practical Exam, Unit test
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	**Wetlands:** Introduction to wetlands: Definition and classification of wetlands (hydrological, vegetative, geographical, functional and global classification). Freshwater and coastal wetlands: an overview; global distribution with special reference to Kerala and its importance. Wetland vegetation: vegetation dynamics and succession. Wetland plant communities and associated fauna.	16
Module II	**Mangrove Ecology:** Mangrove biology and adaptations: Importance of mangroves in coastal ecosystems; types of mangrove vegetation;	20

	morphology and anatomy of mangrove plants. Physiological adaptations to saline environments. Reproduction and dispersal mechanisms. Major species of mangroves in India and their status. Ecological and physiological function of mangroves: carbon sequestration and blue carbon storage, productivity; coastal protection and erosion control. Nursery habitat for marine species.	
Module III	**Conservation Practices:** Mangrove restoration practices: Role of NGOs and Government in conservation; international efforts in conservation; conservation status and legal frameworks. Restoration techniques and case studies. Community-based conservation initiatives; mangrove nurseries and planting techniques. Conservation efforts by Kallen Pokkudan and Dr. Kathiresan. Traditional farming systems in the mangrove ecosystem (Kaipad, Pokkali) and their significance. Traditional rice varieties and hybrid varieties developed to promote saline paddy cultivation.	18
Module IV (Self Study)	**Wetland Biodiversity:** Wetland associated algae and fungi; marine and freshwater (mangrove and paddy field) ferns and bryophytes; aquatic angiosperms. Field and laboratory techniques, adaptations, ecology, physiology, applications; role in biodegradation and biotechnology. Invasive plant species and their impacts on the wetland ecosystem. Reasons for loss of biodiversity in wetlands. Anthropogenic threats to wetlands; deforestation and land conversion. Pollution and habitat degradation. Climate change and sea-level rise.	18

PRACTICAL (36 Hours)

1. Estimation of water quality parameters of selected ecosystems:
    a. pH
    b. Acidity
    c. Alkalinity
    d. Hardness
    e. Macro and micro nutrients
    f. Total solids, dissolved solids and suspended solids.
    g. Turbidity
    h. Electrical conductivity
    i. Dissolved oxygen
2. Estimation of primary productivity of an aquatic ecosystem.
3. Estimation of selected pollutants and microbiological parameters of an aquatic ecosystem.
4. Study of the plant diversity of an aquatic ecosystem.

References

Herrera-Silveira, J.E.R. & Rivera-Monroy, V.H. (Year unknown). *Nutrient cycling in mangrove forests*.

Jayakumar, M., Balachandran, S. & Varghese, K.P. (Year unknown). *Wetland ecosystems in Kerala: Status, threats, and conservation*.

Mitsch, W.J. & Bernal, B. (2012). *Ecosystem ecology of wetlands: Concepts and applications*.

Mitsch, W.J., & Gosselink, J.G. (2015). *Wetlands* (5th ed.). John Wiley & Sons.

Richardson, C.J. & Vepraskas, M.J. (2017). *Wetland soils: Genesis, hydrology, landscapes, and classification* (2nd ed.).

Saintilan, N., Wilson, S.C. & Rogers, K.A. (Year unknown). *Methods for soil and plant analysis in mangrove ecosystems*.

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3								3			2		
CO2	3	1	2							2		3		
CO3	3		2			1						3	2	
CO4	3									3		3	2	
CO5	3	1	2		2	2				2		3	2	
CO6	3	1	3		2	3	2	2		2		3	3	

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics

	Quiz / Discussion / Seminar	Internal Theory / Practical Exam.	Assignment / Viva	End Semester Exam.
CO 1	✓	✓		✓
CO 2	✓		✓	
CO 3		✓	✓	✓
CO 4	✓		✓	
CO 5	✓		✓	
CO 6		✓	✓	✓

MSPSB04E07 HORTICULTURE AND MUSHROOM CULTIVATION

Course Code	MSPSB04E07			
Course	HORTICULTURE AND MUSHROOM CULTIVATION			
Type of Course	Elective Course			
Semester	IV			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	4	2	72 + 36 = 108
Pre-requisites	Basic knowledge in agricultural practices and fungi			
Course summary	This specialisation course will give an overall idea on Horticulture and mushroom cultivation through theoretical and practical sessions. This course enables the student to practice horticulture and mushroom cultivation.			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Basic understanding of various terms related to horticulture and mushroom cultivation.	R, U	F	Quiz
CO2	Understanding of various steps in horticulture and mushroom cultivation.	U	C, P	Test paper
CO3	Application of the knowledge on various types of structural methods of horticulture and mushroom cultivation during experiential learning sessions.	Ap, An	C, P	Practical examination
CO4	Enthusiasm to develop new innovation in the field of horticulture and mushroom cultivation.	C	M	Viva Voce, Group discussion
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	**GENERAL INTRODUCTION TO HORTICULTURE:** Methods of propagation of horticultural crops: Introduction, principles and classification of plant propagation methods. Definition, types, factors affecting, merits and demerits of seed propagation and vegetative propagation – cutting, layering, grafting and budding. Assessment of various factors required for plant growth and development: Nutritional requirements based on soil, tissue analysis, and field experiments; Identification of deficiency symptoms of various nutrients and methods of nutrient application. Fertilisers – Biofertilizer, Green manure, NPK, Compost – Vermicompost. Assessment of irrigation	18

	requirements for different horticultural crops and different methods of irrigation. Cultural practices - Need of spacing, pruning, thinning and training, trimming their objectives and methods at different stages of development.	
Module II	Method of production and cultivation: System of cultivation and planting systems - weed, water and fertiliser management, Plant protection, harvesting and its management, grading and packaging. Production technology of high value vegetables like Bitter gourd, *Capsicum*, *Pea* and flowers viz. Rose, Carnation, Gerbera, *Lilium*, *Chrysanthemum*. Precision farming. Organic farming. Smart farming- use of IoT, robotics, AI and Drones in Horticulture.	12
Module III	**MUSHROOM CULTIVATION:** Biology, cultivation, harvesting and packaging of Mushrooms: Button, Straw and Oyster – with general morphology, distinguishing characteristics, spore germination and life cycle. Nutrient Profile of Mushroom - carbohydrates, proteins, fats, vitamins & minerals. Calorific value. Health benefits of Mushroom: Antiviral value, antibacterial effect, antifungal effect, anti-tumour effect, haematological value cardiovascular & renal effect, in therapeutic diets. Types of Constraints in Mushroom Cultivation. Mushroom Diseases and Control measures. Value addition of Mushrooms.	15
Module IV (Self-Study)	Horticulture: Concept, history, nature and scope of horticulture; importance of horticulture in terms of economy, production and employment generation. Indian horticulture institutions. Different branches of horticulture, pomology, olericulture, spices and planting, ornamental horticulture. Basic requirements — land, water, soil, landscape, propagules, implements and practices — types of garden plants, Plant growing structures – Greenhouse, Glass house and Mist chamber. Factors influencing growth and development- internal- seed dormancy and viability, pollen viability, seed germination, parthenocarpy, fruit growth, fruit drop and fruit ripening and external factors – soil, light, temperature, rainfall, humidity, wind. Mushroom Classification: Based on occurrence - Epigenous & Hypogenous, Natural Habitats -Humicolous, Lignicolous & Coprophilous, Color of spores - white, yellow, pink, purple brown & black, Morphology - fruiting layers exposed to air, fruiting layers not exposed to air, plants with predominantly pitted cap, cap saddled shape & saucer shape, Structure and texture of fruit bodies -gilled fungal & pore fungal, fruit bodies and spores. Different parts of a typical mushroom & variations in mushroom morphology. Key to differentiate Edible from Poisonous mushrooms. Classification - Ainsworth *et al.* (1973).	27

PRACTICAL (36 Hours)

1. Budding – ‘T’ Budding and Patch Budding.
2. Layering – Air Layering, Serpentine Layering.
3. Grafting – Whip grafting, Cleft grafting.
4. Tools and implements used for tillage, seeding, soil management, irrigation, plant care, harvesting, and transport.

5. Analysis of soil texture.
6. Analysis of soil nutrients – N, P, K.
7. Estimation of Soil water and soil moisture content.
8. Determination of soil pH.
9. Measurement of irrigation water.
10. Prepare a report on the practices found in a horticultural farm after a visit.
11. Visit to a mushroom cultivating farm.
12. Training in Mushroom Cultivation.
13. Spawn preparation for Mushroom Cultivation.
14. Packaging Techniques in Mushroom cultivation.

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Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3										3			
CO2	3		1		1	2					3			
CO3	3	1	1		3	3	2				3		2	
CO4	3	1	3		1			3			3		2	

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics

	Quiz / Discussion / Seminar	Internal Theory / Practical Exam.	Assignment / Viva	End Semester Exam.
CO 1	✓			
CO 2		✓		✓
CO 3		✓		✓
CO 4	✓			

MSPSB04E08 ETHNOBOTANY AND BIOPROSPECTING

Course Code	MSPSB04E08			
Course	ETHNOBOTANY AND BIOPROSPECTING			
Type of Course	Elective Course			
Semester	IV			
Course Details	Credit	Lecture/week	Practical/week	Total Hours
	4	4	2	72 + 36 = 108
Pre-requisites	Understanding of biodiversity and knowledge in basic biochemistry.			
Course summary	The course discusses the relationship of plants with man and the traditional knowledge of the indigenous population. Bioprospecting deals with the use of traditional knowledge and biodiversity in quality human life and sustainable development and to develop novel products and services.			

Course Outcomes (COs)

On the successful completion of the course, student will be able to:

CO	CO Statement	Cognitive Level*	Knowledge Category**	Evaluation Tool
CO1	Understand the relationship of plants with man.	U	C	Quiz, Unit test
CO2	Understand the diversity of indigenous population and role of plants in their life	U	C	Quiz, Assignment
CO3	Appraise the value of traditional knowledge and the need of its conservation	Ap	P	Assignment, Unit test, Discussion
CO4	Apply the knowledge of ethnobotany in quality human life and sustainable development and to develop novel products and services by the utilization of traditional knowledge and natural phenomena.	Ap	P	Assignment, Discussion
CO5	Understand the ethical and legal aspects of ethnobotany, traditional knowledge, bioprospecting and intellectual property rights.	An	C	Assignment, Seminar, Discussion
CO6	Document various strategies of bioprospecting, reverse pharmacology, databases used for the welfare of tribes.	E	M	Assignment, Practical Exam, Unit test
* Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)				
** Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus

Module	Content	Hours
Module I	**Ethnobotany:** Definition, significance, scope and categories. Man-plant relationship, history, indigenous uses of plants; local and global food systems, cultural and social aspects of food. A brief account of the tribes of India; tribes of Kerala. Role of ethnobotany in art, craft, ecology, conservation and sustainable development.	10
Module II	**Linkage of ethnobotany with other disciplines:** Archaeology, Anthropology, Agriculture, History, Palaeontology. Indigenous agriculture practices; preservation of seeds and planting materials. Biodiversity conservation by indigenous groups; role of ethnic groups in conservation of plant genetic resources; sacred groves; major sacred groves of northern Kerala, rare habitats and plants; minor forest products, medicinal plants; plants and plant products used in rituals, ceremonies and magico-religious beliefs. Sacred plants; traditional ecological knowledge in agriculture and Conservation; indigenous farming systems. Ethnomedicobotany and ethnopharmacology: folk medicines, plant-derived medicines and their preparation, bioactive compounds; traditional healing practices. Wild food plants, intoxicants, beverages, resins, oils and dyes used by the tribes**.**	28
Module III	Documentation of traditional knowledge: threats to traditional knowledge; Peoples Biodiversity Register. Relevance of ethnobotany in the present context; drug discovery; ethnobotany and biotechnology. Ethical considerations in ethnobotanical studies: legal aspects; intellectual property rights and traditional knowledge; Traditional Knowledge Digital Library Unit (TKDL). Modern approach to ethnobotany: Bioprospecting and commercial use of traditional knowledge; reverse pharmacology; database of ethnomedicinal plants and traditional knowledge (IMPPAT 2.0); Traditional Ecological Knowledge Mapping (TEK).	18
Module IV (Self Study)	**BIOPROSPECTING:** Biodiversity and bioprospecting; economic value of biodiversity; ecosystem products and services. ABS, biopiracy. Definition, concept and practice of bioprospecting; traditional and modern bioprospecting. Types of bioprospecting: Chemical prospecting; Gene prospecting; bionic prospecting. Bioprospecting and conservation. Regulations of bioprospecting. Bioprospecting and sustainable development. Bioprospecting and Biological Diversity Act 2002.	16

PRACTICAL (36 Hours)

1. Conduct a field visit to a major sacred grove of the nearby area and submit a report on its floristic diversity and ecology.

2. Prepare voucher specimens of at least 10 wild plants of ethnobotanical interest.
3. Conduct a field survey to record ethnobotanical/traditional knowledge from the nearby ethnic population, and submit the report.

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Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3													
CO2	3											2		
CO3	3			2	3		1					1	1	
CO4	3	3	3		3	3						2		
CO5	3				3	2						1	3	
CO6	3	3	2		3	2	2	2				2	3	

***Correlation Levels:** - Nil, 1 - Slightly/Low, 2 - Moderate/Medium, 3 - Substantial/High

Assessment Rubrics

	Quiz / Discussion / Seminar	Internal Theory / Practical Exam.	Assignment / Viva	End Semester Exam.
CO 1	✓	✓		✓
CO 2	✓		✓	
CO 3	✓	✓	✓	
CO 4	✓		✓	
CO 5	✓		✓	
CO 6		✓	✓	✓