FYUGP

BOTANY HONOURS/ RESEARCH

FOR UNDER GRADUATE COURSES UNDER RANCHI UNIVERSITY

Upgraded & Implemented from 3rd Semester of Academic Session 2022-26
& From 1st Semester of Session 2023-27 Onwards

Members of Board of Studies for preparing Provisional Syllabus of the Four - Year Undergraduate Programme (FYUGP)

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3. **External Members -**

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4. **Special Invitee Member -**

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Associate Professor and Principal
Department of Botany
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29/05/2023

ii. **Dr. Malay Bharti**
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iii. **Mrs. Anshu Ankita Bara**
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29/05/2023

5. **Student Alumni Member -**

i. **Ms. Zeba Parween**
Research Scholar
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Students are Instructed to

Refer Syllabus of Allied/ Opted Subjects from R.U. Website

HIGHLIGHTS OF REGULATIONS OF FYUGP

PROGRAMME DURATION

- The Full-time, Regular UG programme for a regular student shall be for a period of four years with multiple entry and multiple exit options.
- The session shall commence from **1st of July**.

ELIGIBILITY

- The selection for admission will be primarily based on availability of seats in the Major subject and marks imposed by the institution. Merit point for selection will be based on marks obtained in Major subject at Class 12 (or equivalent level) or the aggregate marks of Class 12 (or equivalent level) if Marks of the Major subject is not available. Reservation norms of The Government of Jharkhand must be followed as amended in times.
- UG Degree Programmes with Double Major shall be provided only to those students who secure a minimum of overall 75% marks (7.5 CGPA) or higher.
- Other eligibility criteria including those for multiple entry will be in light of the UGC Guidelines for Multiple Entry and Exit in Academic Programmes offered in Higher Education Institutions.

ADMISSION PROCEDURE

- The reservation policy of the Government of Jharkhand shall apply in admission and the benefit of the same shall be given to the candidates belonging to the State of Jharkhand only. The candidates of other states in the reserved category shall be treated as General category candidates. Other relaxations or reservations shall be applicable as per the prevailing guidelines of the University for FYUGP.

VALIDITY OF REGISTRATION

- Validity of a registration for FYUGP will be for maximum for Seven years from the date of registration.

ACADEMIC CALENDAR

- An Academic Calendar will be prepared by the university to maintain uniformity in the CBCS of the UG Honours Programmes, UG Programmes, semesters and courses in the college run under the university (Constituent/Affiliated).
- **Academic Year:** Two consecutive (one odd + one even) semesters constitute one academic year.
- **Semester:** The Odd Semester is scheduled from **July to December** and the Even Semester is from **January to June**. Each week has a minimum of 40 working hours spread over 6 days.
- Each semester will include – Admission, course work, conduct of examination and declaration of results including semester break.
- In order to undergo 8 weeks' summer internship/ apprenticeship during the summer camp, the Academic Calendar may be scheduled for academic activities as below:
  a) Odd Semester: **From first Monday of August to third Saturday of December**
  b) Even Semester: **From first Monday of January to third Saturday of May**
- An academic year comprising 180 working days in the least is divided into two semesters, each semester having at least 90 working days. With six working days in a week, this would mean that each semester will have 90/ 6 = 15 teaching/ working weeks. Each working week will have 40 hours of instructional time.
- Each year the University shall draw out a calendar of academic and associated activities, which shall be

strictly adhered to. The same is non-negotiable. Further, the Department will make all reasonable endeavors to deliver the programmes of study and other educational services as mentioned in its Information Brochure and website. However, circumstances may change prompting the Department to reserve the right to change the content and delivery of courses, discontinue or combine courses and introduce or withdraw areas of specialization.

PROGRAMME OVERVIEW/ SCHEME OF THE PROGRAMME

- Undergraduate degree programmes of either 3 or 4-year duration, with multiple entries and exit points and re-entry options within this period, with appropriate certifications such as:
  - UG Certificate after completing 1 year (2 semesters) of study in the chosen fields of study provided they complete one vocational course of 4 credits during the summer vacation of the first year or internship/ Apprenticeship in addition to 6 credits from skill-based courses earned during first and second semester.,
  - UG Diploma after 2 years (4 semesters) of study diploma provided they complete one vocational course of 4 credits or internship/ Apprenticeship/ skill based vocational courses offered during first year or second year summer term in addition to 9 credits from skill-based courses earned during first, second, and third semester,
  - Bachelor's Degree after a 3-year (6 semesters) programme of study,
  - Bachelor's Degree (Honours) after a 4-year (8 semesters) programme of study.
  - Bachelor Degree (Honours with Research) after a 4-year (8 semesters) programme of study to the students undertaking 12 credit Research component in fourth year of FYUGP.

CREDIT OF COURSES

The term 'credit' refers to the weightage given to a course, usually in terms of the number of instructional hours per week assigned to it. The workload relating to a course is measured in terms of credit hours. It determines the number of hours of instruction required per week over the duration of a semester (minimum 15 weeks).

a) One hour of teaching/ lecture or two hours of laboratory /practical work will be assigned per class/interaction.
   One credit for Theory = 15 Hours of Teaching i.e., 15 Credit Hours
   One credit for Practicum = 30 Hours of Practical work i.e., 30 Credit Hours

b) For credit determination, instruction is divided into three major components:
   Hours (L) – Classroom Hours of one-hour duration.
   Tutorials (T) – Special, elaborate instructions on specific topics of one-hour duration
   Practical (P) – Laboratory or field exercises in which the student has to do experiments or other practical work of two-hour duration.

CALCULATION OF MARKS FOR THE PURPOSE OF RESULT

- Student's final marks and the result will be based on the marks obtained in Semester Internal Examination and End Semester Examination organized taken together.
- Passing in a subject will depend on the collective marks obtained in Semester internal and End Semester University Examination both. However, students must pass in Theory and Practical Examinations separately.

PROMOTION CRITERIA

First degree programme with single major:

i. The Requisite Marks obtained by a student in a particular subject will be the criteria for promotion to the next Semester.
ii. No student will be detained in odd Semesters (I, III, V & VII).
iii. To get promotion from Semester-II to Semester-III a student will be required to pass in at least 75% of Courses in an academic year, a student has to pass in minimum 9 papers out of the total 12 papers.
iv. To get promotion from Semester-IV to Semester-V (taken together of Semester I, II, III & IV) a student has to pass in minimum 18 papers out of the total 24 papers.
v. To get promotion from Semester-VI to Semester-VII (taken all together of Semester I, II, III, IV, V & VI) a student has to pass in minimum 26 papers out of the total 34 papers.
vi. However, it will be necessary to procure pass marks in each of the paper before completion of the course.

First degree programme with dual major:

vii. Above criterions are applicable as well on the students pursuing dual degree programmes however first degree programme will remain independent of the performance of the student in dual major courses.
viii. To get eligible for taking ESE, a student will be required to pass in at least 75% of Courses in an academic year.
ix. A student has to pass in minimum 3 papers out of the total 4 papers.
x. It will be a necessity to clear all papers of second major programme in second attempt in succeeding session, failing which the provision of dual major will be withdrawn and the student will be entitled for single first degree programme.

PUBLICATION OF RESULT

- The result of the examination shall be notified by the Controller of Examinations of the University in different newspapers and also on University website.
- If a student is found indulged in any kind of malpractice/ unfair means during examination, the examination taken by the student for the semester will be cancelled. The candidate has to reappear in all the papers of the session with the students of next coming session and his one year will be detained. However, marks secured by the candidate in all previous semesters will remain unaffected.
- There shall be no Supplementary or Re-examination for any subject. Students who have failed in any subject in an even semester may appear in the subsequent even semester examination for clearing the backlog. Similarly, the students who have failed in any subject in an odd semester may appear in the subsequent odd semester examination for clearing the backlog.

Regulation related with any concern not mentioned above shall be guided by the Regulations of the University for FYUGP.

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COURSE STUCTURE FOR FYUGP **'HONOURS/ RESEARCH'**

Table 1: Credit Framework for Four Year Undergraduate Programme (FYUGP) under State Universities of Jharkhand [Total Credits = 160]

Level of Courses	**Semester**	**MJ**; Discipline Specific Courses – Core or Major (80)	**MN**; Minor from discipline (16)	**MN**; Minor from vocational (16)	**MDC**; Multidisciplinary Courses [Life sciences, Physical Sciences, Mathematical and Computer Sciences, Data Analysis, Social Sciences, Humanities, etc.] (9)	**AEC**; Ability Enhancement Courses (Modern Indian Language and English) (8)	**SEC**; Skill Enhancement Courses (9)	**VAC**; Value Added Courses (6)	**IAP**; Internship/ Dissertation (4)	**RC**; Research Courses (12)	**AMJ**; Advanced Courses in lieu of Research (12)	**Credits**	**Double Major (DMJ)**
1	2	3	4	5	6	7	8	9	10	11	12	13	14
100-199: Foundation or Introductory courses	**I**	4	4		3	2	3	4				**20**	4+4
	II	4+4		4	3	2	3					**20**	4+4
	Exit Point: Undergraduate Certificate provided with Summer Internship/ Project (4 credits)												
200-299: Intermediate-level courses	**III**	4+4	4		3	2	3					**20**	4+4
	IV	4+4+4		4		2		2				**20**	4+4
	Exit Point: Undergraduate Diploma provided with Summer Internship in 1st or 2nd year/ Project (4 credits)												
300-399: Higher-level courses	**V**	4+4+4	4						4			**20**	4+4
	VI	4+4+4+4		4								**20**	4+4
	Exit Point: Bachelor's Degree												
400-499: Advanced courses	**VII**	4+4+4+4	4									**20**	4+4
	VIII	4		4						12	4+4+4	**20**	4+4
	Exit Point: Bachelor's Degree with Hons. /Hons. with Research											**160**	**224**

Note: Honours students not undertaking research will do 3 courses for 12 credits in lieu of a Research project / Dissertation.

Upgraded & Implemented from 3rd Sem. of Session 2022-26 & 1st Sem. of Session 2023-27 Onwards

COURSES OF STUDY FOR FOUR YEAR UNDERGRADUATE PROGRAMME **2022 onwards**

Table 2: Semester wise Course Code and Credit Points for Single Major:

Semester	Common, Introductory, Major, Minor, Vocational & Internship Courses		
	Code	**Papers**	**Credits**
I	AEC-1	Language and Communication Skills (MIL 1 - Hindi/ English)	2
	VAC-1	Value Added Course-1	4
	SEC-1	Skill Enhancement Course-1	3
	MDC-1	Multi-disciplinary Course-1	3
	MN-1A	Minor from Discipline-1	4
	MJ-1	Major paper 1 (Disciplinary/Interdisciplinary Major)	4
II	AEC-2	Language and Communication Skills (MIL 2 - English/ Hindi)	2
	SEC-2	Skill Enhancement Course-2	3
	MDC-2	Multi-disciplinary Course-2	3
	MN-2A	Minor from Vocational Studies/Discipline-2	4
	MJ-2	Major paper 2 (Disciplinary/Interdisciplinary Major)	4
	MJ-3	Major paper 3 (Disciplinary/Interdisciplinary Major)	4
III	AEC-3	Language and Communication Skills (Language Elective 1 - Modern Indian language including TRL)	2
	SEC-3	Skill Enhancement Course-3	3
	MDC-3	Multi-disciplinary Course-3	3
	MN-1B	Minor from Discipline-1	4
	MJ-4	Major paper 4 (Disciplinary/Interdisciplinary Major)	4
	MJ-5	Major paper 5 (Disciplinary/Interdisciplinary Major)	4
IV	AEC-3	Language and Communication Skills (Language Elective - Modern Indian language including TRL)	2
	VAC-2	Value Added Course-2	2

	MN-2B	Minor from Vocational Studies/Discipline-2	4
	MJ-6	Major paper 6 (Disciplinary/Interdisciplinary Major)	4
	MJ-7	Major paper 7 (Disciplinary/Interdisciplinary Major)	4
	MJ-8	Major paper 8 (Disciplinary/Interdisciplinary Major)	4
V	MN-1C	Minor from Discipline-1	4
	MJ-9	Major paper 9 (Disciplinary/Interdisciplinary Major)	4
	MJ-10	Major paper 10 (Disciplinary/Interdisciplinary Major)	4
	MJ-11	Major paper 11 (Disciplinary/Interdisciplinary Major)	4
	IAP	Internship/Apprenticeship/Field Work/Dissertation/Project	4
VI	MN-2C	Minor from Vocational Studies/Discipline-2	4
	MJ-12	Major paper 12 (Disciplinary/Interdisciplinary Major)	4
	MJ-13	Major paper 13 (Disciplinary/Interdisciplinary Major)	4
	MJ-14	Major paper 14 (Disciplinary/Interdisciplinary Major)	4
	MJ-15	Major paper 15 (Disciplinary/Interdisciplinary Major)	4
VII	MN-1D	Minor from Discipline-1	4
	MJ-16	Major paper 16 (Disciplinary/Interdisciplinary Major)	4
	MJ-17	Major paper 17 (Disciplinary/Interdisciplinary Major)	4
	MJ-18	Major paper 18 (Disciplinary/Interdisciplinary Major)	4
	MJ-19	Major paper 19 (Disciplinary/Interdisciplinary Major)	4
VIII	MN-2D	Minor from Vocational Studies/Discipline-2	4
	MJ-20	Major paper 20 (Disciplinary/Interdisciplinary Major)	4
	RC/ AMJ-1 AMJ-2 AMJ-3	Research Internship/Field Work/Dissertation OR Advanced Major paper-1 (Disciplinary/Interdisciplinary Major) Advanced Major paper-2 (Disciplinary/Interdisciplinary Major) Advanced Major paper-3 (Disciplinary/Interdisciplinary Major)	12/ 4 4 4
		Total Credit	**160**

NUMBER OF CREDITS BY TYPE OF COURSE

The hallmark of the new curriculum framework is the flexibility for the students to learn courses of their choice across various branches of undergraduate programmes. This requires that all departments prescribe a certain specified number of credits for each course and common instruction hours (slot time).

Table 3: Overall Course Credit Points for Single Major

Courses	Nature of Courses	3 yr UG Credits	4 yr UG Credits
Major	Core courses	60	80
Minor	i. Discipline/ Interdisciplinary courses and ii. Vocational Courses	24	32
Multidisciplinary	3 Courses	9	9
AEC	Language courses	8	8
SEC	**Courses to be developed by the University**	9	9
Value Added Courses	Understanding India, Environmental Studies, Digital Education, Health & wellness, Summer Internship/ Apprenticeship/ Community outreach activities, etc.	6	6
Internship (In any summer vacation for Exit points or in Semester-V)		4	4
Research/ Dissertation/ Advanced Major Courses	Research Institutions/ 3 Courses		12
	Total Credits =	**120**	**160**

Table 4: Overall Course Code and Additional Credit Points for Double Major

Courses	Nature of Courses	3 yr UG Credits	4 yr UG Credits
Major 1	Core courses	60	80
Major 2	Core courses	48	64
Minor	i. Discipline/ Interdisciplinary courses and ii. Vocational Courses	24	32
Multidisciplinary	3 Courses	9	9
AEC	Language courses	8	8
SEC	**Courses to be developed by the University**	9	9
Value Added Courses	Understanding India, Environmental Studies, Digital Education, Health & wellness, Summer Internship/ Apprenticeship/ Community outreach activities, etc.	6	6
Internship (In any summer vacation for Exit points or in Semester-V)		4	4
Research/ Dissertation/ Advanced Major Courses	Research Institutions/ 3 Courses		12
	Total Credits =	**168**	**224**

Table 5: Semester wise Course Code and Additional Credit Points for Double Major:

Semester	Double Major Courses		
	Code	Papers	Credits
I	DMJ-1	Double Major paper-1 (Disciplinary/Interdisciplinary Major)	4
	DMJ-2	Double Major paper-2 (Disciplinary/Interdisciplinary Major)	4
II	DMJ-3	Double Major paper-3 (Disciplinary/Interdisciplinary Major)	4
	DMJ-4	Double Major paper-4 (Disciplinary/Interdisciplinary Major)	4
III	DMJ-5	Double Major paper-5 (Disciplinary/Interdisciplinary Major)	4
	DMJ-6	Double Major paper-6 (Disciplinary/Interdisciplinary Major)	4
IV	DMJ-7	Double Major paper-7 (Disciplinary/Interdisciplinary Major)	4
	DMJ-8	Double Major paper-8 (Disciplinary/Interdisciplinary Major)	4
V	DMJ-9	Double Major paper-9 (Disciplinary/Interdisciplinary Major)	4
	DMJ-10	Double Major paper-10 (Disciplinary/Interdisciplinary Major)	4
VI	DMJ-11	Double Major paper-11 (Disciplinary/Interdisciplinary Major)	4
	DMJ-12	Double Major paper-12 (Disciplinary/Interdisciplinary Major)	4
VII	DMJ-13	Double Major paper-13 (Disciplinary/Interdisciplinary Major)	4
	DMJ-14	Double Major paper-14 (Disciplinary/Interdisciplinary Major)	4
VIII	DMJ-15	Double Major paper-15 (Disciplinary/Interdisciplinary Major)	4
	DMJ-16	Double Major paper-16 (Disciplinary/Interdisciplinary Major)	4
		Total Credit	**64**

Abbreviations:

AEC	Ability Enhancement Courses
SEC	Skill Enhancement Courses
IAP	Internship/Apprenticeship/ Project
MDC	Multidisciplinary Courses
MJ	Major Disciplinary/Interdisciplinary Courses
DMJ	Double Major Disciplinary/Interdisciplinary Courses
MN	Minor Disciplinary/Interdisciplinary Courses
AMJ	Advanced Major Disciplinary/Interdisciplinary Courses
RC	Research Courses

AIMS OF BACHELOR'S DEGREE PROGRAMME IN BOTANY

The broad aims of bachelor's degree programme in Botany are:

1. The programme is designed to equip students with essential knowledge and technical skills to study plants and related subjects in a holistic manner.
2. The main aim is to train the learners in all areas of plant biology using appropriate combinations of core and elective papers with significant inter- disciplinary components.
3. Students would be exposed to cutting-edge technologies that are currently used in the study of plant life forms, their evolution and interactions with other organisms within the ecosystem. Students would also become aware of the social and environmental significance of plants and their relevance to the national economy.

PROGRAM LEARNING OUTCOMES

The broad aims of bachelor's degree programme in Botany are:

(i) Students will be able to understand and explain different specializations of Botany such as systematics, evolution, ecology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, genetics, cell and molecular biology of plants.

(ii) Students will be trained in various analytical techniques of plant biology, use of plants as industrial resources or as support system for human livelihood and will be well versed with the use of transgenic technologies for both basic and applied research in plants.

(iii) Students will be able to identify various life forms of plants, design and execute experiments related to basic studies on evolution, ecology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, genetics, microbiology, molecular biology, recombinant DNA technology, transgenic technology. Students are also familiarized with the use of bioinformatics tools and databases and in the application of statistics to biological data.

(iv) Students will acquire core competency in the subject Botany and in allied subject areas.

(v) They will be able to use the evidence based comparative studies approach to explain the evolution of organism and understand the genetic diversity and its significance.

(vi) The students will be able to explain various physiological and metabolic processes unique to plants.

(vii) They would be able to elaborate on the concepts of gene, genome and the molecular processes of replication, transcription and translation.

(viii) They will be able to understand adaptation, development and behaviour of different forms of life.

(ix) The students will get an understanding of functioning of ecosystem and tracing the energy pyramids through nutrient flow.

(x) Students will be able to demonstrate the experimental techniques and methods in plant sciences and have innovative research ideas.

SEMESTER WISE COURSES IN BOTANY MAJOR-1 FOR FYUGP **2022 onwards**

Table 7: Semester wise Examination Structure in Discipline Courses:

Semester	Courses		Examination Structure			
	Code	Papers	Credits	Mid Semester Theory (F.M.)	End Semester Theory (F.M.)	End Semester Practical/ Viva (F.M.)
I	MJ-1	Microbiology, Phycology and Mycology	4	25	75	---
II	MJ-2	Non-Flowering Plants and Palaeobotany	4	25	75	---
	MJ-3	**Practical-I**	4	---	---	100
III	MJ-4	Plant Anatomy And Embryology	4	25	75	---
	MJ-5	**Practical-II**	4	---	---	100
IV	MJ-6	Ecology And Environmental Studies	4	25	75	---
	MJ-7	Plant Taxonomy & Economic Botany	4	25	75	---
	MJ-8	**Practical-III**	4	---	---	100
V	MJ-9	Cell Biology & Biochemistry	4	25	75	---
	MJ-10	Genetics	4	25	75	---
	MJ-11	**Practical-IV**	4	---	---	100
VI	MJ-12	Plant Physiology	4	25	75	---
	MJ-13	Molecular Biology	4	25	75	---
	MJ-14	Plant Biotechnology	4	25	75	---
	MJ-15	**Practical-V**	4	---	---	100
VII	MJ-16	Bioinformatics & Computational Biology	4	25	75	---
	MJ-17	Advanced Molecular Biology	4	25	75	---
	MJ-18	Applied Botany	4	25	75	---
	MJ-19	**Practical-VI**	4	---	---	100
VIII	MJ-20	Advanced Biotechnology	4	25	75	---
	AMJ-1	Biological Instrumentation	4	25	75	---
	AMJ-2	Nanobiotechnology	4	25	75	---
	AMJ-3	**Practical-VII**	4	---	---	100
	or RC-1	Research Methodology	4	25	75	---
	RC-2	Project Dissertation/ Research Internship/ Field Work	8	---	---	200
		Total Credit	**92**			

Table 8: Semester wise Course Code and Credit Points for Skill Enhancement Courses:

Semester	Skill Enhancement Courses		Examination Structure			
	Code	Papers	Credits	Mid Semester Theory (F.M.)	End Semester Theory (F.M.)	End Semester Practical/ Viva (F.M.)
I	SEC-1	Floriculture & Landscaping	3	---	75	---
II	SEC-2	Minor Forest Produce	3	---	75	---
III	SEC-3	Elementary Computer Application Softwares	3	---	75	---
		Total Credit	**9**			

Table 9: Semester wise Course Code and Credit Points for Minor Courses:

Semester	Minor Courses		Examination Structure			
	Code	Papers	Credits	Mid Semester Theory (F.M.)	End Semester Theory (F.M.)	End Semester Practical/ Viva (F.M.)
I	MN-1A	Biodiversity	4	15	60	25
III	MN-1B	Plant Ecology And Taxonomy	4	15	60	25
V	MN-1C	Plant Anatomy & Embryology	4	15	60	25
VII	MN-1D	Plant Physiology & Metabolism	4	15	60	25
		Total Credit	**16**			

INSTRUCTION TO QUESTION SETTER

SEMESTER INTERNAL EXAMINATION (SIE):

There will be Only One Semester Internal Examination in Major, Minor and Research Courses, which will be organized at college/institution level. However, Only One End semester evaluation in other courses will be done either at College/ Institution or University level depending upon the nature of course in the curriculum.

A. (SIE 10+5=15 marks):

There will be two group of questions. **Question No.1 will be very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks.

B. (SIE 20+5=25 marks):

There will be two group of questions. **Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which any one to answer.

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 20 Marks, (b) Class Attendance Score (CAS) of 5 marks.

Conversion of Attendance into score may be as follows:

Attendance Upto 45%, 1mark; 45<Attd.<55, 2 marks; 55<Attd.<65, 3 marks; 65<Attd.<75, 4 marks; 75<Attd, 5 marks.

END SEMESTER UNIVERSITY EXAMINATION (ESE):

A. (ESE 60 marks):

There will be two group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type five questions of fifteen marks each, out of which any three are to answer.

B. (ESE 75 marks):

There will be two group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type six questions of fifteen marks each, out of which any four are to answer.

C. (ESE 100 marks):

There will be two group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of ten questions of 1 mark each. **Question No. 2 & 3 will be short answer type** of 5 marks. Group B will contain descriptive type six questions of twenty marks each, out of which any four are to answer.

FORMAT OF QUESTION PAPER FOR SEMESTER INTERNAL EXAMINATION

Question format for **10 Marks**:

Subject/ Code

F.M. =10 **Time**=1Hr. Exam Year

General Instructions:

i. **Group A** carries very short answer type compulsory questions.
ii. **Answer 1 out of 2** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....

Group B

2. ..... [5]
3. ..... [5]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **20 Marks**:

Subject/ Code

F.M. =20 **Time**=1Hr. Exam Year

General Instructions:

i. **Group A** carries very short answer type compulsory questions.
ii. **Answer 1 out of 2** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]

Group B

3. ..... [10]
4. ..... [10]

Note: There may be subdivisions in each question asked in Theory Examination.

FORMAT OF QUESTION PAPER FOR END SEMESTER UNIVERSITY EXAMINATION

Question format for **50 Marks**:

Subject/ Code

F.M. =50 **Time**=3Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 3 out of 5** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....

Group B

2. ..... [15]
3. ..... [15]
4. ..... [15]
5. ..... [15]
6. ..... [15]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **60 Marks**:

Subject/ Code

F.M. =60 **Time**=3Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 3 out of 5** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]
3. ..... [5]

Group B

4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **75 Marks**:

Subject/ Code

F.M. = 75 **Time**=3Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]
3. ..... [5]

Group B

4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]
9. ..... [15]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **100 Marks**:

Subject/ Code

F.M. = 100 **Time**=3Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [10x1=10]
   i. ..... vi. .....
   ii. ..... vii. .....
   iii. ..... viii. .....
   iv. ..... ix. .....
   v. ..... x .....
2. ..... [5]
3. ..... [5]

Group B

4. ..... [20]
5. ..... [20]
6. ..... [20]
7. ..... [20]
8. ..... [20]
9. ..... [20]

Note: There may be subdivisions in each question asked in Theory Examination.

SEMESTER I

I. MAJOR COURSE –MJ 1:
MICROBIOLOGY, PHYCOLOGY AND MYCOLOGY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

On completion of this course, the students will be able to understand

1 To gain knowledge of diversity, life forms, life cycles, morphology and importance of microorganisms.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. Students would understand the classification, characteristic features, cell structure and growth andreproduction in viruses, bacteria and economic importance.

Course Content:

Microbiology:

Unit 1: Introduction to microbial world

Types and Classification. **(2 lectures)**

Unit 2: Viruses

Discovery, physiochemical and biological characteristics; classification (Baltimore), general structure with special reference to viroids and prions; replication (general account), DNA virus (T-phage), lytic and lysogenic cycle; RNA virus (TMV). Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases. **(8 lectures)**

Unit 3: Bacteria

Discovery, general characteristics; Types-archaebacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts); Cell structure; Nutritional types; Reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction). **(8 lectures)**

Phycology:

Unit 4: Algae

General characteristics of Algae, Criteria for classification of algae, Fritsch (1935) system of classification. Significant contributions of eminent phycologists (F.E. Fritsch and M.O.P. Iyengar). Economic importance of algae. **(5 lectures)**

Unit 5: Cyanophyta

Brief account of ecology and occurrence; Range of thallus organization; Cell structure; Reproduction, Morphology and life-cycle of *Nostoc* and *Oscillatoria*. **(4 lectures)**

Unit 6: Chlorophyta, Charophyta and Xanthophyta

Brief account of general characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction Morphology and life-cycles of *Chlamydomonas, Volvox, Oedogonium, Chara, Vaucheria*. **(7 lectures)**

Unit 7: Phaeophyta and Rhodophyta

Brief account of characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Ectocarpus* and *Polysiphonia.* **(5 lectures)**

Mycology:

Unit 8: Introduction to Fungi

Classification –Ainsworth (1966, 1973).

Brief account of allied fungi and applied mycology. Brief account of evolution. Brief account and life cycle pattern of *Synchytrium, Phytophthora, Erysiphe, Claviceps, Peziza, Puccinia, Ustilago, Alternaria*.

(11 lectures)

Unit 9: Phytopathology

Terms and concepts; General symptoms; Etiology; Symptomology; Host-Pathogen relationships; Disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine. Bacterial diseases – Citrus canker. Viral diseases – Tobacco Mosaic viruses. Fungal diseases – Early blight of potato, Black stem rust of wheat. **(10 lectures)**

Reference Books:

1. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGrawHill International.
2. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
3. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
4. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
5. Sharma, O.P. (2018). A text book of algae. TATA McGRAW – HILL.
6. Bilgrami, K. S. and Saha, L. C. (2020). A textbook of Algae, CBS.
7. Agrios, G.N. (1997) Plant Pathology, 4th edition, Academic Press, U.K.
8. Agrios, G.N. (2011) Plant Pathology, 6th edition, Academic Press, U.K.
9. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia)Singapore. 4th edition.
10. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge Univ Press, Cambridge. 3rd Ed.
11. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Pub. India Ltd.
12. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.

II. SKILL ENHANCEMENT COURSE- SEC 1: FLORICULTURE & LANDSCAPING

Marks: 75 (ESE: 3Hrs) = 75	Pass Marks: Th (ESE) = 30

(Credits: Theory-03) **45 Hours**

Course Objectives:

1. Familiarize with the cultivation of flowers and ornamental crops from the time of planting to the time of harvesting.
2. It also includes production of planting materials through seeds, cuttings, budding, grafting, etc, up to the marketing of the flower and flower produce.

Course Learning Outcomes:

1. learns about identification and study important commercial varieties of the flowering crops. Preparation of ground and beds for planting specific flower crops. Layout of plots and gardens, planning for home gardens, landscape gardens. Preparation and execution of landscape plants maintenance of gardens and lawns.
2. Protected cultivation of flowers. Identifications and study of poly house, shed net house, mulching.

Course Content:

1. Global and Indian floriculture scenario with special reference to Jharkhand. **(3 lectures)**

2. Technology intervention:

Breeding: General methods of breeding suitable for sexually and asexually propagated flower crops and ornamental plants; Breeding constraints and achievements made in commercial flowers and its management and global trades in ornamental plants – Rose, China rose, Tuberose, Marigold, Gladiolus.

Micropropagation: Rose, Orchid; Harvesting and Packaging of commercial flowers (Rose, China rose, Tuberose, Marigold, Gladiolus). **(15 lectures)**

3. Production technology of important flowers and foliage: Rose, China rose, Tuberose, Marigold, Gladiolus, Palm, Asparagus, Dracaena. **(05 lectures)**

4. Landscaping: Landscape designs, Styles of garden, formal, informal and free style gardens, types of gardens; Urban landscaping; Garden plant components, arboretum, shrubbery, fernery, palmatum, arches and pergolas, edges and hedges, climbers and creepers, cacti and succulents, herbs, annuals, flower borders and beds, bamboo groves; Bio-aesthetic planning, eco-tourism, theme parks (Nakshatra Van), indoor gardening, therapeutic gardening, non-plant components, water scaping. **(10 Lectures)**

5. Protected Floriculture: Prospects of protected floriculture in India; Types of protected structures – Greenhouses, polyhouses, shade houses, rain shelters; Suitable flower crops for protected cultivation; Containers and substrates, soil decontamination, layout of drip and fertigation system, water and nutrient management, weed management (Common local weeds and its control), physiological disorders, IPM and IDM; Staking and netting, Photoperiod regulation; Harvest indices, harvesting techniques, post-harvest handling techniques, Precooling, sorting, grading, packing, storage, quality standards. **(10 lectures)**

7. Environmental Factors for the floriculture. Biotic (Bacterial, Fungal, Insects and Nematodes) and abiotic factors (Light, Temperature, Humidity). **(2 lectures)**

PRACTICALS:

1. Identification of local annual, biennial, perennial and bulbous flower plants, herb, shrub, climbers and foliage plants. Identification of indoor plants.
2. Identification of main garden tools and implements.
3. Selection of ornamental plants, draw and practices in preparing designs for home garden, industrial garden, institutional garden, corporate and avenue planting.
4. Propagation techniques for floriculture.
5. Plant breeding techniques for floriculture. Growing of flowering plants in pots.

Reference Books:

1. G. S. Randhawa and A. Mukhopadhyay (1986). Floriculture in India, Allied (https://books.google.co.in/books?id=fABzMgAACAAJ)

SEMESTER II

I. MAJOR COURSE- MJ 2:
NON-FLOWERING PLANTS AND PALAEOBOTANY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

On successful completion of this course the student should be able to:

1. To introduce students with lichens, their ecology, classification, characteristics, reproduction and economic Importance.
2. Study of morphology, anatomy, reproduction and developmental changes there in through typological study should create a knowledge base in understanding plant diversity, economic values, taxonomy of lower group of plants.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. To learn the organ formation in early land plants that resulted to diversity of species of Lichens "Bryophytes", "Pteridophytes" and "Gymnosperms".
2. Information on the Ecological and Economic Importance of bryophytes, pteridophytes and gymnosperms will help to understand their role in ecosystem functioning.

Course Content:

Unit 1: Symbiotic association

Lichen – Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction; Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance. **(10 lectures)**

Unit 2: Bryophytes

General characteristics; Adaptations to land habit; Classification; Range of thallus organization. Morphology, anatomy, reproduction and alternation of generation of *Riccia*, *Marchantia*, *Anthoceros*, *Sphagnum* and *Funaria*. Ecological and economic importance of Bryophytes. **(13 lectures)**

Unit 3: Pteridophytes

Origin and evolution of land plants, Classification, morphology, anatomy and life cycle and alternation of generation of *Psilotum*, *Selaginella*, *Equisetum* and *Pteris*. Ecological and economic importance of pteridophytes. **(15 lectures)**

Unit 4: Gymnosperms

General characteristics, classification, morphology, anatomy and life cycle of *Cycas* and *Pinus*; Ecological and economic importance. **(11 lectures)**

Unit 5: Palaeobotany

Brief introduction of palaeobotanist of India. Fossils and Types of fossils; Process of fossilization and its Significance. Geological time scale; General characteristics; Classification; Early land plants (*Cooksonia*, *Rhynia*)**.** **(11 lectures)**

Reference Books:

1. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.
2. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
3. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.
4. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
5. Vanderpoorten, A. & Goffinet, B. (2009) Introduction to Bryophytes. Cambridge University Press.

II. MAJOR COURSE- MJ 3:
PRACTICALS-I:

Marks: Pr (ESE: 3Hrs) =100	Pass Marks: Pr (ESE) = 40

(Credits: Practicals-04) **120 Hours**

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 60 marks*
Practical record notebook	*= 15 marks*
Viva-voce	*= 25 marks*

Practical:

Unit I: Diversity & Economic Importance of Microbes

Microbiology

1. Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs ofLytic and Lysogenic Cycle.
2. Types of Bacteria to be observed from temporary/permanent slides/photographs. Electronmicrographs of bacteria, binary fission, endospore, conjugation, root Nodule.
3. Gram staining.

Phycology

Study of vegetative and reproductive structures of *Nostoc, Volvox, Oedogonium, Chara* and *Vaucheria* through temporary slide preparations and permanent slides

Fungi

1. *Aspergillus*: study of asexual stage from temporary mounts. Study of Sexualstage from permanent slides/photographs.
2. *Peziza*: sectioning through ascocarp.
3. *Alternaria*: Specimens/photographs and temporary mounts.
4. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; sections/ mounts of spores on wheat and permanent slides of both the hosts.
5. Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Viral diseases: TMV, Fungal diseases: Early blight of potato, Black stem rust of wheat.

Unit II: Non-Flowering Plants and Palaeobotany

Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides. Mycorrhizae: ectomycorrhiza and endomycorrhiza (Photographs)

Archegoniate: *Riccia, Marchantia, Anthoceros, Sphagnum, Funaria, Selaginella, Equisetum, Pteris, Cycas, Pinus.*

Botanical excursion.

Reference Books

1. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGrawHill International.
2. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
3. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
4. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
5. Sharma, O.P. (). A text book of algae. TATA McGRAW – HILL.
6. Agrios, G.N. (1997) Plant Pathology, 4th edition, Academic Press, U.K.
7. Agrios, G.N. (2011) Plant Pathology, 6th edition, Academic Press, U.K.
8. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia)Singapore. 4th edition.
9. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd Ed.
10. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
11. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.
12. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.
13. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, N. Delhi.
14. Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.

15. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
16. Vanderpoorten, A. & Goffinet, B. (2009) Introduction to Bryophytes. Cambridge University Press.

III. SKILL ENHANCEMENT COURSE- SEC 2: MINOR FOREST PRODUCE

Marks: 75 (ESE: 3Hrs) = 75	**Pass Marks: Th (ESE) = 30**

(Credits: Theory-03) **45 Hours**

Course Objectives:

1. The purpose of this course is to familiarize with Minor Forest Products, management, collection, storage and post-harvest processing.

Course Learning Outcomes:

On successful completion of this course the student should be able to:

1. To acquaints with Minor Forest Products (NWFPs) and their scientific extraction, processing and disposal.
2. Livelihood of indigenous community based on minor forest produce.

Course Content:

Unit 1: Introduction: Forest of Jharkhand and Minor Forest Produce. **(2 Lectures)**

Unit 2: Forest produce of Jharkhand: **(20 Lectures)**

Aromatic and Medicinal Plants: Neem, Karanj, Giloy, Munga, Pudina, Van Tulsi, Tulsi, Sweet flag, Kalmegh, Satavar, Lemon grass
Nutritional Plants: Mushroom, Mahua flower, Imli, Chironjee, Kathal
Oil Yielding Plants: Sal Seed, Mahua Seed, Neem Seed, Karanj Seed, Kusum, Castor
Fruit Trees: Kendu, Ber, Sahtoot, Mango, Jamun, Piyar**,** Karonda, Carombola
Leafy Vegetables: Chakor Sag, Beng Sag, Konar Sag

Unit 3: Source and Use of Minor Forest Products (MFPs): Gums and Resins, Katha, Dyes, Tannins, Oils. Technologies for extraction of Gums, Resins, Katha, Dyes, Tannins, Oils and other products. **(8 Lectures)**

Unit 5: Post Harvest Technology: Cleaning, Packing, Storage and Processing. **(3 Lectures)**

Unit 6: Marketing of Minor Forest Produce: Primary Agriculture Credit Society (PACS), Vyapaar Mandal Sahyog Samity (VMSS), Primary Minor Forest Produce Co-Operative Societies (PMFPCS), Women SHG or Repudiated NGO.

Unit 7: Forest Conservation. **(2 Lectures)**

Unit 8: Strategy for Minor Forest Produce Management. **(2 Lectures)**

Unit 9: Livelihood based on Minor Forest Produce of Jharkhand: Bamboos, Canes and Grass. **(6 Lectures)**

Unit 10: Role of Minor Forest Produce in Sustainable development. **(2 Lectures)**

Reference Books:

1. Importance of Minor forest produces in tribal life- Manoshi Das (2018).
2. The Significance of Minor forest produce in the Indian tribal economy- K. Mohan Reddy (2018).
3. Tribal settlement and minor forest produce- D. Thakur (2009).
4. Procurement and Marketing of Minor Forest Produce in Tribal Areas- G. Parthasarathy and K. U. Shankar Patnaik (2003).

SEMESTER III

I. MAJOR COURSE- MJ 4:
PLANT ANATOMY AND EMBRYOLOGY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

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

1. To acquaint the students with internal basic structure and cellular composition of the plant body.
2. To correlate structure with important functions of different plant parts.
3. Study of various tissue systems and their development and functions in plants.

Course Learning Outcomes:

On successful completion of this course the student shall know:

1. Knowledge of various cells and tissues, meristem, epidermal and vascular tissue system in plants.
2. Various aspects of growth, development of the tissues and differentiation of various plant organs.
3. Knowledge of basic structure and organization of plant parts in angiosperms.
4. Correlation of structure with morphology and functions.

Course Content:

Plant Anatomy

Unit 1: Introduction and scope of Plant Anatomy **(2 Lectures)**

Unit 2: Tissues and its types (Permanent and Meristematic). **(4 Lectures)**

Unit 3: Apical meristems Evolution of concept of organization of shoot apex and root apex (Theories). **(6 Lectures)**

Unit 4: Vascular Cambium and Wood Structure, function and seasonal activity of cambium; Secondary growth and anomalous secondary growth in root and stem. Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses. Development and composition of periderm. **(12 Lectures)**

Unit 5: Morphological and Anatomical adaptations of xerophytes and hydrophytes. **(6 Lectures)**

Embryology

Unit 1: **Introduction**

Brief account of embryology and contributions of W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri and scope**.** **(3 lectures**)

Unit 2: Anther and pollen biology

Anther wall: Structure and functions, microsporogenesis and its significance. Microgametogenesis**.** **(5 lectures)**

Unit 3: Ovule

Structure; Types; Special structures–endothelium, obturator, aril, caruncle and hypostase; Female gametophyte–megasporogenesis and megagametogenesis. **(6 lectures)**

Unit 4: Pollination and fertilization

Brief account of Pollination and double fertilization**.** **(3 lectures)**

Unit 6: Embryo, Endosperm and Seed

Structure and types; General pattern of development of dicot and monocot embryo, endosperm types and function, Seed structure (Monocot and Dicot). **(10 lectures)**

Units 7: Polyembryony and apomixis

Introduction; Classification; Causes and applications. **(3 lectures)**

Reference Books:

1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.
4. Evert, R.F. (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc
5. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Pub. House. Delhi. 5th edition.
6. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Pub. Co. Pvt. Ltd. Delhi.
7. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
8. Johri, B.M. l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands

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II. MAJOR COURSE- MJ 5:
PRACTICALS-II:

Marks: Pr (ESE: 3Hrs) =100	Pass Marks: Pr (ESE) = 40

(Credits: Practicals-04) **120 Hours**

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment = 60 marks
Practical record notebook = 15 marks
Viva-voce = 25 marks

Practicals:

Study of anatomical details through permanent slides/temporary stain mounts/ macerations/ museum specimens with the help of suitable examples.

1. Distribution and types of parenchyma, collenchyma and sclerenchyma.
2. Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres.
3. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibers.
4. Epidermal system: cell types, stomata types.
5. Root: monocot, dicot, secondary growth.
6. Stem: monocot, dicot - primary and secondary growth.
7. Leaf anatomy: isobilateral, dorsiventral.
8. Adaptive Anatomy: xerophytes, hydrophytes.
9. Anther: Wall structure, MMC, spore tetrads.
10. Pollen germination.
11. Ovule: Types and embryo dissection.

Reference Books

1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
2. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.
4. Evert, R.F. (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body:Their Structure, Function and Development. John Wiley and Sons, Inc
5. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, VikasPublishing House, Delhi. 5th edition.
6. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co.Pvt. Ltd. Delhi.
7. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
8. Johri, B.M. l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands

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III. SKILL ENHANCEMENT COURSE- SEC 3: ELEMENTARY COMPUTER APPLICATION SOFTWARES

Marks: 75 (ESE: 3Hrs) = 75	Pass Marks: Th (ESE) = 30

A Common Syllabus for FYUGP (Credits: Theory-03) **45 Hours**

Instruction to Question Setter for
End Semester Examination (ESE):
*There will be **objective type test** consisting of **Seventy-five questions of 1 mark each**. Students are required to mark their answer on **OMR Sheet** provided by the University.*

Course Objectives:

The objective of the course is to generate qualified manpower in the area of Information Technology (IT) and Graphic designing which will enable such person to work seamlessly at any Offices, whether Govt. or Private or for future entrepreneurs in the field of IT.

A. INTRODUCTION TO COMPUTER SYSTEM

1. Basic Concept of Computer: What is Computer, Applications of Computer, Types of computer, Components of Computer System, Central Processing Unit (CPU) **(3 Lecture)**

2. Concepts of Hardware: Input Devices, Output Devices, Computer Memory, Types of Memory, processing Concept of Computer **(4 Lecture)**

3. Operating system: What is an Operating System, Operating System Examples, Functions of Operating System(Basic), Introduction to Windows 11, Working on Windows 11 environment, Installation of Application Software, My Computer, Control Panel, searching techniques in windows environment, Basic of setting **(6 Hours)**

4. Concept of Software: What is Software, Types of Software, Computer Software- Relationship between Hardware and Software, System Software, Application Software, some high level languages **(4 Hours)**

5. Internet & its uses: Basic of Computer networks; LAN, WAN, MAN, Concept of Internet, Applications of Internet; connecting to internet, what is ISP, World Wide Web, Web Browsing software's, Search Engines, URL, Domain name, IP Address, using e-governance website, Basics of electronic mail, getting an email account, Sending and receiving emails. **(6 Hours)**

B. MICROSOFT OFFICE 2016 AND LATEST VERSIONS

6. Microsoft Word: Word processing concepts, Creation of Documents, Formatting of Documents, Formatting of Text, Different tabs of word 2016 environment, Formatting Page, Navigation of Page, Table handling, Header and footer, Page Numbering, Page Setup, Find and Replace, Printing the documents **(7 Hours)**

7. Microsoft Excel (Spreadsheet): Spreadsheet Concepts, Creating, Saving and Editing a Workbook, Inserting, Deleting Work Sheets, Formatting worksheet, Excel Formula, Concept of charts and Applications, Pivot table, goal seek, Data filter, data sorting and scenario manager, printing the spreadsheet **(6 Hours)**

8. Microsoft Power Point (Presentation Package): Concept and Uses of presentation package, Creating, Opening and Saving Presentations, working in different views in Power point, Animation, slide show, Master Slides, Creating photo album, Rehearse timing and record narration **(5 Hours)**

9. Digital Education: What is digital education, Advantages of digital Education, Concept of e-learning, Technologies used in e learning **(4 Hours)**

Reference Books

1. Nishit Mathur, Fundamentals of Computer, APH publishing corporation (2010)
2. Neeraj Singh, Computer Fundamentals (Basic Computer), T Balaji, (2021)
3. Joan Preppernau, Microsoft Power Point 2016 step by step, Microsoft press (2015)
4. Douglas E Corner, The Internet Book 4th Edition, prentice –Hall (2009)
5. Steven Welkler, Office 2016 for beginners, Create Space Independent Publishing Platform (2016)
6. Wallace Wang, Microsoft Office 2019, Wiley (January 2018)
7. Noble Powell, Windows 11 User Guide For Beginners and Seniors, ASIN, (October 2021)

SEMESTER IV

I. MAJOR COURSE- MJ 6:
ECOLOGY AND ENVIRONMENTAL STUDIES

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

1. This course aims to introduce the students to the concepts and principles of ecology, biological diversity, conservation, sustainable development, population, community and ecosystem structure and function, application of these concepts to solve environmental problems.
2. To make them understand complex community patterns, processes, and ecosystem functioning.

Course Learning Outcomes:

1. It will acquaint the students with complex interrelationship between organisms and environment; make them understand methods to studying vegetation, community patterns and processes, ecosystem functions, and principles of phytogeography. What are the limiting factors controlling distribution and growth of organisms?
2. What are the characteristics of organisms as population, community and ecosystems? What are the intra- and inter-specific interactions? What are the ecosystem functions? What are applications of ecological knowledge for the benefit of anthropogenic society?

Course Content:

Unit 1: Introduction Basic concepts of ecology and environmental biology. **(2 lectures)**

Unit 2: Abiotic interactions
Soil: Importance and Soil profile. Water: Importance and Hydrological Cycle. Light and temperature. **(6 lectures)**

Unit 5: Biotic interactions
Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; ecological pyramids; biomass, standing crop. **(6 lectures)**

Unit 6: Population ecology
Characteristics and Dynamics. Ecological Speciation **(4 lectures)**

Unit 7: Plant communities
Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession (Hydrosere and Xerosere). **(6 lectures)**

Unit 8: Ecosystems Structure and function; Trophic organization; Food chains and Food webs; Ecological pyramids. Pond ecosystem, grassland ecosystem and forest ecosystem, Biogeochemical cycles (Carbon, Nitrogen and Phosphorus cycle), Energy flow and productivity. **(9 lectures)**

Unit 10: Phytogeography
Phytogeographical regions of India; Local Vegetation and Endemism; hotspots. **(5 lectures)**

Unit 11: Pollution and Climate change
Introduction to pollutants, pollution, causes, control and impact of air, water, soil, noise. Role of Biotechnology in pollution control. Major global environmental issues: Climate change, ozone depletion, global warming, acid rain, carbon emission; Objectives of United Nations Framework Convention on Climate Change (UNFCC). **(12 lectures)**

Unit 13: Biodiversity and Conservation Biodiversity: Definition, threats and importance, natural resources: renewable and non-renewable, conservation- in-situ and ex-situ methods. IUCN conservation category: Endangered, threatened, vulnerable, Biodiversity management committees, people's biodiversity register; Red Data Book, sustainable development goals: Biofuel and Green hydrogen. Convention on Biological Diversity, National Biodiversity Authority and Botanical Survey of India. **(10 lectures)**

Reference Books:

1. Raziuddin, M.., Mishra P.K. 2014, A Handbook of Environmental Studies, Akanaksha Publications, Ranchi.
2. Mukherjee, B. 2011: Fundamentals of Environmental Biology. Silverline Publications, Allahabad.
3. Carson, R. 2002. Silent Spring. Houghton Mifflin Harcourt.
4. Gadgil, M., & Guha, R.1993. This Fissured Land: An Ecological History of India. Univ. of California Press.
5. Gleeson, B. and Low, N. (eds.) 1999.Global Ethics and Environment, London, Routledge.
6. Gleick, P. H. 1993. Water in Crisis. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
7. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. Principles of Conservation Biology. Sunderland: Sinauer Associates, 2006.
8. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. Science, 339: 36---37.
9. McCully, P. 1996. Rivers no more: the environmental effects of dams (pp. 29---64). Zed Books.
10. McNeill, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.
11. Odum, E.P., Odum, H.T. & Andrews, J. 1971.Fundamentals of Ecology. Philadelphia: Saunders.
12. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
13. Rao, M.N. & Datta, A.K. 1987. Waste Water Treatment. Oxford and IBH Publishing Co. Pvt. Ltd.
14. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012.Environment. 8th edition. John Wiley & Sons.
15. Rosencranz, A., Divan, S., & Noble, M. L. 2001. Environmental law and policy in India. Tripathi 1992.
16. Sengupta, R. 2003. Ecology and economics: An approach to sustainable development. OUP.
17. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.
18. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. Conservation Biology: Voices from the Tropics. John Wiley & Sons.
19. Thapar, V. 1998. Land of the Tiger: A Natural History of the Indian Subcontinent.
20. Warren, C. E. 1971. Biology and Water Pollution Control. WB Saunders.
21. Wilson, E. O. 2006.The Creation: An appeal to save life on earth. New York: Norton.
22. World Commission on Environment and Development. 1987. Our Common Future. Oxford University
23. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
24. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
25. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
26. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
27. Das, M.C. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

II. MAJOR COURSE- MJ 7:
PLANT TAXONOMY & ECONOMIC BOTANY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

After completion of the course, the learner shall be able to understand:

1. To gain the knowledge on the taxonomy, phylogeny of plants.
2. To make the students familiar with economic importance of diverse plants that offer resources to human life.
3. It emphasizes the plants used as- food for man, fodder for cattle, feed for poultry, plants having medicinal value and also plant source of huge economic value etc.

Course Learning Outcomes:

On successful completion of this course the student should know the:

1. Understanding of systematics its importance in bioresource utilization and biodiversity management. Nomenclature pattern, Phylogeny, Classification systems of the plants.
2. After studying Economic Botany, students would have first-hand information of plants used as food, the various kinds of nutrients available in the plants. The dietary requirements of proteins, fats, amino-acids, vitamins etc. that can be met by plants.
3. The students will learn to perform the micro-chemical tests to demonstrate various components.
4. The students will learn about the use of fiber plants, beverages, fruits and vegetables that are integral to day to day life of plants.
5. Students will learn to explore the regional diversity in food crops and other plants and their ethno-botanical importance as well.

Course Content:

Plant Taxonomy

Unit 1: Introduction to Plant Taxonomy

1. Fundamental components of taxonomy (identification, nomenclature, classification)
2. Botanical Nomenclature- Principles and rules of ICN (ranks and names; principle of priority, binomial system; type method (Typification), author citation and valid-publication).
3. Taxonomic resources: Herbarium- functions & important herbaria, Botanical gardens, Flora.

(4 lectures)

Unit 2: Taxonomic hierarchy, Types of classification and Evidences

1. Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept.
2. Types of classification- Artificial, Natural and Phylogenetic.
3. Bentham & Hooker's system of classification - merits and demerits.
4. Engler & Prantle's system of classification - merits and demerits.
5. Hutchinson classification - merits and demerits.
6. Taxonomic evidences from morphology, cytology and phytochemistry. **(10 lectures)**

Unit 3: Plant Systematics

1. Diagnostic characteristics, Systematic Phylogeny and economic importance of families: Ranunculaceae, Apocynaceae, Lamiaceae, Magnoliaceae, Poaceae, Cyperaceae. **(11 lectures)**

Unit 4: Modern trends in Plant taxonomy:

1. Phenetics and Cladistics: Brief idea on Phenetics, Numerical taxonomy- methods, Operational Taxonomic Units (OUT's).
2. Origin and evolution of angiosperms; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram). **(5 lectures)**

Economic Botany

Study of following economically important plants with special reference to Jharkhand:

Unit 1: Cereals and Millets: Wheat, Rice, Ragi and Jowar – morphology and uses. **(4 Lectures)**

Unit 2: Pulses & Vegetables General account with special reference to Gram, soybean and Potato.

(4 Lectures)

Unit 3: Spices: General account with special reference to clove, black pepper, cinnamon, Ginger and Turmeric (Botanical name, family, part used, morphology and uses) **(4 Lectures)**

Unit 4: Beverages Tea and Coffee (morphology, processing, uses) **(5 Lectures)**

Unit 5: Oils and Sugar General description with special reference to groundnut and sugarcane **(4 Lectures)**

Unit 6: Timber and Fiber and Yielding Plants General description (Botanical name, family, parts used, morphology and uses) **(4 Lectures)**

Unit 7: Medicinal Plants Brief account of *Ocimum*, *Turmeric*, *Tinospora*, *Aloe*, *Rauvolfia*, *Emblica* and *Cathranthus* (Botanical name, family, parts used and uses) **(5 Lectures)**

Reference Books

1. Singh, (2012). Plant Systematics: Theory and Practice Oxford & IBH Pvt. Ltd., New Delhi.3rdedition.
2. Jeffrey, C. (1982). An Introduction to Plant Taxonomy. Cambridge University Press,Cambridge.
3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.
4. Maheshwari, J.K. (1963). Flora of Delhi. CSIR, New Delhi.
5. Radford, A.E. (1986). Fundamentals of Plant Systematics. Harper and Row, New York.
6. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
7. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer AcademicPublishers, The Netherlands.

III. MAJOR COURSE- MJ 8:
PRACTICALS-III:

Marks: Pr (ESE: 3Hrs) =100	Pass Marks: Pr (ESE) = 40

(Credits: Practicals-04) **120 Hours**

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment = 60 marks
Practical record notebook = 15 marks
Viva-voce = 25 marks

Practical:

1. Study of instruments used to measure microclimatic variables: Soil thermometer, anemometer, rain gauge, lux meter.
2. Determination of pH of various soil and water samples (pH meter and pH paper)
3. Comparison of water holding capacity, porosity and rate of infiltration of water in soils of three habitats.
4. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
5. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
6. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.
7. Field visit to familiarize students with ecology of different sites
8. Study of common plants, insects, birds and basic principles of identification. Study of simple ecosystems--pond, river etc.

Plant Taxonomy & Economic Botany

1. Systematic study of locally available plants belonging to the families prescribed in theorysyllabus with reference to vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification)
2. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).
3. Study of economically important plants: Wheat, Rice, Gram, Soybean, Potato, Black pepper, Clove, Cinnamon, Ginger, Turmeric, Tea, Coffee, Cotton, Groundnut, Sugarcane, Mustard and Medicinal plants (Tulsi, Neem, Karanj, Haldi, Ghritkumari, Kalmegh) through specimens, sections.

Reference Books

1. Raziuddin, M., Mishra P.K. 2014, *A Handbook of Environmental Studies*, Akanaksha Publications, Ranchi.
2. Mukherjee, B. 2011: *Fundamentals of Environmental Biology*. Silverline Publications, Allahabad.
3. Carson, R. 2002. *Silent Spring*. Houghton Mifflin Harcourt.
4. Gadgil, M., & Guha, R.1993. *This Fissured Land: An Ecological History of India*. Univ. of California Press.
5. Gleeson, B. and Low, N. (eds.) 1999.*Global Ethics and Environment*, London, Routledge.
6. Gleick, P. H. 1993. *Water in Crisis*. Pacific Institute for Studies in Dev., Environment &Security. Stockholm Env. Institute, Oxford Univ. Press.
7. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. *Principles of Conservation Biology*.Sunderland: Sinauer Associates, 2006.
8. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. *Science*, 339: 36---37.
9. McCully, P. 1996. *Rivers no more: the environmental effects of dams* (pp. 29---64). Zed Books.
10. McNeill, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.
11. Odum, E.P., Odum, H.T. & Andrews, J. 1971.*Fundamentals of Ecology*. Philadelphia: Saunders.
12. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
13. Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatment*. Oxford and IBH Publishing Co. Pvt. Ltd.
14. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012.*Environment*. 8th edition. John Wiley & Sons.
15. Rosencranz, A., Divan, S., & Noble, M. L. 2001. *Environmental law and policy in India*. *Tripathi 1992*.
16. Sengupta, R. 2003. *Ecology and economics*: An approach to sustainable development. OUP.
17. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation*. S. Chand

Publishing, New Delhi.
18. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. *Conservation Biology*: *Voices from the Tropics*. John Wiley & Sons.
19. Thapar, V. 1998. *Land of the Tiger*: *A Natural History of the Indian Subcontinent*.
20. Warren, C. E. 1971. *Biology and Water Pollution Control*. WB Saunders.
21. Wilson, E. O. 2006.*The Creation: An appeal to save life on earth*. New York: Norton.
22. World Commission on Environment and Development. 1987. *Our Common Future*. Oxford University
23. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
24. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
25. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
26. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
27. Das, M.C. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.
28. Singh, (2012). Plant Systematics: Theory and Practice Oxford & IBH Pvt. Ltd., New Delhi. 3rdedition.
29. Jeffrey, C. (1982). An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge.
30. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.
31. Maheshwari, J.K. (1963). Flora of Delhi. CSIR, New Delhi.
32. Radford, A.E. (1986). Fundamentals of Plant Systematics. Harper and Row, New York.
33. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
34. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.

SEMESTER V

I. MAJOR COURSE- MJ 9:
CELL BIOLOGY & BIOCHEMISTRY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

After completion of the course, the learner shall be able to understand:

1. Cell biology study will provide inside into the organization of cell, its features and regulation at different levels.
2. Through the study of cell organelles, they will be able to understand the various metabolic processes such as respiration, photosynthesis etc. which are important for life.
3. The objective of the present course content is to provide a foundation and background in cellular and acellular entities of plants, cell structure in relation to functions, eukaryotic genome structure (including nuclear and organellar), and regulatory mechanisms.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. This course will be able to demonstrate foundational knowledge in understanding of cell.
2. Understanding of Cell metabolism, chemical composition, physiochemical and functional organization of organelle
3. Contemporary approaches in modern cell and molecular biology.

Course Content:

Cell Biology

Unit1: The cell- Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells. **(3 lectures)**

Unit 2: Cell wall and plasma membrane

Chemistry, structure and function of Plant cell wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes. **(5 lectures)**

Unit 3: Cell organelles

Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus. **Chloroplast, mitochondria and peroxisomes:** Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast. **Endomembrane system**: Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing; Smooth ER, export of proteins and lipids. **Golgi Apparatus** – organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Lysosomes. **(12 lectures)**

Unit 4: Cell division Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle- checkpoints. **(7 lectures)**

Biochemistry:

Unit 6: Biomolecules Types and significance of chemical bonds; Structure and properties of water; pH and buffers.

Carbohydrates: Nomenclature and classification; Monosaccharides; Disaccharides; Oligosaccharides and polysaccharides and its significance.

Lipids: Definition and major classes of storage and structural lipids; Fatty acids structure and functions; Essential fatty acids; Triacyl glycerols structure, functions and properties; Phosphoglycerides.

Proteins: Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and quaternary and biological roles of proteins.nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of tRNA. **(23 lectures)**

Unit 7: Enzymes

Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of

enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced - fit theory). **(6 lectures)**

Unit 8: Vitamins General characteristics of vitamins. Nomenclature and classification of vitamins and its significance. **(4 lectures)**

Reference Books:

1. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
2. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
3. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press &Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. 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
5. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett Publishers)

II. MAJOR COURSE- MJ 10:
GENETICS

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

2. The paper will deal with heredity inheritance pattern among the organism.
3. Linkage and genetic recombination.
4. Gene mapping
5. Chromosomal structure.

Course Learning Outcomes:

1. The unit will enable the students to learn about the use of linkage and recombination frequencies to map genes.
2. The unit will provide an understanding of:
   - Morphology of chromosomes and its relevance in genetics.
   - Chromosomal and their role in genome evolution with special reference to crop plants.

Genetics

Unit 1: Mendelian genetics and its extension
Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits; Polygenic inheritance. (**10 lectures)**

Unit 2: Extrachromosomal Inheritance
Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast; Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in Paramecium. **(4 lectures)**

Unit 3: Linkage, crossing over, genetic recombination and chromosome mapping
Linkage and crossing over-Cytological basis of crossing over; two factor and three factor crosses; genetic recombination, Recombination frequency, Interference and coincidence; Numericals based on gene mapping; Sex Linkage. **(5 lectures)**

Unit 4: Variation in chromosome number and structure
Deletion, Duplication, Inversion, Translocation, Euploidy and Aneuploidy **(5 lectures)**

Unit 5: Gene mutations
Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: ClB method. Role of Transposons in mutation. DNA repair mechanisms. **(8 lectures)**

Unit 6: Fine structure of gene
Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism; Structure of Phage T4, rII Locus. **(6 lectures)**

Unit 7. Population and Evolutionary Genetics
Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation. **(5 lectures)**

Plant Breeding and Crop improvement

Unit 1. Plant Breeding: Introduction to plant breeding, steps in plant breeding, various technique of selfing and crossing, methods of plant breeding in self-pollinated, cross pollinated and asexual propagated plants; Parasexuality; sources of variation in plant breeding; mutation breeding; field trial techniques. **(10 lectures)**

Unit 2. Crop improvement: Methods of crop improvement for disease and pest resistance; Breeding and improvement in rice, wheat, maize, millets, sugarcane and potato. Biofortification. **(8 lectures)**

Reference Books:

1. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
2. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
3. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press &Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. 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
5. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett Publishers)
6. P K Gupta, Plant Breeding, Rastogi Publication.
7. B D Singh, Plant Breeding, Kalyani Publication.
8. Kumar and Sinha, A cytogenetics plant breeding and evolutionary biology.

III. MAJOR COURSE- MJ 11:
PRACTICALS-IV:

Marks: Pr (ESE: 3Hrs) =100	Pass Marks: Pr (ESE) = 40

(Credits: Practicals-04) **120 Hours**

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment = 60 marks
Practical record notebook = 15 marks
Viva-voce = 25 marks

Cell Biology & Biochemistry and Cytogenetics & Plant Breeding

1. Study of cell and its organelles with the help of electron micrographs.
2. Stain preparation and different types of strains used in cytogenetics (Acetocarmine).
3. Study the phenomenon of plasmolysis and deplasmolysis.
4. Study the effect of organic solvent and temperature on membrane permeability.
5. Pollen viability test.
6. Preparation of temporary slides to study different stages of mitosis (Onion root tip/Provided material) and meiosis (Onion floral buds/Provided materials) using squash technique.
7. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
8. Chromosome mapping using point test cross data.
9. Incomplete dominance and gene interaction through seed ratios. (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
10. Photographs/Permanent Slides showing stages of mitosis and meiosis, Translocation Ring, Laggards andInversion Bridge.
11. Biochemical test of carbohydrate, lipid and protein.
12. Demonstration of hybridization techniques (Emasculation, Bagging and tagging)

Reference Books:

1. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
2. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
3. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press &Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. 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
5. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett Publishers)

SEMESTER VI

I. MAJOR COURSE- MJ 12: PLANT PHYSIOLOGY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

1. The course aims at making students realize how plants function, namely the importance of water, minerals, hormones, and light in plant growth and development; understand transport mechanisms and translocation in the phloem, and appreciate the commercial applications of plant physiology.
2. Current understanding of regulation and integration of metabolic processes in plants with reference to crop productivity. To gain the knowledge of physiological and biochemical processes in the plant system

Course Learning Outcomes:

On successful completion of this course the student should be able to:

1. To understand water and nutrient uptake and movement in plants, role of mineral elements, translocation of sugars. Role of various plant growth regulator as, phytochrome cytochromes and phototropins, and flowering stimulus. Students will gain the knowledge on reproductive strategies in higher plants along with physiology of flowering, molecular and hormonal basis of flowering mechanism.

Course Content:

Unit 1: Plant-water relations Water Potential and its components, mechanism of water absorption-active and passive absorption, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap– cohesion-tension theory. Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement. **(9 lectures)**

Unit 2: Mineral nutrition

Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents. **(7 lectures)**

Unit 3: Nutrient Uptake Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, antiport. **(7 lectures)**

Unit 4: Phloem Translocation Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship. **(5 lectures)**

Unit 5: Photosynthesis

Photosynthesis as a chemical process – Light and Dark reaction; mechanism of absorption of light. The pigment system – PS I and PS II. Phosphorylation – Electron Transport System and Photophosphorylation (Cyclic and Non-cyclic). Hatch and Slack Pathway. CAM Cycle; Significance of C4 cycle and CAM. Factors affecting rate of photosynthesis. Significance of photosynthesis. **(9 lectures)**

Unit 6: Respiration Types of respiration, mechanism (Glycolysis). Kreb's cycle: Electron Transport System, Oxidative phosphorylation, fermentation. Factors affecting rate of respiration. Photorespiration. **(7 lectures)**

Unit 7: Plant growth regulators Discovery, chemical structure and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene. **(7 lectures)**

Unit 8: Physiology of flowering

Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy. **(6 lectures)**

Unit 9: Phytochrome, cryptochromes and phototropins

Discovery, chemical nature and structure, role in photomorphogenesis. **(3 lectures)**

Reference Books:

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons.
2. U.S.A. 4thedition.
3. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
4. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.
5. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
6. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
7. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H. Freeman
8. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H. Freeman and Company
9. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company

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II. MAJOR COURSE- MJ 13:
MOLECULAR BIOLOGY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

1. To gain the knowledge of structure and functions of DNA and RNA.

Course Learning Outcomes:

1. Understanding of nucleic acid, organization of DNA in prokaryotes and Eukaryotes, DNA replication mechanism, genetic code and transcription process.
2. Processing and modification of RNA and translation process, function and regulation of expression. Application in biotechnology.

Course Content:

Unit 1: Nucleic acids: Carriers of genetic information. Introduction, DNA as the carrier of genetic information (Griffith's, McLeod & McCarty experiment). **(4 lectures)**

Unit 2. The Structures of DNA and RNA / Genetic Material

DNA Structure: Watson and Crick model, Salient features of double helix, denaturation and renaturation, Organization of DNA- Prokaryotes, Viruses, Eukaryotes. RNA Structure Organelle DNA -- mitochondria and chloroplast DNA. The Nucleosome Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin. **(15 lectures)**

Unit 3: The replication of DNA

Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semiconservative and semi discontinuous replication; Various models of DNA replication, including rolling circle, replication of linear ds-DNA, replication of the 5'end of linear chromosome; Enzymes involved in DNA replication. **(10 lectures)**

Unit 4: Genetic code Genetic code (deciphering and salient features) **(2 lectures)**

Unit 4: Transcription

Concept of central dogma, Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E.coli*. Gene silencing. **(8 lectures)**

Unit 5: Processing and modification of RNA

Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I and group II intron splicing, alternative splicing eukaryotic mRNA processing (5' cap, 3' polyA tail). **(7 lectures)**

Unit 6: Translation

Ribosome structure and assembly, mRNA; aminoacyl tRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis; Post-translational modifications of proteins. **(14 lectures)**

Reference Books:

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology ofthe Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th ed.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.
4. Russell, P. J. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis.
6. W. H. Freeman and Co., U.S.A. 10th edition.
7. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications ofrecombinant DNA. ASM Press, Washington.
8. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.

III. MAJOR COURSE- MJ 14:
PLANT BIOTECHNOLOGY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

1. The objective of the course is to give students new knowledge and widening of the knowledge acquired in other course by handling of classical and modern plant biotechnology processes, including tissue culture for healthy plants, plants with improved characteristics.
2. This course explores the use of biotechnology to both generate genetic variation in plants and to understand how factors at the cellular level contribute to the expression of genotypes and hence to phenotypic variation.
3. Understanding of biotechnological processes such as recombinant DNA technology.
4. This knowledge is central to our ability to modify plant responses and properties for global food security and commercial gains in biotechnology and agriculture. In the laboratory classes, students will perform some of the techniques currently used to generate information and detect genetic variation.

Course Learning Outcomes:

1. Learn the basic concepts, principles and processes in plant biotechnology. Have the ability of explanation of concepts, principles and usage of the acquired knowledge in biotechnological and agricultural applications.
2. Use basic biotechnological techniques to explore molecular biology of plants.
3. Understand, how biotechnology is used to for plant improvement and discuss the biosafety concern and ethical issue of that use.

Course Content:

Unit 1: Plant Tissue Culture

Introduction, Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation). **(15 lectures)**

Unit 2: Recombinant DNA technology

Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC). **(10 lectures)**

Unit 3: Gene Cloning

Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR mediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR. **(10 lectures)**

Unit 4: Methods of gene transfer

Biological method (Indirect): Agrobacterium-mediated; Physical methods (Direct): Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP). **(10 lectures)**

Unit 5: Applications of Biotechnology

Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns. **(15 lectures)**

Reference Books:

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology ofthe Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th ed.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.
4. Russell, P. J. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis.

6. W. H. Freeman and Co., U.S.A. 10th edition.
7. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
8. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
9. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.
10. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
11. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

IV. MAJOR COURSE- MJ 15:
PRACTICALS-V:

Marks: Pr (ESE: 3Hrs) =100	Pass Marks: Pr (ESE) = 40

(Credits: Practicals-04) **120 Hours**

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment = 60 marks
Practical record notebook = 15 marks
Viva-voce = 25 marks

Practicals:

Plant Physiology

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Determination of water potential of given tissue (potato tuber) by weight method.
3. Study of the effect of wind velocity and light on the rate of transpiration in excisedtwig/leaf.
4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
5. To study the phenomenon of seed germination (effect of light).
6. To study the effect of different concentrations of IAA on *Avena* coleoptileelongation (IAA Bioassay).
7. To study the induction of amylase activity in germinating barley grains.
8. Perform rate of photosynthesis and oxygen evolution by Wilmott's bubbler. Perform Moll's experiment.

Demonstration experiments

1. To demonstrate suction due to transpiration.
2. Bolting experiment/Avena coleptile bioassay (demonstration).
3. Study of plant cell structure with the help of epidermal peel mount of Onion/Rhoeo/Crinum.
4. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.
5. Measurement of cell size by the technique of micrometry.

MOLECULAR BIOLOGY & PLANT BIOTECHNOLOGY

1. Isolation of genomic DNA from *E.Coli.*
2. DNA isolation from plant leaves.
3. DNA estimation by diphenylamine reagent/UV Spectrophotometry.
4. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).
5. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
6. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments)
7. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing
8. (a) Preparation of MS medium.
   (b) Demonstration of in vitro sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura, Brassica* etc.
9. Study of anther, embryo and endosperm culture, micropropagation, somaticembryogenesis &artificial seeds through photographs.
10. Isolation of protoplasts.
11. Study of methods of gene transfer through photographs: Agrobacterium-mediated,direct gene transfer by electroporation, microinjection, microprojectile bombardment.
12. Study of steps of genetic engineering for production of Bt cotton, Golden rice,Flavr Savr tomato through photographs.

Reference Books

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology ofthe Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th ed.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.
4. Russell, P. J. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
5. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis.
6. W. H. Freeman and Co., U.S.A. 10th edition.
7. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. ElsevierScience Amsterdam. The Netherlands.
8. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications ofrecombinant DNA. ASM Press, Washington.
9. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas PublicationHouse Pvt. Ltd., New Delhi. 5th edition.
10. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
11. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques andApplications. John Wiley & Sons Inc. U.S.A.

SEMESTER VII

I. MAJOR COURSE- MJ 16:
BIOINFORMATICS & COMPUTATIONAL BIOLOGY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

1. To familiarize the students with the fundamental principles of Bioinformatics and Computational biology.
2. Various potential application of Bioinformatics and Computational tools in biology.

Course Learning Outcomes:

1. Ability to carry out research /investigation independently in specialized area of Bioinformatics and Computational Biology.

Course Content:

Bioinformatics (30 Lectures)

1. Bioinformatics: Introduction – genomics – transcriptome – proteome.
2. Biological databases: Generalized and specialized databases – DNA, protein and carbohydrate databases – nucleic acid sequence databases – premier institutes for databases – nucleic acid codes used in database formats; Collection and down loading of information from databases – literature search.
3. Sequence alignment and its evolutionary basis: Simple alignment and multiple sequence alignment - searching the database for sequence similarity – search programmes with special reference to FASTA, BLAST, CLUSTAL W. Application of bioinformatics in phylogenetic analysis.

Computational Biology (30 lectures)

1. Computer assisted drug design- concept, methods and practical approaches.
2. Diagrammatic, graphical and tabular representations of data; measures of central tendency, dispersion, skewness and kurtosis.
3. Basic concepts of hypothesis testing, two kinds of error, level significance, p value, t- Test for mean and difference between two means, partial t-test., and Chi square test for goodness of fit.

Reference Books

1. Xiong, Essential Bioinformatics, Cambridge University Press.
2. Marketa J Zvelebil, Understanding Bioinformatics, Garland Sciences.
3. Shui Quing Ye, Bioinformatics: A practical approach.
4. Anna Tramantano, Introduction to Bioinformatics.
5. David W Mount, Bioinformatics. CBS.
6. Mani K and Vijayaraj N, Bioinformatics, Kalaikathir Achchagam.

II. MAJOR COURSE- MJ 17:
ADVANCED MOLECULAR BIOLOGY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objectives:

1. To familiarize the students with the fundamental principles of molecular tools and techniques, and various potential application of molecular biology.

Course Learning Outcomes:

1. Use the techniques, skills, and modern tools necessary for imbalances in various life processes, design a molecular cell biology research project, collect and analyze data, and interpret results.

Course Content:

Unit 1: Introduction to Molecular Cloning

Vectors: Characteristics of cloning vectors, Plasmids (pBR322, pUC18/I9) and Ti plasmid. Shuttle vectors and Expression vectors: *E. coli lac* and T7 promoter-based vectors.

Enzymes used in Molecular Cloning: Restriction enzymes. Types I, II and III, nomenclature, use of Type II restriction enzymes in cloning. Reverse transcriptase.

Methods used in Molecular Cloning: Agarose gel electrophoresis of DNA, Southern, Northern and Western blotting. RFLP (Restriction Fragment Length Polymorphism).

Molecular probes: cDNA probes – RNA probes **(15 Lectures)**

Unit 2: PCR Techniques

Principle of Polymerase Chain Reaction, RT-PCR, Real-Time PCR and their applications. **(10 lectures)**

Unit 3: Gene Expression

Regulation of gene expression in Prokaryotes: various models - operon - details of lac operon-negative and positive control lac operon. Regulation gene expression in eukaryotes: Regulation of transcription - regulation of RNA processing and translation. Microarray and gene expression analysis. **(20 lectures)**

Unit 4: DNA Sequencing

DNA sequencing: Maxam Gilbert chemical method - Sanger's enzymatic chain termination method – foot printing. **(8 Lectures)**

Unit 5: Gene Silencing and Genome Editing

Introduction to gene silencing (RNAi)/ post-transcriptional gene silencing (PTGS) and its mechanism.

Introduction and Principle of genome editing **(7 Lectures)**

Reference Books:

1. Brown TA. (2010) Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Primrose SB and Twyman RM. (2006) Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
3. Sambrook J and Russell D. (2001) Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.
4. Walker J M and Gringold EB, Molecular Biology and Biotechnology. Panima.
5. Benjamin Lewin. Genes 1X. John Wiley.
6. Hartwell L H et al., Genetics: From Genes to Genome. Mc Graw Hill.
7. Watson J D et al., Molecular Biology of the Gene. The Benjamin / Cummings.
8. Lodish H et al., Molecular Cell Biology. Scientific American Books. W H Freeman.
9. David Freid felder, Molecular Biology. Narosa.
10. Adrin J Harwood, Methods in Molecular Biology, Vol.58, Basic DNA and RNA protocols. Humana Press.
11. Chris R Calladine et al., Understanding DNA. Elsevier.
12. Micklos D A et al., DNA Science. Cold Spring Harbour.
13. Cox et al, Molecular Biology, Principles and Practice, Freeman
14. Tropp, Molecular Biology, Genes to proteins, Jones and Bartlett
15. Allison, Fundamental Molecular Biology, Wiley.
16. Ernst L Winnacker, from genes to clones, Panim

III. MAJOR COURSE- MJ 18:
APPLIED BOTANY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objective:

1. To discuss the application of botany in various fields including the role of microbes and plants in the production of various products for the well-being of humans.
2. To acquaint with the recent technologies and methods in the field of improvement of crops and environment.

Course Learning Outcome:

1. The students will be able to know the basic as well as advanced trends in the field of botany to remediate the environment with the help of microbes and their various applications.
2. Various recent trends to improve the plants quality and its products.
3. To analyse the basic knowledge regarding the proteins and genome of the plants.

Course Content:

1. Role of microbes in Industries and Human Welfare (10 lectures)

(i) Production and application of organic acids; lactic acid, citric acid and acetic acid. Concept of antibiosis, secondary metabolites, antibiotic fermentation.

(ii) Biological wastewater treatment: Upflow Anaerobic Sludge Blanket (USAB), Reactor and Fluidized Bed Reactor (FBR).

(iii) Food toxicology: Microbial toxins (Endotoxin and exotoxin). Source of microbial toxin in contamination of food grains and food products, spoilage of food.

(iv) Basic concept in brief FDA (Food and Drug Administration), EPA (Environment Protection Act), HACCP (Hazard Analysis and Critical Control Points) and FSA (Flexible Spending Account).

2. Application of microbes in fermentation processes: Types, design and maintenance of bioreactors. Application of fermentation technology in industry. **(4 lectures)**

3. Fossil fuels and their environmental impact; Biofuels: Microbial enhanced oil recovery, Bio-ethanol and bio-diesel production, commercial production from lignocellulosic waste, Biogas production – Methane and hydrogen production using microbial culture. Extremophiles and their biotechnological applications. **(10 lectures)**

4. Production of antibiotics, vaccines, and biocides: Bioreactors; Bioprocess engineering; Production of non-microbial origin products by genetically engineered microorganisms. Concept of probiotics and applications of new tools of biotechnology for quality feed/food production. Single cell protein, Bioinsecticides; Biofertilizers; Recent advances in microbial biotechnology. Mass cultivation of *Spirulina*, *Chlorella* and *Scenedesmus*, Commercial potential of *Spirulina*, *Duneliella* and *Porphyra*. **(10 lectures)**

5. A brief account on Phytochemical and Pharmacological aspects and uses of following medicinal plants: *Andrographis paniculata, Bacopa monnieri, Centella asiatica, Curcuma longa, Momordica charantia, Ocimum sanctum, Phylanthus niruri, Tinospora cordifolia, Withania somnifera.* **(10 lectures)**

6. Conventional versus non-conventional methods for crop improvement. Genetic engineering for resistance against abiotic and biotic stresses; Genetic engineering for increasing crop productivity; Genetic engineering for quality improvement. Molecular breeding: constructing molecular maps, physical and molecular maps; diversity assessment and phylogenetic analysis; molecular tagging of genes/traits. **(10 lectures)**

7. Classical ways of genome analysis. DNA chips and their use in transcriptome analysis. General uses and application of Crystallography. Genomics and proteomics of cyanobacteria, yeast and *fusarium*. Applications of genomics and proteomics in agriculture, human health and industry. **(6 lectures)**

Reference Book:

1. Brown TA. (2010) Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Primrose SB and Twyman RM. (2006) Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
3. Sambrook J and Russell D. (2001) Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.
4. Walker J M and Gringold EB, Molecular Biology and Biotechnology. Panima.
5. Benjamin Lewin. Genes 1X. John Wiley.
6. Hartwell L H et al., Genetics: From Genes to Genome. Mc Graw Hill.
7. Watson J D et al., Molecular Biology of the Gene. The Benjamin / Cummings.
8. Lodish H et al., Molecular Cell Biology. Scientific American Books. W H Freeman.
9. David Freid felder, Molecular Biology. Narosa.
10. Adrin J Harwood, Methods in Molecular Biology, Vol.58, Basic DNA and RNA protocols. Humana Press.
11. Chris R Calladine et al., Understanding DNA. Elsevier.
12. Micklos D A et al., DNA Science. Cold Spring Harbour.
13. Cox et al, Molecular Biology, Principles and Practice, Freeman
14. Tropp, Molecular Biology, Genes to proteins, Jones and Bartlett
15. Allison, Fundamental Molecular Biology, Wiley.
16. Ernst L Winnacker, from genes to clones, Panim
17. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
18. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGrawHill International.
19. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
20. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, New Delhi.
21. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008).
22. Biology, Pearson Benjamin Cummings, USA. 8th edition.
23. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
24. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
25. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
26. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
27. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
28. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman andCompany.
29. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
30. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A.
31. 8th edition.
32. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press &Sunderland, Washington, D.C.; Sinauer Associates, MA.
33. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009) The World of the Cell. 7th edition.
34. Pearson Benjamin Cummings Publishing, San Francisco
35. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology ofthe Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
36. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th ed.
37. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.
38. Russell, P. J. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
39. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis.
40. W. H. Freeman and Co., U.S.A. 10th edition.
41. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. ElsevierScience Amsterdam. The Netherlands.
42. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications ofrecombinant DNA. ASM Press, Washington.
43. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas PublicationHouse Pvt. Ltd., New Delhi. 5th edition.
44. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
45. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques andApplications. John Wiley & Sons Inc. U.S.A.

IV. MAJOR COURSE- MJ 19:
PRACTICALS-VI:

Marks: Pr (ESE: 3Hrs) =100	Pass Marks: Pr (ESE) = 40

(Credits: Practicals-04) **120 Hours**

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment = 60 marks
Practical record notebook = 15 marks
Viva-voce = 25 marks

Practicals:
BIOINFORMATICS AND COMPUTATIONAL BIOLOGY

1. Gene identification by using Genbank (NCBI).
2. Sequence alignment and construction of phylogenetic tree by using tools (BLAST, MEGA, Bioedit).
3. Student t-test and Chi square test.

ADVANCED MOLECULAR BIOLOGY

1. Isolation of plasmid/genomic DNA.
2. Agarose Gel Electrophoresis of plasmid/genomic DNA.
3. Digestion of plasmid DNA using restriction enzymes and analysis by agarose gel electrophoresis.

Reference Books

1. Brown TA. (2010) Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Primrose SB and Twyman RM. (2006) Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
3. Sambrook J and Russell D. (2001) Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

SEMESTER VIII

I. MAJOR COURSE- MJ 20:
ADVANCED BIOTECHNOLOGY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objective
To familiarize the students with the fundamental principles of Biotechnology, various developments in Biotechnology and its potential applications.

Course Learning Outcomes
Ability to carry out research /investigation independently in specialized area of Biotechnology.

Course Content:
Unit 1: History of plant cell and tissue culture; Culture media; Various types of culture; callus, suspension, nurse, root, meristem, etc.; In vitro differentiation: organogenesis and somatic embryogenesis; Plant growth regulators: mode of action, effects on in vitro culture and regeneration; Molecular basis of plant organ differentiation. **(10 Lectures)**

Unit 2: Micropropagation; Anther and microspore culture; Somaclonal variation; In vitro mutagenesis; In vitro fertilization; In vitro germplasm conservation; Production of secondary metabolites; Synthetic seeds. **(10 Lectures)**

Unit 3: Embryo rescue and wide hybridization; Protoplast culture and regeneration; Somatic hybridization: protoplast fusion, cybrids, asymmetric hybrids, etc. **(8 Lectures)**

Unit 4: Methods of plant transformation; Vectors for plant transformation; Genetic and molecular analyses of transgenics; Target traits and transgenic crops; Biosafety issues, testing of transgenics, regulatory procedures for commercial approval. **(15 Lectures)**

Unit 5: Secondary Agriculture Biotechnology: Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters. **(5 Lectures)**

Unit 6: GM crops: Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals. **(5 Lectures)**

Unit 7: Bioethics and Biosafety **(3 Lectures)**

Unit 8: Intellectual Property Right in Biotechnology **(4 Lectures)**

Reference Books:

1. Bhojwani SS. 1983. Plant Tissue Culture: Theory and Practice. Elsevier.
2. Christou P & Klee H. 2004. Handbook of Plant Biotechnology. John Wiley & Sons.
3. Dixon RA. 2003. Plant Cell Culture. IRL Press.
4. George E F, Hall MA & De Klerk GJ. 2008. Plant Propagation by Tissue Culture. Agritech Publ.
5. Gupta PK. 2004. Biotechnology and Genomics. Rastogi Publ.
6. Herman EB. 2005-08. Media and Techniques for Growth, Regeneration and Storage. Agritech Publ.
7. Pena L. 2004. Transgenic Plants: Methods and Protocols. Humana Press.
8. Pierik RLM. 1997. In vitro Culture of Higher Plants. Kluwer.
9. Singh BD. 2007. Biotechnology: Expanding Horizon. Kalyani.

II. ADVANCED MAJOR COURSE- AMJ 1: BIOLOGICAL INSTRUMENTATION

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objective

1. Understand the Principles of microscopy.
2. Understand the structure and functioning of various biological instruments.
3. Get enlighten their knowledge in various biochemical methods

Course Learning Outcomes

1. Skill in operating laboratory equipment, their upkeep, and adept at various biological techniques.
2. Ability to prepare molar, molal, normal solutions and solutions of different dilutions. Interpreting
3. scientific results, and ability to present results in a scientific way through graphs, photographs, poster presentations and power point presentations.

Course Content:

Unit 1: Imaging and related techniques: Principles of microscopy; Light microscopy; Fluorescence microscopy; Electron Microscopy (a) Flow cytometry (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. **(15 lectures)**

Unit 2: pH and Centrifugation: pH meter: Principles and instrumentation, Centrifugation: Principles, types of centrifuges, types of rotors, differential and density gradient centrifugation, application. Sonication, Freeze drying. **(10 lectures)**

Unit 3: Spectrophotometry: Principle involved in Spectrophotometer; Spectrophotometric techniques, Instrumentation: ultraviolet and visible spectrophotometry (single and double beam, double wavelength spectrophotometers), Infrared spectrometers - Luminometry and densitometry – principles and their applications - Mass Spectroscopy-principles of analysis, application in Biology. **(15 lectures)**

Unit 4: Chromatography: Chromatographic techniques: Principle and applications – Column - thin layer – paper, affinity and gas chromatography - Gel filtration - Ion exchange and High-performance liquid chromatography techniques– Examples of application for each chromatographic system - Basic principles of electrophoresis. **(10 lectures)**

Unit 5: Preparation of molar, molal and normal solutions, buffers, the art of scientific writing: Understanding the details on the label of reagent bottles. Molarity and normality of common acids and bases. Preparation of solutions. Dilutions. Percentage solutions. Molar, molal and normal solutions. Technique of handling micropipettes; Knowledge about common toxic chemicals and safety measures in their handling. The art of scientific writing and presentation of scientific matter. Scientific writing and ethics. Writing references. PowerPoint presentation. Poster presentation. Introduction to copyright-academic misconduct/plagiarism in scientific writing. **(10 lectures)**

Reference Books:

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 micro technique and microscopy. Oxford University Press, New York, U.S.A.
4. Bajpai, P.K. 2006. Biological Instrumentation and methodology. S. Chand & Co. Ltd.
5. K. Wilson and J. Walker Eds. 2005. Biochemistry and Molecular Biology. Cambridge University Press.
6. K. Wilson andKHGoulding. 1986. Principles and techniques of Practical Biochemistry. (3 edn) Edward Arnold, London.
7. 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.
8. Ruzin, S.E. (1999). Plant micro technique and microscopy. Oxford University Press, New York, U.S.A

III. ADVANCED MAJOR COURSE- AMJ 2: NANOBIOTECHNOLOGY

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 40

(Credits: Theory-04) **60 Hours**

Course Objective

To familiarize the students with the fundamental principles of Nanobiotechnology, various potential application of Nanobiotechnology.

Course Learning Outcomes

Ability to carry out research /investigation independently in specialized area of Nanobiotechnology.

Course Content:

NANO-BIOTECHNOLOGY

1. Introduction of Nanobiotechnology and its applications. Various types of nanomaterial utilized in agriculture.
2. Synthesis of nanoparticle: Physical, Chemical and Biological.
3. Structural characterization techniques: X-ray diffraction (XRD) technique, particle size determination using XRD, Applications of XRD, Electron diffraction and its application, neutron diffraction and its applications. Zeita particle analyser and its application.
4. Electron Microscopy: Introduction to Scanning Electron Microscopy, FESEM, Transmission Electron Microscopy, Scanning Tunneling Microscopy.
5. Spectroscopic Techniques: UV visible spectroscopy, Infrared Spectroscopy and Fourier Transform Infrared Spectroscopy.
6. Nanoparticles in agricultural and food diagnostics: Biopesticides, biofertilizers, Biosensors and Diagnostics - DNA-Based Biosensors and Diagnostics, Radiofrequency Identification.
7. Nanotechnology in food production: Food and new ways of food production. Efficient fractionation of crops, Efficient product structuring, Optimizing Nutritional Values, Applications of Nanotechnology in Foods: Sensing, Engineering Food Ingredients to Improve Bioavailability, Nanocrystalline Food Ingredients – Nano-emulsions – Nano Engineered Protein Fibrils as Ingredient Building Blocks.
8. Nanotechnology in food packaging: Reasons to Package Food Products. Smart nanomaterials for packaging.
9. Application of nanotechnology in synthesis of drug.
10. Regulatory and safety measures for nanotechnology based agriculture products.

Reference Books:

1. The 2018-2023 World Outlook for Nanobiotechnology Paperback – December 18, 2017, Icon group international.
2. Arunava Goswami and Samrat Roy Choudhury, Nanobiotechnology, Basic and Applied Aspects.
3. Clive Jarvis, Nanobiotechnology: An Introduction.
4. H B Singh, S Mishra, L F Fraceto, R D D Lima; Emerging Trends in Agri-Nanotechnology.
5. Elements of X-ray diffraction, B D Cullity- Addison-Wesley Publishing Company, Inc.
6. Encyclopedia of Materials Characterization, C. Richard Brundle and Charles A. Evans, Jr.
7. Willard, Merritt, Dean, Settle - Instrumental Methods of Analysis, 7th edition.

IV. ADVANCED MAJOR COURSE- AMJ 3: **PRACTICALS-VII:**

Marks: Pr (ESE: 3Hrs) =100	**Pass Marks: Pr (ESE) = 40**

(Credits: Practicals-04) **120 Hours**

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment = 60 marks
Practical record notebook = 15 marks
Viva-voce = 25 marks

Practicals:

1. Preparation of nutrient media; handling and sterilization of plant material; inoculation, sub-culturing and plant regeneration.
2. Anther and pollen culture.
3. Embryo rescue.
4. Suspension cultures and production of secondary metabolites.
5. Protoplast isolation, culture and fusion.
6. Gene cloning and vector construction Gene transfer using different methods, reporter gene expression, selection of transformed tissues/plants, molecular analysis.
7. The art of imaging of samples through microphotography and field photography.
8. Poster presentation on defined topics.
9. Technical writing on topics assigned.

Reference Books

1. Bhojwani SS. 1983. Plant Tissue Culture: Theory and Practice. Elsevier.
2. Christou P & Klee H. 2004. Handbook of Plant Biotechnology. John Wiley & Sons.
3. Dixon RA. 2003. Plant Cell Culture. IRL Press.
4. George E F, Hall MA & De Klerk GJ. 2008. Plant Propagation by Tissue Culture. Agritech Publ.
5. Gupta PK. 2004. Biotechnology and Genomics. Rastogi Publ.
6. Herman EB. 2005-08. Media and Techniques for Growth, Regeneration and Storage. Agritech Publ.
7. Pena L. 2004. Transgenic Plants: Methods and Protocols. Humana Press.
8. Pierik RLM. 1997. In vitro Culture of Higher Plants. Kluwer.
9. Singh BD. 2007. Biotechnology: Expanding Horizon. Kalyani.

COURSES OF STUDY FOR FYUGP IN **"BOTANY" MINOR**

MINOR COURSE-1A (SEM-I)

I. MINOR COURSE- MN 1A: BIODIVERSITY

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	**Pass Marks: Th (SIE + ESE) = 30**

(Credits: Theory-03) **45 Hours**

Course Objectives:

1. To introduce the students with diversity of plants such as microbes, algae, fungi, archegoniates.

Course Learning Outcomes:

1. It acquaints the students with diversity of plants like microbes, algae, fungi, archegoniates and, complex interrelationship between organisms and environment; community patterns andprocesses, ecosystem functions, and principles of phytogeography.

Course Content:

Unit 1: Microbes

General characteristic and economic importance of microorganism. Viruses –Lytic and lysogenic cycle, RNA virus (TMV); Bacteria – cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction). **(6 lectures)**

Unit 2: Algae

Classification of algae, General characteristics; Range of thallus organization and life cycle pattern; Life cycle of Nostoc, Chlamydomonas and Batrachospermum. Economic importance of algae. **(7 lectures)**

Unit 3: Fungi

Classification of fungi, General characteristics; Range of thallus organization and life cycle pattern; True Fungi- life cycle of Albugo, Puccinia, Alternaria, Agaricus; economic importance of fungi.
Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza and their significance **(10 lectures)**

Unit 4: Introduction to Archegoniate

Unifying features of archegoniates, Transition to land habit, Alternation of generations. **(2 lectures)**

Unit 5: Bryophytes

General characteristics, adaptations to land habit, Classification. Life cycle of Marchantia and Sphagnum. Economic importance of Bryophytes. **(6 lectures)**

Unit 6: Pteridophytes

General characteristics, classification. Life cycle of Lycopodium, Selaginella and Pteris. heterospory and Seed habit. Types of stele. **(8 lectures)**

Unit 4: Gymnosperms

General characteristics; Classification. Life cycle of Cycas and Pinus. Economic importance. **(6 lectures)**

Reference Books:

1. Botany for degree students; A.C. Dutta
2. College Botany; Vol I, Ganguly, Das and Dutta
3. College Botany; Vol. II, Ganguly, Kar and Santra
4. Study of Botany; Mitra, Mitra and Guha
5. A text book of Botany; K. S. Bilgrami
6. A text book of Botany; Vol. I & II, Hait, Bhattacharya and Ghosh
7. Practical botany: Bendre and Kumar, and S. P. Lal

II. MINOR COURSE- MN 1A PR:
MINOR PRACTICALS-1A PR

Marks: Pr (ESE: 3Hrs) = 25	Pass Marks: Pr (ESE) = 10

(Credits: Practicals-01) **30 Hours**

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

Practicals:

1. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
2. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
3. Gram staining
4. Study of vegetative and reproductive structures of Nostoc, Chlamydomonas (electron micrographs), through temporary preparations and permanent slides.
5. Alternaria: Specimens/photographs and tease mounts.
6. Puccinia: Herbarium specimens of Black Stem Rust of Wheat and infected Barberryleaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
7. Agaricus: Specimens of button stage and full grown mushroom; Sectioning of gills of Agaricus.
8. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
9. Marchantia- morphology of thallus, w.m. rhizoids and scales, v.s. thallus throughgemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).
10. Sphagnum- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
11. Selaginella- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m.microsporophyll and megasporophyll (temporary slides), l.s. strobilus (permanent slide).
12. Equisetum- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore,w.m. spores (wet and dry)(temporary slides); t.s rhizome (permanent slide).
13. Pteris- morphology, t.s. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores (temporary slides), t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).
14. Cycas- morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet,v.s. microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).
15. Pinus- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m.dwarf shoot, t.s. needle, t.s. stem, , l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores (temporary slides), l.s. female cone, t.l.s. & r.l.s. stem (permanent slide).

Reference Books:

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Pub. Pvt. Ltd., Delhi.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
7. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

MINOR COURSE-1B (SEM-III)

III. MINOR COURSE- MN 1B:
PLANT ECOLOGY AND TAXONOMY

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

(Credits: Theory-03) **45 Hours**

Course Objectives:

1. To make them understand complex community patterns and processes, and ecosystem functioning.
2. environmental factors affecting the plants, the basic principles of ecology and phytogeography.
3. Objective of this paper is to make students aware about the diversity of plant life and their role in economical, ecological and biotechnological aspects with focus on restoration of ecosystems and sustainable development.

Course Learning Outcomes:

1. This knowledge is critical in evolving strategies for sustainable natural resource management and biodiversity conservation.
2. Students will be able to learn the diversity of plant kingdom and scientific nomenclature of plants. Acquaintance of students with micro to macro flora of different groups along with their utilization for human welfare.

Course Content:

Unit 1: Introduction **(2 lectures)**

Unit 2: Ecological factors

Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes. **(7 lectures)**

Unit 3: Plant communities

Succession: Hydrosere and Xerosere. **(5 lectures)**

Unit 4: Ecosystem

Structure and function of ecosystem; energy flow trophic organisation; Food chains and food webs, Ecological pyramids; Biogeochemical cycling; Cycling of carbon, nitrogen and phosphorous. **(6 lectures)**

Unit 5: Phytogeography

Phytogeographical regions of India.

Unit 6 Introduction to plant taxonomy

Classification (Bentham and Hooker), Identification, Nomenclature). Functions of Herbarium, important herbaria and botanical gardens of India. Principle of ICN. Ranks, categories and taxonomic groups. **(2 lectures)**

Unit 7 Taxonomic evidences

Taxonomic evidences from morphology and anatomy. **(3 lectures)**

Reference Books:

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson BenjaminCummings, U.S.A. 10th edition.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt.Ltd., Delhi.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi,India.
6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
7. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers,New Delhi, India.
8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot,Allahabad.

9. Carson, R. 2002. *Silent Spring*. Houghton Mifflin Harcourt.
10. Gadgil, M., & Guha, R.1993. *This Fissured Land: An Ecological History of India*. Univ. of California Press.
11. Gleeson, B. and Low, N. (eds.) 1999.*Global Ethics and Environment*, London, Routledge.
12. Gleick, P. H. 1993. *Water in Crisis*. Pacific Institute for Studies in Dev., Environment & Security.Stockholm Env. Institute, Oxford Univ. Press.
13. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll.*Principles of Conservation Biology*.Sunderland: Sinauer Associates, 2006.
14. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. *Science*, 339:36--37.
15. McCully, P. 1996. *Rivers no more: the environmental effects of dams* (pp. 29--64). Zed Books.
16. McNeill, John R. 2000. Something New Under the Sun: An Environmental History of the TwentiethCentury.
17. Odum, E.P., Odum, H.T. & Andrews, J. 1971.*Fundamentals of Ecology*. Philadelphia: Saunders.
18. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. AcademicPress.
19. Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatment*. Oxford and IBH Publishing Co. Pvt. Ltd.
20. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012.*Environment*. 8th edition. John Wiley & Sons.
21. Rosencranz, A., Divan, S., & Noble, M. L. 2001. *Environmental law and policy in India*. *Tripathi1992*.
22. Sengupta, R. 2003. *Ecology and economics*: An approach to sustainable development. OUP.
23. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation*.
24. S. Chand Publishing, New Delhi.
25. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. *Conservation Biology*: *Voices from the Tropics*.John Wiley & Sons.
26. Thapar, V. 1998. *Land of the Tiger*: *A Natural History of the Indian Subcontinent*.
27. Warren, C. E. 1971. *Biology and Water Pollution Control*. WB Saunders.
28. Wilson, E. O. 2006.*The Creation: An appeal to save life on earth*. New York: Norton.
29. World Commission on Environment and Development. 1987. *Our Common Future*. OxfordUniversity
30. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
31. Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition

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IV. MINOR COURSE- MN 1B PR:
MINOR PRACTICALS-1B PR

Marks: Pr (ESE: 3Hrs) = 25	Pass Marks: Pr (ESE) = 10

(Credits: Practicals-01) **30 Hours**

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

Practicals:

1. Study of instruments used to measure microclimatic variables: Soil thermometer, anemometer, rain gauge and lux meter.
2. Determination of pH of soil sample.
3. Comparison of water holding capacity in soil of three habitats.
4. Study of morphological adaptations of hydrophytes and xerophytes (four each).
5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
6. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law
7. Study of vegetative and floral characters of the following families (Description, V.S. flower, sectionof ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification): Local available flora.
8. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

Reference Books

1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
2. Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
3. Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A. Singh, G. (2012).
4. Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.

MINOR COURSE-1C (SEM-V)

V. MINOR COURSE- MN 1C:
PLANT ANATOMY & EMBRYOLOGY

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

(Credits: Theory-03) **45 Hours**

Course Objectives:

1. The Objective of this paper is to provide basic knowledge of plant internal architecture, cellularcomposition and reproduction.
2. This help them to understand how different plant tissue structureevolve and modify their functions with respect to their environment. Also, to make them awareabout identification, nomenclature and classification.

Course Learning Outcomes:

1. Knowledge regarding anatomy equipped the students to identify different types of tissues andmake them able to correlate their physiology in a better away.
2. This will also help them to understand how different plant tissue evolve and modify their structure and functions with respect to their environment.
3. Knowledge regarding embryology make them understand how reproduction play significant role in defining population structure and natural diversity.
4. Also, after successful completion of the course the student shall have adequate knowledge about thebasic principle and nomenclature of plant classification, herbarium preparation.

Course Content:

Unit 1: Meristematic and permanent tissues
Root and shoot apical meristems; Simple and complex tissues **(8 lectures)**

Unit 2: Organs Structure of dicot and monocot root stem and leaf. **(4 lectures)**

Unit 3: Secondary Growth
Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood) **(8 lectures)**

Unit 4: Adaptive and protective systems
Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes. **(8 lectures)**

Unit 5: Structural organization of flower
Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac. **(8 lectures)**

Unit 6: Pollination and fertilization
Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms. **(8 lectures)**

Unit 7: Embryo and endosperm
Endosperm types, structure and functions; Dicot and monocot embryo; Embryoendospermrelationship **(8 lectures)**

Unit 8: Apomixis and polyembryony
Definition, types and Practical applications **(8 lectures)**

Reference Books:

1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd New Delhi. 5th edition.
2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

VI. MINOR COURSE- MN 1C PR:
MINOR PRACTICALS-1C PR

Marks: Pr (ESE: 3Hrs) = 25	Pass Marks: Pr (ESE) = 10

(Credits: Practicals-01) **30 Hours**

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

Practicals:

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
3. Stem: Monocot: Zea mays; Dicot: Helianthus; Secondary: Helianthus (only Permanent slides).
4. Root: Monocot: Zea mays; Dicot: Helianthus; Secondary: Helianthus (only Permanent slides).
5. Leaf: Dicot and Monocot leaf (only Permanent slides).
6. Adaptive anatomy: Xerophyte (Nerium leaf); Hydrophyte (Hydrilla stem).
7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous.
9. Female gametophyte: Polygonum (monosporic) type of Embryo sac Development (Permanent slides/photographs).
10. Ultrastructure of mature egg apparatus cells through electron micrographs.
11. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
12. Dissection of embryo/endosperm from developing seeds.
13. Calculation of percentage of germinated pollen in a given medium.

Reference Books:

1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.
2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

MINOR COURSE-1D (SEM-VII)

VII. MINOR COURSE- MN 1D: PLANT PHYSIOLOGY & METABOLISM

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

(Credits: Theory-03) **45 Hours**

Learning Objectives:

1. The course aims at making students realize how plants function, namely the importance of water, minerals, hormones, and light in plant growth and development.
2. Understand transport mechanisms and translocation in the phloem, and appreciate the commercial applications of plant physiology.
3. Also, students acquired knowledge about handling of classical and modern plant biotechnology processes, including tissue culture for healthy plants, plants with improved characteristics.

Learning Outcomes:

1. The students are able to correlate morphology, anatomy, cell structure and biochemistry with plant functioning.
2. The link between theory and practical syllabus is established, and the employability of youth would be enhanced.
3. The youth can also begin small-scale enterprises.
4. Have the ability of explanation of concepts, principles and usage of the acquired knowledge in biotechnological, pharmaceutical, medical, ecological and agricultural applications.

Course Content:

Unit 1: Plant-water relations

Importance of water, water potential and its components; Transpiration types and its mechanism, significance; Factors affecting transpiration; Root pressure and guttation. **(2 lectures)**

Unit 2: Mineral nutrition

Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport. **(2 lectures)**

Unit 3: Translocation in phloem

Composition of phloem sap, girdling experiment; Pressure flow model; Mechanism of translocation of Organic solutes. **(2 lectures)**

Unit 4: Photosynthesis

Photosynthetic Pigments (Chla, Chlb, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Photophosphorylation; C3, C4 and CAM pathways of carbon fixation; Photorespiration. **(3 lectures)**

Unit 5: Respiration

Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway. **(3 lectures)**

Unit 6: Enzymes

Structure and properties; Mechanism and mode of enzyme action, factors. **(2 lectures)**

Unit 7: Nitrogen metabolism

Biological nitrogen fixation; Nitrate and ammonia assimilation. **(3 lectures)**

Unit 8: Plant growth regulators

Discovery and physiological roles of Auxins, Gibberellins, Cytokinins, ABA, Ethylene. **(3 lectures)**

Unit 9: Plant response to light and temperature

Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization. **(3 lectures)**

Reference Books:

1. Taiz, L., Zeiger, E., (2010). Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.
2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. JohnWiley & Sons, U.S.A. 4th ed.
3. Bajracharya, D., (1999). Experiments in Plant Physiology- A LaboratoryManual. Narosa Publishing House, New Delhi.
4. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory andPractice. Elsevier Science Amsterdam. The Netherlands.
5. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles andApplications of recombinant DNA. ASM Press, Washington.

VIII. MINOR COURSE- MN 1D PR:
MINOR PRACTICALS-1D PR

Marks: Pr (ESE: 3Hrs) = 25	**Pass Marks: Pr (ESE) = 10**

(Credits: Practicals-01) **30 Hours**

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

Practicals:

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Measurement of rate of transpiration; Farmers photometer/Ganogs photometer.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Demonstration of Hill reaction.
5. To study the effect of light intensity and bicarbonate concentration on O2 evolution inphotosynthesis.
6. Separation of amino acids / pigments by paper chromatography.
7. To determine the absorption of water by Oily and starchy seed.

Demonstration experiments

1. Effect of auxins on rooting.
2. Suction due to transpiration.
3. R.Q.
4. Respiration in roots.

Reference Books:

1. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.
3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.
