PONDICHERRY UNIVERSITY
PUDUCHERRY

B.Sc. BOTANY (HONOURS)

(NEP SYLLABUS)

Effective from 2023-2024

PONDICHERRY UNIVERSITY
NEP - AFFILIATED COLLEGES REGULATIONS FOR 2023-24

MAJOR HIGHLIGHTS

1. These NEP Regulations are applicable to all Arts and Science Colleges affiliated to Pondicherry University from the Academic Year 2023-24.
2. Multi Disciplinary 4 years UG programmes with award of Hons degrees are proposed.
3. Exiting students may be considered for award of a Certificate (after 1 year of study), Diploma (after 2 years of study)
4. Existing CBCS system is replaced with NEP Curriculum framework.
5. Along with Major, Minor disciplinary courses all students are expected to learn Multi-disciplinary subjects, ability enhancement courses, skill focused vocational courses
6. Course work shall focus on learning outcomes expected by NEP.
7. Learning through Internships/Field studies/Community service, etc is embodied in Curriculum.
8. Activity based learning for increased employability skills is the focus of Teaching-Learning process.
9. Colleges/Institutions shall develop network/MoUs with Industry, Natural Institutes for Training.
10. Dual degree programme with Foreign Universities is encouraged.

PONDICHERRY UNIVERSITY

NEP - REGULATIONS

1.0. INTRODUCTION:

- Government of India has launched the National Education Policy (NEP - 2020), encompassing radical changes in the delivery and governance of Higher Education in the country.
- Pondicherry University has adopted the NEP and its Curriculum Framework from the Academic Year 2023-24 in its campus and proposing to implement in affiliated Colleges.
- These NEP Regulations are expected to provide clear direction and procedure for implementation of different provisions of NEP in all Higher Educational Institutions for starting 4 year Undergraduate Degree (Hons) programmes.
- Whereas the University seeks to enforce the academic disciplines to adopt the spirit of NEP in entry-exit requirements, academic bank of credits and credit transfer from MOOCS courses
- Whereas the regulations ought to preserve the academic autonomy of Colleges/HEIs in formulation of curriculum, outline learning outcomes, pedagogical approaches and evaluation methods and assignments of assessment of students.
- These regulations are poised for skill development, inter/multi-disciplinary learning, wider access and inclusiveness and entrepreneurship.

1.1. Major Highlights:

- NEP-Regulations are applicable for Affiliated Colleges from the Academic Year 2023-24
- All UG Boards of Students are mandated to revised regulations for UG and UG (Hons) Degree programmes with entry – exit facility
- Exiting students at the end of First Year will be award a Certificate, second year end with a Diploma, third year end with a UG degree and 4th year end with an Honours Degree.
- Colleges to organize vocational education in approved trades
- Summer vacation is allocated for conducting Internships/fieldstudies/exploring/Scientific Innovations/conducting social/community outreach programmes and other similar field/work related programmes.
- Boards of Studies with inputs from different Colleges would design curriculum as per the NEP guidelines.
- Faculty members are expected to network with industry and design assignments having components of job-oriented skills. They are also encouraged to adopt innovative methods of Teaching for imparting all contemporary developments.
- Internationalisation of Higher Education is encouraged for adopting such best practices and to bench mark with Foreign Universities/Inter-national Institutes.
- All Colleges are expected to network with skill development centres, vocational training institutes for facilitating student internships.
- Overall monitoring and implementation of NEP-2020 will coordinated by College level NEP coordinating Committee or the IQAC.

1.2. Transformative initiatives in Higher Education envisaged by NEP:

- Introducing holistic and Multidisciplinary undergraduate Education, that would help develop all capacities of human beings- intellectual, aesthetic, social, physical, emotional, ethical, and moral- in an integrated manner, soft skills, such as complex

problem solving, critical thinking, creative thinking, communication skills and rigorous specialisation in a chosen filed (s) of learning.

- Adoption of flexible curricular structures in order to enable creative combinations of disciplinary areas for study in multidisciplinary contexts that would also allow flexibility in course options that would be on offer to students, in addition to rigorous specialization in a subject or subjects.
- Environment education to include areas such as climate change, pollution, waste management, sanitation, conservation of biological diversity, management of biological resources and biodiversity, forest and wildlife conservation, and sustainable development and living.
- Value-based education to include the development of humanistic, ethical, constitutional and universal human values of truth, righteous conduct, peace, love, nonviolence, scientific temper, citizenship values, and life skills.
- Global Citizenship Education and education for sustainable development to form an integral part of the curriculum to empower learners to become aware of and understand global sustainable development issues and to become active promoter of more peaceful, tolerant, inclusive, secure and sustainable societies.
- Reorienting teaching programmes to ensure the development of capabilities across a range of disciplines including sciences, social sciences, arts, humanities, languages as well as vocational subjects. This would involve offering programmes/course of study relating to Languages, Literature, Music, Philosophy, Art, Dance, Theatre, Statistics, Pure and applied sciences, sports, etc. and other such subjects needed for a multidisciplinary and stimulating learning environment.

Preparing professional in cutting edge areas that are fast gaining prominence, such as Artificial Intelligence (AI), 3D machining, big data analysis and machine learning, in addition to genomic studies, biotechnology, nanotechnology, neuroscience with important applications to health, environment and sustainable living that will be woven into undergraduate education for enhancing the employability of the youth.

2.SHORT-TITLE AND DEFINITIONS

2.1. Short-title, Commencement and Application

i. These Regulations shall be called NEP Regulations for Affiliated Colleges of the Pondicherry University, 2023-24.
ii. These Regulations shall come into force from the Academic Year 2023-24.
iii. These Regulations shall apply to all teaching programmes of Arts & Science Colleges affiliated to Pondicherry University and other Institutions/Centres admitted to the privileges of the University for award of under graduate Degrees/Diplomas/Certificates.
iv. The programmes governed by other Statutory bodies/professional associations may adopt Regulations brought out by them (Eg. NCTE, AICTE, BCI etc…)

2.2 Definitions.

Terms used in the NEP-CBCS Regulations shall have the meaning assigned to them as given below unless the context otherwise requires:

a. Credit:

A credit is the number of hours of instruction required per week for the given subject in a given semester of 16-18weeks.Onecreditisequivalentto15hoursofteaching(lectureortutorial)or30hoursofpracticeorfieldworkorcommunityengagementandserviceperSemester.

b. **Academic Year**" means the year starting on 1st day of July and ends on the 30th day of June succeeding year.

c. "**Residence time"** means the time a student spends for attending classes in the College/Institution (either Online/Offline) as a full-time student and enrolled in any Academic programme of the Institution.

d. "**Semester**" means 18 weeks (90 Working days) of teaching-learning session of which two weeks shall be set apart for examinations and evaluation;

e. "**Grade**" means a letter grade assigned to a student in a Course for his performance at academic sessions as denoted in symbols of : O(outstanding), A+(Excellent), A(Very good), B+(good), B(Above average), C(average), P(Pass) F(fail) and Ab(Absent) with a numeric value of O=10, A+=9, A=8, B+=7, B=6, C=5 P=4, and F=0, Ab=0;

f. "**Grade Point Average (GPA)**" means an average of the Grades secured by a student in all courses in a given academic session duly weighted by the number of credits associated to each of the courses;

g. **"Cumulative GPA (CGPA)**" is the weighted average of all courses the student has taken in a given Programme;

h. "**A common Course**" means the set of courses that all students who are admitted to any Programme of the University are required to study; these courses include, Languages (English- modern Indian languages), NEP specific courses- viz. Understanding India, Environmental sciences/Education, Health and wellbeing/Yoga, Digital & Technological solutions;

i. **"Major Discipline"** means the core subject mandatory for the programme, Major discipline may be a single discipline or interdisciplinary/ multidisciplinary courses. Eg. B.Sc (Physics) or B.Sc (Physics, Maths and Chemistry)

j. **"Minor Discipline"** means allied or elective subjects to major discipline.

(i) **"Minor discipline Cognate"** refers to a pool of courses offered by the parent department/ cognate (allied) departments. Eg. B.Com. (General) may have minors streams leading in 2/3 to B.Com. (Accounting & Taxation), B.Com. (Banking & Finance), B.Com. (Company Law & Corporate Secretaryship) or B.Com. (Computer applications and Data Analytics)

(ii) "**Minor discipline Generic"** refers to the subsidiary/elective subjects chosen from a basket of courses offered by different departments other than the minors offered by the parent department. Eg. B.Com. (Corporate Economics)

k. "**Credit Requirement**" for a Degree/Diploma/Certificate Programme means the minimum number of credits that a student shall accumulate to achieve the status of being qualified to receive the said Degree, Diploma/Certificate as the case may be;

l. "**Exit option**" means the option exercised by the students, to leave the Programme at the end of any given Academic year;

m. "**Lateral entry**" means a student being admitted into an ongoing Programme of the University otherwise than in the 1st year of the programme.

n. **"Vocational Studies/ Education "**This refer to set of activities for participation in an approved project or practical or lab, practices of application of scientific theories, studio activities involving students in creative artistic activities, workshop-based activities, field-based shop-floor learning, and Community engagement services, etc… ***(These courses are expected to***

enable students to incorporate the learned skills in daily life and start up entrepreneurship.)

o. Skill-based learning/project

This refers to activities designed to understand the different socio-economic contexts, first-hand understanding of the policies, regulations, organizational structures, processes, and programmes that guide the development process.

p. Work-based internship

This refers to structured internships with local industry, businesses, artists, crafts persons etc. which will further improve employability.

3. PROGRAMMES OF STUDY, ELIGIBILITY

3.1. Programmes to be offered at Colleges:

The Curriculum Framework designed by UGC for implementing NEP 2020 specifies that all Undergraduate (UG) degree programmes are to be for a period either for 3 years or for 4 years leading to award of UG or UG(Hons) Degrees.

All UG courses shall focus on conceptual understanding and development of critical thinking in a given field of Study, incidentally the skills such as communication, team work and leadership shall embodied in Teaching-learning process to facilitate for career option in the given field of specialization.

3.2. Degrees, Diplomas and Certificates:

NEP 2020 introduces the facility to breakdown the Programme of study at Undergraduate (UG) level after completion of every year of study. The students will be awarded the following:

- An UG Certificate after completion of 1 Year (2 Semesters) of study in the chosen field of study. (After completing specific number of courses and 4 week internship)
- An UG Diploma after completing 2 years (4 Semesters) of Study and an Internship.
- A Bachelor Degree after completing 3 Years (6 Semesters) of Programme of Study.
- A 4 year Bachelor Degree with Honors after completion of 8 Semesters (4 Years) of Programme of Study and a Research Project in final semester).

4. STRUCTURE OF ACADEMIC PROGRAMMES:

All Academic Programmes offered under NEP shall be stylised in terms of credits. Each course/subject in a given Programme of study shall carry certain number of credits which will be awarded on completion of the said course.

4.1. Breakup of Credits and Courses:

Every Undergraduate (UG) programme offered by a College shall confirm to the Structure specified by the UGC's Framework, 2023. A student of 3 year UG programme is mandated to complete a minimum of 120 credits and the student of 4 year Honors degree shall complete 160 credits.

An UG student shall complete the following courses under different heads as listed below:

1. Major Disciplinary Courses
2. Minor Disciplinary Courses
3. Multi Disciplinary Courses
4. Ability Enhancement Courses
5. Skill Enhancement Courses
6. Value added/Common Courses
7. Internships and Community Service based projects
8. Research Project work for (Honors degree)

NEP Framework has specified the minimum number of credits that a Bachelor student has to earn in ¾ year period. Table I specifies the number of credits and number of courses that a 3 year UG student and a 4 year UG (Hons) Degree student is expected to complete in 3 and 4 year duration respectively.

TABLE I
BREAKUP OF CREDITS AND COURSES

Sl. No.	Component	3 Year Degree	4 Year Hons Degree
1	Major Disciplinary Courses	60 Credits (15 Courses of 4 credits each)	80 Credits (20 Courses of 4 credits each)
2	Minor Discipline Courses	24 Credits (6 Courses of 4 Credits each)	32 Credits (8 Courses of 4 credits each)
3	Multi-Disciplinary Courses	9 Credits (3 courses of 3credits each)	9 Credits (3 courses of 3 credits each)
4	Ability Enhancement Courses	8 Credits (4 courses of 2 credits each)	8 Credits (4 courses of 2 credits each)
5	Skill Enhancement Course	9 Credits (3 courses of 3 credits each)	9 Credits (3courses of 3 credits each)
6	Common Value added courses	8 Credits (4 course of 2 credits each)	8 Credits (4 course of 2 credits each)
7	Community Science	2 Credits (1 field based course)	2 Credits (1 field based course)
8	Research Dissertation Project	-	12 Credits (Project report & background subjects)
9	Total (3 year) credits required	120 Credits	160 Credits1

4.2. NEP Classification of Courses:

i) Major Disciplinary courses (MJD): (60/80 credits)

Major disciplinary courses are subject specific compulsory subjects that a student has to complete to obtain the UG/UG (Hons) Degree in the given discipline. Major disciplinary courses shall constitute 50% of the total credits.

All discipline specific major courses shall be designed for 4 credits each with one/two additional hours or guidance of teaching at Tutorials/ Practicals.

UG programmes may be offered in a single major discipline or in Multiple Major disciplines giving equal weightage in credits. For example a B.Sc. course may be in a single discipline like B.Sc. (Maths) or with multiple major disciplines like B.Sc. (Maths, Physics & Chemistry).

ii) Minor Disciplinary Course (MID): (24/32 credits)

Minor disciplinary courses refer to those subjects which are Allied/Specialization/ Elective subjects to the Major discipline. These allied courses are expected to provide additional understanding of the subject in a specific focused area. For example, a B.A. (Political Science) student shall study allied subjects like Public Administration, Sociology as these subjects have inter linkages with the Major Disciplinary subjects.

Minor disciplinary courses(MID) may also be designed by the parent department or collaborated with sister departments. Parent departments may introduce minor specializations to students by offering a set of 6 to 8 courses in one/two streams as electives or specialization subjects. A BBA/MBA programme may have electives in HR, marketing, finance, etc. with a set of 6 to 8 subjects in each.

In order to provide choice to the students to choose a particular specialization/elective, the BOS may develop 2 to 3 streams of minor specialization courses to focus on such trades for better placemen of students. Each stream of 6/8 specialization/elective subjects may facilitate award of two/three unique degrees in a given major Eg. B.Sc. (Physical Chemistry), B.Sc. (Pharmaceutical chemistry), etc.

iii) Multi-Disciplinary courses (MLD): (9 Credits)

All undergraduate students are mandated to pursue 9 credits worth of courses in such Multi-disciplinary areas/Courses out of 9/10 NEP defined subjects. Colleges may identify any 3 multiple disciplinary streams listed below based on availability of resources and manpower.

a) Natural Sciences
b) Physical Sciences
c) Mathematics & Statistics
d) Computer Science/Applications
e) Data Analysis

f) Social Sciences
g) Humanities
h) Commerce & Management
i) Library Science
j) Media Sciences, etc.

Students are expected to learn basic/introductory courses designed by other departments for this purpose. Colleges may list any 3 introductory courses (one each in natural Sciences, Physical Sciences, Humanities) for uniform adoption of all UG students.

iv)Ability Enhancement (AEC) courses: (8 Credits)

All Undergraduate (UG) students are mandated to complete at least 8 Credits worth of Courses which focus on Communication and Linguistic skills, Critical reading, writing skills. These courses are expected to enhance the ability in articulation and presentation of their thoughts at workplace. Colleges may design these ability enhancement courses tuned to the requirements of given major discipline. Eg. A course in Business Communication is more appropriate in place of literature/prose/poetry.

a) English Language

Ability Enhancement Course	
I. English Language a) English Language & Literature – 1 and 2 b) Functional English – 1 and 2 c) Communicative English – 1 and 2	II. Indian Language (two courses) a) Indian language & Literature – 1 and 2 b) Functional language – 2 c) Communicative language - 1 & 2

v) Skill Enhancement Course: (9 Credits)

These courses focus at imparting practical skills with hands-on Training. In order to enhance the employability of students, Colleges are expected to design such courses that they deem fit for their students for better employment/entrepreneurship/career development, etc. Colleges may also outsource the Skill Enhancement Courses to AICTE approved agencies for conducting short term Training Workshops, Skill India initiatives of GOI and approved Trades by Skill development of corporation are to be considered. short term courses.

vi) Value Added Common courses (VAC): (8 credits)

Under NEP, the UGC has proposed for 6 to 8 credits worth of common courses which are likely to add value to overall knowledge base of the students. These courses include:

a) Understanding India
a) Environmental Sciences/Education
b) Digital and Technological solutions
c) Health, Wellness, Yoga Education, Sports & Fitness

The course structure and coverage of topics are suggested by UGC in its draft documents, colleges/UG Boards of Studies may design the methodology for conducting these value added courses.

vii) Summer Internship (2 to 4 Credits)

As per the UGC guidelines all UG students should be exposed to 4 to 6 week Summer Internship in an industrial organisations/Training Centres/Research Institution, etc. Such Summer Internship is to be conducted in between 4^{th} Semester and 5^{th} semester. A review of report and award of grade based on Work based learning by students is to be recorded during the 5^{th} Semester.

a) Community Engagement and Service (CES) (2 credits)

All UG students are also mandated to participate in a 15 days community engagement activity during their winter vacation between 5^{th} and 6^{th} Semesters. This Community engagement activity is expected to expose the students to social problems of neighbourhood village students may prepare a report on the activities carried out for a award of 2 credits.

viii) Research Project (12 Credits)

All UG (Hons) Degree students are expected to conduct a semester long Research work - during their 8th Semester and submit a Research Report. Students may be given necessary guidance by faculty members in identifying the research problem, conduct of study and preparation of a Project Report.

All these Research Reports are evaluated by a Jury of external experts. A presentation of Results and Viva may also be part of evaluation. A Publication out of findings of the Research Project may also be encouraged.

4.3. Levels of Courses:

NEP Framework classifies all courses into certain levels based on the content and level of Teaching-Learning standards adopted. While Introductory/Basic courses are taught in the First/Second years of UG Degree programme, Core/Advanced courses are introduced at 3rd/4th years of graduation. Further, additional bridge courses are designed for other discipline students. These Bridge courses are designed to bridge the knowledge gap between different disciplinary students to enable them to seamlessly learn the Major/Minor disciplinary courses.

The levels are:

0 to 99 = Pre requisite/ Bridge courses
100 to 199 = Foundation courses/Introductory courses
200 to 299 = Intermediate Level courses
300 to 399 = Core courses/Advanced courses
400 and above = Specialization subjects

4.4 Pedagogical Styles:

In order to achieve the expected Learning outcomes, UGC Framework has specified different Pedagogical approaches for different courses at undergraduate level. These approaches include:

a) Lecture course
b) Tutorial course
c) Practice cum or laboratory courses
d) Seminar Course
e) Internship course
f) Studio activity based course
g) Field practicing
h) Project work courses
i) Community engagement and service course

The details of these different types of Pedagogical methods are as follows:

All major/minor and other courses may be stylised into the following forms:

a) Lecture Courses	Regular classrooms lectures by qualified/experienced Expert Teachers • These Lectures may also include classroom discussion, demonstrations, case analysis, • Use of Models, A.V, Documentaries, PPTs may supplement.

b) Tutorial Courses	Problem solving Exercise classes guided discussion, supplementary readings vocational training, etc.
c) Practicals/Lab work	Practical Lab activity with Theoretical support Mini projects, Activity based engagement, Programme excisions, Data processing and presentation exercise
d) Seminar Course	A course requiring student to design and participate in discussions, Group Discussions, Elocution and Debate, Oral Communication Paper presentations, Poster Presentation, Role play participation, Quiz competitions, Business plan preparation/presentation, etc.
e) Internship course	Courses requiring students to Learn by doing in the workplace external to the educational Institutions. Internships involve working in Business establishment, Local industry, Government Departments, NGOs, Arts and Crafts on the job experience at different service organisations. All Internships should be properly guided and inducted for focused learning.
Studio Activity based course	Engagement of students with creative/artistic/Innovative activities. The activity should have a for visual/experimental activities. These involve building models based on Scientific Theories, creation imaginatory fiction, Drama nine, Modern Art, Motivations/Ethics-moral based plays, craft models floral/fruit arrangements, drawings and design, dissertation, etc.

4.5. Semester –wise Break up of Courses for 3 year UG and 4 Year UG (Hons) Degree programmes

Incorporating the focus of NEP in terms of different categories of courses and award of Certificates, Diplomas and Degrees during different stages of 4 year Degree programmes, a template for Semester-wise course work was designed by the UGC and presented in para 5.3 of "Curriculum Framework". Salient features of it are as follows:

- All courses shall carry specified number of credits.
- Every Semester shall have a minimum of 20 credits worth of courses.
- Credits for a course shall be decided on the basis of number of Contact hours of the teaching in a classroom.
- One credit means one hour of Teaching in case of Theory subject and at least 2 hours of conducting Practical in hours case of Lab subjects.
- All Major and Minor disciplinary Courses shall have 4 credits with 6 hours of work load (including 2 hours of tutorials)
- Language courses, ability enhancement, skill enhancement and value added common course also will have 2 hours of hands on training.
- Progress of Learning is measured in terms of credits earned by a students by successfully completion the course.

- Students can exercise his/her choice for exiting the course at the end of every Academic year.
- Graduate attributes listed by UGC shall be the focus of Teaching-Learning process.
- Semester I and II shall focus on introductory courses/subjects in Major/Minor disciplines and shall focus on providing knowledge in Multidisciplinary areas, skill enhancement and ability enhancement courses.
- Semester III and IV shall focus on Core disciplinary courses with a focus on building strong foundation in the given Discipline.
- Semester V and VI shall focus on providing in-depth knowledge and skills required for taking up a career in the given discipline.
- Semester VII and VIII shall focus on Advanced knowledge and shall direct the students to take up socially relevant projects/Research works newer applications of the knowledge.

While directing the above mentioned requirements, UGC has designed a Template for each Semester. The same with greater clarification is given in **Annexure I**.

5. IMPLEMENTATION OF NEP REGULATIONS:

5.1. Course Design and Boards of Studies (BOS):

Boards of Studies (BOS) is responsible for implementing the NEP Framework proposed by the UGC. Boards of Studies (BOS) is a Statutory academic Body consisting of a Chairman and members of faculty, external experts, industrialists etc.

BOS undertakes the responsibility of incorporating the required Courses i.e. Theory, Practicals, Internships, Project work, Viva voce, etc. based on the developments in Research, Technology, Economy and the Society, BOS decides on the skills and knowledge requirements for graduates in the given Degree programme.

5.2. Course Regulations:

BOS prepares the course-wise "Regulations" for deciding the Learning outcomes, eligibility of students for admission and evaluation, Faculty, technical staff requirements, equipments and stores required and pedagogical methods to be adopted for each subject. (A Proforma for listing Regulations for each UG program is given in **Annexure II**).

5.3. Curriculum and Syllabus:

BOS is also preparing the overall "Curriculum Framework", Semester-wise breakup, detailed Syllabus for each subject listed in the curriculum framework. The BOS also specifies the Learning outcomes from each subject, number of sessions of Teaching, Basic Text books, Reference Books, Journals/Magazines, E-resources, list of student activities for each subject and methodology of Teaching and evaluation of each subject. (Appendix III (A) and III (B) gives Templates for presentation of syllabus for each Theory subject and a Practical Lab subject)

5.4. Approval by School board and Academic Council:

The Curriculum and Course structure and the detailed syllabus prepared by the BOS shall be placed before the School Board and Academic Council for their approval before implementing the same across Colleges.

5.5. Academic Audit of Courses:

IQAC at every College is expected to supervise the implementation of NEP Regulations in every discipline of the College. Availability of required number of Classrooms, Faculty rooms, Labs, Library facilities, Computer Centre and recruitment of Faculty members, allocation of funds for running the Science Labs/Computer Centre etc., is the responsibility of Principal/College Management.

6. ELIGIBILITY, ADMISSIONS, LATERAL ENTRY, MINIMUM ATTENDANCE REQUIREMENTS:

6.1. Eligibility:

All students who have completed their Higher Secondary School Certificate are eligible for admission into an undergraduate degree programme, subject to securing 45% percentage of marks at 12^{th} standard fixed by the respective Universities/State Govts for each UG Programme.

6.2. Admissions:

As per the NEP, students shall be admitted to Undergraduate Programmes on basis of merit order in an All India Admission Test like CUET, NEET, etc. However, the respective State/UT Govts shall decide the order of merit for admission of students for different courses offered at Colleges.

6.3. Lateral Entry:

As per NEP, students have a choice of exit and entry into the Programme of Study multiple number of times. UGC specifies that about 10% of seats over and above the sanctioned strength shall be allocated to accommodate the Lateral Entry students. Detailed guidelines for lateral Entry would be finalized by the University shortly.

7. EVALUATION:

7.1. Total Marks: 100

All Credit courses are evaluated for 100 marks. Internal Assessment component is for 25 marks and the End Semester University exam is for 75 marks. In case of Practicals, Project work etc., it is 50:50 marks for Internal and End-Semester Exams.

7.2. Break up of Internal Assessment marks:

Total Internal Assessment mark for a theory subject is 25 marks. The breakup is:

a)	Mid Semester Exam (one) - 20 Marks *
b)	Percentage of Attendance - 5 Marks
Total - 25 Marks	

* For the Practicals conducted as a part of the MJD, MID & SEC courses based on the content prescribed within the syllabus there should be an end semester practical examination. For which two Internal Examiners must be there (one internal examiner will be the Course in-charge and the other will be the Head of the concerned department).
The practical marks should be treated as the Mid semester marks for those courses (Practical 20 + Attendance 5= 25 marks)
For the separate Practical courses there would be an Internal Examiner and an External Examiner (ESE 50 + ICA 50= 100 marks).

Marks for Attendance is as follows:

Below 75%	0
75% - 80%	1
80% - 85%	2
85% - 90%	3
90% - 95%	4
95% - 100%	5

7.3. Internal Test Scheme:

Principal of the College schedules the Mid-Semester Exam for all courses during 8/9th week of start of classes. All faculty members are expected to conduct this Mid-Semester exam for 1.30 hr duration and evaluate, upload the marks to Controller of Examinations of University. Colleges are also requested to preserve the answer books of Mid-Semester exams until declaration of results by the University.

7.4. Internal Assessment marks for Practicals/Project work/ Internships subjects:

Faculty member in-charge of Lab practicals shall evaluate the practical subjects for 50 marks. The break up is as follows:

a) Observation note/Demo note/Work dairy	15
b) Practical Record/Internship Report	15
c) Regular performance in the practical classes for the whole semester	15
d) Attendance	5
Total	**50**

7.5. End-Semester University Exam:

Controller of Examinations (COE) of Pondicherry University schedules the End-Semester exams for all theory and practical subjects based on University calendar.

A detailed Exam Time Table shall be circulated to all Colleges at least 15 days before the start of exams mostly during 15/16th week of the Semester. Question Papers shall be set externally based on BOS approved syllabus. **All students who have a minimum of 70% attendance are eligible to attend the end-semester exams.**

The breakup of end semester marks:

a) Theory subjects (Sec A, Sec B and Sec C) Question from all units of Syllabus	75 marks
b) Practical/Internship Project Work subjects (Based on Practical Exams/Presentation/Viva)	50 marks

7.6. Consolidation of Marks and passing Minimum

Controller of Examinations of the University consolidates the Internal Assessment marks uploaded by the Colleges and marks secured by students in end-semester examination. The total marks will be converted into letter grades as shown in the following Table 2. As per NEP Regulations, **the passing minimum is 50% marks** (IA+End semester put together). However, **Pondicherry University considers 40% marks as pass during first 3 years of study** and students who secured less than 50 will be awarded 'P' (Pass Grade)

7.7. Arrear Exam:

A student who failed to secure 40% marks in aggregate is declared as Failed and he is eligible to take up supplementary examination by registering to the said course in the following Semester. All other candidates who failed due to shortage of attendance, those who are seeking to improve the grade shall repeat the course.

7.8. Letter Grades and Calculation of CGPA:

Total Marks Secured by a student in each subject shall be converted into a letter grade. UGC Framework has suggested a Country wide uniform letter grades for all UG courses. The following Table shows the seven letter grades and corresponding meaning and the grade points for calculation of CGPA.

TABLE – 2

Equivalent Letter Grade	Meaning	Grade Points for Calculation of CGPA
O	Outstanding	10
A+	Excellent	9
A	Very Good	8
B+	Good	7
B	Above Average	6
C	Average	5
P	Pass	4
F	Fail	0
Ab	Absent	0

In order to workout the above letter grades, the marks secured by a students (Total of IA and Semester End) would be categorized for relative grading.

The ranges of marks for each grades would be worked as follows:

Highest marks in the given subject: X

Cut of marks for grading purpose: 50 marks

Passing mark (for 3 year of UG) = 40

Number of grades (excepting P grade)
(O,A+,A,B+,B,C) = 6

Range of marks = K

$$K = \frac{x-50}{G}$$

The following table given the range of marks and letter grades.

According to K value, one of the following grading scheme will be followed.

(i) If K ≥ 5, then the grades shall be awarded as given in Table II.

Table II

Range of Marks in %	Letter Grade Points for	Letter Grade Points for
X to (X-K)+1	O	10
(X-K) to (X-2K)+1	A+	9
(X-2K) to (X-3K)+1	A	8
(X-3K) to (X-4K)+1	B+	7
(X-4K) to (X-5K)+1	B	6
(X-5K) to 50	C	5
40 – 49	P	4
Below 40	F	0
Absent (Lack of Attendance)	Ab	0

(ii) If K<5, then the grades shall be awarded as given in Table III.

Table III

Range of Marks in %	Letter Grade Points for	Letter Grade Points for
80-100	O	10
71-79	A+	9
66-70	A	8
61-65	B+	7
56-60	B	6
50-55	C	5
40-49	P	4
Below 40	F	0
Absent (lack of attendance)	Ab	0

7.8.1. Calculation of Semester Grade Point average and CGPA:

Semester Grade point Average (SGPA) is calculated by taking a weighted average of all grade points secured by a candidate from all subjects registered by him/her in the given Semester. The weights being the number of credits that each subject carries.

Cumulative Grade point Average (CGPA) CGPA shall be calculated as the weighted average of credits that course carries and the value of Grade points averaged for all subjects.

Computation of SGPA and CGPA

The following procedure shall be followed to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

The SGPA is the ratio of the sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e. **SGPA** (Si) = Σ(Ci x Gi) / ΣCi

Where Ci is the number of credits of the i^{th} course and Gi is the grade point scored by the student in the i^{th} course.

(i) Example for Computation of SGPA where candidate has not failed in any course.

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course 1	3	A	8	3 X 8 = 24
I	Course 2	4	B+	7	4 X 7 = 28
I	Course 3	3	B	6	3 X 6 = 18
I	Course 4	3	O	10	3 X 10 = 30
I	Course 5	3	C	5	3 X 5 = 15
I	Course 6	4	B	6	4 X 6 = 24
		20			139
	SGPA				139/20=6.95

(ii) Example for Computation of SGPA where candidate has failed in one course.

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course 1	3	A	8	3 X 8 = 24
I	Course 2	4	B+	7	4 X 7 = 28
I	Course 3	3	B	6	3 X 6 = 18
I	Course 4	3	O	10	3 X 10 = 30
I	Course 5	3	C	5	3 X 5 = 15
I	Course 6	4	F	0	4 X 0 = 00
		20			115
	SGPA				115/20=5.75

(iii) Example for Computation of SGPA where candidate has failed in two courses.

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course 1	3	A	8	3 X 8 = 24
I	Course 2	4	B+	7	4 X 7 = 28
I	Course 3	3	F	0	3 X 0 = 00
I	Course 4	3	B	6	3 X 6 = 18
I	Course 5	3	C	5	3 X 5 = 15
I	Course 6	4	F	0	4 X 0 = 00
		20			85
	SGPA				85/20=4.25

The CGPA shall also be calculated in similar way as shown in examples (i), (ii) and (iii) of SGPA for all subjects taken by the students in all the semesters. However, if any student fails

more than once in the same subject, then while calculating CGPA, the credit and grade point related to the subject in which the student fails in multiple attempts will be restricted to one time only. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

In case of audit courses offered, the students may be given (P) or (F) grade without any credits. This may be indicated in the mark sheet. Audit courses will not be considered towards the calculation of CGPA.

7.9. Declaration of Results:

Controller of Examinations (COE) of the University shall declare the results of given UG programme following the CGPA secured by students by the end of 6th Semester and 8th Semester.

PASS CLASSES

Range of CGPA	Result
9.0 above	First Class with distinction
6.0 above	First Class
5.0 Below 5.99	Second Class
4.0 4.99	Pass Class

8. Role and Responsibility of the College:

8.1. Role of Principal:

Principal/Director/Dean of the College shall exercise the responsibility for the implementation UGCs NEP in all Undergraduate programmes. Provision of required Infrastructure, Equipments, Budgetary allocations for funds for library purchases, development of Common facilities, conduct of Special training programmes for Soft skill development, Campus Placement facility and provision of Student Amenities and conduct of different Events like Induction day, Fresher's Meet, Farewell, College Day, Graduation Day, Celebration of UN days, etc. He shall ensure the quality teaching by recruiting qualified faculty members and ensure fair conduct of all exams.

8.2. Role and Responsibility of HODs/Programme Coordination:

All UG programmes shall be offered by designed Academic Departments. A minimum number of Core Faculty members for the given discipline are to be recruited. The HODs/Programme Coordinators shall taken the responsibility of organizing the Academic Programme.

HOD shall take the responsibility of implementing the University Calendar for starting the Class work, Class Time Table, coordinate the Course Work with other disciplines. The schedule of Internships/Project works/Community engagement activity shall be prepared in advance. He/She shall develop the required Industry network with necessary collaborations/MoUs for skill training to all UG students, Winter/Summer internships.

8.3. Powers to Resolve the Grievance:

Notwithstanding to the above provisions of these Regulations, the Chairman of Academic Council/Vice-Chancellor of Pondicherry University has the ultimate authority to interpret, modify and relax any of the above mentioned provisions/Guidelines. He/She may constitute such Committees from time to time for smooth implementation of UGC's NEP Framework across all Colleges affiliated to Pondicherry University.

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PONDICHERRY UNIVERSITY

B.Sc. BOTANY (HONOURS) COURSE OUTLINE AS PER NEP- 2023-2024

Sl. No.	Course Code	Name of the Course	Theory/ Practical	Credits	Teaching Hours
SEMESTER I					
1	MJD-1	Algology, Mycology and Lichenology	T+P	3+1	3+2
2	MID-1	A) Introduction to Botany -I	T+P	3+1	3+2
		B) Plants in Traditional Systems of medicine			
3	MLD-1*	Any one from the list of MLD courses/ MOOC/ SWAYAM	T	3	4
4	AEC-1	English 1	T	2	4
5	SEC-1	A) Algal Culture Technology	T	3	4
		B) Botanical Garden and Landscaping			
6	VAC-1	EVS	T	2	4
7	VAC-2	Understanding India	T	2	4
			Total	**20**	**30**
SEMESTER II					
8	MJD-2	Bryology and Pteridology	T+P	3+1	3+2
9	MID-2	A) Introduction to Botany II	T+P	3+1	3+2
		B) Herbal Technology			
10	MLD-2*	Any one from the list of MLD courses/ MOOC/ SWAYAM	T	3	4
11	AEC-2	MIL-1	T	2	4
12	SEC-2	A) Mushroom Culture Technology	T	3	4
		B) Fermentation Technology			
13	VAC-3	Health and Wellness/Yoga Education	T	2	4
14	VAC-4	Digital and Technological Solutions	T	2	4
			Total	**20**	**30**
SEMESTER III					
15	MJD-3	Gymnosperms and Paleobotany	T+P	3+1	3+2
16	MJD-4	Morphology and Taxonomy of Angiosperms	T+P	3+1	3+2
17	MID-3	A) Allied Chemistry 1	T+P	3+1	3+2
		B) Phytochemistry			
18	MLD-3	Any one from the list of MLD courses/ MOOC/ SWAYAM	T	3	4
19	AEC-3	English-2	T	2	4
20	SEC-3	A) Bio-fertilizer technology	T	3	4
		B) Floriculture			

			Total	**20**	**27**
SEMESTER IV					
21	MJD-5	Anatomy of Angiosperms and Embryology- Theory	T	4	5
22	MJD-6	Cell Biology and Evolution- Theory	T	4	5
23	MJD-7	Anatomy of Angiosperms and Embryology & Cell Biology and Evolution- Practical	T	4	5
24	MID-4	A) Allied Chemistry-II B) Bioanalytical Techniques	T+P	3+1	3+2
25	AEC-4	MIL 2	T	2	4
26	Project/ Internship	Community Engagement	P	2	6
			Total	**20**	**30**
SEMESTER V					
27	MJD-8	Genetics and Plant Breeding	T+P	3+1	3+2
28	MJD-9	Molecular Biology	T+P	3+1	3+2
29	MJD-10	Microbiology and Plant Pathology	T+P	3+1	3+2
30	MID-5	A) Economic Botany B) Medical Botany	T+P	3+1	3+2
31	SKD (MJD-15)	Summer Internship	P	4	6
			Total	20	26
SEMESTER VI					
32	MJD-11	Plant Physiology and Plant Biochemistry- Theory	T	4	5
33	MJD-12	Plant Biotechnology- Theory	T	4	5
34	MJD-13	Plant Physiology and Plant Biochemistry & Plant Biotechnology- Practical	P	4	6
35	MJD-14	Ethnobotany	T+P	3+1	3+2
36	MID-6	A) Ecology and Biodiversity B) Research Methodology	T+P	3+1	3+2
			Total	**20**	**26**
SEMESTER VII					
37	MJD-16	Genomics and Proteomics- Theory	T	4	5
38	MJD-17	Horticulture- Theory	T	4	5
39	MJD-18	Genomics and Proteomics &Horticulture- Practical	P	4	6
40	MID-7	A) Industrial Microbiology B) Marine Biotechnology	T+P	3+1	3+2
41	MID-8	A) Forensic Botany B) Biostatistics and Computer Applications in Biology	T+P	3+1	3+2
			Total	**20**	**26**

SEMESTER VIII					
42	MJD-19	Agriculture and Food Microbiology	T	4	3+2
43	MJD-20	Seed Technology and Germplasm Storage	T	4	3+2
44	MID	Research Project	P	12	15
	(OR)				
45	MJD-21	Plant Stress Physiology- Theory	T	4	5
46	MJD-22	Dendrology and Arboriculture-Theory	T	4	5
47	MJD-23	Plant Stress Physiology & Dendrology and Arboriculture-Practical	P	4	5
			Total **Overall Total**	**20** **160**	**25** **203**

*** No course should be studied more than once by the students.**

MJD – Major Disciplinary Courses;

MID – Minor Disciplinary course

MLD – Multi Disciplinary course;

SEC – Skill Enhancement Course

VAC – Value Added Common Course:

AEC – Ability Enhancement Course

SEMESTER I

ALGOLOGY, MYCOLOGY AND LICHENOLOGY

Course code	Credits	Teaching hours per week	Maximum Marks
MJD-1	**4**	**5**	**ESE 75 (Theory) + ICA 25 (Practical) = 100**

Course outcomes:
On completion of the course, the students should be able to:

- Differentiate the algae from other plant groups
- Identify the types and cultivation of algae
- Understand the habitats and importance of algae
- Acquire the knowledge on saprophytic and parasitic fungi
- Classify the fungi
- Understand the habitats and importance of fungi and lichens in nature

Key words:
Algae, Fungi, Lichens, Thallus, Pigments, Mycelium, Haustoria, Mycorrhiza.

THEORY

Unit 1: Algae I **(9 lectures)**
Life histories of algae, General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae (Chapman, 1970). Economic importance of algae.

Unit 2: Algae II **(9 lectures)**
Cell structure/ thallus organization, reproduction and life cycle of the following algae: *Nostoc*, *Oedogonium*, *Caulerpa*, *Sargassum*, *Polysiphonia*. Algal pigments.

Unit 3: Fungi I **(9 lectures)**
General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification (Alexopolous and Mims, 1996);

Unit 4: Fungi II **(9 lectures)**
Cell structure/ thallus organization, reproduction and life cycle of the following fungi), *Mucor* (Zygomycota), *Aspergillus*, *Yeast* (Ascomycota), and *Agaricus* (Basidiomycota), *Fusarium* (Deuteromycetes).

Unit 5: Lichens **(9 lectures)**
Symbiotic associations-Lichens: General account, Types of lichens: Crustose, Foliose and Fruticose. Reproduction and significance.
Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.
Lichens as a pollution indicator. Economic importance of lichens.

PRACTICALS: (30 lectures)

1. Study of vegetative and reproductive structures of *Nostoc* (electron micrographs), *Oedogonium, Caulerpa, Sargassum and Polysiphonia* through temporary preparations and permanent slides.
2. *Mucor* and *Aspergillus*: Asexual stage from temporary mounts and sexual structures through permanent slides.
3. *Yeast:* Specimens/photographs and tease mounts.
4. *Agaricus*: Sectioning of gills; Culture.
5. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose).
6. Mycorrhiza: ectomycorrhiza and endomycorrhiza (Photographs).

Suggested Readings:

1.Alexopoulos C.J., Mims C.W. and Blackwell M. 2002. Introductory Mycology (4thed.). John Wiley and Sons (Asia), Singapore.
2. Gangulee H.C. and Kar A.K. 2011. College Botany (Vol. II). New Central Book Agency. Calcutta.
3. Kumar H.D. 1999. Introductory Phycology (2nded.). Affiliated East-West Press Pvt. Ltd. Delhi.
4. Raven P.H., Johnson G.B., Losos J.B. and Singer S.R., 2005. Biology. Tata McGraw Hill. New Delhi.
5. Sethi I.K. and Walia S.K. 2011.Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd. New Delhi.

SEMESTER II

BRYOLOGY AND PTERIDOLOGY

Course code	Credits	Teaching hours per week	Maximum Marks
MJD-2	**4**	**5**	**ESE 75 (Theory) + ICA 25 (Practical) = 100**

Course outcomes:

- On completion of this course, the students will be able to:
- Demonstrate an understanding of Bryophytes and Pteridophytes
- Develop critical understanding on morphology, anatomy and reproduction of Bryophytes and Pteridophytes
- Understanding of plant evolution and their transition to land habitat

Key Words:
Moss, Liverworts, Hornworts, Fern

THEORY

Unit 1: Introduction and Classification (9 lectures)
Transition to land habit. Bryophytes: Alternation of generations. General characteristics, Range of thallus organization.
Resemblances of bryophytes with Thallophytes (algae) – Differences between Thallophytes and Bryophytes.
Classification- outline according to Schuster, 1966 (up to family).

Unit 2: Bryophytes (9 lectures)
Morphology, anatomy and reproduction of *Marchantia* (Hornworts), *Anthoceros* (Liverworts), *Funaria* (Moss).
(Developmental details not to be included).

Unit 3: Pteridophytes I (9 lectures)
Introduction to early land plants. General characteristics, G.M.Smith (1955) Classification (up to Class).
Morphology, anatomy and reproduction of *Psilotum, Lycopodium.*

Unit 4: Pteridophytes II (9 lectures)
Morphology, anatomy and reproduction of *Selaginella, Equisetum* and *Marsilea* (developmental details not to be included).
Apogamy and apospory. Heterospory and seed habit, telome theory, stelar evolution.

Unit 5: Uses of Bryophytes and Pteridophytes (9 lectures)
Economic importance of bryophytes.
Common ferns of India, Ecological and economic importance of Pteridophytes.

PRACTICALS:
I) External and internal morphology of the following Bryophytes:
1.*Anthoceros*
2. *Marchantia*

3. *Funaria*

II) External and internal morphology of the following Pteridophytes:
1. *Psilotum*
2. *Lycopodium*
3. *Equisetum*
4. *Marsilea*

Suggested Readings:

BRYOPHYTES

1. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot, Allahabad.
2. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, New Delhi.
3. Vanderpoorten, A. and Goffinet, B. (2009). Introduction to Bryophytes. Cambridge University Press, Cambridge.

PTERIDOPHYTES

1. Rashid (1999). An Introduction to Pteridophyta, 2nd Edition: Diversity, Development, Differentiation. Vikas Publication House., India

2. Sporne K.R. (2023) The Morphology of Pteridophytes the Structure of Ferns and Applied Plants. United Book Prints, India

3. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.

SEMESTER III

GYMNOSPERMS AND PALAEOBOTANY

Course code	Credits	Teaching hours per week	Maximum Marks
MJD-3	**4**	**5**	**ESE 75 (Theory) + ICA 25 (Practical) = 100**

Course outcomes:

- Students are able to understand about the Gymnosperms.
- To Develop critical understanding on morphology, anatomy and reproduction of Gymnosperms.
- Understanding of plant evolution and their transition to land habitat.
- Demonstrate proficiency in the experimental techniques and methods of appropriate analysis of Gymnosperms

Keywords:
Cones, ovules, seeds, vessels, fossilization, Geological time scale, Petrification,

THEORY

Unit 1: Brief Introduction on Gymnosperms (9 lectures)
Comparison of Gymnosperms with Pteridophytes.
General characteristics, classification according to K.R.Sporne (1962; up to class).
Occurrence, external morphology, anatomy and reproduction of *Cycas* (developmental details not to be included).

Unit 2: Life cycle of important Gymnosperms (9 lectures)
Occurrence, external morphology, anatomy and reproduction of *Pinus* and
Occurrence, external morphology, anatomy and reproduction of *Gnetum*.
(Developmental details not to be included).

Unit 3: Economic Importance of Gymnosperms (9 lectures)
Economic importance of gymnosperms: timber yielding gymnosperms, secondary metabolites from gymnosperms.

Unit 4: Paleobotany (9 lectures)
General account on fossils and fossilization; kinds of preservation: compressions, coal balls, impressions, incrustations (Casts), petrifactions (mineralized plants), compactions (Mummified plants), ambers. Geological time scale, computation of age of fossils (radio carbon dating). Economic importance of Fossils.

Unit V: Fossil Botany (9 lectures)
Detailed study of the following fossil Pteridophytes: *Rhynia, Lepidodendron*.
Detailed study of the following fossil Gymnosperms: *Williamsonia*.

PRACTICALS:
Gymnosperms: (20 lectures)
Vegetative, anatomical and reproductive characters of the following plants:
Cycas

Pinus
Gnetum

Paleobotany: (10 lectures)
Study of the structure of fossil plants:
Rhynia
Lepidodendron
Calamites
Williamsonia

Suggested Readings
1. Arnold C.A. 2008. An Introduction to Palaeobotany. Read Books. New York.
2. Bhatnagar S.P. and Moitra A. 1996. Gymnosperms. New Age International (P) Ltd Publishers. New Delhi.
3. Pandey B.P. 2012. College Botany (Vol. II). S.Chand & Company Pvt. Ltd. New Delhi.
4. Parihar N.S. 1991.An introduction to Embryophyta (Vol.I). Bryophyta. Central Book Depot. Allahabad.
5. Rashid A. 1999. An Introduction to Pteridophyta: Diversity, Development, Differentiation (2nd revised ed.). Vikas Publishing House Pvt Ltd. New Delhi.
6. Vashishta B.R. 1995. Botany for degree students: Bryophyta. S.Chand & Company Ltd. New Delhi.
7. Vashishta P.C., Sinha A.K. and Kumar A. 2010. Pteridophyta. S.Chand & Company Pvt. Ltd. New Delhi.

MORPHOLOGY AND TAXONOMY OF ANGIOSPERMS

Course code	Credits	Teaching hours per week	Maximum Marks
MJD-4	**4**	**5**	**ESE 75 (Theory) + ICA 25 (Practical) = 100**

Course outcomes:

- Students able to understand the morphology of root, stem, leaf and flower of angiosperm plants
- To understand the modification of different plant parts of angiosperms
- To understand how the higher plants are classified based on classical vs modern methods
- To understand the characteristics of plants present in the family under Polypetalae, Gamopetale, Monochlamydiae and Monocots.

Key words:
Angiosperm, Rhizome, Tuber, Phyllode, Inflorescence, ICBN, Phylogeny, Herbarium, Genus, Specific epithet, Dicots, Polypetalae, Gamopetalae, Monochlamydeae, Monocots.

THEORY

Unit 1: History of Plant identification and Root-Stem Morphology (9 lectures)
History of morphology of Angiosperms (brief).
Types of roots (adventitious and tap root), Modifications of roots- storage roots, anchorage roots, respiratory roots or pneumatophores. Economic importance of roots. Alternate foods-tubers.
Stem morphology: Forms- Erect forms (herbs, shrubs and trees), Weak forms (creepers, climbers, trailers). Modifications of stem (rhizomes, stem-tubers, bulb, corm). Runner, stolon, sucker, offset, phyllode/ cladophyll, cladode, thorn, bulbil. Alternate foods-fibre.

Unit 2: Leaf, Flower and Fruit Morphology (9 lectures)
Phyllotaxy, shape of leaves, leaf tip, leaf margin, leaf modifications. Stipule, petiole. Dorsiventral and isobilateral leaves. Venation: parallel and reticulate. Simple leaves and compound leaves (pinnate and foliate leaves). Unipinnate, bipinnate, tripinnate; paripinnate and imparipinnate. Trichomes of leaves.
Inflorescence types: Raceme- Panicle, corymb, spike, spadix, umbel, capitulum/ head, catkin. Cyme- solitary, simple, monochasial cyme, dichasial cyme, polychasial cyme. Special types of inflorescence (hypanthodium), verticillaster, cyathium, thyrsus, fascicle.
Flower- a modified shoot. Peduncle, scape, bract, bracteole, calyx, corolla, androecium and gynoecium. Horticultural applications of flowers.
Types of fruits- simple fruits (fleshy and dry fruits), compound fruits. Importance of fruits in plant classification. Seeds: a fertilized ovule. Endosperms.

Unit 3: Angiosperm Taxonomy (9 lectures)
Classification, Nomenclature and Identification.
Functions of Herbaria, important herbaria and botanical gardens of the world and India (BSI); Documentation: Flora, Keys (Indented and Bracketed). Ranks, categories and taxonomic groups. Principles and rules (ICBN); binominal system, typification, author citation, effective and valid publication, rejection of names, principle of priority and its limitations.

Unit 4: Angiosperm Classification and Polypetalae Families (9 lectures)
Types of classification- artificial, natural and phylogenetic. Bentham and Hooker (up to series), Engler and Prantl (up to series/ order). Introduction to the APG system of classification. Study of the following Polypetalae families and their economic importance: Annonaceae, Rutaceae, Anacardiaceae, Fabaceae, Caesalpiniaceae, Mimosaceae and Cucurbitaceae.

Unit 5: Gamopetalae, Monochlamydeae and Monocot Families (9 lectures)
Study of the following Gamopetalae families and their economic importance: Asteraceae, Asclepiadaceae, Solanaceae, Lamiaceae.
Study of the following Monochlamydeae family and their economic importance: Euphorbiaceae.
Study of the following Monocot families and their economic importance: Liliaceae, and Poaceae.

PRACTICALS
EXTERNAL MORPHOLOGY (10 lectures)

1. Identification of different types of root of Dicotyledonous and Monocotyledonous plants
2. Identification of different types of stem of Dicotyledonous and Monocotyledonous plants
3. Identification of different types of Si mple leaves of Dicotyledonous and Monocotyledonous plants
4. Identification of different types of Compound leaves of Dicotyledonous and Monocotyledonous plants
5. Identification of different types of Inflorescences- Racemose/ Cymose/ of Dicotyledonous plants
6. Identification of different types of Simple- fleshy Fruits
7. Identification of different types of Simple- dry Fruits
8. Identification of different types of Compound Fruits- Aggregate fruits and Multiple fruits

TAXONOMY (20 Lectures)

1. Study of vegetative and floral characters of the following Polypetalaefamilies:
   Annonaceae
   Rutaceae
   Anacardiaceae
   Fabaceae
   Caesalpiniaceae
   Mimosaceae and
   Cucurbitaceae.

2. Study of vegetative and floral characters of the following Gamopetalae families:
   Asteraceae
   Asclepiadaceae
   Solanaceae
   Lamiaceae.

3. Study of vegetative and floral characters of the following Monochlamydeae families:
   Euphorbiaceae

(Description, L.S. of flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification).

4. Mounting of a properly dried and pressed specimen of any ten plant species with herbarium label (to be submitted along with Field Note).

5. Study tour (female staff should accompany girl students).

Suggested Readings

1.Baruah A. 2011. Advanced Morphology of Angiosperms. Aavishkar Publishers Distributors, Jaipur.
2. Gangulee H.C., Das K.S. and Dutta C. 1988. College Botany (Vol.I). New Central Book Agency. Calcutta.
3.Jones Jr. S.B. andLuchsinger A.E. 1987. Plant Systematics. McGraw-Hill Book Company. New York.
4. Lawrence G.H.M. 1951. Taxonomy of Vascular Plants. Oxford & IBH Co. Pvt. Ltd. New Delhi.
5. Simpson M.G. 2006. Plant Systematics. Elsevier Academic Press. San Diego, CA, U.S.A.
6. Singh G. 2010. Plant Systematics: An Integrated Approach (3rded.). Science Publishers. U.S.A.
7. Venkateswarlu V. 1974. External Morphology of Angiosperms. S.Chand& Co. (Pvt) Ltd. New Delhi.
8.Kormondy E.J. 1996. Concepts of Ecology (4^{th}ed.). Prentice Hall. USA.
9. Kumaresan V. and Annie R. 2013. Taxonomy-Systematic Botany, Economic Botany, Ethnobotany. Saras Publication. Nagercoil.
10. Lawrence G.H.M. 1951. Taxonomy of Vascular Plants. Oxford & IBH Co. Pvt. Ltd. New Delhi.
11. Pandey B.P. 2005. Taxonomy of Angiosperms. S.Chand& Company Pvt. Ltd. New Delhi.
12. Pandey B.P. 2012. College Botany (Vol. II). S.Chand& Company Pvt. Ltd. New Delhi.
13. Pandey B.P. 2010. Modern Practical Botany (Vol. II). S.Chand& Company Ltd. New Delhi.
14. Sharma P.D. 2010. Ecology and Environment (8thed.). Rastogi Publications. Meerut.
15. Simpson M.G. 2006. Plant Systematics. Elsevier Academic Press. San Diego, CA, U.S.A.
16. Singh G. 2012. Plant Systematics: Theory and Practice (3rded.). Oxford & IBH Pvt. Ltd. New Delhi.
17. Singh G. 2010. Plant Systematics: An Integrated Approach (3rded.). Science Publishers. USA.

SEMESTER IV

ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS

THEORY

Course code	Credits	Teaching hours per week	Maximum Marks
MJD-5	**4**	**5**	**ESE 75 (Theory) + ICA 25 (Theory) = 100**

Course outcomes:
At the end of the course the students will be able to:

- To understand the fundamental concepts of plant anatomy and embryology
- To analyze and recognize the different organs of plant and its secondary growth.
- To evaluate the structural organization of flower and the process of pollination and
- fertilization.

Keywords:
Apical meristems, Dicots, Monocots, Secondary growth, Anther, Pollen, Ovules, Embryo sacs, Apomixis, Polyembryony.

Unit 1: Plant Tissues and Classification (15 Lectures)
Root (Histogen theory) and shoot apical meristems (Tunica-Corpus theory); Simple tissue (Parenchyma, Collenchyma, Sclerenchyma) and Complex tissues (Xylem and Phloem).

Unit 2: Tissues and Organs (15 Lectures)
Primary structure of dicot and monocot root, stem and leaf. Adaptive and productive systems – epidermis, cuticle, stomata-types, guard cells, subsidiary cells.

Unit 3: Secondary Growth (15 Lectures)
Vascular cambium – structure and function, fusiform initials, ray initials, seasonal activity-annual rings. Secondary growth in root and stem, periderm, Wood (heartwood and sapwood). Anomalous secondary growth- *Dracaena*, *Boerhaavia*.

Unit 4: Organization of Flower and Pollination (15 Lectures)
Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac. Pollination mechanisms.

Unit 5: Fertilization, Embryo and Endosperm (15 Lectures)
Double fertilization; Seed-structure, appendages and dispersal types.
Endosperm types, structure and functions; Dicot and monocot embryo. Apomixis and polyembryony: Definition, types and practical applications.

Suggested Readings
1.Becker W.M., Kleinsmith L.J., Hardin J. and Bertoni G. P. 2009. The World of the Cell (7th ed.). Pearson Benjamin Cummings Publishing. San Francisco.
2. Bhojwani S.S. and Bhatnagar S.P. 2011. Embryology of Angiosperms (5th ed.). Vikas Publication House Pvt. Ltd. New Delhi.

3. Cooper G.M. and Hausman R.E. 2009. The Cell: A Molecular Approach. (5th ed.). ASM Press & Sunderland. Washington, D.C. 4. De Robertis E.D.P. and De Robertis E.M.F. 2006.Cell and Molecular Biology. 8thed.). Lippincott Williams and Wilkins. Philadelphia.
5. Dickison W.C. 2000. Integrative Plant Anatomy. Academic Press. San Diego.
6. Evert R.R. 2006. Esau's Plant Anatomy. John Wiley & Sons Inc. New Jersey.
7. Fahn A. 1990. Plant Anatomy (4th ed.). Pergamon Press. Oxford.
8. Gangulee H.C., Das K.S. and Datta C. 1988. College Botany (Vol.I). New Central Book Agency (P) Ltd. Calcutta. 9. John Jothi Prakash E. 1987. A Text Book of Plant Anatomy. Emkay Publications. Delhi.
10. Karp G. 2010. Cell and Molecular Biology: Concepts and Experiments (6thed.). John Wiley & Sons. Inc. New York.
11. Pandey B.P. 2001. Plant Anatomy. S.Chand & Company Ltd. New Delhi.
12.Rudall P.J. 2007. Anatomy of Flowering Plants: An Introduction of Structure and Development (3rded.). Cambridge University Press. Cambridge.

CELL BIOLOGY AND EVOLUTION

THEORY

Course code	Credits	Teaching hours per week	Maximum Marks
MJD-6	**4**	**5**	**ESE 75 (Theory) + ICA 25 (Theory) = 100**

Course outcomes:

- To help the students to gain knowledge on the structural and functional organization of cells.
- Study cell organelles and the various metabolic pathways vital for life.
- Study the fundamental concepts of evolutionary biology and understand how evolutionary forces have shaped the diversity of life on Earth.

Key words: Cell, Organelles, Cell cycle, Evolution, Phylogenetic Tree, Mass Extinction.

Unit 1: Introduction to Cell Biology (15 lectures)

History of cell biology; Cell theory; Diversity of cell size and shape; Micrometry; Characteristics of prokaryotic and eukaryotic cells; Plant cell wall - structure and function; Cell membrane - Fluid Mosaic Model; Transport across cell membrane - passive, active and facilitated transport; endocytosis and exocytosis.

Unit 2: Cell Organelles (20 lectures)

Structure and function of the organelles: Mitochondria and Chloroplast - role in energy transactions; Endoplasmic Reticulum - types and structure; Golgi Apparatus - organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Lysosomes, Peroxisomes and Vacuoles; Cytoskeleton - function and structure of microtubules, microfilaments and intermediary filament; Nucleus and its organization; Nucleolus.

Unit 3: Cell division and cycle (10 lectures)

Cell division - phases of eukaryotic cell cycle; mitosis and meiosis; Regulation of cell cycle - checkpoints and role of protein kinases; Introduction to Cancer Cell Biology; Apoptosis (Cell Death)

Unit 4: Origin and evolution of life forms (15 lectures)

Overview of Geological Time Scale; Origin of prokaryotes and eukaryotes; Origin of eukaryotic cell (Endosymbiotic theory); RNA world hypothesis; Evidences of evolution - Analogy and Homology; Evolution - tree of life (TOL); Phylogenetic tree.

Unit 5: Concept of Speciation and variation (15 lectures)

Plant speciation; Allopatric, Sympatric; Reproductive isolation; Biological Species concept. Sources of Variations; Population Genetics; Hardy-Weinberg Law and Genetic Drift; Climate change and plant evolution; Weed evolution; Extinctions - an overview; K-T extinction.

Suggested Readings

CELL BIOLOGY
1. Cooper G.M. (2015). The cell: A Molecular Approach. 7th Edition. Sinauer Associates.
2. Alberts, B., Johnson, A.D., Lewis, J., Morgan, D., Raff, M., Roberts, K., Walter, P. (2014). Molecular Biology of Cell. (6th ed.). WW. Norton & Co.
3. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
4. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell. 8th edition. Pearson Education Inc. U.S.A.
5. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
6. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. 7thedition. Pearson Benjamin Cummings Publishing, San Francisco.
7. Power, C.B. 2010: Cell Biology, Himalaya Publishing House, India

EVOLUTION
1. Gupta, P.K. 2018. Genetics, Rastogi Publication, India
2. Mark Ridley. Evolution. 3rd Edition. Blackwell Publishing. (2004).
3. Mathur, Tomar, Singh. Evolution and Behaviour. Rastogi Publication, Meerut.
4. Mohan P. Arora. Evolutionary Biology, Himalaya Publishing House, Bombay.
5. Verma P. S. and Agarwal V.K. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, Revised Edition. S. Chand Publication (2004).
6. Strickberger. Evolution. Prentic Hall. (2002).
7. Theodore H., Jr Eaton. Evolution. 1st Edition. W. W. Norton Publication. (1970).

ANATOMY AND EMBRYOLOGY OF ANGIOSPERMS
&
CELL BIOLOGY AND EVOLUTION

PRACTICAL

Course code	Credits	Teaching hours per week	Maximum Marks
MJD-7	**4**	**5**	**ESE 50 + ICA 50 = 100**

Course outcomes:

- Students are able to understand the microscopic architecture of plant organs
- To distinguish the monocot and dicot cell structure of plants
- To understand the cell division such as mitosis and meiosis in plants using different staining technique
- To understand the male and female gametes, fertilization and development of embryo in angiosperm plants
- To draw the phylogenetic tree of the plant species.

Key words:
Electron micrograph, parenchyma, collenchyma, sclerenchyma, meristem, mitosis, meiosis, phylogenic tree.

Unit 1: Anatomy of Angiosperms (25 lectures)

1.To study eukaryotic cells with the help of light and electron micrographs.
2. Study of the photomicrographs of cell organelles.
3. To study the structure of plant cell through temporary mounts.
4. Study of mitosis and meiosis (temporary mounts and permanent slides).
5. Study of meristems through permanent slides and photographs.
6. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
7. Stem: Monocot: *Zea mays;* Dicot: *Helianthus*; Secondary: *Helianthus* (sections). 8. Root: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (sections).
9. Leaf: Dicot and Monocot leaf (sections).

Unit 2: Embryology of Angiosperms (15 lectures)

1. Structure of anther (young and mature), tapetum (amoeboid and secretory) (sections).
2. Types of ovules: anatropous, hemianatropous, orthotropous, circinotropous, amphitropous/ campylotropous.
3. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs).
4. Ultrastructure of mature egg apparatus cells through electron micrographs.
5. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
6. Dissection of embryo/endosperm from developing seeds.
7. Calculation of percentage of germinated pollen in a given medium.

Unit 3: Cell Biology and Evolution (35 lectures)

1.To study prokaryotic cells (bacteria), eukaryotic cells and viruses with the help of light and electron micrographs.
2. Study of the photomicrographs of cell organelles.
3. Study of plant cell structure with the help of epidermal peel mount of Onion/Rhoeo/ Crinum.
4. Measure the cell size (either length or breadth/diameter) by micrometry.
5. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.
6. Study of different stages of mitosis and meiosis using acetocarmine and aceto-orcein method from Onion root tip and bud respectively.
7. Study of homologous and analogous organs.
8. To construct a phylogenetic tree of seed plants by using public repositories like (GenBank) and phylogenetic data (Open Tree of Life project).

Suggested Readings:

1. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Karp, G. 2010. Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
3. Reven, F.H., Evert, R.F., Eichhorn, S.E. 1992. Biology of Plants. New York, NY: W.H.Freeman and Company.
4. Futuyma D. 2006. Evolutionary Biology. 3rd edition. Sinauer Associates, Inc.
5. Gupta P.K. 2018. Cytology, Genetics and Evolution. Rastogi Publication.
6. Ridley M. 2003. Evolution. 3rd ed. Blackwell.
7. Taylor T.N. and Taylor E.L. 2009. Paleobotany: The Biology and Evolution of Fossil Plants. 2nd edition. Academic Press, Amsterdam.

SEMESTER V

GENETICS AND PLANT BREEDING

Course code	Credits	Teaching hours per week	Maximum Marks
MJD-8	**4**	**5**	**ESE 75 (Theory) + ICA 25 (Practical) = 100**

Course outcomes:
On completion of this course, the students will be able to:

- Have conceptual understanding of laws of inheritance, genetic basis of loci, alleles and their linkage.
- Comprehend the effect of chromosomal abnormalities in numerical as well as structural changes leading to genetic disorders.
- Develop critical understanding of chemical basis of genes and their interactions at population and evolutionary levels.
- Analyze the effect of mutations on gene functions and dosage.
- Understanding the concepts of plant hybridization and propagation

Key words:
Alleles, genes, heredity, inheritance, mutation, linkage, crossing over, mass selection, pure-line selection, hybrid, bagging, labelling, emasculation

THEORY

Unit 1: Heredity (9 lectures)
Brief life history of Mendel and his experiments, terminologies, Laws of inheritance, Modified Mendelian ratios: Lethal alleles; Co-dominance, incomplete dominance; complementary genes; duplicate genes; epistasis. Multiple allelism (polygenic inheritance).

Unit 2: Linkage, Crossing over and Population Genetics (9 lectures)
Linkage: complete and incomplete linkage, coupling & repulsion, recombination frequency, linkage maps based on two and three point test crosses. Crossing over: concept and significance, cytological proof of crossing over. Cis-Trans complementation test for functional allelism; Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection-mutation, genetic drift. Genetic variation and Speciation.

Unit 3: Mutations and extrachromosomal inheritance (9 lectures)
Types of mutations, effects of physical & chemical mutagens. Numerical chromosomal changes: Euploidy, Polyploidy and Aneuploidy;
Structural chromosomal changes: Deletions, Duplications, Inversions & Translocations.
Cytoplasmic Inheritance: Kappa particles in Paramecium, leaf variegation in *Mirabilis jalapa*, Male sterility.

Unit 4: Methods of Crop Improvement (9 lectures)
Introduction: Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods- pureline and mass selection for self-pollinated, cross-pollinated and vegetatively propagated plants.

Unit 5: Hybridization, Inbreeding depression and Heterosis (9 Lectures)
Hybridization: for self-pollinated, cross-pollinated and vegetatively propagated plants – Procedure, advantages and limitations. History, genetic basis of inbreeding depression and heterosis; Applications.

PRACTICALS (20 lectures)

GENETICS
1. Mitosis, and study of chromosome morphology through squash preparation, including effect of chemicals on mitosis.
2. Meiosis and study of chiasma frequency through temporary squash preparation.
3. laws through seed ratios. Laboratory exercises in probability and chi-square.
4. Chromosome mapping using point test cross data.
5. Pedigree analysis for dominant and recessive autosomal and sex-linked traits.
6. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1,13:3, 15:1, 12:3:1, 9:3:4).
7. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.
8. To test PTC tasting ability in a random sample and calculate gene frequencies for the taster and non–taster alleles.
9. Identification of inactivated X chromosome as Barr body and drumstick.

PLANT BREEDING (10 lectures)
1. Methods of emasculation (Wheat, Barley, Mustard, Pigeon pea, Cotton)
2. Hybridization methods
3. Pollen viability test
4. Seed viability test
5. Effect of radiation and chemical mutagens on seed germination, seedling growth and cell division (mitotic index).

Suggested Readings
GENETICS
1. Acquaah G. 2010. Principles of Plant Genetics and Breeding. Wiley India Pvt Ltd. New Delhi.
2. Chaudhari H.K. 1984. Elementary Principles of Plant Breeding (2nd ed.). Oxford – IBH. New Delhi.
3. Gardner E.J., Simmons M.J. and Snustad D.P. 2008. Principles of Genetics (8th ed.). Wiley India.
4. Klug W.S., Cummings M.R., Spencer C. and Palladino M. 2011. Concepts of Genetics (10th ed.). Benjamin Cummings. U.K.
5. Griffiths A.J.F., Wessler S.R., Carroll S.B. and Doebley J. 2010. Introduction to Genetic Analysis (10th ed.). W. H. Freeman and Co. U.S.A.
6. Pierce B.A. 2011. Genetics: A Conceptual Approach (4th ed.). Macmillan Higher Education Learning. U.K.
7. Snustad D.P. and Simmons M.J. 2010. Principles of Genetics (5th ed.). John Wiley & Sons Inc. India.

PLANT BREEDING
1. Chaudhari H.K. 1984. Elementary Principles of Plant Breeding (2nded.). Oxford-IBH. New Delhi.
2. Hayes H.K. 2007. Methods of Plant Breeding. Kosta press. USA.

3. Sharma J.R. 1994. Principles and Practices of Plant Breeding. Tata McGraw Hill Publishing Co.Ltd. New Delhi.
4. Singh B.D. 2005. Plant Breeding: Principles and Methods (7^{th}ed.). Kalyani Publishers. New Delhi.
5. Shukla R.S and Chandel P.S. 1996.Cytogenetic, Evolution and Plant Breeding. S.Chand& Co., New Delhi.
6. Vijendra Das L.D. 2006. Genetics and Plant Breeding, New Age International. New Delhi.

MOLECULAR BIOLOGY

Course code	Credits	Teaching hours per week	Maximum Marks
MJD-9	**4**	**5**	**ESE 75 (Theory) + ICA 25 (Practical) = 100**

Course outcomes:
On completion of this course, the students will be able to;

- Analyse the structures and chemical properties of DNA and RNA through various historic experiments.
- Differentiate the main types of prokaryotes through their grouping abilities and their Characteristics.
- Evaluate the experiments establishing central dogma and genetic code.
- Gain an understanding of various steps in transcription, protein synthesis and protein modification.

Keywords
Central Dogma, DNA, RNA, DNA Replication, Transcription, Translation, Post translational modifications, Wobble hypothesis, Exons, Cistron

THEORY

Unit 1: The Genetic Material (9 lectures)
Nature of genetic material and fine structure of gene. Griffith effect, transforming principle, Hershey & Chase experiment, RNA as genetic material (TMV). Cis-trans test. Structure of DNA and RNA- Nucleoside and Nucleotides. DNA Double helix: B-form, A-form & Z-form. Chemical bonds-base pair rules. Types of RNA- mRNA, rRNA, tRNA (in prokaryotes and Eukaryotes) and miRNA (in eukaryotes).

Unit 2: Replication and Transcription of DNA (9 lectures)
Replication of DNA- Messelson & Stahl experiment, semi-conservative, bidirectional, semicontinuous model-reverse transcription.
Transcriptional machinery and key events - RNA polymerase, promoter gene- initiation, elongation and termination (in prokaryotes and eukaryotes). Modification and processing of mRNA in eukaryotes.

Unit 3: Protein synthesis (9 lectures)
Translation- features of genetic code- Wobble hypothesis, role of t-RNA and ribosomes. Initiation, elongation and termination- peptidyl transferase.

Unit 4: Gene Regulation Gene Mutation (9 lectures)
Regulation of gene expression- regulation at transcriptional level. Lac Operon- negative and positive control.
Gene mutation- frame shift, substitution mutation, tautomerization, depurination, base analogues, chemical and physical mutagens.

Unit 5: Polymerase chain reaction (9 lectures)
Gene amplification (Polymerase chain reaction -PCR). Basic PCR and its modification. Application of PCR in Agriculture, Medicine and Forensics.
Sequencing of DNA: Maxam and Gilbert method, Sanger's method.

PRACTICALS **(30 lectures)**

1. Isolation and purification of DNA from plant tissues
2. Isolation and purification of RNA from plant tissues
3. Isolation and purification of bacterial plasmids
4. Separation of DNA by Agarose gel electrophoresis
5. Separation of RNA by Agarose gel electrophoresis
6. Staining of nucleic acid *in vivo* (Giemsa stain)
7. Restriction digestion of plasmid DNA using Type II Restriction enzyme
8. Demonstration of PCR.

Suggested Readings

1. Allison L.A. 2007. Fundamental Molecular Biology. Blackwell Publishing. U.S.A.
2. Cooper G.M. and Hausman R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
3. De Robertis E.D.P. and De Robertis E.M.F. 2006. Cell and Molecular Biology (8th ed). Lippincott Williams and Wilkins. Philadelphia.
4. Friefelder D. 1987. Molecular Biology (2nded.). Narosa Publishing House. New Delhi.
5. Karp G. 2010. Cell and Molecular Biology: Concepts and Experiments(6thed.). John Wiley & Sons. Inc.
6. Krebs J.E., Goldstein E.S. and Kilpatrick S.T. 2014. Jones & Bartlett Learning, LLC. Burlington, MA.
7. Sheeler P. and Bianchi D.E. 2006. Cell and Molecular Biology (3rded.). Wiley India (P.) Ltd. New Delhi.
8. Smith- Keatry P. 1991. Molecular Genetics, MacMillan Publication Co. Ltd. London.
9. Verma P.S. and Agarwal V.K. 2009. Molecular Biology. S.Chand & Company Ltd. New Delhi.
10. Watson J.D., Baker T.A., Bell S.P., Gann A., Levine M. and Losick R. 2004. Molecular Biology of the Gene. Dorling Kindersley Publishing Inc. New Delhi.

MICROBIOLOGY AND PLANT PATHOLOGY

Course code	Credits	Teaching hours per week	Maximum Marks
MJD-10	**4**	**5**	**ESE 75 (Theory) + ICA 25 (Practical) = 100**

Course Outcomes:

- Students will gain understanding of microbial diversity and their distribution across different habitats.
- Students will recognize the ecological and economic importance of microorganisms in the ecosystem and day-to-day life.
- They will comprehend the growth, reproduction and life cycles of viruses and microorganisms.
- Students will acquire knowledge on genetic recombination processes in bacteria.
- An understanding on the etymology of diseases, symptoms, causative organisms and control measure of pathogenic microorganisms

Key words: Microbes, Bacteria, Viruses, Reproduction, Biogeochemical cycling.

THEORY

Unit 1: Microbiology: History and Viruses (12 lectures)

A brief history and development of Microbiology; Koch postulates; Major groups of microorganisms; Distinction between prokaryotic and eukaryotic microorganisms.

Characteristics of viruses; Biochemical composition, genetic materials and structural organization; Classification (Baltimore system); Morphological structure of TMV and Bacteriophage (T4); Life cycle and reproduction of T4 bacteriophage; Lytic and lysogenic cycle; Important viral diseases in plants and animals; Viroids and prions.

Unit 2: Microbiology: Bacteria (6 lectures)

General characteristics of bacteria; shapes and sizes; ultra-cellular structure; major groups of bacteria with their general characteristics; Gram staining of bacteria; General characteristics of Actinomycetes, Mycoplasma and Rickettsia; Nutritional groups in bacteria; Bacterial growth; Pure culture isolation - streaking, serial dilution and plating methods.

Unit 3: Microbiology: Bacterial Reproduction (9 lectures)

Bacterial Reproduction – binary fission and endospore formation; horizontal gene transfer and genetic recombination in bacteria (conjugation, transformation and transduction); Quorum sensing; Examples of agriculturally and industrially important bacteria.

Unit 4: Microbes, Environment and Applications (5 lectures)

Microorganisms in different habitats - air, soil and water; Role of microorganisms in biogeochemical cycles (C, N, P and S); Microorganisms in extreme environments (hot water spring, marine water, hydrothermal vent); Application of microorganisms in food industries (fermentation and SCP production) and in agriculture (biofertilizer and biopesticides).

Unit 5: Plant Pathology (13 lectures)

Terms and concepts; General symptoms; Geographical distribution of diseases; Etiology;

Symptomology; Host-Pathogen relationships; Disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine.
Viral diseases – Tobacco Mosaic viruses, vein clearing.
Bacterial diseases – Citrus canker and angular leaf spot of cotton.
Fungal diseases – Early blight of potato, Black stem rust of wheat (*Puccinia),* Blast of paddy (*Pyricularia oryzae*), Leaf spot of Groundnut (*Cercospora arachicola, C. personata*), Red rot of Sugarcane (*Colletotrichum*). Phyllody of Sesamum (Mycoplasma).

PRACTICAL

MICROBIOLOGY (20 lectures)

1. To study the principle and applications of important instruments (autoclave, incubator, BOD incubator, hot air oven, laminar air flow, light microscope, pH meter) used in the microbiology laboratory.
2. Preparation of culture media.
3. Sterilization of medium and glassware.
4. Microbial culture methods: streak plate culture, pour plate culture, stab culture.
5. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.
6. Pure culture isolation of soil bacteria/ fungi through serial dilution plating and count the colony forming unit (CFU).
7. Gram staining of bacteria (curd bacteria, nodule bacteria).
8. Motility determination of budding yeast / microbes by Hanging Drop Technique.
9. Slide preparation and study of *Nostoc*, *Anabaena*, *Rhizopus*, *Aspergillus*, *Penicillium* using temporary mounts.
10. Collection and study of diseases caused by viruses, bacteria and fungi in crop plants.

PLANT PATHOLOGY (10 lectures)

1.Study of the following viral disease: TMV
2.Study of the following bacterial diseases: Citrus canker, angular leaf spot of cotton
3.Study of the following fungal diseases: *Puccinia*, *Colletotrichum* and *Pyricularia oryzae*.

Suggested Readings:

1. Alexopoulos C.J., Mims C.W. and Blackwell M. 2002. Introductory Mycology (4thed.). John Wiley and Sons (Asia), Singapore.
2. Aneja K.R., Jain P., Aneza R. 2021. A Textbook of Basic and Applied Microbiology. New Age International Publisher.
3. Aneja K.R. 2022. Experiments in Microbiology, Plant Pathology, Tissue Culture and Microbial Biotechnology. New Age International Publisher
4. Pelczar Jr. M.J., Chan E.C.S. and Krieg N.R. 2009. Microbiology: Application Based Approach. Tata McGraw-Hill Education. New Delhi.
5. Sethi I.K. and Walia S.K. 2011.Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd. New Delhi.
6. Sharma PD. 2009. Microbiology. Rastogi Publication, Meerut.
7. Singh RP. 2021. Microbiology, Kalyani Publisher
8. Singh RS. 2018. Plant Diseases. CBS Publishers & Distributors Pvt Ltd, India
9. Tortora G.J., Funke B.R. and Case C.L. 2010. Microbiology: An Introduction (10^{th} ed.). Pearson Benjamin Cummings. U.S.A.
10. Tortora GJ, Funke BR, Case CL. 2008. Microbiology. Pearson Education.
11. Wiley JM, Sherwood LM and Woolverton CJ. 2013. Prescott's Microbiology. McGraw Hill International.

SEMESTER VI

PLANT PHYSIOLOGY AND PLANT BIOCHEMISTRY

THEORY

Course code	Credits	Teaching hours per week	Maximum Marks
MJD-11	**4**	**5**	**ESE 75 + ICA 25 = 100**

Course outcomes:

- Comprehend different fundamental concepts related to plant cell organelles, photosynthesis, respiration and lipid metabolism etc.
- Analyze the structure and properties of various enzymes
- Evaluate the process of ATP Synthesis, nitrogen metabolism and lipid metabolism

Keywords:
Plant nutrients, Membrane transport, Carbohydrates, C3 cycle, C4 cycle, CAM, Lipids, Amino acids, Proteins, Enzymes, Plant stress, vernalization, Phytohormones

Unit 1: Plant-water relations and Mineral Nutrition (15 lectures)
Water as a universal solvent. Water potential and its components. Factors affecting transpiration; Root pressure and guttation. Essential growth elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane (active and passive transport), carriers, channels and pumps.

Unit 2: Carbohydrates and Lipids (20 lectures
Carbohydrates: importance, classification, structure and properties.
Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.
Lipids: importance, classification, structure and properties. Fatty acids – nomenclature and types. Biosynthesis of fatty acids (Palmitic acid).

Unit 3: Photosynthesis and Translocation of solutes (20 lectures)
Photosynthetic Pigments (Chlorophyll *a*, *b*, xanthophylls, carotene); Photosystem I and II, reaction centre, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation; Photorespiration.
Transpiration- Ascent of sap (Cohesion and Tension hypothesis) and its significance. Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading.

Unit 4: Amino acids, Proteins and Enzymes (12 lectures)
Amino acids and Proteins: importance, classification and structure.
Enzymes: nomenclature, classification. Structure and properties. Mechanism of enzyme catalysis and enzyme inhibition.

Unit 5: Environmental Plant Physiology (8 lectures)
Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis. Vernalization. Phytohormones (natural Auxins and Gibberellins).

Plant Stress- definition. Plant responses to Abiotic Stresses: - cold, drought, salt and UV.

Suggested Readings

1. Hopkins W.G. and Huner N.P. 2009. Introduction to Plant Physiology (4th ed.). John Wiley & Sons. U.S.A.
2.Murray R.K., Granner D.K., Mayes P.A. and Rodwell V.W. 2000. Harper's Illustrated Biochemistry (26th ed.). McGraw-Hill Company Inc. U.S.A.
3. Narayanan L.M., Meyyan R.P., Nallasingam K., Prasanna Kumar S., Arumugam N. and Fatima D. 2014. Biochemistry. Saras Publication. Nagercoil, Tamil Nadu.
4. Nelson D.L. and Cox M.M. 2017. Lehninger Principles of Biochemistry (7th ed.). W.H.Freeman. London.
5. Rodwell V.W., Bender D., Botham K.M., Kennelly P.J. and Weil P.A. 2015.Harpers Illustrated Biochemistry (30th ed.). The McGraw-Hill Education. USA.
6. Salisbury F.B. and Ross C.W. 1986. Plant Physiology (3rd ed.). CBS Publishers & Distributors. New Delhi.
7. Taiz L. and Zeiger E. 2010. Plant Physiology (5th ed.). Sinauer Associates Inc. U.S.A.

PLANT BIOTECHNOLOGY

THEORY

Course code	Credits	Teaching hours per week	Maximum Marks
MJD-12	**4**	**5**	**ESE 75 + ICA 25 = 100**

Course outcomes:

- On the completion of the course the students will be able to
- Understand the core concepts and fundamentals of plant biotechnology and genetic engineering
- Develop their competency on different types of plant tissue culture
- Analyze the enzymes and vectors for genetic manipulations
- Examine gene cloning and evaluate different methods of gene transfer
- Critically analyze the major concerns and applications of transgenic technology

Keywords:
Totipotency, Callus, Protoplast, Somatic hybridization, Embryoids, Embryo culture, Anther culture, Gene Cloning, Vectors, Transgenic plants

Unit 1: Plant Tissue Culture, Design of Lab and Media (15 lectures)
Plant tissue culture: Definition, History of Plant Tissue Culture (PTC). Cellular differentiation and redifferentiation. Totipotency. Designing of PTC lab. Sterilization procedures for chemicals and glassware. Out lines on PTC media- (MS medium in detail). Plant growth regulators. Gelling agents (Agar). Types of explants.

Unit 2: Types of Tissue Cultures- I and Secondary metabolites (15 lectures)
Callus culture and cell suspension culture. Direct and indirect organogenesis. Somaclonal variations and their uses in agriculture.
Basics of Secondary metabolite production of Shikonin from *Lithospermum erythrorhizon*;Morphine from *Papaver somniferum*; Vincristine from*Catharanthus roseus.*

Unit 3: Types of Tissue Cultures- II (15 lectures)
Meristem culture- virus free plant production. Micropropagation (using axillary and apical bud cultures). Anther and pollen cultures. Protoplast isolation and culture. Somatic hybridization: selection of somatic hybrids and cybrids. Somatic embryogenesis- artificial seed production.

Unit 4: Genetic Engineering and Cloning Vectors (15 Lectures)
Principles and tools of genetic engineering: Restriction endonucleases- Type II enzymes; nomenclature. DNA ligase and DNA Polymerases.
Cloning Vectors –Bacterial vectors (pBR322, pUC8), Viral vectors (M13, λ phage), Hybrid vectors (cosmids), Artificial Chromosomes (Bacterial and Yeast).

Unit 5: Transgenic Plants, Bioethics and Biosafety (13 Lectures)
Agrobacterium (Ti plasmid) mediated gene transfer. Particle gun bombardment, Microinjection, Electroporation. Introduction to molecular markers.

Production of transgenic plants: Insect resistance (*Bt* gene), Bruise resistance and drought resistance.
Introduction to Golden Rice, Plantibodies, Edible vaccines, Bioplastics. Bioethics and Biosafety of GM crops.

Suggested Readings

1. Brown T.A. 2001. Gene Cloning and DNA Analysis- An Introduction (4^{th}ed.). Blackwell Science. Oxford.
2. Clark D.P. and Pazdernik N.J. 2009. Biotechnology- Applying the Genetic Revolution. Elsevier Academic Press. USA.
3. Das H.K. 2010.Textbook of Biotechnology (4^{th}ed.). Wiley India Pvt Ltd. New Delhi.
4. Chawla H.C. 2003. Plant Biotechnology- Laboratory Manual for Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
5. Desmond S.T. Nicholl. 2010. An Introduction to Genetic Engineering. Cambridge University Press. New Delhi.
6. Dubey R.C. 2006. A Text Book of Biotechnology. S.Chand & Company Ltd. New Delhi.
7. Gupta P.K. 2000. Elements of Biotechnology. Rastogi Publications. Meerut.
8. Ignacimuthu S. 2003. Plant Biotechnology. Oxford& IBH Publishing Co. Pvt. Ltd. New Delhi.
9. Keshavachandran R. and Peter, K.V. 2008. Plant Biotechnology- Methods in Tissue Culture and Gene Transfer. University Press (India) Pvt. Ltd. Hyderabad.
10. Kumar H.D. 1998. Modern Concepts of Biotechnology. Vikas Publishing House Pvt Ltd. New Delhi
11. Kumaresan V. 2010. Biotechnology. Saras Publication. Nagercoil. Tamil Nadu.
12. Mosier N.S. and Ladisch M.R. 2009. Modern Biotechnology- Connecting Innovations in Microbiology and Biochemistry to Engineering Fundamentals. John Wiley & Sons Inc. New Jersey.
13. Prakash J. and Pierik R.L.M. 1993. Plant Biotechnology- Commercial prospects and Problems. Science Publishers, Inc. U.S.A.
14. Verma P.S. and Agarwal V.K. 2009.Genetic Engineering. S.Chand & Co. Ltd. New Delhi.

PLANT PHYSIOLOGY AND BIOCHEMISTRY & PLANT BIOTECHNOLOGY

PRACTICAL

Course code	Credits	Teaching hours per week	Maximum Marks
MJD-13	**4**	**5**	**ESE 50 + ICA 50 = 100**

Course outcomes:

- Students would be able to determine the effect of various environmental factors influencing the Physiology of the plants: transpiration, respiration, photosynthesis
- To determine the catalytic activities of the enzymes.
- To estimate the quantity of the biomolecules present in the plants.
- To prepare the plant tissue culture media.
- In vitro culture of various explants.
- To manipulate the genes using *Agrobacterium tumefaciens*.

Key words:
Osmosis, transpiration, respiration, photosynthesis, enzyme kinetics, chromatography, calorimeter, MS medium, *in vitro* cultures, recombinant DNA.

PLANT PHYSIOLOGY AND BIOCHEMISTRY

1.Determination of osmotic potential of plant cell sap by plasmolytic method.
2. To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
3. To compare the rate of respiration by Ganong's respirometer in different parts of the plant (Demonstration).
4. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
5. Demonstration of Hill reaction.
6. Demonstration of the activity of catalase and study of the effect of pH and enzyme concentration.
7. To study the effect of light intensity and bicarbonate concentration on O_2 evolution in photosynthesis.
8. Comparison of the rate of respiration in any two parts of a plant.
9. Demonstration of Thin layer chromatography (TLC)/Column chromatography.
10. Separation of photosynthetic pigments by paper chromatography.
11. Estimation of sugar content by DNSA method.
12. Estimation of phenol/tannin/flavonoid by colorimetric method.
13. Estimation of protein in plant sample by Lowry's method/ Biuret method.
14. Separation of amino acids by paper chromatography.

PLANT BIOTECHNOLOGY

1. Murashige and Skoog medium preparation.
2. Sterilization and inoculation of explants on culture media.
3. Callus culture.
4. Micropropagation (axillary bud or terminal bud).
5. Anther and Ovary culture.
6. Protoplast isolation and culture- demonstration.
7. Identification of photographs pertaining to chapters mentioned in the theory.

8. Identification of Crown gall disease by specimen or photograph.

Suggested Reading:

1. Battacharya D. 1999.Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House. New Delhi.
2. Harisha S. 2007. Biotechnology Procedures and Experiments Handbook. Infinity Science Press Llc. Hingham. MA.
3. Primrose S., Twyman R. and Old B. 2001. Principles of Gene Manipulation (6th ed.). Blackwell Science. Oxford.

ETHNOBOTANY

Course code	Credits	Teaching hours per week	Maximum Marks
MJD-14	**4**	**5**	**ESE 75 (Theory) + ICA 25 (Practical) = 100**

Course outcomes:
Upon completion of the course the students would be able to

- understand various plants used by the ethnic people for various purposes.
- Identify the medicinally useful plants
- Understand the importance of Ethnobotany in modern medicine
- Conserve the medicinal plants and protect the rights of the ethnic people.

Key words:
Ethnobotany, Ethnic people, Herbarium, Sacred Groves, medicinal plants, Genetic resources conservation, TKDL, IPR

THEORY

Unit 1: Ethnobotany (9 lectures)
Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary y science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: (a) Food plants, (b) intoxicants and beverages, (c) Resins and oils and miscellaneous uses.

Unit 2: Methodology of Ethnobotanical Studies (9 lectures)
(a) Field work (b) Herbarium (c) Ancient Literature (d) Archaeological findings (e) temples and sacred places.

Unit 3: Role of Ethnobotany in Modern Medicine (9 lectures)
Medico-ethnobotanical sources in India; Significance of the following plants in ethnobotanical practices (along with their habitat and morphology) (a) *Azadirachta indica* (b) *Ocimum sanctum* (c) *Vitex negundo*. (d) *Gloriosa superba*(e) *Tribulus terrestris* (f) *Pongamia pinnata* (g) *Cassia auriculata* (h) *Indigofera tinctoria*. Role of ethnobotany in modern medicine with special example *Rauvolfia serpentina, Trichopus zeylanicus, Artemisia annua, Withania somnifera*.

Unit 4: Conservation of Plant Genetic Resources (9 lectures)
Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).

Unit 5: Ethnobotany and Legal Aspects (9 lectures)
Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge-Patent

PRACTICAL (35 lectures)
1. Field visit to meet ethnic people of hills and preparation and submission of report on Botanical names, vernacular name, family, uses of plants for traditional medicines.
2. Preparation of 5 Herbarium of ethnobotanically important plants.

3. Study of habitat of ethnobotanical plants mentioned in theory.
4. Study of morphology of plants used in traditional medicine.

Suggested Readings

1.Colton C.M. 1997.Ethnobotany – Principles and applications. John Wiley and Sons. Lichester.
2. Jain S.K. 1995. Manual of Ethnobotany. Scientific Publishers. Jodhpur.
3. Jain S.K. (ed.). 1981. Glimpses of Indian Ethnobotany. Oxford and IBH. New Delhi.
4. Jain S.K. 1990. Contributions of Indian ethnobotany. Scientific publishers. Jodhpur.
5. Kumaresan V. and Annie R. 2013. Taxonomy-Systematic Botany, Economic Botany, Ethnobotany. Saras Publication. Nagercoil.
6. Pullaiah T. and Krishnamurthy K.V. and Bahadur B. 2017. Ethnobotany of India: The Indo-Gangetic Region and Central India (Vol. 5). Apple Academic Press. USA.
7. Rama Ro N. and Henry A.N. 1996. The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah.
8.Sinha R.K. 1969. Ethnobotany. The Renaissance of Traditional Herbal Medicine – INA – SHREE Publishers. Jaipur.

SEMESTER VII

GENOMICS AND PROTEOMICS

THEORY

Course code	Credits	Teaching hours per week	Maximum Marks
MJD-16	**4**	**5**	**ESE 75 + ICA 25= 100**

Course outcomes:
On successful completion of the course students will be able to
• Access knowledge available in the various databases for carrying out genomic and proteomic research
• Understand the role played by mutations in plant and would be in a position to put the accrued knowledge for use
• Genomics will provide the way for the students to take up *in silico* investigations towards assisting work in manipulating genes to produce plants with desired characters.

Key words:
Mutation, mutagens, DNA repair, Meta genomics, Next generation genome sequencing, Proteomics, Bioinformatics, Data bases, PubMed, EMBL, EXPASY, TAIR, CLUSTAL

Unit 1: Mutations 15 lectures)
Types of mutations, methods of detection of mutations, CIB method and attached-X method, Molecular mechanism of spontaneous and induced mutations, site directed mutagenesis. Homeotic mutants in *Arabidopsis* and *Antirrhinum*. Mutagenic effects of food additives and drugs. Ames test. DNA damage and repair.

Unit 2: Genomics (15 lectures)
Genomes: definition, size, approximate number of genes in sequenced organisms (viral, bacterial, fungal, plant, animal, and human genomes). Genome map, genome sequence - differences. EST maps and markers.
Outlines on metagenomics, functional genomics, comparative genomics. Practical applications of genomics. Next (2^{nd}, 3^{rd}) Generation sequencing.

Unit 3: Proteomics (15 lectures)
Identification of protein-coding genes, determining gene functions from gene sequence; introns and exons, repetitive sequences; Accessing and annotating genomes; The Bio Project; Specialized genomic data bases**:** BOLD, GOLD, *Arabidopsis* Information Resource. Proteomes: deducing proteome from genome sequence, post-translation modification prediction.

Unit 4: Bioinformatics (15 lectures)
History, introduction and scope; role of computers in biology. Search and Retrieval in literature databases (PubMed). Bioinformatics Workstations. Biological databases; types: sequence, structures, genomes and organism-specific databases; open source and web services. Data warehousing, data capture, data mining, data analysis.

Unit 5: Biological Databases (15 lectures)

Primary nucleotide sequence databases: Genbank, European Nucleotide Archive, DDBJ. Primary protein sequence databases: NCBI, PIR, EMBL, ExPAsy, Uniprot, signal peptide data bank. Data submission and retrieval with: Entrez, DBGET/Link, and SRS. Sequence Analysis: Pair-wise alignment (Smith-Waterman similarity searches); BLAST & FASTA types and algorithms; Multiple sequence alignment (CLUSTAL: V, W, X, Omega; T-Coffee); gene and protein families, motif finding. Structural databases (PDB, CSD). Gene expression databases and transcriptomes, DNA microarray. Molecular modeling and visualization tools; docking and drug designing. Metabolic and signalling pathways databases. Phylogenetics: phylogenetic trees and clades, software and online tools; inference methods (UPGMA). Biodiversity informatics: introduction, global (GBIF, ITIS, Plant List, BHL, RBG, Kew) and national databases, standards, and protocols.

Suggested Readings

Text Books

1. Acquaah G. 2010. Principles of Plant Genetics and Breeding. Wiley India Pvt. Ltd. New Delhi.
2. Brown T. A. 2002. Genomes. Wiley-Liss Publications.
3. Campell and Heyer. 2003. Discovering Genomics, Proteomics and Bioinformatics. Cold Spring Harbor Laboratory.
4. Gardner E.J., Simons M.J., Snustard D.P. 2006. Principles of Genetics. John Wiley and Sons Inc.
5. Krane, *et al.* 2002. Fundamental Concepts of Bioinformatics. Benjamin Cummings. Learning. U.K.
6. Pierce B.A. 2011. Genetics: A Conceptual Approach (4thed.). Macmillan Higher Education.
7. Sinnott E.W., Dunn L.C. and Dobzhansky T. 2004. Principles of Genetics. Tata Mc Graw Hill.
8. Snustad D.P. and Simmons M.J. 2010. Principles of Genetics (5th edition). John Wiley & Sons Inc. India.
9. Snustad D. P. and Simmons M. J. 2000. Principles of Genetics (2nd edition). John Wiley & Sons, Inc.

References Books

1. Griffiths A.J.F., Wessler S.R., Carroll S.B. and Doebley J. 2010. Introduction to Genetic Analysis (10th edition). W. H. Freeman and Co. U.S.A.
2. Guttman B., Griffiths A., Suzuki D. and Cullis T. 2011. Genetics: The Code of Life. Rosen Publishing, New York.
3. Herron J.C. and Freeman, S. 2014. Evolutionary Analysis (5th edition). Pearson.
4. Jolles O. and H. Jornvall (editors). 2000. Proteomics in Functional Genomes. Birk hauser Verlag, Basel, Switzerland.
5. Lesk AM. 2002. Introduction to Bioinformatics. Oxford University Press.
6. Liebler. 2001. Introduction to Proteomics: Tools for the new biology. Humana Press.
7. Mount D. 2004. Sequence and Analysis. Cold Spring Harbor Laboratory Press. New York.
8. Pennington S. and Dunn MJ. 2001. Proteomics: From protein sequence to function (2nd edition). Bios Scientific Publications Ltd.
9. Primrose SB.1995. Principles of Genome Analysis. Blackwell Science, Oxford.
10. Campbell and Heyer. 2003. Discovering Genomics, Proteomics, & Bioinformatics. Pearson Education,
11. Baxevanis and Ouellette. 2001. Bioinformatics, Methods of Biochemical Analysis, Series Vol. 43, John Wiley & Sons,

12. Pevzner, P.A. 2000. Computational Molecular Biology. MIT Press,
13. D. Baxevanis and B. F. Francis Ouellette. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (2004). Andreas 3rd Edition. Wiley & Sons,

HORTICULTURE

THEORY

Course code	Credits	Teaching hours per week	Maximum Marks
MJD-17	**4**	**5**	**ESE 75 + ICA 25= 100**

Course outcomes:

- Students will be understanding how a garden is constructed according to the different landscapes and their management.
- They would understand the principles behind the orchard and kitchen garden.
- Establishment of nursery.
- Water and weed management in different cropping systems.
- Understanding on horticulturally important plants diseases and their control measures.

Key words:
Gardening, irrigation, vegetable garden, kitchen garden, orchard, floriculture, grafting, layering, cutting, pruning, nursery, water and disease management

Unit 1: Landscaping and Gardening (15 lectures)
Plants of aesthetic interest. Gardening types. Importance and classification of horticultural crops - their culture and nutritive value, area and production, exports and imports, fruit and vegetable zones of India and of different states, nursery management practices, soil and climate. Irrigation, fertilizer application, pest and diseases.

Unit 2: Orchard and Kitchen Garden Layout (15 lectures)
Vegetable gardens, nutrition and kitchen garden and other types of gardens – principles, planning and layout, management of orchards, planting systems and planting densities. Rejuvenation of old orchards, top working, frame working, principles of organic farming.

Unit 3: Nursery and Canopy Management (15 lectures)
Production and practices for fruit, vegetable and floriculture crops, propagation- cutting, layering, grafting. Principles and methods of pruning. Micropropagation of the horticultural plants; Nutrients and Plant growth regulators.

Unit 4: Cropping Systems (15 lectures)
Types and use of growth regulators in horticulture, water management, weed management, fertility management, cropping systems: intercropping, multi-tier cropping, mulching, bearing habits, factors influencing the fruitfulness and unfruitfulness.

Unit 5: Disease Control and Pest Management (12 lectures)
Horticultural crop diseases by:
(i) Viruses
(ii) Insects

Suggested Readings
1. Adams C.R. and Early M.P. 2004. Principles of Horticulture. Butterworth Heinemam. Oxford University Press. Oxford.

2. Bansil P.C. 2008. Horticulture in India. CBS Publishers and Distributors. New Delhi.
3. Chadha K.L. 2001. Handbook of Horticulture. ICAR, New Delhi.
4. Chattopadhyay P.K.2001. A text book on Pomology (Fundamentals of fruit growing). Kalyani Publication. New Delhi.

GENOMICS AND PROTEOMICS & HORTICULTURE

PRACTICAL

Course code	Credits	Teaching hours per week	Maximum Marks
MJD-18	**4**	**5**	**ESE 50 + ICA 50 = 100**

Course outcomes:

- Students would understand the DNA and Protein sequences.
- They will be able to align the DNA and Protein sequences using different web tools.
- Students could predict the homology model of the protein structure.
- Different types garden would be constructed by the students.
- Will be able to propagate the horticulture plants through clonal propagation and *in vitro* culture methods.

Key words:
DNA sequence alignment, Protein sequence alignment, 3D structures of protein, Gardening, Auxin, Cytokinins, Gibberellins, Micropropagation.

GENOMICS AND PROTEOMICS

1. Retrieving, viewing and printing of the specific protein sequence (by accession no. or name) using a public database site.

2. Exploring the NCBI, ExPASy, www.ebi.ac.uk/Tools etc. websites for information and tools available there.

3. Pairwise alignment of Protein and DNA sequences & data interpretation. Local and global alignment of sequence data and comparing both results.

4. Retrieving DNA and/or protein sequences of a given item (by name or accession number) from GENBANK.

5. Performing a sequence similarity search using the BLAST. Retrieving the protein sequence of a given organism and downloading the structure of this protein from existing database.

6. Short-listing protein sequences of highest similarity from the list of BLAST search result and doing a multiple sequence alignment (Using CLUSTALW). Finding out the regions of exact/good match in the protein sequences of these sequences.

7. Aligning nucleotide sequences; designing a degenerate primer of 20 bases from nucleotide alignment data, and calculate the level of degeneracy of this primer.

8. Learning about the Phylip/MEGA program and its uses for the construction of phylogenetic trees.

9. Searching and downloading protein structure data using Entrez. Viewing the structure using public domain software.

10. Protein structures: Visualizing and analysis of inter atomic distances, H-bond calculations, secondary structure analysis and salt bridge analysis of protein structures using different software. Prediction of 3D structure of protein.

HORTICULTURE

1. Vegetable gardening.
2. Making of kitchen garden.
3. Pruning of crop plants.
4. Study of effect of growth regulators, Auxin (IAA, NAA), Cytokinins (Zeatin, BAP), Gibberellins on plant growth.
5. Micropropagation of horticultural plants using MS medium.

Suggested Readings:

GENOMICS AND PROTEOMICS

1. Jolles O. and H. Jornvall (editors). 2000. Proteomics in Functional Genomes. Birk Hauser Verlag, Basel, Switzerland.
2. Lesk AM. 2002. Introduction to Bioinformatics. Oxford University Press.
3. Liebler. 2001. Introduction to Proteomics: Tools for the new biology. Humana Press.
4. Mount D. 2004. Sequence and Analysis. Cold Spring Harbor Laboratory Press. New York.
5. Pennington S. and Dunn MJ. 2001. Proteomics: From protein sequence to function (2nd edition). Bios Scientific Publications Ltd.
6. Primrose SB.1995. Principles of Genome Analysis. Blackwell Science, Oxford.
7. Discovering Genomics, Proteomics, & Bioinformatics (2003). Campbell &Heyer Pearson Education,
8. Bioinformatics, Methods of Biochemical Analysis (2001), Series Vol. 43, Baxevanis & Ouellette, John Wiley & Sons,
9. Computational Molecular Biology. Pevzner, P.A. (2000) MIT Press,
10. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (2004). Andreas D. Baxevanis & B. F. Francis Ouellette. 3rd Edition. Wiley & Sons,

HORTICULTURE

1. Chaudhari H.K. 1984. Elementary Principles of Plant Breeding (2nded.). Oxford-IBH. New Delhi.
2.Christopher E.P. 2001. Introductory Horticulture. Biotech Books. New Delhi.
3. Chadha K.L. 2001. Handbook of Horticulture. ICAR, New Delhi.
4. Hartmann H.T., Kester D.E., Davies JR. F.T. and Geneve R.L. 2011. Hartmann & Kester's Plant Propagation: Principles and Practices (8thed.). PHI Learning Pvt. Ltd. Delhi.
5. Sheela V.L. 2011. Horticulture. MJP Publishers. Chennai.

SEMESTER VIII

AGRICULTURE AND FOOD MICROBIOLOGY

THEORY

Course code	Credits	Teaching hours per week	Maximum Marks
MJD-19	**4**	**5**	**ESE 75 + ICA 25 = 100**

Course outcomes:

- Develop understanding of the significance of intrinsic and extrinsic factors on growth of micro-organism
- Identify ways to control microbial spoilage of foods
- Analyze the practices involved in Food Microbiology

Key words:
Symbiotic bacteria, Free living bacteria, Cyanobacteria, Biofertilizers, Food poisoning, Food intoxication, Fermented foods

Unit 1: Role of Microorganisms in Agriculture (18 lectures)
Role of symbiotic (Rhizobium, and free-living bacteria and cyanobacteria in agriculture., Mycorrhiza, Plant Growth Promoting Microorganims (PGPM) and Phosphate Solubilizing Microorganims (PSM).

Unit 2: Biocontrol and Biofertilization (15 lectures)
Biocontrol of plant pathogens, pests and weeds, Restoration of waste and degraded lands, Biofertilizers: Types, technology for their production and application, vermicompost.

Unit 3: Food Microbiology-I (15 lectures)
Intrinsic and extrinsic factors influencing growth of microorganisms in food, Microbes as source of food: Mushrooms, single cell protein.

Unit 4: Food Microbiology-II (15 lectures)
Microbial spoilage of food and food products: Cereals, vegetables, prickles, fish and dairy products. Food poisoning and food intoxication. Food preservation processes.

Unit 5: Fermented Products (9 lectures)
Microbes and fermented foods: Butter, cheese and bakery products.

Suggested readings

1. Adams, M.R. and Moss M. O. (2008). Food Microbiology, 3rd Edition, Royal Society of Chemistry, Cambridge, U.K.
2. Sylvia D.M. (2004). Principles and Applications of Soil Microbiology, 2nd Edition, Prentice Hall, USA.
3. W.C. Frazier (1995). Food Microbiology, 4th Edition, Tata McGraw Hill Education, Noida, India.
4. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st Edition, Blackwell Science, London, UK.

5. Pelczar M.J., Chan E.C.S. and Krieg N.R. (2003). Microbiology. 5th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi.
6. N. S. Subba Rao. (2000). Soil microbiology. 4th Edition, Oxford and IBH publishing Co. Pvt. Ltd., Calcutta, New Delhi, India.
7. Rangaswami, G. and Bagyaraj, D.J. (2006) Agricultural Microbiology. 2nd Unit 2nd Edition, PHI Learning, New Delhi, India.

SEED TECHNOLOGY AND GERMPLASM STORAGE

THEORY

Course code	Credits	Teaching hours per week	Maximum Marks
MJD-20	**4**	**5**	**ESE 75 + ICA 25 = 100**

Course outcomes:

- Understand the theoretical orientation of seed development
- Analyse the different ways of seed processing in different plants
- Examine the various methods of Seed testing
- Understand the method of seed production in different plants and
- Explain the concept of hybrid seed production

Key words:
Seed development, Seed morphology, Seed dormancy, Seed testing, Seed entomology, Seed storage and Viability

Unit 1:Seed development and Production (15 lectures)
Theory of seed development and morphology, Principles of seed production in agricultural crops, seed production in vegetables, fruits, flowers, forage and fodder crops. Seed Dormancy- possible reasons and methods of breaking of dormancy.

Unit 2: Seed processing, Viability and Germination (15 lectures)
Concept of seed processing, diversity in seed storage and viability issues, Methods of testing of seed viability. Behaviour of seed germination and concept of speed of germination/seed vigour, design of experiments for evaluation of seed related traits

Unit 3: Seed Testing and Certification (15 lectures)
Methods used for seed testing, ISTA (International Seed Testing Association). Procedure of seed certification and quality control of seed pathology and seed entomology. Plant Quarantine: Principles, objectives and relevance of plant quarantine; Introductory regulations and plant quarantine set up in India.

Unit 4: Commercial Production of Seeds (15 lectures)
Economics of seed production and marketing, seed production in medicinal and aromatic plants, Concept of hybrid seed and production

Unit 5: Germplasm Storage and Conservation (15 lectures)
Germplasm storage and conservation: History and importance of germplasm collection; Overview of: Ecogeographical distribution of diversity, General account of: Biotechnology in plant germplasm acquisition, plant tissue culture in disease elimination, *in vitro* conservation and exchange, cryopreservation, transgenics – exchange and biosafety issues, economic significance of seed borne pests, pathogens and weeds; detection and post entry quarantine operations.

Suggested Readings:

1. Agrawal, P. K., (2010). Principles of Seed Technology. Indian Council of Agricultural Research, New Delhi.
2. Agrawal, R.L. (2015). Seed Technology. Oxford & Ibh Publishing Co Pvt Ltd.
3. Basra, A. (2006). Handbook of Seed Science and Technology. CRC Press.
4. Khare, D. and Bhale, M. S. (2014). Seed Technology 2nd Revision, Jain Book Agency. 5. International Rules for Seed Testing, 2018 (Free online)
5. Chrispeels, M.J. and Sadava, D.E. (1994) Plants, Genes and Agriculture. Jones & Bartlett Publishers.

PLANT STRESS PHYSIOLOGY

THEORY

Course code	Credits	Teaching hours per week	Maximum Marks
MJD-21	**4**	**5**	**ESE 75 + ICA 25 = 100**

Course outcomes:

- Develop the understanding of concept of stress, stress factors and resistance mechanisms.
- Explain different types of stress with examples.
- Develop the ability for critical appraisal of various physiological mechanisms that protect the plant from environmental stress i.e. adaptation, avoidance and tolerance.
- Analyze the role of production and scavenging mechanisms

Key words:

Stress factors, Resistance, Pathogenesis, Signalling, Isoprotein, ROS, Tolerence, Acclimation

Unit 1: Defining Plant Stress (15 lectures)

Plant stress and stress factors: Biotic and abiotic, Resistance Mechanisms; Tolerance, Acclimation and avoidance.

Unit 2: Abiotic and Biotic Stress Factors (15 lectures)

Water stress; Salinity stress, Hight stress; Temperature stress; Hypersensitive reaction; Pathogenesis– related (PR) proteins; Systemic acquired resistance; Mediation of insect and disease resistance by jasmonates.

Unit 3: Signal Transduction during Stress (15 lectures)

Signal transduction and various mechanisms of acquiring resistance. Pyrethroids, isoprenoids and allelopathy.

Unit 4: Stress Sensing Mechanisms in Plants (15 lectures)

Signalling: Hormonal, Calcium modulation, Phospholipid signaling.

Unit 5: Developmental and Physiological Mechanisms that Protect Plants Against Environmental Stress (15 lectures)

Adaptation in plants; Changes in root:shoot ratio; Aerenchyma development; Osmotic adjustment; Compatible solute production. Reactive oxygen species: Production and scavenging mechanisms of ROS.

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology (4th ed.). John Wiley and Sons. U.S.A.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. 6th edition. Sinauer Associates Inc. USA.
3. Singh D.P. (2003). Stress Physiology. New Age International pvt. Ltd.

DENDROLOGY AND ARBORICULTURE

THEORY

Course code	Credits	Teaching hours per week	Maximum Marks
MJD-22	**4**	**5**	**ESE 75 + ICA 25 = 100**

Course outcomes:

- Identify, classify and characterize the habitats of major trees and shrubs.
- Understand the fundamental requirements of trees and shrubs, their common associates, wildlife and commercial uses.
- Examine the importance of arboriculture, urban and community forest ecosystem
- Reflect upon the utility of urban/community forestry and community involvement

Key words:
Dendrology, arboriculture, Xerophytes, Urban forestry, Community forestry, social forestry

Unit 1: Dendrology (15 lectures)
Introduction to Dendrology, Identification, Classification, Nomenclature, Uses and Characterization habitats of major trees and shrubs.

Unit 2: Tree Biology with Examples (15 lectures)
Range of woody species, common native tree species, Invasive, Avenue tree species, Cover types, Xerophytic evergreen, deciduous trees.

Unit 3: Trees and Shrubs (15 lectures)
Shade tolerance, moisture and nutrient requirements of trees and shrubs, their common associates, wildlife and commercial uses

Unit 4: Arboriculture (15 lectures)
Introduction, history and importance of arboriculture, urban and community forest ecosystem tree physiology, tree identification, utilities.

Unit 5: Urban Greens (15 lectures)
Urban/community forestry, Planning and design and interplay with natural environment, Community involvement, Forest law nursery for quality saplings, and evaluation of sites for appropriate species planting locations.

Suggested Readings
1. Mishra, S.R. 2015. Textbook of Dendrology. Discovery Publishing Pvt. Ltd
2. Harlow and Harra. 2000. Textbook of Dendrology. 9th edition. McGraw-Hill.
3. Bussard L. and Bussard L. 2010. Aboriculture Fruitiere. Nabu Press

PLANT STRESS PHYSIOLOGY & DENDROLOGY AND ARBORICULTURE

PRACTICAL

Course code	Credits	Teaching hours per week	Maximum Marks
MJD-23	**4**	**5**	**ESE 50 + ICA 50 = 100**

Course outcomes:
After completing this course, the students will be able to:

- Measure the osmotic stress.
- Identify the effect of physical factors on pigmentation
- Differentiate the anatomical and physiological variations of plants upon different stress
- Identify the plants specific to particular habitats and measure the Trees
- Plant identifications.

Key words:
Osmotic potential, oxidative damage, pigments, stress indicators, peroxidase, superoxide dismutase, catalase, plant habitats, dendrography, tree measurement

STRESS PHYSIOLOGY
1. Determination of osmotic potential and RWC in plant tissue.
2. Effect of light/Temperature on pigment oxidation.
3. Determination of oxidative damage in tissue using TBARS method.
4. Morphological and anatomical variations in plants under stress (such as number of stomata/chl-a/b ratio and anatomical variations).
5. Stress induced organic solute Proline as a physiological marker of stress.
6. Quantitative estimation of peroxidase activity in the seedlings in the absence and presence of salt stress.
7. Superoxide activity in seedlings in the absence and presence of salt stress.
8. Zymographic analysis of peroxidase, superoxide dismutase, and catalase.

DENDROLOGY AND ARBORICULTURE
1. Collection, identification of 20 habitat indicator plants.
2. Collection and identification of 20 deciduous and evergreen tree species.
3. Diseases on trees and shrubs and their control.
4. Measurement of height of standing trees using possible available tools – total, bole/merchantable, bark thickness, Trunk diameter, tree wood volume
5. Identification of local trees, counting their numbers and working out the diversity index
6. Measurement of tree growth

Suggested Readings

STRESS PHYSIOLOGY
1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. 4th edition.John Wiley and Sons. U.S.A.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. 6th edition. Sinauer Associates Inc. USA.

3. Singh D.P. (2003). Stress Physiology. New Age International pvt. Ltd.

DENDROLOGY AND ARBORICULTURE

1. Mishra, S.R. 2015. Textbook of Dendrology. Discovery Publishing Pvt. Ltd
2. Harlow and Harra. 2000. Textbook of Dendrology. (9th ed.) McGraw-Hill.
3. Bussard L. and Bussard L. 2010.Arboriculture Fruitiere. Nabu Press.

SEMESTER I

INTRODUCTION TO BOTANY- I

(Bacteria, Algae, Fungi, Archegoniatae, Angiosperms and Economic Botany)

Course code	Credits	Teaching hours per week	Maximum Marks
MID-1A	4	5	ESE 75 (Theory) + ICA 25 (Practical) = 100

Course outcomes:

- Students able to understand the primitive group of plants such as Bacteria, Algae and Fungi
- To understand the characteristic features of Bryophytes, Pteridophytes and Gymnosperms
- To conceptualise the knowledge about different types of Inflorescence, Fruits and seeds in Angiosperms
- To recognise and identify different families of Angiosperms
- To understand the economic importance of some Angiosperms

Key words:
Cyanobacterium, *E. coli*, Fungi, Mycelium, Archegoniatate, Inflorecscence, Cereals, Spices, Beverages, Medicinal plants

THEORY

Unit 1: Monerans (9 lectures)
Salient features of bacterium and cyanobacterium. Ultrastructure and reproduction of *Escherichia coli* and *Nostoc*.

Unit 2: Algae and Fungi (9 lectures)
General characters of Algae and Fungi. Study of structure and reproduction of *Volvox* and *Oedogonium*; *Aspergillus* and *Puccinia*.

Unit 3: Archegoniatae (9 lectures)
Salient features of Bryophytes, Pteridophytes and Gymnosperms. Structure, reproduction and life cycle of the following genera: *Marchantia, Selaginella* and *Pinus*.

Unit 4: Angiosperms (9 lectures)
Introduction to flower, fruit and seeds. Study of Angiospermic families: Annonaceae, Apocyanaceae, Euphorbiaceae and Poaceae.

Unit 5: Economic Botany (9 lectures)
Binomial, family and morphology of the useful parts of the following categories: Cereals (rice, wheat, barley), Millets (finger millet, pearl millet, broom-corn), Pulses (green gram, ground nut, soya bean), Oils (sunflower, coconut, gingelly), Spices (clove, pepper, cardamom), Beverages (cocoa, tea, coffee) and Medicines (*Adhatoda*, ginger, *Aloe*).

PRACTICAL (30 lectures)

1. Study of the monerans: *Escherichia coli* and *Nostoc*
2. Study of the algae: *Volvox* and *Oedogonium*; *Aspergillus* and *Puccinia*
3. Study of the bryophytes: *Marchantia*
4. Study of the pteridophytes: *Selaginella*
5. Study of the gymnosperms: *Pinus*
2. Study of the angiosperm families: Annonaceae, Apocyanaceae, Euphorbiaceae and Poaceae.
3. Study of products of economic importance:
   Cereals (rice, wheat, barley),
   Millets (finger millet, pearl millet, broom-corn),
   Pulses (green gram, ground nut, soya bean),
   Oils (sunflower, coconut, gingelly),
   Spices (clove, pepper, cardamom),
   Beverages (cocoa, tea, coffee) and Medicines (*Adhatoda*, ginger, *Aloe*).

Suggested Readings

1.Kumaresan V. and Annie R. 2013. Taxonomy-Systematic Botany, Economic Botany, Ethnobotany. Saras Publication. Nagercoil.
2. Pandey B.P. College Botany (Vol. I). 2010. S.Chand and Company Ltd. New Delhi.
3. Rashid A. 1998. An introduction to Bryophyta. Vikas Publishing House (P) Ltd. New Delhi.
4. Singh G. 2010. Plant Systematics: An Integrated Approach. Science Publishers. USA.
5. Srivastava H.N. 1998. Gymnosperms. Pradeep Publications. Jalandhar.
6.Vasishta B.R., Sinha A.K. and Kumar A. 2010.Botany for degree students- Pteridophyta. S. Chand and Company Ltd. New Delhi.
7.Vasishta B.R., Sinha A.K. and Kumar A. 2011.Botany for degree students- Bryophyta. S.Chand and Company Ltd. New Delhi.

PLANTS IN TRADITIONAL SYSTEMS OF MEDICINE

Course code	Credits	Teaching hours per week	Maximum Marks
MID-1B	**4**	**5**	**ESE 75 (Theory) + ICA 25 (Practical) = 100**

Course outcomes:

- Conceptualize ethnobotany as an interdisciplinary science
- Restate the established methodology of ethnobotany studies
- Categories various indigenous ethnic groups and their environmental practices.
- Understand the legalities associated with ethnobotany.
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Keywords:
Ethnobotany, Ethnic groups, Ethnobotanical sources, Biopiracy, Endangered taxa

THEORY

Unit 1: Ethnobotany (9 lectures)
Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses.

Unit 2: Methodology of Ethnobotanical Studies (9 lectures)

a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places.

Unit 3: Role of Ethnobotany in Modern Medicine-I (9 lectures)
Medico-ethnobotanical sources in India; Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadiracta indica* b) *Ocimum sanctum* c) *Vitex negundo*. d) *Gloriosa superba* e) *Tribulus terrestris* f) *Pongamia pinnata* g) *Cassia auriculata* h) *Indigofera tinctoria*.

Unit 4: Role of Ethnobotany in Modern Medicine-II (9 lectures)
Role of ethnobotany in modern medicine with special example *Rauvolfia sepentina, Trichopus zeylanicus, Artemisia, Withania*. Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).

Unit 5: Ethnobotany and Legal Aspects (9 lectures)
Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.

PRACTICAL (30 lectures)
1. Visit to the field and botanical garden in the nearby area and attempt to identify the plants.
2. Attempt be made to grow the ethnobotanical plants.
3. Visit the villages and rural areas to consult some senior people to discuss the

traditional medicines being used since ages.
4. Prepare a list of plants that provide parts for traditional uses and construct a chart or check-list in terms of botanical significance, chemical constituent, medicinal use, and major industries available in India and the world; Economical-value strength.

Suggested Readings

1. Jain, S.K. (1995). Manual of Ethnobotany, Scientific Publishers, Jodhpur.
2. Jain, S.K. (1981). Glimpses of Indian. Ethnobotany, Oxford and IBH, New Delhi.
3. Jain, S.K. (1989). Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
4. Jain, S.K. (1990). Contributions of Indian ethnobotany. Scientific publishers, Jodhpur.
5. Colton, C.M. (1997). Ethnobotany – Principles and applications. John Wiley and sons.
6. Rama, R, N and Henry, A.N. (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah.
7. Sinha, R. K. (1996). Ethnobotany; The Renaissance of Traditional Herbal Medicine –INA –SHREE Publishers, Jaipur.
8. Faulks, P.J. (1958). An introduction to Ethnobotany, Moredale pub. Ltd.

SEMESTER II

INTRODUCTION TO BOTANY II
(Cytology, Anatomy, Physiology, Microbiology and Plant Ecology)

Course code	Credits	Teaching hours per week	Maximum Marks
MID-2A	4	5	ESE 75 (Theory) + ICA 25 (Practical) = 100

Course outcomes:
Students able understand the concept of ultrastructure of cell and cell organelles
To conceptualize the different types of cells and its architecture with the plant tissues.
Understand the basic concept of plant physiology.
Also, able to study the importance microorganism present in the soil especially for its application in agriculture.
Students also study the ecosystem and its component.

Keywords:
Chloroplast, Mitochondria, Photosynthesis, Nitrogen fixation, Auxin, Cytokinin, Symbiosis, Biofertilizers, Food spoilage, Food chain, Ecological pyramid.

Unit 1: Cytology (9 lectures)
Study of plant cell organelles with emphasis on cell wall, Chloroplast, Mitochondria and Nucleus.

Unit 2: Plant Anatomy (9 lectures)
Anatomy of primary and secondary structure of dicot- stem and root; primary structure of stem and root in monocot, anatomy of dicot and monocot leaf.

Unit 3: Plant Physiology (9 lectures)
Brief study of mechanism of ion uptake and transport, photosynthesis (photochemical reactions, carbon assimilation reactions-C3 and C4 cycles), nitrogen fixation by symbiotic bacteria and phytohormones (auxins and cytokinins).

Unit 4: Microbiology (9 lectures)
Survey of useful microbes: Agricultural uses of microbes: biodegradation and biodeterioration. Soil microflora- biofertilizers. Industrial uses of microbes (fermentation, alcoholic beverages); Food microbiology (microbial spoilage of food, microbial contamination of milk and water).

Unit 5: Plant Ecology (9 lectures)
Plant Ecology: Brief study of ecosystems, plants as primary producers, food chain and food web, ecological pyramids. Forests their importance and conservation, urban and rural forestry. Plants as pollution indicators.

PRACTICAL (30 lectures)
1. Study of Cell Organelles include in Unit 1 from electron micrographs.
2. Anatomical studies of plant parts included in Unit 2.
3. To perform simple experiments as included in Unit 3.
4. Study of microbes as included in Unit 4.

5. Study of ecological processes included in Unit 5.

Suggested Readings

1.De Robertis E.D.P. and De Robertis E.M.F. 2006. Cell and Molecular Biology. 8th ed.). Lippincott Williams and Wilkins. Philadelphia.
2.Dickison W.C. 2000. Integrative Plant Anatomy. Academic Press. San Diego.
3. John Jothi Prakash E. 1987. A Text Book of Plant Anatomy. Emkay Publications. Delhi.
4. Kormondy E.J. 1996. Concepts of Ecology (4^{th} ed.). Prentice Hall, U.S.A.
5. Regland A. and Arumugan N. 2016. Fundamentals of Plant Anatomy and Microtechniques. Saras Publication. Nagercoil, Tamil Nadu.

HERBAL TECHNOLOGY

Course code	Credits	Teaching hours per week	Maximum Marks
MID-2B	**4**	**5**	**ESE 75 (Theory) + ICA 25 (Practical) = 100**

Course outcomes:
On completion of this course the students will be able to;

- Develop their understanding on Herbal Technology
- Define and describe the principle of cultivation of herbal products.
- List the major herbs, their botanical name and chemical constituents.
- Evaluate the drug adulteration through the biological testing
- Formulate the value added processing / storage / quality control for the better use of herbal medicine
- Develop the skills for cultivation of plants and their value added processing / storage /quality control

Keywords:
Herbal medicines, Plant products, Biopesticides, Pharmacognosy, Adulteration, Secondary Metabolites, Germplasm storage

THEORY

Unit 1: An Overview (9 lectures)
Herbal Technology: Definition and scope; Herbal medicines: history and scope; Traditional systems of medicine, and overview of AYUSH (Traditional Indian Systems of Medicine). Cultivation - harvesting - processing - storage of herbs and herbal products.

Unit 2: Herbal Products (9 lectures)
Value added plant products: Herbs and herbal products recognized in India; Major herbs used as herbal medicines, nutraceuticals, cosmetics and biopesticides, their Botanical names, plant parts used, major chemical constituents.

Unit 3: Pharmacognosy I (9 lectures)
Systematic position, botany of the plant part used and active principles of the following herbs: Tulsi, Ginger, Curcuma, Fenugreek, Indian Gooseberry, *Catharanthus roseus*, *Withania somnifera*, *Centella asiatica*, *Achyranthes aspera*, Kalmegh, Giloe (*Tinospora cordifolia*), Sathavar. Herbal foods, future of pharmacognosy.

Unit 4: Pharmacognosy II (9 lectures)
Analytical pharmacognosy: Morphological and microscopic examination of herbs, Evaluation of drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds).

Unit 5: Germplasm Storage (9 lectures)
Plant gene banks, Cultivation of Plants and their value-added processing / storage / quality control for use in herbal formulations, Introductory knowledge of Tissue culture and Micro propagation of some medicinal plants (*Withania somnifera*, neem and tulsi).

PRACTICAL (30 lectures)

1. Morphological and anatomical studies of crude drugs of plants included in the syllabus.
2. Identification of crude drugs by histochemical and phytochemical methods.
3. Identification of drug adulterants.

Suggested Readings

1. Agarwal, P., Shashi, Alok., Fatima, A. and Verma, A. (2013). Current scenario of Herbal Technology worldwide: An overview. *Int J Pharm Sci Res*; 4(11): 4105-17.
2. Arber, Agnes. (1999). Herbal Plants and Drugs. Mangal Deep Publications, Jaipur.
3. Varzakas, T., Zakynthinos, G, and Francis Verpoort, F. (2016). Plant Food Residues as a Source of Nutraceuticals and Functional Foods. Foods 5: 88.
4. Aburjai, T. and Natsheh, F.M. (2003). Plants Used in Cosmetics. Phytotherapy Research 17 :987-1000.
5. Patri, F. and Silano, V. (2002). Plants in cosmetics: Plants and plant preparations used as ingredients for cosmetic products - Volume 1.
ISBN 978-92-871-8474-0, pp 218.
6. AYUSH (www.indianmedicine.nic.in). *About the systems—An overview of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy.* New Delhi: Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH), Ministry and Family Welfare, Government of India.
7. Evans, W.C. (2009): Trease and Evans PHARMACOGNOSY. 16th Edition, Saunders / Elsevier.
8. Sivarajan, V.V. and India, B. (1994). Ayurvedic Drugs and Their Plant Sources. *Oxford &IBH Publishing Company*, 1994 - Herbs - 570 pages.
9. Miller, L. and Miller, B. (2017). Ayurveda & Aromatherapy: The Earth Essential Guide to Ancient Wisdom and Modern Healing. *Motilal Banarsidass*; *Fourth edition.*
10. Kokate, C.K. (2003). Practical Pharmacognosy. Vallabh Prakashan, Pune.

PHYTOCHEMISTRY

Course code	Credits	Teaching hours per week	Maximum Marks
MID-3B	**4**	**5**	**ESE 75 (Theory) + ICA 25 (Practical) = 100**

Course outcomes:

- Understand the fundamental concepts of phytochemistry
- Develop the skills of cold and hot solvent extraction.
- Examine the solvent fractionation.
- Evaluate the process of screening each fraction for plant pathogens or human pathogens

Keywords:
Sample collection, sample identification, Solvent extraction, Solvent fractionation, Secondary metabolites

THEORY

Unit 1: Extraction methods (9 lectures)
Collection of samples, identification and drying**,** Cold and hot solvent extraction (Soxhlet and otherwise) for analysis purpose

Unit 2: Post extraction methods (9 lectures)
Concentration of extract (Rotary evaporation/ air drying) and retrieving of solvent

Unit 3: Separation of the molecules (9 lectures)
Solvent fractionation (using separating funnel and solvent from polar to non-polar like methanol/ Chloroform/ isopropanol/butanol/hexane/water).

Unit 4: Screening for Secondary metabolites (9 lectures)
Determination of each fraction for secondary metabolites.
1. Phenolic compounds Flavonoids/anthocyanin
2. Terpenes essential oils (Limonene/composite- TLC)

Unit 5: Alkaloids and Screening for pathogens (9 lectures)
1. Alkaloids, Amino acids- proteins (potato) or non-protein seed of Cucurbitaceae -2D paper chromatography)
2. Screening each fraction for plant pathogens or human pathogens
3. Further analysis for active ingredient

PRACTICAL (30 Lectures)

1. Techniques of extraction and isolation of phytochemicals (solvent extraction, distillation methods, pressing and sublimation methods).
2. Extraction procedure using Soxhlet extractor.
3. Methods used in solvent fractionation.
4. Preparation for solutions and buffers.
5. Qualitative test for proteins and Carbohydrates.

6. Methods of separation of compounds from different system (solid in liquid mixture, liquid in liquid mixture)
7. Separation of phytochemicals by using TLC.
8. Phytochemical tests for Tannins and Alkaloids.
9. Qualitative analysis of secondary metabolites of the plant extracts.

Suggested Reading

1. Harborne. J.B. (1998). Phytochemical methods. A guide to modern techniques of Plant Analysis. Chapman and Hall publication, London
2. Plumber, D. T. (2006). An introduction to practical biochemistry TATA-McGraw-Hill Publication, New Delhi
3. Shah, B.N. (2005). Text book of Pharmacognosy and phytochemistry. CBS Publishers & Distributors, New Delhi.
4. Egbuna, C., Chinenye, J. Stanley I. and Udedi, C. (2018). Phytochemistry: Fundamental, modern techniques and applications. Apple Academic Press. CRC press.

BIOANALYTICAL TECHNIQUES

Course code	Credits	Teaching hours per week	Maximum Marks
MID-4B	**4**	**5**	**ESE 75 (Theory) + ICA 25 (Practical) = 100**

Course outcomes:

At the end of the study of this course the students would be able to:

- Develop conceptual understanding of cell wall degradation enzymes and cell
- fractionation.
- Classify different types of chromatography techniques.
- Explain the principles of Light microscopy, compound microscopy, Fluorescence
- microscopy and confocal microscopy
- Apply suitable strategies in data collections and disseminating research findings.

Keywords:
Centrifugation, Chromatography, HPLC, Fluorochrome, Spectrophotometry, AGE, PAGE, FACS, FISH, SEM, TEM, Microscopy, Data analysis.

THEORY

Unit 1: Cellular Fractionation and Separation Techniques (9 lectures)
Good laboratory practices, Cell fractionation, Cell wall degradation enzymes, Sedimentation of cellular particles, Mobility of particles under external centrifugal forces, type of centrifugation: Differential and density gradient centrifugation, type of rotors, analytical centrifugation for estimation of mass of biological molecules, Svedberg equation, ultracentrifugation and applications.

Unit 2: Separation of Biomolecules (6 lectures)
Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

Unit 3: Characterization of Molecules I (12 lectures)
Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE.
Principles of microscopy; Light microscopy; compound microscopy, Fluorescence microscopy; Confocal microscopy.

Unit 4: Characterization of Molecules II (9 lectures)
Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching. Use in biological research, auto-radiography, pulse chase experiment.

Unit 5: Data Analysis (9 lectures)
Data collection methods, population, samples, parameters; Representation of Data: Tabula, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of

dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.

PRACTICAL (30 lectures)

1. To separate nitrogenous bases by paper chromatography.
2. To separate sugars by thin layer chromatography.
3. Isolation of chloroplasts by differential centrifugation.
4. To separate chloroplast pigments by column chromatography.
5. To estimate protein concentration through Lowry's methods.
6. To separate proteins using PAGE.
7. To separate the DNA (marker) using AGE.
8. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
9. Demonstration of ELISA.
10. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
11. Preparation of 5 permanent slides (double staining).

Suggested Readings

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. 3rd edition. Tata McGraw-Hill Publishing Co. Ltd. New Delhi.
2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. 3rd edition. John Wiley & Sons.
4. Zar, J.H. (2012). Biostatistical Analysis. 4th edition. Pearson Publication. U.S.A.

SEMESTER V

ECONOMIC BOTANY

Course code	Credits	Teaching hours per week	Maximum Marks
MID-5A	**4**	**5**	**ESE 75 (Theory) + ICA 25 (Practical) = 100**

Course outcomes:
The students after studying this course would be able to:

- Understand the plants and economic values
- Categorize the plants according to their uses
- Acquaint the knowledge on the origin, distribution and cultivation of various- Crop plants, Fible yielding plants, Timber yielding plants, Oil plants, Spices and Condiments.

Key words:
Vavilov's centres of origin, Crop plants, Timber plants, Oil plants, Spices, Condiments.

THEORY

Unit 1: Origin of Crop Plants (9 lectures)
Introduction to Economic Botany. Vavilov's centres of origin of crop plants. Origin, distribution, brief idea of cultivation and economic uses of the following Food plants:
i. **Cereals** (rice, wheat and maize)
ii. **Pulses** (gram, arhar and pea)
iii. **Vegetables** (potato, tomato and onion)

Unit 2: Fibre Plants (9 lectures)
Origin, distribution, brief idea of cultivation and economic uses of the following Fibre plants:
i. Cotton
ii. Jute
iii. Flax

Unit 3: Timber Plants (9 lectures)
Origin, distribution, brief idea of cultivation and economic uses of the following Timber plants:
(i) Neem
(ii) Teak
(iii) Cedar

Unit 4: Oil Plants (9 lectures)
Origin, distribution, brief idea of cultivation and economic uses of the following Oil plants:
i. Groundnut
ii. Sunflower
iii. Coconut

Unit 5: Spices and Condiments (9 lectures)
Origin, distribution, brief idea of cultivation and economic uses of the following Spices:
i. Coriander

ii. Clove
iii. Ginger

PRACTICAL **(30 lectures)**

1. Study of morphological features of Food plants:
i. Cereals (rice, wheat and maize)
ii. Pulses (gram, arhar and pea)
iii. Vegetables (potato, tomato and onion)

2. Study of morphological features of Fibre yielding plants:
i. Cotton
ii. Jute
iii. Flax

3. Study of morphological features of Oil yielding plants:
i. Groundnut
ii. Sunflower
iii. Coconut

4. Study of morphological features of Spices and Condiments:
i. Coriander
ii. Clove
iii. Ginger

5. Study of anatomical features of the following plants:
i. *Coriander*
ii. Clove
iii. Ginger
iv. *Azadirachta*
v. *Withania*.

6. Histochemical localization of starch in rice and potato.

7. Economic significance of tea, coffee, rubber, sugarcane

Suggested Readings:

1.Gonsalves J. 2010. Economic Botany and Ethnobotany. International Scientific Publishing Academy. New Delhi.
2. Kumaresan V. and Annie R. 2013. Taxonomy-Systematic Botany, Economic Botany, Ethnobotany. Saras Publication. Nagercoil.
3. Kocchar S.L. 2009. Economic Botany in The Tropics (3rded.), MacMillan Publishers India Ltd. New Delhi.
4. Pooja. 2005. Economic Botany. Discovery Publishing House. New Delhi.
5. Sambamurthy A.V.S.S. and Subramanyam N.S. 1989. A Textbook of Economic Botany. Wiley Eastern Ltd. New Delhi.
6. Sharma O.P. 1996. Hills Economic Botany. Tata McGraw Hill Co. Ltd. New Delhi.
7. Simpson B.B. and Conner-Ogorzaly M. 1986. Economic Botany- Plants in Our World. McGraw Hill. New York.
8. Verma V. 2009. Text Book of Economic Botany. Ane Books Pvt. Ltd. New Delhi.

MEDICAL BOTANY

Course code	Credits	Teaching hours per week	Maximum Marks
MID-5B	**4**	**5**	**ESE 75 (Theory) + ICA 25 (Practical) = 100**

Course outcomes:

- The students would learn the outlines of the Indian Traditional System of Medicine.
- Understanding on the crude drugs from the plants would be imparted to the students.
- Plant toxins and their uses will be taught to the students
- The stakeholders will learn how to isolate and identify the antibiotics from the lower plants
- Students will have an understanding on neutraceuticals and cosmeceuticals.

Key words:
Traditional systems of medicine, raw materials, active principles, carbohydrates, glycosides, tannins, fixed oils, volatile oils, resins, alkaloids, steroids, Allergens, Teratogens, Hallucinogens, Antibiotics.

THEORY

Unit 1: **Introduction** **(9 lectures)**
Introduction- Health through herbs. Historical back ground, present status, scope of medicinal botany, Indian contribution to medicinal botany, Ethnobotany, a brief outline on traditional systems of medicine – Ayurvedha, Siddha, Unani, Naturopathy and Homeopathy.

Unit 2: **Raw materials for Drugs from Plants I** **(9 lectures)**
Plant secondary metabolites of medical importance: source, description of the products, chemical constituents, active principles and therapeutic uses of the following:
i. **Carbohydrates -** Ispaghula (*Plantago ovata*), Agar (*Gracilaria*).
ii. **Glycosides** - Senna (*Cassia* sp), *Digitalis*, *Glycorrhiza* and *Aloe.*

Unit 3: **Raw materials for Drugs from Plants II** **(9 lectures)**
Plant secondary metabolites of medical importance: source, description of the products, chemical constituents, active principles and therapeutic uses of the following:
i. **Tannins** - *Acacia* and Myrobalan (*Terminlia chebula).*
ii. **Fixed oils** - Groundnut oil (*Arachis hypogea*) and Castor oil (*Ricinus communis*).
iii. **Volatile oils** - *Eucalyptus*, Clove, lemon and *Ocimum*.
iv. **Resins** - Asafoetida and *Pinus*.
v. **Alkaloids** - Cinchona, *Rauwolfia, Atropa, Opium,* Vasaka (*Adhatoda zeylanica)* and *Ephedra*.
vi. **Steroids** – *Solanum* and *Dioscorea.*

Unit-4: Plant Toxins **(9 lectures)**
Toxins of plant origin: Allergens, Teratogens and hallucinogens from hemp and mycotoxins and aflatoxins from fungi.

Unit-5: Antibiotics (9 lectures)

Introduction to Antibiotics: Properties and Functions of antibiotics. Extraction, chemistry and therapeutic uses of the antibiotics obtained from *Penicillium, Aspergillus,* and *Streptomyces.* General account on neutraceuticals and cosmoceuticals.

PRACTICAL (30 lectures)

1. Morphological and anatomical studies of crude drugs of plants included in the syllabus.
2. Identification of crude drugs by histochemical and phytochemical methods.
3. Identification of drug adulterants.

Suggested Readings

1. Evans W.C. 1989. Trease and Evans Pharmacognosy (13th ed.). BaillièreTindall. London.
2. Kadavul K. 2016. Hand Book on Utilization of Medicinal Plants. Published by author.No.9, 4th Cross Street, Vengateswara Nagar-East, Puducherry-605013.
3. Kokate C.K., Purohit A.P. and Gokhale, S.B. 2003. Pharmacognosy (23rd ed.). Nirali Prakashan. Pune.
4. Purohit and Vyas. 2008. Medicinal Plant Cultivation: A Scientific Approach (2nd ed.). Agrobios. India.
5. Trivedi P.C. 2006. Medicinal Plants: Ethnobotanical Approach. Agrobios. India.

SEMESTERS VI

ECOLOGY AND BIODIVERSITY

Course code	Credits	Teaching hours per week	Maximum Marks
MID-6A	**4**	**5**	**ESE 75 (Theory) + ICA 25 (Practical) = 100**

Course outcomes:
After the completion of this course, the learner will be able to:

- Develop understanding of the concept and scope of plant biodiversity
- Identify the causes and implications of loss of biodiversity
- Apply skills to manage plant biodiversity
- Utilize various strategies for the conservation of biodiversity
- Conceptualize the role of plants in human welfare with special reference to India

Key words:
Biodiversity, Biodiversity loss, Hot spots, Biodiversity management, Conservation strategies, Biodiversity awareness programmes.

THEORY

Unit 1: Introduction, soil and water (9 lectures)
Basic concepts; Levels of organization. Abiotic and biotic Components and their interrelationships and dynamism, homeostasis. **Soil:** Origin; Types and Formation; Composition; Physical, Chemical and Biological components; Soil profile. Types of soils in India. **Water:** States of water in the environment; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Atmospheric moisture; Water in soil; Ground water table. Water resources of India

Unit 2: Ecological adaptations, Population ecology (9 lectures)
Variations in adaptation of plants in relation to light, temperature, water, wind and fire. **Biotic interactions:** Competition: Inter- and intraspecific competition; Ammensalism, heterotrophy; mutualism, commensalism, parasitism; herbivory, carnivory, protocooperation, **Population ecology:** Characteristics and population growth, population regulation, life history strategies; *r* and *k* selection. Ecological Speciation.

Unit 3: Plant Communities and Ecosystem (9 lectures)
Community characteristics: analytical and synthetic; Concept of ecological amplitude; Habitat and niche; Ecotone and edge effect; Succession: processes, types; climax concept. Primary vs Secondary succession. **Ecosystem:** Structure; Processes; Trophic organization; Food chains and Food webs; Ecological pyramids. Ecosystems of India. Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles of carbon, nitrogen and phosphorus.

Unit 4: Plant Diversity and its Scope (9 lectures)
Levels of biodiversity: Genetic, Species and Ecosystem; Agrobiodiversity and cultivated plant taxa and related wild taxa. Values and uses of Biodiversity, Methodologies for

valuation, Ethical and aesthetic values, Uses of plants; Ecosystem services. Loss of biodiversity- causes and implications, Hot spots of biodiversity, extinction of species, projected scenario for biodiversity loss.

Unit 5: Conservation and Management of Plant Biodiversity (9 lectures)
Organizations associated with biodiversity management, IUCN, UNEP, WWF, UNESCO, NBPGR; Methodology for execution; Biodiversity legislation; Information management and communication. Conservation of genetic, species and ecosystem diversity, *In situ* and *ex situ* conservation strategies, India's biodiversity and its conservation Social approaches to conservation, Biodiversity awareness programmes, Sustainable development.

PRACTICAL (30 lectures)

ECOLOGY

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH of various soil and water samples (with pH meter, universal indicator/Lovibond comparator and/or pH paper strip)
3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
4. Determination of organic matter of different soil samples by Walkley & Black rapid titration method.
5. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.
6. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
7. Study of morphological adaptations of hydrophytes and xerophytes (four each).
8. Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*) Epiphytes, Predation (Insectivorous plants).
9. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
10. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
11. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.
12. Field visit to familiarise students with ecology of different sites.

BIODIVERSITY
1. Visit any unattended area with natural vegetation
2. Use Quadrat method to evaluate the minimum size of the quadrat required for vegetation study
3. Find out the minimum number of quadrats need for analyzing the vegetation structure in the study area
4. Find out the alpha-diversity of plants in the area

Suggested Readings
1. Odum, E.P. 2005. Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J.S., Singh, S.P., Gupta, S. 2006. Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.

3. Sharma, P.D. 2010. Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
4. Wilkinson, D.M. 2007. Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
5. Kormondy, E.J. 1996. Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. (4^{th} ed).
5. Krishnamurthy, K.V. 2004. An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi
6. Singh, J.S., Singh, S.P. and Gupta, S. 2006. Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
7. Reddy, K.V. and Veeraiah, S. 2010. Biodiversity and Plant Resources. Aavishkar publication, New Delhi.
8. Heywood, V. H. and Watson, R. T. 1995. Global biodiversity and Assessment. Cambridge University Press.

RESEARCH METHODOLOGY

Course code	Credits	Teaching hours per week	Maximum Marks
MID-6B	**4**	**5**	**ESE 75 (Theory) + ICA 25 (Practical) = 100**

Course outcomes:
At the end of the course the students will be able to:

- Understand the concept of research and different types of research in the context of
- biology
- Develop laboratory experiment related skills.
- Develop competence on data collection and process of scientific documentation
- Analyze the ethical aspects of research
- Evaluate the different methods of scientific writing and reporting

Key words:
Qualitative, Quantitative, Reproducibility, Scientific methodology, Plagiarism, Scientific misconduct, Ethics in Science

THEORY

Unit 1: Basic Concepts of Research (9 lectures)
Research-definition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs empirical). Research methods vs methodology. Literature-review and its consolidation; Library research; field research; laboratory research.

Unit 2: Data Collection and Documentation of Observations (9 lectures)
Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissue specimens and application of scale bars. The art of field photography.

Unit 3: Overview of Biological Problems (9 lectures)
History; Key biology research areas, Model organisms in biology (A brief overview): Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics, Proteomics-Transcriptional regulatory network.

Unit 4: Ethics and Good Practical's and Art of Scientific Writing I (9 lectures)
Authors, acknowledgements, reproducibility, plagiarism, Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references.

Unit 5: Ethics and Good Practical's and Art of Scientific Writing II (9 lectures)
Power-point presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism.

PRACTICAL (30 lectures)
1. Experiments based on chemical calculations.
2. Plant microtechnique experiments.
3. The art of imaging of samples through microphotography and field photography.
4. Poster presentation on defined topics.

5. Technical writing on topics assigned.
6. Identification of different type of research in day-by-day life
7. Testing of a formulated hypothesis with type I and type II errors
8. Curation of relevant scientific literature from Google Scholar
9. Poster presentation on defined topics
10. Demonstration for checking of plagiarism using recommended software
11. Technical writing on topics assigned.
12. More Practical may be added depending on the local habitats and available facilities.

Suggested Readings

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
3. Ruzin, S. E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.

SEMESTER VII

INDUSTRIAL MICROBIOLOGY

Course code	Credits	Teaching hours per week	Maximum Marks
MID-7A	4	5	ESE 75 (Theory) + ICA 25 (Practical) = 100

Course outcomes:
After completion of the course, the students will be able to:

- Understand concepts of industrial microbiology
- Apply the usage of microorganisms in industry
- Measure the growth of microorganisms
- Analyze the use of microbes in industries such as dairy and medicines
- Explain the concept of fermentation
- Understand the use of patent with respect to industrial microbiology

Keywords:
Industrial microorganisms, Culture collection, Strain maintenance, Growth curves, Fermentation, Sterilization

Unit 1: Fundamentals of Industrial Microbiology (9 lectures)
Fundamentals of Industrial microbiology: Definition, history and scope, Desirable characteristics and selection of industrial microorganisms, Isolation of suitable industrial microorganism form natural habitat. Culture collection Centres, Strain improvement and maintenance.

Unit 2: Measurement of Microbial Growth (9 lectures)
Media for fermentation, sterilization, development of inoculums, aeration. Definition of growth, mathematical nature and expression of growth, Generation time, growth curves in bacteria.
Measurement of growth (cell number, cell mass and cell constituent. Effect of environment on the microbial growth (temperature, pH and other parameters).

Unit 3: Fermentation Process (9 lectures)
Fermentation and fermenter, Concept of fermentation and discovery of fermentation. Fermentation system, Fermentor design, Scale up study, metabolic control of product formation. Batch, Fed-batch and Continuous fermentation, solid and liquid state fermentation, Down-stream processes, fermentation economics: market potential, fermentation and product recovery cost.

Unit 4: Fermentation Products (9 lectures)
Fermented dairy products (yoghurt, butter milk and cheese fermentation, baking product (bread), fermented beverages (beer, wine and ethanol), Single cell protein, probiotics and prebiotics; Recombinant protein, Enzymes (amylase), organic acid (citric acid), antibiotic (penicillin).

Unit 5: Product Patenting (9 lectures)

Patent and secret processes: concept of patent, composition and characteristics of patent; protection of right.

PRACTICAL (30 lectures)

1. Practice of cleaning and disinfecting of the glassware/plasticware
2. Use of laminar flow
3. Measurement of Microbial growth
4. Preparation of wine from grapes
5. Preparation of different culture media
6. Measurement of growth - cell number, cell mass and cell constituent
7. Study impact of environmental conditions on microbial growth.

Suggested Readings

1. Casida, L. E. J. R. 2016. Industrial Microbiology. New Age International Publisher.
2. Sivakumaar, P.K. 2010. An Introduction to Industrial Microbiology. S Chand publishing.
3. Waites, M.J., Morgan, N.L., Rockey, Higton G. 2001. Industrial Microbiology: An Introduction. Blackwell Science.
4. Okafor, N., Benedict, C. and Okeke. 2017. Modern Industrial Microbiology and Biotechnology. Taylor & Francis.

MARINE BIOTECHNOLOGY

Course code	Credits	Teaching hours per week	Maximum Marks
MID-7B	**3 + 1**	**5**	**ESE 50 (Theory) + ICA (Theory) 25 + ESE (Practical) 25 = 100**

Course outcomes:

- Students will understand the overview structure and function of life in the marine environment.
- Students will also understand the diversity of organisms in the ocean and their importance.
- They will also appreciate marine resources and how oceans influence the climate.

Key words:

Seawater, Barophiles, Thermophiles; Seaweeds, Plankton, GFP

THEORY

Unit 1: Marine Ecosystem (9 lectures)
Sea as a biological environment; Classification of the marine zones; Estuarine ecosystems; Coral reefs - occurrence, distribution and economic importance; Mangroves - distribution, adaptation (morphological, anatomical) and their importance; Critical habitats and biological hotspots.

Unit 2: Ocean Climatic Change (9 lectures)
Seawater composition and its properties; differences between fresh and seawater; Ocean acidification and its significance; El Niño-Southern Oscillation: El Niño & La Niña and its effect on global climate; Marine pollution.

Unit 3: Marine Diversity (9 lectures)
Diversity of marine microorganisms: viruses, bacteria, archaea, protists, fungi Specialized microorganisms: Extremophiles: barophiles, thermophiles, psychrophiles, halophiles, actinomycetes, polyextremophiles, anaerobes.

Unit 4: Marine Plants (9 lectures)
Marine algae and plants (seaweeds, sea grasses, mangrove plants); Plankton (phytoplankton and zooplankton); Marine biomass and productivity - primary production, photosynthetic efficiency; secondary production; Geographical Information System (GIS) for chlorophyll distribution.

Unit 5: Applications of Marine Organisms (9 lectures)
Application of Marine organisms: Barophilic organisms & their applications; Seaweeds for removal of metal pollutants; GFP, RFP characteristics and their applications; Green mussel adhesive protein; Chitosan : products and applications; Marine Biomimetics

PRACTICALS (30 lectures)

1. Estimation of Dissolved oxygen
2. Estimation of Salinity
3. Estimation of pH
4. Identification of locally available Sea Grasses.
5. Identification of locally available Seaweeds.
6. Identification of locally available Mangroves.
7. Sampling (Field trips) and identification: Phytoplankton & Zooplankton
8. Estimation of Chlorophyll
9. Study of morphology and cultural characteristics of microbes
10. Preparation of solid & liquid media for bacterial and fungal study
11. Isolation of bacteria from seawater /sediments samples
12. Cultivation of marine fungi
13. Gram staining of marine bacteria

Suggested Readings:

1. Sumich, J.L., 1999. Introduction to the Biology of Marine life. Seventh Edition. The Mc Graw Hill Companies Inc.
2. Hogarth P. 2007. The Biology of Mangroves and Seagrasses First Edition. Oxford Press.
3. Munn, C.B. 2004. Marine Microbiology: Ecology and Applications, BIOS Scientific Publisher.
4. Krichman, D.L., 2000, Microbial Ecology of the Oceans. Wiley-Liss, New York.
5. Naskar K. and Mandal R., 1999. Ecology and Biodiversity of Indian Mangroves. Daya.
6. Le Gal, Y., Ulber, R., & Antranikian, G. 2005. Marine Biotechnology
7. Nabti, E. 2017. Biotechnological Applications of Seaweeds.
8. Day, R., Davidson, M. 2014. The Fluorescent Protein Revolution.
9. Hicks, B. 2002. Green Fluorescent Protein.
10. Ahmed, S., Ikram, S. (2017). Chitosan.
11. Bar-Cohen, Y. (2006). Biomemetics.
12. Beer, T. (2017). Environmental oceanography. CRC Press.
13. Robert Blasiak et al. (2022). A forgotten element of the blue economy: marine biomimetics and inspiration from the deep sea. PNAS Nexus, 2022, 1,1–17 (Assess :https://doi.org/10.1093/pnasnexus/pgac196)
14. Grasshoff, K., 1999. Methods of Sea water Analysis. Wiley VCH, New York.

FORENSIC BOTANY

Course code	Credits	Teaching hours per week	Maximum Marks
MID-8A	**4**	**5**	**ESE 75 (Theory) + ICA 25 (Practical) = 100**

Course outcomes:
After completing this course, the learner will be able to:

- Conceptualize classification of plants from forensic point of view.
- Understand forensic importance of different parts of plants.
- Collect and preserve botanical evidences of crime and analyze classic and DNA based forensic botany cases**.**

Key words:
Plant classification, Forensic importance, Poisonous plants, Drugs, Botanical evidences, Sample analysis

THEORY

Unit 1: Organization and Classification of Plants (9 lectures)

Introduction to Forensic Science- Locard's exchange principle. General plant classification schemes, Sub specialization of forensic botany- plant morphology, plant anatomy, plant systematic, palynology, plant ecology, limnology, Plant architecture- roots, stems, flowers, leaves. Practical plant classification schemes: - vegetables and herbs, fruits bearing trees and plants, landscaping plants: trees, shrubs and vines, grasses, plant cell structure and functions.

Unit 2: Importance of Plant Parts (9 lectures)

Various types of woods, timbers, seeds and leaves and their forensic importance, Identification and matching of various types of wood, timber varieties, seeds and leaves. Types of fibres – forensic aspects of fibre examinations, Identification and comparison of man–made and natural fibres.

Unit 3: Identification of Microbes and Plant Products (9 Lectures)

Various types of Planktons and diatoms and their forensic importance,
Study and identification of pollen grains, Identification of starch grains, powder and stains of spices etc. Paper and Paper Pulp identification.
Types of plants yielding drugs of abuse – opium, cannabis, coco, tobacco, dhatura, *Psilocybin* mushrooms.

Unit 4: Poisonous Plants (9 lectures)

Various types of poisonous plants-*Abrus precatorius*, *Aconitum*, *Anacardium occidentale, Argemone mexicana, Calotropis, Cannabis sativa, Claviceps purpurea, Cinchona, Croton tiglium, Atropa belladonna, Erythroxylum cocoa, Gloriosa superba, Jatropha curcas, Lathyrus sativus, Manihot utilissima, Nerium oleander, Nicotiana tabacum, Plumbago zeylanica, Ricinus communis, Semicarpus anacardium, Strychnos nux vomica, Thevetia peruviana,*

Unit 5: Application of various Techniques in Forensic Botany (9 lectures)
Collection and preservation of botanical evidences: Botanical samples, outdoor crime scene consideration, Analysis of samples, DNA analysis, plant DNA typing, Classic forensic botany cases: Case histories by using Plant anatomy and systematic, Palynology, Plant ecology, Limnology, Plant Molecular Biology and DNA, Drug enforcement and DNA.

PRACTICAL (30 lectures)
1. Study of phytoplanktons using morphological characters- Diatoms, Microalgae, etc.
2. Study of plant pollen grains types
3. Study of narcotic leaf, *Cannabis* / tobacco with the from other non-narcotic leaf using external morphological and anatomical features.
4. Study of plant stems- Rose wood/ Sandal wood and common plants wood.
5. Study of poisonous and non-poisonous plant flowers
6. Study on the differentiation of poisonous seeds of *Nerium* and *Ricinus communis* (Castor) from non-poisonous seeds.
7. Differentiation of cotton fibres with synthetic fibres using dyes.
8. Study of plant crystals.
9. Study of poisonous and non-poisonous mushrooms

Suggested Readings
1. Coyle H.M. 2004. Forensic Botany: Principles and Applications to Criminal Casework. CRC Press.
2. James S.H., Nordby J.J., Bell S. 2015. Forensic Science: An Introduction to Scientific and Investigative Techniques. CRC Press; 4th edition.
3. Hall D.W. and Byrd J. 2012 Forensic Botany: a practical guide. Wiley-Blackwell, 1st edition.
4. Bock J.H. and Norris D.O. 2016. Forensic Plant Science. Academic Press.

BIOSTATISTICS AND COMPUTER APPLICATIONS IN BIOLOGY

Course code	Credits	Teaching hours per week	Maximum Marks
MID-8B	**4**	**5**	**ESE 75 (Theory) + ICA 25 (Practical) = 100**

Course outcomes:
At the end of the course the students will be able to:

- Comprehend the fundamental concepts related to descriptive and inferential biostatistics.
- Develop skills in data tabulation, its treatment, analysis, interpretation and graphical representation of data.
- Analyze the implications of inferential statistics in biology.
- Develop their competence in hypothesis testing and interpretation.

Key words:
Probability, Frequency, ANOVA, t-test, P-value, Hypothesis testing, Correlation, regression

THEORY

Unit 1: Biostatistics-I (9 Lectures)
Introduction to Biostatistics, definition, characteristics, importance and usefulness, limitations. Collection, classification and presentation of data (tabulation, graphical representation-Histogram, simple bar, multiple bar and divided bar diagrams, pie diagram, frequency curve and frequency polygon). Frequency distribution: definition, types, class width, class mark, class frequency, relative frequency, percentage frequency and frequency density.

Unit 2: Biotstatistics-II (9 Lectures)
Measures of central tendency- Characteristics: definition and calculations of mean, median, and mode. Measures of variation- standard deviation and standard error.

Unit 3: Basics of Computer (9 Lectures)
Types of computers, accessories and its functions, input-output devices, concepts of different operation systems, details of Networks, Internet and email. Database types and its uses, fundamentals of digital imaging, uses of different programming languages.

Unit 4: Softwares used in Biology (9 Lectures)
Outline of MS-Office (MS-Word, MS-Excel and MS-Power point). Database softwares- MS access, Image editing softwares (Photoshop), Biological Sequence Searching and Comparison softwares (BLAST), Search engines (Google, Mozilla Firefox), GIS softwares (Google Earth).

Unit 5: Computer Applications in Biology (9 Lectures)
Introduction to Bioinformatics and its applications, EMBL and GenBank Data Libraries, PIR Database, Fundamentals of Geographic Information Systems (GIS) and Remote Sensing and its uses in biology. Information systems- BTIS, ENVIS.
Introduction to statistical softwares- SPSS and PSPP (open source), use for descriptive statistical analysis.

PRACTICAL (30 Lectures)

1. Tabulation of biological data.
2. Calculation of mean, median, mode, standard deviation and standard error using biological data.
3. To plot and import Graphs and Charts using biological and statistical data in MS-office.
4. Search biological information (texts and images) using Internet.
5. Biological sequence searching using BLAST software.

Suggested Readings

1. Banerjee P.K. 2009 Introduction to Biostatistics- A Text Book of Biometry. S.Chand & Co. New Delhi.
2. Bemis K. PSPP: Purdue STAT 582 User Manual.http://www.stat.purdue.edu/~jennings/stat582/software/pspp_manual.pdf
3. Chernick M.R. and Friis R.H. 2003. Introductory Biostatistics for the Health Sciences: Modern Applications including Bootstrap. John Wiley & Sons. New Jersey.
4. Cox J. Lambert J. and Frye C. 2011. Step by Step: Microsoft Office Professional 2010. Microsoft Press. Washington.https://capdtron.files.wordpress.com/2013/01/office-professional-2010-step-by-step.pdf
5. Daniel W.W. 2005.Biostatistics: A Foundation for Analysis in the Health Sciences (7thed.). John Wiley & Sons (Asia) Pvt. Ltd. Singapore.
6. Lambert J. and Frye C. 2015. Microsoft Office 2016 Step by Step. Microsoft Press. USA. https://ptgmedia.pearsoncmg.com/images/9780735699236/samplepages/9780735699236.pdf
7. PSPP Users' Guide. GNU PSPP Statistical Analysis Software Release 0.10.2.http://www.gnu.org/software/pspp/manual/pspp.pdf
8. PSPP Tutorial. https://www.youtube.com/watch?v=GG-wbMS9i7g
9. Rutkosky 2007. MS Office.BPB Publication. New Delhi.
10. Genebank: https://www.ncbi.nlm.nih.gov/genbank/
11. EMBL Nucleotide Sequence Database http://www.ebi.ac.uk/

MULTI DISCIPLINARY COURSE

BASIC BOTANY

Course code	Credits	Teaching hours per week	Maximum Marks
MLD	3	4	ESE 75 + ICA 25 = 100

Course outcomes:
On successful completion of the course, students will:

- Understand the cell and its types with emphasis on plant cells
- Understand the major groups of plants.
- Understand the concept of ecology and biodiversity.
- 4. Understand the importance of plants and their role in human life.

Key words: Cell, Anatomy, Ecology, Ecosystem, Biodiversity

Unit 1: Cell and Anatomy (12 lectures)
Introduction to cell and its types - Prokaryotes and Eukaryotes; Study of plant cells; Introduction to tissues - simple and complex; Study of Leaf - monocot and dicot; Structure and function of flower.

Unit 2: Plant Diversity (12 lectures)
Five Kingdom concept; Study of major groups - Bacteria, Algae, Fungi, Bryophytes, Pteridophytes, Gymnosperm and Angiosperm (only general characteristics).

Unit 3: Ecology (12 lectures)
Concepts of ecology; Structure and function of ecosystem; Trophic organization - food chain and food web; Ecological pyramid

Unit 4: Ecosystem Types (12 lectures)
Ecosystem types in India; Case study of any one of the following - forest ecosystem, aquatic ecosystem (marine or freshwater) and mountain ecosystem. Concept of biodiversity hotspot.

Unit 5: Plants and Human Affairs (12 lectures)
Important vascular plants and products used as food, textiles and medicines, oils and perfumes; Study of harmful plants; Advantages and disadvantages of genetically modified plants.

Suggested Readings:

1. Campbell NA, Reece JB (2008) Biology, 8th edition, Pearson Benjamin Cummings, San Francisco.
2. Evert RF, Eichhorn SE (2012) Raven Biology of Plants, 8th edition, New York, NY: W.H. Freeman and Company.
3. Singh V, Pandey PC, Jain DK (2001) A Text Book of Botany. Meerut, UP: Rastogi and Co.
4. Odum EP (2005) Fundamentals of Ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
5. Ambasht and Ambasht (2002) A text book of Plant Ecology. CBS publisher and Distributors.

SKILL ENHANCEMENT COURSES

SEMESTER I

ALGAL CULTURE TECHNOLOGY

Course code	Credits	Teaching hours per week	Maximum Marks
SEC-1A	**3**	**4**	**ESE 75 (Theory) + ICA 25 (Practical) = 100**

Course Outcomes:
On the completion of the course the students will be able to:

- Understand the common cultivation methods of microalgae including photobioreactors and open ponds
- Analyze the major cultivation methods of seaweeds, along with detailed life history of selected high-value seaweed species from India
- Examine the cultivation and optimization strategies of biofuel production and carbon capture and sequestration using algae

Key words:
Floating raft, off-bottom, IMTA, clonal seaweeds, CCS, Photobioreactor

THEORY

Unit 1: Cultivation Methods for Microalgae (9 lectures)
Lab-scale culture, Photobioreactors: types and optimization, Open systems: Ponds, Strategies to increase biomass in algal culture systems. Culture and importance of *Spirulina*- Single Cell Protein (SCP).

Unit 2: Cultivation Methods for Seaweeds I (9 lectures)
Life history of major commercially important seaweed species of India (Including *Kappaphycus, Sargassum, Monostroma, Ulva, Porphyra*), Nursery rearing of zoids of seaweed species.

Unit 3: Cultivation Methods for Seaweeds II (9 lectures)
Commercial mariculture methods of seaweeds, Floating raft method, semifloating raft method, off-bottom method and bottom planting method, Integrated Multi-Trophic Aquaculture.

Unit 4: Production of Biofuel (9 lectures)
Major algal species for biofuel research, advantageous for using algae for biofuel production in comparison with terrestrial plants like *Jatropha*, strategies to increase oil content of algae, downstream processing for the biofuel production.

Unit 5: Carbon Capture and Sequestration with algae (9 lectures)
Introduction to Carbon Capture and Sequestration (CCS), CCS as a mitigation for climate change, CCS through algae, strategies to increase carbon sequestration levels, Major algal species as a candidate for CCS.

PRACTICAL (30 lectures)
1. Study of identification of microalgae present in fresh water (borewell, river, pond, lake, etc) and marine water.

2. Preparation of algal culture media.
3. Flask culture / tank culture of microalgae.
4. Culture of *Spirulina*.
5. Assessment of lipid contents of microalgae grown in different conditions (media, temperature, aeration etc)
6. Demonstration of photobioreactor and trial run with a microalgal culture
7. A study visit to raceway pond culture of microalgae
8. A study visit to seaweed farm (*Kappaphycus* cultivation farm)

Suggested Readings

1. Hoek, C. Van D et al (2009) Algae: An Introduction to Phycology. Cambridge University Press
2. Bast, F. (2014). An Illustrated Review on Cultivation and Life History of Agronomically Important Sea plants. In Seaweed: Mineral Composition, Nutritional and Antioxidant Benefits and Agricultural Uses, (Vitor Hugo Pomin Eds.), 39-70. Nova Publishers, New York ISBN: 978-1-63117-571-8
3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi
4. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, New Delhi.
5. Bast, F (2014). Seaweeds: Ancestors of land plants with rich diversity. Resonance, 19(2) 1032-1043 *ISSN*: 0971-8044

BOTANICAL GARDEN AND LANDSCAPING

Course code	Credits	Teaching hours per week	Maximum Marks
SEC-1B	3	4	ESE 75 (Theory) + ICA 25 (Practical) = 100

Course outcomes:
After the completion of this course the learner will be able to:

- Apply the basic principles and components of gardening
- Conceptualize flower arrangement and bio-aesthetic planning
- Design various types of gardens according to the culture and art of bonsai
- Distinguish between formal, informal and free style gardens
- Establish and maintain special types of gardens for outdoor and indoor landscaping

Keywords:
Gardening, Landscaping, Flower arrangement, Vertical gardens, Roof gardens, Computer aided designing

THEORY

Unit 1: Types of Garden I (9 lectures)
Principles of gardening, garden components, adornments, lawn making, methods of designing rockery, water garden, etc. Special types of gardens, their walk-paths, bridges, constructed features. Greenhouse.

Unit 2: Types of Garden II (9 lectures)
Special types of gardens, trees, their design, values in landscaping, propagation, planting shrubs and herbaceous perennials. Importance, design values, propagation, plating, climbers and creepers, palms, ferns, grasses and cacti succulents.

Unit 3: Bioaesthetics of Gardens (9 lectures)
Flower arrangement: importance, production details and cultural operations, constraints, postharvest practices. Bioaesthetic planning, definition, need, round country planning, urban planning and planting avenues, schools, villages, beautifying railway stations, dam sites, hydroelectric stations, colonies, river banks, planting material for play grounds.

Unit 4: Urban Gardening (9 lectures)
Vertical gardens, roof gardens. Culture of bonsai, art of making bonsai. Parks and public gardens. Landscape designs, Styles of garden, formal, informal and free style gardens, types of gardens, Urban landscaping, Landscaping for specific situations, institutions, industries, residents, hospitals, roadsides, traffic islands, damsites, IT parks, corporate.

Unit 5: Garden Designing (9 lectures)
Establishment and maintenance, special types of gardens, Bio-aesthetic planning, ecotourism, theme parks, indoor gardening, therapeutic gardening, non-plant components, water scaping, xeriscaping, hardscaping; Computer Aided Designing (CAD) for outdoor and indoorscaping Exposure to CAD (Computer Aided Designing).

PRACTICAL **(30 lectures)**

1. Preparation of a water garden.
2. Making of a lawn inside college campus.
3. Making of a kitchen garden college campus.
4. Designing of rockery
5. Prepare beds for growing nursery for herbs, shrubs and trees.
6. Count the number of types of animals, birds, and insects in the garden
7. Identification of pathogenic and non-pathogenic diseases of garden plants and grasses
8. Field trips: Field visit to any Botanical Garden, Identify the trees shrubs and other herbaceous vegetation.

Suggested Readings

1. Berry, F. and Kress, J. (1991). Heliconia: An Identification Guide. Smithsonian Books.
2. Butts, E. and Stensson, K. (2012). Sheridan Nurseries: One hundred years of People, Plans, and Plants. Dundurn Group Ltd.
3. Russell, T. (2012). Nature Guide: Trees: The world in your hands (Nature Guides).

SEMESTER II

MUSHROOM CULTURE TECHNOLOGY

Course code	Credits	Teaching hours per week	Maximum Marks
SEC-2A	3	4	ESE 75 (Theory) + ICA 25 (Practical) = 100

Course outcomes:
On completion of this course, the students will be able to:

- Recall various types and categories of mushrooms.
- Demonstrate various types of mushroom cultivating technologies.
- Examine various types of food technologies associated with mushroom industry.
- Value the economic factors associated with mushroom cultivation
- Device new methods and strategies to contribute to mushroom production.

Keywords:
Edible mushrooms, Poisonous mushrooms, Cultivation technology, Mushroom bed, Mushroom unit, Storage and Nutrition

Unit 1: History of Mushroom Culture (9 lectures)
Mushroom as food. Medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India – *Volvariella volvacea, Pleurotus citrinopileatus, Agaricus bisporus*.

Unit 2: Infrastructure and Inputs (9 lectures)
Mushroom Cultivation: Infrastructure and implements-mushroom sheds, design, conditions, materials- Factors influencing mushroom cultivation.

Unit 3: Stages in Mushroom Production (9 lectures)
Medium preparation, preparation of spawn- quality of good spawn, multiplication. Mushroom bed preparation. Casing; pests, diseases and abnormalities.

Unit 4: Harvest and Storage (9 lectures)
Harvest methods. Storage: Short-term storage (Refrigeration – up to 24 hours). Long term storage, drying, storage in salt solutions. Nutritive values– Proteins, amino acids, mineral elements. Nutrition - Carbohydrates, Crude fibre content - Vitamins.

Unit 5: Mushroom Recipes (9 lectures)
Types of recipes prepared from mushroom. Research Centres- National level and Regional level. Cost benefit analysis - Marketing in India and abroad.

PRACTICAL (30 lectures)
1. Sterilization of paddy straw.
2. Preparation of bed inside the polythene bags and
3. Incubation of bags.
4. Preparation of spawn.
5. Visit to a mushroom culture unit/ industry

Suggested Readings

1. Hirst B. 2015. Mushrooms: A Beginners Guide to Home Cultivation. Create space Independent Publishing Platform. USA.
2. Marimuthu T., Krishnamoorthy A.S., Sivaprakasam K. and Jayarajan R. 1991.Oyster Mushrooms. Department of Plant Pathology, TNAU, Coimbatore.
3. Pandey R.K. and Ghosh S.K. 1998. Hand book on mushroom cultivation. Emkay Publications. Delhi.
4. Swaminathan M.S. 1990. Food and Nutrition. The Bangalore Printing and Publishing Co. Ltd. Bangalore.
6. Tewari and Pankaj Kapoor S.C. 1988. Mushroom cultivation, Mittal Publications. New Delhi.

FERMENTATION TECHNOLOGY

Course code	Credits	Teaching hours per week	Maximum Marks
SEC-2B	3	4	ESE 75 (Theory) + ICA 25 (Practical) = 100

Course outcomes:
After completing this course, the learner will be able to:

- Employ the process for maintenance and preservation of microorganisms
- Analyze the various aspects of the fermentation technology and apply for
- Fermentative production
- Demonstrate proficiency in the experimental techniques for microbial production of
- enzymes: amylase and protease, bio product recover

Key words:
Microbial culture, Fermentation, Metabolites, Fermented products, Enzyme production, Bioproduct recovery

THEORY

Unit 1: Culture media and Sterilization (9 lectures)
Preparation of microbial culture, Preparation and sterilization of fermentation media. Isolation and improvement of industrially important microorganisms.

Unit 2: Culture Maintenance (9 lectures)
Maintenance and preservation of microorganisms, Metabolic regulations and overproduction of metabolites. Kinetics of microbial growth and product formation.

Unit 3: Types of Fermentation (9 lectures)
Scope and opportunities of fermentation technology. Principles of fermentation: Submerged, solid state, batch, fed-batch and continuous culture.

Unit 4: Fermentation Products I (12 lectures)
Fermentative production of vinegar, alcohol (ethanol, wine, beer), acids (citric acid and gluconic acid), amino acids (lysine and glutamic acid) and antibiotics (penicillin and streptomycin).

Unit 5: Fermentation Products II (6 lectures)
Microbial production of enzymes: Amylase and Protease. Bioproduct recovery.

PRACTICAL (30 lectures)
1. Preparation of culture media for microorganisms
2. Sterilization of the glassware and culture media
3. Culture methods of yeast
4. Growth measurement of yeast (Spectrophotometric method)
5. Preparation of wine using grapes
6. Production of organic acids/ antibiotics through fermentation technique
7. Production of amylase/ protease using microbes

Suggested readings

1. Waites M.J. 2008. Industrial Microbiology: An Introduction (7th ed.), Blackwell Science, London, UK.
2. Prescott S.C., Dunn C.G., Reed G. 1982. Prescott & Dunn's Industrial Microbiology (4th ed.), AVI Pub. Co., USA.
3. Reed G. 2004. Prescott & Dunn's industrial microbiology (4th ed.), AVI Pub. Co., USA.
4. JR Casida L.E. 2015. Industrial Microbiology (3rd ed.), New Age International (P) Limited Publishers, New Delhi, India.
5. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. 2001. Industrial Microbiology: An Introduction. 1st Edition, Blackwell Science, London, UK.
6. Pelczar M.J., Chan E.C.S. and Krieg N.R. 2003. Microbiology. 5th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi.

SEMESTER III

BIOFERTILIZER TECHNOLOGY

Course code	Credits	Teaching hours per week	Maximum Marks
SEC-3A	3	4	ESE 75 (Theory) + ICA 25 (Practical) = 100

Course Outcomes:
On the completion of this course the students must be able to:

- Understand the difference between chemical and biofertilizers
- Isolate and cultivate the bacteria and algae for use as biofertilizers
- Isolate and cultivate the fungi to use as biofertilizers
- Would be able to set up an organic farm

Key words:
N2 fixation, Manures, Biofertilizers, *Azotobacter, Rhizobium*, Symbiosis, *Azospirillum, Azolla, Anabaena azollae*, VAM, Biocompost, Green manure, Panchakavya, Biopesticide

THEORY

Unit 1: Manures and Biofertilizers (9 lectures)
Need for fertilizers, manures. Manure composition. Manures for crop productivity. Differences between fertilizers and biofertilizers: pH changes and water contamination.

Unit 2: Bacterial Biofertilizers (9 lectures)
General account on the microbes used as biofertilizer. *Azotobacter*: classification, characteristics– crop response to *Azotobacter* inoculum, maintenance and mass multiplication. *Rhizobium* – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.

Unit 3: Algal Biofertilizers (9 lectures)
Azospirillum: isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms. *Azolla* and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, *Azolla* in rice cultivation.

Unit 4: Fungal Biofertilizers (9 lectures)
Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield, colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

Unit 5: Organic Farming (9 lectures)
Organic farming – Green manuring and organic fertilizers, Recycling of bio-degradable municipal, agricultural and industrial wastes, Biocompost making- types, method of vermicomposting, Panchakavya. Biological pest control (neem)

PRACTICAL (30 lectures)
1. Isolation and culture of *Rhizobium* and Algae.
2. Anatomy of *Azolla* leaf and identification of *Anabaena azollae.*
3. Mass cultivation of *Azolla*.
4. Isolation and culture of VAM.

5. Compost preparation- green manure, vermicompost.

Suggested Readings

1. Dubey R.C. 2005. A Text book of Biotechnology. S.Chand & Co. New Delhi.
2. Kumaresan V. 2005. Biotechnology. Saras Publications. New Delhi.
3. John Jothi Prakash E. 2004. Outlines of Plant Biotechnology. Emkay Publication. New Delhi.
4. Sathe T.V. 2004. Vermiculture and Organic Farming. Daya Publishers. New Delhi.
5. Subha Rao N.S. 2000. Soil Microbiology, Oxford & IBH Publishers. New Delhi.
6. Vayas S.C, Vayas S. and Modi H.A. 1998.Bio-fertilizers and organic Farming Akta Prakashan. Nadiad.

FLORICULTURE

Course code	Credits	Teaching hours per week	Maximum Marks
SEC-3B	3	4	ESE 75 (Theory) + ICA 25 (Practical) = 100

Course outcomes:
After completing this course the learner will be able to;

- Develop conceptual understanding of gardening from historical perspective
- Analyze various nursery management practices with routine garden operations.
- Distinguish among the various Ornamental Plants and their cultivation
- Evaluate garden designs of different countries
- Appraise the landscaping of public and commercial places for floriculture.
- Diagnoses the various diseases and uses of pests for ornamental plants.

Key words:
Gardening, Transplanting, Mulching, Plant growth regulators, Ornamental plants, Commercial floriculture

THEORY

Unit 1: Introduction to Floriculture (9 lectures)
History of gardening; Importance and scope of floriculture and landscape gardening. Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators.

Unit 2: Ornamental Plants (9 lectures)
Flowering annuals; Herbaceous perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and fern allies; Cultivation of plants in pots; Indoor gardening; Bonsai.

Unit 3: Principles of Garden Designs (11 lectures)
English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden. Some Famous gardens of India.

Unit 4: Landscaping Places of Public Importance (6 lectures)
Landscaping highways and Educational institutions.

Unit 5: Factors Affecting Floriculture (10 lectures)
Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolus, Marigold, Rose, Lilium, Orchids). Diseases and Pests of Ornamental Plants.

PRACTICAL (30 lectures)
1. Floriculture in the college campus.
2. Making of flower garden on the terrace.

3. Pruning of plants.
4. Study of effect of growth regulators:
    i. Auxin (IAA, IBA),
    ii. Cytokinins (BAP, Kinetin)
    iii. Gibberellins on plant growth.

Suggested Readings

1. Randhawa, G.S. and Mukhopadhyay, A. (1986). Floriculture in India. Allied Publishers.
2. Adams, C., M. Early and J. Brrok (2011). Principles of Horticulture. Routledge, U.K.

VALUE ADDED COURSES

SEMESTER I

ENVIRONMENTAL STUDIES

Course code	Credits	Teaching hours per week	Maximum Marks
VAC-1	2	4	ESE 75 + ICA 25 = 100

Course outcomes:
After completing this course, the students would be able:

- To understand different kinds of natural resources
- Types of ecosystems and the energy flow
- Distribution of plants with respect to geography and their conservation
- Various kinds of pollution and controlling measures
- The act which protects the environment

Key words:
EPA, renewable resource, non-renewable resources, ecosystems, pollution, conservation

Unit 1: Multidisciplinary nature of environmental studies (12 lectures)
1. Definition, scope and importance; Need for public awareness.
2. Environmental ethics: Issues and possible solutions
3. Environment Protection Act.

Unit 2: Natural Resources, Renewable and Non-renewable Resources (12 lectures)
1. Forest resources: Use and over-exploitation, deforestation, Timber extraction.
2. Water resources: Use and over-utilization of surface and ground water, floods, drought, dams-benefits and problems.
3. Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture,
4. Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources.
5. Land resources: Land as a resource, land degradation, soil erosion and desertification.

Unit 3: Ecosystems (12 lectures)
1. Concept of an ecosystem.
2. Structure and function of an ecosystem.
3. Energy flow in the ecosystem.
4. Food chains, food webs and ecological pyramids.
5. Characteristic features, structure and function of
a. Forest ecosystem
b. Grassland ecosystem
c. Desert ecosystem
d. Aquatic ecosystems

Unit 4: Biodiversity and its conservation (12 lectures)

1. Introduction – Definition: genetic, species and ecosystem diversity.
2. Biogeographical classification of India, India as a mega-diversity nation
3. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic values.
4. Hot-spots of biodiversity.
5. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.
6. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Unit 5: Environmental Pollution (12 lectures)

1. Definition, cause, effects and control measures of:
    a. Air pollution
    b. Water pollution
    c. Soil pollution
    e. Noise pollution
    f. Thermal pollution
    g. Nuclear hazards
2. Solid waste management: Causes, effects and control measures of urban and industrial wastes.
3. Disaster management: floods, earthquake, cyclone and landslides.

Suggested Readings:

1. Odum, E. P., Barrett G., W., 2011, Fundamentals of Ecology, 5ed., Cengage Learning. ISBN-13: 978-8131500200
2.Sharma, P. D., 2011. Ecology and Environment, Rastogi Publications. ISBN-13: 978-8171339655

UNDERSTANDING INDIA

Course code	Credits	Teaching hours per week	Maximum Marks
VAC-2	2	4	ESE 75 + ICA 25 = 100

Course Overview:
The course aims at enabling the students to acquire and demonstrate the knowledge and understanding of contemporary India with its historical perspective, the basic framework of the goals and policies of national development, and the constitutional obligations with special emphasis on constitutional values and fundamental rights and duties.
The course would also focus on developing an understanding among students of Indian society, Indian knowledge systems and cultural heritage.

Course Objective and Outcome:
The course aims at making the students understand India from global, national and local perspectives. A student would be able to understand India in geographical, historical, social, cultural and political settings. At the end of the semester, the students will be able to appreciate the multicultural and multifaceted nature of India.

Key words:
Geography, freedom struggle, caste, community, class, gender, Indian polity

Unit 1: Geography of India (12 lectures)
- India on the map of the world and its neighbouring countries
- Geographical diversities

Unit 2: History of India (12 lectures)
- India's Freedom Struggle
- An introduction to Indian knowledge systems

Unit 3: Communicating Culture (12 lectures)
- Oral narratives: Myths, tales and folklore
- Introduction to the Tribal Cultures of India

Unit 4: Indian Social Structure (12 lectures)
- Continuity and change of the Indian Social Structure: Caste, Community, Class and Gender

Unit 5 Understanding Indian Polity (12 lectures)
- The evolution of State in India: Nature and origin
- Interpreting India: Traditional, Modern and Contemporary
- Constitution as a living document

Suggested Readings:
Unit 1: Geography of India
Ramesh Dutta Dikshit, *Political Geography: Politics of Place and Spatiality of Politics,* Macmillan Education,2020.
Deshpande C. D., 1992: India: A Regional Interpretation, ICSSR, New Delhi.
Johnson, B. L. C., ed. 2001. Geographical Dictionary of India. Vision Books, New Delhi.

Mandal R. B. (ed.), 1990: Patterns of Regional Geography – An International Perspective. Vol. 3 – Indian Perspective.
Tirtha, Ranjit 2002: Geography of India, Rawat Publs., Jaipur & New Delhi.
Pathak, C. R. 2003: Spatial Structure and Processes of Development in India. RegionalScience Assoc., Kolkata.
Tiwari, R.C. (2007) Geography of India. Prayag Pustak Bhawan, Allahabad 12.
Sharma,T.C. (2013) Economic Geography of India. Rawat Publication, Jaipur

Unit 2: History of India

https://iksindia.org
Bose D. M., S. N. Sen and B. V. Subbarayappa ed. (1971) *A Concise History of Sciencein India*, Indian National Science Academy, New Delhi.
Chandra, Bipan, Amales Tripathi & Barun De (1972), *Freedom Struggle*, National BookTrust, New Delhi.
Husain, S. Abid. (2003). *The National Culture of India*, National Book Trust, New Delhi.
Kapoor, Kapil and Avadesh Kumar Singh ed. (2005), *Indian Knowledge Systems*, 2Volumes, DK Printworld, New Delhi.
Mohanta, Basant Kumar and Vipin Kumar Singh ed. (2012), Traditional *KnowledgeSystem and Technology in India*, Pratibha Prakashan
History of Technology in India, 3 Volumes (1997-2012), Indian National ScienceAcademy, New Delhi.
The Cultural Heritage of India Series, 8 Volumes (2002), Ramakrishna Mission Institute,Calcutta.

Unit 3: Communicating Culture: Tellings, Representations, and Leisure

Kanak Mital, “A Santhal Myth, Five Elements” & M.D. Subash Chandran, “PeasantPerception of Bhutas, Uttara Kannada” in Prakrti, The Integral Vision, Vol. 1 (PrimalElements – The Oral Tradition, edited by Baidyanath Saraswati), pp. 119-125; 151-166.
A. K. Ramanujan, “‘A Flowering Tree’: A Woman’s Tale”, Oral Tradition, 12/1 (1997):226-243.
Stuart H. Blackburn, “The Folk Hero and Class Interests in Tamil Heroic Ballads”, AsianFolklore Studies, Vol. 37, No. 1 (1978), pp. 131-149.
Beatrix Hauser, “From Oral Tradition to "Folk Art": Reevaluating Bengali Scroll Paintings”, in Asian Folklore Studies, Vol. 61, No. 1 (2002), pp. 105-122.
Komal Kothari, “Myths, Tales and Folklore: Exploring the Substratum of Cinema” pdf.

Unit 4: Indian Social Structure

Singh, Y. (1968). Caste and Class: Some Aspects of Continuity and Change. Sociological Bulletin, 17(2), 165–186. ttps://doi.org/10.1177/0038022919680205
Singh, Y. (1986). Modernization of Indian Tradition: A Systemic Study of SocialChange. India: Rawat Publications.
Gupta, D. (2000). Interrogating caste: understanding hierarchy and difference in Indiansociety. India: Penguin Books.
Rege, S. (1996). Caste and Gender: The Violence Against Women in India. Italy:European University Institute.
Xaxa, V. (2008). State, Society, and Tribes: Issues in Post-colonial India. India: DorlingKindersley (India), licencees of Pearson Education in South Asia.
Uberoi, P. (1994). Family, Kinship and Marriage in India. India: Oxford University Press.
Robinson, R. (2004). Sociology of Religion in India. India: SAGE Publications.
Srinivas, M. N. (2000). Caste: Its 20Th Century Avatar. India: Penguin Books Limited.
Jamil, G. (2021). Women in Social Change. SAGE Publishing India.

Bhasin, K. (2000). Understanding Gender.

Unit 5: Understanding Indian Polity

Madhav Khosla. *The Indian Constitution*. New Delhi, Oxford University Press, 2012.
Ramachandra Guha. *Makers of Modern India*. Cambridge, Mass., The Belknap Press of Harvard University Press, 2013.
Thapar, Romila. *Indian Cultures as Heritage: Contemporary Pasts*. London, Seagull Books, 2021.
Venkataraghavan Subha Srinivasan. *The Origin Story of India's States*. Penguin Random House India Private Limited, 25 Oct. 2021.
J Sai Deepak. *India That Is Bharat: Coloniality, Civilisation, Constitution*. New Delhi, Bloomsbury, 2021.

SEMESTER II

HEALTH & WELLNESS, YOGA EDUCATION, SPORTS AND FITNESS

Course code	Credits	Teaching hours per week	Maximum Marks
VAC-3	2	4	ESE 75 + ICA 25 = 100

Course outcomes:

- Describing Health & Wellness programs and services offered, how to access them, and their value to their well-being.
- Learn that principles of nutrition are all important parts of overall wellness.
- To learn the basic concept of wellbeing.
- Demonstrate how to get healthy and stay healthy using multiple strategies.
- Identify healthy behaviors and practices that help to avoid and reduce health risks.
- Yoga education to practice mental hygiene.
- Yoga education to integrate moral values
- Yoga education to possess emotional stability.
- Learn the physical fitness management.

Key words:
Health, Wellness, Diet, Nutrition, Drugs, Exercise, Yoga

Unit 1: Health & Wellness (12 lectures)

Define and differentiate health and wellness - Components of health wellness and their relationship between physical activity-Local, demographic, societal issues and factors affecting health and wellness.

Diet and nutrition for health & wellness - Essential components of balanced diet for healthy living with specific reference to the role of carbohydrates, proteins, fats, vitamins &minerals

-malnutrition, under nutrition and over nutrition.

Unit 2: Management of Health and Wellness (12 lectures)

Meaning & importance of various dimensions of wellness. Relationship of physical fitness in achieving wellness. Drugs, doping and wellness. Role of diet and exercise in health management.

Unit 3: Yoga Education 12 lectures)

Meaning and definition of yoga and its aims and objectives - Basic principles of yoga and its importance in our daily life-Yoga for mental attitude-Mind, body, breath and emotional level for higher plan of living.

Unit 4: Yoga Practices (12 lectures)

Types and limbs of yoga - Yoga postures—Asana - Breathing Practices—Pranayama - Relaxation-Meditation - Mudra.

Unit 5: Fitness Activities (12 lectures)

Types of fitness activities-Out door activities—Basic movement patterns. Indoor activity Aerobics 'Dance Fitness, Resistance Training for fitness.

Suggested Readings:

1. Physical Activity and Health by Claude Bouchard, Steven N.Blair, William L. Haskell.2.MentalHealthWorkbookbyEmilyAttached&MarziaFernandez,2021.
2. Mental Health Workbook for Women: Exercises to Transform Negative Thoughts and Improve Well Being by Nashay Lorick, 2022
3. Lifestyle Diseases: Lifestyle Disease Management, by C.Nyambichu & JeffLumiri, 2018.
4. PhysicalActivityandMentalHealthbyAngelaClow&SarahEdmunds,2013.
5. The Fitness Mindset by Brian Keane
6. Health Promotion: Mobilizing Strengths to Enhance Health, Wellness, and We11-being [1 ed.] F.A. Davis Company.
7. Yoga RX: A Step-by-Step Program to Promote Health, Wellness, and Healing for Common Ailments, Broadway.
8. Advanced Hatha Yoga: Classic Methods of Physical Education and Concentration [1 ed.], Inner Traditions.
9. Yoga and Physical Education, National Council of Educational Research and Training (NCERT), India.
10. Wealth First: Winning at Weight Loss and Wellness.
11. Administration of Health and Physical Education Programme. Bucher, Charles A.
12. Treaties of Hygiene and Public Health, Ghosh,B.N.
13. Principles of Public Health Administration. 2003, Hanlon, JohnJ.
14. The School Health and Health Education, Turner,C.E.
15. Health Education (National Education Association of U.T.A.), Mosset.al.
16. The School Health Education (Harber and Brothers, NewYork), NemirA.
17. Nutrition Encyclopedia, edited by Delores C.S.James, The Gale Group, Inc.
18. The Stone Age Health Programme: Diet and Exercise as Nature Intended. Angus and Robertson, Boyd-Eaton S. et al (1989)
19. Stress, How Your Diet can Help: The Practical Guide to Positive Health Using Diet, Vitamins, Minerals, Herbs and Amino Acids, Thorons, Terras S. (1994).

DIGITAL AND TECHNOLOGICAL SOLUTIONS

Course code	Credits	Teaching hours per week	Maximum Marks
VAC-4	2	4	ESE 75 + ICA 25 = 100

Course outcomes:
Learn about digital paradigm
Understand the importance of digital technology, digital financial tools, e-commerce
Analyses the concepts of communication and networks
Understand the e-governance and digital India initiatives
Learn the applications of machine learning and big data

Key words:
ICT, software, algorithms, PoS, NEFT, RTGS, IMPS, Cloud computing, Robotics

Unit 1: (12 lectures)
Introduction & Evolution of Digital Systems. Role & Significance of Digital Technology. Information & Communication Technology & Tools. Computer System & its working. Software and its types, Operating Systems. Types and Functions. Problem Solving: Algorithms and Flowcharts.

Unit 2: (12 lectures)
Communication Systems: Principles, Model & Transmission Media. Computer Networks & Internet: Concepts & Applications, WWW, Web Browsers, Search Engines, Messaging, Email, Social Networking. Computer Based Information System: Significance & Types. E-commerce & Digital Marketing: Basic Concepts, Benefits & Challenges.

Unit 3: (12 lectures)
Digital India & e-Governance: Initiatives, Infrastructure, Services and Empowerment. Digital Financial Tools: Unified Payment Interface, Aadhar Enabled Payment System, USSD, Credit/ Debit Cards, e-Wallets, Internet Banking, NEFT/RTGS and IMPS, Online Bill Payments and PoS. Cyber Security: Threats, Significance, Challenges, Precautions, Safety Measures, & Tools, legal and ethical perspectives.

Unit 4: (12 lectures)
Emerging Technologies & their applications: Overview of Cloud Computing, Big Data, Internet of Things, Virtual Reality.

Unit 5: (12 lectures)
Emerging Technologies & their applications: Blockchain & Cryptocurrency, Robotics, Machine Learning & Artificial Intelligence, 3D Printing. Digital Signatures.

Practical Component
1. Operating System Installation and configuration
2. Application Software Installation and configuration
3. Hardware understanding and minor troubleshooting
4. Networking, cabling, configuration

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(NEP SYLLABUS)
(Effective from the academic year 2023-2024)

Course Code:
Time: 3 hrs **Maximum Marks: 75**

Section- A
Answer ALL the questions.
Each answer should not exceed 15 words. (10 x 1 = 10 marks)
1. Unit I
2. Unit I
3. Unit II
4. Unit II
5. Unit III
6. Unit III
7. Unit IV
8. Unit IV
9. Unit V
10. Unit V

Section- B
Answer any FIVE questions.
Each answer should not exceed 200 words. (5 x 5 = 25 marks)
11. Unit I
12. Unit II
13. Unit III
14. Unit IV
15. Unit V
16. Any unit
17. Any unit

Section- C
Answer any FOUR questions.
Each answer should not exceed 600 words. (4 x 10 = 40 marks)
18. Unit I
19. Unit II
20. Unit III
21. Unit IV
22. Unit V

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Semester I

ALGOLOGY, MYCOLOGY AND LICHENOLOGY

Practical Question Paper

Course Code: MJD-1

Time: 3 hrs **Maximum Marks: 25**

1. Make suitable micropreparation of **A**. Leave the slide for valuation. Identify with reasons.
(Preparation-2, Identification-1, Diagram-2, Reasons-2 marks) (7 marks)

2. Make suitable micropreparation of **B**. Leave the slide for valuation. Identify with reasons.
(Preparation-2, Identification-1, Diagram-2, Reasons-2 marks) (7 marks)

3. Draw labeled sketches and identify giving reasons **C, D,** & **E**.
(Identification-1, Diagram-1, Reasons-2 marks) (3 x 04 = 12 marks)

3. Identify **F** giving reasons.
(Identification-1, Diagram-1, Reasons-2 marks) (1 x 04 = 04 marks)

For Practical = 30 marks
Record Marks = 10 marks

Total = 40 marks

Normalized to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Plant group	Section/ spotter	Name/ part of the plant
A	Algae	Section	
B	Fungi	Section	
C	Algae	Spotter	
D	Algae/ Fungi	Spotter	
E	Fungi	Spotter	
F	Lichen	Spotter	

INTRODUCTION TO BOTANY I
(Bacteria, Algae, Fungi, Archegoniatae, Angiosperms and Economic Botany)

Practical Question Paper

Course Code: MID-1A
Time: 3 hrs **Maximum Marks: 25**

1. Make suitable micropreparation of the given specimen **A**. Leave the slide for valuation. Identify with reasons.
(Preparation- 2, Identification – 1, Diagram– 2, Reasons – 2 marks) (07 marks)
2. Assign the given specimen **B** to its family. Describe in technical terms and draw diagrams.
(Family – 1, Technical description – 2, Diagram – 2 marks) (05 marks)
3. Identify, draw and write notes on **C, D & E**.
(Identification – 1, Diagram – 1, Notes – 2 marks) (3x04 = 12 marks)
4. Identify the binomial, family, morphology of the useful part and its uses of the given specimen **F** & **G.**
(Binomial – 1, Family – 1, Uses- 1 marks) (2x03= 6 marks)

For Practical = 30 marks
Record Marks = 10 marks

Total = 40 marks

Normalized to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Plant group	Section/ spotter	Name/ part of the plant
A	Bryophyte/ Pteridophyte/ Gymnosperm	Section	
B	Angiosperms	Specimen	
C	Bacteria	Spotter	
D	Algae	Spotter	
E	Archegoniatae	Spotter	
F	Economic Botany	Specimen	
G	Economic Botany	Specimen	

PLANTS IN TRADITIONAL SYSTEMS OF MEDICINE

Practical Question Paper

Course Code: MID-1B
Time: 3 hrs **Maximum Marks: 25**

1. Make suitable micropreparation of the given specimen **A**. Leave the slide for valuation. Identify with reasons.
(Preparation-2, Identification-1, Diagram-1, Reasons-1 marks) (05 marks)
2. Make suitable micropreparation of the given specimen **B**. Leave the slide for valuation. Identify with reasons.
(Preparation-2, Identification-1, Diagram-1, Reasons-1 marks) (05 marks)
3. Identify, draw and write critical notes on ethnobotanical uses of given specimen **C** &**D**.
(Identificaion-1, Diagram -1, Notes-2 marks) (2x04= 08 marks)
4. Write the family, botanical name, common name and uses of the given specimen **E** & **F**.
(Family- 1, Botanical name- 1, Common name- 1, Uses- 1 marks) (2x04= 08 marks)

For Practical = 26 marks
Record Marks = 10 marks
Herbarium = 04 marks

Total = 40 marks

Normalize to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Section/ spotter	Name/ part of the plant
A	Micropreparation	
B	Micropreparation	
C	Specimen/ Photographs	
D	Specimen/ Photographs	
E	Specimen/ Photographs	
F	Specimen/ Photographs	

ALGAL CULTURE TECHNOLOGY

Practical Question Paper

Course Code: SEC-1A
Time: 3 hrs **Maximum Marks: 25**

1. Prepare the algal culture medium, **A**. Write the procedure and draw diagram.
(Preparation-3, List of materials-1, Procedure-2, Diagram-1, Inference-1 marks) (08 marks)

2. Identify the microalgae present in the given sample, **B**.
(Preparation-2, Identification-2, Diagram-1, Notes-2 marks) (07 marks)

3. Identify, draw the diagrams and write the critical notes on, **C, D** & **E**.
(Identification-1, Diagram-2, Notes-2 marks) (03x05= 15 marks)

For Practical = 26 marks
Record Marks = 10 marks
Herbarium = 04 marks

Total = 40 marks

Normalize to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Section/ spotter	Name/ part of the plant
A	Preparation	
B	Preparation	
C	Specimen/ Photographs	
D	Specimen/ Photographs	
E	Specimen/ Photographs	

BOTANICAL GARDEN AND LANDSCAPING

Practical Question Paper

Course Code: SEC-1B
Time: 3 hrs **Maximum Marks: 25**

1. Write the procedure for the construction of a lawn, **A**.
(List of materials- 1, Procedure- 3, Diagrams-2, Inference-1 marks) (07 marks)
2. Prepare the bed for growing herbs/ shrubs/ trees, **B**.
(Preparation- 3, List of materials- 1, Procedure- 3, Diagrams-1, Inference-1 marks) (09 marks)
3. Identify, draw diagrams and write notes on the following, **C, D** & **E**.
(Identification- 1, Diagrams-1, Notes-2 marks) (03x04=12 marks)
4. Identify the type of disease in the given plant sample **F**.
(Identification- 1, Notes-1 marks) (02 marks)

For Practical = 26 marks
Record Marks = 10 marks
Herbarium = 04 marks

Total = 40 marks

Normalize to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Section/ spotter	Name/ part of the plant
A	Preparation	
B	Preparation	
C	Specimen/ Photographs	
D	Specimen/ Photographs	
E	Specimen/ Photographs	
F	Specimen/ Photographs	Viral/ Bacterial/ Fungal disease

SEMESTER II

BRYOLOGY AND PTERIDOLOGY

Practical Question Paper

Course Code: MJD-2
Time: 3 hrs **Maximum Marks: 25**

1. Make suitable micropreparations of **A** & **B**. Leave the slide for valuation. Identify with reasons.
(Preparation-2, Identification-1, Diagram- 1, Reasons-1 marks) (2 x05 = 10 marks)
2. Make suitable micropreparation of **C**. Leave the slide for valuation. Identify with reasons.
(Preparation-2, Identification-1, Diagram- 1, Reasons-1 marks) (2 x05 = 05 marks)
3. Draw labelled sketches and identify giving reasons **D.**
(Identification-1, Diagram-1, Reasons-2 marks) (1 x04 = 04 marks)
4. Identify **E** giving reasons.
(Identification-1, Diagram-1, Reasons-2 marks) (1 x04 = 04 marks)
5. Write critical notes on **F** & **G**. (2 x03 = 06 marks)
6. Write the Binomial of the given plant specimen **H**. (01 mark)

For Practical = 30 marks
Record Marks = 10 marks

Total = 40 marks

Normalized to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Plant group	Section/ spotter	Name/ part of the plant
A	Bryophyte	Section	
B	Pteridophyte	Section	
C	Bryophyte/ Pteridophyte	Section	
D	Bryophyte	Spotter	
E	Pteridophyte	Spotter	
F	Bryophyte	Spotter	
G	Pteridophyte	Spotter	
H	H Bryophyte/ Pteridophyte	Spotter	

INTRODUCTION TO BOTANY II
(Cytology, Anatomy, Physiology, Microbiology and Plant Ecology)

Practical Question Paper

Course Code: MID-2A
Time: 3 hrs **Maximum Marks: 25**

1. Make suitable micropreparation of the given specimen, **A**. Leave the slide for valuation. Identify with reasons.
(Preparation- 2, Identification – 1, Diagram– 1, Reasons – 1 marks) (05 marks)
2. Make suitable micropreparation of the given specimen, **B**. Leave the slide for valuation. Identify with reasons.
(Preparation- 2, Identification – 1, Diagram– 1, Reasons – 1 marks) (05 marks)
3. Identify, draw and write notes on, **C** & **D**.
(Identification – 1, Diagram – 1, Notes – 2 marks) (2x04 = 08 marks)
4. Comment on the physiological importance of **E**.
(Notes – 2, Diagram – 2 marks) (04 marks)
5. Comment on the microbiological importance of **F**.
(Notes – 2, Diagram – 2 marks) (04 marks)
6. Comment on the ecological importance of **G**.
(Notes – 2, Diagram – 2 marks) (04 marks)

For Practical = 30 marks
Record Marks = 10 marks

Total = 40 marks

Normalized to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Plant group	Section/ spotter	Name/ part of the plant
A	Anatomy of Dicots	Section	
B	Anatomy of Monocots	Section	
C	Cell Biology	Section	
D	Physiology	Spotter	
E	Physiology	Spotter	
F	Microbiology	Spotter	
G	Ecology	Spotter	

HERBAL TECHNOLOGY

Practical Question Paper

Course Code: MID-2B
Time: 3 hrs **Maximum Marks: 25**

1. Make suitable micropreparation of the given specimen **A**. Leave the slide for valuation. Identify with reasons.
(Preparation- 2, Identification – 1, Diagram– 1, Reasons – 1 marks) (1x05 = 05 marks)

2. Make suitable micropreparation and localize the phytochmemicals of the given specimen **B**. Leave the slide for valuation. Identify with reasons.
(Preparation- 2, Identification – 1, Diagram– 1, Reasons – 1 marks) (1x05 = 05 marks)

3. Identify, draw and write notes on **C** &**D**.
(Identification – 1, Diagram – 1, Notes – 2 marks) (2x04 = 08 marks)

4. Draw the diagram and comment on the medicinal importance of **E**.
(Notes – 2, Diagram – 2 marks) (1x04 = 04 marks)

5. Write the systematic position of the given medicinal plant **F**. (1x04 = 04 marks)

6. List the active principles present in the given plant specimen **G**. (1x04 = 04 marks)

For Practical = 30 marks
Record Marks = 10 marks

Total = 40 marks

Normalized to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Section/ spotter	Name/ part of the plant
A	Section	
B	Section	
C	Spotter	
D	Spotter	
E	Spotter	
F	Spotter	
G	Spotter	

MUSHROOM CULTURE TECHNOLOGY

Practical Question Paper

Course Code: SEC-2A
Time: 3 hrs **Maximum Marks: 25**

1. Write the procedure and prepare the bed with the given material, **A** inside the polythene bags for mushroom culture.
(Preparation-3, Diagram-1, Procedure-3, Reasons-2 marks) (09 marks)
2. Prepare spawn of the given mushroom, **B** and write the procedure.
(Preparation-3, Diagram-1, Procedure-3, Reasons-2 marks) (09 marks)
3. Identify, draw and write critical notes on the given specimen, **C, D** & **E**.
(Identificaiton-1, Diagram-1, Notes-2 marks) (03x04= 12 marks)

For Practical = 30 marks
Record Marks = 10 marks

Total = 40 marks

Normalized to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Section/ spotter	Name/ part of the plant
A	Preparation	
B	Preparation	
C	Spotter	
D	Spotter	
E	Spotter	

FERMENTATION TECHNOLOGY

Practical Question Paper

Course Code: SEC-2B
Time: 3 hrs **Maximum Marks: 25**

1. Prepare the culture medium the growth of yeast, **A**.
(Preparation-2, List of materials-1, Procedure-2, Diagram-1, Inference-1 marks) (07 marks)
2. Prepare the set up for the production of wine using the given materials, **B**.
(Preparation-3, List of materials-1, Procedure-2, Diagram-1, Inference-1 marks) (08 marks)
3. Measure the OD (optical density) value of the given microbial culture using Spectrophotometer and identify the growth phase of it, **C**.
(List of materials-1, Procedure-2, Graph-1, Result-1 marks) (05 marks)
4. Identify, draw diagram and write notes on, **D** & **E**.
(Identification-1, Diagram-1, Notes- 3) (02x05= 10 marks)

For Practical = 30 marks
Record Marks = 10 marks

Total = 40 marks

Normalized to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Section/ spotter	Name
A	Preparation	
B	Preparation	
C	Experiment	
D	Spotter/ Photograph	
E	Spotter/ Photograph	

SEMESTER III

GYMNOSPERMS AND PALAEOBOTANY

Practical Question Paper

Course Code: MJD-3

Time: 3 hrs **Maximum Marks: 25**

1. Make suitable micropreparation of specimen **A** and **B**. Leave the slide for valuation. Identify with reasons and diagrams.
(Preparation-2, Identification-1, Diagram-1, Reasons-2 marks) (2x06=12 marks)
2. Make suitable micropreparation of specimen **C**. Leave the slide for valuation. Identify with reasons and diagrams.
(Preparation-2, Identification-1, Diagram-1, Reasons-2 marks) (06 marks)
3. Write critical notes on **D**, **E** & **F**, with diagram.
(Identification-1, Diagram-1, Reasons-2 marks) (3x04=12 marks)

For Practical = 30 marks
Record Marks = 10 marks

Total = 40 marks

Normalized to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	**Micropreparation / Spotter**	**Name**
A=Gymnosperm	Micropreparation	
B=Gymnosperm	Micropreparation	
C=Gymnosperm	Micropreparation	
D=Palaeobotany	Spotter / Specimen	
E=Palaeobotany	Spotter / Specimen	
F=Palaeobotany	Spotter / Specimen	

EXTERNAL MORPHOLOGY AND TAXONOMY OF ANGIOSPERMS

Practical Question Paper

Course Code: MJD-4

Time: 3 hrs **Maximum Marks: 25**

1. Describe the given specimen, **A** in technical terms. Draw L.S. and Floral Diagram of the flower. Write the Floral Formula. Assign to its Family giving reasons.
(Identification-1, Description-2, Flower L.S-1, Floral Diagram-1, Reasons-1 marks)
(06 marks)
2. Identify the given specimen, **B** to its family giving reasons. Write its Taxonomic hierarchy.
(Identification-1, Reasons-2, Taxonomic hierarchy-2 marks)
(05 marks)
3. Identify the morphology of the given plant parts **C, D** & **E**. Draw the diagram and write the definition.
(Identification -1, Diagram -1, Definition -1 marks) (03x03= 09 marks)
4. Identify, **F** and give reasons with labeled diagrams.
(Identification-1, Diagram-1, Reasons-2 marks) (04 marks)

For Practical = 25 marks
Record Marks = 10 marks
Herbarium = 5 marks

Total = 40 marks

Normalized to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Specimen/ Spotter	Name of the plant/ part
A= Taxonomy	Specimen	
B= Taxonomy	Specimen	
C= External morphology	Specimen	
D= External morphology	Spotter / Specimen	
E= External morphology	Spotter / Specimen	
F= Taxonomy	Spotter / Specimen	

PHYTOCHEMISTRY

Practical Question Paper

Course Code: MID-3B

Time: 3 hrs **Maximum Marks: 25**

1.Extract the phytochemicals by solvent extraction/ distillation methods/ pressing and sublimation methods from given material, **A**.
(Preparation-2, List of materials-1, Procedure-2, Diagram-1, Result-1 marks) (07 marks)
2. Perform the qualitative test for, **B**. Write the procedure.
(Preparation-2, List of materials-1, Procedure-2, Diagram-1, Result-1 marks) (07 marks)
3. Separate the given substance, **C** by TLC/ Paper chromatography method. Write the procedure. (Preparation-3, Procedure-3, List of materials-1, Diagram-2, Results-1marks) (07 marks)
4. Identify, draw and write notes on **D, E,** & **F**.
(Identificaiton-1, Diagram-1, Notes-1 marks) (03x03 = 09 marks)

For Practical = 25 marks
Record Marks = 10 marks
Herbarium = 5 marks

Total = 40 marks

Normalized to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Experiment / Spotter	Name
A	Experiment	
B	Experiment	
C	Experiment	
D	Spotter	
E	Spotter	
F	Spotter	
G	Spotter	

BIO-FERTILIZER TECHNOLOGY

Course Code: SEC-3A

Time: 3 hrs **Maximum Marks: 25**

1.Write the procedure and isolate *Rhizobium* from the given material, **A**.
(Preparation-2, Identification- 1, Diagram-2, Procedure-2, Reasons-1 marks) (08 marks)
2. Make suitable micropreparation of the given specimen, **B**. Leave the slide for valuation. Identify with reasons.
(Preparation-2, Identification-1, Diagram-2, Reasons-2 marks) (1x07= 07 marks)
3. Identify, draw and write critical notes on the given specimen, **C, D & E**.
(Identificaiton-1, Diagram-2, Notes-2 marks) (3x05= 15 marks)

For Practical = 25 marks
Record Marks = 10 marks
Herbarium = 5 marks

Total = 40 marks

Normalized to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Preparation / Spotter	Name
A	Preparation	
B	Preparation	
C	Spotter/ Photograph	
D	Spotter/ Photograph	
E	Spotter/ Photograph	

FLORICULTURE

Course Code: SEC-3B

Time: 3 hrs **Maximum Marks: 25**

1. Demonstrate pruning of the given plant specimen **A**. Draw diagram and write the procedure.

(09 marks)

2. Outline the procedure for inoculation of the given experiment, **B**. List the materials required. Set up the experiment and draw. Tabulate the data recorded. Report the results and leave the setup for valuation.
(Set up-2, Procedure-2, List of materials-1, Sketch/Graph-1, Tabulation-2 and Results-1 marks)

(09 marks)

3. Identify, draw and write notes on **C, D** & **E**.
(Identification- 1, Diagram-1, Notes-2 marks) (3 x 04= 12 marks)

For Practical = 25 marks
Record Marks = 10 marks
Herbarium = 5 marks

Total = 40 marks

Normalized to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Preparation / Spotter	Name
A	Experiment	
B	Experiment	
C	Spotter/ Photograph	
D	Spotter/ Photograph	
E	Spotter/ Photograph	

SEMESTER IV

ANATOMY OF ANGIOSPERMS AND EMBRYOLOGY &

CELL BIOLOGY AND EVOLUTION

Practical Question Paper

Course Code: MJD-7

Time: 3 hrs **(ICA= 25 marks + ESE= 75 marks = 100 marks)**

1. Make suitable micropreparations of **A** & **B**. Leave the slide for valuation. Identify with reasons. (Preparation-3, Identification-1, Diagram-2, Reasons-2 marks)
(2x08=16 marks)
2. Prepare squash/ smear of the material, **C**. Identify any two stages giving reasons.
Leave the slide for valuation.
(Preparation-3, Identification - 2, Diagram-1, Reasons-2 marks) (08 marks)
3. Make suitable micropreparations of leaf peel of **D**. Draw and give reasons. Leave the slide for valuation.
(Preparation-2, Diagram- 1, Reasons - 2 marks) (06 marks)
4. Dissect and mount the Embryo/ Endosperm of the specimen, **E**. Leave the slide for valuation.
(05 marks)
5. Identify, draw and write notes on **F** & **G**.
(Identification -1, diagram-1, Notes-3). (2 x 05 = 10 marks)
6. Draw labeled sketches and identify giving reasons **H, I** & **J**.
(Identification-1, Diagram-1, Reasons-3 marks) (03 x 05 = 15 marks)

Total for Practical = 60 marks
Record= 15 marks

Total for ESE = 75 marks
ICA = 25 marks

Grand Total (ESE + ICA) = 100 marks

KEY

Question	**Section/ Preparation/ Spotter**	**Name**
A=Anatomy	Section	
B=Embryology	Section	
C= Cell Biology	Preparation	
D=Cell Biology	Section	
E= Embryology	Dissection	

F= Anatomy	Spotter/Photograph	
G= Embryology	Spotter/Photograph	
H = Cell Biology	Spotter/Photograph	
I = Evolution	Spotter/Photograph	
J = Evolution	Spotter/Photograph	
H= Anatomy	Spotter/Photograph	

BIOANALYTICAL TECHNIQUES
Practical Question Paper

Course Code: MID-4B

Time: 3 hrs **Maximum Marks: 25**

1. Separate the Nitrogenous bases/ sugars by paper chromatography, **A**.
(Setup-2, Materials required-1, Procedure- 2, Result-1 marks) (06 marks)
2. Isolate the Chloroplasts/ separate the Chloroplast Pigments/ estimate the proteins using suitable technique, **B**.
(Setup-2, Materials required-1, Procedure- 2, Result-1 marks) (06 marks)
3. Separate the DNA/ Proteins using appropriate technique, **C.**
(Preparation-2, Materials required-1, Procedure- 2, Result-1 marks) (06 marks)
4. Identify **D** giving reasons.
(Identification-1, Diagram-1, Reasons-2 marks) (04 marks)
5. Write critical notes on **E**. (03 marks)

For Practical = 25 marks
Record Marks = 10 marks
Permanent slides= 5 marks

Total = 40 marks

Normalized to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Experiment/ spotter	Name of the Experiment/ Spotter
A	Experiment	
B	Experiment	
C	Experiment	
D	Spotter	
E	Spotter	

SEMESTER V

GENETICS AND PLANT BREEDING

Practical Question Paper

Course Code: MJD-8

Time: 3 hrs **Maximum Marks: 25**

1. Solve the given problem, **A**. (08 marks)

2. Solve the given problem, **B**. (07 marks)

3. Demonstrate emasculation of the given plant specimen, **C**. Draw diagram and write the procedure.
(Preparation-2, Procedure- 2, Diagram-1, Notes-2) (07 marks)

4. Identify, draw and write notes on **D** & **E**.
(Identification- 1, Diagram-1, Notes-2 marks) (2x04= 08 marks)

For Practical = 30 marks
Record Marks = 10 marks

Total = 40 marks

Normalized to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

Question	Genetics/ Plant Breeding	Problem/ Experiment/ Spotter	Name of the Problem/ Experiment/ Spotter
A	Genetics	Problem	
B	Genetics	Problem	
C	Plant Breeding	Experiment	
D	Plant Breeding	Spotter	
E	Plant Breeding	Spotter	

MOLECULAR BIOLOGY

Practical Question Paper

Course Code: MJD-9

Time: 3 hrs **Maximum marks = 25**

1. Isolate/Estimate the materials from the given specimen **A**. List the materials required. Evaluate and record the results. Leave the preparation for valuation.
(Preparation-2, Procedure-3, List of materials-1, Sketch-1, Results-1 marks) (08 marks)

2.Stain the materials from the given specimen **B**. List the materials required. Evaluate and record the results. Leave the preparation for valuation.
(Preparation-2, Procedure-2, List of materials-1, Sketch-1, Results-1marks) (07 marks)

3. Identify and write notes on **C, D** & **E**.
(Identification-1, Diagram-2, Notes-2 marks) (3x05= 15 marks)

For Practical = 30 marks
Record Marks = 10 marks

Total = 40 marks

Normalized to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Experiment	Section/ spotter	Name/ part of the plant
A	DNA isolation/ Estimation	Experiment	
B	Giemsa staining of DNA	Experiment	
C	DNA/ RNA types	Spotter	
D	Transcription/ Translation	Spotter	
E	DNA sequencing	Spotter	

MICROBIOLOGY AND PLANT PATHOLOGY

Practical Question Paper

Course Code: MJD-10

Time: 3 hrs **Maximum Marks: 25**

1. Stain the given bacterial specimen, **A**. Write the procedure, identify, draw and submit the slide for valuation.
(Slide - 2, Identification - 1, Procedure - 2, Diagram – 1, Result - 1 marks). (07 marks)
2. Demonstrate the culture method: streak plate/ pour plate/ stab culture using given specimen, **B**.
(Preparation - 2, Procedure - 2, Diagram – 1 marks). (05 marks
3. Make a suitable micropreparation of the given specimen, **C**. Draw the diagram, write critical notes and leave the slide for valuation.
(Slide - 2, Identification - 1, Diagram – 1, Notes - 2 marks). (06 marks)
4. Identify, draw and write notes on, **D**.
(Identification -1, diagram-1, Notes-1). (03 marks)
5. Identify, draw and write notes on, **E**, **F** & **G**.
(Identification -1, diagram-1, Notes-1). (03x03= 09 marks)

For Practical = 30 marks
Record Marks = 10 marks

Total = 40 marks

Normalize to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Experiment/ Spotter	Name of the Experiment/ Spotter
A = Microbiology	Experiment	
B = Microbiology	Experiment	
C = Plant Pathology	Experiment	
D = Microbiology	Spotter/ Photograph	
E = Plant Pathology	Spotter/Photograph	
F = Plant Pathology	Spotter/Photograph	
G = Plant Pathology	Spotter/Photograph	

ECONOMIC BOTANY

Practical Question Paper

Course Code: MID-5A

Time: 03 hrs **Maximum Marks: 25**

1. Identify the given material, **A** using micropreparation.
(Preparation-3, Identification-1, Reasons/ Procedure-3, Diagram-2 marks) (1x09= 09 marks)
2. Localise the starch by Histochemical method of the given material, **B**.
(Preparation-3, Identification-1, Reasons/ Procedure-3, Diagram-2 marks) (1x09= 09 marks)
3. Identify, write the binomial and economic uses of **C, D, E** & **F**.
(Identification-1, binomial-1, uses-1 marks) (4x03= 12 marks)

For Practical = 30 marks
Record Marks = 10 marks

Total = 40 marks

Normalize to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Experiment	Section/ spotter	Name/ part of the plant
A	Micropreparation	Section	
B	Histochemical localization	Section	
C	Fibre yielding plant	Specimen/ spotter	
D	Timber yielding plant	Specimen/ spotter	
E	Oil yielding plant	Specimen/ spotter	
F	Spices/ Condiments	Specimen/ spotter	

MEDICAL BOTANY

Practical Question Paper

Course Code: MID-5B

Time: 03 hrs **Maximum Marks: 25**

1.Identify the given material **A** using micropreparation/ histochemical/ phytochemical methods.
(Preparation-2, Identification-1, Procedure-2, Diagram-2 marks) (07 marks)
2. Identify the given material **B** using micropreparation/ histochemical/ phytochemical methods.
(Preparation-2, Identification-1, Procedure-2, Diagram-2 marks) (07 marks)
3. Identify and draw specimens **C** & **D** giving reasons.
(Identification-1, diagram-2, reasons-2 marks) (2x05 = 10 marks)
4. Write medicinal uses of specimen **E** & **F.** (2 x03= 06 marks)

For Practical = 30 marks
Record Marks = 10 marks

Total = 40 marks

Normalize to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Experiment	Section/ spotter	Name/ part of the plant
A	Volatile oils	Specimen	
B	Resins	Specimen	
C	Carbohydrate	Specimen	
D	Glycosides	Specimen	
E	Plant toxins	Spotter	
F	Antibiotics	Spotter	

SEMESTER VI

PLANT PHYSIOLOGY AND PLANT BIOCHEMISTRY & PLANT BIOTECHNOLOGY

Practical Question Paper

Course Code: MJD-13
Time: 04 hrs **Maximum Marks: 75**

1. Outline the procedure for the given experiment, **A**. List the materials required. Set up the experiment and draw. Tabulate the data recorded. Report the results and leave the setup for valuation.
(Set up-2, Procedure-2, List of materials-1, Sketch/Graph-1, Tabulation-2 and Results-2 marks) (10 marks)
2. Outline the procedure for the given experiment, **B**. List the materials required. Set up the experiment and draw. Tabulate the data recorded. Report the results and leave the setup for valuation.
(Set up-2, Procedure-2, List of materials-1, Sketch/Graph-1, Tabulation-2 and Results-1 marks) (09 marks)
3. Identify, draw and write notes on, **C, D** & **E**.
(Identification- 1, Diagram-1, Notes-2 marks) (3 x 04= 12 marks)
4. Perform the experiment, **F.** Prepare the tissue culture medium and write the procedure.
(Preparation-3, Procedure-3, List of materials-1, Diagram-2, Results-1marks) (10 marks)
5. Perform the experiment, **G.** Inoculate the given explant in the medium. Write the procedure. (Preparation-3, Procedure-3, List of materials-1, Diagram-1, Results-1marks) (09 marks)
6. Identify, draw and write notes on, **H**.
(Identificaiton-1, Diagram-1, Notes-2 marks) (04 marks)
7. Identify, draw and write notes on, **I** & **J**.
(Identificaiton-1, Diagram-1, Notes-2 marks) (2 x 03= 06 marks)

For Practical = 60 marks
Record Marks = 15 marks

Total = 75 marks

KEY

Question	Experiment	Specimen/ spotter	Name of the experiment/ specimen/ spotter
A	Plant Physiology	Experiment	
B	Biochemistry	Experiment	
C	Plant Physiology	Spotter	
D	Biochemistry	Spotter	
E	Plant Physiology/	Spotter	

	Biochemistry		
F	Biotech- Plant Tissue Culture	Preparation	
G	Biotech- Plant Tissue Culture	Experiment	
H	Biotech- Plant Tissue Culture	Specimen/ Photograph	
I	Biotech- Genetic Engineering	Specimen/ Photograph	
J	Biotech- Genetic Engineering	Specimen/ Photograph	

ETHNOBOTANY

Practical Question Paper

Course Code: MJD-14

Time: 03 hrs **Maximum Marks: 25**

1. Make suitable micropreparation of the given specimen **A**. Leave the slide for valuation. Identify with reasons.
(Preparation-2, Identification-1, Diagram-1, Reasons-1 marks) (05 marks)
2. Make suitable micropreparation of the given specimen **B**. Leave the slide for valuation. Identify with reasons.
(Preparation-2, Identification-1, Diagram-1, Reasons-1 marks) (05 marks)
3. Identify, draw and write critical notes on ethnobotanical uses of given specimen **C** & **D**.
(Identificaion-1, Diagram -1, Notes-2 marks) (2x04= 08 marks)
4. Write the family, botanical name, common name and uses of the given specimen **E & F**.
(Family- 1, Botanical name- 1, Common name- 1, Uses- 1 marks) (2x04= 08 marks)

For Practical = 26 marks
Record Marks = 10 marks
Herbarium = 04 marks

Total = 40 marks

Normalized to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Experiment	Section/ spotter	Name/ part of the plant
A		Micropreparation	
B		Micropreparation	
C		Specimen/ Photographs	
D		Specimen/ Photographs	
E		Specimen/ Photographs	
F		Specimen/ Photographs	

ECOLOGY AND BIODIVERSITY

Practical Question Paper

Course Code: MID-6A

Time: 03 hrs **Maximum Marks: 25**

1. Estimate the Importance Value Index (IVI) from the given values in **A.** (06 marks)

2. Make a suitable micropreparation of given specimen **B**. Leave the slide for valuation. Identify with reasons.

(Preparation-2, identification-1, diagram-1, Reasons-2 marks) (06 marks)

3. Make a suitable micropreparation of given specimen **C**. Leave the slide for valuation. Identify with reasons.

(Preparation-2, identification-1, diagram-1, Reasons-2 marks) (06 marks)

4. Identify, draw and write notes on **D**, **E** & **F**.

(Identification-1, Diagram-1, Notes-2 marks) (03x04= 12 marks)

For Practical = 30 marks
Record Marks = 10 marks

Total = 40 marks

Normalized to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Experiment	Section/ spotter	Name/ part of the plant
A	Ecology- IVI	Experiment	
B	Ecology- Hydrophyte	Section	
C	Ecology- Xerophyte	Section	
D	Biodiversity	Spotter/ Photograph	
E	Biodiversity	Spotter/ Photograph	
F	Biodiversity	Spotter/ Photograph	

RESEARCH METHODOLOGY

Practical Question Paper

Course Code: MID-6B

Time: 03 hrs **Maximum Marks: 25**

1. Write the outline of a typical research article for publishing in a reputed journal, **A**. (05 marks)
2. Calculate the molarity of the given chemical, **B**. (05 marks)
3. Identify the pH of the given solution using pH meter, **C**. (05 marks)
4. Find out the size of the cell of the given plant specimen using micrometers, **D**. (05 marks)
5. Prepare the Poster for presentation on the given topic, **E**. (05 marks)
6. Using a computer prepare the Power Point Presentation on the given topic, **F**. (05 marks)

For Practical = 30 marks
Record Marks = 10 marks

Total = 40 marks

Normalize to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Experiment	Section/ spotter	Name
A			
B			
C			
D			
E			
F			

SEMESTER VII

GENOMICS AND PROTEOMICS & HORTICULTURE

Course Code: MJD-18

Time: 04 hrs **Maximum Marks: 75**

1. Align the given DNA sequence using CLUSTALW software, **A**. (05 marks)
2. Align the given Protein sequence using CLUSTALW software, **B**. (05 marks)
3. Retrieve the DNA sequences of a given gene name from GENBANK, **C**. (05 marks)
4. Retrieve the Protein sequences of a given gene name from GENBANK, **D**. (05 marks)
4. Predict the homology 3D structure of the given Protein sequence, **E**. (05 marks)
5. Identify the codons present in the given gene sequence, **F**. (05 marks)
6. Demonstrate pruning of the given plant specimen **G**. Draw diagram and write the procedure. (09 marks)
7. Outline the procedure for inoculation of the given experiment, **H**. List the materials required. Set up the experiment and draw. Tabulate the data recorded. Report the results and leave the setup for valuation.
(Set up-2, Procedure-2, List of materials-1, Sketch/Graph-1, Tabulation-2 and Results-1 marks) (09 marks)
8. Identify, draw and write notes on **I, J** & **K**.
(Identification- 1, Diagram-1, Notes-2 marks) (3 x 04= 12 marks)

For Practical = 60 marks
Record Marks = 15 marks

Total = 75 marks

KEY

Question	Experiment	Specimen/ spotter	Name of the experiment/ specimen/ spotter
A	Genomics	Experiment	
B	Proteomics	Experiment	
C	Genomics	Experiment	
D	Proteomics	Experiment	
E	Proteomics	Experiment	
F	Genomics	Spotter	
G	Horticulture	Experiment	
H	Horticulture	Experiment	
I	Horticulture	Spotter	
J	Horticulture	Spotter	
K	Horticulture	Spotter	

INDUSTRIAL MICROBIOLOGY

Practical Question Paper

Course Code: MID-7A

Time: 03 hrs **Maximum Marks: 25**

1. Prepare a suitable microbial culture medium **A**. Write the procedure.
   (Preparation-3, Procedure-3, List of materials-1, Diagram-2, Result-1 marks)
   (10 marks)
2. Make a suitable micropreparation **B**. Leave the slide for valuation. Identify with reasons.
   (Preparation-2, Indentification-1, Diagram-1, Reason-1 Marks). (05 marks)
3. Isolate the microbial culture from industrial waste using suitable techniques **C**.
   (Preparation-2, Indentification-1, Diagram-1, Reason-1 Marks). (05 marks)
4. Count the microbial colony in give specimen **D** using colony counter. (03 marks)
5. Perform the various streaking methods on suitable solid microbial culture medium **E**.
   (03 marks)
6. Write critical notes on **F** & **G**. (2x2= 04 marks)

For Practical=30 marks
Record Marks= 10 marks

Total=40 marks

Normalized to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Section	Name
A	Experiment	Medium preparation
B	Micro- preparation	Gram staining
C	Experiment	Pour plate/serial dilution method
D	Observation	Count the number of colonies given in Petri dish
E	Experiment	Inoculation of Bacteria
F	Spotter	Specimen/ Slide/ Photographs
G	Spotter	Specimen/ Slide/ Photographs

MARINE BIOTECHNOLOGY

Practical Question Paper

Course Code: MID-7B

Time: 3 hrs **Maximum Marks: 25**

1. Perform the experiment **A**. Prepare the culture medium and write the procedure. (Preparation-2, Procedure-1, List of materials-1, Diagram-1, Results-1 marks) (06 marks)
2. Perform the experiment, **B**. Write the procedure.
(Preparation-2, Procedure-1, List of materials-1, Diagram-1, Results-1 marks) (06 marks)
3. Perform the experiment, **C**. Write the procedure.
(Preparation-2, Procedure-1, List of materials-1, Diagram-1, Results-1marks) (06 marks)
4. Identify, draw and write notes on **D, E, F,** & **G**. (4x03= 12 marks)
(Identificaiton-1, Diagram-1, Notes-1 marks)

For Practical=30 marks
Record Marks= 10 marks

Total=40 marks

Normalized to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Experiment / Spotter	Name
A	Experiment	
B	Experiment	
C	Experiment	
D	Spotter	
E	Spotter	
F	Spotter	
G	Spotter	

FORENSIC BOTANY

Practical Question Paper

Course Code: MID-8A

Time: 3 hrs **Maximum Marks: 25**

1. Identify the types of microalgae present in the given water sample, **A**. Draw the diagram, write critical notes and submit the slide for valuation.
(Preparation-2, Identification-1, Diagram-2, Notes-2 marks) (07 marks)
2. Identify the narcotic leaf from the given plant samples, **B**. Draw the diagram, write critical notes and submit the slide for valuation.
(Preparation-2, Identification-1, Diagram-2, Notes-2 marks) (07 marks)
3. Identify the rose wood/ sandal wood from the given samples, **C**.
(Identification-1, Diagram-2, Notes-2 marks) (05 marks)
4. Identify the poisonous seed from the given samples, **D**.
(Identification-1, Diagram-2, Notes-2 marks) (05 marks)
5. Write short notes on **E** & **F**.
(Identification-1, Notes-2 marks) (02x03= 06 marks)

For Practical=30 marks
Record Marks= 10 marks

Total=40 marks

Normalized to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Experiment / Spotter	Name
A	Preparation	
B	Preparation	
C	Experiment	
D	Specimen/ Spotter	
E	Specimen/ Spotter	
F	Specimen/ Spotter	

BIOSTATISTICS AND COMPUTER APPLICATIONS IN BIOLOGY
Practical Question Paper

Course Code: MID-8B

Time: 3 hrs **Maximum Marks: 25**

1. Solve the given problem **A**. (09 marks)

2. Solve the given Problem **B** using computer software. (09 marks)

3. Identify, draw and write notes on **C, D** & **E**.
(Identificaiton-1, Diagram-1, Notes-2marks) (3x4= 12 marks)

For Practical=30 marks
Record Marks= 10 marks

Total=40 marks

Normalized to = 20 marks
Attendance = 05 marks

Grand Total (Practical + Attendance) = 25 marks

KEY

Question	Experiment/ Problem	Name
A	Biostatistics	Problem
B	Computer Applications	Problem
C	Biostatistics	Specimen/ Photograph
D	Computer Applications	Specimen/ Photograph
E	Biostatistics / Computer Applications	Specimen/ Photograph

Semester VIII

PLANT STRESS PHYSIOLOGY &
DENDROLOGY AND ARBORICULTURE

Practical Question Paper

Course Code: MJD-23

Time: 4 hrs **Maximum Marks: 75**

1. Outline the procedure for the given experiment **A**. List the materials required. Set up the experiment and draw. Tabulate the data recorded. Report the results and leave the setup for valuation.
(Set up-2, Procedure-2, List of materials-1, Sketch/Graph-1, Tabulation-2 and Results-2 marks) (1x10=10 marks)
2. Outline the procedure for the given experiment **B**. List the materials required. Set up the experiment and draw. Tabulate the data recorded. Report the results and leave the setup for valuation.
(Set up-2, Procedure-2, List of materials-1, Sketch/Graph-1, Tabulation-2 and Results-2 marks) (1x10=10 marks)
3. Outline the procedure for the given experiment **C**. List the materials required. Set up the experiment and draw. Tabulate the data recorded. Report the results and leave the setup for valuation.
(Set up-2, Procedure-2, List of materials-1, Sketch/Graph-1, Tabulation-2 and Results-2 marks) (1x10=10 marks)
4. Identify, draw and write notes on **D** & **E**.
(Identification- 1, Diagram-1, Notes-2 marks) (2x04= 08 marks)
5. Identify the habitat of the plant specimens, draw the diagram and write notes, **F, G** & **H.**
(Identification- 1, Diagram-1, Notes-2 marks) (3x04= 12 marks)
6. Identify and write notes on the disease found in the given tree specimen, **I.**
(Identification- 1, Pathogen name-1, Diagram-1, Notes-2 marks) (1x05= 05 marks)
7. Identify and write notes on the disease found in the given shrub specimen, **J.**
(Identification- 1, Pathogen name-1, Diagram-1, Notes-2 marks) (1x05= 05 marks)

For Practical = 60 marks
Record Marks = 15 marks

Total = 75 marks

KEY

Question	Experiment	Specimen/ spotter	Name of the experiment/ specimen/ spotter
A	Stress Physiology	Experiment	
B	Stress Physiology	Experiment	
C	Stress Physiology	Experiment	
D	Stress Physiology	Specimen/	

		Photograph	
E	Stress Physiology	Specimen/ Photograph	
F	Dendrology/ arboriculture	Specimen/ Photograph	
G	Dendrology/ arboriculture	Specimen/ Photograph	
H	Dendrology/ arboriculture	Specimen/ Photograph	
I	Dendrology/ arboriculture	Specimen/ Photograph	
J	Dendrology/ arboriculture	Specimen/ Photograph	

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