JAMSHEDPUR WOMEN'S UNIVERSITY

DEPARTMENT OF BOTANY

B.Sc. BOTANY HONOURS/ RESEARCH

IMPLEMENTED FROM 2022

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)

(NEP, 2020)

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 entries and multiple exit options.

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 and when 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

- The Requisite Marks obtained by a student in a particular subject will be the criteria for promotion to the next Semester.
- 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.
- 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.
- 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 during examination, the examination taken by the student will be cancelled. The candidate will be awarded zero marks in that paper. The candidate may re-appear in the subsequent semesters as per the available provisions.
- 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]

- 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.

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

Jharkhand, NEP, FYUGP 2022 onwards

	Semester	Common Courses (29)							Introductory Courses (15)		Internship/ Project (4)	Major* (54) + Adv. Major (24)	Minor** (32)		Research Courses (18)			Total Credit
		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)	
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.

Jharkhand, NEP, FYUGP 2022 onwards

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 (6+6=12 Credits)	Research Methodology (6 Credits)	Research Proposal (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)

SEMESTER WISE COURSES OF STUDY FOR FOUR YEAR UNDERGRADUATE PROGRAMME

Semester	Common, Introductory, Major, Minor, Vocational & Internship Courses		Credits
	Code	Paper	
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-2B	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

SEMESTER WISE COURSES IN BOTANY FOR FYUGP

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 and Phycology (Theory + Practical)	6			
II	MJ-2	Biomolecules and Cell Biology (Theory + Practical)	6			
III	MJ-3	Mycology and Phytopathology (Theory + Practical)	6			
IV	MJ-4	Archegoniates (Theory + Practical)	6			
	MJ-5	Plant Systematics and Economic Botany (Theory + Practical)	6			
V	MJ-6	Reproductive Biology of Angiosperms (Theory + Practical)	6			
	MJ-7	Plant Anatomy and Ecology (Theory + Practical)	6			
VI	MJ-8	Cytogenetics and Molecular Biology (Theory + Practical)	6			
	MJ-9	Plant Physiology, Biochemistry and	6			

		Biotechnology (Theory + Practical)				
VII	AMJ-1	Natural Resource Management	6			
	AMJ-2	Plant Breeding	6			
	RC-1	Research Methodology	6			
	RC-2	Research Proposal	4			
VIII	AMJ-3	Stress Biology	6			
	AMJ-4	Biostatistics	6			
	RC-3	Research Internship/Field Work	4			
	RC-4	Research Report	4			
	VSR	Vocational Studies (Associated with Research)	2			
	Total Credit		98			

Semester wise Course Code and Credit Points:

Semester	Introductory and Minor 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	Introduction to Botany	3			
IV	MN-1	Plant Ecology and Taxonomy	6			
V	MN-2	Plant Anatomy and Embryology	6			
VI	MN-3	Plant Physiology and Cytogenetics	6			
	Total Credits		21			

AIM OF BACHELOR'S DEGREE PROGRAMME IN BOTANY

- To create the facilities and learning environment in educational institutions to consolidate the knowledge acquired at +2 level, motivate students to develop a deep interest in Botany, and to gain a broad and balanced knowledge and understanding of physical concepts, principles and theories of Botany. A dialogue about plants and their significance is fostered in this framework.
- To provide the latest subject matter, both theoretical as well as practical, such a way to foster their core competency and discovery learning. A botany graduate as envisioned in this framework would be sufficiently competent in the field to undertake further discipline-specific studies, as well as to begin domain-related employment.
- The student will be able to identify major groups of plants and compare the characteristics of lower (e.g., algae and fungi) and higher (angiosperms and gymnosperms) plants. They will be able to use the evidence-based comparative botany approach to explain the evolution of organisms and understand the genetic diversity on the earth. The students will also be able to explain various plant processes and functions, metabolism, concepts of gene, genome, and how organism's function is influenced at the cell, tissue, and organ level.
- Students will be able to understand the adaptation, development, and behaviour of different forms of life. The understanding of networked life on earth and tracing the energy pyramids through nutrient flow is expected from the students. Students will be able to demonstrate the experimental techniques and methods of their area of specialization in Botany.
- In light of all of the above to provide students with the knowledge and skill base that would enable them to undertake further studies in Botany and related areas, or in Interdisciplinary/multidisciplinary areas, or join and be successful in diverse professional streams including entrepreneurship.

PROGRAM LEARNING OUTCOME

- The framework of curriculum for the Bachelor's program in Botany aims to transform the course content and pedagogy to provide a multidisciplinary, student-centric, and outcome-based, holistic education to the next generation of students.
- Aside from structuring the curriculum to be more in-depth, focused, and comprehensive with significant skill-set for all exit levels; keeping in mind the job prospects; the emphasis has been to maintain academic coherence and continuum throughout the program of study and help build a strong footing in the subject, thereby ensuring a seamless transition into their careers.
- Special attention is given to eliminate redundancy, discourage rote learning, and espouse a problem-solving, critical thinking, and inquisitive mindset among learners.
- The curriculum embraces the philosophy that science is best learned through experiential learning, not limited to the confines of a classroom but rather through hands-on training, projects, field studies, industrial visits, and internships.
- This updated syllabus, with modern technology, helps students stay informed on the leading-edge developments in plant sciences and promotes curiosity, innovation, and a passion for research, that will serve them well in their journey into scientific adventure and discovery beyond graduation.
- The goal is to equip students with holistic knowledge, competencies, professional skills, and a strong positive mindset that they can leverage while navigating the current stiff challenges of the job market.

SEMESTER I

MAJOR COURSE- 1 (MJ-1) THEORY

Microbiology and Phycology

(Credits: Theory- 4, Practical- 2)

Unit 1: Introduction to microbial world (15 lectures)

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).

Unit 2: Viruses and Bacteria (15 lectures)

General account of Viruses, Viroides and Prions. Structure, Replication of DNA virus (T4 and λ), RNA (TMV), lytic and lysogenic cycle.
General account of Bacteria, Archaebacteria, Eubacteria: cell structure, reproduction.
Genetic Recombination in Bacteria (conjugation, transformation and transduction).
General account of Mycoplasma.

Unit 3: Algae, Cyanophyta and Xanthophyta (15 lectures)

Range of thallus organization; Classification (by Fritsch), Algal cell structure, Algal evolution, Algal bioprospecting. Ecology and occurrence; Range of thallus organization; Cell structure; Reproduction, Morphology and reproduction *Nostoc* and *Vaucheria*.

Unit 4: Chlorophyta and Phaeophyta and Rhodophyta (15 lectures)

General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Volvox, Oedogonium* and *Chara*; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of *Ectocarpus* and *Polysiphonia*. Commercial cultivation and economic importance of brown and red algae.

MAJOR COURSE- 1 (MJ-1) PRACTICAL

Microbiology

1. Models of viruses and TMV.
2. Photographs of Lytic and Lysogenic cycle.
3. Types of bacteria to be observed from temporary/ permanent slides/photographs.
4. Gram's staining of bacteria.

Phycology

Study of vegetative and reproductive structures of:

1. *Nostoc*
2. *Volvox*
3. *Oedogonium*
4. *Chara*
5. *Vaucheria*
6. *Ectocarpus*
7. *Polysiphonia*

Suggested readings:

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition
2. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th edition. McGraw Hill International.
3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
4. Pelczar, M.J. (2001). Microbiology, 5th edition, Tata McGraw Hill Co., New Delhi.
5. Fristch, F.E. (1945). The Structure and Reproduction of Algae, Cambridge University Press, California.

SEMESTER II

MAJOR COURSE- 2 (MJ-2) THEORY

Biomolecules and Cell Biology

(Credits: Theory- 4, Practical- 2)

Unit 1: Biomolecules (20 lectures)

Carbohydrates: Nomenclature and classification; Monosaccharides; Disaccharides; Oligosaccharides and polysaccharides.
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.
Lipids: Definition and major classes of storage and structural lipids. Fatty acids; structure and function, essential fatty acids.

Unit 2: Enzymes (10 lectures)

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.

Unit3: Cell Biology and Signal transduction (20 lectures)

Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Plant and animal cells; Origin of eukaryotic cell (Endosymbiotic theory). 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. Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast. Lysosomes and Vacuoles. Endomembrane system: Endoplasmic Reticulum ‑ Types and Structure. Golgi Apparatus ‑ organization, protein glycosylation, protein sorting and export from Golgi Apparatus. Nucleus-structure, nuclear envelope, nuclear pore complex and nuclear lamina.

Unit 4: Cell division (10 lectures)

Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle-checkpoints, role of protein kinases. Signal transduction: Receptors and primary and secondary signal transduction.

MAJOR COURSE- 2 (MJ-2) PRACTICAL

1. Qualitative tests for carbohydrates, lipids and proteins.
2. Measurement of cell size by the technique of micrometry.
3. Study of cell and its organelles with the help of electron micrographs/ photographs
4. Study the phenomenon of plasmolysis and deplasmolysis using Rhoeo leaf
5. Study different stages of mitosis and meiosis.

Suggested Readings

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
6. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
7. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
8. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

SEMESTER III

MAJOR COURSE- 3 (MJ-3) THEORY

Mycology and Phytopathology

(Credits: Theory- 4, Practical- 2)

Unit 1: Introduction to fungi and classification (15 lectures)

General characteristics; Affinities with plants and animals; Thallus organization; Cell wall composition; Nutrition; Classification. Mastigomycotina: Characteristic features; Life cycle with reference to *Synchytrium, Phytophthora, Albugo*. Ascomycotina: General characteristics; Life cycle with reference to *Peziza.*

Unit 2: Basidiomycotina, Allied fungi and Deuteromycotina (15 lectures)

General characteristics; Life cycle with reference to *Ustilago, Agaricus*; Allied Fungi: General characteristics; General characteristics of slime molds. Deuteromycotina: General characteristics; Life cycle with reference to *Alternaria, Cercospora*

Unit 3: Symbiotic Associations and applied Mycology (15 lectures)

Lichen – Occurrence; General characteristics; and range of thallus organization, & Economic Importance. Mycorrhiza: Ectomycorrhiza, Endomycorrhiza and their significance. Role of fungi in biotechnology; Application of fungi in food industry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Mycoproteins); Secondary metabolites (Pharmaceutical preparations); Agriculture (Biofertilizers); Mycotoxins; Biological control (Mycofungicides, Mycoherbicides, Mycoinsecticides, Myconematicides)

Unit 4: Phytopathology (10 lectures)

General symptoms; etiology and control of following diseases:

a) Wart disease of potato
b) Late blight of potato
c) White rust of crucifers
d) Loose smut of wheat
e) Early blight of potato
f) Tikka disease of groundnut
g) Tobacco Mosaic Virus
h) Citrus canker

MAJOR COURSE- 3 (MJ-3) PRACTICAL

1. Study of asexual stage from temporary mounts and sexual structures through permanent slides of the following Fungi:

Synchytrium
Phytophthora
Albugo
Peziza
Ustilago
Agaricus
Alternaria
Cercospora

2. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides of Lichens.

3. Phytopathology: Herbarium specimens of bacterial diseases: Citrus Canker; Viral diseases: TMV; Fungal diseases: Wart disease of potato, Late blight of potato, Loose smut of wheat, Early blight of potato, Tikka disease of groundnut and White rust of crucifers.

Suggested Readings

1. Agrios, G.N. (1997) Plant Pathology, 4th edition, Academic Press, U.K.
2. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
3. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
4. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
5. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.

SEMESTER IV

MAJOR COURSE- 4 (MJ-4) THEORY

Archegoniates

(Credits: Theory- 4, Practical- 2)

Unit 1: Introduction (4 lectures)

Unifying features of archegoniates; Transition to land habit; Alternation of generations.

Unit 2: Bryophytes and type of bryophytes (15 lectures)

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

Unit 3: Pteridophytes (20 lectures)

General characteristics; Classification; Early land plants (*Rhynia*). Morphology, anatomy and reproduction of *Selaginella, Equisetum, Ophioglossum* and *Pteris* (Developmental details not to be included). Heterospory and seed habit, stelar evolution; Common ferns of India; Ecological and economic importance.

Unit 4: Gymnosperms (18 lectures)

General characteristics, classification (up to family), fossil gymnosperm *Lyginopteris*; morphology, anatomy and reproduction of *Cycas, Pinus* and *Gnetum* (Developmental details not to be included); Ecological and Economic Importance.

MAJOR COURSE- 4 (MJ-4) PRACTICAL

1. *Riccia* – Morphology of thallus. Vertical transverse section of thallus showing antheridia and archegonia.

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

3. *Anthoceros*- Morphology of thallus, vertical section of thallus (permanent slide).

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

5. *Funaria*- Morphology, whole mount of leaf; permanent slides showing antheridial and archegonial heads, longitudinal section of capsule.

6. *Selaginella*- Morphology, transverse section of stem, whole mount of strobilus, longitudinal section of strobilus (permanent slide).

7. *Equisetum*- Morphology, transverse section of internode, longitudinal section of strobilus, transverse section of strobilus, transverse section of rhizome (permanent slide).

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

9. *Cycas*- Morphology (coralloid roots), 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).

10. *Pinus*- Morphology, transverse section of Needle, transverse section of stem, longitudinal section of male and female cones.

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

Suggested Readings

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. 3. Parihar, N.S. (1991). An introduction to Pteridophytes: Vol. I. Pteridophyta. Central Book Depot. Allahabad.

5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.

6. Vanderpoorten, A. & Goffinet, B. (2009) Introduction to Bryophytes. Cambridge University Press.

SEMESTER IV

MAJOR COURSE- 5 (MJ-5) THEORY

Plant Systematics and Economic Botany

(Credits: Theory- 4, Practical- 2)

Unit 1: Significance of Plant systematics (12 lectures)
Introduction to systematics; Plant identification, Classification, Nomenclature.
Evidences from palynology, cytology, phytochemistry and molecular data.
Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium.

Unit 2: Botanical nomenclature (7 lectures)
Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary).
Principles and rules (ICBN); Ranks and names; author citation

Unit 3: Systems of classification and Phylogeny of Angiosperms (12 lectures)
Artificial (Linnaeus); Natural (Bentham and Hooker); Phylogenetic (Hutchinson).
Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades).

Unit 4: Origin and conservation of Cultivated Plants (14 lectures)
Origin, Importance and domestication: Concept of Centres of Origin; Vavilov's Centres of Origin and diversity of crop plants, domestication, evaluation, bioprospection, Crop domestication and loss of genetic diversity; **Germplasm augmentation and conservation:** History and importance of germplasm Collection. **Plant Quarantine:** Principles, objectives and relevance of plant quarantine.

Unit 5: Botany, Utilization of Plant Wealth (Food crops, Spices, Beverages, Oil yielding, Medicinal plants, Timber, Rubber, Fibres) (15 lectures)
Morphology and uses of some selected crops: Cereals: Wheat, Rice, maize. Pulses: Origin, morphology, uses of pulses (Pigeon pea, Chickpea, Lentil).
Spices: Listing of important spices (Saffron, Cloves, Cardamom, Cinnamon, Tejpat, Anise, Cumin, Asafoetida, Fenugreek, Fennel, Coriander), their botanical name, family and part used. Origin, distribution, botany, cultivation practices, main chemical constituents, and economic Importance of the Major spices, namely Turmeric, Ginger, Capsicum, Black Pepper, Coriander.
Beverages: Tea and Coffee: History, origin, Botany, cultivation practices.

Oil seeds and fats: General description, classification, extraction and uses of groundnut, coconut, linseed, soybean, mustard.
Major Medicinal Plants: Fumitories and Masticatories: Processing, therapeutic uses, and health hazards of habit-forming drugs, with special reference to *Papaver, Cannabis* and Tobacco.
Botany, Uses, Cultivation and Processing of major medicinal plants, namely: Ashwagandha, Kalmegh, Satavar, Ghrit Kumari (*Aloe vera*), Senna, Bhui Amla (*Phyllanthus*), Stevia, Sarpagandha, Atropa, Digitalis, Giloy (Tinospora).
Timber plants and Fibres: General account with special reference to, Saal (*Shorea robusta*), Teak and Pine. General account of the Fibre yielding plants, with special reference to Cotton, Sun-hemp, flax, Coir, Jute.

MAJOR COURSE- 5 (MJ-5) PRACTICAL

1. 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):
   Apocyanaceae (Catharanthaceae) – *Catharanthus/ Thevetia*
   Brassicaceae - *Brassica*
   Asteraceae - *Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax*
   Solanaceae - *Solanum nigrum/Withania*
   Lamiaceae - *Salvia/Ocimum*
   Euphorbiaceae - *Euphorbia hirta/E.milii, Jatropha*
   Liliaceae - *Asphodelus/Lilium/Allium*
   Poaceae - *Triticum/Hordeum/Avena*
   Whatever plants are in season in the locality.
2. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the department).
3. Cereals: Wheat, Rice (habit sketch, study of grains)
4. Pulses: Pigeon pea, Chickpea, Lentil
5. Spices: Black pepper, Fennel and Clove
6. Beverages: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).
7. Sources of oils and fats: Mustard–plant specimen.
8. Woods: Tectona, Shorea (Specimen)
9. Fiber-yielding plants: Cotton, jute, coir (specimen)

Suggested Readings

1. Singh, (2012). Plant Systematics: Theory and Practice Oxford & IBH Pvt. Ltd., New Delhi. 3rdedition.
2. Jeffrey, C. (1982). An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge.
3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.
4. Maheshwari, J.K. (1963). Flora of Delhi. CSIR, New Delhi.
5. Radford, A.E. (1986). Fundamentals of Plant Systematics. Harper and Row, New York.
6. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
7. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.
8. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett Publishers.
9.

SEMESTER V

MAJOR COURSE- 6 (MJ-6) THEORY

Reproductive Biology of Angiosperms

(Credits: Theory- 4, Practical- 2)

Unit 1: Reproductive development (6 lectures)

Induction of flowering; flower as a modified determinate shoot. Flower development

Unit 2: Anther and pollen biology (10 lectures)

Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance. Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure; Palynology and scope (a brief account); Pollen wall proteins; Pollen viability and germination.

Unit 3: Ovule (10 lectures)

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

Unit 4: Fertilization (6 lectures)

Structure of stigma and style; path of pollen tube in pistil; double fertilization.

Unit 5: Embryo, Endosperm and Seed (10 lectures)

Structure and types; General pattern of development of dicot and monocot embryo. Endosperm (Types and significance); Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Seed structure.

Units 6: Polyembryony (6 lectures)

Introduction; Classification; Causes and applications.

MAJOR COURSE- 6 (MJ-6) PRACTICAL

1. Anther: Transverse section of anther showing microsporogenesis.
2. Pollen grains: Fresh and acetolyzed showing structure, pollinia (slides/photographs, fresh material). Pollen germination on stigma.
3. Ovule: Types-anatropous, orthotropous, anatropous, amphitropous/campylotropous, circinotropous (through models/ photographs)
4. Embryo: Study of monocot and dicot embryo through permanent slides. Embryo dissection.
5. Polyembryony: Study of polyembryony in citrus species.

Suggested Readings

1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
2. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi. 38
3. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
4. Johri, B.M. l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.
5. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.

SEMESTER V

MAJOR COURSE- 7 (MJ-7) THEORY

Plant Anatomy and Ecology

(Credits: Theory- 4, Practical- 2)

Unit 1: Introduction and scope of Plant Anatomy (3 Lectures)
Applications in systematics, forensics and pharmacognosy.
Internal organization of plant body: The three tissue systems, types of cells and tissues. Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements; Pits and Plasmodesmata.

Unit 2: Meristems, Vascular cambium and Wood (12 Lectures)
Evolution of concept of organization of shoot and root apex (Apical cell theory, Histogen theory, Tunica Corpus theory, Korper-Kappe theory); Types of vascular bundles; Structure of dicot and monocot stem and root. Kranz anatomy. Quiescent centre; Root-cap.
Structure, function and seasonal activity of cambium; Secondary growth in root and stem. Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Development and composition of periderm, rhytidome and lenticels

Unit 3: Introduction to Plant Ecology, soil and water (8 lectures)
Basic concepts; Levels of organization. **Soil:** Origin; Types and Formation; Composition; Physical, Chemical and Biological components; Soil profile. Types of soils in India. **Water:** Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil.

Unit 4: Ecological adaptations, Population ecology (12 lectures)
Variations in adaptation of plants in relation to light, temperature, water, wind and fire. **Biotic interactions:** Competition: Inter- and intraspecific competition; Ammensalism, heterotrophy; mutualism, commensalism, parasitism; herbivory, carnivory, protocooperation, **Population ecology:** Characteristics and population growth, population regulation, life history strategies; *r* and *k* selection. Ecological Speciation.

Unit 5: Plant Communities and Ecosystem (10 lectures)
Community characteristics: analytical and synthetic; Concept of ecological amplitude; Habitat and niche; Ecotone and edge effect; Succession: processes, types; climax concept. Primary vs Secondary succession. **Ecosystem:** Structure; Processes; Trophic organization; Food chains and Food webs; Ecological pyramids. Ecosystems of India.

Unit 6: Functional Aspects of Ecosystem and Phytogeography (15 lectures)
Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles of carbon, nitrogen and phosphorus.
Phytogeography: Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phyto-geographical division of India; Local Vegetation.

MAJOR COURSE- 7 (MJ-7) PRACTICAL

1. Apical meristem of root, shoot and vascular cambium.
2. Distribution and types of parenchyma, collenchyma and sclerenchyma.
3. Root: monocot, dicot, secondary growth.
4. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels. Determination of pH of various soil and water samples (pH meter, pH paper)
5. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
6. Study of morphological and anatomical adaptations of hydrophytes and xerophytes (two each).
7. Study of biotic interactions of the following: Stem parasite (Cuscuta), Epiphytes (Orchid).
8. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
9. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
10. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.
11. Field visit to familiarise students with ecology of different sites.

Suggested Readings

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
5. Structure, Function and Development. John Wiley and Sons, Inc.

6. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
7. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
8. Sharma, P.D. (2010). Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
9. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
10. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

SEMESTER VI

MAJOR COURSE- 8 (MJ-8) THEORY

Cytogenetics and Molecular Biology

(Credits: Theory- 4, Practical- 2)

Unit 1: Mendelian genetics and its extension (8 lectures)
Mendelism: History; Principles of inheritance; Chromosomal theory of inheritance; Deviation of Mendel's Law; Incomplete dominance and codominance; Multiple alleles, Epistasis, Pleiotropy, Numericals; Polygenic inheritance.

Unit 2: Linkage, crossing over and chromosome mapping and Chromosomal aberration (Structure and Aberration) (10 lectures)
Changes in chromosome number; Linkage and crossing over-Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Gene mapping; Sex Linkage. Deletion, Duplication, Inversion, Translocation, Position effect, Haploidy, Euploidy and Aneuploidy.

Unit 3: Gene mutations (6 lectures)
Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Transposons. Fine structure of gene- Classical vs. molecular concepts of gene. Genetic variation and Speciation.

Unit 4: Nucleic acids : Carriers of genetic information (10 lectures)
Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, McLeod & McCarty.
DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, 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. The Nucleosome; Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.

Unit 5: The replication of DNA (10 lectures)
Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semi-conservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA; Enzymes involved in DNA replication. The Central Dogma; Genetic code (deciphering & salient features**)**

Unit 6: Transcription (12 lectures)
Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E.coli.* Eukaryotes: transcription factors; Role of enzymes in transcription. Split genes-concept of introns and exons and splicing.

Unit 7: Translation (8 lectures)
Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyltRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Role of enzymes in translation; Inhibitors of protein synthesis.

MAJOR COURSE- 8 (MJ-8) PRACTICAL

1. Preparation of carmine.
2. Mitosis and Meiosis through temporary squash preparation.
3. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
4. Chromosome mapping using point test cross data.
5. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
6. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).
7. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
8. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's and Hershey & Chase's Experiments.

Suggested Readings

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9th edition.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
5. 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.
6. Russell, P. J. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.

SEMESTER VI

MAJOR COURSE- 9 (MJ-9) THEORY

Plant physiology, Biochemistry and Biotechnology

(Credits: Theory- 4, Practical- 2)

Unit 1: Plant-water relations (10 lectures)
Water Potential, water absorption by roots, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap–cohesion-tension theory. Transpiration and factors affecting transpiration, mechanism of stomatal movement. Translocation in the phloem: Mass flow hypothesis of Munch.
Mineral nutrition: Essential and beneficial elements, macro and micronutrients, criteria for essentiality, mineral deficiency symptoms, roles of essential elements.
Unit 2: Plant growth regulators and Physiology of flowering (14 lectures)
Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene.
Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy.
Unit 3: Concept of metabolism (8 lectures)
Introduction, anabolic and catabolic pathways, regulation of metabolism.
Carbon assimilation: Photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO2 reduction, photorespiration, C4pathways. Synthesis and catabolism of sucrose and starch. Carbon Oxidation: Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, TCA cycle, amphibolic role, anaplerotic reactions, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation.

Unit 4: ATP-Synthesis (8 lectures)
Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase.

Unit 5: Lipid metabolism (8 lectures)
Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle
Nitrogen metabolism**:** Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination
Unit 6: Plant Tissue Culture (16 lectures)

Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryo culture and its significance. Somatic embryogenesis; Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination).

Unit 7: Plant Biotechnology (12 lectures)
Recombinant DNA Technology: steps, process; Restriction Endonucleases (History, Types I-IV, biological role and application); Cloning Vectors: Prokaryotic vectors (pUC 18 and pUC19, pBR322, Ti plasmid, BAC, YAC); Genetic vectors (Transposons, Retroposons)
Gene Cloning: Cell mediated and Cell free (PCR) gene cloning.
Methods of gene transfer: Indirect *(Agrobacterium*-mediated) and Direct (Electroporation, Microinjection, Microprojectile bombardment) methods
Applications of Biotechnology:Transgenic plants with Pest resistant (Bt-cotton); herbicide resistant plants (Round Up Ready soybean); Transgenic crops with improved quality traits (FlavrSavr tomato, Golden rice)

MAJOR COURSE- 9 (MJ-9) PRACTICAL

1. Determination of osmotic potential of plant cell sap by plasmolytic method. Determination of diffusion pressure deficit of potato tuber.
2. Comparison of the rate of imbibition of fatty and starchy seeds.
3. To determine the effect of cuticle on the rate of transpiration.
4. Demonstration of working method of Ganong's potometer and Bell jar method to study transpiration.
5. Demonstration of Ganong's light screen experiment and Moll's half leaf experiment.
6. To demonstrate that oxygen is evolved during photosynthesis by inverted funnel method.
7. Chemical separation of photosynthetic pigments by chromatography paper.
8. To study the effect of light intensity on the rate of photosynthesis.
9. Effect of carbon dioxide on the rate of photosynthesis.
10. Preparation of MS medium.

11. Demonstration of in vitro sterilization and inoculation methods.
12. Study of anther, embryo and endosperm culture.
13. Study of micropropagation, somatic embryogenesis & artificial seeds through photographs.
14. Construction of restriction map of circular and linear DNA from the data provided.
15. Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
16. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.

Suggested Readings

1. Singh, B.D. (2006). Plant Biotechnology. Kalyani publications.
2. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
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. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
6. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.
7. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
8. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
9. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.
10. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
11. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.

SEMESTER VII

ADVANCE MAJOR COURSE- (AMJ 1) THEORY

Natural Resource Management

(Credits: Theory- 4, Practical- 2)

Unit 1: Natural resources (2 lectures)
Definition and types.

Unit 2: Sustainable utilization (8 lectures)
Concept, approaches (economic, ecological and socio-cultural).

Unit 3: Land (8 lectures)
Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation and management.

Unit 4: Water (8 lectures)
Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.

Unit 5: Biological Resources (12 lectures)
Biodiversity-definition and types; Significance; Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan).

Unit 6: Forests (6 lectures)
Definition, Cover and its significance (with special reference to India); Major and minor forest products; Depletion; Management.

Unit 7: Energy (6 lectures)
Renewable and non-renewable sources of energy

Unit 8: National and international efforts in resource management and conservation (4 lectures)

ADVANCE MAJOR COURSE- (AMJ 1) PRACTICAL

Project to be given to students on topics related to the paper. In exam viva based on the project to be held.

Suggested Readings

1. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
2. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
3. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.

SEMESTER VII

ADVANCE MAJOR COURSE- (AMJ 2) THEORY

Plant Breeding and Crop Improvement

(Credits: Theory- 4, Practical- 2)

Unit 1: Plant Breeding (10 lectures)

Introduction and objectives. Breeding systems: modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding.

Unit 2: Methods of crop improvement (20 lectures)

Introduction: Plant genetic resources (Introduction, domestication and Acclimatization); Selection methods: For self-pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.

Unit 3: Quantitative inheritance (10 lectures)

Concept, mechanism, examples of inheritance of Kernel colour in wheat, Skin colour in human beings, length of petal in tobacco.

Unit 4: Inbreeding depression and heterosis (8 lectures)

History, genetic basis of inbreeding depression and heterosis; Applications.

Unit 5: Mutation Breeding (3 lectures)

Role of mutations in breeding.

Unit 6: Ploidy Breeding (4 lectures)

Haploid breeding; triploid breeding; Role of tetraploidy in crop breeding.

Unit 7: Distant hybridization and role of biotechnology in crop improvement. (6 lectures)

ADVANCE MAJOR COURSE- (AMJ 2) PRACTICAL

Project to be given to students on topics related to the paper. In exam viva based on the project to be held.

Suggested Readings

1. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.
2. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2ndedition. 52
3. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.
4. Allard, R.W. Principles of Plant Breeding. Hutchinson Publication.
5. Chaudhary, R.C. Principles of Plant Breeding. Kalyani Publications.

SEMESTER VIII

ADVANCE MAJOR COURSE- (AMJ 3) THEORY

Stress Biology

(Credits: Theory- 4, Practical- 2)

Unit 1: Defining plant stress (2 lectures)

Acclimation and adaptation.

Unit 2: Environmental factors (20 lectures)

Water stress; Salinity stress, High light stress; Temperature stress; Hypersensitive reaction; Pathogenesis; Systemic acquired resistance

Unit 3: Stress sensing mechanisms in plants (20 lectures)

Calcium modulation, Phospholipid signalling

Unit 4: Developmental and physiological mechanisms that protect plants against environmental stress (12 lectures)

Adaptation in plants; Changes in root: shoot ratio; Aerenchyma development; Osmotic adjustment; Compatible solute production.

Unit 5: Reactive oxygen species–Production and scavenging mechanisms. (6 lectures)

ADVANCE MAJOR COURSE- (AMJ 3) PRACTICAL

Project to be given to students on topics related to the paper. In exam viva based on the project to be held.

Suggested Readings

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

SEMESTER VIII

ADVANCE MAJOR COURSE- (AMJ 4) THEORY

Biostatistics

(Credits: Theory- 4, Practical- 2)

Unit 1: Biostatistics (12 lectures)

Definition - statistical methods - basic principles. Variables - measurements, functions.

Unit 2: Collection of data primary and secondary (12 lectures)

Types and methods of data collection procedures - merits and demerits. Classification - tabulation and presentation of data - sampling methods.

Unit 3: Measures of central tendency (14 lectures)

Mean, median, mode, geometric mean - merits & demerits. Measures of dispersion - range, standard deviation; Co- efficient of variations.

Unit 4: Correlation (12 lectures)

Types and methods of correlation, regression, simple regression equation

Unit 5: Statistical inference (10 lectures)

Hypothesis - simple hypothesis - student 't' test - chi square test

ADVANCE MAJOR COURSE- (AMJ 4) PRACTICAL

Project to be given to students on topics related to the paper. In exam viva based on the project to be held.

Suggested Readings

1. Biostatistics, Danniel, W.W., 1987.New York, John Wiley Sons.
2. An introduction to Biostatistics, 3rd edition, Sundarrao, P.S.S and Richards, J. Christian Medical College, Vellore
3. Statistical Analysis of Epidemiological Data, Selvin, S., 1991. New York University Press.
4. Statistics for Biology, Boston, Bishop, O.N. Houghton, Mifflin.
5. The Principles of Scientific Research, Freedman, P. New York, Pergamon Press.
6. Statistics for Biologists, Campbell, R.C., 1998.Cambridge University Press.
7. Panse and Sukhatami (1967). Statistical Methods for Agricultural Science. 2nd edition; Indian, Council of Agricultural Research, New Delhi.

INTRODUCTORY REGULAR COURSE (IRC)

Unit 1: Introduction to Botany

General concept of Botany as a science subject.
Branches of Botany and related areas.
Scope and Future prospects of Botany

Unit 2: Cryptogams

General characteristics of Thallophyta, Bryophyta and Pteridophyta.

Unit 3: Phanerogams

General characteristics of Gymnosperms. Salient features and reproduction of Angiospermic plants.

Unit 4: Cytology and Genetics

General concept of structure and function of prokaryotic and eukaryotic cells.

Cell division- Mitosis and Meiosis and their significance.

Mutation and its significance.

Unit 5: Ecology and Environment

General concept of Ecology; Biotic and abiotic factors; Adaptation.

Pollution: Air, Water and soil pollution; Current Environmental Issues.

Unit 6: Plant Physiology and Basic Biochemistry

General concept of transpiration.

Basic concept of Photosynthesis and Respiration; Process, similarities and differences; general concept of ATP synthesis.

MINOR COURSE- MN 1 (THEORY)

Plant Ecology and Taxonomy

Unit 1: Introduction to Ecology (2 lectures)

Unit 2: Ecological factors (10 lectures)

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

Unit 3: Plant communities (12 lectures)

Characters; Succession; Processes and types.

Unit 4: Ecosystem (10 lectures)

Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids; Biogeochemical cycling; Cycling of carbon, nitrogen.

U nit 5: Introduction to plant taxonomy (2 lectures)

Identification, Classification, Nomenclature.

Unit 6: Taxonomic hierarchy (outline) (2 lectures)

Ranks, categories and taxonomic groups

U nit 7: Botanical nomenclature (6 lectures)

Principles and rules of ICBN

Unit 8: Classification (6 lectures)

Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Hutchinson (upto orders).

Unit 9: Angiospermic Families (10 lectures)

Catharanthaceae, Acanthaceae, Amaranthaceae, Lamiaceae, Cyperaceae

MINOR COURSE- MN 1 (PRACTICAL)

1. Study of morphological adaptations of hydrophytes and xerophytes (four each).
2. Study of biotic interactions of the following: Stem parasite (Cuscuta), Epiphytes.
3. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
4. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
5. 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): Catharanthaceae (*Catharanthus roseus/ Thevetia*), Acanthaceae (*Ruellia/ Andrographis*), Amaranthaceae (*Achyranthus*), Lamiaceae (*Ocimum/ Clerodendron*), Cyperaceae (*Cyperus*).

Suggested Readings

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

MINOR COURSE- MN 2 (THEORY)

Plant Anatomy and Embryology

Unit 1: Meristematic tissues (8 lectures)

Apical, Intercalary and Lateral Meristems; simple and complex tissues

Unit 2: Secondary Growth (8 lectures)

Vascular cambium – structure and function, seasonal activity. Normal and Abnormal growth

Unit 3: Anomalous secondary growth

Boerhavia, Dracaena and Tinospora

Unit 4: Structural organization of flower (8 lectures)

Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization

Unit 5: Fertilization (8 lectures)

Double fertilization

Unit 6: Embryo and endosperm (8 lectures)

Endosperm types, structure and functions; Dicot and monocot embryo; Embryo endosperm relationship

MINOR COURSE- MN 2 (PRACTICAL)

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma)
3. Stem: Monocot: Zea mays; Dicot: Helianthus; Secondary: Helianthus (only Permanent slides).
4. Root: Monocot: Zea mays; Dicot: Helianthus; Secondary: Helianthus (only Permanent slides).
5. Adaptive anatomy: Xerophyte (Nerium leaf); Hydrophyte (Hydrilla stem).
6. Structure of anther (young and mature)
7. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous.
8. Dissection of embryo/endosperm from developing seeds.

Suggested Readings

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

MINOR COURSE- MN 3 (THEORY)

Plant Physiology and Genetics

UNIT – 1 25 lectures

1. Transpiration - Mechanism & significance
2. Ascent of Sap – Root Pressure transpiration pull, theory
3. Photosynthesis – Photophosphorylation, C_3, C4 Cycle
4. Respiration – Glycolysis, TCA Cycle.
5. Growth Hormone – Auxins, Gibberellins

UNIT – 2 25 lectures

1. Structure of Cytoplasmic Cell Organelles – Mitochondria, Chloroplast, Ribosome
2. Cell Division – Mitosis, Meiosis,
3. Principles of inheritance, Mendel's Law
4. Complimentary Genes & Epistasis
5. Gene – Mutation & Polyploidy

UNIT – 3 5 lectures

Plant Tissue Culture – History, Requirement, Technique & Application

MINOR COURSE- MN 3 (PRACTICAL)

1. Comparison of the rate of imbibition of fatty and starchy seeds.
2. Demonstration of Ganong's light screen experiment and Moll's half leaf experiment.
3. To demonstrate that oxygen is evolved during photosynthesis by inverted funnel method.
4. To study the effect of light intensity on the rate of photosynthesis by demonstration of wilmott's bubbler.

Suggested Readings

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

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.