JSS COLLEGE OF ARTS, COMMERCE AND SCIENCE

(Autonomous)

B N ROAD, MYSURU- 570 025

DEPARTMENT OF BOTANY

Syllabus

CHOICE BASED CREDIT SYSTEM

For B.Sc programmes

Chemistry, Botany, Zoology

Botany, Biochemistry, Microbiology

2017-18

SCHEMATIC SYLLABUS UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

w.e.f.

2017-2018

BSc CBZ (Chemistry, Botany, Zoology)

Semester/ Course code	Title of the paper	Duration for teaching hours /week		No. of credits			Total credits	Total Hours/ sem		Continuous assessment						Duration for exam	
										C_1(15)		C_2(15)		C_3 (70%)			
	Core courses	**T**	**P**	**L**	**T**	**P**		**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**
I CMA23008	BIODIVERSITY OF MICROBES AND ARCHEGONIATE	04	04	4	-	2	06	60	60	10	05	10	05	70	70	3	4
II CMB23008	PLANT ECOLOGY MORPHOLOGY AND TAXONOMY	04	04	4	-	2	06	60	60	10	05	10	05	70	70	3	4
III CMC23008	PLANT ANATON AND EMBYOLO	04	04	4	-	2	06	60	60	10	05	10	05	70	70	3	4
IV CMD23008	PLANT PHYSIOLOGY AND METABOLISM	04	04	4	-	2	06	60	60	10	05	10	05	70	70	3	4
V CME23008	**Discipline specifi elective** CELL AND MOLECULAR BIOLOGY	04	03	4	-	1.5	5.5	60	60	10	05	10	05	70	70	3	4

CME23208	OR ECONOMIC BOTANY AND BIOTECHNOLO																
CMF23408 CMF23608	**Skill enhancemer course** ETHNOBOTANY OR FLORICULTURE	02	-	2	-	-	02	30	-	15	-	15	-	50	-	2	-
VI	**Discipline specific elective**																
CMF23008 CMF23208	GENETICS PLANT BREEDING OR ANALYTICAL TECHNIQUES AND PLANT SCIENCES	04	03	4	-	1.5	5.5	60	60	10	05	10	05	70	70	3	4
TOTAL CREDITS = 37																	
Practical=70 marks(50marks For Practical Exam Proper,10marks For Record,10marks for submission of specimens /photographs)																	

Programme Outcome for Bachelor of Science in Chemistry, Botany, Zoology:

After completing the graduation in the Bachelor of Science the students are able to:

PO1. Demonstrate the ability to justify, explain, and/or approach the concept

PO2. Demonstrate the ability to present clear, logical and succinct arguments

PO3. Develop state-of-the-art laboratory skills and professional communication skills

PO4. Apply the scientific method to design, execute, and analyze an experiment

PO5. Appreciate the role and use of chemistry for ethical issues facing chemists/drugs

PO6 Understand the impact of the plant diversity in societal and environmental context

PO7. Use interdisciplinary approaches with quantitative skills to work on biological problems

PO8. Use interdisciplinary approaches with quantitative skills to work on biological problems

PO9. Understand Chemistry as an integral part for addressing social, economic, and environmental problems

PO10. Identify the major groups of organisms with an emphasis on animals and plants

Programme Specific Outcome

Bachelor of Science in Chemistry, Botany and Zoology

After completing the graduation in the Bachelor of Science the students are able to:

PSO1. Find jobs at all level of chemical, pharmaceutical, food products, life oriented material industries, etc.

PSO2. Apply appropriate techniques for the qualitative and quantitative analysis of chemicals in laboratories and in industries.

PSO3. Explicate ecological interconnectedness of life

PSO4: Analyse the avenues and remedies for burning environmental issues

PSO5. Recognized the relationships between different structures and functions at different levels

PSO6. Characterize the biological, chemical and physical features of environments that

Animals inhabits

BSc BBM (Botany, Biochemistry, Microbiology)

Semester/ Course code	Title of the paper	Duration for teach hours /w		No. of credits			Tota cred	Total Hours/ sem		Continuous assessment						Duration r exam	
										C_1(15)		C_2(15)		C_3 (70%			
	Core courses	**T**	**P**	**L**	**T**	**P**		**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**
I CMA23007	BIODIVERSITY OF MICROBES AND ARCHEGONIATE	04	04	4	-	2	06	60	60	10	05	10	05	70	70	3	4
II CMB23007	PLANT ECOLOGY MORPHOLOGY AND TAXONOMY	04	04	4	-	2	06	60	60	10	05	10	05	70	70	3	4
III CMC23007	PLANT ANATOMY AND EMBYOLOGY	04	04	4	-	2	06	60	60	10	05	10	05	70	70	3	4
IV CMD23007	PLANT PHYSIOLOGY AND METABOLISM	04	04	4	-	2	06	60	60	10	05	10	05	70	70	3	4
V CME23007	**Discipline specific elective**	04	03	4	-	1.5	5.5	60	60	10	05	10	05	70	70	3	4
	CELL AND MOLECULAR BIOLOGY OR ECONOMIC BOTANY A BIOTECHNOLOGY																
CMF23407 CMF23607	**Skill enhancement course**	02	-	2	-	-	02	30	-	15	-	15	-	50	-	2	-
	ETHNOBOTANY OR																

	FLORICULTURE																
VI	**Discipline specific elective**	04	03	4	-	1	5	60	60	10	05	10	05	70	70	3	4
CMF23007	GENETICS PLANT BREEDING OR																
CMF23207	ANALYTICAL TECHNIQUES AND PLANT SCIENCES																
															TOTAL CREDITS = 37		
Practical=70 marks(50marks For Practical Exam Proper,10marks For Record,10marks for submission of specimens /photographs)																	

Programme Outcome for Bachelor of Science in Botany, Biochemistry & Microbiology

After completing the graduation in the Bachelor of Science the students are able to:

PO1. Identify the taxonomic position of plants using principles and methods of nomenclature and classification in Botany

PO2. Understand the impact of the plant diversity in societal and environmental context

PO3.Demonstrate the knowledge of, and need for sustainable development

PO4. Use interdisciplinary approaches with quantitative skills to work on biological problems

PO5. Demonstrate the ability to justify and explain their thinking and/or approach

PO6. Develop state-of-the-art laboratory and professional communication skills

PO7. Apply the scientific method to design, execute, and analyze an experiment

PO8. Explain scientific procedures and their experimental observations

PO9.Demonstrate an understanding of fundamental biochemical principles, structure and function

PO10. Work as a laboratory technician, biochemists or medical scientist

PO11. Explain the processes used by microorganisms for the growth

PO12. Explain the theoretical basis of the tools, technologies and methods of microbiology

Programme Specific Outcome
Bachelor of Science in Botany, Biochemistry & Microbiology

After completing the graduation in the Bachelor of Science the students are able to;

PSO 1: Demonstrate applications of biochemical and biological sciences

PSO2: Inculcating proficiency in all experimental techniques and methods of analysis

PSO3: Acquire, articulate, retain and demonstrate laboratory safety skills

PSO4: Communicate scientific information effectively, relating to microbes and their role in ecosystem and health

PSO5: Gain proper procedures and regulations in handling and disposal of chemicals

PSO6: Understand biochemical and molecular processes that occur in and between the cells

CMA23008/CMA23007

I Semester

Credits: Theory-4, Practicals-2 **Theory**: 60 Lectures

Course Outcome

After completion of the course the student is able to:

CO1. Understand the characteristics of viruses

CO2. Learn the classification and characteristics of bacteria

CO3. Identify the classification and characteristics of archegoniate

CO4. Identify the characteristics of algae

CO5. Understand the classification and characteristics of fungi

DSC-I: Biodiversity of Microbes and Archegoniate

Unit 1: Microbial diversity: **(34 Lectures)**

A. Virus **(5 Lectures)**

Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance;

B. Bacteria **(5 Lectures)**

Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (Conjugation, Transformation and Transduction); Economic importance

C. Algae **(12 Lectures)**

General characteristics; Ecology and distribution; Reproduction; Classification of algae; Morphology and life-cycles of the following: Nostoc, Spirogyra, Sargassum, Polysiphonia (Only Morphology). Economic importance of algae

D. Fungi **(12 Lectures)**

Introduction- General characteristics, ecology cell wall composition, nutrition, reproduction and classification; ecology and significance, life cycle of Rhizopus, Penicillium, Puccinia, Symbiotic Associations-Lichens: General account, reproduction and significance.

Unit 2: Archegoniate: (26 Lectures)

Introduction, Transition to land habit, Alternation of generations **(2 Lectures)**

A. **Bryophytes** **(10 Lectures)**

B. General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), Morphology, Anatomy and Reproduction of Marchantia and Polytrichum. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of Sphagnum.

C. **Pteridophytes** **(8 Lectures)**

D. General characteristics, classification, early land plants (Rhynia). Classification (up to 11 family) morphology, anatomy and reproduction of Selaginella, Equisetum and Marsilia. (Developmental details not to be included). stelar evolution. Ecological and economical importance of Pteridophytes.

C. 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

Practicals

1. **T-Phage and TMV**, Line drawing/Photograph of Lytic and Lysogenic Cycle.

2. **Types of Bacteria**, structure of bacterium; Binary Fission; Conjugation; Structure of root nodule.

3. **Gram staining** of Bacteria.

4. Study of vegetative and reproductive structures of ***Nostoc*** **and** ***Spirogyra*****,** through temporary preparations and permanent slides. (Specimen and permanent slides)

5. Study of ***Sargassum*** (vegetative and reproductive) and ***Polysiphonia*** (vegetative morphology)

6. ***Rhizopus*** **and** ***Penicillium***: Asexual stage from temporary mounts and sexual structures through permanent slides.

7. ***Puccinia****:* Study of Uredosorus, Teleutosorus, Basidiospores, Pycnidium and Aeciospores.

8**. Lichens**: Study of growth forms of lichens (crustose, foliose and fruticose), T.S. of thallus, L.S of Apothecium .

9. ***Marchantia***- morphology of thallus, V.S thallus through gemma cup, w.m. gemmae , V.S. antheridiophore, archegoniophore, L.S. sporophyte .

10. ***Polytrichum*****-** morphology, operculum, peristome, annulus, spores, permanent slides showing antheridial and archegonial heads, L.S capsule and protonema. (photographs)

11. ***Selaginella***- morphology, W.M. leaf with ligule, T.S. stem, w.m. strobilus, W.M. microsporophyll and megasporophyll (temporary slides), L.S. strobilus (permanent slide).

12. ***Equisetum***- morphology, T.S. through internode, L.S. strobilus, T.S. strobilus, W.M. sporangiophore, W.M. spores wet and dry.

13. ***Marsilea***- morphology, T.S. of rhizome,W.M and T.S of Sporocarp.

14. ***Cycas***- morphology (coralloid roots, bulbil, leaf), T.S. coralloid root, T.S. leaflet, V.S. microsporophyll, L.S. ovule.

15. ***Pinus***- morphology. W.M dwarf shoot, T.S. needle, L.S. of male cone, L.S. female cone.

References

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.

BOTANY THEORY

I B.Sc. SEMESTER I: PAPER I

SCHEME OF THEORY QUESTION PAPER

Time: 3.00 Hours **Max. Marks: 70**

Blue print

Units	No. of questions from each category			Total marks
	2 marks (5/8)	4marks (4/6)	6marks (4/6)	
Unit I :Microbial Diversity				
A&B.Virus and Bacteria (10hrs)	2X1=2	5X1=5	10X1=10	**17**
C. Algae (12 hrs)	2X1=2	5X2=10	10X1=10	**22**
D. Fungi (12hrs)	2X1=2	5X2=10	10X1=10	**22**
Unit II: Archegoniate				
A. Bryophytes (12hrs)	2X1=2	5X1=5	10X1=10	**17**
B. Pteridophytes (08hrs)	2X2=4	-	10X1=10	**14**
C. Gymnosperms (06hrs)	2X2=4	-	10X1=10	**14**
Total	**8X2=16**	**4X6=30**	**6X6=60**	**106**

CMA23008/CMA23007

BOTANY PRACTICALS

I B.Sc. SEMESTER I -PAPER 1

SCHEME OF QUESTION PAPER

Biodiversity of Microbes and Archegoniate

Time: 4 Hours **Max. Marks: 70**

(50+10+10)

I. Identify the specimens 'A' and 'B' with reasons and labelled sketches

5x2=10 marks

(**A**-Algae and **B**-fungi)

Identification – 1 mark

Classification – 1 mark

Reasons with labelled sketch – 3 marks

II. Prepare a stained temporary slide of 'C'. Sketch, label and Identify with reasons. Leave the preparation for evaluation. 5 marks

(C-Cyanobacteria)

Identification – 1 marks

Preparation/staining and mounting– 2 marks

Reasons with labelled sketch – 2 marks

III. Write critical notes on 'D', 'E' and 'F' 5x3=15 marks

(D-Algae/Fungi, E-Lichens/Bryophytes, F- Pteridophytes /Gymnosperms)

Identification _ 1 mark

Classification – 1 mark

Reasons with lablled sketch – 3 marks

IV. Identify the Microslides 'G', 'H', 'I' and 'J' and with reasons and labeled sketches

5x4=20 marks

(G-Algae,H-Fungi,I-lichens /Bryophytes,J-pteridophytes/gymnosperms)

Identification – 1 mark

Classification – 1 mark

Reasons with lablled sketch – 3 marks

V. Practical record **10marks**

VI. Submissions **10marks**

Note: Each student should submit the **Duly valued and certified practical record and Assigned submissions** at the time of practical examination.

CMA23008/CMA23007

BOTANY PRACTICALS

IB.Sc. SEMESTER I : PAPER 1

MODEL QUESTION PAPER

Biodiversity of Microbes and Archegoniate

Time: 4 Hours **Max. Marks: 70**

(50+10+10)

I. Identify the specimens 'A' and 'B' with reasons and labelled sketches

5x2=10 marks

II. Prepare a stained temporary slide of 'C'. Sketch, label and Identify with reasons. Leave the preparation for evaluation. 5 marks

III. Write critical notes on 'D', 'E'and 'F' 5x3=15 marks

IV. Identify the Microslides 'G', 'H', 'I' and 'J' and with reasons and labelled sketches

5x4=20 marks

V. Practical record 10marks

VI. Submissions 10marks

Note: Each student should submit the **Duly valued and certified practical record** and **Assigned submissions** at the time of practical examination.

CMB23008/CMB23007

II Semester

Credits: Theory-4, Practicals- 2 Theory 60**:** Lectures

Course outcome

After completion of the course the student is able to:

CO1. Learn the classification and characteristics of plant communities

CO2. Understand in depth herbarium

CO3. Understand in details with examples plant morphology

CO4. Specify the characteristics of ecosystem

DSC-II: Plant Ecology, Morphology and Taxonomy

Unit 1: Plant Ecology

A. Introduction to Ecology and significance. (6 Lectures)

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

B. Ecological factors (6 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.

D. **Plant communities (6 Lectures)**

E. Morphological Adaptation of hydrophytes and xerophytes, Succession; Processes and types, Characters; Ecotone and edge effect.

D: Phytogeography (4 Lectures)

Principle biogeographical zones; Endemism

Unit 2: Leaf and Floral Morphology (08 Lectures)

A. Structure of a typical leaf (*Hibiscus*), variation in leaf morphology, types of leaves, phyllotaxy.
B. Parts of a typical flower (*Tribulus terrestris* / *Muntingia calabura*), Variation in floral morphology and floral organs in detail (aestivation and placentation).

Unit 3: Taxonomy

A. Introduction to plant taxonomy (10 Lectures)

1. Principles of taxonomy

2. Taxonomic hierarchy Ranks, categories and taxonomic groups

2. Types of classification (artificial, natural and phylogenetic)

3. Systems of classification-Bentham and Hooker, Engler and Prantl

4. Plant Nomenclature-Binomial system

5. ICN principles

6. Recent trends in Taxonomy: a brief account of Chemotaxonomy, Cytotaxonomy. & APG System of Classification

B. Herbarium technique (6 Lectures)

1. Herbarium (mentioning important herbaria and botanical gardens of the world and India)

2. Botanical gardens

3. Flora and their importance

4. Botanical survey of India (B.S.I) and its function.

C: Angiosperm families (14 Lectures)

Study of the following families according to Bentham and Hooker's system of classification

Malvaceae ,Fabaceae (Papilionaceae, Caesalpiniaceae and Mimosaceae), Apiaceae Apocynaceae and Acanthaceae.

Practicals

1. Study of instruments used to measure microclimatic variables: Soil thermometer, Maximum and Minimum Thermometer, Anemometer, Psychrometer/Hygrometer, Rain gauge.

2. Determination of pH and analysis of two soil samples and plant extracts and Porosity of water in soil of three habitats.

3. (I) Study of morphological adaptations of the following

a. Hydrophytes Eg: ***Hydrilla. Pistia and Eichhornia***

b. Xerophytes Eg: ***Opuntia, Euphorbia Tirucalli,Nerium and Casuarina***

(II)Study of biotic interactions of the following:

a.Stem parasite Eg: ***Cuscuta.***

b.Root parasite Eg: ***Striga***.

c.Epiphytes, Eg: ***Vanda***

d. Predatary plants (Insectivorous plants) Eg: ***Nepenthes***.

4. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (Species to be listed)

5. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law

6. Study of leaf, types, phyllotaxy and its modifications.

7. Parts of a typical flower **(*Tribulus terrestris* / *Muntingia calabura*),** Variation in floral morphology.

8. Floral organs in detail with their variations.

9. 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 and Malvaceae

10 Fabaceae (Papilionaceae, Caesalpiniaceae and Mimosaceae)
11 Apiaceae, Apocynaceae
12 Solanaceae, Acanthaceae,
13 Lamiaceae, Asteraceae
14 Liliaceae, Arecaceae
15 Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

References

1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.

2. Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.

3. Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A.

4. Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd

CMB23008/CMB23007

BOTANY THEORY

I B.Sc SEMESTER II: PAPER II

SCHEME OF THEORY QUESTION PAPER

Plant Ecology, Morphology and Taxonomy

Time: 3.00 Hours **Max. Marks: 70**

units	2 marks (5/8)	5marks (4/6)	10marks (4/6)	Total marks
Unit 1: Plant Ecology				
A. Introduction to Ecology ıd significance (6hrs)	2x1=2	5x1=5	-	**7**
B. Ecological factors (6hrs)	-	-	10x1=10	**10**
C. Plant communities (6 hrs)	2x1=2	5x1=5	-	**7**
D: Phytogeography (4hrs)	2x1=2	5x1=5	-	**7**
Unit II: Leaf and Floral Morphology(8hrs)	2x2=4	-	10x1=10	**14**
Unit III: Taxonomy				
A. Introduction to plant xonomy (10 's)	2X2=4	5x1=5	10x1=10	**19**
B. Herbarium technique (6hrs)	-	5x1=5	10x1=10	**15**
C:Angiosperm families(14hrs)	2x1=2	5x1=5	10x2=20	**27**
Total	**8x2=16**	**5x6=30**	**10x6=60**	**106**

CMB23008/CMB23007

BOTANY PRACTICALS

I B.Sc SEMESTER II : PAPER II

SCHEME OF PRACTICAL QUESTION PAPER

Plant Ecology, Morphology and Taxonomy

Time: 4 Hour **Max. Marks: 70 (50+10+10)**

I. Write critical motes on 'A' 'B' and 'C' with reasons and labeled sketches 5x3=15 marks

(A-Ecological instruments, B-Hydrophytes/xerophytes/parasites/ephiphytes, C-Leaf phyllotaxy /leaf types/ essential organs of flower)

Identification – 1 mark

Labelled sketch with reasons – 4marks

II. Assign the plants 'D', 'E' and 'F' to their respective families giving reasons. 5x3=15marks

(D-Apiaceae/Apocynaceae/Acanthaceae,E- Lamiaceae/Asclepiadaceae/Liliaceae/Arecaceae)

Family name – 1 mark

Salient features – 4 marks

III. Describe the plant 'G' in technical terms. 5x1=5 marks

(Papilionaceae /Caesalpiniaceae)

Family name – 1 mark

Technical terms – 4 marks

IV. Draw the floral diagram and write the floral formula of the give plant 'H'.

(Malvaceae, Solanacae, Apocynaceae) **5x1=5 marks**

Floral formula -1mark

Floral diagram-4marks

V. Identify the slide 'I'. (Placentation) 5x1=5 marks

Identification – 1 mark

Definition -1mark

Reasons – 3 marks

VI. Determination of pH in the given plant extract by pH paper method 5x1=5marks

Definition –1 mark

Principle– 3marks

Result – 1 mark

VII. Practical record 10marks

VIII. Submissions 10marks

Note: each student should submit the **Duly valued and certified practical record and Assigned Submissions**, at the time of practical examination.

CMB23008/CMB23007

BOTANY PRACTICALS

I B.Sc SEMESTER II: PAPER II

SCHEME OF PRACTICAL QUESTION PAPER

Plant Ecology, Morphology and Taxonomy

Time: 4 Hours **Max. Marks: 70**

(50+10+10)

I. Write critical notes on 'A' 'B' and 'C' with reasons and labeled sketches. 5x3=15 marks

II.Assign the plants 'D', 'E' and 'F' to their respective families giving reasons. 5x3=15marks

III. Describe the plant 'G' in technical terms. 5x1=5 marks

IV. Draw the floral diagram and write the floral formula of the give plant 'H'.

5x1=5 marks

V. Identify the slide 'I'. (Placentation) 5x1=5 marks

VI. Determination of pH in the given plant extract by pH paper method 5x1=5marks

VII. Practical record 10marks

VIII. Submissions 10marks

Note: each student should submit the **Duly valued and certified practical record and Assigned Submissions**, at the time of practical examination.

CMC23008/CMC23007

III Semester

Credits: Theory-4, Practicals- 2 **Theory: 60Lectures**

Course outcome

After completion of the course the student is able to:

CO1. Learn the details of embryology

CO2. Understand the details of anatomy

CO3. Understand the details of histology

CO4. Understand the characteristics of secondary growth

DSC: III Plant Anatomy and Embryology

Unit 1: Meristematic and permanent tissues (8 Lectures)

Root and shoot apical meristems; Simple and complex tissues.

Unit 2: Organs (4 Lectures)

tructure 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 anatomical adaptations in xerophytes and hydrophytes

Unit 5: Structural organization of Reproductive organs (8 Lectures)

Structure of stamen, anther and pollen Structure of gynoecium/pistil and types of ovules; Types of embryo sacs, organization and ultra structure 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; Embryoendosperm relationship.

Unit 8: Apomixis and polyembryony **(8 Lectures)**

Definition, types and practical applications

Practicals

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

References

1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.

2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

CMD23008/CMD23007

IV Semester

Credits: Theory-4, Practicals- 2 Theory: 60Lectures

Course outcomes

After completion of the course the student is able to:

CO1. Identify the characteristics of plant response to light and temperature

CO2. Understand the details of photosynthesis

CO3. Learn in depth translocation in phloem

CO4. Specify the classification and characteristics of enzyme

DSC IV: Plant Physiology and Metabolism

Unit 1: Plant-water relations (8 Lectures)

Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation

Unit 2: Mineral nutrition (8 Lectures)

Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

Unit 3: Translocation in phloem (6 Lectures)

Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading.

Unit 4: Photosynthesis (12 Lectures)

Photosynthetic Pigments ($Chl_{a,\ b}$, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation; Photorespiration

Unit 5: Respiration (6 Lectures)

Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway

Unit 6: Enzymes (4 Lectures)

Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition

Unit 7: Nitrogen metabolism (4 Lectures)

Biological nitrogen fixation; Nitrate and ammonia assimilation

Unit 8: Plant growth regulators (6 Lectures)

Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene

Unit 9: Plant response to light and temperature **(6 Lectures)**

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

Practicals

1. Determination of osmotic potential of plant cell sap by plasmolytic method. Study of plasmolysis and deplasmolysis on Rhoeo leaf.
2. To study the effect of two environmental factors (light and wind) on transpiration by excised twig,using Ganong's potometer.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Experiments pertaining to growth- i.Phototropism, ii.Geotropism.
5. Experiments pertaining to growth-Arc Auxanometer experiment.
6. To study the effect of light intensity and bicarbonate concentration on O2 evolution in photosynthesis.
7. Comparison of the rate of respiration in any two parts of a plant using Ganong's respiroscope
8. Separation of photosynthetic pigments by paper chromatography.
9. Separation of amino acids by paper chromatography
10. Qualitative biochemical tests for carbohydrates, fats and proteins

Demonstration experiments (any four)

1. Bolting.
2. Effect of auxins on rooting.
3. Suction due to transpiration.
4. Relation between absorption and transpiration.
5. Kuhne's experiment.

References

1. Taiz, L., Zeiger, E., (2010). Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.

2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.

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

Discipline Centric Elective Courses

Two (2) be selected from each of the three disciplines

Discipline Centric Elective Botany

CME23008/CME23007

V Semester

Credits: Theory-4, Practicals-2 **Theory: 60Lectures**

Course outcomes

After completion of the course the student is able to:

CO1. Understand in depth microscopy

CO2. Learn the details of cell

CO3. Specify the details of DNA

CO4. Learn the details of gene regulation

DSE-1: Cell and Molecular Biology

Unit 1: Techniques in Biology (8 Lectures)

Principles of microscopy; Light Microscopy; Phase contrast microscopy; Fluorescence microscopy; Confocal microscopy; Sample Preparation for light microscopy; Electron microscopy (EM)- Scanning EM and Scanning Transmission EM (STEM); Sample Preparation for electron microscopy; X-ray diffraction analysis.

Unit 2: Cell as a unit of Life (2 Lectures)

The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components

Unit 3: Cell Organelles (20 Lectures)

Mitochondria: Structure, marker enzymes, composition; Semiautonomous nature; Symbiont hypothesis; Proteins synthesized within mitochondria; mitochondrial DNA.

Chloroplast Structure, marker enzymes, composition; semiautonomous nature, chloroplast DNA

ER, Golgi body & Lysosomes: Structures and roles.

Peroxisomes and Glyoxisomes: Structures, composition, functions in animals and plants and biogenesis.

Nucleus: Nuclear Envelope- structure of nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure (brief).

Unit 4: Cell Membrane and Cell Wall (6 Lectures)

The functions of membranes; Models of membrane structure; The fluidity of membranes; Membrane proteins and their functions; Carbohydrates in the membrane; Faces of the membranes; Selective permeability of the membranes; Cell wall.

Unit 5: Cell Cycle (6 Lectures)

Overview of Cell cycle, Mitosis and Meiosis; Molecular controls.

Unit 6: Genetic material **(6 Lectures)**

DNA: Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase bacteriophage experiment, DNA structure, types of DNA, types of genetic material.

DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi–conservative, semi discontinuous RNA priming, Ø (theta) mode of replication, replication of linear, dsDNA, replicating the 5′end of linear chromosome including replication enzymes.

Unit 7: Transcription (Prokaryotes and Eukaryotes) **(6 Lectures)**

Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types; Translation (Prokaryotes and eukaryotes), genetic code

Unit 8: Regulation of gene expression **(6 Lectures)**

Prokaryotes:Lac operon and Tryptophan operon ; and in Eukaryotes.

Practicals

1. Preparation of fixatives and stains: FAA, Carnoy"s fixative, safranine, acetocarmine and acetorcein.
2. To study prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and electron micrographs.
3. Study of the photomicrographs of cell organelles
4. To study the structure of plant cell through temporary mounts.
5. Study of mitosis (temporary mounts and permanent slides).
6. Study of meiosis (temporary mounts and permanent slides).
7. Measure the cell size (either length or breadth/diameter) by micrometry.
8. Study the structure of nuclear pore complex by photograph (from Gerald Karp)Study of special chromosomes (polytene & lampbrush) either by slides or photographs.
9. Study DNA packaging by micrographs.
10. Preparation of the karyotype and ideogram from given photograph of somatic metaphase chromosome.

References

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.

2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.

3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA. 4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

CME23208/CME23207

V Semester

Credits: Theory-4, Practicals- 2 **Theory: 60Lectures**

Course outcome

After completion of the course the student is able to:

CO1. Specify the details of plant tissue culture

CO2. Understand in details with application, if applicable, economic botany

CO3. Understand in details with examples recombinant DNA technology

DSE-2: Economic Botany and Biotechnology

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 description 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 & 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. Hybridoma and monoclonal antibodies, ELISA and Immunodetection Molecular diagnosis of human disease, Human gene Therapy

Practicals

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.

References

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.

CMF23608/ CMF23607

V SEMESTER

Credits 2 **Theory: 30Lectures**

Course outcome

After completion of the course the student is able to:

CO1 Specify the classification and characteristics of gardening

CO2 Understand in depth nursery management

CO3 Identify in details with examples ornamental plants

SEC-1: Floriculture

Unit 1: Introduction: History of gardening; **(2 Lectures)**

Importance and scope of floriculture and landscape gardening

Unit 2: Nursery Management and Routine Garden Operations: **(8 Lectures)**

Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators

Unit 3: Ornamental Plants: **(4 Lectures)**

Flowering annuals; Herbaceous perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and *Selaginellas*; Cultivation of plants in pots; Indoor gardening; Bonsai.

Unit 4: Principles of Garden Designs: **(4Lectures)**

English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden Some Famous gardens of India.

Unit 5: Landscaping Places of Public Importance: **(4 Lectures)**

Landscaping highways and Educational institutions

Unit 6: Commercial Floriculture: (6 Lectures)

Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Marigold,Rose, Lilium, Orchids).

Unit 7: Diseases and Pests of Ornamental Plants. (2 Lectures)

References

1. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India Allied Publishers

CMF23408/ CMF23407

SEMESTER V

Credits 2 **Theory: 30Lectures**

Course outcome

After completion of the course the student is able to:

CO1. Understand the details of Ethnobotany

CO2. Learn the characteristics of traditional medicinal plants

SEC-2: Ethnobotany

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.

References

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-19969)

CMF23008/ CMF23007

VI Semester

Credits: Theory-4, Practicals- 2 **Theory: 60Lectures**

Course outcome

After completion of the course the student is able to:

CO1. Specify the details of heredity

CO2. Write down the classification and characteristics of mutations

CO3. Learn the details of plant breeding

CO4. Identify in details with examples linkage

DSE-2: Genetics and Plant Breeding

Unit 1: Heredity (24 Lectures)

1. Brief life history of Mendel

2. Terminologies

3. Laws of Inheritance

4. Modified Mandelian Ratios: 2:1- lethal Genes; 1:2:1- Co- dominance, incomplete dominance; 9:7; 9:4:3; 13:3; 12:3:1.

5. Multiple allelism,

6.Pleiotropism

7. Pedigree Analysis

8. Cytoplasmic Inheritance: leaf variegation in Mirabilis jalapa, Male sterility.

9. Chromosome theory of Inheritance.

10.Quantitative inheritance-Concept, mechanism, examples. Monogenic vs polygenic Inheritance.

Unit 2: Sex-determination and Sex-linked Inheritance (4 Lectures)

Unit 3: Linkage and Crossing over (8 Lectures)

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

Unit 4: Mutations and Chromosomal Aberrations (4 Lectures)

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

Unit 5: Plant Breeding (4 lectures)

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

Unit 6: Methods of crop improvement (8 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 7: Inbreeding depression and heterosis (4 lectures)

History, genetic basis of inbreeding depression and heterosis; Applications

Unit 8: Crop improvement and breeding (4 lectures)

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

Practicals

1. Mendel's laws through seed ratios. Laboratory exercises in probability and chisquare.

2. Chromosome mapping using point test cross data.

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

4. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
5. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes through photographs.

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

7. Hybridization techniques - Emasculation, Bagging (For demonstration only).

8. Induction of polyploidy conditions in plants (For demonstration only).

References

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. WileyIndia.

2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.

3. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings

4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

5. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
6. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.

7. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2nd edition.

8. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.

CMF23208/ CMF23207

VI SEMESTER

Credits: Theory-4, Practicals-2 **Theory: 60Lectures**

Course outcome

After completion of the course the student is able to:

CO1. Learn the details of Spectrophotometry

CO2. Write down the details of chromatography

CO3. Specify the details of cell fractioning

CO4. Identify in details with application, if applicable, biostatistics

DSE-2: Analytical Techniques in Plant Sciences

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, chromosome painting; 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,

CsCl2 gradient, 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, Ionexchange

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

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Practicals

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 separate 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).

References

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGrawHill 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