FYUGP

BOTANY HONOURS/ RESEARCH

FOR UNDER GRADUATE COURSES UNDER RANCHI UNIVERSITY

Implemented from
Academic Session 2022-2026

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

1. **Chairman –**

   Dr. Kunul Kandir
   Professor & Head,
   University Department of Botany, Ranchi University, Ranchi

2. **Internal Members-**

   i. **Dr. Latika Sharan**
   Associate Professor,
   University Department of Botany, Ranchi University, Ranchi

   ii. **Dr. Anita Mehta**
   Associate Professor,
   University Department of Botany, Ranchi University, Ranchi

   iii. **Dr. Anil Kumar**
   Associate Professor,
   University Department of Botany, Ranchi University, Ranchi

   iv. **Dr. Radha Krishna Jha**
   Associate Professor,
   University Department of Botany, Ranchi University, Ranchi

   v. **Dr. Smrity Prabha**
   Assistant Professor,
   University Department of Botany, Ranchi University, Ranchi

   vi. **Dr. Ladly Rani**
   Assistant Professor,
   University Department of Botany, Ranchi University, Ranchi

   vii. **Dr. Sameer Gunjan Lakra**
   Assistant Professor,
   University Department of Botany, Ranchi University, Ranchi

   viii. **Dr. Shweta Nag**
   Assistant Professor,
   University Department of Botany, Ranchi University, Ranchi

   ix. **Dr. Binod Kumar Mahto**
   Assistant Professor,
   University Department of Botany, Ranchi University, Ranchi

3. **External Members :-**

   i. **Dr. Anjani Kumar Srivastava**
   University Professor (Retd.),
   University Department of Botany, Ranchi University, Ranchi

   ii. **Dr. Ashok Kumar Choudhary**
   University Professor (Retd.),
   University Department of Botany, Ranchi University, Ranchi

   iii. **Dr. Sudhanshu Kumar**
   University Professor,
   Department of Botany, P.P.K. College, Bundu

23/9/2022
DIRECTOR
IQAC, RANCHI UNIVERSITY
RANCHI-834 001

Kandir
10.8.2022

iv. **Dr. J.P. Singh**
Associate Professor,
Department of Botany, R.L.S.Y. College, Ranchi

v. **Dr. Malay Bharti**
Associate Professor,
Department of Botany, Doranda College, Ranchi

vi. **Dr. Suniti Chaudhary**
Associate Professor,
Department of Botany, Y.S.M., Ranchi

vii. **Dr. Mridula Xess**
Assistant Professor,
Department of Botany, Gossner College, Ranchi

viii. **Dr. Anubhuti Singh**
Assistant Professor,
Department of Botany, Nirmala College, Ranchi

ix. **Dr. Birbal Nag**
Assistant Professor,
Department of Botany, Simdega College, Simdega

x. **Dr. S.N. Oraon**
Assistant Professor,
Department of Botany, J.N. College, Dhurwa

xi. **Dr. Amar Das**
Assistant Professor,
Department of Botany, K.O. College, Gumla

xii. **Dr. Bidya Sahu**
Assistant Professor,
Department of Botany, S.G.M. College, Pandra

xiii. **Dr. Suchitra Mahato**
Assistant Professor,
Department of Botany, Silli College, Silli

xiv. **Dr. Ashmrita Mahto**
Assistant Professor,
Department of Botany, Birsa College, Khunti

xv. **Dr. Sarita Mehta**
Assistant Professor,
Department of Botany, B.S. College, Lohardaga

xvi. **Miss. Anshu Ankita Bara**
Assistant Professor
Department of Botany, St. Paul's College, Ranchi

23/8/22
DIRECTOR
IQAC, RANCHI UNIVERSITY
RANCHI-834 001

Kandir
10.08.2022
Dr. Kunul Kandir
H.O.D. Botany
Professor & Head
Univ. Dept. of Botany
RANCHI UNIVERSITY, RANCHI

Contents

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.

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.

ACADEMIC CALENDAR

- 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:
  - a Certificate after completing 1 year (2 semesters) of study in the chosen fields of study,
  - a Diploma after 2 years (4 semesters) of study,
  - a Bachelor after a 3-year (6 semesters) programme of study,
  - a Bachelor (with Hons. / Research) after a 4-year (8 semesters) programme of study

VALIDITY OF REGISTRATION

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

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 AND SPAN PERIOD

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. However, it will be necessary to procure pass marks in each of the paper before completion of the course.
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 16 papers out of the total 22 papers.
v. Eligibility to get entry in Semester VII is to secure a minimum of 7.5 CGPA up to semester VI along with other criteria imposed by the Institution.

PUBLICATION OF RESULT

- The result if 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.

---*---

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

Table 1: Credit Framework for Four Year Undergraduate Programme (FYUGP) under State Universities of Jharkhand [Total Credits = 176]

	Common Courses (29)									**Introductory Courses (15)**		**Internship/ Project (4)**	**Major* (54) + Adv. Major (24)**	**Minor** (32)**		**Research Courses (18)**				**Total Credit**
Semester	Language and Communication Skills (Modern Indian Language including TRL) (6)	Language and Communication Skills (English) (6)	Environmental Studies (3)	Understanding India (2)	Health & Wellness, Yoga Education, Sports & Fitness (2)	Digital Education (3)	Mathematical & Computational Thinking and Analysis (2)	Value-Based Course/ Global Citizenship Education (2)	Community Engagement/ NCC/ NSS/ (3)	Introductory Courses [Natural Sc./ Humanities/ Social Sc./Commerce] (9)	Introductory Course [Vocational Studies] (6)			Natural Sc./ Humanities/ Social Sc./ Commerce (18)	Vocational Studies (14)	Research Methodology Courses (6)	Research Proposal, Review of literature (4)	Research Internship/ Field Work (4)	Preparation of the Research Project Report (4)	**176**
1	2	3	4	5	6	7	8			9	10	11	14	15	16	17	18	19	20	21
I	6			2	2					3	3		6							**22**
II		6					2	2		3	3		6							**22**
Exit Point: Undergraduate Certificate																				
III			3			3			3	3		4	6							**22**
IV													6+6	6	4					**22**
Exit Point: Undergraduate Diploma																				
V													6+6	6	4					**22**
VI													6+6	6	4					**22**
Exit Point: Bachelor's Degree																				
VII													6+6 (Adv. Topics)			6	4			**22**
VIII													6+6 (Adv. Topics)		2			4	4	**22**
Exit Point: Bachelor's Degree with Hons. /Research																				

*There will be four disciplinary areas: A-Natural Science, B-Humanities, C-Social Science, and D-Commerce; each having basket of courses. A student will have to select a 'Major' from any of the four disciplinary areas (out of A, B, C & D). The selection for admission will be primarily based on availability of seats in Major and marks imposed by the institution.

**A student has to select three subjects for 'Introductory Regular Courses' from a pool of subjects associated with the Major offered by the institution. One of the three subjects will continue as 'Minor' from semester IV onwards, based on the academic interest and performance of the student.

Session 2022-26 onwards

COURSES OF STUDY FOR FOUR YEAR UNDERGRADUATE PROGRAMME

Table 2: Course structure for Undergraduate Certificate Programme *[May Exit after Sem.-II]*

Semester	Common Courses			Introductory Courses		Major	Total Credits
Sem.-I	LCS (MIL/TRL) (6 Credits)	Understanding India (2 Credits)	Health & Wellness, Yoga Education, Sports & Fitness (2 Credits)	IRC-1 (3 Credits)	IVS-1A (3 Credits)	MJ-1 (6 Credits)	**(22)**
Sem.-II	LCS (English) (6 Credits)	Global Citizenship Education (2 Credits)	Mathematical & Computational Thinking (2 Credits)	IRC-2 (3 Credits)	IVS-1B (3 Credits)	MJ-2 (6 Credits)	**(22)**

Total = 44 Credits

(LCS: Language and Communication Skills; MIL: Modern Indian Languages; TRL: Tribal Regional Languages; IRC: Introductory Regular Courses; IVS: Introductory Vocational Studies, MJ: Major)

Table 3: Course structure for Undergraduate Diploma Programme *[May Exit after Sem.-IV]*

Semester	Common Courses			Introductory Courses	Major	Minor	Internship/ Project	Vocational	Total Credits
Sem.-III	Environmental Studies (3 Credits)	Community Engagement/ NCC/ NSS (3 Credits)	Digital Education (3 Credits)	IRC-3 (3 Credits)	MJ-3 (6 Credits)		Internship/ Project (4 Credits)		**(22)**
Sem.-IV					MJ-4, MJ-5 (6+6=12 Credits)	MN-1 (6 Credits)		VS-1 (4 Credits)	**(22)**

Total = 88 Credits

(MN: Minor; VS: Vocational Studies)

Table 4: Course structure for Bachelor's Degree Programme *[May Exit after Sem.-VI]*

Semester	Major Courses	Minor Courses	Vocational	Total Credits
Sem.-V	MJ-6, MJ-7 (6+6 = 12 Credits)	MN-2 (6 Credits)	VS-2 (4 Credits)	**(22)**
Sem.-VI	MJ-8, MJ-9 (6+6= 12 Credits)	MN-3 (6 Credits)	VS-3 (4 Credits)	**(22)**

Total = 132 Credits

Table 5: Course structure for Bachelor's Degree with Hons./Research Programme

Semester	Advance Courses	Research Courses		Vocational	Total Credit
Sem.-VII	AMJ-1, AMJ-2	Research Methodology (6+6=12 Credits)	Research Proposal (6 Credits)	(4 Credits)	**(22)**
Sem.-VIII	AMJ-3, AMJ-4 (6+6=12 Credits)	Research Int./Field Work (4 Credits)	Research Report (4 Credits)	VSR (2 Credits)	**(22)**

Total = 176 Credits

(AMJ: Advance Major; VSR: Vocational Studies associated with Research)

Table 6: Semester wise Course Code and Credit Points:

Semester	Common, Introductory, Major, Minor, Vocational & Internship Courses		
	Code	Papers	Credits
I	CC-1	Language and Communication Skills (Modern Indian language including TRL)	6
	CC-2	Understanding India	2
	CC-3	Health & Wellness, Yoga Education, Sports & Fitness	2
	IRC-1	Introductory Regular Course-1	3
	IVS-1A	Introductory Vocational Studies-1	3
	MJ-1	Major paper 1 (Disciplinary/Interdisciplinary Major)	6
II	CC-4	Language and Communication Skills (English)	6
	CC-5	Mathematical & Computation Thinking Analysis	2
	CC-6	Global Citizenship Education & Education for Sustainable Development	2
	IRC-2	Introductory Regular Course-2	3
	IVS-1B	Introductory Vocational Studies-2	3
	MJ-2	Major paper 2 (Disciplinary/Interdisciplinary Major)	6
III	CC-7	Environmental Studies	3
	CC-8	Digital Education (Elementary Computer Applications)	3
	CC-9	Community Engagement & Service (NSS/ NCC/ Adult Education)	3
	IRC-3	Introductory Regular Course-3	3
	IAP	Internship/Apprenticeship/ Project	4
	MJ-3	Major paper 3 (Disciplinary/Interdisciplinary Major)	6
IV	MJ-4	Major paper 4 (Disciplinary/Interdisciplinary Major)	6
	MJ-5	Major paper 5 (Disciplinary/Interdisciplinary Major)	6
	MN-1	Minor Paper 1 (Disciplinary/Interdisciplinary Minor)	6

	VS-1	Vocational Studies-1 (Minor)	4
V	MJ-6	Major paper 6 (Disciplinary/Interdisciplinary Major)	6
	MJ-7	Major paper 7 (Disciplinary/Interdisciplinary Major)	6
	MN-2	Minor Paper 2 (Disciplinary/Interdisciplinary Minor)	6
	VS-2	Vocational Studies 2 (Minor)	4
VI	MJ-8	Major paper 8 (Disciplinary/Interdisciplinary Major)	6
	MJ-9	Major paper 9 (Disciplinary/Interdisciplinary Major)	6
	MN-3	Minor Paper 3 (Disciplinary/Interdisciplinary Minor)	6
	VS-3	Vocational Studies 3 (Minor)	4
VII	AMJ-1	Advance Major paper 1 (Disciplinary/Interdisciplinary Major)	6
	AMJ-2	Advance Major paper 2 (Disciplinary/Interdisciplinary Major)	6
	RC-1	Research Methodology	6
	RC-2	Research Proposal	4
VIII	AMJ-3	Advance Major paper 3 (Disciplinary/Interdisciplinary Major)	6
	AMJ-4	Advance Major paper 4 (Disciplinary/Interdisciplinary Major)	6
	RC-3	Research Internship/Field Work	4
	RC-4	Research Report	4
	VSR	Vocational Studies (Associated with Research)	2
		Total Credit	**176**

Abbreviations:

CC Common Courses
IRC Introductory Regular Courses
IVS Introductory Vocational Studies
IAP Internship/Apprenticeship/ Project
VS Vocational Studies
MJ Major Disciplinary/Interdisciplinary Courses
MN Minor Disciplinary/Interdisciplinary Courses
AMJ Advance Major Disciplinary/Interdisciplinary Courses
RC Research Courses
VSR Vocational Studies associated with Research

Table 7: Semester wise Examination Structure in Discipline Courses:

Semester	Common, Introductory, Major, Minor, Vocational & Internship 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	6	15	60	25
II	MJ-2	Non-Flowering Plants and Palaeobotany	6	15	60	25
III	MJ-3	Plant Anatomy and Embryology	6	15	60	25
IV	MJ-4	Ecology and Environmental Studies	6	15	60	25
	MJ-5	Plant Taxonomy & Economic Botany	6	15	60	25
V	MJ-6	Cell Biology & Genetics	6	15	60	25
	MJ-7	Plant Physiology & Biochemistry	6	15	60	25
VI	MJ-8	Molecular Biology & Plant Biotechnology	6	15	60	25
	MJ-9	Computational Biology & Research Methodology for Plants	6	15	60	25
VII	AMJ-1	Advance Molecular Biology	6	15	60	25
	AMJ-2	Bioinformatics and Nanobiotechnology	6	15	60	25
	RC-1	Research Methodology	6	25	75	---
	RC-2	Research Proposal	4	25	75	---
VIII	AMJ-3	Applied Botany	6	15	60	25
	AMJ-4	Advance Biotechnology	6	15	60	25
	RC-3	Research Internship/Field Work	4	---	---	100
	RC-4	Research Report	4	---	---	100
	VSR	Vocational Studies (Associated with Research)	2	---	---	100
		Total Credit	**98**			

Table 8: Semester wise Course Code and Credit Points:

Semester	Common, Introductory, Major, Minor, Vocational & Internship Courses		Examination Structure			
	Code	Papers	Credits	Mid Semester Theory (F.M.)	End Semester Theory (F.M.)	End Semester Practical/ Viva (F.M.)
I/ II/ III	IRC	Introductory Botany	3	---	75	25
IV	MN-1	Diversity of Plants, Ecology and Environmental Science	6	15	60	25
V	MN-2	Taxonomy, Anatomy & Embryology	6	15	60	25
VI	MN-3	Physiology, Biotechnology & Genetics	6	15	60	25
		Total Credit	**21**			

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:

1. 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.
2. 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.
3. 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.
4. Students will acquire core competency in the subject Botany and in allied subject areas.
5. 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.
6. The students will be able to explain various physiological and metabolic processes unique to plants.
7. They would be able to elaborate on the concepts of gene, genome and the molecular processes of replication, transcription and translation.
8. They will be able to understand adaptation, development and behaviour of different forms of life.
9. The students will get an understanding of functioning of ecosystem and tracing the energy pyramids through nutrient flow.
10. Students will be able to demonstrate the experimental techniques and methods in plant sciences and have innovative research ideas.

SEMESTER I

I. MAJOR COURSE –MJ 1: (Credits: Theory-04, Practicals-02)

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

Instruction to Question Setter for

Semester Internal Examination (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. 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 Examination (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.*

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

MICROBIOLOGY, PHYCOLOGY AND MYCOLOGY

Theory: 60 Lectures

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 and reproduction in viruses, bacteria and economic importance.

Course Content:

Unit 1: Introduction to microbial world
Microbial nutrition, growth and metabolism. Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases. Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine). **(5 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). **(7 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). **(7 lectures)**

Unit 4: Algae

General characteristics of Algae, Criteria for classification of algae, Fritsch (1935) and Lee (2008) systems of classification of algae. Significant contributions of eminent phycologists (F.E. Fritsch and M.O.P. Iyengar). Economic importance of algae, role of algae in integrated aquaculture. Economic importance of major seaweed resources of India. **(5 lectures)**

Unit 5: Cyanophyta and Xanthophyta

Brief account of ecology and occurrence; Range of thallus organization; Cell structure; Reproduction, Morphology and life-cycle of *Nostoc* and *Vaucheria*. **(5 lectures)**

Unit 6: Chlorophyta and Charophyta

Brief account of general characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Chlamydomonas, Volvox, Oedogonium, Coleochaete, Chara*. **(6 lectures)**

Unit 7: Phaeophyta and Rhodophyta

Brief account of characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Ectocarpus, Fucus* and *Polysiphonia*. **(4 lectures)**

Unit 8: Introduction to Fungi

Classification – Gwynne-Vaughan and Barnes (1926) and Ainsworth (1966, 1973).

Brief account of allied fungi and applied mycology. Brief account of evolution. Brief account of thallus structure and life cycle pattern of the following genera:

Characteristic features of *Synchytrium* and *Rhizopus*
General characteristics of *Alternaria, Neurospora* and *Peziza*
General characteristics of *Puccinia* and *Agaricus*
General characteristics of Slime molds
General characteristics of *Albugo*

Unit 9: Phytopathology

Terms and concepts; General symptoms; Geographical distribution of diseases; Etiology; Symptomology; Host-Pathogen relationships; Disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine. Bacterial diseases – Citrus canker and angular leaf spot of cotton. Viral diseases – Tobacco Mosaic viruses, vein clearing. Fungal diseases – Early blight of potato, Black stem rust of wheat, White rust of crucifers. **(21 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. (). 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 Univ Press, Cambridge. 3rd Ed.
10. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Pub. India Ltd.
11. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.

BOTANY PRACTICAL- MJ 1 LAB

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

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: 60 Lectures

Diversity & Economic Importance of Microbes

Microbiology

1. Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs of Lytic and Lysogenic Cycle.
2. Types of Bacteria to be observed from temporary/permanent slides/photographs. Electron micrographs of bacteria, binary fission, endospore, conjugation, root Nodule.
3. Gram staining.
4. Endospore staining with malachite green using the (endospores taken from soil bacteria).

Phycology

Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas* (electron micrographs), *Volvox, Oedogonium, Coleochaete, Chara, Vaucheria, Ectocarpus, Fucus* and *Polysiphonia, Procholoron* through electron micrographs, temporary preparations and permanent slides

Fungi

1. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, ascocarps & basidiocarps).
2. *Rhizopus:* study of asexual stage from temporary mounts and sexual structures through permanent slides.
3. *Aspergillus* and *Penicillium*: study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs.
4. *Peziza*: sectioning through ascocarp.
5. *Alternaria*: Specimens/photographs and temporary mounts.
6. *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.
7. *Agaricus*: Specimens of button stage and full-g r o w n mushroom; sectioning of gills of *Agaricus*, fairy rings and bioluminescent mushrooms to be shown.
8. Study of phaneroplasmodium from actual specimens and/or photograph. Study of Stemonitis sporangia.
9. Albugo: Study of symptoms of plants infected with Albugo; asexual phase study through section/ temporary mounts and sexual structures through permanent slides.
10. Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Angular leaf spotof cotton, Viral diseases: TMV, Vein clearing, Fungal diseases: Early blight of potato, Black stem rust of wheat and White rust of crucifers.

SEMESTER II

I. MAJOR COURSE- MJ 2: (Credits: Theory-04, Practicals-02)

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

Instruction to Question Setter for

Semester Internal Examination (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. 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 Examination (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.*

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

NON-FLOWERING PLANTS AND PALAEOBOTANY

Theory: 60 Lectures

Course Objectives:

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

1. To introduce students with various fungal groups and 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. Design and syntheses of organic molecules.
2. Structure identification through IR, NMR and Mass spectroscopic data.
3. Lab/Instrumentation techniques used for analyzing reaction mechanisms.

Skills to be learned:

1. Understand the world of lichens. Appreciate the characteristics of the lichens. Understand the ecological and economic significance of lichen.

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. **(5 lectures)**

Unit 2: Bryophytes

General characteristics; Adaptations to land habit; Classification; Range of thallus organization. Classification (up to family), morphology, anatomy, reproduction and alteration of generation of *Riccia, Marchantia, Anthoceros, Sphagnum* and *Funaria*; Reproduction and evolutionary trends (developmental stages not included). Ecological and economic importance of Bryophytes with special reference to *Sphagnum*. **(15 lectures)**

Unit 3: Pteridophytes

Origin and evolution of land plants, Classification (up to family), morphology, anatomy and life cycle of *Psilotum, Selaginella, Equisetum* and *Pteris* (Developmental details not to be included). Apogamy and Apospory, heterospory and seed habit, Telome theory, stelar evolution; Ecological and economic importance. **(15 lectures)**

Unit 4: Gymnosperms

General characteristics, classification (up to family), morphology, anatomy and life cycle of Cycas, *Pinus* and *Gnetum* (Developmental details not to be included); Ecological and economic importance. **(15 lectures)**

Unit 5: Palaeobotany

Brief introduction of Prof. Birbal Sahani. Types of fossils; Process of fossilization and Significance of fossilization. Geological time scale; General characteristics; Classification; Early land plants (*Cooksonia* and *Rhynia*)**.** **(10 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.

BOTANY PRACTICAL- MJ 2 LAB:

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

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: **60 Lectures**

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 – Morphology of thallus.

Marchantia- Morphology of thallus, whole mount of rhizoids & Scales, vertical section of thallus through Gemma cup, whole mount of Gemmae (all temporary slides), vertical section of Antheridiophore, Archegoniophore, longitudinal section of Sporophyte (all permanent slides).

Anthoceros- Morphology of thallus, dissection of sporophyte (to show stomata, spores, pseudoelaters, columella) (temporary slide), vertical section of thallus (permanent slide).

Pellia, Porella- Permanent slides.

Sphagnum- Morphology of plant, whole mount of leaf (permanent slide only).

Funaria- Morphology, whole mount of leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, longitudinal section of capsule and protonema.

Psilotum- Study of specimen, transverse section of synangium (permanent slide).

Selaginella- Morphology, whole mount of leaf with ligule, transverse section of stem, whole mount of strobilus, whole mount of microsporophyll and megasporophyll (temporary slides), longitudinal section of strobilus (permanent slide).

Equisetum- Morphology, transverse section of internode, longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wetand dry) (temporary slide), transverse section of rhizome (permanent slide).

Pteris- Morphology, transverse section of rachis, vertical section of sporophyll, wholemount of sporangium, whole mount of spores (temporary slides), transverse section of rhizome, whole mount of prothallus with sex organs and young sporophyte (permanent slide).

Cycas- Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll, transverse section of coralloid root, transverse section of rachis, vertical section of leaflet, vertical section of microsporophyll, whole mount of spores (temporary slides), longitudinal section of ovule, transverse section of root (permanent slide).

Pinus- Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and female cones), transverse section of Needle, transverse section of stem, longitudinal section of / transverse section of male cone, whole mount of microsporophyll, whole mount of Microspores (temporary slides), longitudinal section of female cone, tangential longitudinal section &radial longitudinal sections stem (permanent slide).

Gnetum- Morphology (stem, male & female cones), transverse section of stem, vertical section of ovule (permanent slide)

Botanical excursion.

SEMESTER III

I. MAJOR COURSE- MJ 3: (Credits: Theory-04, Practicals-02)

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

Instruction to Question Setter for

Semester Internal Examination (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. 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 Examination (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.*

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

PLANT ANATOMY AND EMBRYOLOGY

Theory: 60 Lectures

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

Applications in systematics, forensics and pharmacognosy**.** **(2 Lectures)**

Unit 2: Tissues Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances. Hydathodes, cavities, lithocysts and laticifers. **(8 Lectures)**

Unit 3: Apical meristems Evolution of concept of organization of shoot apex and root apex. **(4 Lectures)**

Unit 4: Vascular Cambium and Wood Structure, function and seasonal activity of cambium; Secondary

growth in root and stem. Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology. Development and composition of periderm, rhytidome and lenticels. **(12 Lectures)**

Unit 5: Adaptive and Protective Systems Anatomical adaptations of xerophytes and hydrophytes. **(4 Lectures)**

Embryology

Unit 1: Introduction

Brief account of contributions (G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison) and scope**.** **(2 lectures**)

Unit 2: Anther and pollen biology

Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance. Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system; Palynology and scope (a brief account**).** **(3 lectures)**

Unit 3: Ovule

Structure; Types; Special structures–endothelium, obturator, aril, caruncle and hypostase; Female gametophyte– megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of Polygonum type); Organization and ultrastructure of mature embryo sac. **(3 lectures)**

Unit 4: Pollination and fertilization

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

Unit 5: Self incompatibility

Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination; Intra-ovarian and in vitro pollination; Modification of stigma surface, parasexual hybridization; Cybrids, invitro fertilization. **(10 lectures)**

Unit 6: Embryo, Endosperm and Seed

Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in Paeonia. Seed structure, importance and dispersal mechanisms **(7 lectures)**

Units 7: Polyembryony and apomixis: Introduction; Classification; Causes and applications. **(2 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

---

BOTANY PRACTICAL- MJ 3 LAB:

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

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: 60 Lectures

1. Study of anatomical details through permanent slides/temporary stain mounts/ macerations/ museum specimens with the help of suitable examples.
2. Apical meristem of root, shoot and vascular cambium.
3. Distribution and types of parenchyma, collenchyma and sclerenchyma.
4. Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres.
5. Wood: ring porous; diffuse porous; tyloses; heart- and sapwood.
6. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
7. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
8. Root: monocot, dicot, secondary growth.
9. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.
10. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy).
11. Adaptive Anatomy: xerophytes, hydrophytes.
12. Secretory tissues: cavities, lithocysts and laticifers.
13. Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.
14. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/ photographs, fresh material), ultrastructure of pollen wall(micrograph); Pollen viability: Tetrazolium test. germination: Calculation of percentage germination in different media using hanging drop method.
15. Ovule: Types-anatropous, orthotropous, amphitropous/ campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/ specimens/ photographs).
16. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus.
17. Intra-ovarian pollination; Test tube pollination through photographs.
18. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.
19. Embryogenesis: Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.

SEMESTER IV

I. MAJOR COURSE- MJ 4: (Credits: Theory-04, Practicals-02)

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

Instruction to Question Setter for

Semester Internal Examination (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. 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 Examination (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.*

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

ECOLOGY AND ENVIRONMENTAL STUDIES

Theory: 60 Lectures

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

1. To introduce the students with environmental factors affecting the plants, the basic principles of ecology and phytogeography.
2. To make them understand complex community patterns, processes, and ecosystem functioning.

Course Learning Outcomes:
On successful completion of this course the student should know:

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.
2. This knowledge is critical in evolving strategies for sustainable natural resource management and biodiversity conservation.

Course Content:

Unit 1: Introduction

Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis. **(3 lectures)**

Unit 2: Soil

Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development. **(6 lectures)**

Unit 3: Water

Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table. **(4 lectures)**

Unit 4: Light, temperature, wind and fire Variations; adaptations of plants to their variation. **(3 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. **(2 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 – processes, types; climax concepts. **(6 lectures)**

Unit 8: Ecosystems Structure; Processes; Trophic organization; Food chains and Food webs; Ecological pyramids. Pond ecosystem, grassland ecosystem and forest ecosystem. **(3 lectures)**

Unit 9: Functional aspects of ecosystem

Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus. **(6 lectures)**

Unit 10: Phytogeography

Principles; Continental drift; Theory of tolerance; Endemism; hotspots, Brief description of major Terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Local Vegetation. Application of Remote sensing and GIS (Geographical International System) **(6 lectures)**

Unit 11: Pollution

Introduction to pollutants, pollution, causes, control and impact of air, water, soil, noise. Role of Biotechnology and Nanobiotechnology in pollution control. **(4 lectures)**

Unit 12: Climate change

Major global environmental issues: Climate change, ozone depletion, global warming, acid rain. Disaster management: Natural and Man-made. Objectives of United Nations Framework Convention on Climate Change (UNFCC), Green hydrogen. **(5 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. Introduction to United Nation environment program, Convention on Biological Diversity, National Biodiversity Authority and Botanical Survey of India. **(8 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.

BOTANY PRACTICAL- MJ 4 LAB:

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

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: 60 Lectures

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

II. MAJOR COURSE- MJ 5: (Credits: Theory-04, Practicals-02)

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

Instruction to Question Setter for

Semester Internal Examination (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. 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 Examination (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.*

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

PLANT TAXONOMY & ECONOMIC BOTANY

Theory: 60 Lectures

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

(4 lectures)

Unit 2: Taxonomic hierarchy, Types of classification and Evidences

1. Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary).
2. Types of classification- Artificial, Natural and Phylogenetic.
3. Bentham & Hooker's system of classification (up to series) - merits and demerits.
4. Engler & Prantle's system of classification (up to series) - merits and demerits.
5. Hutchinson classification with its - merits and demerits.
6. Angiosperm phylogeny group (APG IV) system classification.
7. Taxonomic evidences from palynology, cytology, phytochemistry & Molecular biology data (Protein and Nucleic acid homology). **(10 lectures)**

Unit 3: Plant Systematics

1. Diagnostic characteristics, Systematic Phylogeny and economic importance of families: Ranunculaceae, Brassicaceae, Apocynaceae, Apiaceae, Asteraceae, Solanaceae, Lamiaceae, Ephorbiaceae. Liliaceae, Poaceae. **(10 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. Cladistics- construction of dendrogram and primary analysis; Monophyletic, polyphyletic and paraphyletic groups; Plesiomorphy and apomorphy.
3. Origin and evolution of angiosperms; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram). **(6 lectures)**

Economic Botany

Unit 1: Introduction, Research centres, Concept of centres of origin, their importance with reference to Vavilov's work. **(4 lectures)**

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

Unit 2: Cereals and Millets: Wheat, Rice, Ragi and Jowar -Origin, morphology, uses **(2 Lectures)**

Unit 3: Pulses & Vegetables General account with special reference to Gram, soybean and Potato **(4 Lectures)**

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

Unit 6: Oils and Sugar General description with special reference to groundnut and sugarcane **(4 Lectures)**

Unit 7: Timber and Fibre and Yielding Plants General description (Botanical name, family, parts used, morphology and uses) **(4 Lectures)**

Unit 8: Medicinal Plants Brief account of *Ocimum, Tinospora, Aloe, Rauvolfia, Emblica* and *Cathranthus* (Botanical name, family, part used, morphology and uses) **(4 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-APhylogenetic 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.

BOTANY PRACTICAL- MJ 5 LAB:

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

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: **60 Lectures**

Plant Taxonomy & Economic Botany

1. Systematic study of locally available plants belonging to the families prescribed in theory syllabus 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. Field visit (local) – Subject to grant of funds from the university.
3. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).
4. Study of economically important plants: Wheat, Rice, Gram, Soybean, Potato, Black pepper, Clove, Cinnamon, Ginger, Turmeric, Tea, Coffee, Cotton, Groundnut, Sugarcaneand Medicinal plants through specimens, sections.

SEMESTER V

I. MAJOR COURSE- MJ 6: (Credits: Theory-04, Practicals-02)

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

Instruction to Question Setter for

Semester Internal Examination (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. 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 Examination (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.*

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

CELL BIOLOGY & GENETICS

Theory: 60 Lectures

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 biomolecules (i.e protein, carbohydrate, lipid and nucleic acid) and cell organelles, they will be able to understand the various metabolic processes such as respiration, photosynthesis etc. which are important for life

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:
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; Origin of eukaryotic cell (Endosymbiotic theory). **(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; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis. **(3 lectures)**

Unit 3: Cell organelles

Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.

Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament. **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 and lipid synthesis, 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, role of protein kinases. **(4 lectures)**

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, Penetrance and Expressivity, Numericals; 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 and chromosome mapping

Linkage and crossing over-Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on gene mapping; Sex Linkage. **(7 lectures)**

Unit 4: Variation in chromosome number and structure

Deletion, Duplication, Inversion, Translocation, Euploidy and Aneuploidy **(4 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. **(5 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. **(4 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. **(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.
3. 8th edition.
4. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press &Sunderland, Washington, D.C.; Sinauer Associates, MA.
5. 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
6. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett Publishers)

BOTANY PRACTICAL- MJ 6 LAB:

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

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: 60 Lectures

1. Study of cell and its organelles with the help of electron micrographs.
2. Cytochemical staining of: DNA- Feulgen and cell wall in the epidermal peel ofonion using Periodic Schiff's (PAS) staining technique.
3. Study the phenomenon of plasmolysis and deplasmolysis.
4. Study the effect of organic solvent and temperature on membrane permeability.
5. Study different stages of mitosis and meiosis.
6. Meiosis through temporary squash preparation.
7. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
8. Chromosome mapping using point test cross data.
9. Pedigree analysis for dominant and recessive autosomal and sex linked traits.
10. Incomplete dominance and gene interaction through seed ratios6. (9:7, 9:6:1,13:3, 15:1, 12:3:1, 9:3:4).
11. Blood Typing: ABO groups & Rh factor.
12. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes.
13. Photographs/Permanent Slides showing Translocation Ring, Laggards andInversion Bridge.
14. Study of human genetic traits: Sickle cell anemia, Xeroderma Pigmentosum, Albinism, red- green Colour blindness, Widow's peak, Rolling of tongue, Hitchhiker's thumb and Attached ear lobe.

II. MAJOR COURSE- MJ 7: (Credits: Theory-04, Practicals-02)

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

Instruction to Question Setter for

Semester Internal Examination (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. 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 Examination (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.*
***Note:** There may be subdivisions in each question asked in Theory Examinations.*

PLANT PHYSIOLOGY & BIOCHEMISTRY

Theory: 60 Lectures

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. A comprehensive study of different pathways including their biochemistry and to some extent the molecular details.
3. Current understanding of regulation and integration of metabolic processes in plants with reference to crop productivity.
4. Significance of metabolic pathways for metabolic engineering in producing transgenics.
5. 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. The students are able to correlate morphology, anatomy, cell structure and biochemistry with plant functioning. The link between theory and practical syllabus is established, and the employability of youth would be enhanced.
2. The youth can also begin small-scale enterprises. Concept and significance of metabolic redundancy in plants.
3. Students will also be able to learn the similarity and differences in metabolic pathways in animals and plants.
4. 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.

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. **(6 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. **(3 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. **(5 lectures)**

Unit 4: Translocation in the phloem

Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model;Phloem loading and unloading; Source–sink relationship. **(3 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. **(6 lectures)**

Unit 6: Respiration

Types of respiration, mechanism (Glycolysis). Kreb's cycle: Electron Transport System, Oxidative phosphorylation, fermentation. Factors affecting rate of respiration. Photorespiration. **(5 lectures)**

Unit 7: Plant growth regulators

Discovery, chemical structure, biosynthesis, bioassays and physiological roles of Auxin, Gibberellins,Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid.**(6 lectures)**

Unit 8: Physiology of flowering

Photoperiodism, flowering stimulus, florigen concept, vernalization, seed germination, seed dormancy. **(3 lectures)**

Unit 9: Phytochrome, cryptochromes and phototropins

Discovery, chemical nature and structure, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action. **(3 lectures)**

Unit 10: 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; Protein denaturation and biological roles of proteins.

Nucleic acids: Structure of 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. **(10 lectures)**

Unit 11: Bioenergetics

Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as an energy currency molecule. **(3 lectures)**

Unit 12: 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), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity. **(5 lectures)**

Unit 13: Vitamins

General characteristics of vitamins, hormones. Nomenclature and classification of vitamins and its significance. **(2 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

---

BOTANY PRACTICAL- MJ 7 LAB:

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

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: 60 Lectures

Plant Physiology & Biochemistry

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 ofleaves of amesophyte 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 Wilmot's bubbler.
9. Perform Moll's experiment.

Demonstration experiments

1. To demonstrate suction due to transpiration.
2. Fruit ripening/Rooting from cuttings (Demonstration).
3. Bolting experiment/Avena coleptile bioassay (demonstration).
4. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
5. Study of plant cell structure with the help of epidermal peel mount of Onion/Rhoeo/Crinum.
6. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.
7. Measurement of cell size by the technique of micrometry.
8. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollengrains).

SEMESTER VI

I. MAJOR COURSE- MJ 8: (Credits: Theory-04, Practicals-02)

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

Instruction to Question Setter for

Semester Internal Examination (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. 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 Examination (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.*

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

MOLECULAR BIOLOGY & PLANT BIOTECHNOLOGY

Theory: 60 Lectures

Course Objectives:

1. To gain the knowledge of structure and functions of DNA and RNA.
2. 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.
3. 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.
4. Understanding of biotechnological processes such as recombinant DNA technology and its applicative value in pharmaceuticals (vaccines, antibodies, antibiotics etc.), food industry (transgenic crops with improved qualities (nutraceuticals, industrial enzymes etc.), agriculture (biotic and abiotic stress tolerant plants, disease and pest resistant plants, improved horticultural varieties etc.), ecology (plants role in bioremediation).
5. 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. 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.
3. 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, pharmaceutical, medical, ecological and agricultural applications.
4. Use basic biotechnological techniques to explore molecular biology of plants.
5. Explain how biotechnology is used to for plant improvement and discuss the biosafety concern and ethical issue of that use.

Course Content:

MOLECULAR BIOLOGY

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

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

DNA Structure: Watson and Crick model, Salient features of double helix, Types of DNA, Types of genetic material, 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. **(5 lectures)**

Unit 3: The replication of DNA

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

Unit 4: Central dogma and genetic code

Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of m-RNA template), Genetic code (deciphering and salient features) **(2 lectures)**

Unit 4: Transcription

Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E.coli*. Eukaryotes: transcription factors, heat shock proteins, steroids and peptide hormones; 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); Ribozymes; RNA editing and mRNA transport. **(4 lectures)**

Unit 6: Translation

Ribosome structure and assembly, mRNA; Charging of tRNA, 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. **(4 lectures)**

PLANT BIOTECHNOLOGY

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). **(8 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). **(6 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. **(5 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). **(4 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. **(7 lectures)**

Reference Books:

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the 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 andApplications. John Wiley & Sons Inc. U.S.A.

BOTANY PRACTICAL- MJ 8 LAB:

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

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: 60 Lectures

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

II. MAJOR COURSE- MJ 9: (Credits: Theory-04, Practicals-02)

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

Instruction to Question Setter for

Semester Internal Examination (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. 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 Examination (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.*

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

COMPUTATIONAL BIOLOGY & RESEARCH METHODOLOGY FOR PLANTS

Theory: 60 Lectures

Course Objectives:

1. To have knowledge of analysis of scientific data.
2. Understand some basic concepts of researchand its methodologies.
3. Identify appropriate research topics and, select and define appropriate research problem and parameters.

Course Learning Outcomes:

1. Understanding of interpreting the scientific data that is generated during scientific experiments.
2. It is the responsibility of biostatisticians and other experts to consider the variables in subjects to understand them, and to make sense of different sources of variation. In essence, the goal of biostatistics is to disentangle the data received and make valid inferences that can be used to solve problems in public health.
3. Biostatistics uses the application of statistical methods to conduct research in the areas of biology, public health, and medicine.
4. Many times, experts in biostatistics collaborate with other scientists and researchers.
5. Prepare a project proposal (to undertake a project), organize and conduct research (advanced project) in a more appropriate manner. write a research report and thesis. Write a research proposal (grants).

Course Content:

Computational Biology

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.
4. Application of GIS **(20 lectures)**

Research Methodology for Plants **(40 lectures)**

INSTRUMENTS & TECHNIQUES

1. Laboratory safety and good laboratory practices
2. Principles and application of Laboratory instruments-microscope, incubator, autoclave, centrifuge, LAF, filtration unit, shaker, pH meter.
3. Buffer preparation & titration
4. Cleaning and Sterilization of glassware
5. Preparation of media- Nutrient Agar and Broth
6. Inoculation and culturing of bacteria in Nutrient agar and nutrient broth
7. Preparation of agar slant, stab, agar plate
8. Phenol Coefficient method to test the efficacy of disinfectants

Herbarium:

Plant collecting, Preservation and Documentation: Stepwise Practicing Herbarium techniques:

1. FIELD EQUIPMENTS, Global Positioning System (GPS) instrument &Collection of any wild 25 plant specimens
2. Learn to handle Herbarium making tools
3. Pressing and Drying of collected plant specimens
4. Special treatments for all varied groups of plants
5. Mount on standard herbarium sheets
6. Labelling with Standard method
7. Organize them and give Index Register Number
8. Introduction and Importance of Bioprospecting
9. Bioreactors

Instrumentation and herbal Preparations

1. Develop Capsules of herbs/, Develop Herbal oils/, Develop Poultice/cream Analyze some active ingredients using chromatography /Spectrophotometry
2. Microbial Techniques & instrumentation Microscopy – Light, phase contrast, electron, scanning and transmission electron microscopy, staining techniques for light microscopy, sample preparation for electron microscopy. Common equipment of microbiology lab and principle of their working – autoclave, oven, laminar air flow, centrifuge. Colorimetry and spectrophotometry, immobilization methods, fermentation, and fermenters.
3. Biopiracy, Biopatent, Intellectual Property Rights,

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.

BOTANY PRACTICAL- MJ 9 LAB:

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

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: 60 Lectures

1. Experiments based on chemical calculations.
2. Plant microtechnique experiments.
3. The art of imaging of samples through microphotography and field photography.
4. Poster presentation on defined topics.
5. Technical writing on topics assigned.

SEMESTER VII

I. ADVANCE MAJOR COURSE- AMJ 1: (Credits: Theory-04, Practicals-02)

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 20+5=25 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. **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 10 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 Examination (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.*
***Note:** There may be subdivisions in each question asked in Theory Examinations.*

ADVANCE MOLECULAR BIOLOGY

Theory: 60 Lectures

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

BOTANY PRACTICAL- AMJ 1 LAB:

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

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: **60 Lectures**

1. Isolation of plasmid DNA.
2. Agarose Gel Electrophoresis of plasmid DNA.
3. Preparation of competent cells for transformation by calcium chloride method.
4. Transformation of E.coli host cell with plasmid DNA.
5. Digestion of plasmid DNA using restriction enzymes and analysis by agarose gel electrophoresis.

II. ADVANCE MAJOR COURSE- AMJ 2: (Credits: Theory-04, Practicals-02)

Marks: 25 (5 Attd. + 20 SIE: 1Hr) + 75 (ESE: 3Hrs) = 100	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 20+5=25 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. **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 10 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 Examination (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.*
***Note:** There may be subdivisions in each question asked in Theory Examinations.*

BIOINFORMATICS AND NANOBIOTECHNOLOGY

Theory: 60 Lectures

Course Objectives:

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

Course Learning Outcomes:

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

Course Content:

BIOINFORMATICS

1. Bioinformatics: Introduction – genomics – transcriptome – proteome. Industrial Application of microalgae.
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. **(30 Lectures)**

NANO-BIOTECHNOLOGY

1. Introduction of Nanobiotechnology and its applications. Various types of nanomaterial utilized in agriculture.
2. Nanoparticles in agricultural and food diagnostics: Enzyme Biosensors and Diagnostics - DNA-Based Biosensors and Diagnostics, Radiofrequency Identification.
3. 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.

4. Nanotechnology in food packaging: Reasons to Package Food Products. Smart nanomaterials for packaging. **(30 Lectures)**

Reference Books:

1. Xiong, Essential Bioinformatics. Cambridge University Press.
2. Marketa J Zvelebil, Understanding Bioinformatics. Garland Science.
3. Shui Quing Ye, Bioinformatics: A practical Approach.
4. Anna Tramontano, Introduction to Bioinformatics
5. David W Mount, Bioinformatics. CBS
6. Mani K and Vijayaraj N, Bioinformatics. Kalaikathir Achchagam.
7. Augen Jeff, Bioinformatics in the post genomic era. Addison Wesley.
8. The 2018-2023 World Outlook for Nanobiotechnology Paperback – December 18, 2017, Icon group international.
9. Arunava Goswami and Samrat Roy Choudhury, Nanobiotechnology, Basic and Applied Aspects.
10. Clive Jarvis, Nanobiotechnology: An Introduction.
11. H B Singh, S Mishra, L F Fraceto, R D D Lima; Emerging Trends in Agri-Nanotechnology.

BOTANY PRACTICAL- AMJ 2 LAB:

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

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: **60 Lectures**

1. Search and Sequence retrieve from genbank database.
2. Alignment of sequence by using tools: Clustal X, Clustal W, Mega and Bioedit.
3. Phylogenetic tree analysis by using Mega software.
4. Primer designing by using online tools.

SEMESTER VIII

1. ADVANCE MAJOR COURSE- AMJ 3: (Credits: Theory-04, Practicals-02)

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

Instruction to Question Setter for

Semester Internal Examination (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. 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 Examination (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*

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

APPLIED BOTANY

Theory: 60 Lectures

Course Objectives:

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 Outcomes:

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

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). **(10 Lectures)**

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

3. Conventional fuels and their environmental impact; 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: A brief account on Phytochemical and Pharmacological aspects and uses of following medicinal plants: *Andrographis paniculate, 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 Books:

1. Kamp RM. 2004. Methods in Proteome and Protein Analysis. Springer.
2. Primrose SB & Twyman RM. 2007. Principles of Genome Analysis and Genomics. Blackwell. Sensen CW. 2005. Handbook of Genome Research. Vols. I, II. Wiley CVH.
3. Jordening H-J & Winter J. 2006. Environmental Biotechnology: Concepts and Applications. Wiley-VCH Verlag.
4. Advancement in crop improvement techniques. Elsevier.
5. Aggarwal Rattan Lal. Fundamentals of Plant Breeding and Hybrid Seed Production.

BOTANY PRACTICAL- AMJ 3 LAB:

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

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: 60 Lectures

1. Enrichment culture and isolation of agriculturally important microorganisms
2. Isolation of antibiotic producing microorganisms
3. Isolation of industrially important microorganisms, their maintenance andimprovement.
4. Production of industrial compounds such as industrial alcohol/ citric acid/lactic acidand their recovery.
5. Study of bio-reactors and their operations.
6. Demonstration of bioinsecticides / biofertilizers production.
7. Media preparation, culture/cultivation of *Spirulina*
8. Isolation of natural products by column chromatography
9. Separation and Isolation of natural products by Preparative TLC.
10. Micro/Macro-Algae isolation technique form local algal flora.

II. ADVANCE MAJOR COURSE- AMJ 4: (Credits: Theory-04, Practicals-02)

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

Instruction to Question Setter for

Semester Internal Examination (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. 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 Examination (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.*

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

ADVANCE BIOTECHNOLOGY

Theory: 60 Lectures

Course Objectives:

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

Course Learning Outcomes:

1. 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 Horiozon. Kalyani.

BOTANY PRACTICAL- AMJ 4 LAB:

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

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: **60 Lectures**

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.

COURSES OF STUDY FOR **INTRODUCTORY/ MINOR ELECTIVE** FYUGP IN **"BOTANY"**

SEMESTER I/ II/ III INTRODUCTORY REGULAR COURSE 1 Paper

I. INTRODUCTORY REGULAR COURSE (IRC)

(Credits: Theory-03)

- All Four Introductory & Minor Papers of Botany to be studied by the Students of **Other than Botany Honours.**

- Students of **Botany Honours** must Refer Content from the **Syllabus of Opted Introductory & Minor Elective Subject**.

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

Instruction to Question Setter for

End Semester Examination (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.*
***Note:** There may be subdivisions in each question asked in Theory Examinations.*

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

INTRODUCTORY BOTANY **Theory: 60 Lectures**

Course Objectives:

1. 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. 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.
2. They will also come to know about various plant pathogens and their integrated control methods helpful in enhancing the yield of crops and implementation of modern tools and techniques in agriculture.
3. Students will acquire knowledge about various pollutants, their ill effects on environmental health and human well-being at the same time with emphasis on control measures requiredfor restoration of our ecosystems and sustainable development.
4. Acquaintance with ethnobotanical practices prevalent in Jharkhand and their application in keeping the environment clean and healthy as well as meeting the needs of malnutritional and anemic population.

Course Content:

Basic Concept of Botany

1. Elementary idea of classification of plant kingdom, Taxonomic hierarchy upto species, Botanical Nomenclature of plants, herbarium - types and use. Family description- Solanaceae and Poaceae **(3 lectures)**

2. A concise introduction to branches and scope of botany. **(2 lectures)**
3. Diversity of Plants: General identifying features, structures, life cycle and economic importance of the following groups: **(8 lectures)**
    a) Bacteria
    b) Virus
    c) Algae
    d) Fungi
    e) Lichens
    f) Bryophyta
    g) Pteridophyta
    h) Gymnosperms
    i) Angiosperms: Morphology of flowering plants (Monocots and Dicots)
4. Plant pathology- Name of causal organisms, symptoms and control of thefollowing diseases: **(2 lectures)**
    a. Wilt of tomato
    b. Citrus canker
    c. Yellow vein mosaic of bhindi
    d. Leaf curl of papaya
    e. Black stem rust of wheat
    f. Loose smut of wheat
5. Brief notes on ethnobotanical uses of the following plants with particular reference to Jharkhand : **(3 lectures)**
    a. Kalmegh
    b. Palash
    c. Karanj
    d. Neem
    e. Bamboo
    f. Sal
6. Cell - Ultra structure of a typical prokaryotic and eukaryotic cell and cell division **(4 lectures)**
    a. Plant cell and its organelles - structure and function
    b. Cell cycle
    c. Mitosis
    d. Meiosis
7. Genetics: Structure and Function of DNA, Mendel's Law. **(2 lectures)**
8. Application of Biotechnology in Agriculture and environment. **(1 lectures)**
9. Introductory knowledge of pollination, Fertilization and seed development in Angiosperms, Monocot and Dicot seeds; Germination of seeds. **(2 lectures)**
10. Physiology of Plants: Ascent of Sap, Transpiration, Photosynthesis and Respiration. Fermentation- Role of microbes in food production and preservation. Biological Nitrogen fixation. **(5 lectures)**
    i. Ecology and Environment: Pond Ecosystem, Forest Ecosystem; Biogeochemical cycle – Carbon and Nitrogen. Pollution: Causes and control of air, water, soil and noise pollution; conservation of natural resources, biodiversity: definition, threats,loss and importance. Indigenous eco-friendly practices. An introduction to major global environmental issues and sustainable development. Disaster management. Peoples Biodiversity Register (PBR). **(8 lectures)**
11. An introduction to organic farming. **(2 lectures)**
12. Economic Botany: Food, fodder, fibre, timber, oil and pulses **(2 lectures)**
13. Botanical Survey of India – Objectives and achievements. **(1 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

BOTANY PRACTICAL-IRC LAB: 30 Lectures

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

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: 60 Lectures

1. Family descriptions of given plant.
2. Anatomical features of: monocot (root and stem) and dicot (root and stem).
3. Morphology of bacteria with the help of photographs.
4. Gram's staining technique.
5. Botanical name, common name, family and uses of cereal, pulses, oil yielding.
6. Osmosis.
7. Plasmolysis.
8. Acquaintance with the instruments.
9. Identifying features and name of the given materials/permanent slides (algae, fungi,bryophytes, pteridophytes and gymnosperms).
10. Mitosis and Meiosis: Study of materials/permanent slides.

SEMESTER IV **MINOR ELECTIVE-1** **1 Paper**

I. MINOR ELECTIVE (MN 1)

(Credits: Theory-04, Practicals-02)

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

Instruction to Question Setter for

Semester Internal Examination (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. 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 Examination (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.*

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

DIVERSITY OF PLANTS, ECOLOGY AND ENVIRONMENTAL SCIENCE

Theory: 60 Lectures

Course Objectives:

1. To introduce the students with diversity of plants such as microbes, algae, fungi, archegoniates, environmental factors affecting the plants, the basic principles of ecology and phytogeography.
2. To make them understand complex community patterns and processes, and ecosystem functioning.

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.
2. This knowledge is critical in evolving strategies for sustainable natural resource management and biodiversity conservation.

Course Content:

DIVERSITY OF PLANTS

Unit 1: Microbes

Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance. **(5 Lectures)**

Unit 2: Algae

General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: Nostoc, Oedogonium, Vaucheria, Ectocarpus, Polysiphonia. Economic importance of algae **(5 Lectures)**

Unit 3: Fungi

Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of Penicillium, Puccinia, Ustilago, Alternaria; Symbiotic Associations- Lichens: General account of Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance. **(5 Lectures)**

Unit 4: Introduction to Archegoniate

Identifying features of archegoniates, Transition to land habit, Alternation of generations. **(2 Lectures)**

Unit 5: Bryophytes

General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of Marchantia and Funaria. (Developmental details not to be included). Ecology and economic importance of bryophytes with special reference to Sphagnum. **(5 Lectures)**

Unit 6: Pteridophytes

General characteristics, classification, Early land plants Fossil and Fossilization process (Rhynia). Classification (up to family), morphology, anatomy and reproduction of Lycopodium, Equisetum and Pteris. Heterospory and seed habit, stelar evolution. **(5 Lectures)**

Unit 7: Gymnosperms

General characteristics, classification (up to family), morphology, anatomy and reproduction of Cycas and Pinus. Ecological and economical importance. **(4 Lectures)**

ENVIRONMENTAL SCIENCE

Unit 1: Introduction to environmental studies

Multidisciplinary nature of environmental studies; Scope and importance; Concept of sustainability and sustainable development. **(2 lectures)**

Unit 2: Ecosystems

Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems: Forest ecosystem Grassland ecosystem Desert ecosystem Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) **(2 lectures)**

Unit 3: Natural Resources: Renewable and Non--renewable Resources

Land resources and land use change; Land degradation, soil erosion and desertification. Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.

Water: Use and over--exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter--state).

Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies. **(4 lectures)**

Unit 4: Biodiversity and Conservation

Levels of biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots. India as a mega--biodiversity nation; Endangered and endemic species of India.

Threats to biodiversity: Habitat loss, poaching of wildlife, man--wildlife conflicts, biological invasions; Conservation of biodiversity: In--situ and Ex--situ conservation of biodiversity. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value. **(3 lectures)**

Unit 5: Environmental Pollution

Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution Nuclear hazards and human health risks. Solid waste management: Control measures of urban and industrial waste. Pollution case studies. **(3 lectures)**

Unit 6: Environmental Policies & Practices

Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture. Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD). Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context. **(3 lectures)**

PLANT ECOLOGY

Unit 1: Introduction

General introduction. **(1 lectures)**

Unit 2: Ecological factors

Climatic, Edaphic and Biotic factors: Variation of Optimal and limiting factors; Shelford law of tolerance. Ecological Adaptation of hydrophytes and xerophytes. **(3 lectures)**

Unit 3: Plant communities

Succession (Primary and secondary); hydrosere, xerosere. **(2 lectures)**

Unit 4: Ecosystem

Structure component, types-Pond & Forest, Ecosystem. Energy flow trophic organisation; Food chains and food webs, Ecological pyramids; Biogeochemical cycling with special reference to of carbon and nitrogen. **(3 lectures)**

Unit 5: Phytogeography

Principle biogeographical zones of India. **(2 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 Benjamin Cummings, 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 Twentieth Century.
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. Academic Press.
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*. *Tripathi 1992*.
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

---

BOTANY PRACTICAL- MN 1 LAB:

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

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: 60 Lectures

1. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lyticand Lysogenic Cycle.
2. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
3. Gram staining.
4. Morphology and structural details of forms belonging to Algae, Fungi, Bryophytes, Pteridophytes and Gymnosperm prescribed in the syllabus and their temporary/permanent stained microscopic slide preparation and studies.
5. Comments upon the spots
6. Vive-voce
7. Field study report
8. Class records, Herbarium, Charts, Model etc.
9. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, hygrometer, rain gauge and lux meter.
10. Determination of pH, and analysis of two soil samples for carbonates and nitrates by rapid field test.
    a. Study of morphological adaptations of hydrophytes (Hydrila Eichhornia) and xerophytes (Nerium, Pinus needle) (two each).
    b. Study of biotic interactions of the following: Stem parasite (Cuscuta), Root parasite (Orobanche), Epiphytes, Predation (Insectivorous plants)
11. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
12. Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc. Visit toa local polluted site--Urban/Rural/Industrial/Agricultural. Study of common plants, insects, birds and basic principles of identification. Study of simple ecosystems--pond, river, Delhi Ridge, etc.

SEMESTER V **MINOR ELECTIVE-2** **1 Paper**

I. MINOR ELECTIVE (MN 2))

(Credits: Theory-04, Practicals-02)

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

Instruction to Question Setter for

Semester Internal Examination (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. 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 Examination (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.*

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

TAXONOMY, ANATOMY & EMBRYOLOGY

Theory: 60 Lectures

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: Introduction to plant taxonomy

Identification, Classification, Nomenclature. **(3 lectures)**

Unit 2: Identification

Functions of Herbarium, important herbaria and botanical gardens of the world and India. Elementary idea of documentation of Flora. **(3 lectures)**

Unit 3: Family description

Magnoliceae, Ranunculaceae, Lamiaceae, Poaceae. **(5 lectures)**

Unit 4: Botanical nomenclature

Principles and rules (ICBN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations. **(3 lectures)**

Unit 5: Classification

Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series). **(3 lectures)**

Unit 6: Biometrics, numerical taxonomy and cladistics

Phenograms, cladograms definitions and differences. **(3 lectures)**

Unit 7: Meristematic and permanent tissues

Root and shoot apical meristems; Simple and complex tissues. **(5 lectures)**

Unit 8: Organs

Structure of dicot and monocot root stem and leaf. **(5 lectures)**

Unit 9: Secondary Growth

Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood). **(6 lectures)**

Unit 10: Adaptive and protective systems

Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes. **(6 lectures)**

Unit 11: 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. **(5 lectures)**

Unit 12: Pollination and fertilization

Pollination mechanisms and adaptations; Double fertilization; Seed-structure. **(4 lectures)**

Unit 13: Embryo and endosperm

Endosperm types, structure and functions; Dicot and monocot embryo. **(5 lectures)**

Unit 14: Apomixis and polyembryony

Definition, types and practical applications. **(4 lectures)**

Reference Books:

1. Simpson, M.G. (2006). *Plant Systematics.* Elsevier Academic Press, San Diego, CA,U.S.A.
2. Singh, G. (2012). *Plant Systematics:* Theory and Practice. Oxford & IBH Pvt. Ltd., NewDelhi. 3rd edition.
3. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. VikasPublication House Pvt. Ltd. New Delhi. 5th edition.
4. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

BOTANY PRACTICAL- MN 2 LAB:

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

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: 60 Lectures

1. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law
2. Study of 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): Brassicaceae -*Brassica*; Asteraceae -*Launaea, Ageratum*, Eclipta/Tridax; Solanaceae -*Solanum nigrum*; Apocyanaceae: *Catharanthus, Thevetia*, *Lantana*, Verbenaceae Liliaceae - *Lilium/Allium*.
3. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).
4. Study of meristems through permanent slides and photographs.
5. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements,Phloem (Permanent slides, photographs)
6. Stem: Monocot: *Zea mays;* Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanentslides).
7. Root: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanentslides).
8. Leaf: Dicot and Monocot leaf (only Permanent slides).
9. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).
10. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanentslides).
11. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous.
12. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development(Permanent slides/photographs).
13. Ultrastructure of mature egg apparatus cells through electron micrographs.
14. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
15. Dissection of embryo/endosperm from developing seeds.

SEMESTER VI **MINOR ELECTIVE-3** **1 Paper**

---

1. MINOR ELECTIVE (MN 3)) (Credits: Theory-04, Practicals-02)

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

Instruction to Question Setter for

Semester Internal Examination (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. 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 Examination (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.*

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

PHYSIOLOGY, BIOTECHNOLOGY & GENETICS

Theory: 60 Lectures

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.
4. Also acquire knowledge of Mendelian and non-Mendelian inheritance, Chromosome biology and structure and function of genes.

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.
5. To generate interest among the students in Genetics and make them aware about the importance and opportunities in higher education and research, the first unit should be Introductory dealing with how this area has revolutionized all aspects of our life from its growth from Mendel to Genetic Engineering.
6. Modes of inheritance of traits/ phenotypes and Phenotype-genotype correlation are the basic learning.

Course Content:

PHYSIOLOGY

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)**

BIOTECHNOLOGY

Unit 1: Introduction

General introduction to biotechnology. **(2 Lectures)**

Unit 2: Plant tissue culture

Micropropagation, Introduction and its significance; haploid production through androgenesis and gynogenesis; brief account of embryo & endosperm culture with their applications. **(6 Lectures)**

Unit 3: Recombinant DNA Techniques

Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR.
Hybridoma and monoclonal antibodies, ELISA and Immunodetection. Molecular diagnosis of human disease, Human gene Therapy. **(10 Lectures)**

GENETICS

Unit 1: Heredity

1. Laws of Inheritance
2. Modified Mandelian Ratios: 2:1- lethal Genes; 1:2:1- Co dominance, incomplete dominance; 9:7; 9:4:3; 13:3; 12:3:1.
3. Chi Square
4. Pedigree Analysis
5. Cytoplasmic Inheritance: Shell Coiling in Snail, Kappa particles in Paramecium, leaf variegation in Mirabilis jalapa, Male sterility.
6. Multiple allelism, Pleiotropism
7. Chromosome theory of Inheritance. **(10 Lectures)**

Unit 2: **Sex-determination and Sex-linked Inheritance** **(2 Lectures)**

Unit 3: Linkage and Crossing over

Linkage: complete & incomplete linkage, bridges experiment, coupling & repulsion, recombination frequency, linkage maps based on two and three factor crosses. Crossing over: concept and significance, cytological proof of crossing over. **(3 Lectures)**

Unit 4: **Mutations and Chromosomal Aberrations**

Types of mutations, effects of physical & chemical mutagens. Numerical chromosomal changes: Euploidy, Polyploidy and Aneuploidy; Structural chromosomal changes: Deletions, Duplications, Inversions & Translocations. **(3 Lectures)**

Unit 5: Plant Breeding

Introduction and objectives. Breeding systems: modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding. **(1 Lecture)**

Unit 6: Methods of crop improvement

Introduction: Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods: For self-pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations. **(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 and Applications of recombinant DNA. ASM Press, Washington.
6. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India.
7. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, JohnWiley& Sons Inc., India. 5th ed.
8. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts ofGenetics, 10th Ed., Benjamin Cummings
9. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introductionto Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
10. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan HigherEducation Learning
11. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.
12. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2ndedition.
13. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.

BOTANY PRACTICAL- MN 3 LAB:

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

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: 60 Lectures

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 in photosynthesis.
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.
5. Familiarization with basic equipment's in tissue culture.
6. Study through photographs: Anther culture, somatic embryogenesis,endosperm and embryo culture; micropropagation.
7. Study of molecular techniques: PCR, Blotting techniques, AGE and PAGE.
8. Medium preparation and inoculation.
9. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
10. Chromosome mapping using point test cross data.
11. Pedigree analysis for dominant and recessive autosomal and sex-linked traits.
12. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1,12:3:1, 9:3:4).
13. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes throughphotographs.
14. Hybridization techniques - Emasculation, Bagging (For demonstration only).
15. Induction of polyploidy conditions in plants (For demonstration only).

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.