



# **Tripura University**

**(A Central University)**

**Suryamaninagar**

**West Tripura**

**Syllabus for**

**Four Years Undergraduate Programme**

**Subject: Botany**

**(As per NEP-2020)**

**Year - 2023**



**Tripura University**  
(A Central University)

**Course Structure of Botany (UG Programme)**  
**As per NEP-2020 under Tripura University**

**BOTANY MAJOR**

Year	Semester	Paper	Credit	Mark	Unit - I	Unit - II	Unit-III	Unit-IV	
1 <sup>st</sup>	1 <sup>st</sup>	Paper-1 Theory	4	100 (IA=20 + ESE=80)	Microbiology-I	Microbiology- II	Phycology-I	Phycology-II	
		Paper-2A Theory	2	50 (IA=10 + ESE=40)	Mycology-I	Mycology-II			
		Paper-2B Practical	2	50 (IA=10 + ESE=40)	Based on Theory paper 1 & 2A				
	2 <sup>nd</sup>	Paper-3 Theory	4	100 (IA=20 + ESE=80)	Bryophyta	Pteridophyta	Gymnosperms	Basic Paleobotanical Principles	
		Paper-4A Theory	2	50 (IA=10 + ESE=40)	Fossil Plants	Principles of Organic Evolution			
		Paper-4B Practicals	2	50 (IA=10 + ESE=40)	Based on Theory paper 3 & 4A				
	2 <sup>nd</sup>	3 <sup>rd</sup>	Paper-5 Theory	4	100 (IA=20 + ESE=80)	Elementary Phytopathology	Angiosperm Morphology	Plant anatomy	Embryology
			Paper-6A Theory	2	50 (IA=10 + ESE=40)	Taxonomy-I	Taxonomy-II		
			Paper 6B Practicals	2	50 (IA=10 + ESE=40)	Based on theory paper 5 & 6A			
4 <sup>th</sup>		Paper-7 Theory	4	100 (IA=20 + ESE=80)	Plant Ecology-I	Plant Ecology- II	Natural Resource Management & Sustainable Development	Phytogeograph y	
		Paper-8A Theory	2	50 (IA=10 + ESE=40)	Biophysics & Biochemistry-I	Biochemistry- II			
		Paper 8B Practicals	2	50 (IA=10 + ESE=40)	Based on theory paper 7 & 8A				
3 <sup>rd</sup>		5 <sup>th</sup>	Paper-9 Theory	4	100 (IA=20 + ESE=80)	Cell biology-I	Cell Biology-II	Plant Physiology-I	Plant Physiology-II
			Paper-10A Theory	2	50 (IA=10 + ESE=40)	Genetics-I	Genetics-II		
			Paper 10B Practicals	2	50 (IA=10 + ESE=40)	Based on theory paper 9 & 10A			
	Paper-11 Theory		4	100 (IA=20 + ESE=80)	Molecular Biology-I	Molecular Biology-II	Plant Biotechnology -I	Plant Biotechnology -II	
	Paper-12A		2	50	Economic	Economic			

		Theory		(IA=10 + ESE=40)	Botany-I	Botany-II		
		Paper 12B Practicals	2	50 (IA=10 + ESE=40)	Based on theory paper 11 & 12A			
	6 <sup>th</sup>	Paper-13 Theory	4	100 (IA=20 + ESE=80)	Plant Breeding	Biometry	Horticultural Practices	Floriculture & Gardening
		Paper-14A Theory	2	50 (IA=10 + ESE=40)	Pharmacognosy	Ethnobotany		
		Paper 14B Practicals	2	50 (IA=10 + ESE=40)	Based on theory papers 13 & 14A			
		Paper-15 Theory	4	100 (IA=20 + ESE=80)	Industrial and Applied Microbiology-I	Industrial and Applied Microbiology- II	Algal Biotechnology	Applied Mycology
		Paper-16A Theory	2	50 (IA=10 + ESE=40)	Palynology	Biodiversity and its Conservation		
		Paper 16B Practicals	2	50 (IA=10 + ESE=40)	Based on theory papers 15 & 16A			
4 <sup>th</sup>	7 <sup>th</sup>	Paper-17 Theory	4	100 (IA=20 + ESE=80)	*	*	*	*
		Paper-18A Theory	2	50 (IA=10 + ESE=40)	*	*		
		Paper 18B Practicals	2	50 (IA=10 + ESE=40)	Based on theory papers 17 & 18A			
		Paper-19 Theory	4	100 (IA=20 + ESE=80)	*	*	*	*
		Paper-20A Theory	2	50 (IA=10 + ESE=40)	*	*		
		Paper-20B Practicals	2	50 (IA=10 + ESE=40)	Based on theory papers 19 & 20A			
	8 <sup>th</sup>	Paper-21 Theory	4	100 (IA=20 + ESE=80)	*	*	*	*
		Paper-22A Theory	2	50 (IA=10 + ESE=40)	*	*		
		Paper-22B Practicals	2	50 (IA=10 + ESE=40)	Based on theory papers 21 & 22A			
		Paper-23 Theory	4	100 (IA=20 + ESE=80)	*	*	*	*
		Paper-24A Theory	2	50 (IA=10 + ESE=40)	*	*		
		Paper-24B Practicals	2	50 (IA=10 + ESE=40)	Based on theory papers 23 & 24A			

\* to be finalised later on...

**DETAILED COURSE CONTENT OF  
BOTANY MAJOR**

# 1<sup>ST</sup> YEAR

## SEMESTER-I

### Paper- 1 (Theory)

Total Mark = 100 (IA = 20 + ESE = 80) Credit = 04

#### Unit-I (Microbiology-I)

1. Whittaker's five kingdom system & Carl Richard Woese's three domain system of classification.
2. **Microbial nutrition & Growth**- Nutritional requirements and nutritional types, Uptake of nutrients by microbial cells, Types of culture medium, Isolation of microbes in pure culture; **Microbial growth** - Phases of microbial growth, Measurement of microbial growth.
3. Significant contribution of Indian Plant Virologist: **Pothur Sreenivasulu**.
4. **Virus**: Nature of virus particles, Definition of Virion, Viroid, Prion & Satellite viruses; General structure of Virus particles - Forms of viral capsids (Helical & icosahedral), Types of nucleic acid in virus with examples, Structure of DNA virus (T4 phage), Lytic and lysogenic cycle, Structure and multiplication of RNA virus (TMV), Classification of Virus (Baltimore).
5. Transmission and translocation of Plant virus.

#### Unit-II (Microbiology-II)

1. Significant contribution of Indian Plant Bacteriologist: **P. Gunasekaran**.
2. **Bacteria**: Characters of archaebacteria & eubacteria, Morphological forms, Structure of bacterial cell.
3. **Bacterial chemotaxis** (definition & mechanism).
4. **Bacterial reproduction**: Asexual - Binary fission, Conidia, Budding, Cysts and Endospore (structure & formation).
5. Bacterial Plasmids (types) & Episome.
6. **Genetic recombination in bacteria** - Transformation, Transduction (generalised & specialised) and Conjugation (F- factor, F<sup>+</sup> x F<sup>-</sup>, Hfr x F<sup>-</sup>).
7. **Bacterial nutritional types** – Photosynthetic bacteria (definition and examples of Green sulphur bacteria, purple sulphur bacteria & non-sulphur bacteria); Chemosynthetic bacteria (definition and examples of Sulphur bacteria, Iron bacteria, Hydrogen bacteria & Nitrifying bacteria); Heterotrophic bacteria (Saprophytic & Parasitic).
8. **Economic importance of bacteria**: Beneficial role (role in Agriculture, Industry, Biological Control & Waste Water treatment) & Harmful effects (Food spoilage, Water pollution, Reduction of soil fertility & as Disease causing agent).
9. **Mycoplasma** – Definition & structure, Mycoplasmal plant diseases (examples).
10. **Actinomycetes** – Definition, general characters & Economic importance.

#### Unit-III (Phycology-I)

1. History and significant contributions of Indian Phycologists: **Prof. M. O. P. Iyengar** & **Prof. T. V. Desikachary**.

2. General characters of Algae: Occurrence, Range of thallus organization, Pigment types, Reserve food materials (RFM) in different groups, Algal Reproduction - Methods of Vegetative, Asexual and Sexual reproduction; Life cycle types.
3. Outline classification of Algae ((Lee, 1999) up to Class.
4. General characters of following algal classes – Cyanophyceae, Chlorophyceae, Xanthophyceae, Bacillariophyceae, Phaeophyceae & Rhodophyceae.
5. Economic importance of Algae.

#### **Unit-IV (Phycology-II)**

1. Structure, reproduction and life-cycle of the following algal genera:
  - i. *Nostoc*
  - ii. *Oedogonium*
  - iii. *Chara*
  - iv. *Vaucheria*
  - v. *Ectocarpus*
  - vi. *Polysiphonia*
2. Diatoms – Cell structure, reproduction & economic importance.

## Paper- 2A (Theory)

Total Mark = 50 (IA = 10 + ESE = 40) Credit = 02

### Unit-I (Mycology-I)

1. History and contribution of **Prof. T. S. Sadasivan**.
2. **General characters of Fungi** – (i) Vegetative structure (Unicellular and mycelial forms); (ii) Hyphal forms – Plectenchyma, Sclerotia, Rhizomorphs, Haustoria, Appresoria, Stroma & Hyphal trap; (iii) Fungal cell wall – Composition; (iv) Fungal mode of nutrition.
3. **Fungal reproduction** – (i) Holocarpic & Eucarpic fungus; (ii) Vegetative reproduction – Fragmentation, Fission & Budding; (iii) Asexual reproduction - Different asexual spore forms (Zoospores, Conidia, Oidia, Chlamydo spores & Sporangiospores; (iv) Sexual reproduction - Stages of sexual reproduction (Plasmogamy, Karyogamy & Meiosis), Different methods of Plasmogamy (Gametic copulation, Gametangial contact, Gametangial copulation, Somatogamy & Spermatization); (v) Different types of sexual spores – Ascospores, Basidiospores, Zygo spores & Oospores.
4. **Classification of Fungi** (Ainsworth, 1973) up to sub-division.
5. **Characteristics of important fungal groups** – Chytridiomycota, Zygomycota, Ascomycota (including types of ascocarps and development of ascus and ascospores), & Basidiomycota (including types and development of basidia and basidiospores) and Duteromycetes (including types of spores).
6. **Lichens:** General characters - morphological types, internal structure & reproduction; Ecological and economic importance of lichens.

### Unit-II (Mycology-II)

1. Structure, reproduction & lifecycle of following fungal genera –
  - i) *Rhizopus*
  - ii) *Saccharomyces*
  - iii) *Ascobolous*
  - iv) *Penicillium*
  - v) *Agaricus*
  - vi) *Fusarium*.
2. **Myxomycetes:** General characters, Status of Slime molds, Types of Plasmodia, Types of Fruiting bodies.
3. **Mycorrhiza:** Types of Mcorrhizal association, Role of Mycorrhizal fungi in agriculture and Forestry.

## Paper-2B (Practical)

Total Mark = 50 (IA = 10 + ESE = 40) Credit = 02

Sl. No.	Practical	Marks
1.	Workout on Microbiology	08
2.	Workout on Algae	10
3	Workout on Fungi	10
4.	Identification with reasons (2 x 2 marks)	4
5.	Laboratory Note book	4
6.	<i>Viva voce</i>	4
<b>TOTAL</b>		<b>40</b>

### CONTENTS:

1. Use of Simple and Compound microscope.
2. **Work out on Microbiology:**
  - (a) Gram staining of bacterial population from curd.
  - (b) Demonstration of Sterilization process.
3. Work out of the following algal genera with reproductive structures (Free hand drawing only): *Nostoc* sp., *Oedogonium* sp., *Chara* sp., *Ectocarpus* sp., *Polysiphonia* sp.
4. **Work out of the following Fungi** with reproductive structures (Free hand drawing): *Rhizopus* sp., *Penicillium* sp., *Ascobolus* sp., *Agaricus* sp., *Polyporus* sp.
5. **Identifications:**
  - a) **Permanent slides of Algae:** *Nostoc*, *Volvox* colony, *Oedogonium* dwarf male, *Ectocarpus* with plurilocular sporangia, *Polysiphonia* – cystocarp & tetrasporophyte.
  - b) **Permanent slides of Fungi:** Zygosporangium of *Rhizopus*, Conidiophore of *Penicillium*, T.S. of gills of *Agaricus*, T.S. of basidiocarp of *Polyporus*, Conidia of *Fusarium*.
  - c) **Macro specimen** - Fruitbody of *Agaricus*, *Polyporus*
6. **Laboratory Records:** Student must get the laboratory note books duly signed by the respective teacher during practical classes.
7. **Viva voce:** Questions based on theory and practical syllabus of 1<sup>st</sup> semester.



## SEMESTER-II

### Paper-3 (Theory)

Total Mark = 100 (IA = 20 + ESE = 80) Credit = 04

#### Unit-I (Bryophyta)

1. History and contributions of Indian Bryologists: **Prof. Shiv Ram Kashyap.**
2. General characters.
3. Bryophyta - Adaptations to land habit.
4. Outline Classification - (Strotler and Crandle-Strotler, 2000) up to class.
1. Distinctive features of three major groups – Liverworts, Hornworts, and Mosses.
2. Importance of Bryophyta – Ecological significance & economic importance of bryophytes.
3. Gametophyte structure, Reproduction, Development and Structure of sporophyte, Spore dispersal of *Riccia*, *Marchantia*, *Anthoceros*, *Funaria*

#### Unit-II (Pteridophyta)

1. General characters.
2. Life cycle pattern (Homosporous and Heterosporous).
3. Apogamy & Apospory.
4. Outline classification (Sporne, 1975) up to Order with example.
5. Important characters of Psilophytopsida, Psilotopsida, Lycopsidea, Sphenopsida, and Pteropsida.
6. Morphology, anatomy and reproduction of *Psilotum*, *Lycopodium*, *Selaginella*, *Equisetum*, *Pteris*.

#### Unit-III (Gymnosperms)

1. General characters of Progymnosperms, Classification of Progymnosperms, Vegetative and reproductive structures of *Archaeopteris*.
2. General characters of Gymnosperms.
3. Outline classification (Sporne, 1965) up to Order with example.
4. Important characters of Cycadopsida, Coniferopsida, and Gnetopsida.
5. Economic importance with reference to Wood, Resins, Essential oils, and Drugs.
6. Distribution, morphology, anatomy and reproduction of *Cycas*, *Pinus*, *Ginkgo*, and *Gnetum*.

#### Unit-IV (Basic Paleobotanical Principles)

1. History and contributions of Indian Paleobotanist: **Dr. Birbal Sahani.**
2. Definition of fossil, Conditions required for fossilisation, fossilisation process.
3. Types of fossil (Body fossil - Micro- and Megafossils, Trace fossil, Chemical fossil, Index fossil).
4. Modes of preservation (after Schopf, 1975).
5. Concept of reconstruction and formed genus.
6. Geological time scale with dominant plant groups through ages.
7. Techniques for studying plant fossils.
8. Principles of radiometric fossil dating (brief idea).

9. Importance of fossil study.

## Paper- 4A (Theory)

**Total Mark = 50 (IA = 10 + ESE = 40) Credit = 02**

### Unit-I (Fossil Plants)

1. Study of fossil plants:
  - i. *Rhynia*
  - ii. *Lepidodendron*
  - iii. *Calamites*
  - iv. *Miadesmia*
  - v. *Lyginopteris*
  - vi. *Willimsonia*
  - vii. *Cordaites*.
2. Indian Gondwana flora system - Three fold division with major megafossil assemblages.

### Unit-II (Principles of Organic Evolution)

1. Origin of life.
2. Biological species concept.
3. Reproductive isolation - Definition and types (pre zygotic & post zygotic).
4. Modes of speciation (Allopatric, Peripatric, Parapatric, & Sympatric).
5. Natural selection - Definition and types (Directional, Stabilizing, Disruptive).
6. Phyletic gradualism, Punctuated equilibrium and Stasis.
7. Macro and Micro evolution (definition).
8. Adaptive radiation and convergence (definition).
9. Darwinism and its limitations.
10. Neo Darwinism (only brief idea).
11. Coevolution – Definition and example.

## Paper-4B (Practical)

Total Mark = 50 (IA = 10 + ESE = 40) Credit = 02

Sl. No.	Practical	Marks
1.	Workout on Pteridophyta	10
2.	Workout on Gymnosperm	10
3	Identification with reasons (5 x 2 marks)	10
4.	Laboratory Note book	05
5.	<i>Viva voce</i>	05
<b>TOTAL</b>		<b>40</b>

### 1. Work out on:

(a) **Pteridophytes:** Workout on reproductive structures of the following Pteridophytes:

*Lycopodium* sp., *Selaginella* sp., *Equisetum* sp., *Pteris* sp.

(b) **Gymnosperms:** Leaflet of *Cycas* sp, *Pinus* sp., Microsporophyll of *Cycas* sp.

### 2. Identification:

(a) **Morphological study of the Bryophyte genera:** *Riccia*, *Marchantia*, *Anthoceros*, and *Funaria*.

(b) **Study of Bryophytes from permanent slides** – *Riccia* (V.S. of thallus), *Marchantia* (L.S. of: Gemma cup, antheridiophore, archegoniophore, sporophyte), *Anthoceros* (L.S. of sporophyte), *Funaria* (L.S. capsule).

(c) **Study of macroscopic structures of Gymnosperm:** *Cycas* microsporophylls, *Cycas* megasporophyll, *Pinus* male cone, *Pinus* female cone, *Gnetum* male cone, *Gnetum* female cone.

(d) **Study of Gymnosperms from permanent slides** – L.S. of *Cycas* ovule, L.S. of *Pinus* male cone, L.S. of *Pinus* female cone, Pollen grains of *Pinus*, L.S. of *Gnetum* male cone, L.S. of *Gnetum* female cone/ovule.

(e) Study from permanent slides/macroscopic fossil specimen.

**4. Laboratory Records:** Student must get the laboratory note books duly signed by the respective teacher during practical classes.

**5. Viva voce:** Questions based on theory and practical syllabus of 3<sup>rd</sup> semester.

## 2<sup>ND</sup> YEAR

### SEMESTER-III

#### Paper- 5 (Theory)

Total Mark = 100 (IA = 20 + ESE = 80) Credit = 04

#### Unit-I (Elementary Phytopathology)

1. Significant contribution of Indian Plant Pathologist: **K.C Mehta** and **B.B Mundkur**.
2. **Terms and concepts** - Infection disease, Non-infection disease, Host (types – Primary, Alternate & Collateral), Pathogen (types), Pathogenicity, Pathogenesis, Necrotroph, Biotroph, Koch's postulates, Inoculum (primary & secondary), Inoculum potential, Causal complex, Disease triangle, Disease cycle, Endemic disease, Epidemic disease, Sporadic disease, Resistance (horizontal & vertical), Hypersensitivity & Klenducity.
3. **Types of symptoms** (Necrotic, Atrophic, Hypertrophic).
4. **Control measures of plant disease** – Physical, Chemical, Biological and Cultural methods.
5. **Specific plant diseases:** Late blight of potato, Brown spot of rice, Black stem rust of wheat, Stem rot of jute, Red rot of sugarcane, Tikka disease of ground nut.

#### Unit-II (Angiosperm Morphology)

1. Root – Types and modifications.
2. Leaf – Types, Phyllotaxy, Stipule types, Venation types.
3. Inflorescence – Types (Racemose, Cymose, Mixed & Special).
4. Types of flower, Complete general morphology of flower, Types of aestivation, Placentation types.
5. Types of fruit.
6. Structures of typical seeds (endospermic and non-endospermic).
7. Fruit and seed dispersal mechanisms.

#### Unit-III (Plant Anatomy)

1. Composition and gross structure of Plant Cell Wall.
2. Meristematic tissues: General characters, Classification.
3. Permanent tissue: Parenchyma (general character), Collenchyma (general character and classification), Sclerenchyma (general character and types of sclerides).
4. Components of Xylem and Phloem.
5. Epidermal tissue system - Cuticle, Epicuticular waxes (including functions), Trichomes (uni-and multicellular, glandular and nonglandular), Types of stomata.
6. Vascular tissue system - Types of vascular bundles.
7. Stele types and evolution.
8. Hydathodes, Lithocysts and Laticifers.
9. General anatomical characters of monocot stem and root, Dicot stem and root, Dorsiventral and isobilateral leaf.
10. Normal secondary growth in dicot stem and root.

#### **Unit-IV (Embryology)**

1. Structure of Microsporangium (anther).
2. Microsporogenesis & formation of male gametophyte.
3. Megasporogenesis & development of female gametophyte (types – monosporic, bisporic & tetrasporic).
4. Ovule – Structure & types.
5. Process of double fertilization.
6. Embryo development (dicot & monocot type).
7. Endosperm development – Nuclear, Cellular & Hellobial types.
8. Polyembryoni (definition and types) and Apomixis (types).

## Paper- 6A (Theory)

**Total Mark = 50 (IA = 10 + ESE = 40) Credit = 02**

### Unit-I (Taxonomy-I)

1. History and significant contribution of plant taxonomist: **H. Santapau and Prof. Gurucharan Singh.**
2. Definition of taxonomy and Systematics.
3. Principles of taxonomy, Aims of taxonomy, Phases of taxonomy.
4. Herbarium techniques and importance of herbaria.
5. Botanical gardens and their importance.
6. Important herbaria and botanical gardens of the world and India.
7. Nomenclature – Binomial nomenclature & its importance.
8. Classification – Definition & types with examples.
9. Artificial Classification – Linnaeus system of classification.
10. Natural Classification - Bentham and Hooker's classification up to series and its merits and demerits.
11. Phyllogenetic Classification - Hutchinson's classification with merits and demerits.
12. Taxonomic Key – Dichotomous key (Indented & Bracketed keys).
13. ICBN – Principles.

### Unit-II (Taxonomy-II)

1. Study of Angiospermic families (diagnostic characters, general characters and economic importance):
  - i. Poaceae
  - ii. Liliaceae
  - iii. Orchidaceae
  - iv. Magnoliaceae
  - v. Malvaceae
  - vi. Cucurbitaceae
  - vii. Solanaceae
  - viii. Lamiaceae
  - ix. Apocynaceae
  - x. Verbenaceae
  - xi. Rubiaceae
  - xii. Leguminosae
  - xiii. Brassicaceae
  - xiv. Asteraceae

## Paper-6B (Practical)

Total Mark = 50 (IA = 10 + ESE = 40) Credit = 02

Sl. No.	Practical	Marks
1.	Workout on Angiospermic plant	10
2.	Workout on Anatomy	08
3	Identification with reasons (4 x 2 marks)	08
4.	Spot identification of plants (3 x 1marks)	03
5.	Submission of Herbarium sheets	03
6.	Submission of Field Note Book	02
5.	Laboratory Note book	03
6.	<i>Viva voce</i>	03
<b>TOTAL</b>		<b>40</b>

- 1. Workout on Angiospermic plants:** Flower dissection, diagram of plant parts, floral diagram, description of plant, floral formula, identification of the family from the families included in the theory syllabus.
- 2. Work out on Plant Anatomy:** Study of Primary structures by preparing temporary slides of the following: **Monocot stem:** T. S. of *Canna* scape / T. S. of Maize stem, **Dicot stem:** T. S. of *Cucurbita* stem / T. S. of Sunflower stem, **Monocot root:** T. S. of Arum root / T. S. of Orchid root, **Dicot root:** T. S. of *Pisum* root, **Dorsiventral leaf:** T. S. of Mango leaf, **Isobilateral leaf:** T. S. of Bamboo leaf / T. S. of *Phoenix* leaf.
- 3. Identification:**
  - I. Inflorescence types:** Study from fresh or preserved specimens.
  - II. Flowers types:** Study of different types of flowers from fresh or preserved specimens- Achlamydeous, Monochlamydeous, Dichlamydeous, Actinomorphic, Zygomorphic flowers.
  - III. Corolla types:** Study of different types of corolla from fresh or preserved specimens- Cruciform, Rosaceous, Papilionaceous, Tubular, Campanulate, Hypocrateriform, Infundibuliform, and Bilabiate.
  - IV. Types of stamens:** Study of different types of stamens from fresh or preserved specimens - Monadelphous, Diadelphous, Polyadelphous, Syngenesious, Synandrous, Epipetalous, Gynandrous.
  - V. Types of placentation:** Study of different types of placentations.
  - VI. Types of fruits:** Study from fresh or preserved specimens.
  - VII. Minor anatomy:** Stomata types, Cystolith, Raphides, Starch grains, Laticiferous ducts.
  - VIII. Pathological specimens:** Name of the disease, Name of Pathogen, Identifying characters of - Brown spot of Rice, Late blight of Potato, Stem rot of Jute, Red rot of Sugarcane.
- 4. Spot identification:** Scientific names of common wild plants from the families included in theory syllabus.
- 5. Submission of Herbarium sheets:** At least 20 herbarium sheets must be submitted.



6. **Field Note book:** Students are required to go for at least one field study tour.
7. **Laboratory Records:** Student must get the laboratory note books duly signed by the respective teacher during practical classes.
8. **Viva voce:** Questions based on theory and practical syllabus of 2<sup>nd</sup> semester.

## SEMESTER-IV

### Paper-7 (Theory)

Total Mark = 100 (IA = 20 + ESE = 80) Credit = 04

#### Unit-I (Plant Ecology-I)

1. History and significant contributions of **Prof. Ramdeo Misra**.
2. Basic ecological concepts – (i) Trophic levels, (ii) Food chain & Food web, (iii) Ecological pyramids – Pyramids of Number, Biomass & Energy, (iv) Energy flow model.
3. Concept of Productivity – Primary & Secondary productivity.
4. Ecological Niche- (i) Definition of Niche, (ii) Types of Niche - Habitat, Trophic and Multidimensional niche, (iii) Fundamental and realized niche, (iv) Niche overlapping and concept of competitive exclusion, (v) resource partitioning, (vi) Ecological equivalent & Guild (definition).
5. Ecology of species- (i) Reproductive strategy (r and k selection), (ii) Interaction between species (competition, consumption, cooperation)
6. Population ecology- (i) Definition of population, (ii) population growth forms (J-shaped and S-shaped), (iii) Carrying capacity & Biotic potential (definition).

#### Unit-II (Plant Ecology-II)

1. Community ecology- (i) Definition of Biotic Community, (ii) Ecological Succession – Types of Succession (Primary and secondary, Allogenic & Autogenic, Autotrophic and Heterotrophic), Stages in successional process, Models of succession – Facilitation, Tolerance and Inhibition models, Concept of climax – (Characters of climatic vegetation, Monoclimax & Polyclimax theory).
2. Hydrosere and Xerosere.
3. Ecological adaptations of Hydrophytes, Xerophytes & Halophytes.
4. Ecotone and edge effect (only definition)
5. Soil - Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile, Types of soil water.
6. Biogeochemical cycles – C, N, and P cycle.

#### Unit-III (Natural Resource Management & Sustainable Development)

##### 1. Natural resource:

- i. Definition and types of Natural resource.
- ii. Sources of energy - Conventional & non-conventional.
- iii. Soil - degradation and management strategies and restoration of degraded lands.
- iv. Wetlands - major threats and management strategies.
- v. Forest - Causes of forest depletion and management strategies.
- vi. Wasteland reclamation.

##### 2. Sustainable development:

- i. Definition & concept of Sustainable Development.
- ii. Goals of sustainable development.
- iii. Organic farming (principle, advantages, & disadvantages).

- iv. Bio fertilizers (definition, examples & importance).
- v. Biofuels (concept, example, sources & importance).

#### **Unit-IV (Phytogeography)**

- 1. Principles of Phytogeography.
- 2. Concept of Continental drift & Theory of tolerance.
- 3. Theory of Island Biogeography.
- 4. Endemism - Definition, types, theories of endemism & factors responsible for endemism.
- 5. Phytogeographical regions of India (D. Chatterjee, 1960).
- 6. Vegetation of Eastern Himalaya, Western Himalaya & Sunderban.
- 7. Vegetation of Tripura.
- 8. Brief concept of major terrestrial Biomes (climatic and geographical conditions & major plant types) – Tropical Rain Forest, Tropical Savanna, Temperate Deciduous Forest, Grassland & Tundra.

## Paper-8A (Theory)

**Total Mark = 50 (IA = 10 + ESE = 40) Credit = 02**

### Unit-I (Biophysics & Plant Biochemistry-I)

1. Types of chemical bonds.
2. Structure and properties of water.
3. Solution – Percentage, Molar, & Normal solutions (definitions).
4. Acid, Base, pH, pKa, Buffer system & its types, Isoelectric point, Zwitterion.
5. Bioenergetics- Free Energy (definition) & standard Free Energy change ( $\Delta G^{\circ}$ ), Endergonic and Exergonic reaction.
6. Coupled reaction, ATP structure and importance.
7. Importance of NADH, NADPH & FADH<sub>2</sub>
8. Carbohydrates- Classification (monosaccharides, disaccharides, oligosaccharides and polysaccharides), Epimers & Anomers (definition), Reducing & non-Reducing sugars, Glycolipids & Glycoproteins.
9. Lipids: Types of fatty acids (saturated and unsaturated), Types of lipids - Simple, compound (phospholipids and glycolipids) and derived lipids.
10. Functions of Carbohydrates and Lipids.

### Unit-II (Biochemistry-II)

1. Proteins- (i) Types of amino acid & Essential amino acid (ii) Properties of peptide bond, (iii) Levels of protein structure - Primary, Secondary ( $\alpha$  helix,  $\beta$ -sheet &  $\beta$ -turn), Tertiary and Quaternary.
2. Classification of Proteins (Simple, Compound & Derived) & Functions of proteins.
3. Enzymes: (i) Structure (holoenzyme, apoenzyme, cofactor, coenzyme and prosthetic group) (ii) Active site – Properties, (iii) Classification of enzymes, (iv) Mechanism of enzyme action (activation energy, lock and key hypothesis, induced - fit theory), (v) Effect of substrate concentration and Michaelis - Menten equation, Concept of  $K_M$  value, (vi) Effect of temperature and pH, (vii) Enzyme inhibition-competitive, uncompetitive and noncompetitive (only definition), (viii) Allosteric enzymes – Definition and properties, (ix) Isozymes, (x) Ribozymes (definition).

## Paper-8B (Practical)

Total Mark = 50 (IA = 10 + ESE = 40) Credit = 02

Sl. No	Practicals	Marks
1.	Study of Ecological anatomy	08
2.	Study on properties of soil	08
3.	Preparation of map of Phytogeographical regions of India with plant name.	06
4.	Detection of Biochemical compound from unknown sample.	10
5.	Laboratory Note book	04
6.	<i>Viva voce</i>	04
<b>TOTAL</b>		<b>40</b>

- 1. Study of Ecological anatomy:** Hydrophytes (*Hydrilla* stem, *Nymphaea* petiole), Xerophytes (*Nerium* leaf).
- 2. Study on physical properties of soil:**
  - (a) Determination of pH of different types of soil by pH paper method.
  - (b) Determination of water holding capacity of soil samples.
  - (c) Determination of porosity of different soil samples.
- 3.** Preparation of map of Phytogeographical regions of India (D. Chatterjee, 1962) with plant name.
- 4. Biochemical detection:**
  - (a) **Detection of carbohydrates:** Glucose, Fructose, Sucrose & Starch.
  - (b) **Detection of organic acids:** Oxalic acid, Tartaric acid, Citric acid.
  - (c) **Detection of Proteins**
- 5. Laboratory Records:** Student must get the laboratory note books duly signed by the respective teacher during practical classes.
- 6. Viva voce:** Questions based on theory and practical syllabus of 4<sup>th</sup> semester.

## 3<sup>RD</sup> YEAR

### SEMESTER-V

#### Paper-9 (Theory)

**Total Mark = 100 (IA = 20 + ESE = 80) Credit = 04**

#### Unit-I (Cell Biology-I)

1. Origin of eukaryotic cell – endosymbiotic theory.
2. Ultra structure of cell wall.
3. Composition, structure and fluidity of plasma membrane.
4. Transport across plasma membrane.
5. Structure and function of Mitochondria and Chloroplast & their semiautonomous nature.
6. Structure and functions of ER, Golgi body, Ribosome, Peroxisome, Lysosome.

#### Unit-II (Cell Biology-II)

1. History and significant contributions of: **Prof. Arun Kr. Sharma.**
2. Structure of Nucleus and Nucleolus.
3. Structure of chromatin (Nucleosome concept and different levels of chromatin organization), Chromosome morphology, Properties of Centromere & Telomere.
4. Cell division- Cell cycle (different phases & their significance), Stages of Mitosis and Meiosis.
5. C-value, C-value paradox, Relation between chromosome number and C-value through different stages of Mitosis and meiosis.
6. Regulations of cell cycle – Cell cycle check points, Role of MPF in cell cycle regulation.

#### Unit-III (Plant Physiology-I)

1. Plant water relationship - Water Potential and its components, Pathway of water movement (symplast & apoplast), Ascent of sap–cohesion-tension theory.
2. Transpiration – Types of transpiration, mechanism of stomatal movement, antitranspirants.
3. Macro and Micronutrients – Mechanism of mineral absorption; Physiological roles and deficiency symptoms of macro nutrients.
4. Photosynthetic pigments, Structure of PSI and PSII, Photosynthetic electron transport, Photophosphorylation, Red drop, Emerson effect.
5. C<sub>3</sub> cycle, C<sub>4</sub> cycle, CAM.
6. Photorespiration.

#### Unit-IV (Plant Physiology-II)

1. Glycolysis, Oxidative decarboxylation, TCA cycle, Mitochondrial electron transport.
2. Pentose Phosphate pathway.
3. Nitrate assimilation, Biological N fixation (nodule formation, role of Nitrogenase and leg haemoglobin), function of *nif* and *nod* genes.
4. Plant hormones - Chemical nature, source and physiological roles of Auxin, Gibberellins, Cytokinin, Function of Abscisic acid, Ethylene.

5. Photoperiodism- Photoperiodic classification of plants, Phytochrome- Chemical nature, mode of action, role in flowering; Floral induction – role of Florigen.
6. Seed dormancy (Types, causes, methods of breaking seed dormancy).

## Paper-10A (Theory)

Total Mark = 50 (IA = 10 + ESE = 40) Credit = 02

### Unit-I (Genetics-I)

1. **Mendelian genetics** - Principles of segregation and independent assortment, Concept of Dominance, Incomplete dominance, Codominance, Multiple allele, Penetrance, Expressivity, Pleiotropism, Phenocopy effect and Atavism.
2. **Determining allelism of mutants** – complementation test, Concept of pseudoallele
3. **Gene interactions** with modified dihybrid ratios (12:3:1, 9:7, 9:3:4, 9:6:1, 13:3, 15:1).
4. **Cytoplasmic inheritance** - Features of cytoplasmic inheritance, Plastid inheritance- leaf colour in mirabilis, Mitochondrial inheritance - Poky & Petite mutation, Maternal effect- shell coiling in snail.
5. **Linkage & Crossing over** - Definitions of complete, incomplete, coupling phase and repulsion phase linkage, linkage group, Crossing over – definition and cytological basis (McClintock Experiment).
6. **Recombination** – Basic concept, Recombination frequency, Two point & Three point test cross, Gene mapping from three point test cross data, coefficient of correlation, interference.

### Unit-II (Genetics-II)

1. **Chromosomal aberration** - Numerical changes (aneuploidy and euploidy), Polyploidy types, Structural changes (definition and types of deletion, duplication, inversion and translocation).
2. **Sex determination** – Mechanism of sex determination in human and Drosophila.
3. **Sex linkage** – Sex linked inheritance, Dosage compensation & Lyon's hypothesis, Sex limited & Sex influenced traits, Problems on Sex linkage (Haemophilia & Colour blindness).
4. **Population genetics** – Concept of Gene pool, Allele frequency & Genotype frequency, Hardy-Weinberg law, Conditions for HW equilibrium, Factors affecting changes in gene frequency – Migration, Mutation, Selection & Genetic drift.
5. **Quantitative inheritance** - Characters and examples of quantitative traits and polygenic inheritance.



## Paper-10B (Practical)

Total Mark = 50 (IA = 10 + ESE = 40) Credit = 02

Sl. No	Practicals	Marks
1.	Work out on Mitotic stages	08
2.	Identification with reasons (3 x 2)	06
3.	Testing goodness of fit of modified di-hybrid ratios (12:3:1, 9:7, 9:3:4, 9:6:1, 13:3, 15:1)	08
4.	Plant Physiology experiment	10
5.	Laboratory Note book	04
5.	<i>Viva voce</i>	04
<b>TOTAL</b>		<b>40</b>

- 1. Work out on Mitotic study:** Temporary preparation of mitotic stages from the root tips of *Allium cepa*.
- 2. Biometry:** Determination of goodness of fit (chi square test) of modified di-hybrid ratios (12:3:1, 9:7, 9:3:4, 9:6:1, 13:3, 15:1)
- 3. Identification:** Study of different stages of Mitosis and Meiosis (Normal and /or Abnormal) from permanent slides.
- 4. Plant Physiological experiments:**
  - Comparison of imbibitions of water by Starchy, Proteinaceous and Fatty seeds.
  - Comparison of water loss in dorsiventral leaf by Cobalt Chloride method.
  - Relationship between transpiration and evaporation.
  - Separation of Chlorophyll pigments by paper chromatography.
  - Determination of released oxygen during photosynthesis.
  - Measurement of oxygen uptake by respiring tissue (per g/hr).
- 5. Laboratory Records:** Student must get the laboratory note books duly signed by the respective teacher during practical classes.
- 6. Viva voce:** Questions based on theory (paper 9 & 10A) and practical (paper 10B) syllabus of fifth semester.

## Paper-11 (Theory)

Total Mark = 100 (IA = 20 + ESE = 80) Credit = 04

### Unit-I (Molecular Biology-I)

1. History and significant contributions of: **Prof. H. G. Khorana**.
2. DNA structure (characters of double helix), types of DNA (A, B and Z forms).
3. Characters of mRNA, rRNA and tRNA.
4. Difference between prokaryotic and eukaryotic gene structure and between prokaryotic and eukaryotic mRNA.
5. Transposons and retrotransposons (only definition).
6. Organelle DNA - Mitochondria and Chloroplast DNA.
7. DNA replication (general properties – bidirectional, semi conservative, semi discontinuous, concept of replicon), DNA replication mechanism in *E. coli* (role of different enzymes and proteins, synthesis of leading and lagging strands).

### Unit-II (Molecular Biology-II)

1. Transcription- initiation, elongation and termination in *E. coli*.
2. Genetic code- properties, wobble concept.
3. Translation- amino-acylation of tRNA, initiation, elongation (peptidyltransferase reaction), and termination in *E. coli*.
4. Regulation of Gene expression in Prokaryotes - Operon model (general concept), lac-operon with its positive and negative control, trp-operon and attenuation.
5. Gene mutation - Base substitution and Frame shift mutation, Effect of UV rays, Base analogues, Alkylating agents, Intercalating agents and Deaminating agents.
6. DNA repair system – Photoreactivation, Mismatch repair, Excision repair.
7. Genomics & Proteomics – Brief idea.

### Unit-III (Plant Biotechnology-I)

1. Composition of plant tissue culture medium.
2. Sterilization technique.
3. Concept of Totipotency.
4. Micropropagation (process and importance).
5. Plant Regeneration - Concept of organogenesis and embryogenesis.
6. Haploid production through anther and pollen culture.
7. Embryo culture and its application.
8. Callus culture and its application.
9. Cell suspension culture.
10. Protoplast culture and somatic hybrid production.
11. Synthetic seed (definition and types).

#### Unit-IV (Plant Biotechnology-II)

1. Vector system: Cloning Vectors– Criteria for good vector, Plasmid vectors – pBR322, pUC19,  $\lambda$ -phage vector (Insertional & Replacement), Cosmid vector, Phagemid vector, BAC & YAC.
2. Enzymes in DNA cloning – Restriction endonuclease (Type I, II, III).
3. PCR – Basic principle, steps & application.
4. Construction of genomic library & Construction of cDNA library.
5. Screening of recombinant clones: Blue-White screening & Reporter Gene Assay (GFP).
6. Blotting techniques: Principles of Northern, Southern and Western Blotting.
7. Production of transgenic plant (Physical delivery and *Agrobacterium* mediated gene transfer).
8. Molecular DNA markers (RAPD, RFLP).

## Paper-12A (Theory)

**Total Mark = 50 (IA = 10 + ESE = 40) Credit = 02**

### Unit-I (Economic Botany-I)

1. Concept of Centres of Origin and their importance with reference to Vavilov's work - (Name of centers, countries included, & examples of crops originated).
2. Crop domestication – Definition of Domestication, Changes during domestication, Loss of genetic diversity.
3. Evolution of new crops/ varieties.
4. Importance of germplasm diversity.
5. Scientific name, family, part used, and uses of following plants: Cereal – Rice, Wheat; Pulses – Gram, Moong and Lens; Beverages – Tea and Coffee; Fruits – Mango, Citrus and Papaya; Drug yielding – Cinchona, Rauwolfia, Digitalis, Papaver, Andrographis; Spices – Ginger, Cumin and Clove; Oil yielding – Mustard, Groundnut, Coconut and Linseed; Vegetables – Potato, Radish and Cabbage; Fibre yielding – Cotton and Jute; Timber yielding – Teak and Sal; Sugar yielding– Sugarcane and Sugar beet; Others – Bamboo & Cane.
6. Active principles and medicinal use of Sarpagandha, Brahmi, Aswagandha & Liquorice.
7. Examples of plants (two each) as source of essential oil, tannin, gum, resin and dye.

### Unit-II (Economic Botany-II)

1. Rice cultivation (Rice growing seasons in India, Soil types for rice cultivation, Conventional method and SRI method with advantages and disadvantages).
2. Fibers - Classification based on the origin of fibres, Jute cultivation and processing.
3. Tea cultivation and processing (orthodox and CTC).
4. Rubber cultivation and processing.
5. Morphology and processing of sugarcane and products and by products of sugarcane industry.
6. Paper and Pulp Industry: Major raw materials for paper pulp, Manufacture of pulp and paper production.

## Paper-12B (Practical)

Total Mark = 50 (IA = 10 + ESE = 40) Credit = 02

Sl. No	Practicals	Marks
1.	Demonstration on aseptic explant preparation (from shoot tip and nodes) and aseptic inoculation of explants.	08
2.	Study of economically important plants (Scientific name, Family, Economically important part, and Uses) as per theory syllabus (4 x 3 marks)	12
3.	Comparative microscopic study of starch grains from different sources with staining – Pea seed, Banana fruit, Sweet potato tuber, Maize grain, Potato tuber	08
4.	Submission of economically important plant	04
5.	Laboratory Note book	04
5.	<i>Viva voce</i>	04
<b>TOTAL</b>		<b>40</b>

- 1. Demonstration on functioning of Autoclave, pH meter, Laminar Air Flow.**
- 2. Demonstration on sterilization technique.**
- 3. Demonstration of aseptic inoculation technique.**
- 4. Study of economically important plants (Scientific name, Family, Economically important part, and Uses)**
5. Comparative microscopic examination of different types of starch grains (Type – simple / compound, Shape, Position of hilum – concentric / excentric) from different sources – Pea seed, Banana fruit, Sweet potato tuber, Maize grain, Potato tuber.
6. Submission of economically important plants (herbarium specimen) [at least four].
- 7. Laboratory Records:** Student must get the laboratory note books duly signed by the respective teacher during practical classes.
- 8. Viva voce:** Questions based on theory (paper 11 & 12A) and practical (paper 12B) syllabus of fifth semester.

## SEMESTER-VI

### Paper-13 (Theory)

**Total Mark = 100 (IA = 20 + ESE = 80) Credit = 04**

#### Unit-I (Plant Breeding)

1. Aims of plant breeding.
2. Breeding methods: Plant introduction – Process, merits and demerits, Acclimatization.
3. Plant domestication – Changes in plants under domestication and loss of genetic diversity.
4. Mass selection, Pureline selection, Clonal selection.
5. Hybridization (different steps) & Production of synthetic variety.
6. Heterosis (definition, genetic and biochemical basis, importance in plant breeding) & Inbreeding depression.
7. Polyploidy – Types, Artificial induction of polyploidy, Effects of polyploidy on crop species, Role of polyploidy in plant breeding.

#### Unit-II (Biometry)

1. Presentation of statistical data – Concept of variable and attribute, Primary and Secondary data, Population and Sample.
2. Frequency and frequency distribution.
3. Graphical presentation of data – Bar diagram & Histogram, Pie chart.
4. Measures of central tendency (AM, Mode, Median).
5. Measures of dispersion (Mean deviation, SD, SE).
6. Test of significance – Null hypothesis and Alternate hypothesis, Degree of Freedom, Level of Significance, Student t-test, chi square test for Goodness of fit.
7. Simple Correlation and Coefficient correlation (r).
8. Definition of probability, Addition and Multiplication rule.

#### Unit-III (Horticultural Practices)

1. Green house – general construction and types.
2. Soilless plant culture - water culture (hydroponic culture) and substrate culture, Nutrient Film Technique (NFT).
3. Seed propagation – Seed structure and types, seed formation, germination types of seed, advantage & disadvantage of seed propagation, Direct and indirect seeding – advantages and disadvantages.
4. Seed production and certification process, Nuclear seed, Breeder seed, Foundation seed, Registered seed, Certified seed.
5. Asexual (vegetative) propagation – advantages and disadvantages.
6. Natural vegetative propagation (Bulbs, Corms, Tubers, Suckers, Rhizomes, Stolons).
7. Artificial vegetative propagation – Cutting (Stem cutting – softwood cutting, semi-hardwood cutting, hardwood cutting, Herbaceous cutting; Leaf cutting, Root cutting), Factors affecting rooting in cutting.
8. Artificial vegetative propagation – Grafting (Root stock, Scion, Inter stock, Detached scion grafting & Approach grafting), Healing of graft junction, Graft incompatibility – causes and method of overcoming.

9. Artificial vegetative propagation – Budding (T budding, Patch budding, Chip budding)
10. Artificial vegetative propagation – Layering (Tip layering, Simple layering, Trench layering, Serpentine layering, Air layering, Mould layering)

#### **Unit-IV (Floriculture & Gardening)**

1. Definition of Floriculture and importance & scope of Floriculture in India.
2. Ornamental plants – Flowering annuals, Herbaceous perennials, Divine vines, Shade trees, Ornamental trees, Ornamental bulbous plants, Ornamental foliage plants, Cacti & Succulents, Palms, Cycads & Ferns (Definition and three examples each from all the types).
3. Traditional flower & Cut flower (definition & example).
4. Important floricultural crops.
5. Factors affecting flower production (Quality of seed & planting material, Water, Soil, Temperature, Light, Nutrients, Diseases & pests).
6. Open cultivation practice of floricultural crops.
7. Production and packaging of cut flowers.
8. Cultivation of important cut flowers - Chrysanthemum, Tuberose & Marigold.
9. Brief concept of Bio-aesthetic planning.
10. Concept of Landscape gardening and definitions of Formal garden, Informal garden, Wild garden.
11. Concept of landscaping of cities and Educational institutions.

## Paper-14A (Theory)

Total Mark = 50 (IA = 10 + ESE = 40) Credit = 02

### Unit-I (Pharmacognosy)

1. A brief idea on ancient Indian knowledge of Botany and medicinal plants.
2. Definition of Pharmacognosy & Pharmacology.
3. Crude drug & Commercial drug.
4. Classification of drugs – Morphological, Chemical, & Pharmacological.
5. Preparation of crude drug for commercial market.
6. Drug adulteration (types).
7. Evaluation of drugs – Physical, Chemical, Organoleptic & Microscopical.
8. Anatomical characters, active principles and pharmacological effects – Leaf of *Adhatoda*, Rhizome of *Zingiber*, Bark of *Alstonia*, Tuber of *Dioscoria sp.*
9. Source, active constituents, and pharmacological uses of some common plants - *Datura*, *Catharanthus*, *Cassia*, *Aloe*, *Asparagus*, *Centella*, *Andrographis*, *Mentha*, *Ocimum*, *Ipomoea*, *Ricinus*, *Terminalia belerica*, *Terminalia chebula*

### Unit-II (Ethnobotany)

1. Definition, scope, objective and applications of Ethnobotany.
2. Methods of ethnobotanical studies – Field work, Herbarium, Ancient literature, Archaeological findings, Temples & sacred places.
3. Role of ethnic groups in the conservation of plant genetic resources.
4. Study of ethnobotanical plants of Tripura: Local name, Family, Brief description, Parts used, Ethnobotanical uses of -
  - i) **Food plants** - *Vigna unguiculata*, *Luffa cylindrical*, *Solanum violaceum*, *Solanum torvum*, *Canavalia gladiata*, *Parkia timoriana*, *Homalomena aromatic*, *Cajanas cajan*.
  - ii) **Medicinal plants** - *Hellenia speciosa*, *Andrographis paniculata*, *Oroxylum indicum*, *Holarrhena pubescens*, *Aristolochia tagala*, *Achyranthes aspera*.



## Paper-14B (Practical)

Total Mark = 50 (IA = 10 + ESE = 40) Credit = 02

Sl. No	Practicals	Marks
1.	Analysis of statistical data	10
2.	Demonstration of T-Budding / Air layering	06
3.	Study of powdered drugs OR Determination of stomatal index from leaf	10
4.	Study report on ethnobotanically important plants	06
5.	Laboratory Note book	04
5.	<i>Viva voce</i>	04
<b>TOTAL</b>		<b>40</b>

- 1. Statistical Data Analysis:** Mean, Mode, Median, SD, SE, t-test.
- Demonstration of T-Budding / Air layering.
- Organoleptic and microscopic study of powdered drugs - Leaf of *Adhatoda*, Rhizome of *Zingiber*, Bark of *Alstonia*, Tuber of *Dioscoria sp.*
- Determination of leaf constant stomatal index from leaf of *Adhatoda*.
- Self study of six (06) ethnobotanically important food / medicinal plants of the locality – the study should include common name, scientific name, family, habitat, growing season, morphology (along with photograph / free hand drawing), flowering season, part used, uses etc. and the duly signed study report must be submitted during practical exam.
- 6. Laboratory Records:** Student must get the laboratory note books duly signed by the respective teacher during practical classes.
- 7. Viva voce:** Questions based on theory (paper 13 & 14A) and practical (paper 14B) syllabus of fifth semester.

## Paper-15 (Theory)

Total Mark = 100 (IA = 20 + ESE = 80) Credit = 04

### Unit-I (Industrial & Applied Microbiology-I)

1. Fermentations - Solid-state and Liquid-state (stationary and submerged) fermentations, Batch and continuous fermentations.
2. Components of a typical bioreactor, Types of bioreactors- Stirred tank fermenter, Tower fermenter, Fixed bed and Fluidized bed bioreactors, Bubble Column fermenter, and Air-lift fermenter.
3. Microbial production of industrial products - Criteria for selection of microorganisms for industrial use.
4. Microbial sources and uses of Enzyme (Amylase, Protease), Amino acid (Glutamic acid, Lysine), Polysaccharides (Dextran).
5. Microbial enzymes of industrial interest – Enzyme immobilization (concept, process and advantages).

### Unit-II (Industrial & Applied Microbiology-II)

1. Vaccine (definition) & its types.
2. Use of microbes as Biofertilizer – Production of Rhizobium biofertilizer.
3. Production and use of yeasts.
4. Use of microbes as Biopesticides (microbial biopesticides).
5. Use of microbes in mineral processing (microbial leaching).
6. Microbial waste water treatment and Bioremediation of contaminated soils.
7. Microbial biosensors.

### Unit-III (Algal Biotechnology)

1. Algae as food (foods from macro algae – Nori, Wakame, Kombu).
2. Algae as a source of SCP and cultivation of *Spirulina*.
3. Large scale production of algal biomass – Open system & Photobioreactor, Harvesting of algal biomass (dewatering) – Flocculation, Electrolysis, Gravity sedimentation, Magnetic separation, Filtration, Evaporation.
4. Algae as source of phycocolloid – source & use of Agar-agar, Algin, Carrageenan.
5. Algal Biotechnology –  $\beta$ -carotene, Biodiesel, Bioethanol, and Bio plastics from algae.
6. Diatomite & its use.
7. Algal toxins.

### Unit-IV (Applied Mycology)

1. Cheese and Ethanol- industrial production.
2. Nutritional value and cultivation of *Volvariella volvacea*, *Pleurotus sp*, and *Agaricus bisporus*.
3. Fungal sources and uses of enzyme (Cellulase), amino acid (Tryptophan), vitamin (Riboflavin) and pharmaceuticals (Cyclosporine-A).
4. Industrial production of Penicillin.
5. Industrial production of Citric acid.
6. Mycotoxins – source and effects.
7. Mycofungicides, Mycoherbicides, Mycoinsecticides.

## **Paper 16A (Theory)**

**Total Mark = 50 (IA = 10 + ESE = 40) Credit = 02**

### **Unit-I (Palynology)**

1. Pollen wall structure in Angiosperms and Difference between angiosperm & gymnosperm pollen wall.
2. Sporopollenin – Definition, chemical nature and function.
3. NPC classification (Erdtman, 1969) of pollen based on aperture – number, position and characters.
4. Types of sculpturing of pollen surface – (Psilate, Clavate, Reticulate, Scabrate, Echinate, Baculate, Verrucate, Rugulate, Foveolate, Gemmate, Striate & Frustillate).
5. Pollen viability – Definition, Causes of loss of pollen viability, Factors affecting pollen viability.
6. Application of Palynology.
7. Paleo-palynology –Application in Stratiography, Paleoclimate & Hydrocarbon exploration.

### **Unit-II (Biodiversity & its Conservation)**

1. Definition, Levels of Biodiversity – Genetic diversity, species diversity & Ecosystem diversity.
2. Values and uses of Biodiversity.
3. Agrobiodiversity (definition and concept).
4. Causes of biodiversity loss - Loss of Genetic diversity, Loss of Species diversity, Loss of Ecosystem diversity, Loss of Agrobiodiversity.
5. Conservation strategies (in situ and ex situ).
6. Social approaches to conservation.
7. Cryopreservation (brief idea).
8. Biodiversity Hotspots & Mega diversity countries.
9. IUCN, Red data Book.

## Paper-16B (Practical)

Total Mark = 50 (IA = 10 + ESE = 40) Credit = 02

Sl. No	Practicals	Marks
1.	Study of pollen sterility & fertility OR Study of in vitro pollen germination	08
2.	Study of Plant community parameters (Frequency, Density, Abundance & Relative abundance) from vegetation map by Quadrature method [any two]	08
3.	Study of amylase activity by starch-iodine method OR Gram staining of <i>Rhizobium</i> from root nodule of leguminous plants.	08
4.	Submission of report on visit to local mushroom cultivation laboratory / unit	08
5.	Laboratory Note book	04
6.	<i>Viva voce</i>	04
<b>TOTAL</b>		<b>40</b>

- 1. Study of pollen sterility & fertility by acetocarmine staining.**
- 2. Study of in vitro pollen germination.**
3. Study of amylase activity by starch-iodine method.
4. Gram staining of *Rhizobium* from root nodule of leguminous plants.
- 5. Study of Plant community parameters** (Frequency, Density, Abundance & Relative abundance) from vegetation map by Quadrature method.
6. Self visit to local mushroom cultivation laboratory / unit and duly signed report with geo-tagged photographs should be submitted during practical exam.
- 7. Laboratory Records:** Student must get the laboratory note books duly signed by the respective teacher during practical classes.
- 8. Viva voce:** Questions based on theory (paper 15 & 16A) and practical (paper 14B) syllabus of fifth semester.



**Tripura University**  
(A Central University)

**Course Structure of Botany (UG Programme)**  
**As per NEP-2020 under Tripura University**

**BOTANY GENERAL (MINOR)**

Year	Semester	Paper	Credit	Total marks	Unit-I	Unit-II	Unit-III
1 <sup>st</sup>	1 <sup>st</sup>	Paper – 1A Theory	3	75 (IA=15 + ESE=60)	Microbiology	Algae	Fungi
		Paper-1B Practical	1	25 (IA=05 + ESE=20)	Based on theory paper 1A		
	2 <sup>nd</sup>	Paper-2A Theory	3	75 (IA=15 + ESE=60)	Bryophyta	Pteridophyta	Gymnosperm & Paleobotany
		Paper-2B Practicals	1	25 (IA=05 + ESE=20)	Based on theory paper 2A		
2 <sup>nd</sup>	3 <sup>rd</sup>	Paper-3A Theory	3	75 (IA=15 + ESE=60)	Phytopatholog y	Morphology & Embryology	Plant Anatomy
		Paper 3B Practicals	1	25 (IA=05 + ESE=20)	Based on theory paper 3A		
	4 <sup>th</sup>	Paper-4A Theory	3	75 (IA=15 + ESE=60)	Taxonomy	Ecology	Phytogeograph y
		Paper 4B Practicals	1	25 (IA=05 + ESE=20)	Based on theory paper 4A		
3 <sup>rd</sup>	5 <sup>th</sup>	Paper-5A Theory	3	75 (IA=15 + ESE=60)	Biochemistry	Plant Physiology	Evolution
		Paper 5B Practicals	1	25 (IA=05 + ESE=20)	Based on theory paper 5A		
	6 <sup>th</sup>	Paper-6A Theory	3	75 (IA=15 + ESE=60)	Cell Biology	Molecular Biology	Genetics
		Paper 6B Practicals	1	25 (IA=05 + ESE=20)	Based on theory paper 6A		
4 <sup>th</sup>	7 <sup>th</sup>	Paper-7A Theory	3	75 (IA=15 + ESE=60)	Biometry	Plant Breeding	Economic Botany
		Paper 7B Practicals	1	25 (IA=05 + ESE=20)	Based on theory paper 7A		
	8 <sup>th</sup>	Paper-8A Theory	3	75 (IA=15 + ESE=60)	Plant Biotechnology	Pharmacognos y	Biodiversity & Sustainable development
		Paper-8B Practicals	1	25 (IA=05 + ESE=20)	Based on theory paper 8A		

**DETAILED COURSE CONTENT OF  
BOTANY GENERAL (MINOR)**

# 1<sup>st</sup> YEAR

## Semester-I

### 1st Paper-BOT E1A (Theoretical)

Full marks-75 (Internal assessment-15; End Sem. Exam.-60)

#### Unit-1: Microbiology

1. **Virus:** General properties of plant virus and Bacteriophage, Structure of DNA virus (T4 phage); Lytic and lysogenic cycle; Structure of RNA virus (TMV).
2. **Bacteria:** General characters of bacteria; Morphological forms, Cell structure (in detail), Bacterial reproduction- binary fission and endospore formation, Genetic recombination in bacteria - (transformation, transduction and conjugation).

#### Unit-2: Phycology

1. General characters of Algae - Thallus organization, Pigments, Outline classification of Lee (1999) up to phylum with characters, Economic importance of algae. *Spirulina* cultivation, Salient features of Cyanophyceae, Chlorophyceae, Phaeophyceae and Rhodophyceae.
2. Life history of the following: *Nostoc*, *Oedogonium*, *Ectocarpus* and *Polysiphonia*.
3. Bacillariophyceae (Diatom)- Cell structure, reproduction and economic importance.

#### Unit-3: Fungi

1. General characters of Fungi including fungal mode of nutrition, Classification of Fungi (Ainsworth, 1973) up to sub-division with diagnostic characters and examples; Economic importance of fungi.
2. General account of Phycomycetes, Ascomycetes, Basidiomycetes, & Duteromycetes.
3. General characters of Myxomycetes.
4. Life history of *Rhizopus*, *Penicillium* & *Agaricus*.
5. Mushroom production and harvesting (*Volvoriella* sp. and *Pleurotus* sp).

## Paper-BOTE1B (Practical)

Full marks-25 (Internal assessment-05; End Sem. Exam.-20)

Sl. No.	Practical	Marks
1.	Workout on Microbiology	05
2.	Workout on Algae or Workout on Fungi	05
3	Identification with reasons (2 x 2 marks)	4
4.	Laboratory Note book	3
5.	<i>Viva voce</i>	3
<b>TOTAL</b>		<b>20</b>

### CONTENTS:

1. Use of Simple and Compound microscope.
2. **Work out on Microbiology:**
  - (a) Gram staining of bacterial population from curd.
  - (b) Demonstration of Sterilization process.
3. **Work out of the following algal genera** with reproductive structures (Free hand drawing only): *Nostoc* sp., *Oedogonium* sp., *Ectocarpus* sp., *Polysiphonia* sp.

**Or**

**Work out of the following Fungi** with reproductive structures (Free hand drawing): *Rhizopus* sp., *Penicillium* sp., *Agaricus* sp., *Polyporus* sp.
4. **Identifications:**
  - a) **Permanent slides of Algae:** *Nostoc*, *Volvox* colony, *Oedogonium* dwarf male, *Polysiphonia* – cystocarp & tetrasporophyte.
  - b) **Permanent slides of Fungi:** Zygosporangium of *Rhizopus*, Conidiophore of *Penicillium*, T.S. of gills of *Agaricus*, T.S. of basidiocarp of *Polyporus*.
  - c) **Macro specimen** - Fruitbody of *Agaricus*, *Polyporus*.
5. **Laboratory Records:** Student must get the laboratory note books duly signed by the respective teacher during practical classes.
6. **Viva voce:** Questions based on theory and practical syllabus of 1<sup>st</sup> semester.



## Semester-II

### 2<sup>nd</sup> Paper- BOTE2A (Theoretical)

Full marks-75 (Internal assessment-15; End Sem. Exam.-60)

#### Unit-1: Bryophyta

1. General characters including Amphibian nature; Origin of Bryophyta.
2. Distinctive features of three major groups – Hepaticopsida, Anthocerotopsida, & Bryopsida.
3. Life history: Gametophyte structure & reproduction, development and structure of sporophyte in of *Riccia*, *Marchantia*, *Anthoceros*, and *Funaria*.

#### Unit-2: Pteridophyta:

1. General characters, Lifecycle pattern (Homosporous & Heterosporous type).
2. Outline classification (Sporne, 1975) up to order with examples.
3. Important characters of the classes – Psilophytopsida, Psilotopsida, Lycopsidea, Sphenopsida, Pteropsida.
4. Life history: Sporophyte structure, reproduction and structure of gametophyte of *Lycopodium*, *Selaginella*, *Equisetum*, and *Pteris*.

#### Unit-3: Gymnosperms and Paleobotany

##### Gymnosperms:

- i. Gymnosperms - General characters.
- ii. Outline classification (Sporne, 1965) up to Order with examples.
- iii. Important characters of three classes – Cycadopsida, Coniferopsida, & Gnetopsida.
- iv. Economic importance of Gymnosperms with reference to Wood, Resins, Essential oils, and Drugs.
- v. Life cycle (Morphology, anatomy and reproduction) of *Cycas*, *Pinus* and *Gnetum*.

##### Paleobotany:

- i. Definition of fossil, Conditions required for fossilization, Fossilization process.
- ii. Types of fossil (Microfossil, Mega fossil and its types on the basis of nature of fossilization); Modes of preservation (after Schopf, 1975).
- iii. Importance of fossil study.
- iv. Geological Time scale with dominant plant groups through ages.

## Paper-BOTE2B (Practical)

Full marks-25 (Internal assessment-05; End Sem. Exam.-20)

Sl. No.	Practical	Marks
1.	Workout on Pteridophyta	05
2.	Workout on Gymnosperm	05
3	Identification with reasons (2 x 2 marks)	4
4.	Laboratory Note book	3
5.	<i>Viva voce</i>	3
<b>TOTAL</b>		<b>20</b>

### CONTENTS:

#### 1. Work out on:

- (a) **Pteridophytes:** Workout on reproductive structures of the following Pteridophytes: *Lycopodium* sp., *Selaginella* sp., *Equisetum* sp., *Pteris* sp.
- (b) **Gymnosperms:** Leaflet of *Cycas* sp, Needle leaf of *Pinus* sp., Microsporophyll of *Cycas* sp.

#### 2. Identification:

- (a) **Study of Bryophytes from permanent slides** – *Riccia* (V.S. of thallus), *Marchantia* (L.S. of: Gemma cup, antheridiophore, archegoniophore, sporophyte), *Anthoceros* (L.S. of sporophyte), *Funaria* (L.S. capsule).
- (b) **Study of macroscopic structures of Gymnosperm:** *Cycas* microsporophylls, *Cycas* megasporophyll, *Pinus* male cone, *Pinus* female cone, *Gnetum* male cone, *Gnetum* female cone.
- (c) **Study of Gymnosperms from permanent slides** – L.S. of *Cycas* ovule, L.S. of *Pinus* male cone, L.S. of *Pinus* female cone, Pollen grains of *Pinus*, L.S. of *Gnetum* male cone, L.S. of *Gnetum* female cone/ovule.
- (d) Study from permanent slides/macroscopic fossil specimen.

**3. Laboratory Records:** Student must get the laboratory note books duly signed by the respective teacher during practical classes.

**4. Viva voce:** Questions based on theory and practical syllabus of 2<sup>nd</sup> semester.

## 2<sup>nd</sup> YEAR

### Semester-III

#### 3<sup>rd</sup> Paper- BOTE3A (Theoretical)

Full marks-75 (Internal assessment-15; End Sem. Exam.-60)

#### Unit-1: Phytopathology

1. Terms and concepts (Infection, disease, Pathogen, Pathogenicity, Pathogenesis, Incubation period, Symptom, Necrotroph, Inoculum, Inoculum potential, Causal complex, Disease cycle, Endemic disease, Epidemic disease, Sporadic disease); Koch's postulates, Types of symptoms (Necrotic, Atrophic, Hypertrophic); Plant quarantine.
2. Symptoms, Casual organisms, Disease cycle and Control measures of the following diseases: Late blight of Potato, Brown sport of Rice, Black stem rust of Wheat.

#### Unit 2: Morphology and embryology

1. Root- Types and modification.
2. Leaf – Types, Shape of lamina, Apex, Margin, Phyllotaxy, Venation, Stipule types.
3. Inflorescence - types with examples.
4. Flower - Flower types, Floral parts- Calyx (types & modifications), Corolla (types & forms), Aestivation; Stamens (types, cohesion and adhesion); Carpel (Apocarpous and Syncarpous), Ovary (types), Style (types) Placentation types.
5. Fruits- types.
6. Seed types and their dispersal.
7. Microsporogenesis, Megasporeogenesis (types – monosporic, bisporic & tetrasporic).
8. Process of double fertilization.
9. Embryo development (dicot & monocot type),
10. Endosperm development – Nuclear, Cellular & Hellobial types.

#### Unit-3: Plant Anatomy

1. Cell wall (Chemical composition & Gross structure).
2. Meristematic tissue: General characters & Classification.
3. Permanent tissue (structure, distribution and function).
4. Cell types of Xylem and Phloem, Vascular bundles – Types; Stele – Types.
5. General anatomical characters of monocot stem and root, Dicot stem and root, Dorsiventral and isobilateral leaf.
6. Normal secondary growth in dicot stem and root.

## Paper-BOTE3B (Practical)

Full marks-25 (Internal assessment-05; End Sem. Exam.-20)

Sl. No.	Practical	Marks
1.	Workout on Anatomy	06
2.	Identification with reasons (4 x 2 marks)	08
3.	Laboratory Note book	03
4.	<i>Viva voce</i>	03
<b>TOTAL</b>		<b>20</b>

### CONTENTS:

- 1. Work out on Plant Anatomy:** Study of Primary structures by preparing temporary slides of the following: **Monocot stem:** T. S. of *Canna* scape / T. S. of Maize stem, **Dicot stem:** T. S. of *Cucurbita* stem / T. S. of Sunflower stem, **Monocot root:** T. S. of Arum root / T. S. of Orchid root, **Dicot root:** T. S. of *Pisum* root, **Dorsiventral leaf:** T. S. of Mango leaf, Isobilateral leaf: T. S. of Bamboo leaf / T. S. of *Phoenix* leaf.
- 2. Identification:**

**Types of placentation:** Study of different types of placentation.

**Types of fruits:** Study from fresh or preserved specimens.

**Minor anatomy:** Types of Stomata, Cystolith, Raphides, Starch grains.

**Pathological specimens (fresh or preserved):** Name of the disease, Name of Pathogen, symptoms, Identifying characters of – Late blight of Potato, Brown sport of Rice, Black stem rust of Wheat.
- 3. Laboratory Records:** Student must get the laboratory note books duly signed by the respective teacher during practical classes.
- 4. Viva voce:** Questions based on theory and practical syllabus of 2<sup>nd</sup> semester.

## Semester-IV

### 4<sup>th</sup> Paper- BOTE4A (Theoretical)

Full marks-75(Internal assessment-15; End Sem. Exam.-60)

#### Unit 1: Plant Taxonomy

1. Components of Plant taxonomy (identification, nomenclature, classification).
2. Elementary knowledge of ICN- Principles.
3. Herbaria and Botanical Gardens – their role in teaching and research & important Herbaria and Botanical Gardens of India and world (3 each).
4. History of Plant classification: Artificial (Linnaeus), Natural (Bentham & Hooker) and Phylogenetic (Hutchinson).
5. Study of the following families: Poaceae, Orchidaceae, Magnoliaceae, Leguminosae (with sub- families Caesalpiniaceae, Mimosaceae, Papilionaceae), Cucurbitaceae, Brassicaceae, Solanaceae, Apocynaceae, Lamiaceae, Rubiaceae and Asteraceae.

#### Unit-2: Plant Ecology

1. Soil- Origin, Formation, Composition, Physical and Chemical properties, Soil types; Water – Types of soil water.
2. Basic ecological concepts (Trophic levels, Food chain, Food web, Ecological pyramids, Energy flow, Production and Productivity).
3. Habitat and Ecological niche.
4. Succession - Hydrosere and Xerosere.
5. Adaptations of Hydrophytes, Xerophytes and Halophytes.
6. Biogeochemical cycles - Cycling of Carbon and Nitrogen.
7. Endemism; Red Data book.

#### Unit-3: Phytogeography:

1. Phytogeographical regions of India (D. Chatterjee, 1960),
2. Vegetations of Eastern Himalaya, Western Himalaya, Sunderban, and Tripura.
3. Endemism - Definition, types, theories of endemism & factors responsible for endemism.

## Paper-BOTE4B (Practical)

Full marks-25 (Internal assessment-05; End Sem. Exam.-20)

Sl. No.	Practical	Marks
1.	Workout on Angiospermic plant	06
2.	Workout on Ecological anatomy	04
3	Spot identification of plants (2 x 1 marks)	02
4.	Submission of Herbarium sheets	02
5.	Laboratory Note book	03
6.	<i>Viva voce</i>	03
<b>TOTAL</b>		<b>20</b>

### CONTENTS:

- 1. Workout on Angiospermic plants:** Flower dissection, diagram of plant parts, floral diagram, description of plant, floral formula, identification of the family from the families included in the theory syllabus.
- 2. Study of Ecological anatomy:** Hydrophytes (*Hydrilla* stem, *Nymphaea* petiole), Xerophytes (*Nerium* leaf).
- 3. Spot identification:** Scientific names of common wild plants from the families included in theory syllabus.
- 4. Submission of Herbarium sheets:** At least 15 herbarium sheets must be submitted.
- 5. Laboratory Records:** Student must get the laboratory note books duly signed by the respective teacher during practical classes.
- 6. Viva voce:** Questions based on theory and practical syllabus of 4<sup>th</sup> semester.

## 3<sup>rd</sup> YEAR

### Semester-V

#### 5<sup>th</sup> Paper- BOTE5A (Theoretical)

Full marks-75 (Internal assessment-15; End Sem. Exam.-60)

#### Unit-1: Biochemistry:

1. Water molecule – general properties.
2. Carbohydrates – Classification with example.
3. Lipids – Classification with example & function.
4. Proteins - Levels of protein structure, Classification of proteins with example and biological roles.
5. Nucleic acids - Types of DNA and RNA; Enzymes: General properties and classification with examples.

#### Unit-2: Plant Physiology

1. Water potential and its components and their relation, Osmosis, Plasmolysis.
2. Water absorption by roots (Apoplastic and Symplastic pathways), Ascent of sap - Cohesion-tension theory.
3. Transpiration and antitranspirant.
4. Photosynthesis: Structure of PSI and PSII, Photosynthetic electron transport (Cyclic & non-cyclic), C3 cycle, C4 cycle, CAM cycle.
5. Glycolysis, Oxidative decarboxylation, TCA cycle, Mitochondrial electron transport, Oxidative Phosphorylation and ATPsynthesis.
6. Photorespiration; Photoperiodism: Photoperiodic responses and classification of plants.
7. Source, physiological role and mode of action of IAA, Gibberellins and Cytokinins.
8. Nitrogen metabolism: Biological N<sub>2</sub> fixation (nodule formation, role of Nitrogenase and leg hemoglobin), function of *nif* and *nod* genes.

#### Unit-3: Evolution

1. Origin of life.
2. Biological species concept, Modes of speciation (Allopatric, Peripatric, Parapatric, & Sympatric); Natural selection - Definition and types (Directional, Stabilizing, Disruptive).
3. Macro and Micro evolution (definition).
4. Darwinism and its limitations, Neo Darwinism (only brief idea).

**Paper-BOTE5B (Practical)**

**Full marks-25 (Internal assessment-05; End Sem. Exam.-20)**

<b>Sl. No</b>	<b>Practical</b>	<b>Mark</b>
<b>1.</b>	Detection of Biochemical compound from unknown sample.	<b>04</b>
<b>2.</b>	Plant Physiology experiment	<b>10</b>
<b>3.</b>	Laboratory Note book	<b>03</b>
<b>4.</b>	<i>Viva voce</i>	<b>03</b>
<b>TOTAL</b>		<b>20</b>

**CONTENTS:**

**1. Biochemical compound detection:**

**(a) Detection of the nature of carbohydrate:** Glucose, Fructose, Sucrose & Starch.

**(b) Detection of organic acids:** Oxalic acid, Tartaric acid, Citric acid.

**2. Plant Physiological experiments:**

i. Comparison of imbibitions of water by Starchy, Proteinaceous and Fatty seeds.

ii. Comparison of water loss in dorsiventral leaf by Cobalt Chloride method.

iii. Relationship between transpiration and evaporation.

iv. Separation of Chlorophyll pigments by paper chromatography.

v. Determination of released oxygen during photosynthesis (ml/gm/hr).

vi. Measurement of oxygen uptake by respiring tissue (per gram/hour).

**3. Laboratory Records:** Student must get the laboratory note books duly signed by the respective teacher during practical classes.

**4. Viva voce:** Questions based on theory and practical syllabus of 5<sup>th</sup> semester.



## Semester-VI

### 6<sup>th</sup> Paper- BOTE6A (Theoretical)

Full marks-75 (Internal assessment-15; End Sem. Exam.-60)

#### Unit-1: Cell biology:

1. Composition and structure of Plasma membrane.
2. Structural organization and functions of Mitochondria, Chloroplast, Endoplasmic reticulum, Ribosome, Semiautonomous nature of Mitochondria and Chloroplast.
3. Structure of Nucleus; Chromosome morphology and organization of eukaryotic chromosome (Nucleosome concept), Euchromatin and Heterochromatin, Telomere & Centromere.
4. Cell cycle – Various phases & events (G1, S, G2, M), Cell division- Stages of Mitosis & Meiosis.

#### Unit-2: Molecular biology:

1. Nucleoside and Nucleotide, DNA structure (Watson & Crick model).
2. Central Dogma of molecular biology.
3. DNA replication - General properties & DNA replication mechanism in prokaryotes.
4. Transcription- Initiation, Elongation and Termination in prokaryotes.
5. Genetic code- Properties.
6. Translation in prokaryotes.
7. Regulation of Gene expression in Prokaryotes - Operon model (general concept), mechanism of lac-operon.
8. Gene mutation- Base substitution (Transition & Transversion) and Frame shift mutation.

#### Unit-3: Genetics

1. Mendelian genetics-Principles of segregation and independent assortment; Concept of Dominance, Incomplete dominance, Codominance.
2. Gene interactions with modified dihybrid ratios (12:3:1, 9:7, 9:3:4, 9:6:1, 13:3, 15:1).
3. Definition of Penetrance, Expressivity, Pleiotropism, Phenocopy effect.
4. Linkage (definition of complete, incomplete, coupling phase and repulsion phase linkage, linkage group) and Crossing over.
5. Chromosomal aberration- Numerical changes (aneuploidy and euploidy), Polyploidy types, Structural changes (definition and types of deletion, duplication, inversion and translocation).

**Paper-BOTE6B (Practical)**

**Full marks-25(Internal assessment-05; End Sem. Exam.-20)**

<b>Sl. No</b>	<b>Practical</b>	<b>Mark</b>
<b>1.</b>	Work out on Mitotic stages	<b>08</b>
<b>2.</b>	Identification with reasons (3 x 2)	<b>06</b>
<b>3.</b>	Laboratory Note book	<b>03</b>
<b>4.</b>	<i>Viva voce</i>	<b>03</b>
<b>TOTAL</b>		<b>20</b>

**CONTENTS:**

- 1. Work out on Mitotic study:** Temporary preparation of mitotic stages from directly fixed root tips of *Allium cepa*.
- 2. Identification:** Study of different stages of Mitosis and Meiosis (Normal and /or Abnormal) from permanent slides.
- 3. Laboratory Records:** Student must get the laboratory note books duly signed by the respective teacher during practical classes.
- 4. Viva voce:** Questions based on theory and practical syllabus of sixth semester.

## 4<sup>th</sup> YEAR

### Semester-VII

#### 7<sup>th</sup> Paper- BOTE7A (Theoretical)

**Full marks-75 (Internal assessment-15; End Sem. Exam.-60)**

##### **Unit-1: Biometry:**

1. Presentation of statistical data – Concept of variable and attribute, Primary and Secondary data, Population and Sample, Frequency and frequency distribution, Graphical presentation of data – Bar diagram & Histogram, Pie chart.
2. Measures of central tendency (Mean, Mode, Median).
3. Measures of dispersion (Mean deviation, SD, SE).
4. Test of significance – Null hypothesis and Alternate hypothesis, Degree of Freedom, Level of Significance, Student t-test, chi square test for Goodness of fit.

##### **Unit-2: Plant Breeding**

1. Aims of plant breeding.
2. Methods of plant breeding: Plant introduction, Acclimatization, Plant domestication.
3. Selection-Mass selection, Pureline selection, Clonal selection.
4. Hybridization (different steps) & Production of synthetic variety.
5. Heterosis (definition, genetic and biochemical basis, importance in plant breeding) & Inbreeding depression.
6. Male sterility (definition, types, importance in plant breeding).

##### **Unit-3: Economic Botany**

1. Scientific name, family, part used, and uses of following plants: **Cereal** – Rice, Wheat; **Pulses** – Gram, Moong and Lens; **Beverages** – Tea and Coffee; **Fruits** – Mango, Citrus and Papaya; **Drug yielding** – Cinchona, Rauwolfia, Digitalis, Papaver, Andrographis; **Spices** – Ginger, Cumin and Clove; **Oil yielding** – Mustard, Groundnut, Coconut and Linseed; **Vegetables** – Potato, Radish and Cabbage; **Fibre yielding** – Cotton and Jute; **Timber yielding** – Teak and Sal; **Sugar yielding** – Sugarcane.
2. Rice cultivation- Conventional method & SRI system.
3. Jute Cultivation and processing.
4. Tea cultivation and processing (orthodox & CTC methods)

**Paper-BOTE7B (Practical)**

**Full marks-25 (Internal assessment-05; End Sem. Exam.-20)**

<b>Sl. No</b>	<b>Practical</b>	<b>Mark</b>
<b>1.</b>	Testing goodness of fit of modified di-hybrid ratios (12:3:1, 9:7, 9:3:4, 9:6:1, 13:3, 15:1)	<b>08</b>
<b>2.</b>	Study of economically important plants (Scientific name, Family, Economically important part, and Uses) as per theory syllabus (2 x 3 marks)	<b>06</b>
<b>3.</b>	Laboratory Note book	<b>03</b>
<b>4.</b>	<i>Viva voce</i>	<b>03</b>
<b>TOTAL</b>		<b>20</b>

**CONTENTS:**

- 1. Biometry:** Determination of goodness of fit (chi square test) of modified di-hybrid ratios(12:3:1, 9:7, 9:3:4, 9:6:1, 13:3, 15:1).
- 2. Study of economically important plants** (Scientific name, Family, Economicallyimportant part, and Uses of the prescribed syllabus).
- 3. Laboratory Records:** Student must get the laboratory note books duly signed by therespective teacher during practical classes.
- 4. Viva voce:** Questions based on theory and practical syllabus of seventh semester.

**Semester-VIII**  
**8<sup>th</sup> Paper- BOTE8A (Theoretical)**

**Full marks-75 (Internal assessment-15; End Sem. Exam.-60)**

**Unit-1: Plant Biotechnology**

1. Totipotency and concept of plant tissue culture.
2. Function and organization of a typical plant tissue culture laboratory.
3. Composition of plant tissue culture medium.
4. Techniques of plant tissue culture: Callus culture, Cell suspension culture technique, Haploid culture and embryo culture.
5. Definition of micropropagation and importance.
6. Definition of Recombinant DNA technology.
7. Enzymes in DNA cloning – Restriction endonuclease (Type I and II).
8. Definition of cDNA library and Genomic library.
9. Criteria for good Vector, Brief concept of cloning Vectors (plasmid, lambda phage, YAC).
10. Production of transgenic plant: *Agrobacterium* mediated gene transfer.

**Unit-2: Pharmacognosy**

1. Definition of Pharmacognosy & Pharmacology, Crude drug & Commercial drug.
2. Classification of drugs – Morphological, Chemical, & Pharmacological.
3. Preparation of crude drug for commercial market.
4. Drug adulteration (types).
5. Evaluation of drugs – Physical, Chemical, Organoleptic & Microscopical.
6. Anatomical characters, active principles and pharmacological effects – Leaf of *Adhatoda*, Rhizome of *Zingiber*, Bark of *Alstonia*, Tuber of *Dioscoria sp.*

**Unit-3: Biodiversity & Sustainable development**

1. Definition, Levels of Biodiversity – Genetic diversity, species diversity & Ecosystem diversity.
2. Values and uses of Biodiversity.
3. Agro-biodiversity (definition and concept).
4. Causes of biodiversity loss - Loss of Genetic diversity, Loss of Species diversity, Loss of Ecosystem diversity, Loss of Agro-biodiversity.
5. Definition & concept of Sustainable Development, Goals of sustainable development.
6. Organic farming (principle, advantages, & disadvantages), Bio fertilizers (definition, examples & importance), Biofuels (concept, example, sources & importance).

## Paper-BOTE8B (Practical)

Full marks-25 (Internal assessment-05; End Sem. Exam.-20)

Sl. No	Practical	Mark
1.	Demonstration on aseptic explant preparation (from shoot tip and nodes) and aseptic inoculation of explants.	06
2.	Study of powdered drugs	08
3.	Laboratory Note book	03
4.	<i>Viva voce</i>	03
<b>TOTAL</b>		<b>20</b>

### CONTENTS:

1. Demonstration on functioning of Autoclave, pH meter, Laminar Air Flow.
2. Demonstration on sterilization technique.
3. Demonstration of aseptic inoculation technique.
4. Organoleptic and microscopic study of powdered drugs - Leaf of *Adhatoda*, Rhizome of *Zingiber*, Bark of *Alstonia*, Tuber of *Dioscoria sp.*
5. **Laboratory Records:** Student must get the laboratory note books duly signed by the respective teacher during practical classes.
6. **Viva voce:** Questions based on theory and practical syllabus of 8<sup>th</sup> semester.

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2. Hogg, S. (2013), Essential Microbiology, 2<sup>nd</sup> Edition, Wiley-Blackwell.
3. Pelczar, M.J. (2001), Microbiology, 5<sup>th</sup> edition, Tata McGraw-Hill Co, New Delhi.
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5. Sharma P. D. (1999), Microbiology and Plant Pathology, Rastogi Publications, Meerut, UP.

## Phycology

1. Kumar, H.D. (1999), Introductory Phycology, 2<sup>nd</sup> edition, Affiliated East-West Press, Delhi.
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