RANCHI WOMEN'S COLLEGE, RANCHI

(AN AUTONOMOUS COLLEGE)

Constituent unit of Ranchi University,Ranchi

CHOICE BASED CREDIT SYSTEM

Course of Study

For

B.Sc. BOTANY

From 2021 onwards

13.4.21

13/4/2021

13.04.2021

13.4.2021

13.4.21

Syllabus Revised by Board of Studies in Botany

Ranchi Women's College,Ranchi

(w.e.f. 2021 Onward)

S.N.		Name of Members		Signature
1	Head , Department of Botany	Dr. Shalini Mehta ,	Chairperson Cum convener	Shalini Mehta 13.04.2021
2	Faculty	Dr. Sushma Das Guru	Member	
		Dr. Snigdha Kumari	Member	
		Ms. Anita Tudu	Member	
		Mrs. Shashi Singh	Demonstrator	13.9.21
3	Expert From Outside College	Prof. Jyoti Kumar Director HRDC, Dean & Head, University Department of Botany, Ranchi University , Ranchi	Subject Expert	Jyoti Kumar
		Dr. Manoj Kumar, Associate Professor, Department of Life Science, Central University of Jharkhand , Brambe, Ranchi	Subject Expert	
4	University Nominee	Prof. Dr. Ashok Kumar Choudhary Retired Dean & Head University Department of Botany	Vice chancellor Nominee	13.4.2021
5	Representative from Industry/ Allied Field	Dr. Prakash Kumar Tiwari Retired Scientist CSB Bangalore At present Research consultant Ram Krishan Mission , Ranchi Centre Morhabadi	Member	13.4.21
6	Meritorious Student	Muskan Kumari	UG Topper (Session: 2018-2021)	

13.4.2021

13.4.21

Shalini Mehta 13.04.2021

13.04.2021

Member Secretary
Academic Council
Ranchi Women's College

CHAIRPERSON
ACADEMIC COUNCIL
RANCHI WOMEN'S COLLEGE

PROGRAMME SPECIFIC OUTCOMES
OPPORTUNITIES AFTER GRADUATION

An ocean of opportunities awaits students after successful completion of their graduation. These range from pursuing higher education and research in their chosen discipline and areas of interest: pursuing employment avenues in public, private and social sectors ; pursuing their career as an entrepreneur /own business ; and pursuing vocational courses in their areas of interest. The Choice Based Credit System (CBCS) followed in University of Ranchi offers students the choice to study certain subjects outside their own discipline (Generic Electives) which enables the students to explore their interests and widen their opportunities by pursing education and employment avenues in these additional areas also.

The following list provides a broad overview of the plethora of options available after graduation in the department of Botany ;

HIGHER EDUCATION:

MASTERS IN BOTANY

Master of Science in Botany, Master of Science in Botany and Forestry, Master of Science in Applied Botany, Master of Science in Herbal Science , Post Graduate Diploma in Medico botany, Post Graduate Diploma in Plant Biodiversity which one can study under the field of Botany and later be a part of this vast field.

Since the world of Botany is very vast field and it would one person to specialize in a particular field to be able to share her expertise on a particular subject. Some of the specializations available for botany are :

- Cytology
- Genetics
- Lichenology
- Economic botany
- Palynology
- Palaeobotany
- Bryology
- Ethnobotany
- Phycology
- Phytochemistry
- Forestry
- Plant morphology
- Phytopathology

Placement Opportunities

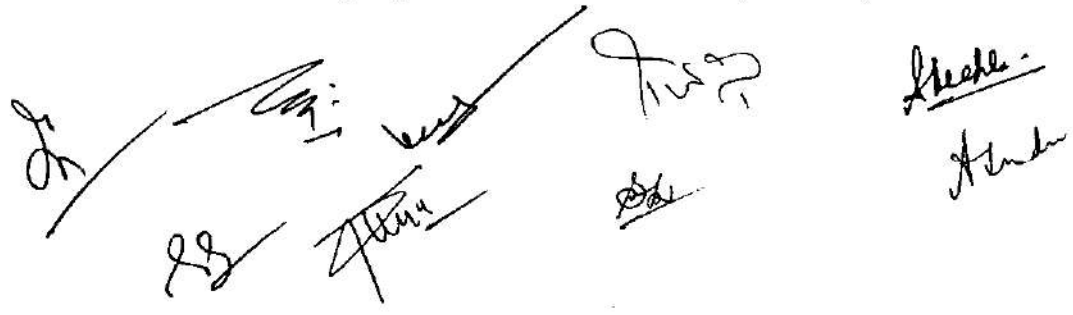
After dully completing their bachelor's education in Botany, a candidate can look forward to being a part of the industry by working as a technician , whereas , a candidate after completing her master's education can look forward to working with some industry giants or being a part of good research teams. The amount of diversity in the field of Botany gives it students to choose their specializations as per their choice aptitude and interests. There is huge scope of being a part of this industry merely keeping in mind the amount of diversity it has to offer. One can be part of any reputed organization as a plant explorer, conservationist, ecologist, environment consultant, horticulturist, plant biochemist, nursery manager, genetics, molecular biologist, taxonomist plant pathologist environmental consultant and farming consultant. Moreover the application of plant sciences improves the yield and supply of medicines, foods ,fibers, building materials and other plant products. The knowledge of plant sciences is essential for development and management of forests , parks, waste lands, sea wealth etc.

Few of the industries which one can work with are:

- Chemical Industry
- Food Companies
- Arboretum
- Forest Services
- Biotechnology firms
- Oil Industry
- Land management agencies
- Seed And Nursery Companies
- Plant Health Inspection services
- National Parks Biological supply houses
- Plant Resources laboratory
- Educational Institutes

COURSE SPECIFIC OUTCOMES

- Comprehend and integrate theoretical and practical skills in basic and applied disciplines of Botany.
- Able to design new biotechnological products or processes by applying knowledge of different disciplines of botany in an integrated manner.
- Trained enough to take employment in diverse areas of biotechnology as well as for further higher studies.
- Having a clear understanding of professional and ethical responsibility.



- Ability to establish themselves as entrepreneur and independently develop the different firm for bioproducts formulations.
- Ability to write and present a substantial technical report/document.
- Able to demonstrate a degree of mastery in the area of botany to enable them in collaborative and multidisciplinary research.
- Recognize the need for continuous learning and will prpare oneself to create, select, learn and apply appropriate techniques, resources, and modern instrumentation to solve complex biotechnological activities with an understanding of the limitations.
- Demonstrate knowledge of botany and management principles and apply to manage projects efficiently and economically with intellectual integrity and ethics for sustainable development of society
- Ability to understand the indigenous ethic groups and conceptualize ethnobotany as an inter disciplinary science.
- Ability to understand the new method and strategies to contribute mushroom production.

Preamble

Under this system, there will be 14 core course paper (C1 to C14). These are compulsory to be studied by a student to complete the requirement of B.Sc. (Hons.) Botany programme. The students will study two core papers per semester in first year, three core paper per semester in the second year and two core papers per semester in the third year. The core papers (6 credits each) will comprise of theory (4 credits) and practicals (2 credits).

The Discipline specific elective papers (6 credits each) will comprise of theory (4 credits) and practicals (2 credits) like the core papers. A particular option of DSE paper will be offered in V and VI semester

a) Following four **Discipline Specific Elective** (DSE) course have been included ,two for semester V and two for Semester VI

DSE1. Analytical Techniques in Plant Sciences
DSE 2-Horticulture Practices and Plant Harvest Technology
DSE3- Plant Breeding/Bioinformatics
DSE4- Natural Resource Management

b) The students will also undertake two **skill Enhancement (SEC) courses** of two credits each in III and IV semesters of second year

SEC 1-Ethanobotany
SEC2- Mushroom Culture Technology

c) Besides the core and elective courses, there are two Ability enhancement compulsory courses, AECC-I (English Communication) and AECC-2 (Environmental Sciences) of two credits each in 1st and 2nd semester

d) Generic Elective (GE) : Different generic elective papers will be offered to students of other departments of the college and the student will have the option to choose one generic elective paper each in the first four semesters. The generic elective will be of six credits each. The Department of Botany is offering four generic elective papers (GE: 1-4) for students of other departments.(Zoology/Chemistry/Biotechnology). These generic elective papers (6 credits each) will comprise of theory (4 credits) and practicals (2 credits).

GE1- Biodiversity (Microbes,Algae,Fungi and Archegoniate)
GE-2- Plant Anatomy and Embryology
GE-3- Plant Ecology and Taxonomy
GE-4- Economic Botany and Biotechnology

In the CBCS system, a credit is unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week. A minimum of 140 credits are required to obtain degree in B.Sc. (Hons.) Botany.

Structure of B.Sc. Honours Botany under CBCS

Core Courses

1. Algae and Microbiology
2. Biomolecules and Cell Biology
3. Mycology and Phytopathology
4. Archegoniate
5. Morphology and Anatomy
6. Economic Botany
7. Genetics
8. Molecular Biology
9. Plant Ecology and Phytogeography
10. Plant Systematics
11. Reproductive Biology of Angiosperms
12. Plant Physiology
13. Plant Metabolism
14. Plant Biotechnology

Discipline Specific Electives

1. Analytical Techniques in Plant Sciences
2. Horticultural Practices and Post-Harvest Technology
3. Plant Breeding / Bioinformatics
4. Natural Resource Management

Generic Electives (For students of other subjects)

1. Biodiversity (Microbes, Algae, Fungi and Archegoniate)
2. Plant Anatomy and Embryology
3. Plant Ecology and Taxonomy
4. Economic Botany and Biotechnology

Ability Enhancement Course Compulsory

1. English/MIL Communication
2. Environmental Science

Skill Enhancement CoursesElective

1.Ethnobotany
2.Mushroom Culture Technology

Ability Enhancement Compulsory Course	
Semester-I AECC-1	English/MIL Communication
Semester-II AECC-2	Environmental Science
Generic Electives (Four) Offered to the students of other Departments	
Semester-I GE 1	Biodiversity (Microbiology,Algae,Fungi and Archegoniate)
Semester-II GE-2	Plant Anatomy and Embryology
Semester-III GE-3	Plant Ecology and Taxonomy
Semester-IV GE-4	Economic botany and Plant biotechnology
Skill Enhancement Courses Elective (Two)	
Semester-III SEC-1	Ethanobotany
Semester-IV SEC-2	Mushroom Culture Technology
Discipline Specific Elective (four)	
Semester-V	DSE-1 Analytical Techniques in Plant Sciences DSE-2 Horticultural Practices and Post Harvest Technology
Semester-VI	DSE-3 Plant Breeding/Bioinformatics DSE-4 Natural Resource Management

Semester	Core Course(14)	Ability Enhancement Compulsory Course (AECC)(2)	Skill Enhancement Course (SEC)(2)	Discipline Specific Elective: (DSE)(4)	Generic Elective: (GE) (4) (for students of other subjects)
I	1. Microbiology and Phyco'ogy 2. Biomolecules	**English/MIL**			**GE I Biodiversity (Microbes,Algae,Fungi and archegoniate)**
II	3. Mycology and Phytopathology 4. Archegoniatae	**Environmental Science**			**GE II Plant Anatomy and Embryology**
III	5. Anatomy of Angiosperms 6. Economic Botany 7.Genetics		**SEC-1 Ethanobotany**		**GE III Plant Ecology and taxonomy**
IV	8.Molecular Biology 9. Ecology 10. Plant Systematics		**SEC-II Mushroom Culture technology**		**GE IV Economic Botany and Biotechnology**
V	11. Reproductive Biology of Angiosperms 12. Plant Physiology			**DSE-I** **1. Analytical Techniques in Plant Science** **DSE-II** **2. Horticultural Practices and Post Harvest technology**	
VI	13. Plant metabolism 14. Plant Biotechnology			**DSE-III** **3. Biodiversity/Bioinformatics** **DSE IV** **4. Natural Resource Management**	

SEMESTER	COURSE OPTED	COURSE NAME	Credits
I	Ability Enhancement Compulsory Course-I	English/MIL	2
	Core Course-I	Microbiology and Phycology	4
	Core course-I Practical		2
	Core course -II	Biomolecules and cell Biology	4
	Core Course II Practical		2
	Generic Elective –I	GE-I Zoolgy/Chemistry	4
	G E –I Practical		2
II	Ability Enhancement Compulsory Course-II	Environmental Science	2
	Core Course III	Mycology and Phytopathology	4
	Core Course III Practical		2
	Core Course IV	Archegoniatae	4
	Core Course IV Practical		2
	Generic Elective II	GE II Zoology/Chemistry	4
	GE II Practical		2
III	Core Course V	Anatomy of Angiosperms	4
	Core Course V Practical		2
	Core Course VI	Economic Botany	4
	Core Course VI Practical		2
	Core Course VII	Genetics	4
	Core Course VII Practical		2
	Skill Enhancement Course I	SEC-1-Ethanobotany	2
	Generic Elective III	GE III Zoology/Chemistry	4
	GE III Practical		2
IV	Core Course VIII	Molecular Biology	4
	Core Course VIII Practical		2
	Core Course IX	Ecology	4
	Core Course IX Practical		2
	Core Course X	Plant Systematics	4
	Core Course X Practical		2
	Skill Enhancement Course II	Mushroom Culture Technology	2
	Generic Elective IV	GE IV Zoology/Chemistry	4
	GE IV Practical		2
V	Core Course XI	Reproductive Biology of angiosperms	4
	Core Course XI Practical		2
	Core Course XII	Plant Physiology	4
	Core Course XII Practical		2
	Discipline Specific Elective I	DSE-I Analytical Techniques in Plant Science	4
	DSE I practical		2
	Discipline specific Elective II	DSE-II Horticultural processes and Post Harvesting Techniques	4
	DSE II Practical		2
VI	Core Course XIII	Plant Metabolism	4
	Core Course XIII Practical		2
	Core Course XIV	Plant biotechnology	4
	Core Course XIV practical		2
	Discipline Specific Elective III	DSE III plant Breeding/Bioinformatics	4
	DSE III practical		2
	Disciplinne Specific Elective IV	DSE IV Natural Resource Management	4
	DSE IV Practical		2
Total			140

Course Structure B. Sc. Botany Honours Under CBCS,Ranchi Women's College,Ranchi

Sem	Core Course	AECC	SEC	DSE	GE
I	CC1-Algae and Microbiology CC2-Biomolecules and Cell Biology Practical on CC1 & CC2	English/MIL			GE-1 Biodiversity(Microbes,Algae, Fungi and Archegoniate)
II	CC3-Mycology and Phytopathology CC4- Archegonitae Practical on CC3 & CC$	Environmental Science			GE-2 Plant Anatomy and Embryology
III	CC5- Anatomy of Angiosperms CC6-Economic Botany CC7- Genetics Practical on CC5+CC6+CC7		SEC1- Ethanobotany		GE-3 Plant Ecology and Taxonomy
IV	CC8- Molecular Biology CC9-Ecology CC10-Plant Systematics Practical on CC8+CC9+CC10		SEC2 Mushroom Culture Technology		GE-4 Economic Botany and Biotechnology
V	CC11-Reproductive Biology of Angiosperms CC12-Plant Physiology Practical on CC11 + CC12			DSE1-Analytical technique in plant sciences DSE2-Horticultural practices and post harvest technology	
VI	CC13-Plant Metabolism CC14-Plant Biotechnology Practical on CC13 + CC14			DSE3-Plant Breeding/Bioinformatics DSE 4- Natural Resource Management	

Abbreviations : CC= Core Course ,AECC= Ability Enhancement Compulsory Course ,SEC = Skill Enhancement Course,DSE= Discipline Specific Elective, GE= Generic Elective

Course Structure and Scheme of Examination of B Sc Botany Honours Under CBCS,Ranchi Women's College,Ranchi

Sem	Core Course	AECC	SEC	DSE	GE
I	CC1-[MT15+ET60=75] 4 credits CC2--[MT15+ET60=75] 4 credits Practical on [CC1 & CC2=50] 4 credits	English/MIL=100 2 credits			GE-1 T=75+P25 (4+2=6 credits) Biodiversity(Microbes,Algae,Fungi and Archegoniate)
II	CC3--[MT15+ET60=75] 4 credits CC4- -[MT15+ET60=75] 4 credits Practical on[CC3 & CC4=50] 4 credits	Environmental Science =100 2 credits			GE-2 T=75+P25 (4+2=6 credits) Plant Anatomy and Embryology
III	CC5- [MT15+ET60=75] 4 credit CC6--[MT15+ET60=75] 4 credits CC7- -[MT15+ET60=75] 4 credits Practical on [CC5+CC6+CC7=75] 6 credits		SEC1-Ethanobotany -100 2 credits		GE-3 T=75+P25 (4+2=6 credits) Plant Ecology and Taxonomy
IV	CC8- -[MT15+ET60=75] 4 credits CC9--[MT15+ET60=75] 4 credits CC10--[MT15+ET60=75] 4 credits Practical on[CC8+CC9+CC10=75] 6 credits		SEC2 Mushroom CT =100 2 credits		GE-4 T=75+P25 (4+2=6 credits) Economic Botany and Biotechnology
V	CC11--[MT15+ET60=75] 4 credits CC12--[MT15+ET60=75] 4 credits Practical on [CC11 + CC12-50] 4 credits			DSE1-ATPS -[MT15+ET60=75] 4 credits DSE2-HPPHT -[MT15+ET60=75] 4 credits Practical on[DSE1+E2=50] 4 credits	
VI	CC13--[MT15+ET60=75] 4 credits CC14--[MT15+ET60=75] 4 credits Practical on [CC13 + CC14=50] 4 credits			DSE3 PB/Bioinformatics -[MT15+ET60=75] 4 credits DSE 4- N RM -[MT15+ET60=75] 4 credits Practical on[DSE3+E4=50] 4 credits	

Total credits = 140 Abbreviations : CC= Core Course ,AECC= Ability Enhancement Compulsory Course ,SEC = Skill Enhancement Course,DSE= Discipline Specific Elective, GE= Generic Elective,ATPS-Analytical Techniques in Plant Science,HPPTT-Horticoltural processes and Post Harvest Technology, PB= Plant Breeding,NRM-Natural Resource Management Marks : 1400+1200=2600

Semester-I
Core Course I: Microbiology and Phycology
(Credits: Theory-4, Practical-2)
THEORY
Lectures: 60

Core Course 1: Phycology and Microbiology

Learning outcomes

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

- Develop understanding on the concept of microbial world
- Classify viruses based on their characteristics and structures
- Develop critical understanding of plant diseases and their remediation.
- Examine the general characteristics of bacteria and their cell reproduction/ Recombination
- Increase the awareness and appreciation of human friendly viruses, bacteria, algae and their economic importance
- Conduct experiments using skills appropriate to subdivisions

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations. Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15 x2= 30

Unit 1 : Introduction to microbial world, microbial nutrition **(2 lectures)**

Unit 2 : Discovery, general structure with special reference to viroids and prions; DNA virus (T-phage), lytic and lysogenic cycle; RNA virus (TMV). **(7 Lectures)**

Unit 3: Bacteria **(8 lectures)**

Discovery, general characteristics, archaebacteria, eubacteria, wall-less forms (mycoplasma), cell structure, nutritional types, reproduction-vegetative, asexual and recombination (conjugation, transformation and transduction).

Unit 4: Applied Microbiology **(4 lectures)**

Economic importance of viruses. Economic importance of bacteria .

Unit 5: Algae **(7 lectures)**

General characteristics: Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; and methods of reproduction, classification; criteria, system of Fritsch, (only upto groups); significant contributions of important phycologists (F.E. Fritsch, G.M. Smith, R.N. Singh, , H.D. Kumar, M.O.P. Iyengar).

Unit 6: Cyanophyta **(6 lectures)**

Occurrence, cell structure, heterocyst, reproduction.economic importance; role in biotechnology. Morphology and life-cycle of *Nostoc.*

Unit 7: Chlorophyta **(5 lectures)**

General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycles of *Chlamydomonas, Volvox, Oedogonium,Coleochaete. Prochloron.*

Unit 8: Charophyta **(2 lectures)**

General characteristics; occurrence, morphology, cell structure and life-cycle of *Chara*; evolutionary significance.

Unit 9: Xanthophyta **(3 lectures)**

General characteristics; Occurrence, morphology and life-cycle of *Vaucheria.*

Unit 10: Phaeophyta **(6 lectures)**

Characteristics, occurrence,. Morphology and life-cycles of *Ectocarpus* and *Fucus.*

Unit 11: Rhodophyta **(6 lectures)**

General characteristics, occurrence,. Morphology and life-cycle of *Polysiphonia.*

Unit 11: Applied Phycology **(4 lectures)**

Role of algae in the environment, agriculture, biotechnology and industry.

Practical

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.

Suggested Readings
1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.

2. Prescott, L.M., Harley J.P., Klein D. A. (2005). Microbiology, McGraw Hill, India. 6th edition.
3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.

4. Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization. Aravali International, New Delhi.

5. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.
6. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.

Semester I
Core Course II: Biomolecules and Cell Biology
(Credits: Theory-4, Practical-2)
THEORY
Lectures: 60

Learning outcomes

On completion of this course, the students will be able to:
- Develop understanding on chemical bonding among molecules
- Identify the concept that explains chemical composition and structure of cell wall and membrane
- Classify the enzymes and explain mechanism of action and structure
- Compare the structure and function of cells & explain the development of cells
- Describe the relationship between the structure and function of biomolecules

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

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Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations.

Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions

Marks allotted: 15 x2= 30

Unit 1: Biomolecules **(20 lectures)**

Types and significance of chemical bonds; Structure and properties of water; pH and buffers.

Carbohydrates: Nomenclature and classification; Role of monosaccharides (glucose, fructose, sugar alcohols – mannitol and sorbitol); Disaccharides (sucrose, maltose, lactose), Oligosaccharides and polysaccharides (structural-cellulose, hemicelluloses, pectin, chitin,mucilage; storage – starch, inulin); Isomers and derivatives of glucose, glucosamine and gluconic acid

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

properties. Saponification.Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers.

Proteins: Structure of amino acids; Peptide bonds; Levels of protein structure-primary, secondary, tertiary and quarternary; 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.

Unit 2: Bioenergenetics **(4 lectures)**

Laws of thermodynamics, concept of free energy,endergonic and exergonic reactions,coupled reactions,redox reactions. ATP: structure, its role as a energy currency molecule.

Unit 3: Enzymes **(6 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 theroy), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity.

Unit4: The cell **(4 lectures)**

Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin ofeukaryotic cell (Endosymbiotic theory).

Unit 5: Cell wall and plasma membrane **(4 lectures)**

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.

Unit 6: Cell organelles **(16 lectures)**

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 and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids;Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus;Lysosomes.

Unit 7: Cell division

Eukaryotic cell cycle, mitosis and meiosis. **(6 lectures)**

Practical

1. Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.
2. Study of plant cell structure with the help of epidermal peel mount of Onion/*Rhoeo/Crinum.*
3. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.
4. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains).
5. Study of cell and its organelles with the help of electron micrographs.
6. Study the phenomenon of plasmolysis and deplasmolysis.
7. Study the effect of organic solvent and temperature on membrane permeability.
8. Study different stages of mitosis

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.
9. 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

Semester-II
Core Course III: Mycology and Phytopathology
(Credits: Theory-4, Practical-2)
THEORY
Lectures: 60

Learning outcomes

On completion of this course, the students will be able to;
□ Develop an understanding of fungi and appreciate their adaptive strategies
□ Identify true fungi and demonstrate the principles and application of plant pathology in the control of plant disease.
□ Demonstrate skills in laboratory, work related to mycology and plant pathology.
□ Identify the common plant diseases according to geographical locations and device control measures
⌂ Understanding the role of Fungi in Biotechnology, application in industry, agriculture, biological control and secondary metabolites

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75

Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations. Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15 x2= 30

Unit 1: Introduction to true fungi **(6 lectures)**
Definition, General characteristics; Affinities with plants and animals; Thallus organization; Cellwall composition; Nutrition; Classification.

Unit 2: Chytridiomycetes **(1 lecture)**
General account with special reference to Synchytrium

Unit 3: Zygomycota **(4 lectures)**
General characteristics; Life cycle with reference to *Rhizopus*.

Unit 4: Ascomycota **(10 lectures)**
General characteristics (asexual and sexual fruiting bodies); Life cycle, Heterokaryosis and parasexuality; life cycle and classification with reference to, *Aspergillus*, *Alternaria* and *Peziza.*

Unit 5: Basidiomycota **(8 lectures)**
General characteristics; Life cycle and Classification with reference to black stem rust on wheat *Puccinia* (Physiological Specialization), loose and covered smut (symptoms only), *Agaricus*; Mushroom Cultivation.

Unit 6: Allied Fungi **(3 lectures)**
General characteristics; Status of Slime molds, Classification; Occurrence; Types of plasmodia;Types of fruiting bodies.

Unit 7: Oomycota **(4 lectures)**
General characteristic; Life cycle and classification with reference to *Phytophthora Albugo.*

Unit 8: Symbiotic associations **(4 lectures)**
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.

Unit 9: Applied Mycology **(10 Lectures)**
Role of fungi in biotechnology, Application of fungi in food industry (Enzymes, Mycoproteins); Secondary metabolites; Agriculture (Biofertilizers); Mycotoxins; Biological control (Mycofungicides, Mycoherbicides, Mycoinsecticides).

Unit 10: Phytopathology **(10 lectures)**
Terms and concepts; General symptoms; etiology; symptomology; Host- Pathogen relationships;disease cycle and environmental relation; prevention and control of plant diseases, and role of biological control and plant quarantine.
Bacterial diseases – Citrus canker and angular leaf spot disease of Cotton.
Viral diseases – Tobacco Mosaic viruses, vein clearing. Fungal diseases – Early blight of potato, Black stem rust of wheat, white rust of crucifers.powdery mildews

Practical

1. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, asocarps & basidiocarps).

2. *Rhizopus*: study of asexual stage from temporary mounts and sexual structures throughpermanent slides.

3. *Aspergillus* and *Penicillium*: study of asexual stage from temporary mounts. Study ofSexual 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 Barberryleaves; sections/ mounts of spores on wheat and permanent slides of both the hosts.

7. *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*, 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 throughsection/ temporary mounts and sexual structures through permanent slides.

10. 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 endo mycorrhiza (Photographs)

11. Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Angular leaf spot of cotton, Viral diseases: TMV, Vein clearing, Fungal diseases: Early blight of potato, Black stem rust of wheat 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 II
Core Course IV: Archegoniatae
(Credits: Theory-4, Practical-2)
THEORY
Lectures: 60

Learning outcomes

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

- Demonstrate an understanding of archegoniatae, Bryophytes, Pteridophytes and Gymnosperms
- Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms
- Understanding of plant evolution and their transition to land habitat.
- Demonstrate proficiency in the experimental techniques and methods of appropriate analysis of Bryophytes, Pteridophytes, Gymnosperms

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations. Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15 x2= 30

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

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

Unit 2: Bryophytes **(18 lectures)**

General characteristics; Adaptations to land habit; Classification; Range of thallus organization.Classification (up to family).*Riccia, Marchantia, Anthoceros, Sphagnum and Funaria*; Reproduction and evolutionary trends in Riccia, Marchantia , Anthoceros 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*). Classification (up to family), morphology, anatomy and reproduction of *Lycopodium*, *Selaginella*, *Equisetum* , Apogamy, and apospory, heterospory and seed habit, telome theory, stelar evolution.Ecological and

economic importanc56e.

Unit 4: Gymnosperms **(20 lectures)**

General characteristics, classification (up to family), morphology, anatomy and reproduction of *Pinus* and *Gnetum*.(Developmental details not to be included).Ecological and economic importance.

Practical

1. ***Riccia*** – Morphology of thallus.
2. ***Marchantia***- Morphology of thallus, whole mount of rhizoids & Scales, vertical sectionof thallus through Gemma cup, whole mount of Gemmae (all temporary slides), vertical section of Antheridiophore, Archegoniophore, longitudinal section of Sporophyte (all permanent slides).
3. ***Anthoceros***- Morphology of thallus, dissection of sporophyte (to show stomata, spores,pseudoelaters, columella) (temporary slide), vertical section of thallus (permanent slide).
4. ***Pellia, Porella***- Permanent slides.
5. ***Sphagnum***- Morphology of plant, whole mount of leaf (permanent slide only).
6. ***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.
7. **Lycopodium**- Study of specimen, transverse section of synangium (permanent slide).
8. ***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).
9. ***Equisetum***- Morphology, transverse section of internode, longitudinal section ofstrobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wet and dry) (temporary slide), transverse section of rhizome (permanent slide).
10. ***Cycas***- Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll,transverse section of coralloid root, transverse section of rachis, transverse/vertical section of leaflet, vertical section of microsporophyll, whole mount of spores (temporary slides), longitudinal section of ovule, transverse section of root (permanent slide).
12. ***Pinus***- Morphology (long and dwarf shoots, whole mount of dwarf shoot, male andfemale 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).
13. ***Gnetum***- Morphology (stem, male & female cones), transverse section of stem, verticalsection of ovule (permanent slide)
14. **Botanical excursion.**

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. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
5. Vander-Poorteri 2009 Introduction to Bryophytes. COP.

Semester-III
Core Course V: Anatomy of Angiosperms
(Credits: Theory-4, Practical-2)
THEORY
Lectures: 60

Learning outcomes

On completion of this course, the students will be able to:
- Develop an understanding of concepts and fundamentals of plant anatomy
- examine the internal anatomy of plant systems and organs
- Develop critical understanding on the evolution of concept of organization of shoot and root apex.
- Analyze the composition of different parts of plants and their relationships
- Evaluate the adaptive and protective systems of plants

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations. Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15 x2= 30

Unit 1: Introduction and scope of Plant Anatomy **(2 Lectures)**
Applications in systematics, forensics and pharmacognosy.

Unit 2: Tissues **(12Lectures)**
Classification of 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.

Unit 3: Stem **(8Lectures)**
Organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory,continuing meristematic residue, cytohistological zonation); Types of vascular bundles;Structureof dicot and monocot stem.

Unit 4: Leaf **(4Lectures)**
Structure of dicot and monocot leaf, Kranz anatomy.

Unit 5: Root **(6Lectures)**
Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe

theory);Quiescentcentre; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin oflateral root.

Unit 6: Vascular Cambium **(6 Lectures)**

Structure, function and seasonal activity of cambium; Secondary growth in root and stem.

Unit 7: Wood **(8Lectures)**

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.

Unit8: Periderm **(3Lectures)**

Development and composition of periderm, rhytidome and lenticels.

Unit 9: Adaptive and Protective Systems **(8Lectures)**

Epidermal tissue system, cuticle, epicuticular waxes, trichomes(uni-and multicellular, glandular and nonglandular, two examples of each), stomata (classification); Adcrustation and incrustation;Anatomical adaptations of xerophytes and hydrophytes.

Unit 10: Secretory System **(3Lectures)**

Hydathodes, cavities, lithocysts and laticifers.

Practical

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.

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. Esau, K. (1977). Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi.

Semester-III
Core Course VI: Economic Botany
(Credits: Theory-4, Practical-2)
THEORY
Lectures: 60

Learning outcomes

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

- Understand core concepts of Economic Botany and relate with environment, populations, communities, and ecosystems
- Develop a basic knowledge of taxonomic diversity and important families of useful plants
- Increase the awareness and appreciation of plants & plant products encountered in everyday life
- Appreciate the diversity of plants and the plant products in human use

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) Pass Marks: 24
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers.
Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations. Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions Marks allotted: 15 x2=30

Unit 1: Origin of Cultivated Plants **(6 lectures)**
Concept of Centres of Origin, their importance with reference to Vavilov's work.examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversty.

Unit 2: Cereales **(6 Lectures)**
Wheat and Rice(Origin,morphology,processing & uses) , brief account of millets

Unit 3: Legumes **(4 Lectures)**
General account,importance to man and pulse/nitrogen ecosystem

Unit 4: Sugars & Starches **(4 lectures)**
Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses.

Unit 5: Spices **(6 lectures)**
Listing of important spices, their family and part used, economic importance with Special reference to fennel, saffron, clove and black pepper

Unit 6: Beverages **(4 lectures)**
Tea, Coffee (morphology, processing & uses)

Unit 7: Oils & Fats **(8 lectures)**
General description, classification, extraction, their uses and health implications groundnut, coconut, linseed and *Brassica* and Coconut (Botanical name, family & uses)

Unit 8: Essential Oils **(4 lectures)**
General account, extraction methods, comparison with fatty oils & their uses.

Unit 9: Natural Rubber **(3 lectures)**
Para-rubber: tapping, processing and uses.

Unit 10: Drug-yielding plants **(4 lectures)**
Therapeutic and habit-forming drugs with special reference to *Papaver, Cannabis, Rauwolfia, Azadirachta, Vinca*

Unit 11: Tobacco **(4 lectures)**
Tobacco (Morphology, processing, uses and health hazards)

Unit 12: Timber plants **(3 Lectures)**
General account with special reference to teak , pine and Shorea

Unit 13: Fibres **(4 lectures)**
Classification based on the origin of fibres, Cotton and Jute (morphology, extraction and uses).

Practical

1. Cereals: Wheat (habit sketch, L. S/T.S. grain, starch grains, micro-chemical tests)Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests).
2. Legumes: Soya bean, Groundnut, (habit, fruit, seed structure, micro-chemical tests).

3. Sugars & Starches: Sugarcane (habit sketch; cane juice- micro-chemical tests), Potato(habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests).

4. Spices: Black pepper, Fennel and Clove (habit and sections).

5. Beverages: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).

6. Oils & Fats: Coconut- T.S. nut, Mustard–plant specimen, seeds; tests for fats in crushedseeds.

7. Essential oil-yielding plants: Habit sketch of*Rosa*, V*etiveria, Santalum*and*Eucalyptus* (specimens/photographs).

8. Rubber: specimen, photograph/model of tapping, samples of rubber products.
9. Drug-yielding plants: Specimens of *Digitalis, Papaver*and*Cannabis.*

10. Tobacco: specimen and products of Tobacco.
11. Woods: Tectona, Pinus: Specimen, Section of young stem.

12. Fibre-yielding plants: Cotton (specimen, whole mount of seed to show lint and fuzz;whole mount of fibre and test for cellulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fibre).

Suggested Readings

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.
3. Chrispeels, M.J. and Sadava, D.E. (2003). Plants, Genes and Agriculture. Jones & Bartlett Publishers.

Semester III
Core Course VII: Genetics
(Credits: Theory-4, Practical-2)
THEORY
Lectures: 60

Learning outcomes

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

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

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) Pass Marks: 24
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations. Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions Marks allotted: 15 x2= 30

Unit 1: Mendelian genetics and its extension (16 lectures)

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.

Unit 2: Extrachromosomal Inheritance (6 lectures)

Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast;Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in *Paramecium.*

Unit 3: Linkage, crossing over and chromosome mapping (12 lectures)
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.

Unit 4: Variation in chromosome number and structure (8 lectures)
Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy

Unit 5: Gene mutations (6 lectures)
Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents).Role of Transposons in mutation.DNA repair mechanisms.

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

Unit 7. Population and Evolutionary Genetics (6 lectures)
Allele frequencies, Genotype frequencies, Hardy-Weinberg Law,
, genetic drift..

Practical

1. Meiosis through temporary squash preparation.

2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square analysis.

3. Chromosome mapping using test cross data.

4. Pedigree analysis for dominant and recessive autosomal and sex linked traits.

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. Blood Typing: ABO groups & Rh factor.

7. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes.

8. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.

9.Study of human genetic traits: Sickle cell anemia, XerodermaPigmentosum, Albinism, red-green Colour blindness, Widow's peak, Rolling of tongue, Hitchhiker's thumb and Attached ear lobe.

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. (2012). Concepts of Genetics. Benjamin Cummings, U.S.A. 10th 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.

Semester-IV
Core Course VIII: Molecular Biology
THEORY (Credit :4)
Lectures: 60

Learning outcomes

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

- Analyse the structures and chemical properties of DNA and RNA through various historic experiments.
- Examinee the structure, function and replication of DNA
- Evaluate the experiments establishing central dogma and genetic code.
- Gain an understanding of various steps in transcription, protein synthesis and protein modification.

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

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2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations. Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions Marks allotted: 15 x2= 30

Unit 1: Nucleic acids : Carriers of genetic information (4 lectures)
Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase,Avery, McLeod & McCarty, Fraenkel-Conrat's experiment.

Unit 2. The Structures of DNA and RNA / Genetic Material (10 lectures)
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 DNA.The Nucleosome_Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.

Unit 3:The replication of DNA (10 lectures)
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.

Unit 4: Central dogma and genetic code **(2 lectures)**
Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of mRNAtemplate), Genetic code (deciphering & salient features)

Unit 5: Mechanism of Transcription **(10 lectures)**
Transcription in prokaryotes; Transcription in eukaryotes

Unit 6: Processing and modification of RNA **(8 lectures)**
Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I & group II intron splicing, alternative splicing eukaryotic mRNA processing(5' cap, 3' polyA tail); Ribozymes,

Unit 7: Translation (Prokaryotes and eukaryotes) **(8 lectures)**
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.

Unit 8: Regulation of transcription in prokaryotes and eukaryotes (8 lectures)
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.

Practical

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.

Suggested Readings

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 edition.
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). iGenetics- 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. W. H. Freeman and Co., U.S.A. 10th edition.

Semester IV
Core Course IX: Ecology
(Credits: Theory-4, Practical-2)
THEORY
Lectures: 60

Learning outcomes

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

- ☐ Understand core concepts of biotic and abiotic
- ☐ Classify the soils on the basis of physical, chemical and biological components
- ☐ Analysis the phytogeography or phytogeographical division of India
- ☐ Evaluate energy sources of ecological system
- ☐ Assess the adaptation of plants in relation to light, temperature, water, wind and fire.
- ☐ Conduct experiments using skills appropriate to subdivisions

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) Pass Marks: 24
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers.
Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations. Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions Marks allotted: 15 x2= 30

Unit 1: Introduction **(4 lectures)**
Basic concepts; Levels of organization.Inter-relationships between the living world and the environment, the components and dynamism, homeostasis.

Unit 2: Soil **(8 lectures)**
Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development.

Unit 3: Water **(4 lectures)**
Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table.

Unit 4: Light, temperature, wind and fire **(6 lectures)**
Variations; adaptations of plants to their variation.

Unit 5: Biotic interactions **(2 lectures)**

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

Unit 7: Plant communitics **(8 lectures)**
Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic;Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts.

Unit 8: Ecosystems **(4 lectures)**
Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids.

Unit 9: Functional aspects of ecosystem **(8 lectures)**
Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.

Unit 10: Phytogeography **(12 lectures)**
Principles; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Local Vegetation.

Practical

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/Lovi bond 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.
7. (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).

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

Semester IV
Core Course X: Plant Systematics

(Credits: Theory-4, Practical-2)
THEORY
Lectures: 60

Learning outcomes

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

- Classify Plant systematics and recognize the importance of herbarium and Virtual herbarium
- Evaluate the Important herbaria and botanical gardens
- Interpret the rules of ICN in botanical nomenclature
- Assess terms and concepts related to Phylogenetic Systematics
- Generalize the characters of the families according to Bentham & Hooker's system of Classification

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) Pass Marks: 24
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: MultipleChoice Questions (withfour options) / Fill in the Blanks /True orFalse. Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations. Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15 x2= 30

Unit 1: Plant identification, Classification, Nomenclature; Biosystematics. (2 lectures)

Unit 2: Identification (6 lectures)
Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access

Unit 3: Systematics- an interdisciplinary science (6 lectures)
Evidence from palynology, cytology, phytochemistry and molecular data.

Unit 4: Taxonomic hierarchy (6 lectures)
Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept

(taxonomic, biological, evolutionary).

Unit 5: Botanical nomenclature **(10 lectures)**
Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.

Unit 6: Systems of classification **(10 lectures)**
Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle,Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series); Brief reference of Angiosperm Phylogeny Group (APG III) classification.

Unit 7: Biometrics, numerical taxonomy and cladistics **(8 lectures)**
Characters; Variations; OTUs, character weighting and coding; cluster analysis; Phenograms, cladograms (definitions and differences).

Unit 8: Diagnostic features and economic importance of following families (12 lectures)
Ranunculaceae , Apocynaceae, Malvaceae, Solanaceae, Asteraceae, Euphosbiaceae , Lamiaceae , Poaceae, Asclepideaceae

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):
Ranunculaceae R*anunculus, Delphinium*
Brassicaceae - *Brassica, Alyssum / Iberis*
Myrtaceae - *Eucalyptus, Callistemon*
Umbelliferae - *Coriandrum /Anethum / Foeniculum*
Asteraceae - *Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax*
Solanaceae - *Solanum nigrum/Withania*
Lamiaceae - *Salvia/Ocimum*
Euphorbiaceae - *Euphorbia hirta/E.milii, Jatropha*
Liliaceae A*sphodelus/Lilium/Allium*
Poaceae - *Triticum/Hordeum/Avena*

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).

Suggested Readings

1. Singh, G. (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.

Semester-V
Core Course XI: Reproductive Biology of Angiosperms
(Credits: Theory-4, Practical-2)
THEORY
Lectures: 60

Learning outcomes

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

- Recall the history of reproductive biology of angiosperms & recognize the importance of genetic and molecular aspects of flower development
- Understand structure and functions of anther wall and pollen wall
- Evaluate the special structures of Ovule
- Solve Self-incompatibility in Pollination and fertilization & relate between Embryo, Endosperm and Seed
- Comprehend the causes of Polyembryony and apomixes with its classification

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers.

Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations. Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions Marks allotted: 15 x2= 30

Unit 1: Introduction **(2 lectures)**
History (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P.Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison) and scope.

Unit 2: Anther **(4 lectures)**
Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance.

Unit 3: Pollen biology **(8 lectures)**
Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system;

Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia.

Unit 4: Ovule **(8 lectures)**

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.

Unit 5: Pollination and fertilization **(6 lectures)**

Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.

Unit 6: Self incompatibility **(8 lectures)**

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

Unit 7: Endosperm **(4 lectures)**

Types, development, structure and functions.

Unit 8: Embryo **(6 lectures)**

Six types of embryogeny; General pattern of development of dicot and monocot embryo; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo;

Unit 9: Seed **(4 lectures)**

Structure, importance and dispersal mechanisms

Units 10: Polyembryony and apomixes **(6 lectures)**

Introduction; Classification; Causes and applications.

Unit 11: Germline transformation **(4 lectures)**

Pollen grain and ovules through pollen tube pathway method/agrobacterium/ electrofusion/ /biolistic

Practical

1. 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.

3. 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 differen media using hanging drop method.

4. Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs).

5. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus.
6. Intra-ovarian pollination; Test tube pollination through photographs.

7. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.

8. 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.

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.

3. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.

4. Johri, B.M. l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

Semester V
Core Course XII: Plant Physiology
(Credits: Theory-4, Practical-2)
THEORY
Lectures: 60

Learning outcomes

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

- Understand Water relation of plants with respect to various physiological processes.
- Explain chemical properties and deficiency symptoms in plants
- Explain role of growth regulators and their significance in plant
- Importance of duration of light and temperature on plants growth & development
- Assess dormancy and germination seeds

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours
Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations. Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions Marks allotted: 15 x2= 30

Unit 1: Plant water relationship **(10 lectures)**

Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sa cohesion-tension theory.Transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement.

Unit 2: Mineral nutrition **(8 lectures)**

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.

Unit 3: Nutrient Uptake **(8 lectures)**

Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP,

systems,proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.

Unit 4: Translocation in the phloem **(8 lectures)**

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

Unit 5: Plant growth regulators **(14 lectures)**

Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin,

Gibberellins, Cytokinin, Abscisic acid, Ethylene.Brassinosteroids and Jasmoni

Unit 6: Physiology of flowering **(6 Lectures)** **(6 lectures)**

Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy.

Unit 7: Phytochrome **(6 lectures)**

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

Practical

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 excised twig/leaf.
4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces).
6. To study the phenomenon of seed germination (effect of light).
7. To study the effect of different concentrations of IAA on *Avena* coleoptile elongation (IAA Bioassay).
8. To study the induction of amylase activity in germinating barley grains.

Demonstration experiments

1. To demonstrate suction due to transpiration.
2. Fruit ripening/Rooting from cuttings (Demonstration).
3. Bolting experiment/*Avena* coleptile bioassay (demonstration).

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.
3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.

Semester-VI
Core Course XIII: Plant Metabolism
(Credits: Theory-4, Practical-2)
THEORY
Lectures: 60

Learning outcomes

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

- Differentiate anabolic and catabolic pathways of metabolism and role of enzyme of plant metabolism
- Explain the significance of photosynthesis and respiration
- Classify aerobic and anaerobic respiration
- Explain the ATP synthesis
- Interpret the Biological nitrogen fixation in metabolism
- Explain the mechanism of cell signaling in plant

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

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2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations. Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions Marks allotted: 15 x2= 30

Unit 1: Concept of metabolism **(6 lectures)**

Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric ,covalent modulation and Isozymes).

Unit 2: Carbon assimilation **(14 lectures)**

Historical background, photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions,photosynthetic electron transport, PSI, PSII, Q cycle, CO_2 reduction, photorespiration,C4pathways; Crassulacean acid metabolism; Factors affecting CO_2 reduction.

Unit 3: Carbohydrate metabolism **(2 lectures)**

Synthesis and catabolism of sucrose and starch.

Unit 4: Carbon Oxidation **(10 lectures)**

Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway,oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle,amphibolic role, anaplerotic reactions, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration, factors affecting respiration.

Unit 5: ATP-Synthesis **(8 lectures)**

Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, Boyers conformational model, Racker's experiment, Jagendorf's experiment; role of uncouplers.

Unit 6: Lipid metabolism **(8 lectures)**

Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α oxidation.

Unit 7: Nitrogen metabolism **(8 lectures)**

Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.

Unit 8: Mechanisms of signal transduction **(4 lectures)**

Calcium, cGMP .

Practical

1. Chemical separation of photosynthetic pigments.

2. Experimental demonstration of Hill's reaction.

3. To study the effect of light intensity on the rate of photosynthesis.

4. Effect of carbon dioxide on the rate of photosynthesis.
5. To compare the rate of respiration in different parts of a plant.
6. To demonstrate activity of Nitrate Reductase in germinationg leaves of different plant sources.

7. To study the activity of lipases in germinating oilseeds and demonstrate mobilization of lipids during germination.

8. Demonstration of fluorescence by isolated chlorophyll pigments.

9. Demonstration of absorption spectrum of photosynthetic pigments.

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.

3. Harborne, J.B. (1973). Phytochemical Methods. John Wiley & Sons. New York.

Semester VI
Core Course XIV: Plant Biotechnology
(Credits: Theory-4, Practical-2)
THEORY
Lectures: 60

Learning outcomes

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

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

1. The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations. Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions Marks allotted: 15 x2= 30

Unit 1: Plant Tissue Culture **(16 lectures)**

Historical perspective; 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).

Unit 2: Recombinant DNA technology **(30 lectures)**

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

gene of interest by genetic selection; complementation, colony hybridization; Probes-oligonucleotide, heterologous, PCR; Methods of gene transfer- *Agrobacterium*-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP)

Unit 3: Applications of Biotechnology (14 lectures)

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); Gentically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns.

Practical

1. (a) Preparation of MS medium.
(b) Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura*, *Brassica* etc.
2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.
3. Isolation of protoplasts.
4. Construction of restriction map of circular and linear DNA from the data provided.
5. Study of methods of gene transfer through photographs: *Agrobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
6. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.
7. Isolation of plasmid DNA.
8. Restriction digestion and gel electrophoresis of plasmid DNA.

Suggested Readings

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

DISCIPLINE SPECIFIC ELECTIVE COURSES

Semester-V
Discipline Specific Elective - 1
Analytical Techniques in Plant Sciences
(Credits: Theory-4, Practical-2)
THEORY
Lectures: 60

Learning outcomes:

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

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

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations. Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15x2=30

Unit 1: Imaging and related techniques **(15 lectures)**

Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

Unit 2: Cell fractionation **(8 lectures)**

Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl2gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

Unit 3: Radioisotopes **(4 lectures)**
Use in biological research, auto-radiography, pulse chase experiment.
Unit 4: Spectrophotometry **(4 lectures)**
Principle and its application in biological research.
Unit 5: Chromatography **(8 lectures)**
Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.
Unit 6: Characterization of proteins and nucleic acids **(6 lectures)**
Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE
Unit 7:Biostatistics **(15 lectures)**
Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.

Practical

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

Suggested Readings

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.
2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.

3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.

4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

Semester V
Discipline Specific Elective - 2
Horticultural Practices and Post-Harvest Technology
(Credits: Theory-4, Practical-2)
THEORY
Lectures: 60

Learning outcomes:

On the completion of the course the students will be able to

- Understand the concept of different types of horticultural crops, their conservation and management
- Examine the various branches of horticulture, fruit and vegetable crops, floriculture, medicinal and aromatic plants.
- Critically evaluate different cultivation practices and disease management
- Reflect upon different Landscaping practices and garden design
- Understand the concept of different types of horticultural practices for value addition
- Visualize the post-harvest problems likely to be confronted
- Know the tricks of the trade and how to increase the longevity of the produce

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) Pass Marks: 24
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations. Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15x2=30

Unit 1: Introduction **(4 lectures)**

Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Importance in food and nutritional security; Urban horticulture and ecotourism.

Unit 2: Ornamental plants **(4 lectures)**

Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental plants [rose, marigold, gladiolus, carnations, orchids, poppies, gerberas, tuberose, sages, cacti and succulents (opuntia, agave and spurges)] Ornamental flowering trees (Indian laburnum, gulmohar, Jacaranda, Lagerstroemia, fishtail and areca palms, semul, coraltree).

Unit 3: Fruit and vegetable crops **(4 lectures)**

Production, origin and distribution; Description of plants and their economic products; Management and marketing of vegetable and fruit crops; Identification of some fruits and vegetable varieties (citrus, banana, mango, chillies and cucurbits).

Unit 4: Horticultural techniques **(8 lectures)**

Application of manure, fertilizers, nutrients and PGRs; Weed control; Biofertilizers, biopesticides; Irrigation methods (drip irrigation, surface irrigation, furrow and border irrigation); Hydroponics; Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation), Scope and limitations.

Unit 5: Landscaping and garden design **(6 lectures)**

Planning and layout (parks and avenues); gardening traditions - Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry; policies and practices.

Unit 6: Floriculture **(6 lectures)**

Cut flowers, bonsai, commerce (market demand and supply); Importance of flower shows and exhibitions.

Unit 7: Post-harvest technology **(10 lectures)**

Importance of post harvest technology in horticultural crops; Evaluation of quality traits; Harvesting and handling of fruits, vegetables and cut flowers; Principles, methods of preservation and processing; Methods of minimizing loses during storage and transportation; Food irradiation - advantages and disadvantages; food safety.

Unit 8: Disease control and management **(8 lectures)**

Field and post-harvest diseases; Identification of deficiency symptoms; remedial measures and nutritional management practices; Crop sanitation; IPM strategies (genetic, biological andchemical methods for pest control); Quarantine practices; Identification of common diseases andpests of ornamentals, fruits and vegetable crops.

Unit 9: Horticultural crops - conservation and management **(10 lectures)**

Documentation and conservation of germplasm; Role of micropropagation and tissue culture techniques; Varieties and cultivars of various horticultural crops; IPR issues; National, international and professional societies and sources of information on horticulture.

Practical

1. Identification & salient features of ornamental plants.
2. Identification of fruits & vegetable varieties .
3. Techniques of soil less culture (Hydroponics)
4. Methods of propagation – Grafting & cutting
5. Bonsai techniques
6. Cold storage techniques for fruits and vegetables
7. Handling of post-harvest equipment : Dryers, Storage containers and vessels

Suggested Readings

1. Singh, D. & Manivannan, S. (2009). Genetic Resources of Horticultural Crops. Ridhi International, Delhi, India.
2. Swaminathan, M.S. and Kochhar, S.L. (2007). Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India. Macmillan Publishers, India.
3. NIIR Board (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi.
4. Kader, A.A. (2002). Post-Harvest Technology of Horticultural Crops. UCANR Publications, USA.
5. Capon, B. (2010). Botany for Gardeners. 3rd Edition. Timber Press, Portland, Oregon.

Semester VI
Discipline Specific Elective - 3
Plant Breeding
(Credits: Theory-4, Practical-2)
THEORY
Lectures: 60

Learning outcomes:

On completion of this course students will be able to:

- Develop conceptual understanding of plant genetic resources, plant breeding, gene bank and gene pool.
- Familiarize with genetic basis of heterosis.
- Classify Sexual and Asexual modes of reproduction.
- Explain monogenic and polygenic inheritance
- Reflect upon the role of various non- conventional methods used in crop improvement

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) Pass Marks: 24
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations. Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15x2=30

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: 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.

Unit 3: Quantitative inheritance **(10 lectures)**

Concept, mechanism, examples of inheritance of Kernel colour in wheat, Skin colour in human beings.Monogenic vs polygenic Inheritance.

Unit 4: Inbreeding depression and heterosis **(10 lectures)**

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

Unit 5: Crop improvement and breeding **(10 lectures)**

Role of mutations; Polyploidy; Distant hybridization and role of biotechnology in crop improvement.

Practical

1. Emasculation techniques
2. Mode of reproduction in plants
3. Self / Cross & vegetatively propagated plants – Procedure, advantages & limitations.
4. Quantitative inheritance – Inheritance of Kernel colour in wheat .
5. Biotechnology in crop improvement – i) BT cotton ii) Golden rice
6. Pollen viability test

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. 2nd edition.
3. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.

Semester VI
Discipline Specific Elective - 4
Natural Resource Management
(Credits: Theory-4, Practical-2)
THEORY
Lectures: 60

Learning outcomes:

At the end of the course the students will be able to,

- Understand the concept of different natural resources and their utilization.
- Critically analyze the sustainable utilization land, water, forest and energy resources.
- Evaluate the management strategies of different natural resources.
- Reflect upon the different national and international efforts in resource management and their conservation

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

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3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations. Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15x2=30

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; Bio-prospecting; IPR; CBD; National Biodiversity Action Plan).

Unit 6: Forests **(6 lectures)**

Definition, Cover and its significance (with special reference to India); Major and minor forestproducts; Depletion; Management.

Unit 7: Energy **(6 lectures)**

Renewable and non-renewable sources of energy

Unit 8: Contemporary practices in resource management **(8 lectures)**

EIA,; Waste management.

Unit 9: National and international efforts in resource management and conservation (4 lectures)

Practical

1. Estimation of solid waste generated by a domestic system (biodegradable and non-biodegradable) and its impact on land degradation.
2. Collection of data on forest cover of specific area.
3. Measurement of dominance of woody species by DBH (diameter at breast height) method.
4. Calculation and analysis of ecological footprint.
5. Ecological modeling.

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 VI
Discipline Specific Elective
Bioinformatics
(Credits: Theory-4, Practical-2)
THEORY
Lectures: 60

Learning outcomes:

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

- Understand the concept of databases and use of different public domain for DNA and proteins sequence retrieval.
- Understand the concept of pairwise alignment of DNA sequences using algorithms.
- Explain the structure of proteins homology modeling approach using SWISS MODEL and SWISS-PDB.
- Reflect upon the role of various models in molecular evolution.
- Analyze the role of (QSAR) techniques in Drug Design.

Full Marks: 15 MID SEMESTER EXAM (MSE) + 60 END SEMESTER EXAM (ESE) =75
Full Marks = 60 (ESE) **Pass Marks: 24**
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations. Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 4 (Four) Long Answer or Essay Type Questions. The examinee are required to answer any two Long Answer Questions
Marks allotted: 15x2=30

Unit 1. Introduction to Bioinformatics **(5 Lecti**
Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics.

Unit 2. Databases in Bioinformatics **(5 Lecti**
Introduction, Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System.

Unit 3. Biological Sequence Databases **(25 Lecti**

National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Basic local alignment search tool (BLAST),Nucleotide Database, Protein Database, Gene Expression Database.
EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence analysis tools.
DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ, Data Submission at DDBJ.Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR. Swiss-Prot: Introduction and Salient Features.

Unit 4. Sequence Alignments **(10 Lectures)**

Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).

Unit 5. Molecular Phylogeny **(8 Lectures)**

Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.

Unit 6. Applications of Bioinformatics **(7 Lectures)**

Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement

Practical

1. Nucleic acid and protein databases.
2. Sequence retrieval from databases.
3. Sequence alignment.
4. Sequence homology and Gene annotation.
5. Construction of phylogenetic tree.

Suggested Readings

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.

2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.

3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. _II Edition. Benjamin Cummings.

Generic Electives Courses (4)

Semester I
Generic Elective-1
Biodiversity (Microbes, Algae, Fungi and Archegoniate)
(Credits: Theory-4, Practical-2)
THEORY
Lectures: 60

Learning outcomes:

After completion of the course, the students will be able to;

- Analyse the interactions between plants and pathogenic fungi, bacteria and viruses
- Understand the interaction between plant and non-pathogenic symbiotic bacteria/fungi.
- Illustrate the defense reactions of the host plant
- Explain the concept of plant immunity

Full Marks = 75 (ESE) Pass Marks: 30
Time Allowed: 03 Hours

Instructions for Paper Setter

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2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations. Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 6 (six) Long Answer or Essay Type Questions. The examinee are required to answer any three Long Answer Questions Marks allotted: 15 x3= 45

Unit 1: Microbes **(10 lectures)**

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.

Unit 2: Algae **(12 lectures)**

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

Unit 3: Fungi **(12 lectures)**

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 *Rhizopus* (Zygomycota) *Penicillium,Alternaria* (Ascomycota), *Puccinia, Agaricus* (Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza andendomycorrhiza and their significance

Unit 4: Introduction to Archegoniate **(2 lectures)**

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

Unit 5: Bryophytes **(10 lectures)**

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 mention of *Sphagnum*.

Unit 6: Pteridophytes **(8 lectures)**

General characteristics, classification, Early land plants (*Cooksonia* and *Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*.(Developmental details not to be included).Heterospory and seed habit, stellar evolution.Ecological and economical importance of Pteridophytes.

Unit 7: Gymnosperms **(6 lectures)**

General characteristics, classification.Classification (up to family), morphology, anatomy and reproduction of *Cycas* and *Pinus*.(Developmental details not to be included).Ecological and economical importance.

Practical

1. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.

2. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.

3. Gram staining

4. Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas* (electron micrographs), *Oedogonium, Vaucheria, Fucus* and Polysiphonia* through temporary preparations and permanent slides. (* *Fucus* - Specimen and permanent slides)

5. *Rhizopus and Penicillium*: Asexual stage from temporary mounts and sexual structuresthrough permanent slides. *Alternaria:* Specimens/photographs and tease mounts. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberryleaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.*Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.

6. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
7. Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs)

8. ***Marchantia***- morphology of thallus, w.m. rhizoids and scales, v.s. thallus throughgemma
   cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).***Funaria***- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores(temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.

9. ***Selaginella***- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m.microsporophyll and megasporophyll (temporary slides), l.s. strobilus (permanent slide).
   Equisetum- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore,w.m. spores (wet and dry)(temporary slides); t.s rhizome (permanent slide).
   Pteris- morphology, t.s. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores(temporary slides), t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).

10. ***Cycas***- morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet,v.s. microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide). ***Pinus***- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m.dwarf shoot, t.s. needle, t.s. stem, , l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores (temporary slides), l.s. female cone, t.l.s. &r.l.s. stem (permanent slide).

Suggested Readings

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.

Semester II
Generic Elective-2
Plant Anatomy and Embryology
(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Learning outcomes

On completion of this course, the students will be able to:
- Understand core concepts of Economic Botany and relate with environment, populations, communities, and ecosystems
- Develop critical understanding on the evolution of concept of organization of apex new crops/varieties, importance of germplasm diversity, issues related to access and ownership
- Develop a basic knowledge of taxonomic diversity and important families of useful plants
- Increase the awareness and appreciation of plants & plant products encountered in everyday life
- Appreciate the diversity of plants and the plant products in human use

Full Marks = 75 (ESE) Pass Marks: 30
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examir consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/ True or False Each question carry 01 (One) mark and there is no negative marki for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer queestions. The examinee are required to answer total of 4(Four) questions only. The limitation of t Answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations. Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 6 (six) Long Answer o Essay Type Questions. The examinee are required to answer any three Long Answer Questions
Marks allotted: 15 x3=

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

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

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

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

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

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

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

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

Practical

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

Calculation of percentage of germinated pollen in a given medium.

Semester III

Generic Elective

Plant Ecology and Taxonomy

(Credits: Theory-4, Practical-2)

THEORY

Lectures: 60

Learning outcomes

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

- Understand core concepts of biotic and abiotic
- Classify the soils on the basis of physical, chemical and biological components
- Analysis the phytogeography or phytogeographical division of India
- Evaluate energy sources of ecological system
- Assess the adaptation of plants in relation to light, temperature, water, wind and fire.
- Interpret the rules of ICN in botanical nomenclature
- Assess terms and concepts related to Phylogenetic Systematics
- Generalize the characters of the families according to Bentham & Hooker's system of classification

Full Marks = 75 (ESE) Pass Marks: 30

Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English

2. The setters are requested to take care and ensure that the questions are within the syllabus

3. The questions should be innovative, clear and understandable

4. Your co-operation is solicited and thankfully acknowledged by the College

5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers.

Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer shee with or without diagrams/ illustrations. Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 6 (six) Long Answer or Essay Type Questions. The examinee are required to answer any three Long Answer Questions Marks allotted: 15x3=45

Unit 1: Introduction **(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 law of tolerance. Adaptation of hydrophytes and xerophytes

Unit 3: Plant communities **(6 lectures)**

Characters; Ecotone and edge effect; Succession; Processes and types

Unit 4: Ecosystem **(8 lectures)**

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

Unit 5: Phytogeography **(4 lectures)**

Principle biogeographical zones; Endemism

Unit 6 Introduction to plant taxonomy **(2 lectures)**

Identification, Classification, Nomenclature.

Unit 7 Identification **(4 lectures)**

Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access

Unit 8 Taxonomic evidences from palynology, cytology, phytochemistry and molecular data (6 Lectres)

Unit 9 Taxonomic hierarchy **(2 lectures)**

Ranks, categories and taxonomic groups

Unit 10 Botanical nomenclature **(6 lectures)**

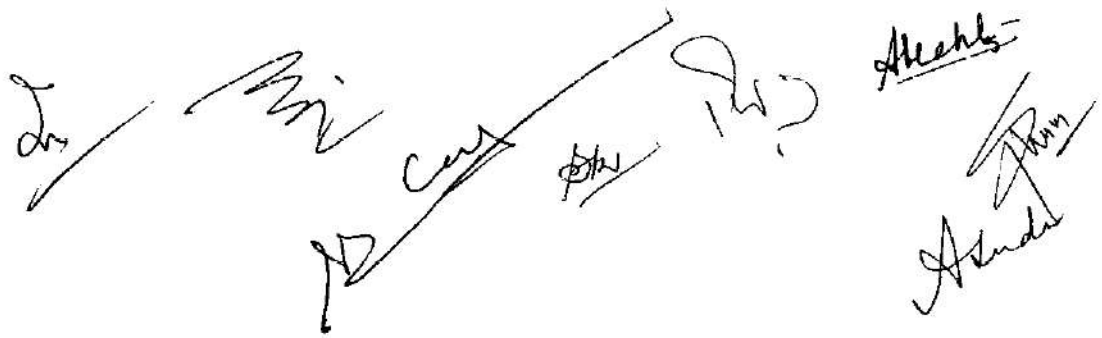
Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations

Unit 11 Classification **(6 lectures)**

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

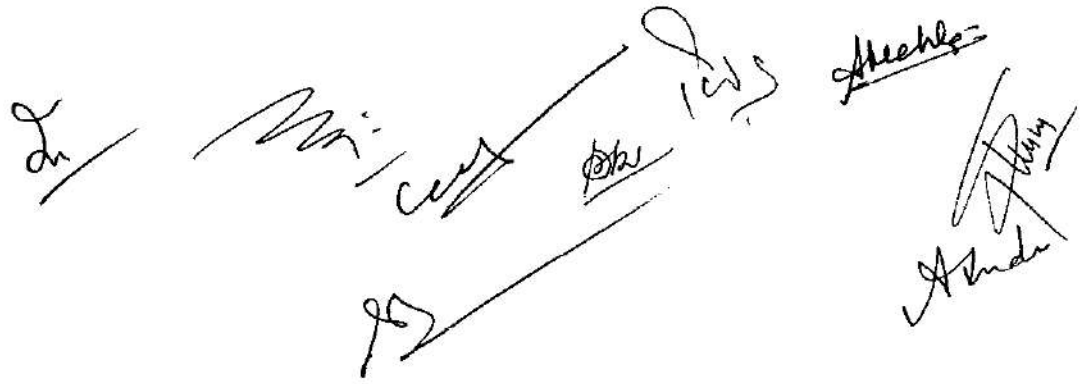
Unit 12 Biometrics, numerical taxonomy and cladistics **(4 lectures)**

Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).



Practical

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, and analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field test.
3. Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats.
4. (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)
5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
6. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law
7. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):Brassicaceae - *Brassica,Alyssum / Iberis;* Asteraceae -*Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax;* Solanaceae -*Solanum nigrum, Withania;* Lamiaceae -*Salvia, Ocimum*; Liliaceae - *Asphodelus / Lilium / Allium.*
8. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).



Semester IV
Generic Elective -4
Economic Botany and Plant Biotechnology
(Credits: Theory-4, Practical-2)

THEORY
Lectures: 60

Learning outcomes

On completion of this course, the students will be able to:
□ Understand core concepts of Economic Botany and relate with environment, populations, communities, and ecosystems
ownership
□ Develop a basic knowledge of taxonomic diversity and important families of useful plants
□ Increase the awareness and appreciation of plants & plant products encountered in everyday life
□ Appreciate the diversity of plants and the plant products in human use

Full Marks = 75 (ESE) Pass Marks: 30
Time Allowed: 03 Hours

Instructions for Paper Setter

1.The questions should be only in English
2. The setters are requested to take care and ensure that the questions are within the syllabus
3. The questions should be innovative, clear and understandable
4. Your co-operation is solicited and thankfully acknowledged by the College
5. The questions are to be set divided in three Sections

Section: A Question Number (1) covering the whole syllabus should be Compulsory for all examinee to attempt consisting of 10 (Ten) Objective Type Questions: Multiple Choice Questions (with four options) / Fill in the Blanks/True or False Each question carry 01 (One) mark and there is no negative marking for wrong answers. Marks allotted: 1x10=10

Section: B Question Number (2) covering the whole syllabus consisting of 8 (Eight) Short Answer Type Questions. The examinee are required to answer total of 4(Four) questions only. The limitation of the answer should be of a paragraph or half the page of the answer sheet with or without diagrams/ illustrations. Marks allotted: 5x4 = 20

Section: C Question Number (3) covering the whole syllabus consisting of 6 (six) Long Answer or Essay Type Questions. The examinee are required to answer any three Long Answer Questions Marks allotted: 15 x3= 45

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

Unit 2: Cereals **(4 lectures)**
Wheat -Origin, morphology, uses

Unit 3: Legumes **(6 lectures)**
General account with special reference to Gram and soybean

Unit 4: Spices **(6 lectures)**
General account with special reference to clove and black pepper (Botanical name, family, part used, morphology and uses)

Unit 5: Beverages **(4 lectures)**
Tea (morphology, processing, uses)

Unit 6: Oils and Fats **(4 lectures)**
General description with special reference to groundnut

Unit 7: Fibre Yielding Plants **(4 lectures)**
General
4description with special reference to Cotton (Botanical name, family, part used,morphology and uses)

Unit 8: Introduction to biotechnology **(2 lecture)**

Unit 9: Plant tissue culture **(8 lectures)**
Micropropagation ; haploid production through androgenesis and gynogenesis; brief account of embryo and endosperm culture with their applications

Unit 10: Recombinant DNA Techniques **(18 lectures)**
Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR.

Practical

1. Study of economically important plants : Wheat, Gram, Soybean, Black pepper, Clove Tea, Cotton, Groundnut through specimens, sections and microchemical tests
2. Familiarization with basic equipments in tissue culture.
3. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.
4. Study of molecular techniques: PCR, Blotting techniques, AGE and PAGE.

Suggested Readings

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

Skill Enhancement Courses

Semester III
Skill Enhancement Course
Ethnobotany
(Credits 2)
Lectures: 30

Learning outcomes:

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

- Recognize the basic medicinal plants
- Apply techniques of conservation and propagation of medicinal plants.
- Setup process of harvesting, drying and storage of medicinal herbs
- Propose new strategies to enhance growth of medicinal herbs considering the practical issues pertinent to India
- Conceptualize ethnobotany as an interdisciplinary science
- Restate the established methodology of ethnobotany studies
- Categories various indigenous ethnic groups and their environmental practices.
- Understand the legalities associated with ethnobotany.

Full Marks 100

Unit 1: Ethnobotany **(6 Lectures)**

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

Unit 2: Methodology of Ethnobotanical studies (6 lectures) a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places.

Unit 3: Role of ethnobotany in modern Medicine **(10 lectures)**

Medico-ethnobotanical sources in India;Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadiractha indica* b) *Ocimum sanctum* c) *Vitex negundo*. d) *Gloriosa superba* e) *Tribulus terrestris* f) *Pongamia pinnata* g) *Cassia auriculata* h) *Indigofera tinctoria*. Role of ethnobotany in modern medicine with special example *Rauvolfia sepentina, Trichopus zeylanicus, Artemisia, Withania*. Role of ethnic groups in conservation of plant genetic resources.Endangered taxa and forest management (participatory forest management).

Unit 4: Ethnobotany and legal aspects **(8 lectures)**

Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.

Suggested Readings

1) S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
2) S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi – 1981
3) Lone et al,. Palaeoethnobotany
4) S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
5) S.K. Jain, 1990. Contributions of Indian ethnobotny.Scientific publishers, Jodhpur.

6) Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester
7) Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India.Botanical Survey of India. Howrah. 8) Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur-1996 9) Faulks, P.J. 1958.An introduction to Ethnobotany, Moredale pub. Ltd.

Semester IV
Skill Enhancement Course
Mushroom Culture Technology
(Credits 2) Lectures: 30

Full Marks 100

Learning outcomes:

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

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

(6 Lectures)

Unit 1: Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms.Types of edible mushrooms available in India - *Volvariella volvacea, Pleurotus citrinopileatus, Agaricus bisporus.* **(5 Lectures)**

Unit 2: Cultivation Technology : Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation - Low cost technology, Composting technology in mushroom production. **(12 Lectures)**

Unit 3: Storage and nutrition : Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickels, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.
Lectures)

Unit 4: Food Preparation :Types of foods prepared from mushroom.Research Centres - National level and Regional level.

Suggested Readings

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.

2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.

3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

FORMAT

Ranchi Women's College,Ranchi

Mid Sem No Exam Year

Subject Code/Bot

F M = 15 Time: 1 Hour

General Instrutions

i) Group A carries very short answer type compulsory questions

ii) Group B consist of short answer type descriptive questions, answer 2 out of 3

iii) Answer in your own words as far as practicable

iv) Numbers in right indicate full marks of the question

Group A

1. (5x1=5)
2.
3.
4.
5.

Group B

6. (5)
7. (5)
8. (5)

Ranchi Women's College,Ranchi

End Sem No | Exam Year

Subject Code/Bot

F M = 60/PM 24 | Time: 3 Hours

General instructions :

1. Group A carries one compulsory question consisting of objective type MCQ/FIB/True or False of 10 marks 1x10=10
2. Group B consists of short answer type questions of 5 marks each/Answer any four out of eight 5x4=20
3. Group C consists of Long Answer Type questions of 15 marks each. Answer any two out of four 15x2=30
4. Answer all parts of a question in one place
5. Number in the right indicates full marks of the question

Group A

1. a)

b)

c)

d)

e)

f)

g)

h)

i)

j)

Group B

2.

a)

b)

c)

d)

e)

f)

g)

h)

Group C

2

a)

o)

c)

d)