REGULATIONS, COURSE AND CURRICULUM FOR POST GRADUATE PROGRAMME

IN

M.Sc. BOTANY & PLANT SCIENCE TECHNOLOGY

AS PER THE REVISED CSS REGULATIONS
(2020 Onwards)

Offered by

National Institute of Plant Science Technology (NIPST)
(Inter School Centre)
(*An Institute established for Excellence in Teaching and Research in Plant Science based Eco-technologies)*

MAHATMA GANDHI UNIVERSITY
KOTTAYAM, KERALA – 686 560

National Institute of Plant Science Technology (NIPST)

This will be a unique University Institute enrolling students through competitive examinations at the National level in the campus of Mahatma Gandhi University for advanced education in plant science, promoting research in **Interdisciplinary areas of 'Plants and their Environment Relations'** towards developing '**Plant-based Eco-technologies'.** The Institute will inspire students to apply their creative talents to research potentials of the rich botanical wealth of Kerala in the development of globally significant technologies useful in sustainable agricultural, phyto-medicinal, bio-fuel, bio-based industrial and eco-remediation purposes. Instead of keeping science and technology as watertight compartments in conventional programmes, this institute will enable science students to end up their post graduation to a productive research on plant-based eco-technology and entrepreneurship based on the technology that they develop. Overall, the Institute aims at boosting entrepreneurship in the country through productive research in plant science.

The institute will have advanced instrumental as well as experimental facilities for plant scientists to pursue excellence in all branches of plant science and is expected to contribute to the talent pool of researchers and specialized technicians in plant-based technologies. Technologies to be focused in the programme include those for plant medicines, nutraceuticals, sustainable agriculture, Phytoremediation and all kinds of bio-fuels. In addition to advanced research laboratories for the above-mentioned technologies, the institute will have a medicinal garden, field experimental station, regional herbarium and museum of plant resources of the Western Ghats.

Major goal of this programme is to attract academically bright undergraduate and graduate students at National Level to study and do productive research on the vast plant wealth of the country, and to support entrepreneurship in the field. This centre will help students to study and explore the potential plant wealth of the nation; apply creatively and positively plant science for sustainable economic growth of the nation and becoming a leader of eco-technologies in the world.

Functioning independently under the direction of the Vice Chancellor, the institute envisages high priority research and dynamic academic programmes in the interdisciplinary areas of plant and their environment relations and operates through a single window system to expedite targets on time. The institute will conduct an MSc programme in Botany & Plant Science Technology from the academic year 2016-17 onwards.

The MSc programme in Botany and Plant Science Technology is innovative and unique in the sense that it seeks to create a talent pool of highly competent and motivated applied plant scientists who will be capable of applying their knowledge of plants in cutting edge plant-based technologies useful in sustainable agriculture and phytoremediations or bioremediations of environmental problems.

I. Rules and Regulation for the M.Sc. Programme

1. Eligibility

Any student who has bachelor's in Botany or Botany - Biotechnology (double main) with not less than CCPA of 5.00 out of 10.00 in the Core Group (Core + Open + Complementary) under the 10+2+3 systems are eligible to apply for admission to **M Sc program** in **Botany and Plant Science Technology**. SC/ST candidates need only a pass in the qualifying examination. SEBC (Socially and educationally backward class) OEC (Other Eligible Castes) will be given a relaxation of 3% and 5%, respectively in the prescribed minimum marks

Those in the final year of their qualifying examination and awaiting results are eligible to apply for entrance examinations. However, they should have acquired all the requirements of the award of their qualifying degree, including all examinations, dissertation or projects, *viva-voce*, and should produce the complete mark-lists at the time of joining.

2. Annual student intake :10

3. Faculty: The degree for the M Sc Botany and plant ScienceTechnology programme shall be awarded under the Faculty of Science.

4.Minimum Total Credits Required: 80

The Regulations for the M Sc Botany and plant Science Technology programme at National institute of Plant Science technology (NIPST) is in accordance with Regulations for Functional Autonomy and the Credit and Semester System in the University Departments/Schools of Teaching and Research and its amendments.

5. Student Admission: Admission will be made through a common admission procedure (CAP) based on a Common Admission Test (CAT). Admission will be solely based on a rank list prepared as per the score obtained in the common admission test (80%) and interview (20%)

6. Course structure and Credit System

Each course has a certain number of credits which describe its weightage. A student's performance is measured by the number of credits that the student has satisfactorily completed. A minimum grade point average is required to be maintained for satisfactory progress in the course work. Also, a minimum number of earned credits should be acquired in all courses in order to qualify for the degree.

The courses are offered either by direct personal engagement or by pre-recorded video presentation. In addition, some of the courses will be covered by tutorials-discussions, lab tasks, minor and major research projects, assignments, seminars, workshops, preparation of reviews - monographs, resource generation camps, off-campus field/industrial visits and instrumental methods as directed by the institute from time to time.

7. Credit transfer: Credit transfer allows transferring of credits earned by a student from another Institution/University, under specific conditions, for the completion of credit requirements for a programme of Mahatma Gandhi University. Credits transfer is allowed for University approved online courses done in MOOC or SWAYAM. Courses of poor quality and courses that have no relevance to the program concerned will not be considered for credit transfer. All credit transfers are to be approved by an expert committee constituted by the University for this purpose. This committee shall have one senior faculty member from the department concerned and two other academic experts in addition to the chairman. The committee shall go through the details submitted by the student and assess their relevance from the perspective of Mahatma Gandhi University before approving the credit transfer. Credit transfer is not permitted for courses completed before three years. If the Institution/University is following the UGC grade format, the grades will be transferred directly. Otherwise University will decide on the grading for the transferred programmes after verifying all relevant documents.

8. Evaluation

8.1. External & Internal Evaluation

There shall be continuous internal assessment as well as end semester examinations for all the programmes. Evaluation of the first and third semester shall be done by the faculty members of the Department offering the courses of study. End semester Examination of second and fourth semesters will be based on the question paper set by External Examiners. Evaluation of the end semester examination of second and fourth semester, except for practical examinations, shall be conducted by External Examiner and concerned faculty member. External Examiner means a competent person in the specified subject from other Universities/ Institutes. A panel of External Examiners must be prepared based on recommendation of Faculty Council and approval of the same by Vice Chancellor

Indirect Grading is employed for the evaluation of courses. The performance of a student in each course is evaluated in terms of percentage of marks converted to grade points. Students have to secure a minimum attendance of 75% to appear for the end semester examination. A separate minimum of 40% of marks is required in the Continuous Assessment (CA) as well as End semester examination for a pass in a course. Students who fail to obtain minimum of 40% mark in the in Continuous Assessment can request the Faculty council for a chance to improve the marks. The Faculty council may permit the student to secure the minimum mark in CA, by taking written Tests. However, only one chance will be given to improve CA marks

8.2 Revaluation: Revaluation or Scrutiny of answer scripts for the first and third semester is provided. There is no provision for revaluation or scrutiny of answer scripts for the end semester examinations of 2nd and 4th Semesters as double valuation is performed on the scripts. The application for scrutiny and revaluation of answer scripts shall be submitted to the Director within 15 days from the date of publication of the results. The Director, in consultation with Faculty Council may entrust an external expert for revaluation.

9. Question paper setting: The Faculty Council of centre shall prepare the panel of question paper setters for each programme and get it approved by the Vice Chancellor. The Director of the centre will make arrangements for getting the question papers set by external experts approved by the Vice Chancellor. Questions for courses offered in the 1 st and 3rd semesters, will be set by faculty members of the Department and for 2nd and 4th semesters by external examiners. The Faculty Council shall as far as possible recommend teachers of other Universities as external examiners for preparing panel of question paper setters and examiners.

10. Process of Evaluation:

The internal assessment will be a continuous assessment (CA) that accounts for 40% of the evaluation in both theory and practical. The end semester examination will account for the remaining 60% of the evaluation.

End-Semester Examination: The end semester examination will account for 60% of the evaluation. The evaluation of the end-semester examination of the first and third semesters shall be done by the faculty who taught the course. Evaluation of the 2nd and 4th semester courses based on questions set by external question paper setters shall be evaluated by two examiners; one, the external (as far as possible the question paper setter shall evaluate the examination paper as well) and the other, internal examiner.

The double valuation of answer scripts in the second and the fourth semester courses shall be done by external examiners and the concerned faculty respectively as approved by the Faculty Council. The Director of the centre will make arrangements for the evaluation of the answer scripts. The project/dissertation shall be evaluated by two examiners, one of them the faculty member who supervised the project and the other an external examiner to be decided by the Director from a panel recommended by faculty council and approved by the Vice Chancellor. The comprehensive viva-voce must be carried out along with project evaluation.

Continuous Assessment (CA): The student's participation and classroom performance as well as the feedback received from tests, tutorials, assignments and term papers shall form the basis for continuous assessment (CA). It accounts for 40% of the evaluation in both theory and practical. This assessment shall be based on a predetermined transparent system involving periodic written tests, assignments and seminars in respect of theory courses and based on tests, lab skill, records/viva and attendance in respect of practical courses.

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

(a) Theory

No.	Components	% of internal marks
i)	Test papers	50%
ii)	Assignments/Book review/debates	25%

iii)	Seminars/Presentation of case study	25%

For each course there shall be at least two class tests during a semester. Average of the best of the marks obtained in the two tests (in the case of more than two tests) or the average of the tests (if there is only two tests) will be counted as the internal test component of CA.

(a) Practicals

No.	Components	% of internal marks
i)	Test paper	40%
ii)	Lab skill	25%
iii)	Records	25%
iv)	Viva	10%

Test Paper: 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 2 assignments/book reviews for each course. Assignments/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 and the like, and inform the same to the students. Punctuality in submission of assignments/records is to be given a weightage in the internal evaluation.

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

Results of Continuous Assessment:

The results of the CA counter-signed by Director of the centre shall be displayed on the notice board 5 days before the end semester examinations. The marks awarded for various components of the CA shall not be rounded off, if it has a decimal part. The total marks of the CA shall be rounded off to the nearest whole number. Relevant records of continuous

assessment (CA) must be kept in the department and that must be made available for verification.

Project Work: There shall be a project/dissertation to be undertaken by all students. The dissertation entails field work, lab work, report writing, presentation and viva voce. The class hours allotted for project work may be clustered into a single slot so that students can do their work at a centre /location for a continuous period. However, appropriate changes can be made by the faculty council in this regard. Project/dissertation shall be carried out under the supervision of a teacher in the parent Centre or any other research institutes or industrial establishment or university departments if they permit the students to do so, after getting permission from the Department Head. In such cases, one of the teachers from the centres would be the Co supervisor/internal guide and an expert from the industry/ research organization concerned shall act as supervisor/ external guide.

External Evaluation of theory answer scripts: The evaluation shall be done after the examination at the earliest, preferably in a centralized valuation. As far as possible bar-coded answer books shall be used to ensure confidentiality. The evaluation of the answer scripts shall be done by examiners based on a well-defined scheme of valuation. End semester evaluation of theory answer scripts shall be conducted and evaluated by one internal examiner for odd semesters. For even semesters, one external and one internal examiner shall do the process of evaluation. That is, there shall be double valuation system of answer books in the 2nd and 4th Semester evaluations. The final marks awarded will be the average of two. If there is a variation of more than 10 % of the maximum marks, the answer books shall be valued by a third external examiner appointed by the Director of the Centre. The final marks to be awarded shall be the average of mark obtained in third valuation and the highest of marks awarded by the other two examiners.

Process of evaluation of project work:

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

i. Continuous Assessment: Supervising teacher/s will assess the project and award Marks.
ii. Final evaluation: Final evaluation will be done by external examiner, based on the work done by the student and a viva voce.

There is no provision for improving the continuous assessment/ final evaluation of the project.

11. Grading System:

The grading system followed is that of relative grading on a ten-point scale.

The following table indicates the performance range and the relative value of the grades (grade points) on the scale.

Letter Grade	Performance	Grade Point
O	Outstanding	10
A plus	Excellent	9
A only	Very good	8

B plus	Good	7
B only	Above Average	6
C	Average	5
P	Pass	4
F	Fail	0
Ab	Absent	0

Minimum grade for passing in a course or programme:

The minimum CGPA for a specific programme will be 4

The Director shall ensure the regular student feedback of courses, teachers and programme in the prescribed format towards the end of all semesters and the same shall be made available to teachers concerned.

Publication of Results: The results of the End Semester Examination (ESE) shall be published within 30 days from the date of the last examination.

Conferment of the Degree: A candidate shall be eligible for the conferment of the degree only after he/she has earned the minimum CGPA as specified in the scheme of the prescribed programme, within the stipulated period.

12. Reappearance and improvement Examinations:

A student who failed for a course in a semester can register for Reappearance in the forthcoming examination, subject to the conditions set forth in the CSS regulation. Improvement of marks/grades in the forthcoming examination can be done, subject to the conditions set forth in the CSS regulations.

Registration for Improvement: A candidate has to apply for registration for Improvement by paying the requisite fee. Candidates are not permitted to Register for improvement of grades for Individual course. Candidates in the 1st and 2 nd semesters, who have secured SGPA letter grade 'P' or above in the end-semester examination can improve their grade by reappearing for all the semester courses along with the next immediate batch.

In such cases a candidate will be awarded a new grade only if there is an improvement in grade in the new examination; otherwise, the candidate is eligible to retain the grade already awarded. Candidates in the 3rd semester, who have secured the SGPA letter grade 'P' or above in the end semester examination, can improve their grade by reappearing for all the semester courses, along with the 3rd semester supplementary examination being conducted for failed candidates immediately after the completion of end semester examination of Fourth semester. This provision is applicable only for third semester.

Improvement of 4th semester can be done along with the immediate lower batch. If the improvement is meant to obtain minimum CGPA requirement, a candidate has the option to decide which semester (3rd or 4th) is to be improved; however, the grade given to the candidate shall be that obtained for the entire semester improvement examination. 1 st and 2nd semester SGPA cannot be improved after the completion of the 4th semester. Only 3rd and 4 th semester SGPA can be improved after the completion of a programme. The marks/grades awarded for Continuous assessment and that for the Project/dissertation cannot be improved. SGPA secured in the 4th semester can be improved only for the purpose of fulfilling the minimum CGPA requirement.

Reappearance:

Candidates in the 1st and 2 nd semesters who have secured a letter grade of 'F' or 'Ab' in any of the courses can avail two immediate consecutive chances to reappear for examination, course wise, provided the candidate has applied for the same and paid the required fee.

Candidate in the 3 rd semester who has secured letter grade of 'F' or 'Ab' in any of the courses can reappear for exams course-wise in the 3 rd semester supplementary examination, which will be conducted immediately after the completion of End semester examination of Fourth semester, provided the candidate has applied for the same and paid the required fee (fee for supplementary examination of any course shall be full semester examination fee irrespective of number of courses involved).

Candidates who secured the grade of only 'F' or 'Ab' in a course in the 4th semester examination can reappear course wise, along with the immediate lower batch. Candidates who secured the grade of only 'F' or 'Ab' in a course in the 3rd /4th semester examinations will be given two additional chances for course-wise reappearance even after the completion of the programme; but it has to be done within a period of two years after the completion. In such cases a candidate has to apply for the same as a supplementary exam and pay the required fee (Fee for supplementary examination of any course shall be full semester examination fee irrespective of number of courses involved).

13. Re-admission

No students shall be readmitted to the 1st semester. Readmission to other semesters of the programme will have to be recommended by the Head of the Department. The student has to apply for Readmission paying the prescribed fee. The student may be permitted to complete the programme by taking the required number of courses within a maximum period of eight continuous semesters. including the period of his/her programme, provided an amount equivalent to the semester fees for all the intervening semesters have been regularly paid and provided he/she has not been removed from the rolls by issuing a Transfer Certificate. In all cases of discontinuation and readmissions, candidates must submit applications countersigned by the Director to the Registrar and obtain the required statutory order for the same.

Candidates who are readmitted to repeat a course must follow the then existing syllabus for the said programme. They need to attend classes along with new batch of students and should obtain the required percentage of attendance as usual.

14. Grade Card: Grade cards will be issued to the student after the publication of results of each End Semester Examination. The Grade Card will indicate the grades obtained for the courses as well as the semester grade point average (SGPA) which is the weighted average of the numerical value (grade point) obtained by the student in the semester. Weighted average is calculated by dividing the sum of the product of the grade point or numerical value obtained for each course and the credits that it carries by the total number of credits earned. The Cumulative Grade Point Average (CGPA) for the whole programme will be calculated in the same way, which will also be indicated in the Grade Card issued for the Final Semester examinations of the programme. Minimum SGPA in all semesters is not an assurance to minimum CGPA for the entire programme.

Percentage Equivalence of Grade:

Range of % of Marks	Grade Letter	Grade Point
95 - ≤100	O	10
85 - <95	A plus	9
75 - <85	A only	8
65 - <75	B plus	7
55 - <65	B only	6
45 - <55	C	5
40 - <45	P	4
<40	F	0
Absent	Ab	0

Calculation of Semester Grade Point Average (SGPA) :

Credit Points for the Course = Credits assigned for the Course X Grade Point secured for the Course. SGPA indicates the performance of a student in a given Semester. SGPA is based on the total Credit Points earned by a student in all the courses divided by the total credits assigned to the Semester.

Note: SGPA is computed only if the candidate passes in all the required courses (gets a minimum required grade for a pass in all the required courses as per the specific curriculum). Securing of SGPA in all semesters may not enable students to secure minimum required CGPA for a pass in the programme.

$$\text{SGPA} = \frac{\text{Total credit points earned by the student from all the required courses of a Semester}}{\text{Total credits of all courses required in a semester}}$$

Calculation of Cumulative Grade Point Average (CGPA)

CGPA refers to the Cumulative Grade Point Average weighted across all the semesters (4 Semesters). CGPA is obtained by dividing the total number of credit points earned by the student in all the semesters by the total number of required credits of all the Semesters as per curriculum.

CGPA = (Sum of the Credit Points secured by the student for each semester)÷ (Sum of the Credits assigned to each Semester of the Programme)

$$\text{CGPA} = \frac{\text{Total CreditPoints of Semester- S1 + 2 + 3 + 4}}{\text{Total Credits of Semester- S1 + 2 + 3 +4}}$$

Conversion of SGPA/CGPA to Grade

10	O
9.0 - <10	A plus

8.0 - <9	A only
7.0 - <8	B plus
6.0 - <7	B only
5.0 - <6	C
4.0 - <5	P
<4	F
Absent	Ab

Conversion of CGPA to percentage

$$\text{Equivalent Percentage} = \frac{\text{(CGPA obtained) X 100}}{\text{Maximum CGPA (=10)}}$$

The equivalent percentage shall be represented in a numeric format rounded to two decimal digits accuracy ("99.99") and will not be rounded to the nearest integer.

11. Rank/Position certificate: Rank Certificate shall be issued to the first three positions only. The position certificate shall be given for the 1st ten positions based on the CGPA secured by the students. Students who have completed the course by availing the opportunity of reappearance for a course will not be eligible for Rank certificate. If Rank certificate/Position certificate in a prescribed format is demanded by institutions for awarding a specific fellowship/scholarship such as for DST Inspire Fellowship etc, the same may be given for such students as a special case in the prescribed format.

12. Registration with CSS: The list of students registered for each semester programme should be forwarded to the CSS along with original certificates (Degree Certificate + SSLC) immediately after closing of admissions to the programme.

13. Consolidation and Declaration of Results:

All work pertaining to the examinations shall be held in the center under the direct control and supervision of Director. The Director in consultation with the Faculty Council shall monitor the Continuous Assessment/ End Semester Examinations and evaluations or nominate a teacher as the chief examiner who will assist him/her in the matter. The marks awarded for internal assessment will be displayed in the Center's notice board / published in the Centre Website at the end of each semester.

Complaints from students regarding the marks awarded in internal assessment should be reported to the concerned faculty member within 3 working days from the date of publication of the same on the notice board/Website. Thereafter, complaints against internal marks will not be entertained under any circumstance. The pass board of a Centre will consist of selected teachers/ the entire faculty of the Centre concerned and will be constituted by Director in consultation with the Faculty Council. The tabulated grade sheets will be forwarded after each end-semester examination to the office of the Controller of Examinations. The CSS section in

the Controller's office will check the Grade card forwarded from the Centre and notify the results after consolidating them and issue statement of credits. On completion of the final semester a consolidated Grade Card showing the details of all the courses taken will be prepared. The consolidated Grade Card containing the details of all the courses with their titles, credits, grades obtained, the total credits earned, the SGPA and the CGPA will be issued to students.

The nomination of the members of the CSS Academic Advisory Committee will be made by the Vice Chancellor. The committee will be reconstituted every three years. The Academic Advisory committee, apart from coordinating and sorting out inter-school matters pertaining to the CSS, will handle student grievances relating to semester examinations that cannot be resolved at the Department. Only student grievances that cannot be settled by the faculty council of the Department need be forwarded to the CSS Academic Advisory Committee and the Vice Chancellor. Student grievances that cannot be settled by the CSS Academic Advisory Committee and the Vice Chancellor shall be dealt with by the Syndicate. The CSS Committee will also prepare a uniform examination schedule for all the programmes in the university. A common admission schedule for all the Departments in the University will also be prepared by the Academic Advisory Committee. All other work pertaining to the CSS will be conducted at the University Departments/Schools of Teaching and Research.

14. Issuing of certificates:

On completion of a semester (when results are ready) the Heads of Departments of all programmes shall forward tabulated grade sheets along with the minutes of the pass board meeting showing details to the CSS Section; in the case of final semester, consolidated details of all semesters showing total

Important definitions

RegulationsThe regulations are called the regulations for the M.Sc. Programme in Botany & Plant Science Technology offered by the National Institute of Plant Sciences Technology, Mahatma Gandhi University.

Programme: the entire course of study and Examinations.

Duration of Programme: duration of post-graduate programme shall be of 4 semesters.

Semester: a term consisting of a minimum of 90 working days, inclusive of examination, distributed over a minimum of 18 weeks of 5 working days each.

Academic week: a unit of 5 working days in which distribution of work is organised from day 1 to 5^{th} day with 7 contact hours of 1-hour duration in each day. A sequence of 18 such academic week constitutes a semester.

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

Credit (Cr): of a course is a measure of the weekly unit of work assigned for that course in a semester.

Course Credit: The total minimum credits, required for completion of M.Sc. programme is **86 Credits** as per university norms

Preparatory/Regular course: a core course that the student admitted to a particular programme must successfully complete to receive the Degree and which cannot be substituted by any other course.

Elective course: a course, which can be substituted, by equivalent course from the same subject option given in the syllabus and a minimum number of elective courses is required to complete the programme.

MOOC Course means Massive Open Online Course.

Open Course means a course offered by a School/Centre/Institute other than the parent department. Every regular postgraduate student is required to choose an open course of 4 credits in the third semester.

Project: a regular project work with stated credits on which the student undergo a project under the supervision of a teacher in the parent department/any appropriate research centre in order to submit a dissertation on the project work as specified. Master level Project work shall be completed by working outside the regular teaching hours under the regular supervision of a teacher in the concerned subject. A candidate may, however, in certain cases be permitted to work on the project in an industrial/Research Organization on recommendation of the supervisor.

There will be an internal assessment and external assessment for the project work. The external evaluation of the Project work is followed by presentation of work including dissertation and Viva-Voce. The title and the credit with grade awarded for the Master level project will be entered in the grade card issued by the university

Tutorial: a class to provide an opportunity to interact with students at their individual/group level to get special training or identify the strength and weakness of individual students.

Seminar: Expected to train the student in broader vision of the subject area and world reality, also aimed to promote self-study by the students

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

Course Teacher: the teacher who is taking classes on the course

Grade: Grade is a letter symbol indicates the broad level of performance of a student in a course. Each grade is assigned a **'Grade point' (G)** which is an integer indicating the numerical equivalent of the broad level of performance of a student in a course.

Semester Grade point average (SGPA): the value obtained by dividing the sum of credit points (P)obtained by a student in the various courses taken in a semester by the total number of credits taken by him/her in that semester. The grade points shall be rounded off to two decimal places. SGPA determines the overall performance of a student at the end of a semester and everything related to SGPA will be as per CSS norms

$$\textbf{SGPA} = \frac{\text{Total } \textbf{credit points} \text{ earned by the student from all the required courses of a Semester}}{\textbf{Total credits of all courses required in a semester}}$$

Cumulative Grade point average (CGPA): the value obtained by dividing the sum of credit points in all the courses taken by the student for the entire programme by the total number of credits and shall be rounded off to two decimal places.

$$\textbf{CGPA} = \frac{\text{Total CPts of Semester} - \text{S1} + 2 + 3 + 4 \ldots}{\text{Total Credits of Semester} - \text{S1} + 2 + 3 + 4..}$$

Minimum CGPA required for the M Sc programme in Botany and Plant Science Technology will be **4**.

Outline of the Syllabus
Programme courses and Credit distribution

Semester I

Sl. No.	Course Code	Course Title	Credits	Hours/Week		
				L	T	P
1	PLM21C01	Research Methodology, Computer Applications and IPR	3	3	1	3
2	PLM21C02	Cell Biology & Biochemistry	3	3	1	3
3	PLM21C03	Microbiology and Immunology	3	3	1	3
4	PLM21C04	Angiosperm Systematics Part-I	3	3	1	3
5	PLM21E05	Organic and Natural Farming*****	4	4	2	3
6	PLM21E06	Environmental monitoring and management*****	4	4	2	3
7	PLM21E07	Allelopathy and Biological Weed and Pest Control*****	4	4	2	3
8	PLM21C08	Laboratory Course 1	4	-	1	12
*** Students can select any one Elective**						
		Total Admissible credits:	**20**			

Semester 2

Sl. No.	Course Code	Course Title	Credits	Hours/Week		
				L	T	P
9	PLM21C09	Phycology	3	3	1	3
10	PLM21C10	Bryology, Pteridology & Gymnosperms	3	3	1	3
11	PLM21C11	Mycology and Plant Pathology	3	3	1	3
12	PLM21C12	Angiosperm Systematics Part-II	3	3	1	3
13	PLM21E13	Phytochemistry*****	4	4	2	3
14	PLM21E14	Applied Marine Phycology*****	4	4	2	3
15	PLM21C15	Laboratory Course 2	4	-	2	12
*** Students can select any one Elective**						
		Total Admissible credits:	**20**			

Semester 3

Sl. No.	Course Code	Course Title	Credits	Hours/Week		
				L	T	P
17	PLM21C16	Molecular Biology &Genetic Engineering	3	3	1	3
18	PLM21C17	Plant Physiology & Biophysics	3	3	1	3
19	PLM21C18	Anatomy, Embryology and Developmental Biology of Plants	3	3	1	3
20	PLM21C19	Genetics, Plant Breeding, Tissue culture, Evolution	3	3	1	3
21		Open Course	4			
22	PLM21C20	Laboratory Course 3	3	-	1	8
23	PLM21C21	Laboratory Course 4	3	-	1	8
Total Admissible credits: **22**						

Semester4

Sl. No.	Course Code	Course Title	Credits	Hours/Week		
				L	T	P
24	PLM21C22	Ecology, Conservation & Phytogeography	3	3	1	3
25	PLM21E23	Remote Sensing of biomass and biodiversity resources*****	4	4	2	3
26	PLM21E24	Horticulture*****	4	4	2	3
27	PLM21E25	Entrepreneurship and Business in Biology*****	4	4	2	3
28	PLM21C26	Laboratory Course 5	3	-	1	8
29	PLM21C27	Research Project	8			
*** Students can select any one Elective** Total Admissible credits: **18**						

Distribution of Credits

Core - **64,** Electives -**12,** Open Course – **04** Total Credits = **80**

SEMESTER - I

PLM21C01: Research Methodology, Computer Applications and IPR

Unit I: Science and Research

Goals of research, essential qualities of a researcher, methods of research, logical scientific methods, different types of inductive logical methods, different types of inductive logical methods, method of causal connections, method of difference, method of concomitant variation, method of residues, method of agreement, joint method of agreement and difference. Other logical methods, method of description and classification, evolutionary methods. Various types of research, data and methods of data collection.

Unit II: Steps in doing research

Review of literature, primary and secondary source, National institutions useful in search of literature- NISCAIR- Library resources – Journals/periodicals, reviews- abstracts treaties- monographs- searching of web resources- electronic data bases- Critical review of literature identification of research gaps- Defining or selection or identification of a research topic or problem, formulation of a hypothesis, significance of hypothesis, types of hypothesis, relevance and assumptions in research, developing of a research plan execution of research works, exploration, description- diagnosis experimentation meaning and nature of experimental research, treatments, Variation and Variables, simple populations, general laboratory techniques, rules and regulations, safe measures.

Unit III: Biostatistics

Biostatistics: Collection and Presentation of Experimental data – Measures of Central Tendency: Arithmetic Mean, Median, Mode, Position of averages, Geometric Mean, Harmonic mean and percentile – Measures of Dispersion: Range, Inter quartile range, variance, standard deviation and standard error. Correlation and Regression: Correlation coefficient – Types of correlation – Regression Simple and Linear regression – Biological significance of correlation and regression – Tests of significance: Basis of statistical inference – Student's 't' test for mean, difference of means and test for correlation and regression coefficients – Chi-square test – Analysis of variance and comparison of means. Experimental Design - Different types of design, sampling techniques, statistical analysis softwares.

Unit IV: Computer application & Bioinformatics

Application of computer in research - Introduction to computer fundamentals, MS-Office, computer aided graphical applications and data analysis, SPSS, M-stat, R. Reference management software.

Bioinformatics: Introduction to Bioinformatics and its scope, Biological databases- primary, secondary and composite; nucleotide sequence database - Genbank, ENA, DDBJ; protein sequence database- PDB, SWISS PROT.

Information retrieval from Biological database; Search Tools - BLAST, FASTA.

Sequence alignment – pairwise and multiple; local and global; tools used for multiple sequence analysis – clustal x and clustal omega

Applications of bioinformatics in evolutionary studies – molecular phylogenetics, molecular clock Molecular phylogeny and phylogenetic trees.

UNIT V- Intellectual Property Right and Protection:

About Intellectual Property and Intellectual Property Right, Choice of intellectual property protection, IPR and Plant Genetic Resources (PGR), GATT and TRIPs. Patenting of biological material: International conventions, international corporations, obligation with, patent applications, implication of patenting of higher plants, patenting transgenic organisms and isolated genes, patenting of genes and DNA sequences, Plant breeders right (PBRs) and Farmers Rights, Traditional Knowledge.

Practicals :

Biostatistics

1. Analysis of data to find the mean, median and mode
2. Analysis of a data for mean deviation and standard deviation
3. Test significance of given data using t-test, F-test Chi-square rest and ANOVA.
4. Analysis of set of data for correlation/regression.
5. Determine probability for different types of events.
6. Statistical software: Systat/R/Genstat/SPSS

Bioinformatics

1. Familiarizing with the different data bank mentioned in the syllabus.
2. Blast search.
3. Multiple sequence alignment using CLUSTAL X (give DNA or protein sequence).

Reference

1. Gupta S P (1984). Statistical methods. S.Chand Publication.
2. Pranab Kuamr Banerjee (2013). Introduction to Biostatistics. S Chand Publication.
3. Daniel Wayne W (2010). Biostatistics Basic Concepts and Methodology for the Health Science. Wiley.
4. Jerrold Zar H (2014). Biostatistics Analysis. Pearson.
5. Aurther M lesk (2014). Introduction to Bioinformatics-4th Ed. OUP
6. Michael Waterman (1995) Introduction to Computational Biology: Maps, sequences and genomes, Springer.

PLM21C02: Cell Biology and Biochemistry

Unit 1- Introduction to cell - History of cell biology, Cell theory, Evolution of the cell, Ultra-structure of Prokaryotic and eukaryotic cell, Morphology, structure and function of different kinds of plant and animal cells; plasma membrane - structure, models and functions, Chemical composition; structure and function of membrane protein, carbohydrate, lipids – membrane transport – active and passive – osmosis and diffusion - sites for ATP ion carriers, channels and pumps, receptors and signals.
Cell organelles: Morphology, structure, biogenesis and function of different cell organelles - Cytoskeleton, organization and role of microtubules, intermediate filaments and microfilaments, molecular motor movements and their role in flagellar and other movements – intracellular transport of macromolecules.

Unit 2- Cell division and cell cycle. - meiosis and mitosis, Overview of the Cell cycle and its control, molecular mechanisms for regulating mitotic events, role of cyclins and cyclin dependent kinases, Check points in cell cycle regulation. Differences between cell division in plant cell and animal cell. Cell biology of Cancer: Apoptosis – major factors that affect apoptosis - molecular causes of cancer, cellular genes involved in cancer – oncogenes and tumour suppressor genes with examples; Different types of biological pathways leading to cancer development; therapeutic targets and drugs used in treatment of cancer.

Unit -3: Carbohydrates and Lipids in living systems: Structure, classifications and functions of carbohydrates monosaccharides, disaccharides and polysaccharides – Sugars in living systems – significance of pentoses and trioses; Sugar derivatives - Sugar acids, sugar alcohols, deoxy sugars, amino sugars, glycosides and their functions, Glycosidic linkages, Heteropolysaccharides, Glycosaminoglycans and Glycoproteins – metabolism of glucose – glycolysis, TCA cycle, glycogenesis, glycogenolysis and gluconeogenesis, photophosphate shunt, ETC. Lipids in living systems: Structure, properties and Classification of fatty acids – saturated, unsaturated and poly-unsaturated, short chain, medium chain and long chain fatty acids. Triglycerides, phospholipids, prostaglandins, prostacyclins and leukotrienes, sphingolipids and glycolipids, gangliosides, rancidity, acid value, saponification value and iodine number. Plant and animal sterols – structure and functions of cholesterol. Lipid peroxidation and antioxidants. Lipoproteins – classification and composition

Unit 4-: Amino acids and proteins: Structure and classification of amino acids. Chemical properties of amino acids; Amino acid derivatives; Non-protein amino acids. Biological amines and their functions; small peptides, cyclic peptides and their biological functions. Proteins: Different types; classifications, physicochemical properties of proteins; structural organization of proteins, primary structure of proteins, Ramachandran plot, secondary structure (α-helix, β-strand, β-sheet, turns and loops), tertiary structure (ion-ion, ion-dipole and dipole-dipole interactions), quaternary structure, protein folding, globular and fibrous proteins, structure of heamoglobin and myoglobin.

Unit 5: **Enzymes and Nucleic acids:** Classification and Nomenclature, units of activity, coenzymes and metal cofactors, temperature and pH effects, Michaelis-Menten Kinetics, inhibitors and activators, active site and mechanism of enzyme action, isoenzymes, allosteric enzymes. Purine and pyrimidine bases, nucleosides and nucleotides, double helical structure of DNA, polymorphism of DNA (A, B, Z forms), RNA structure, major classes of RNA – mRNA, rRNA, tRNA, sn RNA, hn RNA – structure and biological functions ribozyme, denaturation and renaturation of DNA, DNA supercoiling, chromatin structure. Protein- Nucleic acid interactions, salient features of nucleic acid recognition by proteins.

Cell Biology Practical

1. Study of cell types – different kinds of animal and plant cells.
2. Preparation of slides from root tip/shoot tips/animal tissue for study of mitosis calculation of mitotic index.
3. Study of meiosis in *Rhoeo*/*Chlorophytum/animal tissues* by smear preparation.
4. Study of giant chromosomes in Drosophila/Chironomus- Orcein staining of salivary gland chromosomes of Chironomas or Drosophila.
5. Isolation of cell organelles: succinate dehydrogenase activity assay (Mitochondria), acid phosphatase activity assay (Lysosomes), acetocarmine staining (Nucleus) and Microscopic observation (Chloroplast).

Practicals (Biochemistry) –

1. Preparation of Solutions and buffers: pH, different types of buffers, molarity and normality of solutions.
2. Qualitative tests for carbohydrates: Test for reducing sugars (Pentose, hexose and ketose sugars), non-reducing sugar and polysaccharides.
3.Quantitative tests for carbohydrates: Nelson-Somogys, Anthrone and DNS methods, Isolation and estimation of starch from potato.
4.Qualitative tests for lipids: Solubility test, acid-value, iodine value and saponification value of fats.
5. Quantitative tests for proteins: Lowry's or Biuret methods.
6. Extraction and separation techniques: Extraction and separation of Phytochemicals or amino acids by Paper or Thin layer chromatography.

References

1. Fritjof Capra (1997), The Web of Life, Anchor Books, New York
2. Maly IV Edited (2009) Systems Biology, Springer
3. Hans-Jorg Edited (2008) Supramolecular systems in biomedical field
4. Denis Noble (2006) The Music of Life, Oxford University Press
5. Savada et al (2010) Life – the Science of Biology 9th Edition, WH Freeman
6. Jeremy et al (2002) Principles of Biochemistry, WH Freeman
7. Lehninger et al (2008) Principles of Biochemistry, WH Freeman
8. Voet et al (2013) Biochemistry, John Wiley and Sons
9. Murray et al (2000) Harper's Biochemistry, Appleton & Lange
10. Dixon et al (1979) The Enzyme, Longman Group
11. Thomas M Davlin (2010) Text book of Biochemistry with clinical correlations, John Wiley and Sons
12. Sadasivam S and A Manickam (1996) Biochemical Methods, New Age International
13. Thimmaiah SK (2004) Standard Methods of Biochemical Analysis, Kalyani Publishers
14. Sawhney SK & Randhir Singh (2010) Introductory Practical Biochemistry, Narosa Publishers
15. Bruce Alberts et al (2002) Molecular biology of the cell (IV Edn) Garland Science, Taylor and Francis group.

16. Cooper GM and Hausman RE (2009) The Cell: A Molecular Approach. V Edition. ASM Press & Sunderland, Washington, D.C; Sinauer Associates, MA.
17. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology. VIII Edition, Lippincott Williams and Wilkins, Philadelphia.
18. Jocelyn E Krebs, Elliott S Goldstein, Stephen T Kilpatrick (2011) Lewin's Genes X, Jones and Bartlett Publishers.
19. Karp G (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition, John Wiley & Sons. Inc.
20. Roberts and Peter Walter (2010) Essential Cell Biology, Garland Science.

PLM21C03: - Microbiology and Immunology

Unit 1: Basic Microbiology: History and Development of Microbiology, Scope and Relevance of Microbiology. Ultra-structure and Characteristics of Microorganisms : Prokaryotic Cell An overview of morphology of bacteria, bacterial cell wall, Archaeal cell walls, Cell membrane, Cytoplasmic matrix, The nucleoid, Extra chromosomal nuclear material, Intra cytoplasmic structures, Protein secretion in prokaryotes, Structures external to the cell wall, Comparison of Prokaryotic and Eukaryotic cell. Bacterial staining, Microbial growth and nutrition, Cultivation and preservation of bacteria. Bacterial classification. Sterilization and disinfection, Antibiotics and drug resistance, Antimicrobial sensitivity testing – microbiology of soil and water - Coli form count – MPN**;** Genetic recombination in prokaryotes, mutation, DNA repair, Bacterial plasmids. Pathogenicity and virulence factors of microbes; Detection and diagnosis of bacterial plant pathogens – major bacterial plant diseases; symbiotic association – Rhizobium and root nodules - associated interactions.

Unit 2: Introduction to viruses and fungi: Discovery of Viruses – history of virology-structure and properties of Viruses – viral symmetry – reproductive cycles - Classification of virus, cryptogram, and cultivation of viruses. Baltimore system of Virus Classification - Genetic Content of viruses – transduction, Virions and prions General characteristics; Classification and life cycle of fungi, affinities with plants and animals; thallus organization; Cell wall composition and nutrition - reproduction. Harmful and beneficial importance of fungi. Common fungal parasites for plant and animals. Single Cell Proteins.

Unit 3: Introduction to Immunology: Historical perspective and importance of Immunology in health and disease. Cells and organ involved in immune sytem. Nonspecific resistance (Innate immunity) Overview of resistance, Definition, Ubiquity, Anatomical barriers, Physiochemical mediators and cell types of innate immunity, Receptors (TLR, Scavange receptor etc.) of the innate immunity, Signal transduction pathways in activation of innate immunity, Phagocytosis and Inflammation.Specific resistance (Adapative immunity)-Definition, Connection between innate and adapative immunity, Types of adapative immnity, Antigens, Definition, Types and properties, Bcell epitopes, Tcell epitopes, Immunogenicity and antigenecity, Adjuvants and mechanisms in enhancing antigenecity, Types of immune response.Immunoglobulins Definition, Basic structure classes and subclasses,Physicochemical and biological properties, Antigenic determinants on immunoglobulins, Antibody mediated effector functions : Enhancement of phagocytasis (opsonization), Activation of complement, Killing of target cell by ADCC, Transcytosis, Theories of antibody formation, Monoclonal and genetically engineered antibodies. Organisation of immunoglobulin genes, Expression of Ig genes, Genetic regulation of immunoglobulin, Generation of Antibody Diversity and Gene rearragement class switching.

Unit 4: Immunotechnology : Antigen Antibody interactions, General properties of Ag-Ab interaction, Importance in host and in laboratory, Principles and applications of in in vitro Ag.Ab interactions, Different types of serological tests (Precipitation, Agglutination, CFT, Immunofluorescence, RIA, ELISA, Flowcytometry). Organisation of MHC, Gene of MHC,

MHC molecules, Regulation of MHC expression, MHC and Immune receptors, Self MHC restriction, MHC and disease susceptibility, MHC and Transplantation.

Unit 5: Application of Immunology : Compliment pathways, cytokines and its characteristics, Tumor immunology, Autoimmune diseases, Hypersensitivity and allergy, classification of hypersensitivity, Immunodeficiency diseases.

Reference

1. Microbiology by Pelezar,Michael J
2. Joanne Willey et al. (2013). Prescott's Microbiology-9th Ed., McGraw-Hill Education.
3. Microbiology-an Introduction-(8th Edn), Authors-Tortora, G.J., Funke, B.R., Case, C.L.
4. General Microbiology, Authors -Stainer, Ingharam, Wheelis and Painter.
5. Microbial Physiology, Authors -Moat and Foster.
6. A Text book of Microbiology, Authors -P. Chakraborty.
7. Textbook of Microbiology, Authors -Dubey and Maheshwari.
8. Microbiology, A Practical Approach. Authors -Patel and Phanse
9. Immunology by Kuby (Free man publication)
10. Immunology and immunotechnology by Ashim k. Chakravarty (Oxford university Press)
11. Immunology by C. Fatima
12. Essentials of immunology by Roitt (Blackwell scientific publication)
13. Immunology by Benacera
14. Infection & Immunity by John Playfair & Gregory Bancroft (Oxford university Press)

Practicals (5 hours per week)

1. Staining techniques: simple and differential staining (Gram staining and acid fast staining), special staining (granule, capsule and spore staining)
2. Slide culture technique
3. Lactophenol Cotton Blue staining
4. Pure culture techniques: Spread plate, Pour plate and Streak plate technique
5. Isolation and enumeration of bacteria and fungi from soil, air and water
6. Determination of Antimicrobial activity
7. Gel diffusion test: Radial Immuno diffusion test. Ouchterlony double immuno diffusion test.
8. WIDAL test for typhoid fever
9. ASO latex agglutination
10. ELISA test

PLM21C04: - Angiosperm Systematics Part-I

Unit - 1 Classification of Angiosperms - Historical background of Angiosperm taxonomy and the classification of plant classificatory systems (artificial, natural, and phylogenetic), A detailed study on the systems of classification proposed by: Carolus Linnaeus; Bentham and Hooker; Engler and Prantl; Armen Takhtajan; and Angiosperm Phylogeny Group.

Unit - 2 Plant Nomenclature

Historical aspects of plant Nomenclature (Polynomial and Binomial Systems), Importance of deciphering the information content of Latin binomials. Emergence of the ICBN; its structure, aims, principles, rules and recommendations. Hierarchical system of taxonomic ranks recognized by the ICBN, Authorship, priority of publication, and name changes and abbreviations. Criteria for valid publication.

Unit -3 Sources of taxonomic information, modern trends and phylogeny of angiosperms: Morphological, anatomical, cytological, biochemical (chemotaxonomy), and molecular (molecular taxonomy). Numerical taxonomy and phylogenetic systematic. Exhaustive study on the phylogeny of Angiosperms.

Unit 5 - Methods of Identification in plant systematic studies and databases: Importance of explorative field collections in plant systematics and documentation of data. Preparation and maintenance of herbarium specimens. Herbarium operations and Data Information systems. Floras, Monographs, and Journals related to research in plant systematics. Taxonomic Keys (Indented and Bracketed), Botanic Gardens, Role of BSI in the advancement of plant systematics.

Taxonomy Practical-1

1. **Vegetative and floral morphology of angiosperms:** The students should familiarize with all the relevant technical terms by collecting and examining fertile plant specimens.
2. Workout nomenclatural problems regarding priority and author citations.

References

1. Judd, Campbell, Kellogg. Stevens. 2003. Phylogeny & Evolution of Vascular Plants. Sinaurer Associates Inc. Publishers Sunderland. Massachusetts. USA
2. Gurucharan Singh (2005) Plant Systematics 2nd Edition, Oxford & IBH.
3. Cole AJ (1969) Numerical Taxonomy, Academic Press.
4. Davis PH, Heywood VM (1973) PLM21C04, RE Kereiger Publ.
5. Harrison HJ (1971), New Concepts in Flowering Plant Taxonomy, Heiman Educational Books
6. Cronquist A (1981), System of classifications of flowering plants, Columbia University Press
7. Naik VV (1984), Taxonomy of Angiosperms, Tata McGraw Hill Publ. Co. Ltd.
8. Radford AE (1986), Fundamentals of Plant Systematics, Harper & Row Publ.

9. Davis PH and VH Heywood (1991) Principles of Angiosperm Taxonomy, Today and Tomorrow Publ.
10. Stace CA (1989), Plant Taxonomy and Biosystematics, Etwaed Arnold
11. Woodland DW (1991), Contemporary Plant Systematics, Prentice Hall
12. Sivarajan VV (1991*),* Introduction to Principles of Plant Taxonomy, Oxford IBH
13. Takhtajan AL (1997) Diversity and Classification of Flowering Plants, Columbia Univ. Press.

PLM21E05: - Organic and Natural Farming

Unit- 1: Introduction to natural and organic farming: Natural, Ecological and organic farming – definition, concepts, and practices – management, principles, methods, merits and demerits. Components - Organic farming for sustainable agriculture - Features of organic orchards.

Unit- 2: Integrated organic farming: Integrated organic farming - concept, ideal planning for small and marginal farmers of rain fed regions - low cost production technologies for growing vegetables, field crops and fruit plants; Introduction of indigenous technical knowledge (ITK) and resource conserving techniques (RCT); Multi cropping systems, mixed cropping, rotation and integrated cropping methods and their advantages in organic and natural farming; Certification of organic products and systems, agencies involved at national and international levels, standards evolved by different agencies, Constraints in certification, organic horticulture and export, IFOAM and global scenario of organic movement, post-harvest management of organic products.

Agronomy of organic and natural farming: Soil organic matter- decomposition, C: N ratios, mineralization and immobilization processes, humus, role of organic matter in soil quality – natural way to prevent soil degradation and erosion, types and control measures. Soil related water pollution- sources, different pollutants in soils and their managements

Unit- 3: Plant nutrient management: Essential plant nutrients- criteria of essentiality, functions for plant growth, mechanisms for movement and uptake of ions in soils and plants - forms of nutrients in soils, deficiency symptoms on plants, luxury consumption, nutrient interactions and chelated micronutrients. Soil fertility, evaluation and management for plant growth, soil testing and fertilizer recommendations. Fertilizers and manures- classifications, NPK fertilizers, their reactions in soils, green mannuring, recycling of organic wastes, composting. Manures – bulky and concentrated – FYM – Compost – rural, urban, vermicompost and coirpith; Enrichment of organic manures; Sewage and sludge; Green manures – potentials and limitations; Quality parameters of organic manures and specifications – Biofertilizers - Soil micro flora – nutrient transformations - Integrated Nutrient Management (INM) and Integrated Plant Nutrient Supply System (IPNS) - NPOP, organic produce quality considerations, certification, labelling, accreditation process and marketing.

Unit -4: Biopesticides and biological control agents: Types of biocontrol agents- biological agents and pheromones, control of weeds, diseases and insect pests and field sanitation - competition, predation, antibiosis and fungistasis; Botanical insecticides- useful and beneficial insects like honeybee, lac insect, silkworm and pollinators. Biological control - concepts and potentialities for managing soil borne pathogens. Types of biological interactions, competition, mycoparasitism; Mycorrhizal associations, operational mechanisms and its relevance in biological control - biopesticides available in market - quality control system of biocontrol

agents,Biodynamic products, Biodynamic composting, ,Liquid manure,Influence of Biodynaic products on crop production.

Practicals:

Biocomposting, biofertilizers and their production. Efficacy of traditional bio pesticides. Panchagavya preparation and other organic nutrients application, methods of preparation of compost, vermicompost and green mannuring. Organic products, documentation for certification, visit to fields cultivated under Sampling of manure materials – basics of Soil chemical analysis - Preparation of soil samples for chemical and biological tests - Bio assay of available K; Soil fertility evaluation by Neubauer technique; Visit to Organic Farms and Critical Reports.

References

1. Allan Wild (1988) Russel's Soil Conditions and Plant Growth Longman group U.K.
2. Burges A and Raw F (1967) Soil Biology, Acad. Press, New York
3. Balasubramaniyan P and Palaniappan SP (2001) Principles and Practices of Agronomy, Agrobios Publishers, Jodhpur
4. Chatterjee BN et al (1989) Cropping Systems - Theory and Practice. Oxford and IBH Publication, New Delhi
5. Dahama AK (2007) Organic Farming for Sustainable Agriculture. 2nd Edn. Published by AGROBIOS (India) Jodhpur
6. Das PC (1993) Manures and Fertilizers Kalyani Publishers, New Delhi.
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8. Gehlot D (2005) Organic Farming: Standards, Accreditation, Certification and Inseption, AGROBIOS (India) Jodhpur
9. Gupta PK (2006) Vermicomposting for Sustainable Agriculture, AGROBIOS (India) Jodhpur
10. Gupta PK (2007) Soil, Plant, Water and Fertilizer Analysis Published by AGROBIOS (India), Jodpur
11. Palaniappan and Annadurai (2008) Organic Farming- Theory and Practise, Scientific Publ.
12. Rao S (1977) Soil Microorganism and Plant Growth, Oxford & IBH.
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14. Sharma AK (2005) Biofertilizers for Sustainable Agriculture, AGROBIOS (India) Jodhpur
15. Sharma AK (2006) A Hand Book of Organic Farming, AGROBIOS (India) Jodhpur
16. Tandon HLS (1993) Methods of Analysis of Soils, Plants Waters and fertilizers, Fertilizer Development and Consultation Organization
17. Durai MV (2014) A hand book of soil, plant, water, fertilizer and manure analysis, New India Publ. Agency

PLM21E06: ENVIRONMENTAL MONITORING AND MANAGEMENT

Unit 1: Environmental Management (a) Concepts, strategies and basic principles of environment management. Management of physical, social, and economic environment. Concepts and scope of environmental planning, regional planning and management. Cost-benefit analysis and Resource economics. (b) Environmental modeling: Simulation modeling, input-output modeling, Linear programming, Software and resource management. (c) Tool box for environmental management – An overview of Ecological foot prints, SEA, Ecological Economics, conflict resolution strategies. Eco-funds. (d) Environmental auditing and Standards - Eco labeling and certification, accreditation – need, objectives and benefits; Corporate social responsibility and Corporate environmental responsibility, ISO standards for environmental management systems (EMS) - ISO 14000, 14001 and 26001; OHSAS 18001.

Unit 2: Ecosystem Management -(a) An overview - Population, Resources and Ecosystem management - Exponential growth in human numbers and the implications. (b) Major management concepts and methodologies: The five basic laws of Ecology and their relevance for ecosystem management; paradigm shifts in the management of Ecosystems - influence of economics in ecology. (c) Management practices for various ecosystems: grasslands, forests, mountains, wetlands and coastal areas. (d) Environmental planning and management of; waste lands, reclaimed lands, mining areas, human settlements, industrial lands and agricultural lands. (e) Eco-restoration/remediation; local knowledge and management systems; environmentally sound management of Biotechnologies; the common property resources and their management.

Unit 3: Solid waste Management - Municipal solid wastes (MSW) - quantities and characteristics, waste collection and transport, waste processing, resources recovery and recycling, incineration, pyrolysis, aerobic and anaerobic systemscomposting, vermicomposting and sanitary landfills and biodigesters (Biogas). Management of plastic and e-waste. Better management strategies (any two model case studies).

Unit 4: Environmental Impact Assessment-- (a) Introduction, definition, history, aim, principles, concept and scope. Baseline data collection, Methods and steps – Ad hoc method, checklist method, matrices, Map overlays method, network method, index method. (b) Impact assessment and impact evaluation: E1A Processes, Stages, E1A Statement. Environment management plan - Risk assessment and disaster management programme. National Policy on EIA. M G University M Sc Botany syllabus 2012 Admission onwards 86 (c) Regulatory Framework: Environmental Impact Assessment Notification 2006 and Coastal Zone Notification 1991; Environmental Clearance Process in India; Legislative requirements (discharge requirements and area restrictions); Environmental Appraisal procedure for mining, industrial, thermal power, nuclear power and multipurpose river valley projects. EIA case studies. Life Cycle Assessment (LCA) and its significance.

Unit 5: Environmental laws and policies --(a) Historical background of environmental law and policy in India. (b) The salient features of the following acts and rules: The water (Prevention and control of pollution) act, 1974; The air (Prevention and control of pollution) act, 1981; The environmental (Protection) act, 1986; The public liability insurance act, 1991; The wildlife protection act, 1972; The forest conservation act, 1980; The biodiversity act, 2002; The hazardous wastes (Management and handling) rules, 1989; The noise pollution (Regulation

and control) rules, 2000. Manufacture, storage and import of hazardous chemicals rules 1989, Biomedical waste (Management and Handling) rules 1998.

Practicals

1. Estimation of BOD and COD of polluted water.
2. Isolation and Enumeration of microorganisms in soil (TBC or TMC) - Types of Bacteria and fungi.
3. Bacteriological quality testing of water and waste water. a. Presumptive Coliform test b. Confirmatory Coliform test. Field Study: (Three/four days)
4. Visit at least one Institution engaged in environment/conservation research and a sanctuary/national park and an industrial/polluted area. Submit a report of the study conducted in a ~10 page write up/print out giving the dates, methodology, results and references. Include photgraphs of the activity.

References

1. Agarwal N K (2004). Essentials of GPS. Spatial Networks Pvt. Ltd.
2. Agarwal N K (2002). Eco-informatics. APH Publishing Corporation.
3. Asit K Biswas et.al., (1987). EIA for Developing Countries. United Nations University, Tokyo. 4. Carter L (1996). Environmental Impact Assessment. McGraw Hill.
5. Coronel C, Morris S, Rob P (2009). Database Systems: Design, Implementation and Management (IX Edn). Course Technology.
6. Eagles P F J (1987). The planning and Management of Environmentally Sensitive areas. Longman Group Ltd.
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19. Meadows D, Randers J, (2004). Limits to Growth: The 30 Year Update. Earthscan.
20. Meffe G K, L Nielson, R Knight, Schenborn (2002). Ecosystem management: Adaptive, Communitybased Conservation. Plenum Press.
21. Miller GT Jr. (2004). Environmental Science. Thomson, California.
22. Milner-Gulland E J, Marcus Rowcliffe (2007). Conservation and sustainable use: A handbook of techniques. Oxford University Press.
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24. Pullin A S (2002). Conservation Biology. Cambridge University Press.
25. Rao D P (Ed) (1998). Remote Sensing for Earth Resources. Association of Exploration Geophysicist, Hyderabad.
26. Simon Dresner (2008). The Principles of Sustainability Solutions. Earthscan paperbacks, The Ecological Footprint Atlas 2010. Oakland: Global Footprint Network.
27. Miller G T Jr. (2005). Advantage Series: Sustaining the Earth: An Integrated Approach. (VII Edn). Thomson/Brooks Cole.
28. Westman W E (1995). Ecology, Impact Assessment and Environmental Planning. John Wiley and sons.
29. World Commission on Environment and Development (1987). 'Our Common Future'. Oxford University Press.

PLM21E07:- Allelopathy and Biological Weed and Pest Control

Unit 1: **Definition & history** - difference between allelospoly, allelopathy and allelomediation, methodology to establish allelopathy, environment hormones, general nature of allelochemics – retention, transformation and transport, mechanisms and process involved in the production of allelochemics.

Sources and release of allelochemicals and methods of isolation bioassay and identification– volatilization, leaching, root exudation, decomposition of plant residues; Mode of action of allelochemics.

Unit 2: **Natural Products as allelochemics** - water-soluble organic acids, simple unsaturated lactones, Long-chain fatty acids and polyacetylenes, Naphthoquinone, anthroquinones and complex quinones , Simple phenols , Benzoic acid and derivates, Cinnamic acid and derivates, Flavonoids , Tannins, Terpenoids and steroids , Amino acids and polypetides , Alkaloids and cyanohydrins, Sulphides and glucosides, Purines and nucleotides, Coumarins, Thiocyanates, Lactones, Actogenins.

Unit 3: Mode of action of allelochemicals: direct and indirect actions, interactions in mineral uptake, cytology and ultra structure, phytohormones and balance, membranes and membrane permeability, photosynthesis and photosynthetic inhibitors, influence on respiration, protein synthesis, enzyme activity, conducting tissue, water relations, genetic material – factors affecting the production of allelochemics, allelopathy and soil microbes.

Unit 4: Application of allelopathy studies - understand the problems in improving the production of manipulated ecosystems, explanation for a specific vegetational pattern, understand the effect of weeds on crops, crops on weeds and crops on crops – biological weed control – role of allelopathy in weed science – application in weed control.

Allelopathy Practical : (2 hours per week**)**

Separation and chemical characterization of allelochemicals.

Reference

1. Aldrich JD (1984)Weed-crop ecology: Principles and practices, Breton Publishers
2. Rizvi SJH & V Rizvi Edited (1992) Allelopathy: Basic and applied aspects. Chapmann & Hall Publishers
3. Chou CH & GR Waller Edited (1989) Phytochemical Ecology: Allelochemicals, Mycotoxins and Insect Pheromones and Allomones. Institute of Botany. Academia Sinica Monographs Series No 9. Taipei
4. Dale Walters (2010) Plant Defense: Warding off attack by pathogens, herbivores and parasitic plants, Wiley Blackwell

5. Rice EL (1984) Allelopathy. 2nd edition. Academic Press
6. Inderjit and Mukerji KG Edited (2006) Allelochemicals: Biological Control of Plant Pathogens and Diseases, Springer
7. Zeng et al Edited (2008) Allelopathy in Sustainable Agriculture and Forestry, Springer
8. Francisco A Macias et al (2003) Allelopathy: Chemistry and Mode of Action of Allelochemicals

SEMESTER – II

PLM21C09: - Phycology

Unit 1: Introduction - History of algal studies in India – classifications – detailed study of the classification by FE Fritsch and GM Smith-Modern trends and criteria for algal classification.

Unit 2: General Features of Major Classes of Algae: Cell wall, flagella, eye-spot, pigments, pyrenoid, photosynthetic products. Range of structure of thalli and the evolution of thalli; Reproduction in algae - different methods of reproduction, evolution of sex organs - major patterns of life cycle and post fertilization stages in Chlorophyta, Xanthophyta, Phaeophyta and Rhodophyta - Fossil algae.

Unit 3: Biochemistry of Algae: Biochemistry of algal cell wall; algal biomolecules — carbohydrates, lipids and proteins in algae; chemistry of pyrenoids, pigments, oil and proteins and amino acids of algae – chemistry of algal hydrogen production.

Unit 4: Algal biotechnology: Methods and techniques of collection, preservation and staining of Algae - Algal culture - importance, methods and algal culture media – algal bioreactors – mass production of algal biomass – application of biotechnology in algal strain improvements – algal genomic DNA, Plastid and mitochondrial DNA – algal molecular taxonomy.

Unit 5: Ecological and Economic importance of Algae. Productivity of fresh water and marine environment; Algae in symbiotic association, Algae in polluted habitat, Algal blooms, algal bioremediation – algae as eco-indicators - algae as food, fodder, biofertilizer, medicine, industrial uses, and fuel from algae. Harmful effects of algae - Use of Algae in experimental studies.

Phycology Practical

1. **Critical study of diagnostic features and identification of the following genera based on morphological, anatomical and reproductive parts**

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

(b) Chlorophyceae - *Chlamydomonas, Gonium, Eudorina, Pandorina, Volvox, Chlorella, Tetraspora, Chlorococcum, Haematococcus, Scenedesmus, Ulothrix, Microspora, Ulva, Cladophora, Pithophora. Coleochaete, Chaetophora, Drapernaldia, Drapernaldiopsis, Trentepohlia, Fritschiella, Cephaleuros, Oedogonium, Bulbochaete, Zygnema, Mougeotia, Sirogonium. Desmedium, Bryopsis, Acetabularia, Codium, Caulerpa, Halimeda, Chara, Nitella.*

(c) Xanthophyceae – *Vaucheria.*

(d) Bacillariophyceae - *Biddulphia, Pinnularia.*

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

(f) Rhodophyceae- *Batrachospermum, Gelidium, Amphiroa, Gracilaria, Polysiphonia*.

2. Field collection of algal specimens.

3. Isolation and monoculture of algae.

References

1. Bold HC and Wynne MJ Wall (1985) Introduction to the algae: structure and reproduction. 3rd Edition, Prentice Hall
2. Lee RE (2009) Phycology. 4th edition. Cambridge University Press
3. Van der Hock DG Mann and Johns, H. M. (1995)An Introduction to Phycology, Cambridge University Press
4. Barsanti, Laura and Paolo Gualitieri (2005) Algal-Anatomy, biochemistry and Biotechnology. Taylor and Francis, London, New York
5. Becker EW (1994) Microalgae- Biotechnology and Microbiology, Cambridge University Press
6. Fritsch F E (Vol. I, II) (1977) The structure and reproduction of Algae, Cambridge University Press
7. Pringsheim EG (1949) Pure culture of Algae, Cambridge University Press
8. Trivedi PC (2001) Algal Biotechnology, Pointer Publishers, Jaipur, India
9. Stein JR (1978) Hand Book of Phycological Methods Vol I & Vol II, Cambridge University Press

PLM21C10: - Bryology, Pteridology & Gymnosperms

Unit 1: Bryology: Introduction to bryophytes, their fossil history and evolution. Concept of algal and pteridophytic origin of Bryophytes, General characters of bryophytes, History of classification of bryophytes; Variations in the Thallus structure and Reproduction of Bryophytes: Comparative structural organization of gametophytes and sporophytes - asexual and sexual reproductive structures - spore dispersal mechanisms and germination of the following groups with reference to the types mentioned in the practical (a) Hepaticopsida (Sphaerocarpales, Marchantiales, Jungermanniales and Calobryales) (b) Anthocerotopsida (Anthocerotales) (c) Bryopsida (Sphagnales, Polytrichales and Bryales).

Unit 2: Evolutionary trends, Ecology and Economic importance of Bryophytes – evolutionary tendency of gametophytes and sporophytes – fossil bryophytes.

Ecology of Bryophytes (a) their **w**ater relations - absorption and conduction, xerophytic adaptations, drought tolerance, dessication and rehydration, ectohydric, endohydric and myxohydric bryophytes (b) Ecological significance of Bryophytes - role as pollution indicators; Economic Importance - Bryophytes used as medicines, food, fuel. Bryophytes as an experimental material/model organism (*Physcomitrella patens*).

Unit -3: Pteridology: General introduction and classification of Pteridophytes: origin, general characteristics and classification of Pteridophytes. The geological time scale and a study of fossil Pteridophytes (Rhinia, Horneophyton, Lepidodendron, Calamites, Cladoxylon, Sphenophyllales, Coenopteridales).

Detailed study of primitive pteridophytes: Distribution, habitat, range, external and internal morphology of sporophytes, spores, mechanism of spore dispersal, gametophytic generation, sexuality, and embryogeny of the following classes of primitive Pteridophytes with reference to the genera mentioned: 1. **Psilopsida** (a) Rhyniales; *Rhynia;* **2. Psilotopsida** (a) Psilotales; *Psilotum;* **3. Lycopsida** (a) Protolepidodendrales; *Protolepidodendron* (b) Lycopodiales; *Lycopodium,* (c) Isoetales; *Isoetes* (d) Selaginellales; *Selaginella*; **4. Sphenopsida** (a) Hyeniales (b) Sphenophyllales; *Sphenophyllum* (c) Calamitales; *Calamites* (d) Equisetales; *Equisetum.*

Unit 4: Morphology, anatomy and reproduction in Pteropsida (i) Primofilices (a) Cladoxylales; *Cladoxylon* (b) Coenopteridales. (ii) Eusporangiatae (a) Marattiales; *Angiopteris* (b) Ophioglossales; *Ophioglossum*. (iii) Osmundales; *Osmunda*. (iv) Leptosporangiatae (a) Marsileales; *Marsilea* (b) Salviniales; *Salvinia*, *Azolla* (c) Filicales; *Pteris*, *Lygodium*, *Acrostichum, Gleichenia, Adiantum.*

Comparative study of Pteridophytes: Stelar organization, soral and sporangial characters, gametophytes and sporophytes of Pteridophytes from an evolutionary perspective,. Telome theory of Zimmerman and Enation theory of Bower.

Ecological and Economic importance: Role in soil formation, phytoremediation, importance as ornamentals – major ornamental species

Unit -5: Gymnosperms: Introduction: Origin, general characteristics, distribution and classification of Gymnosperms, Distribution of living gymnosperms in India.

Vegetative and reproductive structures of Gymnosperms: Detailed study of the vegetative morphology, internal structure, reproductive structures, and evolution of the orders and families (with reference to the genera mentioned); (a) Class Progymnospermopsida: *Aneurophyton* (b) Class Cycadopsida: *Heterangium, Lyginopteris, Lagenostoma, Glossopteris, Medullosa, Caytonia. Bennettites, Williamsoniella, Nilsonia, Cycas, Zamia, Pentoxylon* (c) Class Coniferopsida: General account of families under Coniferales, range of form and structure of stem, leaves; range of form, structure and evolution of female cones in coniferales such as *Pinus, Taxodium, Cupressus, Podocarpus, Agathis, Araucaria, Taxus and Ginkgo* (d) Class Gnetopsida: *Gnetum.*

Gametophyte development and economic importance of Gymnosperms: General account of male and female gametophyte development in Gymnosperms (Cycas); Economic significance of Gymnosperms.

Paleobotany: Fossils and ideal conditions for fossilization, Kinds of fossils-impressions, casts, molds, petrifactions and coal ball. Geological time scale-era, period, epoch, evolution of the different flora. Brief study of the following fossils-Lepidodendron, Lepidocarpon and Calamites. Importance of Paleobotany.

Practical :

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

2. **Pteridology :** Study of morphology and anatomy of vegetative and reproductive organs using clear whole mounts/sections of the following genera: *Psilotum, Lycopodium, Isoetes, Selaginella, Equisetum, Angiopteris, Ophioglossum, Osmunda Marsilea, Salvinia, Azolla, Lygodium, Acrostichum, Gleichenia, Pteris, Adiantum, Polypodium and Asplenium;* Study of fossil Pteridophytes with the help of specimens and permanent slides

3. Gymnosperm :

1. Study of the morphology and anatomy of vegetative and reproductive parts of Cycas, Zamia, Pinus, Cupressus, Agathis, Araucaria and Gnetum.
2. Study of fossil gymnosperms through specimens and permanent slides.
3. Conduct field trips to familiarise various gymnosperms in nature and field identification of Indian gymnosperms and submit a report.

References

1. Schefield WB (1985) Introduction to Bryology, Mermilan Publishing Company. New York
2. Chopra RN, PK Kumar (1988) Biology of Bryophytes, Wiley Eastern Ltd
3. Rashid A (1981) An Introduction to Bryophyta, Vikas publishing house Pvt. Ltd
4. Richardson DHS (1981), Biology of Mosses, Blackwell Scientific publications, Oxford
5. Vashishta BR, AK Sinha and A Kumar (2003) Bryophyta, S Chand & Co. Ltd
6. Udak R (1976) Bryology in India, Chronica Botanica Co
7. Pandey B P (1994) Bryophyta, *S* Chand and Co. Ltd
8. Goffinet B and AJ Shaw (2009), Bryophytic Biology 2nd Ed., Cambridge University Press
9. Dyer AF and JG Duckett Edited (1984), The experimental Biology of Bryophytes,
10. Academic Press
11. Bonver FO (1935) Primitive land plants, MacMillan & Co. Ltd
12. Campbell D (1940) The evolution of land plants, Stanford University Press

PLM21C11: - Mycology and Plant Pathology

Unit 1: Introduction to fungi, and fungal stramenopiles; their morphology and reproduction: General characteristics of 'true fungi' and fungal stramenopiles; their life cycle pattern and their phylogenetic relationship with plants and animals, Chemotaxonomic value of Lysine biosynthetic pathway in mycology.

Unit 2 - Classification of fungi and fungal stamenopiles down to the ordinal rank:-
Kingom Fungi – Chytridomycota, Zygomycota, Ascomycota and Basidiomycota.
Kingdom Stramenopila – Oomycota

Unit 3: Fungal-plant associations and Economic importance of fungi:

(a) Lichen: Occurrence; General characteristics; Growth forms and range of somatic organization; nature of association of photobionts and mycobionts and their reproduction. Physiological aspects of lichen thalli.

(b) Mycorrhiza: Ectomycorrhiza,, Endomycorrhiza and their significance. Common fungal parasites of plants.

(c) Economic importance : Role of fungi in the decomposition of organic matter - coprophilous fungi, cellulolytic fungi, lignolytic fungi; Fungi as food – single cell proteins, fungi as food spoiler – food toxicity – aflatoxins; role of fungi in fermentation – bioreactors - fungal antibiotics and vitamins, drugs and hallucinogens.

Unit 4: Plant Pathology – Introduction to Viral, Bacterial and Fungal Diseases in plants, defence mechanisms in plants: structural and biochemical. Fungal deterioration of fruits and vegetables - control measures, Molecular plant pathology: Molecular aspects of host pathogen interactions - PR proteins, degradation of phytoalexins, systemic resistance mechanism; application of molecular biology to plant disease control - transgenic approach for crop protection, engineering chemicals that elicit defence response to plants.

Major microbial diseases in plants (a) Cereals: Rice - blast disease, bacterial blight; Wheat - black rust disease (b) Vegetables: Chilly - leaf spot; Ladies finger - vein clearing disease (c) Fruits: Banana - bacterial leaf blight, leaf spot; Mango - Anthracnose; Citrus canker; Papaya – mosaic (d) Spices: Ginger - rhizome rot; Pepper - quick wilt; Cardamom - marble mosaic disease (e) Oil seeds: Coconut - grey leaf spot, bud rot disease (f) Rubber - abnormal leaf fall, powdery mildew (g) Sugarcane - red rot; root knot nematode (h) Cash crops: Arecanut - nut fall disease (i) Tea - blister blight; Coffee – rust.

Practical

Mycology and Plant Pathology Practical

Mycology

1. Critical study of the following fungal species by preparing suitable micro-preparations; *Saprolegnia, Phytophthora, Albugo, Mucor, Aspergillus, Penicillium, Pilobolous, Saccharomyces, Xylaria, Peziza, Puccinia, Pleurotus, Auricularia, Polyporus, Lycoperdon, Dictyophora, Geastrum, Cyathus, Fusarium, Alternaria, Graphis, Parmelia, Cladonia, Usnea.*
2. Isolation of fungi from soil and water by culture plate technique.
3. Estimation of mycorrhizal colonization in root.
4. Collection and identification of common field mushrooms (5 types).
5. **Lichens**
   Study of thallus and reproductive structures of different lichens.
6. **Plant Pathology**
   Herbarium specimens of bacterial diseases, Viral diseases and Fungal diseases.

Reference

1. Ananthanarayan R and CKG Paniker (2009) Text book of Microbiology 8th Edition, Universities Press
2. Flores E and A Hrrero Edited (2014) Cell biology of Cyanobacteria, Caister Academic Press
3. Remaut H and R Fronzes (2014), Bacterial Membranes, Bacterial Membranes –Structural and Molecular Biology, Caister Academic Press
4. Ullrich M (2009) Bacterial Polysaccharides, Caister Academic Press
5. John GH et al Edited (1993) Bergey's manual of determinative bacteriology, Baltimore
6. George MG Edited (2001) Bergey's manual of systematic bacteriology, Springer
7. Benson HJ (2012) Benson's microbiological applications : laboratory manual in general microbiology, McGraw-Hill
8. Allen IL and Hubert AL Edited (1982) CRC handbook of microbiology, CRC Press
9. Collins CH et al Edited (1989) Collins and Lyne's microbiological methods 6th Edition, Butterworths
10. Vasanthakumary R (2007) Text Book of Microbiology, BI Publ. Pvt Ltd
11. Wagner EK and Hewlett JM (2004) Basic Virology, Blackwell Science
12. Alexopoulos CJ (1977) Introductory Mycology, Blackwell
13. Jim Deacon (2006) Fungal Biology (IV Edn), Blackwell Publishing
14. Nair LN (2010), Methods of microbial and plant biotechnology, New Central Book agency
15. Dube HC (1983) An introduction to fungi, Vikas Publ. New Delhi.
16. Nair MC and S Balakrishnan (1986) Beneficial fungi and their utilization, Sci. Publ. Jhodpur
17. Webster J and Weber R (2007) Introduction to Fungi, Cambridge University Press
18. Sethi IK and Walia SK (2011) Text book of Fungi and Their Allies, Macmillan Publ.
19. Sharma PD (2011) Plant Pathology, Rastogi Publication, Meerut, India.

PLM21C12: - Angiosperm Systematics Part-II

Unit - 1 Bentham and Hooker System of Classification

Unit – 2 Detailed exposition of phenotypic Characters, Phylogeny and economic importance of the following families belonging to Polypetalae.

1.Ranunculaceae, 2. Magnoliaceae, 3. Menispermaceae, 4. Annonaceae, 5. Brassicaceae s.s, 6. Polygalaceae, 7. Caryophyllaceae, 8. Clusiaceae, 9. Dipterocarpaceae, 10. Malvaceae s.s, 11. Sterculiaceae, 12. Tiliaceae, 13. Rutaceae, 14. Meliaceae, 15. Vitaceae, 16. Sapindaceae, 17. Fabaceae, 18. Rosaceae, 19. Rhizophoraceae, 20. Melastomaceae, 21. Myrtaceae, 22. Cucurbitaceae, 23. Aizoaceae, 24. Apiaceae.

UNIT -3 Detailed exposition of phenotypic characters, phylogeny and economic importance of the following families belonging to Gamopetalae, Monochlamydeae and Monocotyledoneae.

1.Rubiaceae, 2. Asteraceae, 3. Sapotaceae, 4. Oleaceae, 5. Apocynaceae s.s, 6. Asclepiadaceae, 7. Gentianaceae, 8. Boraginaceae, 9. Convolvulaceae, 10. Solanaceae, 11. Scrophulariaceae, 12. Acanthaceae, 13. Verbenaceae, 14. Lamiaceae, 15. Amaranthaceae, 16. Nyctaginaceae, 17. Aristolochiaceae, 18. Lauraceae, 19. Loranthaceae, 20. Euphorbiaceae, 21. Orchidaceae, 22. Zingiberaceae, 23. Cannaceae, 24. Musaceae, 25. Cyperaceae, 26. Poaceae.

Unit - 4 Principles and Applications of Ethnobotany

Introduction, history and development of ethnobotanical studies, methods in Ethnobotanical study, traditional Botanical Knowledge and subsistence and role of ethnobotany in sustainable development.

Taxonomy Practical

1. In the laboratory record, each family should be represented by a minimum of two different species with suitable sketches and description in technical terms.
2. Identification of taxa down to the species rank using the keys presented in the Flora of the Presidency of Madras.
3. Preparation of dichotomous keys based on 4 randomly chosen specimens belonging to different taxa.
4. Students should familiarize with most of the economically and ethnobotanically important plants belonging to families prescribed in the syllabus.

Field Study:

Field studies which span a period of at least 5 days must be conducted under the guidance and supervision of teachers. A minimum of 75 herbarium specimens representing all the prescribed familial taxa are to be prepared and submitted with field books having duly documented data.

References

1. Paye GD (2000) Cultural Uses of Plants: A Guide to Learning about Ethnobotany, The New York Botanical Garden Press.

2. Hooker JD, The flora of British India (Vol. I – VII),
3. Gamble JS, Flora of the Presidency of Madras (Vol. I – III).
4. Cronquist A (1981) An integrated system of classification of flowering plants, Columbia University Press
5. Heywood VH, Moore D M Edited (1984) Current concepts in Plant taxonomy
6. Radiford AE (1986) Fundamentals of plant systematic, Harper & Row.
7. Rendle AE (1970) Classification of flowering plants, Vikas Co.
8. Stace CA (1989) Plant Taxonomy and Biosystematics (II Edn), CBS Publ.
9. Woodland DW (1991) Contemporary Plant Systematics, Prentice Hall.
10. Sivarajan VV (1991*)*, Introduction to Principles of Plant Taxonomy, Oxford IBH.
11. Takhtajan AL (1997), Diversity and Classification of Flowering Plants, Columbia Univ. Press

PLM21E13: - Phytochemistry

Unit 1: Extraction: Introduction, definition, factors influencing the choice of extraction, principles of extraction methods; Selection and purification of solvents for extraction; Types (Conventional and advanced techniques) of extraction and their merits and demerits.

Unit 2: Glycosides and Vitamins*:* Introduction, Definition, Classification, Nomenclature, Source, importance, Structure, chemistry, structural elucidation of cardiac glycosides - digoxin, Anthracene glycosides - Sennosides. **Vitamins*:*** Introduction, Definition, Classification, Nomenclature, Source, importance, Structure, chemistry, structural elucidation of Ascorbic acid.

Unit 3: Steroids: Introduction, Definition, Classification, Nomenclature, Source, importance, Structure, chemistry, structural elucidation of cholesterol.

Unit 4: Terpenoids and Natural Pigments*:* Introduction, Definition, Classification, Nomenclature, Source, importance, Structure , chemistry , structural elucidation of Citral, Menthol and Zingiberene; ***Natural Pigments:*** Introduction, Definition, Classification, Nomenclature, Source, importance, Structure , chemistry , structural elucidation of Carotene, Lycopene, Bixin , Chlorophyll, Quercetine and Indigotine.

Unit 5: Natural products as markers for new drug discovery: The Role of natural products as potential new drug discovery, Selection and optimization of lead compounds for further development with suitable examples.
Methods of isolation,(including industrial methods) purification and characterization of following natural products: Citric acid, Pectin, Sennosides, Lawsone, Phyllanthin, Bacosides, Lycopene, Hesperidin, Diosgenin, Curcumin, Lemon grass oil and Caffeine.

Phytochemistry Practical :

1. Isolation and characterization of pectin from Orange peel.
2. Isolation and characterization of Citric acid from Lemon.
3. Isolation and characterization of sennosides from Senna.
4. Isolation and characterization of Laswone from Henna.
5. Isolation and characterization of Diosgeninfrom Diascorea.
6. Isolation and characterization of Beta carotene from Daccus.
7. Isolation and characterization of Lycopene from tamato.
8. Isolation and characterization of naringin from Grapes.
9. Isolation and characterization of Eugenol from Clove.
10. Isolation and characterization of Curcumine from Turmeric

Reference

1. Thomson RH Edited (1994) The Chemistry of Natural Products, Springer.
2. Peter B. Kaufman (1998)Natural Products from Plants, 1st edition, by, CRC Press, NewYork.
3. Raphael Ikan (1991) Natural products: A lab guide 2nd Edition, Academic Press.
4. Harbone JB (1998)Phytochemical methods of chemical analysis, Spriner.
5. Brain KR & TD Turner (1975) Practical Evaluation of Phytopharmaceuticals, Bristol: Wright-Scientechnica.

PLM21E14: - Applied Marine Phycology

Unit 1: Introduction to Marine habitat and marine algal wealth – classification of marine algae; biochemical composition of different economically significant groups – proteins, amino acids, lipids, glycerol, vitamins, pigments, chlorophyll, carotenoids, phycobilins – toxic marine algae – algicides; measure of primary production , factors influencing primary production of marine algae – assessment of fishery resources on the basis of algal resources – marine food chain.

Unit -2: Culture of Marine Micro algae –nutrition – factors affecting growth; algal growth kinetics, isolation methods – development of monocultures and auxenic cultures – mass culture of marine micro-algae – statistical designing, modelling and optimization in mass production, open pond design and management; Photobioreactors – design considerations, Fermentors – heterotrophic production – maintenance of mass cultures – biomass harvesting and processing techniques – preservation methods – production of industrial species of microalgae – case studies – national status of marine microalgal production – culture of macro-algae - bioprocess engineering of seaweed tissue culture – maintenance of macro-algal culture – advances in seaweed culture.

Unit 3: Process and products from Marine algae: Marine algae in human and animal nutrition, aquaculture and cosmetics, high value products from algae – polysaccharides, lipids, pigments, hydrocarbons, bioplastics, other chemicals – production, recovery and application. Biofertilizers from marine algae – production procedures; Stable isotope biochemicals from marine algae; Antimicrobials toxins and other bioactive compounds; Marine algae in bioremediation, algal immobilization and application, Marine algae for enhancement of marine productivity, climate stabilization and food security.

Unit 4: Marine algae and bioenergy: bio-fuels from marine micro-algae, biodiesel from algal biomass – screening methods, analysis of lipids, optimization of production, extraction of oil; methods for conversion to biodiesel; Biochemical, genetic and metabolic engineering of the lipid metabolism; Marine algae for hydrogen production – induction and analysis of hydrogen production, strategies to enhance hydrogen production; Marine algae useful in Methane production – Marine algae for bio-ethanol – process and methods for analyses; Bio-energy from Macro-algae – selection of species, biomass processing, butanol production – by-products from algal bio-fuel production – economic importance of bio-energy from marine algae – concept of marine bio-refinery.

Reference

1. Richmond A (2004) Handbook of microalgal culture: Biotechnology and applied phycology, Blackwell Sciences Ltd
2. Anderson RA (2005) Algal culturing techniques, Elsevier Academic Press
3. Becker EW (1994) Microalgae: Biotechnology and Microbiology, Cambridge University Press
4. Cohen Z (1999) Chemicals from Microalgae, Taylor & Francis Ltd

5. Graham LE and Wilcox LW (2000) Algae, Prentice Hall
6. Chen F and Jian Y (2001) Algae and their biotechnological Potential, Kluwer Academic Publ.
7. Chapman VJ and DJ Chapman (1980) Seaweeds and their uses, Methuen and Co Ltd
8. Jefford CW, KL Rinehart and LS Shield (1988) Pharmaceuticals and the Se, Technomic Publ.
9. Riley JP and Skirrow G (1975) Chemical Oceanography Vol IV, Academic Press.

Practicals

Extraction of phyco-colloids from marine algae – extraction and characterization of common bioactive compounds and toxins from marine algae – measurement of algal productivity – oxygen method and isotopic methods.

Field Work: Students are expected to visit field for collection and field identification of botanical specimens of all kinds and prepare field book as well as Herbarium and Museum Specimens: Compulsory study tour to specific environments to identify the botanical specimens are also included in this head.

SEMESTER - III

PLM21C16: - Molecular Biology & Genetic Engineering

Unit-1: Introduction to molecular Biology: History and scope of molecular biology- Historical developments of molecular biology; Nucleic acids as genetic material- Organization of eukaryotic genome- components of eukaryotic chromatin- chromatin and chromosome structure- DNA-super coiling - DNA replication- Prokaryotic and eukaryotic DNA replication- Enzymes and necessary proteins in DNA replication-Telomeres, telomerase and role of telomerase in aging and cancer- Transcription- Prokaryotic and eukaryotic Transcription- RNA polymerases- general and specific transcription factors- regulatory elements- mechanism of transcription regulation- Transcription termination Post transcriptional modifications- Translation- Genetic code- Prokaryotic and eukaryotic translational machinery – cell signalling, cell communication and protein trafficking. Molecular basis of mutations- DNA repair mechanisms.

Unit- 2: Genomes, Vectors and recombinant DNA technology: The genomes of bacteria, viruses, plasmids, mitochondria and chloroplast- Gene transfer in microorganisms; DNA sequencing; DNA modifying enzymes and vectors- types of vectors; Methods of recombinant DNA technology; Nucleic acid hybridization; Gene libraries; PCR amplifications, Molecular markers and their applications; Molecular tools for the detection of plant pathogens. Molecular probes- Different molecular methods for the identification of pathogens. Molecular Biology of disease resistance and plant microbial interactions. Gene-for-gene interaction - quorum sensing; Genomics, transcriptomics and proteomics.

Unit- 3: Nucleic acids – isolation, synthesis, cloning and gene library: Isolation and purification of DNA (genomic and plasmid) and RNA -Phosphodiester, phosphotriester and phosphite-triester method of DNA synthesis (Brief study only) Phosphoramidite method, automated DNA synthesis - Artificial genome synthesis -Procedure of cDNA synthesis, reverse transcriptase PCR.

Modern cloning vectors: M13, pUC, artificial chromosomes – YAC, BAC, PAC, HAC – important features, construction and applications of each.

Gene library Genomic and cDNA library - Procedure for the construction of a genomic library using phage λ system - Identification of desirable clones from library – hybridization probing, colony and plaque hybridization probing, immunological screening. Locating and isolating a gene - *in situ* hybridization, positional cloning, chromosome walking and jumping.

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

Unit -4: Plant transformation and advanced transgenic technology: *(a) Agrobacterium tumefaciens* mediated gene transfer in plants - details of vector system based on *A.tumefaciens*, binary vector and cointegrate vector - Steps involved in *Agrobacterium* mediated gene transfer to plants (b) Plant transformation by direct transfer of DNA (Vectorless methods) - microprojectiles, electroporation, microinjection, chemica, lipofection (c) Details of the creation of Bt plants, Golden rice, *Flavr Savr* Tomato.

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

Unit 5: Protein engineering and Biosensors Applications of protein engineering, protein modification by site-directed mutagenesis - combinatorial methods.

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

Applications of rDNA technology: Uses of GM microbes: Bacteria and yeast - producing useful proteins, basic genetic research, Applications of GM animals in basic research, producing novel proteins; disease studies, prevention and cure of diseases Uses of transgenic plants: Herbicide, insect and disease resistance, stress resistance. Genetic engineering for increasing nutritional and other novel qualities in plants.

Molecular Biology & Genetic Engineering Practical:

1. Plasmid DNA extraction from bacteria and its quantification by using UV spectrophotometer.
2. Genomic DNA isolation from plant cell, chloroplast and mitochondria.
3. Agarose gel Electrophoresis and elution of DNA.
4. Isolation of plasmids and its purification
5. Restriction enzyme digestion, ligation, transformation and screening of transformants.
6. Restriction mapping of genomic and plasmid DNA.
7. Bacterial transformation.
8. Extraction and quantification of protein by Bradford method.
9. SDS-PAGE analysis, Western Blot analysis,
10. PCR.

Reference

1. Lewin B (2007) Genes IX, Jones & Bartlet
2. Malacinski GM and Freifelder D (1998) Essentials of Molecular Biology 3rd Edition, Jones & Bartlett Publishers.
3. Primrose SB (2001) Molecular Biotechnology, 2nd edition, Wiley & Blackwell
4. Watson JD et al (2008) Molecular Biology of the Gene 6th Edition, Pearson Education International

5. Jocelyn EK et al (2012) Lewin's Genes XI, 11th Edition, Jones and Barlett Pub., USA
6. Robert F Weaver (2011) Molecular Biology, 5th Edition, McGraw-Hill.
7. Gurr SJ et al(1998) Molecular Plant Pathology, Oxford University Press
8. Chrispeels MJ and DE Sadava (2003) Plants, Genes and Crop Biotechnology, Jones and Bartlett Publishers
9. Marshell G and D Walters(1996) Molecular Biology in Crop Protection, Kluwer Academic Publishers
10. Lodish H et al (2012) Molecular Cell Biology, 7th Edition, WH Freeman & Co

PLM21C17: - Plant Physiology & Biophysics

Unit 1 - Water and ionic relations in Plant life: The Physical and Chemical Attributes of water which qualify it as the "Solvent of life" (Intermolecular hydrogen bonds, high specific heat capacity, high latent heat of vaporization, tensile strength cohesion, adhesion, and capillarity), Quantitative study of diffusion, osmosis and bulk flow. Concept of water potential (ψ_w) ; its derivation from the chemical potential of water (μ_w); and its components ($\psi_s, \psi_{p,} \psi_m, and\ \psi_g$), Uptake and translocation of water through the soil-plant –atmosphere continuum. Apoplast, Symplast and transmembrane pathways Root Pressure, Cohesion-Tension theory, Cavitation and Embolism.

Membrane Transport: Components of plant cell membrane transport systems-Pumps, Channels and cotransporters, A detailed study of transmembrane electrochemical potential.

ATP ases - F-type, PMH^+-, and H^+- PPase.

Ion channels - K^+ - and Ca^{2+} channels.
Water transport through aquaporins.

Unit 2 - Intermediary metabolism: A comprehensive study of the given primary metabolic pathways without compromising biochemical and biophysical aspects: Gluconeogenesis in plants, Biosynthesis of fatty acids, triacylglycerols and plant cell membrane lipids.

Aerobic respiration – glycolysis, oxidative decarboxylation of pyruvate. Citric acid cycle, plant mitochondrial electron transfer and ATP synthesis.

Photo synthesis - General concepts, Key experiments in understanding photosynthesis, Organization of photosynthetic Apparatus and light-Absorbing Antenna Systems, Mechanisms of electron and proton transport (chemiosmotic hypothesis) and ATP synthesis in chloroplasts Calvin-Benson Cycle. C_2 Oxidative photosynthetic carbon cycle, C_4 Carbon cycle and crassulacean Acid Metabolism (CAM).

Accumulation and partitioning of photosynthates, formation and mobilization of starch in chloroplasts, Sucrose biosynthesis.

Nucleic acid metabolism: Biosyntheses of purines and pyrimidines.

Nitrogen metabolism: Nitrate and Ammonium assimilation; GS-GOGAT pathway; and Aminoacid biosynthesis.

Sulphate assimilation: reduction of sulphate to cysteine; synthesis of methionine from cysteine.

Unit 3 - Plant secondary metabolites (Natural products)

Terpenoids - Definition, classification and their important ecological roles in plants, biosynthesis of IPP and DMAPP via mevalonate pathway, Cyanogenic glycosides and their role as plant defence compounds, Glucosinolates (a brief account).

Alkaloids - History of human use of alkaloids, role of physiologically active alkaloids in plant chemical defences (Examples to be discussed must include Vincristine, Strychnine, Quinine, Nicotine, Morphine, Coniine, Codeine, Cocaine, Caffeine, Atropine Hyoscyamine, and Ajmaline.

Plant phenolic compounds: Definition, classification and evolution of phenolics, benefits of phenolics to humans, Phenyl propanoid and phenyl propanoid acetate pathways.

Phytoalexins – Their structural and functional characteristics.

Unit 4 - Plant Growth and development; abiotic stress

Plant hormones: Biosynthesis, storage, breakdown and transport of phytohormones; their physiological effects and mechanisms of action. Seed development and germination.
Photo-morphogenesis: photo-receptors, phytochrome.
Physiology of flowering: photoperiodism and vernalization.
Abiotic stress: Physiological and biochemical perturbations caused water deficit, flooding, salinity, high temperature and freezing. HSPs, ROS, compatible solutes and antioxidative enzymes – SOD, Ascorbate peroxidise, Catalase and Glutathione peroxidise.

Unit -5: Biophysics: Microscopy & Spectroscopy: Principles of microscopy – Types of microscopes - simple and compound; Stereomicroscope, Phase contrast microscope, Fluorescence microscope, Polarization microscope, confocal microscope and electron microscope (TEM & SEM). Specimen preparation for transmission electron microscopy: Material collection, fixing, dehydration, embedding, sectioning (glass knife preparation, grid preparation, ultra-microtome) and staining Micrometry; Photomicrography and microphotography.

Spectroscopy – electromagnetic spectrum – spectrophotometry – uv-spectrophotometers – colourimetry – IR – NMR – X-Ray Diffraction.

Instrumentation for Separations (1) Centrifuges (Table top centrifuge and ultra centrifuge) (2) Chromatography: Principles and application; paper, TLC, Column chromatography, GC, HPLC (3) Electrophoresis - AGE- SDS PAGE.

Plant Physiology and Biophysics Practicals

Physiology

1. Estimation of total proteins – Lowry's methods.
2. Estimation of total phenols
3. Estimation of Proline
4. Identification of CAM plants
5. Determination of Hill activity
6. Absorption spectra and quantification of total chlorophyll and carotenoids in 5 plant species.

Bio Physics

1. **Micrometry -** Calibrate the ocular micrometer stage micrometer on a light microscope and measure the size of an object (e.g., diameter of spore/pollen grains, width of algal filaments).
2. **Separation** – using Centrifuge/Chromatography.
3. **Spectrophotometric and colourimetric estimations –** estimation of nitrogen and phosphorus in soils/plant tissues.
4. **Separation Techniques:** separation of amino acids by paper chromatography; Separation of amino acids/lipids/sugars/plant pigments by TLC; Separation of plant pigments by column chromatography.

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2. Sharma PD (2002) Plant Physiology
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4. Taiz L and E Zeiger (2010) Plant Physiology, Sinauer Associates
5. Nilsen ET and DM Orcutt (1996) The Physiology of Plants Under Stress - Abiotic Factors, wiley
6. Peter Scott (2008) Physiology and Behaviour of Plants,Wiley-Blackwell
7. Holbrook M N and M Zwieniecki (2005)Vascular Transport in Plants, Academic Press
8. Dey PM and JB Harborne(1997)Plant Biochemistry, Academic Press
9. Heldt H and B Piechulla (2010) Plant Biochemistry, Academic Press
10. Gleason F and Chollet R(2011)Plant Biochemistry, Jones and Bartlett Publishers
11. Wilson and Walker (2000)Principles and Techniques of Practical Biochemistry, Cambridge
12. David T Plummer (2008) An Introduction to Practical Biochemistry, TATA McGraw Hill.
13. Sopory AP et al (2010) Abiotic stress Adaptation in Plants-Physiological, Molecular and Genomic Foundation, Springer
14. David S. Seigler (1998), Plant Secondary Metabolism, Springer

PLM21C18: - Anatomy, Embryology and Developmental Biology of Plants

Unit -1: Introduction: Scope and significance of plant anatomy, interdisciplinary relations – history of the studies. Applications of anatomy in systematics (histotaxonomy) and Pharmacognosy. Stages of development of primary meristem and theories of apical organization, origin of branches and lateral roots – root-stem transition - primary thickening meristem (PTM) in monocots. Reproductive apex in angiosperms.

Secondary growth in plants: (a) Vascular cambium and cork cambium: Structure and function, factors affecting cambial activity (b) Secondary xylem and phloem: Ontogeny, structure and function. Lignification patterns of xylem (c) Reaction wood: Compression wood and tension wood. Factors affecting reaction wood formation (d) Anomalous secondary growth in dicots and monocots (e) Wood: Physical, chemical and mechanical properties (f) Plant fibers: Distribution, structure and commercial importance of coir, jute, and cotton.

Unit -2: Leaf, Node, Floral, Fruit and Seed anatomy: (a) Leaf: Initiation, plastochronic changes, ontogeny and structure of leaf. Structure, development and classification of stomata and trichomes. Krantz anatomy, anatomical peculiarities in CAM plants. Leaf abscission (b) Nodal anatomy: Unilacunar, trilacunar and multilacunar nodes, nodal evolution.

Ecological anatomy and Applied anatomy Morphological and structural adaptations in different ecological groups - hydrophytes, xerophytes, epiphytes and halophytes. Secretory tissues in plants: Structure and distribution of secretory trichomes (*Drocera, Nepenthes*), salt glands, colleters, nectaries, resin ducts and laticifers. Structure of bark and distribution pattern of laticifers in *Hevea brasiliensis.*

Unit -3: Developmental biology & Embryology: Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development. Sporogenesis and Gametogenesis - Embryo sac development and double fertilization in plants; embryogenesis, establishment of symmetry in plants; seed formation and germination. Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development (ABC Model) in *Arabidopsis* and *Antirrhinum*- Programmed cell death, aging and senescence.

Unit -4: Microtechniques – **Killing, fixing**: Principles and techniques of killing and fixing; properties of reagents, fixation images; properties and composition of important fixatives - Carnoy's Fluid, FAA, FPA, Chrome acetic acid fluids, Zirkle-Erliki fluid,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. Dehydration Methods: (i) Tertiary-butyl alcohol method (ii) Alcohol-xylol

method. (b) Embedding: Paraffin embedding. (c) Sectioning: Free hand sections – Prospects and problems; Sectioning in rotary microtome - sledge microtome and cryotome.

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

Unit -5: Whole mounts and Permanent Slides: Principles and techniques of whole mounting, TBA/Hygrobutol method, Glycerine-xylol method. Staining of whole mount materials (haematoxylin, fast green or Safranine-fast green combination) Significance of whole mounts (b) Techniques of smear, squash and maceration. (c) Mounting: Techniques, common mounting media used - DPX, Canada balsam, Glycerine jelly and Lactophenol. Cleaning, labeling and storage of slides.

Practicals:

Anatomy

1. Study the anomalous primary and secondary features in, *Amaranthus, Boerhaavia,Mirabilis, Nyctanthes*, *Piper* and *Strychnos.*
2. Study of stomata, trichomes, and laticifers - Determination of stomatal index.
3. Study the anatomical peculiarities of C4 and CAM plants (Leaf/Stem).
4. Study of nodal patterns.
5. Preparation of histotaxonomic key.
6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem)

Embryology

1. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/campylotropous.
2. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs).
3. Study of pollen morphology.
4. Pollen germination study.
5. Embryo excision from young seeds.

Microtechnique

(a) Preparation of semi permanent slides
(b) Preparation of permanent slides
(c) Preparation of whole mounts
(d) Maceration
(e) Preparation of fixatives (FAA, Carnoys'fluid)
(f) Preparation of dehydration series (Alcohol, Acetone, TBA)
(g) Preparation of paraffin blocks
(h) Preparation of serial sections

(i) Free hand sections (single/double stained)
(j) Serial sections (single/double stained)
(k) Wood sections and whole mounts

Reference for Unit 1, 2 & 3

1. Fahn (1982) Plant Anatomy, John Willey
2. Eames AJ and Mc Daniels LH (1994) An Introduction of Plant Anatomy. Tata Mc. Graw Hill Company Limited
3. Edred J & Henry C (1976) The seeds of dicotyledons (vol. I, II), Cambridge
4. University Press
5. Ella Werker (1997) Seed Anatomy, Borntreager
6. Elizabeth G Cutter (1978) Plant anatomy part I & II, Clive and Arnald Ltd
7. Elizabeth G Cutter (1978), Applied Plant Anatomy, Clive and Arnald Ltd
8. Esau K (1965) Vascular differentiation in plants, Rirehant and Winston, Inc.
9. Esau K (1977) Anatomy of seed plants, Wiley and sons.
10. Fahn A (1997) Plant anatomy, Aditya Publishers.
11. Chowdhuri () Edited; Indian woods (6 volumes). Forest research institute, Dehradun
12. Ingrid Roth (1977) Fruits of Angiosperm, Gebruder Borntreager
13. Metcalf C R, Chalk L (1983) Anatomy of the dicotyledons: Wood structure and conclusion of the general introduction, Oxford University press

Reference for Unit 4 & 5

1. Johanson DA (1940) Plant microtechnique, McGraw Hill co.
2. John E Sass (1967), Botanical Microtechnique, Oxford IBH Publ. Company.
3. Gray (1964) Handbook of Basic Microtechnique, McGraw Hill co.
4. Prasad MK, M Krishna Prasad (1983), Outlines of Microtechnique. Emkay Publications.
5. Geoffrey AM (1976) Practical electron microscopy, John Willey and sons.
6. Krishnamurthy KV (1987) Methods in Plant Histochemistry, S Viswanathan printers, Anand book depot, Madras.

PLM21C19: - Genetics, Plant Breeding, Tissue culture & Evolution

Unit- 1 Principles of Genetics: History of Genetics; Mendelian principles; Non-Mendelian Gene interactions, Multiple alleles, maternal influence - penintrance and gene expressions - cytoplasmic inheritance - Chromosomal theory of inheritance - Linkage- Linkage maping and gene maping; Mechanisms of sex determination; Sex-linked, sex-influenced and sex-limited traits; Intergenic and intragenic complementation and recombination of genome; Mutations. Allelic complementation, Split genes, Transposable genetic elements, Overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters; Concepts of eugenics, epigenetics, Genetic disorders and behavioural genetics.

Unit-2 Plant Breeding and crop improvement: Introduction to plant breeding: History, objectives, potential achievements and opportunities. Plant genetic resources: Importance of plant genetic resources and diversity in plant breeding, collection, evaluation and conservation of germplasm. Breeding methods for self and cross pollinated crops and asexually propagated crops; Heterosis breeding; Aspects of molecular breeding. Marker assisted selection (MAS) in backcross and heterosis breeding; Transgenic breeding; Foreground and background selection; male-sterility and self incompatibility; Inbreeding depression; Land races, pure line selection and mass selection; Pedigree selection, bulk method and its modification; Hybrid breeding, Clonal selection. Mutation breeding: use of polyploidy and distant hybridization in plant breeding; Release and registration of new varieties, quality seed - classes, production practices and maintenance of pure seed, seed purity standards – terminator seeds and the impact.

Unit-3 Plant tissue culture: History of plant cell and tissue culture; Tissue culture conditions and culture media; various types of tissue cultures; *in vitro* differentiation: organogenesis and somatic embryogenesis; Plant growth regulators: mode of action, effects on in vitro culture and regeneration; Molecular basis of plant organ differentiation. Micro propagation; Anther and microspore culture; Somaclonal variation; *in vitro* mutagenesis; In vitro fertilization; In vitro germplasm conservation; Production of secondary metabolites; Synthetic seeds. Embryo rescue and wide hybridization; Protoplast culture and regeneration; Somatic hybridization: protoplast fusion, cybrids. Applications of plant tissue culture in plant breeding and crop improvements.

Unit -4: **Basic concepts of Origin of Life and Evolution**: Origin of basic biological molecules, abiotic synthesis of organic monomers and polymers, concept of Oparin - Haldane, Miller-Urey Experiments - The RNA world - Idea of Panspermia - The First Cell - Evolution of Prokaryotes- origin of eukaryotic cells- evolution of unicellular eukaryotes, genome evolution. Anaerobic metabolism - origin of photosynthesis and aerobic metabolism. Geological Timescale, Major events in evolutionary timescale. Anthropocene. Tools and techniques in estimating evolutionary time scale. Mass extinction and its consequences. Fossils- fossilization and its significancePre-Darwanian, Lamarck, Darwin and Wallace - Post Darwanian theories of evolution. Concepts of variation, adaptation, struggle, fitness and natural selection - spontaneity of mutation and the evolutionary synthesis. Neutral Evolution, Molecular Evolution - Neutralist versus Selectionist - Contributions of Margulis (Endosymbiotic theory), Eldredge and Gould

(Punctuated equilibrium), Rose Mary and Peter Grant (Molecular evolution in Darwinian finches); Debates in evolutionary biology; Primate Evolution and Human Origins, Stages in Primate evolution - Prosimii, Anthropoidea and Hominids; Factors in human origin, hominid fossils; Cytogenetic and molecular basis of origin of man - African origin of modern man - Mitochondrial Eve, Y chromosomal Adam, early migration, hunter- gatherer societies - Evolution of human brain-communication, speech and language - Evolution of culture.

Unit -5: Population Genetics - Gene pool, gene frequency, Hardy-Weinberg Law - Rate of change in gene frequency through natural selection, migration and random genetic drift. Founder effect - Isolating mechanisms and speciation - Micro, Macro and Mega evolution. Co-evolution, Developmental and Evolutionary Genetics; The idea of Evo-Devo, Heterochrony, Heterotopy, Heterometry and Heterotypy. Developmental genes and gene co-option. Evolution of plasticity and complexity. Evolution of sex, Polygenic inheritance, analysis of quantitative traits, quantitative traits and natural selection, estimation of heritability, QTL mapping, genotype-environment interactions, molecular analysis of quantitative traits, phenotypic plasticity.

Practicals

Genetics

1. Problems in Genetics – monohybrid cross, dihybrid corss, gene interactions, linkage – 2 point and 3 point cross.
2. Floral biology in self and cross pollinating crop species; selfing and crossing techniques in major field crops.

Plant Tissue Culture

1. Preparation of Tissue culture media; handling and sterilization of plant material; inoculation, sub culturing and plant regeneration.
2. Anther, pollen culture, synthetic seed preparation and embryo rescue.
3. Suspension cultures and production of secondary metabolites.
4. Protoplast isolation, culture and fusion.

References for Unit 1, 2 & 3

1. Bhojwani SS (1983) Plant Tissue Culture: Theory and Practice. Elsevier
2. Christou P & Klee H (2004) Handbook of Plant Biotechnology. John Wiley & Sons
3. Dixon RA (2003) Plant Cell Culture, IRL Press.
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5. Gupta PK (2004) Biotechnology and Genomics, Rastogi Publ
6. Herman EB (2008) Media and Techniques for Growth, Regeneration and Storage. Agritech Publ
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8. Pierik RLM (1997) In vitro Culture of Higher Plants, Kluwer
9. Singh BD (2007) Biotechnology: Expanding Horiozon. Kalyani.

10. Griffiths AJF et al (1996) An Introduction to Genetic Analysis 6th Edition, W.H. Freeman, New York.
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12. Allard RW (1960) Principles of Plant Breeding. John Wiley & Sons, New York.
13. Rana RS et al Edited (1994) Plant Genetic Resources: Exploration, Evaluation and Maintenance, NBPGR, New Delhi.

Reference for Units 4

1. Arthur W (2011) Evolution – A Developmental Approach.Wiley-Blackwell, Oxford,UK
2. Camilo J C and Francisco JA (2007) Human Evolution-Trails from the Past, Oxford University Press
3. Campbell BG (2009) Human Evolution, Transaction Publishers, NJ, USA
4. Charles WF and Janson BW (2006) Evolutionary Genetics-Concepts and Case Studies, Oxford University Press, NY. USA
5. Carroll SB (2005) Endless Forms Most Beautiful: The New Science of Evo-Devo, WW Norton, New York
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8. Elliott S (2008) Evidences and Evolution: The Logic Behind the Science, Cambridge University Press, UK.
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10. Gould SJ (2002) The Structure of Evolutionary Theory, Harvard University Press, MA, USA
11. Hall BK and Hallgrimsson B (2008) Strickberger's Evolution (4thedn), Jones and Bartlett Pub, London, UK.
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13. Kimura M (1983) The neutral theory of molecular evolution, Cambridge University Press

SEMESTER IV

PLM21C22: Ecology, Conservation & Phytogeography

Unit 1: Ecology

1. **Introduction to Ecology and the different approaches to study -** Definition, history and scope of ecology, ecology vs environmental science,inter-disciplinary nature of environmental science.

2. **Physical environment -** Biotic and abiotic environment, their interactions. Concepts and dynamics of Ecosystems: Types – Freshwater, marine and terrestrial. Components of ecosystem, application of Law of thermodynamics, food chain, food web, trophic levels, ecological pyramids and recycling - energy flow and transaction.
   Productivity and Biogeochemical cycles. Development and evolution of ecosystems. Ecosystem management.

3. Population Ecology

Characteristics of populations- community structure and attributes, levels of species diversity and its measurement; population growth curves; population regulation; life history strategies (*r* and *K* selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.
Nature of communities; community structure and attributes; levels of species diversity and its measurement; edge effect and ecotone.
Species interactions - types of interactions, interspecific competition, herbivory, carnivory, symbiosis.

4. **Ecological succession**

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

b. Retrogressive changes or the concept of degradation, concept of climax or stable communities, resilience of communities, ecological balance and survival thresholds.

5. Environmental pollution

a. Definition and classification

b. **Water pollution -**

Water quality parameters and standards, different types of pollutants and their consequences, types of water pollution, prevention and control, water shed management, waste water treatment, waste water treatment with aquatic macrophytes.

c. **Air pollution -**

Air quality standards and index, ambient air monitoring using high volume air sampler, types and sources of air pollutants, air pollution and human health hazards, control of air pollution
d. **Noise pollution -** hazardous noise levels, sources, prevention.
e. **Radioactive and thermal pollution -** Causes and hazardous effects, effective management.

Concept of solid wastes and waste management strategies.

Pollution Control - Bioremediation, Phytoremediation, bioaugmentation, biofilms, biofilters, bioscrubbers and trickling filters. Use of bioreactors in waste management

Global environmental issues - Factors responsible for climate change, *El-Nino* and *La Nina* phenomenon and its consequences.

Environmental laws, environmental monitoring and bio indicators, environmental safety provisions in Indian constitution, major environmental laws in India.

Unit 2: <u>Conservation of Natural Resources</u>

Concept aim and principles of conservation
Objectives,definition of biodiversity, threatened species, roles of IUC (IUCN), red data book.
Conservation strategies -Principles of conservation, major approaches to management; *In-situ* and *Ex-situ* conservation,biosphere reserves, wild life sanctuaries and National parks in India with special reference to Kerala, Project Tiger.

Agriculture and conservation of resources - Novel agricultural technologies, nitrification inhibitors, wind mills for irrigation, solar energy for drawing ground water, biogas for cooking and slurry left to be used as fertilizers.

Urbanization and Conservation – Conservation of Physical resources. (soil, water and air), Planning for environmentally compatible human settlements, sustainable development, strategies for sustainable industrial development.

Conservation and energy – Causes of energy crisis, Conventional and Non-conventional energy sources, Development of non-polluting energy systems - Solar energy, Wind energy, energy recovery from solid wastes, Plant as a source of renewable energy.
Afforestation - social forestry, agroforestry.

Legislations and action plans- Wild life preservation act (1972), Indian forest conservation act (1980), United Nations Environmental Programme, Environment protection Act. International Biological programme (IBP), Man and Biosphere (MAB), World environment day.

Unit 3: Phytogeography

Definition, static and dynamic phytogeography, principles governing plant distribution, factors affecting plant distribution, theories of distribution, different types of distribution of vegetations on the earth, continuous and discontinuous distribution.

Climate and its interaction with living organisms - different climatic types, plant distribution and adaptation to the environment. Deserts (dry and cold) Tundra, Grassland, Savannah, Temperate forests, Tropical rain forests, Mangrove, vegetation and botanical zones of India.

Practical

1. Analysis of water quality

(a) Dissolved CO2 (b) Dissolved oxygen (c) COD (d) Total dissolved minerals (e) Quantitative estimation of dissolved chloride ions and dissolved sulphate, nitrate and total alkalinity.

2. Physico-chemical analysis of soil

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

2. **Analysis of vegetation -** Quadrate /line transects to find frequency and interpret the vegetation in terms of Raunkiaer's frequency formula.

3. Visit to an ecologically significant location (Polluted site/National parks/ mangroves/estuaries) to make them aware of conservation efforts, common environmental problems, their consequences and possible solutions.

References

1. APHA Standard methods for the examination of water and waste water, APHA.
2. Barbour MD et. al. (1980) Terrestrial plant ecology. The Benjamin-Cammings Pub. Com
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4. Dash MC (1993) Fundamentals of Ecology, Tata McGraw Hill.
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19. Elaine RI et al (2010) Soil Biology Primer, USDA.
20. Jeffrey S et al (2004) Water Auditing and Water Conservation, IWA Publ.
21. Amy Vickers (2001) Water Use and conservation, Amazon Press.
22. Christopher AS (2006) Alternative Energy, Political, Economical and Social Feasibility, Rowman & Littlefield, Lanham, Maryland.
23. Tim F (2005) The Weather Makers: The History and Future Impact of Climate Change.
24. Rajagopalan R (2015) Environmental studies-from crisis to cure, Third Edition, Oxford University Press.

PLM21E23: - Remote Sensing of biomass and biodiversity resources

Unit -1: Concepts and types of remote sensing – evolution of remote sensing technology – stages of remote sensing – spatial data acquisition – interdisciplinary nature and relationship to other disciplines –application of remote sensing –applications over conventional methods of surveying and inventorying

Unit -2: Basic principles – electromagnetic spectrum - characteristics of electromagnetic radiations – types of remote sensing with respect different wavelength regions – definition of radiometry – blackbody radiation – special characteristics of solar radiations – EMR interactions with earth materials – spectral signature concepts – spectral reflectance and emittance – specular reflection and non-specular reflectance – Albedo of materials – EMR interaction with vegetation, water and rocks – factors affecting spectral reflectance of materials.

Unit 3: Sensors, Platforms and Georeferencing – aerial photographs and photogrammetry - types of sensors – passive and active sensors – imaging systems – photographic sensors – sensor resolution – thermal sensors – atmospheric sensors – platforms – principles of satellite missions – IRS, Landsat and the like – **Fundamentals of satellite image interpretation** –pre-processing of multispectral imagery – image enhancement and interpretation – digital image classification - types of imaging elements of interpretation – techniques of visual interpretation – generation of thematic maps – advance remote sensing technology –thermal imaging system – advance LASER terraiin mapping – satellite data acquisition, storage and retrieval – data formats – compression – satellite system – image display system - planimetric information from aerial photographs – overlapping of vertical photographs – geometry, scale orientation and measurements

Unit 4: Applications of Remote Sensing - Lidar Remote Sensing for Biomass Assessment - Forest Structure Retrieval from Multi-Baseline SARs - Ocean Color Remote Sensing of Phytoplankton Functional Types - Mapping Aboveground and Foliage Biomass – remote sensing of biodiversity

Practicals

- Spectral measurements in the field and the laboratory. Including an understanding of BRDF and multiple view angle (MVA) imaging.
- Calibration and Normalisation of image data. From DN to radiance in visible, near IR and thermal wavelengths.
- Atmospheric correction. Including methods than can be used with archived data.

- Geometric correction. Focusing on parametric methods and mosaic creation.

References

1. Campbell James B (2011) Introduction to Remote Sensing, 5th edition**.** New York. The Guilford Press
2. Congalton R and K Green (2009) Assessing the Accuracy of Remotely Sensed Data. 2nd edition. CRC Press
3. Maune DF ed. (2007) Digital Elevation Model Technologies and Applications: The DEM Users Manual, 2nd edition. Bethesda, MD. American Society for Photogrammetry and Remote Sensing
4. McGlone JC ed. (2004) Manual of Photogrammetry, 5th edition. Bethesda, Md.: American Society for Photogrammetry and Remote Sensing
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6. Photogrammetric Engineering and Remote Sensing , American Society for Photogrammetry and Remote Sensing
7. Jensen JR (2007) Remote Sensing of the Environment - an Earth Resource Perspective 2nd ed. Upper Saddle River, NJ, Prentice Hall

PLM21E24: - Horticulture

Unit- 1: Introduction to Horticultural science: Definition, importance and objectives of Horticulture, branches of Horticulture, Pomology, Olericulture, Landscape Gardening, Nurseries and development Allied branches; **Nursery management and ornamental gardening:** Tools and machinery used in Nursery management and ornamental gardening - different types of nursery and gardens and their essential requirements; Basics of greenhouse design, different types of structures – glasshouse, shade net, poly tunnels - Automated greenhouses, microcontrollers. Different types of propagation, seed propagations, hybrids, apomixis, polyembryony, chimeras; Factors influencing seed germination of horticultural crops, seed dormancy, hormonal regulation of germination and seedling growth. Asexual method of propagations: Cutting methods, layering methods, budding methods, grafting methods. Lawn plants - purpose of preparation of lawn, method of preparation of lawn and management of lawn and lawn plants

Unit -2: Nursery Management of Fruit and Cash Crops: Biodiversity of local fruit crops: Mango, sapota, citrus, guava, banana, papaya, grapes, jackfruit and custard applea – nursery management of these and other rare tropical fruit crops; Nursery management of Rubber, Cardamomum, Coconut and Tea

Unit -3: Post harvest technology for horticultural Crops: Maturity indices, harvesting practices of flowers and fruits for specific market requirements – flower and fruit packaging for transport/export - influence of pre-harvest practices, enzymatic and textural changes, respiration, and transpiration. Physiology and biochemistry of fruit ripening, ethylene management, factors leading to post-harvest loss, pre-cooling - Treatments of fruits and flowers prior to shipment, viz., chlorination, waxing, chemicals, bio-control agents and natural plant products; Methods of storage, packing methods and transport, principles and methods of preservation, food processing, canning, fruit juices, beverages, pickles, jam, jellies, candies. Dried and dehydrated products

Unit -4: Horticulture technology: Biotechnological interventions, achievements and future thrust in the economically important garden plants and fruit crops. Green house technology and hardening of plants. Space gardens technology. Seed harvesting technology- Integrated and modern approaches in water and nutrient management in horticultural crops- Layout and construction of irrigation systems, care and their attention. Total quality management (TQM).

Practicals

Documentation of germplasm – maintenance of passport data and other records of accessions; field exploration trips, exercise on *ex situ* conservation – cold storage, pollen/seed storage, cryopreservation, visits to National Gene Bank and other centers of PGR activities. Detection of genetic constitution of germplasm, core sampling, germplasm characterization using molecular techniques. Visits to Regional Agriculture Research Stations (RARS) and their centers for plant propagation practices.

Reference

1. Bose TK, Mitra SK & Sadhu MK. 1991. Propagation of Tropical and Subtropical Horticultural Crops, Naya Prokash.
2. Chadha KL and Pareek OP Edited (1996) Advances in Horticulture, Vols. IIIV, Malhotra Publishing House.
3. Durbin R et al (1999) Biological Sequence Analysis: Probabilistic Model of Proteins and Nucleic Acids, Cambridge Univ. Press.
4. Frankel OH and Hawkes JG (1975) Crop Genetic Resources for Today and Tomorrow, Cambridge University Press
5. Haid NF and Salunkhe SK (1997) Post Harvest Physiology and Handling of Fruits and Vegetables, Grenada Publ.
6. Hartmann HT and Kester DE (1989) Plant Propagation – Principles and Practices, Prentice Hall of India.
7. Keshavachandran R et al (2007) Recent Trends in Biotechnology of Horticultural Crops, Vols. I- II, New India Publ. Agency
8. Pant V Nelson (1991) Green House Operation and Management, Bali Publ.
9. Peter KV and Abraham Z (2007) Biodiversity in Horticultural Crops, Vol. I, Daya Publ. House.
10. Peter KV (2008) Biodiversity of Horticultural Crops, Vol. II, Daya Publ. House.
11. Rajan S and Baby LM (2007) Propagation of Horticultural Crops, New India Publ. Agency
12. Sudheer KP and Indira V (2007) Post Harvest Technology of Horticultural Crops, New India Publ. Agenc

PLM21E25: - Entrepreneurship and Business in Biology

Unit -1: Entrepreneurship: Entrepreneur - Classification of entrepreneurs - Entrepreneurial attributes and characteristics - Entrepreneurial challenges – Entrepreneurship Vs. Management. Roles and functions of entrepreneurship - Small business as seedbed of entrepreneurship - Entrepreneur competencies - Entrepreneur motivation- Performance and rewards; Role of Entrepreneurship Development Institute of India; National Institute of Entrepreneurship and Small Business.

Unit -2: Opportunity scouting and idea generation: Role of creativity and innovation and business research - Sources of business ideas- Entrepreneur opportunities in contemporary business environment - The process of setting up a small business in bio-based areas - Concept of project and classification of project – Identification and project formulation - Project report - Project appraisal.

Unit -3: Management – its roles and functions in a small business: Designing of business plan, location, layout- Management principles and functions - Managing business growth - Pros and cons of alternative growth options: Internal expansion, Acquisitions and mergers, Integration and diversification - Good business management- Leadership and human relations- Leadership Vs. Management - Importance of team goals and accountability, Delegation of authority- Understanding effective communication - Effective communication in the workplace - Essential listening skills.

Unit -4: Principles of double-entry book-keeping: Journal entries- Cash-book and pass book- Bank reconciliation statement - Ledger accounts - Trial balance - Trading and profit and loss account - Balance-sheet - Single-entry system of record keeping - Sources of risk/venture capital, fixed capital, working capital and a basic awareness of financial services such as leasing and factoring.

Unit -5: Issues in small business management and marketing. Recruiting employees, the interview process, from resume vetting to the job offer, effective interviewing skills, creating performance/evaluation systems- Providing feedback - Employee termination issues - The concept and application of product lifecycle, advertising and publicity, sales and distribution management. The idea of consortium marketing, competitive bidding/tender marketing, negotiating with principal customers - The contemporary perspectives on infrastructure development, product and procurement reservation, marketing assistance, subsidies and other

fiscal and monetary incentives. National state level and grass-root level financial and non-financial institutions in support of small business development.

References

1. Brandt S C (1977): The 10 Commandments for Building a Growth Company, Third Edition, Macmillan Business Books, Delhi.
2. Bhide AV (2000): The Origin and Evolution of New Business, Oxford University Press, New York.
3. Dollinger M J (2006): Entrepreneurship Strategies and Resources', 3rd edition, Pearson Education, New Delhi.
4. Desai V (2004): Management of Small Scale Enterprises, Himalaya Publishing House, New Delhi.
5. Taneja G (2010): Entrepreneur Development New Venture Creation, 2nd ed. Galgotia Publishing Company.
6. Holt D H (1955): Entrepreneurship: Strategies and Resources, Illinois, Irwin.
7. Panda S C (2008): Entrepreneurship Development, New Delhi, Anmol Publications.
8. Patel V G (1995): The Seven Business Crises and How to Beat Them, Tata-Mcgraw, New Delhi.
9. SIDBI Report on Small Scale Industries Sector [latest edition]
10. Verma J C and Gurpal Singh (2002): Small Business and Industry-A Handbook for Entrepreneurs, Sage, New Delhi.
11. Desai V: Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House, Mumbai.
12. Louis A Allen: Management and Organization, McGrawHill, New York.
13. Antony R N: Management Accounting, Taraprewalla, Mumbai.

MODEL QUESTION PAPERS

Reg. No.....

Name.....

MAHATMA GANDHI UNIVERSITY

National Institute of Plant Science Technology (NIPST)

M.Sc. Botany and Plant Science Technology

SEMESTER I: Model Question paper

PLM21C01: Research Methodology, Computer Applications and IPR

Time 3 Hrs **Max. Marks: 60**

I. Answer very briefly on any *twelve* of the following (12×2=24)

1. Qualities of a researcher.
2. Methods of data collection.
3. Hypothesis.
4. Resources in writing a review of literature
5. Standard deviation and standard error.
6. Sampling in experiment.
7. Genbank
8. SPSS
9. Patent.
10. GATT
11. Correlation and Regression.
12. Molecular clock

II. Write short note on any *four* of the following (4×6=24)

13. Types of research.
14. General laboratory techniques, rules and regulations.
15. Measures of central tendencies.
16. Sequence alignment tools.
17. Plant breeder's rights and farmer's rights.
18. Protein sequence database.

III. Answer elaborately on any *one* of the following (12×1=12)

19. Steps in research process.

20. Compute the mean, median & standard deviation from the following distribution.

Scores	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
Frequency	2	5	3	5	8	12	25	30	10

N=100

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Reg. No.....

Name.....

MAHATMA GANDHI UNIVERSITY

National Institute of Plant Science Technology (NIPST)

M.Sc. Botany and Plant Science Technology

SEMESTER I: Model Question paper

PLM21C02: Cell Biology and Biochemistry

Time 3 Hrs **Max. Marks: 60**

I. Answer very briefly on any *twelve* of the following (12×2=24)

1. Membrane transport
2. Functions of plasma membrane
3. Oncogenes
4. Differences between cell division in plant cell and animal cell
5. Structure and functions of cholesterol
6. Sphingolipids and Glycolipids
7. Ramachandran plot
8. Structure of histidine and tryptophan
9. Michaelis – Menten equation
10. Allosteric enzymes
11. Differentiate between a channel and a pump
12. DNA supercoiling

II. Write short note on any *four* of the following (4×6=24)

13. Structure and function of cytoskeleton
14. Check points in cell cycle regulation
15. Glycogenolysis and gluconeogenesis
16. Apoptosis
17. Types of RNA
18. Mechanism of enzyme action

III. Answer elaborately on any *one* of the following (12×1=12)

19. Structure of protein.

20. ATP production and Electron transport chain.

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Name.....

MAHATMA GANDHI UNIVERSITY

National Institute of Plant Science Technology (NIPST)

M.Sc. Botany and Plant Science Technology

SEMESTER I: Model Question paper

PLM21C03: Microbiology and Immunology

Time 3 Hrs **Max. Marks: 60**

I. Answer very briefly on any *twelve* of the following (12×2=24)

1. MPN
2. Plasmids
3. Single cell proteins
4. Virions and prions
5. Phagocytosis
6. Immunogenecity and antigenecity
7. Radio immuno assay
8. MHC molecules
9. Allergy
10. Innate immunity and adaptive immunity
11. ADCC
12. TLR

II. Write short note on any *four* of the following (4×6=24)

13. Staining in bacteria
14. Transduction in viruses
15. Monoclonal antibodies.
16. Different types of serological tests
17. Autoimmune diseases
18. Symbiotic association of bacteria in plants

III. Answer elaborately on any *one* of the following (12×1=12)

19. Classical complement pathway

20. Basic structure and classes of immunoglobulin.

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Reg. No.....

Name.....

MAHATMA GANDHI UNIVERSITY

National Institute of Plant Science Technology (NIPST)

M.Sc. Botany and Plant Science Technology

SEMESTER I: Model Question paper

PLM21C04: Angiosperm Systematics Part-I

Time 3 Hrs **Max. Marks: 60**

I. Answer very briefly on any *twelve* of the following (12×2=24)

1. What is meant by holotype?
2. Distinguish between plesiomorphic character and apomorphic character
3. What are homonyms?
4. Distinguish between andropetals and bracteopetals
5. What do you mean by flora and monograph?
6. Nomen Nudum
7. How does a monphyletic group differ from a paraphyletic one?
8. What is meant by commemorative generic name? Give an example.
9. Difference between couplet and lead
10. OTU
11. Tetradynamia
12. Valid publication

II. Write short note on any *four* of the following (4×6=24)

13. Sate the basic tenets of numerical taxononmy
14. Describe the reasons for choosing Latin as the language for biological importance.
15. Write a note on typification
16. Explain priority of publication
17. Explain the basic features of Engler & Prantl system of classification
18. Give an account on preparation and maintanence of herbarium.

III. Answer elaborately on any *one* of the following (12×1=12)

19. 'Molecular systematics is the result of marvelous developments in the field of molecular biology'. Substantiate the above statement with suitable examples.

20. 'Bentham and Hooker's system of classification is user friendly'. Critically elaborate on the validity of the above statement.

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Name.....

MAHATMA GANDHI UNIVERSITY

National Institute of Plant Science Technology (NIPST)

M.Sc. Botany and Plant Science Technology

SEMESTER I: Model Question paper

PLM21E05: Organic and Natural farming

Time 3 Hrs **Max. Marks: 60**

I. Answer very briefly on any *twelve* of the following (12×2=24)

1. NPK fertilizers
2. Methods to prevent soil degradation and Soil erosion
3. INM and IPNS
4. Management of soilborne pathogens
5. Farmyard Manure
6. Biodynamic products and composting
7. Antibiosis and Fungistasis
8. Write a note on Lac Insect as beneficial insect
9. C:N ratio
10. Humus and its Decomposition
11. Management practices for sustainable agriculture
12. Liquid manure and its importance

II. Write short note on any *four* of the following (4×6=24)

13. Classification of fertilizers and manures
14. Write the principles, methods, merits and demerits of Organic farming
15. Post-harvest management of organic products
16. Write a note on Multi cropping system andmixed cropping
17. Mycorrhizal association
18. Write a note on Green manures

III. Answer elaborately on any *one* of the following (12×1=12)

19. Give an account on Biopesticides and its classification

20. Give a detail account on Vermicomposting

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Reg. No.....

Name.....

MAHATMA GANDHI UNIVERSITY

National Institute of Plant Science Technology (NIPST)

M.Sc. Botany and Plant Science Technology

SEMESTER I: Model Question paper

PLM21E06: Environmental Monitoring and Management

Time 3 Hrs **Max. Marks: 60**

I. Answer very briefly on any *twelve* of the following (12×2=24)

1. What is Eco-funds?
2. Mention the basic laws of ecology.
3. What is LCA. write its significance.
4. Explain biodigester.
5. Hazardous waste.
6. Suggest a few methods for domestic waste management
7. EIA
8. What is Ecolabelling and certification
9. Methods and steps for Environmental impact assessment.
10. What is Ecological Footprints. Write down its significance.
11. Eco-restoration
12. Suggest methods for management of plastic and e-waste.

II. Write short note on any *four* of the following (4×6=24)

13. Explain the basic principles of environment management.
14. Give an account on ISO standards for environmental management systems.
15. Briefly explain stages of EIA processes
16. Write an account on solid waste management
17. Detail the Importance of vermicomposting in waste management.
18. Write the salient features of Biodiversity Act,2002.

III. Answer elaborately on any *one* of the following (12×1=12)

19. Describe the management strategies for different types of ecosystems.

20. Briefly explain the Water Act,1974.

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MAHATMA GANDHI UNIVERSITY

National Institute of Plant Science Technology (NIPST)

M.Sc. Botany and Plant Science Technology

SEMESTER I: Model Question paper

PLM21E07: Allelopathy and Biological weed and Pest control

Time 3 Hrs **Max. Marks: 60**

I. Answer very briefly on any *twelve* of the following (12×2=24)

1. What is allelomediation
2. Mention the application of allelopathy in crop production.
3. Detail about the methodology for establishing allelopathy
4. How is allelopathy beneficial to plants?
5. Explain the general nature of allelochemics
6. Writ some examples for allelopathy
7. Methods in the isolation of allelochemicals
8. Role of photosynthetic inhibitors in allelochemicals
9. Difference between Allelopathy and Allelospoly
10. Role of Allelopathy in weed science.
11. Disadvantages of allelopathy to a plant
12. Examples for natural products as allelochemicals

II. Write short note on any *four* of the following (4×6=24)

13. Explain the mode of action of Allelochemics
14. Importance of allelopathy studies
15. Mention the role of Naphthoquinone and complex quinones in allelochemics.
16. Detail on volatilization, leaching and root exudation.
17. What are the factors affecting the production of allelochemicals
18. Detail on decomposition of plant residues.

III. Answer elaborately on any *one* of the following (12×1=12)

19. What is allelochemics? Explain the mechanisms and process of production.

20. Give a detail account on Allelopathy mediated weed control for sustainable Agriculture.

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MAHATMA GANDHI UNIVERSITY

National Institute of Plant Science Technology (NIPST)

M.Sc. Botany and Plant Science Technology

SEMESTER II: Model Question paper

PLM21C09: Phycology

Time 3 Hrs **Max. Marks: 60**

I. Answer very briefly on any *twelve* of the following (12×2=24)

1. Red tides
2. Reproductive methods in *Cyanophyceae*
3. Explain the different kinds of flagellation in algae
4. Cell wall characteristics of diatoms
5. Algae as source of energy
6. Chantransia
7. Reproductive organs in *Gelidium*
8. Algal blooms
9. Fritsch classification of algae
10. Morphology of *Batrachospermum*
11. Major kinds of asexual reproduction in algae
12. Nutritionally valuable products from algae

II. Write short note on any *four* of the following (4×6=24)

13. Explain the different kinds of chloroplasts in algae
14. Reproductive structure in *Chara*
15. Post fertilization changes in *Amphiroa*
16. Sexual reproduction in green algae
17. Harmful effects of algae
18. Explain the different thallus structure in algae

III. Answer elaborately on any *one* of the following (12×1=12)

19. Explain the different techniques involved in collection and preservation of algae
20. Explain the life cycle in *Dictyotales*

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Reg. No.....

Name.....

MAHATMA GANDHI UNIVERSITY

National Institute of Plant Science Technology (NIPST)

M.Sc. Botany and Plant Science Technology

SEMESTER II: Model Question paper

PLM21C10: Bryology, Pteridology and Gymnosperms

Time 3 Hrs **Max. Marks: 60**

I. Answer very briefly on any *twelve* of the following (12×2=24)

1. What is a protocorm? Give an example of a pteridophyte producing it.
2. Endohydric and Myxohydric bryophytes
3. Bryophytes as fuel
4. Petrifaction and coal ball.
5. Glochidia
6. Briefly explain the morphology and anatomy of fertile spike of *Ophioglossum*
7. What do you mean by intra marginal sorus? Give an example
8. What is massula? Where can you find it? What is its function?
9. Fossil bryophytes.
10. Salient features of Cycadeodiaceae
11. Apogamy and apospory in pteridophytes
12. Syngenesis or Webbing

II. Write short note on any *four* of the following (4×6=24)

13. Discuss the evolutionary tendencies in the sporophytes of bryophytes
14. Briefly describe the biological importance of sphagnum. Give an account on its uses.
15. Male and Female gametophyte development in Cycas?
16. Explain the internal structure of Marchantia thallus.
17. Write Short notes on:
    a) 'Relic nuclei' b) Syndetochelic stomata c) Canada balsam
18. Differentiate between Eusporangiate and Leptosporangiate development of sporangium. Give an example for a protoleptosporangiate pteridophyte

III. Answer elaborately on any *one* of the following (12×1=12)

19. Stelar organization in Pteridophytes
20. Short notes on
    a) Economic Importance of Cycadales and Gnetales
    b) How will you determine the Age of *Cycas*
    c) Carbon dating.
    d) U:S:E pattern of development in Gymnosperms.

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MAHATMA GANDHI UNIVERSITY

National Institute of Plant Science Technology (NIPST)

M.Sc. Botany and Plant Science Technology

SEMESTER II: Model Question paper

PLM21C11: Mycology and Plant Pathology

Time 3 Hrs **Max. Marks: 60**

I. Answer very briefly on any *twelve* of the following (12×2=24)

1. Modes of nutrition in Fungi
2. Haustorium
3. Hartignet
4. Single cell protein
5. Aflatoxins
6. Systemic resistance
7. What is chlorosis?
8. Disease triangle
9. Soredia and Isidia
10. Mention the names of causal organism of the following:
    a) Anthracnose in mango b) Grey leaf spot in Coconut
11. P R proteins
12. Lignolytic fungi

II. Write short note on any *four* of the following (4×6=24)

13. Give an account of types of lichen thalli.
14. Give an illustrated account of external and internal structure of homiomerous lichen.
15. Write a brief account of mycorrhiza.
16. Role of fungi in industry
17. What are the basic types of plasmodia found in myxomycetes.
18. With the help of a sketch give a detailed account of the structure of an apothecium.

III. Answer elaborately on any *one* of the following (12×1=12)

19. Explain the different defense mechanisms in plants.
20. Give an account of alternation of generation in *Ustilago*

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MAHATMA GANDHI UNIVERSITY

National Institute of Plant Science Technology (NIPST)

M.Sc. Botany and Plant Science Technology

SEMESTER II: Model Question paper

PLM21C12: Angiosperm Systematics Part-II

Time 3 Hrs **Max. Marks: 60**

I. Answer very briefly on any *twelve* of the following (12×2=24)

1. Androecium in Cucurbitaceae
2. Describe the identifying characters of Magnoliaceae
3. What is polycyclic condition? Describe it with reference to any one example.
4. What are the salient features of the family Sapotaceae
5. Write the binomials and families of the following plants.
   a) Cumin b) Chicory c) Aswagandha c) Mango ginger
6. Write an account on adnation in Solanaceae
7. Pollination mechanism in *Salvia*
8. Give the family name and economic products of the following plants.
   i) *Rosemarinus officinalis* ii) *Sechium edule* iii) *Vateria indica* iv) *Digitalis purpurea*
9. Compare the fruit in Morinda with that of Annona
10. Write the morphology of the useful part in the following plants
    i) *Ferula asafoetida* ii) *Pyrus malus* iii) *Helianthus annus* iv) *Thespesia populnea*
11. Write notes on floral variations of Scrophulariaceae
12. Distinguish between Rubiaceae and Apiaceae

II. Write short note on any *four* of the following (4×6=24)

13. Give an account on the morphology of labellum in Zingiberaceae and Orchidaceae
14. 'Poaceae is of greater importance than any other family of flowering plants.Comment
15. Compare the androecium in Clusiaceae and Dipterocarpaceae
16. Explain the spikelet morphology in Poaceae
17. Give an account on the floral morphology of Euphorbiaceae
18. Write brief notes on tribes of Asclepiadaceae.

III. Answer elaborately on any *one* of the following (12×1=12)

19. Why Orchidaceae is considered as an advanced family? Describe the process of pollination in this family.

20. With the help of suitable floral diagrams explain the floral variations in Musaceae and Zingiberaceae.

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Reg. No.....

Name.....

MAHATMA GANDHI UNIVERSITY

National Institute of Plant Science Technology (NIPST)

M.Sc. Botany and Plant Science Technology

SEMESTER II: Model Question paper

PLM21E13: Phytochemistry

Time 3 Hrs **Max. Marks: 60**

I. Answer very briefly on any *twelve* of the following (12×2=24)

1. Explain vitamin absorption and storage
2. Structure and different forms of vitamin E
3. Write a note on extraction-digestion
4. Write a note on microwave assisted extraction
5. What are glycosides?
6. Write a note on scurvy
7. Give examples of saponin glycosides.
8. Define R_f value in TLC
9. Briefly explain steam-distillation
10. Write notes on factors affecting the choice of extraction
11. Sennosides
12. Lemon grass oil

II. Write short note on any *four* of the following (4×6=24)

13. Give an account on four major groups of natural pigments with examples
14. Explain primary and secondary glycosides with examples.
15. Briefly explain two classes of cardiac glycosides with examples
16. Give an account on classification of vitamins
17. Draw the structures of any three natural pigments.
18. Give an account on role of natural products in drug discovery

III. Answer elaborately on any *one* of the following (12×1=12)

19. Explain the structure and synthesis pathway of cholesterol

20. Explain the different methods for purification of solvents emphasizing on the merits and demerits.

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Reg. No.....

Name.....

MAHATMA GANDHI UNIVERSITY

National Institute of Plant Science Technology (NIPST)

M.Sc. Botany and Plant Science Technology

SEMESTER II: Model Question paper

PLM21E14: Applied Marine Phycology

Time 3 Hrs **Max. Marks: 60**

I. Answer very briefly on any *twelve* of the following (12×2=24)

1. What is primary productivity?
2. What are the factors affecting the growth of marine micro algae?
3. What are the products and uses of marine micro algae?
4. Strategies for enhancement of hydrogen production of marine micro algae?
5. How marine fishery resource is connected with marine algal resources.
6. Write down the classification of marine algae with examples.
7. Comment on basic nutritional requirements for culturing marine micro algae.
8. Advantages and disadvantages of open pond design for marine micro algal culturing
9. Role of marine algae in the enhancement of food security
10. Techniques for harvesting marine micro algae.
11. Write briefly on by products from algal bio-fuel production.
12. Monocultures and auxenic cultures

II. Write short note on any *four* of the following (4×6=24)

13. Biochemical composition of various economically significant groups of marine algae
14. Techniques for culturing marine micro algae
15. Stable isotope biochemicals from marine algae
16. Methods of screening marine algae for the production of bio-diesel from biomass
17. Toxic marine algae
18. Comment on economic importance of marine algae

III. Answer elaborately on any *one* of the following (12×1=12)

19. Explain marine macro algal culturing, its maintenance and advances in sea weed culture.

20. Explain the steps and processes involved in the production of bio-diesel from algal biomass.

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Name.....

MAHATMA GANDHI UNIVERSITY

National Institute of Plant Science Technology (NIPST)

M.Sc. Botany and Plant Science Technology

SEMESTER III: Model Question paper

PLM21C16: Molecular Biology and Genetic Engineering

Time 3 Hrs **Max. Marks: 60**

I. Answer very briefly on any *twelve* of the following (12×2=24)

1. Telomere
2. Artificial chromosomes
3. Chromosome walking
4. *Flavr Savr* tomato
5. Enzymes in DNA replication
6. RAPD
7. Characteristics of genetic code
8. Biosensors
9. Palindrome
10. Gene silencing
11. TATA box
12. RFLP

II. Write short note on any *four* of the following (4×6=24)

13. Explain different methods of plant transformation by direct transfer of DNA
14. Site directed mutagenesis
15. Give an account on PCR
16. Explain *Agrobacterium* mediated gene transfer in plants
17. Give an account on cDNA synthesis
18. Give an account on post transcriptional modifications.

III. Answer elaborately on any *one* of the following (12×1=12)

19. Give an account on DNA repair mechanisms

20. Describe the basic steps of genetic engineering with an example.

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Reg. No.....

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MAHATMA GANDHI UNIVERSITY

National Institute of Plant Science Technology (NIPST)

M.Sc. Botany and Plant Science Technology

SEMESTER III: Model Question paper

PLM21C17: Plant Physiology and Biophysics

Time 3 Hrs **Max. Marks: 60**

I. Answer very briefly on any *twelve* of the following (12×2=24)

1. Cohesion -tension theory
2. Compare Diffusion and Osmosis
3. Photomicrography and microphotography
4. NMR-XRAY diffraction
5. Apoplast and symplast pathways
6. Differentiate between pump, channels and co-transporters
7. ROS
8. Benefits of phenolics to human
9. Ecological importance of terpenoids in plants
10. What is Oxidative phosphorylation
11. TLC
12. Water potential

II. Write short note on any *four* of the following (4×6=24)

13. Explain Glycolytic pathway
14. Water transport through aquaporins
15. Describe photoperiodism and vernalization
16. Explain isocratic mobile phase in HPLC
17. Give an account on PAGE
18. Briefly describe absorption spectra and emission spectra.

III. Answer elaborately on any *one* of the following (12×1=12)

19. Give an account on any three chromatographic techniques

20. Describe the process and role of citric acid cycle in living organisms

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MAHATMA GANDHI UNIVERSITY

National Institute of Plant Science Technology (NIPST)

M.Sc. Botany and Plant Science Technology

SEMESTER III: Model Question paper

PLM21C18: Anatomy, Embryology and Developmental Biology of Plants

Time 3 Hrs **Max. Marks: 60**

I. Answer very briefly on any *twelve* of the following (12×2=24)

1. Discuss the role of sunken stomata
2. Commercial importance of coir
3. Describe anatomical peculiarities of CAM plants
4. Activity of vascular cambium and cork cambium
5. What is potency?
6. What is ruminate endosperm?
7. What is degenerating synergid?
8. Name a natural mountant for permanent slide.
9. What is a sledge microtome?
10. What is progressive and retrogressive staining?
11. What is induction and competence?
12. Composition of Carnoy's fluid.

II. Write short note on any *four* of the following (4×6=24)

13. Briefly explain theories of shoot apical meristem.
14. Give an account on different types of vascular bundles
15. Explain different types of endosperm development.
16. Explain the procedure for paraffin infiltration of biological materials
17. ABC model of floral development
18. What is dehydration? What are the principles of dehydration? Give examples.

III. Answer elaborately on any *one* of the following (12×1=12)

19. With the help of diagrams explain the stages of root-stem transition with examples.
20. Explain different types of embryo sac development in plants.

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SEMESTER III: Model Question paper

PLM21C19: Genetics, Plant Breeding, Tissue culture & Evolution

Time 3 Hrs **Max. Marks: 60**

I. Answer very briefly on any *twelve* of the following (12×2=24)

1. Multiple alleles
2. Transposons
3. Euchromatin and heterochromatin
4. Heterosis
5. Terminator seeds
6. Concept of Oparin-Haldane
7. Propositions of Lamarck
8. Hardy-Weinberg Law
9. QTL mapping
10. Heterochrony and heterotropy
11. Synthetic seeds
12. Cybrids

II. Write short note on any *four* of the following (4×6=24)

13. Give a detailed account on mechanisms of sex determination
14. Explain mutation breeding
15. Explain the applications of plant tissue culture in plant breeding.
16. Give an account on Urey-Miller experiment
17. Briefly explain fossilization and its significance
18. Explain the different causes of change in gene frequency in a population.

III. Answer elaborately on any *one* of the following (12×1=12)

19. With the help of diagrams explain the different special types of chromosomes.

20. Explain the various cytological consequences of crossing over in inversion and translocation heterozygotes.

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SEMESTER IV: Model Question paper

PLM21C22: Ecology, Conservation & Phytogeography

Time 3 Hrs **Max. Marks: 60**

I. Answer very briefly on any *twelve* of the following (12×2=24)

1. Distinguish between food chain and food web
2. Explain edge effect
3. What is climax community? Give examples
4. Define photochemical smog
5. Explain *El Nino* and *La Nina* phenomenon
6. Red data book
7. Explain theory of land bridge
8. What do you mean by metapopulation?
9. Ecological pyramid
10. Components of ecosystem
11. r and k selection
12. Bioremediaton

II. Write short note on any *four* of the following (4×6=24)

13. Give an account on different types of species interactions
14. Comment on major environmental laws in India
15. Give an account on *in-situ* and *ex-situ* conservation strategies.
16. Briefly explain different climatic types.
17. Write notes on prevention and control of water pollution.
18. Explain briefly ecological succession.

III. Answer elaborately on any *one* of the following (12×1=12)

19. Explain the different botanical zones of India.

20. What are biogeochemical cycles? Explain Nitrogen cycle with diagrams.

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SEMESTER IV: Model Question paper

PLM21E23: Remote sensing of Biomass and Biodiversity resources

Time 3 Hrs **Max. Marks: 60**

I. Answer very briefly on any *twelve* of the following (12×2=24)

1. Differentiate between Specular reflection and non-specular reflection.
2. Black body radiation
3. Thermal Imaging system
4. Albedo of materials in remote sensing
5. Geo referencing
6. Lidar remote sensing
7. EMR
8. Radiometry
9. Spectral signature concept
10. Platforms in remote sensing
11. Stages of remote sensing
12. Importance of remote sensing in Biodiversity

II. Write short note on any *four* of the following (4×6=24)

13. Give a note on special characteristics of solar radiations.
14. Give a detail on Laser Terrain Mapping
15. Explain the principles of satellite mission
16. What are the techniques of visual interpretation
17. Short note on advance remote sensing technology
18. Importance of thermal sensors in Remote sensing

III. Answer elaborately on any *one* of the following (12×1=12)

19. Write a detail on remote sensing and its applications.

20. Give an account on types of Sensors.

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SEMESTER IV: Model Question paper

PLM21E24: Horticulture

Time 3 Hrs **Max. Marks: 60**

I. Answer very briefly on any *twelve* of the following (12×2=24)

1. What are the basics of a greenhouse design?
2. What do you mean by apomixis?
3. What do you mean by maturity indices?
4. Total Quality Management
5. Seed dormancy
6. Olericulture
7. Comment on importance of horticulture
8. Horticultural tools and equipment
9. Factors influencing seed germination
10. Chlorination and waxing
11. Space garden
12. Polyembryony

II. Write short note on any *four* of the following (4×6=24)

13. Give an account on nursery management.
14. Give an account on nursery management of rubber
15. Explain briefly physiology and biochemistry of fruit ripening
16. Give an account on irrigation systems.
17. Briefly explain pre-cooling techniques prior to shipment.
18. Write notes on methods of preservation of fruits.

III. Answer elaborately on any *one* of the following (12×1=12)

19. Explain in details different methods of asexual propagation of plants
20. Explain the different packaging methods of horticultural products

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SEMESTER IV: Model Question paper

PLM21E25: Entrepreneurship and Business in Biology

Time 3 Hrs **Max. Marks: 60**

I. Answer very briefly on any *twelve* of the following (12×2=24)

1. What are the basic behavioral competencies of an entrepreneur?
2. What are the sources for business ideas?
3. Explain project appraisal.
4. Distinguish between Acquisitions and mergers.
5. Comment on delegation of authority
6. Ledger accounts
7. Single-entry system of record keeping
8. Consortium marketing
9. Stages of product life cycle.
10. Steps in interview process
11. Role of Entrepreneurship Development Institute of India
12. Distinguish between entrepreneurship and management

II. Write short note on any *four* of the following (4×6=24)

13. Give an account on the concept of project and classification of project
14. Explain the roles and functions of entrepreneurship
15. Describe briefly designing of business plan
16. Comment on the best practices in business management
17. Give an account on the fundamental principles of double entry system
18. Employee termination issues

III. Answer elaborately on any *one* of the following (12×1=12)

19. Explain the different sources of capital for investment.

20. Give an account on the main principles of management.

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