Tripura University

(A Central University)
Suryamaninagar
West Tripura

Syllabus for

Four Years Undergraduate Programme

Subject: Botany (Major)

(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	Credits	Mark	Unit - I	Unit - II	Unit-III	Unit-IV
1st	1st BT101C	Paper-1 Theory	4	100 (IA=40 + ESE=60)	Microbiology-I	Microbiology-II	Phycology-I	Phycology-II
	1st BT102C	Paper-2A Theory	2	60 (IA=24 + ESE=36)	Mycology-I	Mycology-II	Mycology-III	Lichen, Myxomycetes & Mycorrhiza
		Paper-2B Practical	2	40 (IA=16 + ESE=24)	*Based on Theory paper 1 & 2A*			
	2nd BT201C	Paper-3 Theory	4	100 (IA=40 + ESE=60)	Bryophyta	Pteridophyta	Gymnosperms	Basic Paleobotanical Principles
	2nd BT202C	Paper-4A Theory	2	60 (IA=24 + ESE=36)	Fossil Plants-I	Fossil Plants-II	Principles of Organic Evolution-I	Principles of Organic Evolution-II
		Paper-4B Practicals	2	40 (IA=16 + ESE=24)	*Based on Theory paper 3 & 4A*			
2nd	3rd BT301C	Paper-5 Theory	4	100 (IA=40 + ESE=60)	Elementary Phytopathology	Angiosperm Morphology	Plant anatomy	Embryology
	3rd BT302C	Paper-6A Theory	2	60 (IA=24 + ESE=36)	Taxonomy-I	Taxonomy-II	Monocot Families	Dicot Families
		Paper 6B Practicals	2	40 (IA=16 + ESE=24)	*Based on theory paper 5 & 6A*			
	4th BT401C	Paper-7 Theory	4	100 (IA=40 + ESE=60)	Plant Ecology-I	Plant Ecology-II	Natural Resource Management & Sustainable Development	Phyto-geography
	4th BT402C	Paper-8A Theory	2	60 (IA=24 + ESE=36)	Biophysics	Biochemistry-I	Biochemistry-II	Biochemistry-III
		Paper 8B Practicals	2	40 (IA=16 + ESE=24)	*Based on theory paper 7 & 8A*			
3rd	5th BT-501C	Paper-9 Theory	4	100 (IA=40 + ESE=60)	Cell biology-I	Cell Biology-II	Plant Physiology-I	Plant Physiology-II
	5th BT502C	Paper-10A Theory	2	60 (IA=24 + ESE=36)	Genetics-I	Genetics-II	Genetics-III	Genetics-IV
		Paper 10B Practicals	2	40 (IA=16 + ESE=24)	*Based on theory paper 9 & 10A*			
	5th BT503C	Paper-11 Theory	4	100 (IA=40 + ESE=60)	Molecular Biology-I	Molecular Biology-II	Molecular Biology-III	Plant Biotechnology-I
	5th BT504C	Paper-12A Theory	2	60 (IA=24 + ESE=36)	Plant Biotechnology-II	Plant Biotechnology-III	Economic Botany-I	Economic Botany-II
		Paper 12B	2	40	*Based on theory paper 11 & 12A*			

		Practicals		(IA=16 + ESE=24)				
	6th BT601C	Paper-13 Theory	4	100 (IA=40 + ESE=60)	Plant Breeding	Biometry	Horticultural Practices-I	Horticultural Practices-II
	6th BT602C	Paper-14A Theory	2	60 (IA=24 + ESE=36)	Floriculture & Gardening-I	Floriculture & Gardening-II	Pharmacognosy	Ethnobotany
		Paper 14B Practicals	2	40 (IA=16 + ESE=24)	*Based on theory papers 13 & 14A*			
	6th BT603C	Paper-15 Theory	4	100 (IA=40 + ESE=60)	Industrial and Applied Microbiology-I	Industrial and Applied Microbiology-II	Algal Biotechnology	Applied Mycology
	6th BT604C	Paper-16A Theory	2	60 (IA=24 + ESE=36)	Palynology	Biodiversity and its Conservation-I	Biodiversity and its Conservation-II	Biodiversity and its Conservation-III
		Paper 16B Practicals	2	40 (IA=16 + ESE=24)	*Based on theory papers 15 & 16A*			
4th	**7th BT701C**	Paper-17 Theory	4	100 (IA=40 + ESE=60)	*	*	*	*
	7th BT702C	Paper-18A Theory	2	60 (IA=24 + ESE=36)	*	*		
		Paper 18B Practicals	2	40 (IA=16 + ESE=24)	*Based on theory papers 17 & 18A*			
	7th BT703C	Paper-19 Theory	4	100 (IA=40 + ESE=60)	*	*	*	*
	7th BT704C	Paper-20A Theory	2	60 (IA=24 + ESE=36)	*	*		
		Paper-20B Practicals	2	40 (IA=16 + ESE=24)	*Based on theory papers 19 & 20A*			
	8th BT801C	Paper-21 Theory	4	100 (IA=40 + ESE=60)	*	*	*	*
	8th BT802C	Paper-22A Theory	2	60 (IA=24 + ESE=36)	*	*		
		Paper-22B Practicals	2	40 (IA=16 + ESE=24)	*Based on theory papers 21 & 22A*			
	8th BT803C	Paper-23 Theory	4	100 (IA=40 + ESE=60)	*	*	*	*
	8th BT804C	Paper-24A Theory	2	60 (IA=24 + ESE=36)	*	*		
		Paper-24B Practicals	2	40 (IA=16 + ESE=24)	*Based on theory papers 23 & 24A*			

***Has been added after 3rd year (6th semester)**

DETAILED COURSE CONTENT OF BOTANY MAJOR

1st YEAR

Botany (Major)

SEMESTER-I

Paper- 1 (Theory)

BT-101C- Microbiology & Phycology

Total Marks = 100 (IA = 40 + ESE = 60) **(Credits = 04)**

Unit-I: Microbiology-I

1. Significant contributions of Indian Plant Virologist: Pothur Sreenivasulu.
2. Carl Richard Woese's three domain system of classification.
3. **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.
4. **Virus:** Nature of virus particles, Definition of Virion, Viroid, Prion & Satellite viruses; General structure of Virus particles - Forms of viral capsids (Helical & icosahadral), 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).
5. Transmission and translocation of Plant virus.
6. **Mycoplasma –** Definition & structure, Mycoplasmal plant diseases (examples).
7. **Actinomycetes –** Definition, general characters & Economic importance.

Unit-II: Microbiology-II

1. Significant contributions of Indian Plant Bacteriologist: P. Gunasekaran.
2. **Bacteria:** 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 (Generalized & Specialized) and Conjugation (F-factor, F^+ x F^-, Hfr x F^-).
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).

Unit-III: Phycology-I

1. Significant contributions of Indian Phycologists: Prof. M. O. P. Iyengar.
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.

Botany (Major)

SEMESTER-I

Paper- 2A (Theory)

BT-102C- Mycology, Lichen, Myxomycetes & Mycorrhiza

Total Marks = 60 (IA = 24 + ESE = 36) **(Credits = 02)**

Unit-I: Mycology-I

1. Significant contributions 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, Chlamydospores & 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, Zygospores & Oospores.

Unit-II: Mycology-II

1. **Classification of Fungi** (Ainsworth, 1973) up to sub-division.
2. **Important characteristics of important fungal groups** –
   i. Mastigomycotina.
   ii. Zygomycotina.
   iii. Ascomycotina (including types of ascocarps and development of ascus and ascospores),
   iv. Basidiomycotina (including types and development of basidia and basidiospores).
   v. Deuteromycotina (including types of spores).

Unit-III: Mycology-III

1. Structure, reproduction &life cycle of following fungal genera –
   i) *Rhizopus*
   ii) *Saccharymyces*
   iii) *Ascobolous*
   iv) *Penicillium*
   v) *Agaricus*
   vi) *Fusarium.*

Unit-IV: Lichen, Myxomycetes & Mycorrhiza

1. **Lichens:** General characters - morphological types, internal structure & reproduction; Ecological and economic importance of lichens.
2. **Myxomycetes:** General characters, Types of Plasmodia, Types of Fruiting bodies.
3. **Mycorrhiza:** Types of Mycorrhizal association, Role of Mycorrhizal fungi in agriculture and Forestry.

Botany (Major)

SEMESTER-I

Paper-2B (Practical)

BT-102C

Total Marks = 40 (IA = 16 + ESE = 24) **(Credits = 02)**

Sl. No.	Practical	Marks
1.	Workout on Microbiology	**05**
2.	Workout on Algae	**06**
3	Workout on Fungi	**06**
4.	Identification with reasons (2 x 1½marks)	**03**
5.	Laboratory Note book	**02**
6.	*Viva voce*	**02**
TOTAL		**24**

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:** Zygospore 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 1st semester.

Botany (Major)
SEMESTER-II

Paper-3 (Theory)

BT-201C- Bryophyta, Pteridophyta, Gymnosperms & Basic Paleobotany

Total Marks = 100 (IA = 40 + ESE = 60) **(Credits = 04)**

Unit-I: Bryophyta

1. Significant contributions of Indian Bryologist: Prof. Shiv Ram Kashyap.
2. General characters of Bryophytes.
3. Bryophyta - Adaptations to land habit.
4. Outline Classification - (Crandall-Stotler and Stotler, 2000) up to class.
5. Distinctive features of three major groups – Liverworts (Phyllum: Marchantiophyta), Hornworts (Phyllum: Anthocerotophyta), and Mosses (Phyllum: Bryophyta).
6. Importance of Bryophyta – Ecological significance & economic importance of bryophytes.
7. Gametophyte structure, Reproduction, Development and Structure of sporophyte, Spore dispersal of *Riccia, Marchantia, Anthoceros, Funaria.*

Unit-II: Pteridophyta

1. General characters of Pteridophytes.
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, Lycopsida, 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. Significant 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.

Botany (Major)

SEMESTER-II

Paper- 4A (Theory)

BT-202C- Fossil Plants & Principles of Organic Evolution

Total Marks = 60 (IA = 24 + ESE = 36) **(Credits = 02)**

Unit-I: Fossil Plants - I

1. Study of the following fossil plants:
   i. *Rhynia*
   ii. *Lepidodendron*
   iii. *Calamites*
   iv. Paleozoic seed fern - *Lyginopteris*
   v. Mesozoic seed fern - *Caytonia*

Unit-II: Fossil Plants - II

1. Study of the following fossil plants:
   i. *Willimsonia*
   ii. *Pentoxylon*
   iii. *Cordaites*
2. Indian Gondwana flora system - Three fold division with major megafossil assemblages.

Unit-III: Principles of Organic Evolution-I

1. Origin of life (Oparin-Haldane concept, Urey-Miller experiment, RNA world hypothesis, Protein first model, Origin of proto cells – Sydney Fox's experiment, Proteinoids, Microspheres & Coacervates).
2. Species Concept – Morphological, Ecological, Evolutionary & Biological species concept.
3. Reproductive isolation - Definition and types (pre zygotic & post zygotic isolating mechanisms).
4. Modes of speciation (Allopatric, Peripatric, Parapatric, & Sympatric).
5. Phyletic gradualism, Punctuated equilibrium and Stasis.

Unit-IV: Principles of Organic Evolution-II

1. Natural selection - Definition and types (Directional, Stabilizing, Disruptive).
2. Darwinism and its limitations.
3. Neo Darwinism (only brief idea).
4. Sexual selection and Group selection (definition).
5. Coevolution – Definition and example.
6. Macro and Micro evolution (definition).
7. Adaptive radiation and convergence.

Botany (Major)

SEMESTER-II

Paper-4B (Practical)
BT-202C

Total Marks = 40 (IA = 16 + ESE = 24) **(Credits = 02)**

Sl. No.	Practical	Marks
1.	Workout on Pteridophyta	**06**
2.	Workout on Gymnosperm	**05**
3	Identification with reasons (4 x 2 marks)	**08**
4.	Laboratory Note book	**02**
5.	*Viva voce*	**03**
TOTAL		**24**

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.

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 2nd semester.

2ND YEAR

Botany (Major)

SEMESTER-III

Paper- 5 (Theory)

BT-301C- Phytopathology, Angiosperm Morphology, Plant Anatomy & Embryology

Total Marks = 100 (IA = 40 + ESE = 60) **(Credits = 04)**

Unit-I: Elementary Phytopathology

1. Significant contributions 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), Pathogenecity, 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. **Flower -** Types of flower, complete general morphology of flower, types of aestivation, Placentation types.
5. **Fruit -** Types of fruit.
6. **Seed -** 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).

Botany (Major)
SEMESTER-III
Paper- 6A (Theory)
BT-302C- Taxonomy

Total Marks = 60 (IA = 24 + ESE = 36) **(Credits = 02)**

Unit-I: Taxonomy-I

1. Significant contributions 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.

Unit-II: Taxonomy-II

1. Classification – Definition & types with examples.
2. Artificial Classification – Linnaeus system of classification.
3. Natural Classification - Bentham and Hooker's classification up to series and its merits and demerits.
4. Phyllogenetic Classification - Hutchinson's classification with merits and demerits.
5. Taxonomic Key – Dichotomous key (Indented & Bracketed keys).
6. ICN – Principles.

Unit-III: Monocot families:

1. Study of Angiospermic families (diagnostic characters, general characters and economic importance):
   - **i.** Poaceae
   - **ii.** Liliaceae
   - **iii.** Orchidaceae
   - **iv.** Arecaceae
   - **v.** Musaceae
   - **vi.** Cannaceae
   - **vii.** Zingiberaceae

Unit-IV: Dicot families:

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

Botany (Major)
SEMESTER-III
Paper-6B (Practical)
BT-302C

Total Marks = 40 (IA = 16 + ESE = 24) **(Credits = 02)**

Sl. No.	Practical	Marks
1.	Workout on Angiospermic plant	**07**
2.	Workout on Anatomy	**05**
3.	Identification with reasons (2 x 1½ marks)	**03**
4.	Spot identification of plants (2 x 1marks)	**02**
5.	Submission of Herbarium sheets	**1 ½**
6.	Submission of Field Note Book	**1 ½**
7.	Laboratory Note book	**02**
8.	*Viva voce*	**02**
TOTAL		**24**

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, Polydelphous, 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 3rd semester.

Botany (Major)

SEMESTER-IV

Paper-7 (Theory)

BT-401C- Plant Ecology, Natural Resource Management & Phytogeography

Total Marks = 100 (IA = 40 + ESE = 60) **(Credits = 04)**

Unit-I: Plant Ecology-I

1. 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 (Solar, Wind, Hydel, Geothermal, Tidal and Nuclear energy); Basic concept of energy plantation.
   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, 1962).
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.

Botany (Major)

SEMESTER-IV

Paper-8A (Theory)

BT-402C- Biophysics & Biochemistry

Total Marks = 60 (IA = 24 + ESE = 36) **(Credits = 02)**

Unit-I: Biophysics

1. Types of chemical bonds.
2. Structure and properties of water.
3. Solution – Percentage, Molar, & Normal solutions (definitions).
4. Colloids – Definition, Types (Sol, Gel, Emulsion, Soliosol, Aerosol & Foam) and properties of colloids.
5. Acid, Base, pH, pKa, Buffer system & its types, Isoelectric point, Zwitterion.
6. Diffusion (definition) & Fick's law of diffusion.
7. Osmosis and Osmotic pressure (definition & van't Hoff Laws).
8. Viscosity (definitions) and Factors for viscosity of liquids (Density, Temperature, Solute concentration & Size and shape of solute particles).
9. Surface tension (definition).

Unit-II: Biochemistry –I (Fundamental & Carbohydrate Biochemistry)

1. Bioenergetics- Free Energy (definition) & standard Free Energy change (ΔG^o), Endergonic and Exergonic reaction.
2. Coupled reaction, ATP structure and importance.
3. Importance of NADH, NADPH & $FADH_2$.
4. Carbohydrates- Classification (monosaccharides, disaccharides, oligosaccharides and polysaccharides).
5. L and D stereoisomerism, Epimers & Anomers (definition), Reducing &Non-reducing sugars.
6. Modification of monosaccharides – Amino sugar, Uronic acid.
7. Chemical nature of important polysaccharides – Starch, Glycogen, Cellulose & Chitin.
8. Glycolipids & Glycoproteins (O-linked & N-linked).
9. Functions of Carbohydrates.

Unit-III: Biochemistry-II (Lipid Biochemistry)

1. Types of fatty acids (saturated and unsaturated); cis-double bond & trans-double bond in unsaturated fatty acids; PUFA & MUFA.
2. Properties of fatty acids – Esterification, Hydrogenation, Halogenation.
3. Types of lipids - Simple, compound (phospholipids, glycolipids & lipoproteins) and derived lipids.
4. Properties of fats – Emulsification, Saponification, Rancidity.
5. Characterizing fats – Saponification number, Iodine number.
6. Cholesterol – Chemical nature and function (in plants).
7. Micelle, Lipid bilayer & Liposome (definition / brief idea).
8. Functions of Lipids.

Unit-IV: Biochemistry-III (Protein Biochemistry & Enzymes)

1. **Proteins**- (i) Types of amino acid & Essential amino acid (ii) Properties of peptide bond, (iii) Levels of protein structure - Primary, Secondary (α helix, β-sheet & β-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).

Botany (Major)

SEMESTER-IV

Paper-8B (Practical)

BT-402C

Total Marks = 40 (IA = 16 + ESE = 24) **(Credits = 02)**

Sl. No	Practicals	Marks
1.	Study of Ecological anatomy	**05**
2.	Study on properties of soil	**04**
3.	Preparation of map of Phytogeographical regions of India with plant name.	**04**
4.	Detection of Biochemical compound from unknown sample.	**05**
5.	Laboratory Note book	**03**
6.	*Viva voce*	**03**
TOTAL		**24**

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^{th} semester.

3rd YEAR

Botany (Major)

SEMESTER-V

Paper-9 (Theory)

BT-501C- Cell Biology & Plant Physiology

Total Marks = 100 (IA = 40 + ESE = 60) **(Credits = 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 Endoplasmic reticulum, Golgi body, Ribosome, Peroxisome, and Lysosome.

Unit-I: Cell Biology-II

1. 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, Emmerson effect.
5. C3 cycle, C4 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).

Botany (Major)

SEMESTER-V

Paper-10A (Theory)

BT-502C- Genetics

Total Marks = 60 (IA = 24 + ESE = 36) **(Credits = 02)**

Unit-I: Genetics-I

1. **Mendelian genetics** - Principles of segregation and independent assortment, Concept of Dominance, Incomplete dominance, Codominance, Multiple allele, Penetrance, Expressivity, Pleotropism, Phenocopy effect and Atavism.
2. **Determining allelism of mutants** – Complementation test; Definition of Cistron, Muton & Recon; Concept of pseudoallele; Fine structure of gene – Structure of phage rII locus.
3. **Gene interactions** with modified dihybrid ratios (12:3:1, 9:7, 9:3:4, 9:6:1, 13:3, 15:1)**.**

Unit-II: Genetics-II

1. **Cytoplasmic inheritance** - Features of cytoplasmic inheritance, Plastid inheritance- leaf colour in mirabilis, Mitochondrial inheritance - Poky & Petite mutation, Maternal effect- shell coiling in snail.
4. **Linkage & Crossing over** - Definitions of complete, incomplete, coupling phase and repulsion phase linkage, linkage group, Crossing over – definition and cytological basis (McClintock Experiment).
5. **Recombination** – Basic concept, Recombination frequency, Two point & Three point test cross, Gene mapping from three point test cross data, coefficient of correlation, interference**.**

Unit-III: Genetics-III

1. **Chromosomal aberration** - Numerical changes (aneuploidy and euploidy), Polyploidy types; Structural changes - Definition and types of Deletion, Duplication, Inversion and Translocation; Meiotic behaviour of inversion and translocation heterozygotes; Position Effect.
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).

Unit-IV: Genetics-IV

1. **Population genetics** – Concept of Gene pool, Allele frequency & Genotype frequency, Hardy-Weinberg law, Conditions for HW equilibrium, Numerical problems based on HW equation.
2. **Factors affecting changes in gene frequency** – Migration, Mutation, Selection & Genetic drift **(**definition and effects on gene frequency**).**
3. **Quantitative inheritance** - Characters of quantitative traits, Heritability – Narrow sense & Broad sense Heritability; Polygenic inheritance – Regulation of kernel colour in wheat.

Botany (Major)

SEMESTER-V

Paper-10B (Practical)

BT-502C

Total Marks = 40 (IA = 16 + ESE = 24) **(Credits = 02)**

Sl. No	Practicals	Marks
1.	Work out on Mitotic stages	**05**
2.	Identification with reasons (2 x 1 ½)	**03**
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)	**04**
4.	Plant Physiology experiment	**08**
5.	Laboratory Note book	**02**
5.	*Viva voce*	**02**
TOTAL		**24**

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:**
   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.
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.

Botany (Major)

SEMESTER-V

Paper-11 (Theory)

BT-503C- Molecular Biology & Plant Biotechnology-I

Total Marks = 100 (IA = 40 + ESE = 60) **(Credits = 04)**

Unit-I: Molecular Biology-I

1. 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 (including clover leaf structure of tRNA).
4. Gene structure in prokaryotes and eukaryotes, structure of prokaryotic and eukaryotic mRNA (concept of monocistronic & polycistronic mRNA).
5. Transposable genetic elements – Bacterial IS element, Transposons and retrotransposons (only definition).
6. Organelle DNA - Mitochondria and Chloroplast DNA (properties and structure).

Unit-II: Molecular Biology-II

1. 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).
2. Transcription- initiation, elongation and termination in *E. coli*.
3. Genetic code - Properties, wobble concept.
4. Translation - Amino-acylation of tRNA, initiation, elongation (peptidyltransferase reaction), and termination in *E. coli*.

Unit-III: Molecular Biology-III

1. Regulation of Gene expression in Prokaryotes - Operon model (general concept), lac-operon with its positive and negative control, arabinose operon, trp-operon and attenuation.
2. Gene mutation - Base substitution and Frame shift mutation, Effect of UV rays, Base analogues, Alkylating agents, Intercalating agents and Deaminating agents.
3. DNA repair system – Photoreactivation, Mismatch repair, Excision repair.

Unit-IV: Plant Biotechnology-I

1. Totipotency and concept of Plant Tissue Culture, Function and organization of Plant tissue culture laboratory.
2. Composition of plant tissue culture medium.
3. Sterilization technique.
4. Different growth regulators used in plant tissue culture and their role.
5. Micropropagation – process (stages) and importance.
6. Plant Regeneration - Concept of organogenesis and embryogenesis (direct and indirect).
7. Callus culture and its application.
8. Cell suspension culture.

Botany (Major)

SEMESTER-V

Paper-12A (Theory)

BT-504C- Plant Biotechnology-I & II and Economic Botany

Total Marks = 60 (IA = 24 + ESE = 36) **(Credits = 02)**

Unit-I: Plant Biotechnology-II

1. Definition of 'Androgenesis' and 'Androgenic Haploids'; Haploid production through anther and pollen culture with advantages and disadvantages; Production of diploids from haploids; Application of Haploids.
2. Embryo culture and its application.
3. Protoplast culture technique and somatic hybrid production; Application of Protoplast culture.
4. Synthetic seed (definition and types).

Unit-II: Plant Biotechnology-III

1. Vector system: Cloning Vectors– Criteria for good vector, Plasmid vectors – pBR322, pUC19, λ-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, principle of RTPCR.
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).

Unit-III: 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. Process of 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.

Unit-IV: 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.

Botany (Major)
SEMESTER-V
Paper-12B (Practical)
BT-504C

Total Marks = 40 (IA = 16 + ESE = 24) **(Credits = 02)**

Sl. No	Practicals	Marks
1.	Demonstration on aseptic explant preparation (from shoot tip and nodes) and aseptic inoculation of explants.	**07**
2.	Study of economically important plants (Scientific name, Family, Economically important part, and Uses) as per theory syllabus (2 x 3 marks)	**06**
3.	Comparative microscopic study of starch grains from different sources with staining – Pea seed, Banana fruit, Sweat potato tuber, Maize grain, Potato tuber	**05**
4.	Submission of economically important plant	**02**
5.	Laboratory Note book	**02**
5.	*Viva voce*	**02**
TOTAL		**24**

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, Sweat potato tuber, Maize grain, Potato tuber.

6. Submission of economically important plants (herbarium/ specimen) [at least six].

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.

Botany (Major)

SEMESTER-VI

Paper-13 (Theory)

BT-601C- Plant Breeding, Biometry & Horticultural Practices

Total Marks = 100 (IA = 40 + ESE = 60) **(Credits = 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 (Arithmetic mean, Median, Mode).
5. Measures of dispersion (Mean deviation, Standard deviation, Standard error).
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 of correlation (r).
8. Definition of probability, Addition and Multiplication rule.

Unit-III: Horticultural Practices-I

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.

Unit-IV: Horticultural Practices-II

1. Natural vegetative propagation (Bulbs, Corms, Tubers, Suckers, Rhizomes, Stolons).
2. Artificial vegetative propagation – Cutting (Stem cutting – softwood cutting, semi-hardwood cutting, hardwood cutting, Herbaceous cutting; Leaf cutting, Root cutting), Factors affecting rooting in cutting.
3. 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.
4. Artificial vegetative propagation – Budding (T budding, Patch budding, Chip budding)
5. Artificial vegetative propagation – Layering (Tip layering, Simple layering, Trench layering, Serpentine layering, Air layering, Mould layering)

Botany (Major)

SEMESTER-VI

Paper-14A (Theory)

BT-602C- Floriculture & Gardening, Pharmacognosy and Ethnobotany

Total Marks = 60 (IA = 24 + ESE = 36) **(Credits = 02)**

Unit-I: Floriculture & Gardening-I

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).

Unit-II: Floriculture & Gardening-II

1. Open cultivation practice of floricultural crops.
2. Production and packaging of cut flowers.
3. Cultivation of important cut flowers - Chrysanthemum, Tuberose & Marigold.
4. Brief concept of Bio-aesthetic planning.
5. Concept of Landscape gardening and definitions of Formal garden, Informal garden, Wild garden.
6. Concept of landscaping of cities and Educational institutions.

Unit-III: 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-IV: 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*.

Botany (Major)
SEMESTER-VI
Paper-14B (Practical)
BT-602C

Total Marks = 40 (IA = 16 + ESE = 24) **(Credits = 02)**

Sl. No	Practicals	Marks
1.	Analysis of statistical data	**06**
2.	Demonstration of T-Budding / Air layering	**04**
3.	Study of powdered drugs OR Determination of stomatal index from leaf	**06**
4.	Study report on ethnobotanically important plants	**04**
5.	Laboratory Note book	**02**
5.	*Viva voce*	**02**
TOTAL		**24**

1. Statistical Data Analysis: Mean, Mode, Median, SD, SE, t-test.

2. Demonstration of T-Budding / Air layering.

3. Organoleptic and microscopic study of powdered drugs - Leaf of *Adhatoda*, Rhizome of *Zingiber*, Bark of *Alstonia*, Tuber of *Dioscoria sp.*

4. Determination of leaf constant stomatal index from leaf of *Adhatoda*.

5. Self study of five (05) 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.

Botany (Major)
SEMESTER-VI
Paper-15 (Theory)
BT-603C- Industrial & Applied Microbiology & Algal Biotechnology

Total Marks = 100 (IA = 40 + ESE = 60) **(Credits = 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 – β-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. Definition and example of Mycofungicides, Mycoherbicides, Mycoinsecticides.

Botany (Major)
SEMESTER-VI
Paper 16A (Theory)

BT-604C- Palynology & Biodiversity

Total Marks = 60 (IA = 24 + ESE = 36) **(Credits = 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, and 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-I

1. Definition of Biodiversity, Levels of Biodiversity – Genetic diversity, species diversity, Ecosystem diversity, and Landscape diversity.
2. Species richness, Species Abundance, Species Evenness, α-diversity, β-diversity & γ-diversity (only definitions).
3. Biodiversity Hotspots & Mega diversity countries.
4. Values and uses of Biodiversity.
5. Agrobiodiversity (definition); Mono-culture (definition & effect) and Poly culture (definition & benefits).
6. Germplasm (Definition), Categories of plants under germplasm (Land races, Obsolete varieties, Cultivated varieties, Breeding lines and Wild forms & Wild relatives).
7. Gene pool (definition); Categories of Gene Pool - Primary, Secondary and Tertiary Gene Pool (only definition).

Unit-III: Biodiversity & its Conservation-II

1. **Causes of biodiversity loss –**
   (i) **Loss of Genetic diversity** (Factors for loss of Genetic diversity – Founder effect, Demographic bottleneck, Genetic drift, Inbreeding depression).
   (ii) **Loss of Species diversity** (processes responsible for species loss & population size and its relation to species extinction).
   (iii) **Loss of Ecosystem diversity** (Factors responsible for loss of Ecosystem diversity).
2. **IUCN Categories** – Extinct, Endangered, Vulnerable, Rare & Indeterminate.
3. **Functions of important organizations associated with Biodiversity management** – IUCN, UNEP, WWF, FAO, and UNESCO-MAB.

Unit-IV: Biodiversity & its Conservation-III

1. Conservation strategies – Top-down and Bottom-up approaches.
2. In situ conservation – Protected area, Biosphere reserve, National Park.
3. Ex situ conservation – Botanical garden, Seed bank (Active & Base collection), Field gene bank, Pollen bank, DNA bank, Test tube gene bank.
4. Social approaches to conservation – Sacred Groves, Participatory Forest management.
5. Role of Biotechnology in conservation of Biodiversity; Cryopreservation (Principle & brief idea).

Botany (Major)
SEMESTER-VI
Paper-16B (Practical)
BT- 604C

Total Marks = 40 (IA = 16 + ESE = 24) **(Credits = 02)**

Sl. No	Practicals	Marks
1.	Study of pollen sterility & fertility	**07**
2.	Study of Plant community parameters (Frequency, Density, Abundance & Relative abundance) from vegetation map by Quadrate method [any two]	**07**
3.	Submission of report on visit to local mushroom cultivation laboratory / unit	**04**
4.	Laboratory Note book	**03**
5.	*Viva voce*	**03**
TOTAL		**24**

1. Study of pollen sterility & fertility by acetocarmine staining.

2. Study of Plant community parameters (Frequency, Density, Abundance & Relative abundance) from vegetation map by Quadrate method.

3. Self visit to local mushroom cultivation laboratory / unit and duly signed report with geo-tagged photographs should be submitted during practical exam.

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 (paper 15 & 16A) and practical (paper 16B) syllabus of fifth semester.

Course Structure of Botany Major 4th Year
(As per NEP-2020 under Tripura University)

Botany Major (4th YEAR)

Year	Semester	Paper	Credits	Mark	Unit - I	Unit - II	Unit-III	Unit-IV
4th	7th BT701C	Paper-17 Theory	4	100 (IA=40 + ESE=60)	Advanced Cryptogamic Botany-I	Advanced Cryptogamic Botany-II	Fungal Biology	Modern Plant Pathology - I
	7th BT702C	Paper-18A Theory	2	60 (IA=24 + ESE=36)	Modern Plant Pathology - II	Modern Plant Pathology - III	Plant Secondary Metabolism-I	Plant Secondary Metabolism-II
		Paper 18B Practicals	2	40 (IA=16 + ESE=24)	*Based on theory papers 17 & 18A*			
	7th BT703C	Paper-19 Theory	4	100 (IA=40 + ESE=60)	Advanced Plant Anatomy - I	Advanced Plant Anatomy - II	Modern Plant Taxonomy	Angiosperm Evolution
	7th BT704C	Paper-20A Theory	2	60 (IA=24 + ESE=36)	Pollination Biology	Plant- Plant & Plant-Animal Interaction	Research Methodology-I	Research Methodology-II
		Paper-20B Practicals	2	40 (IA=16 + ESE=24)	*Based on theory papers 19 & 20A*			
	8th BT801C	Paper-21 Theory	4	100 (IA=40 + ESE=60)	Advanced Cell & Molecular Biology-I	Advanced Cell & Molecular Biology-II	Analytical Techniques - I	Analytical Techniques - II
	8th BT802C	Paper-22A Theory	2	60 (IA=24 + ESE=36)	Applied Biotechnology-I	Applied Biotechnology-II	Environmental Botany-I	Environmental Botany-II
		Paper-22B Practicals	2	40 (IA=16 + ESE=24)	*Based on theory papers 21 & 22A*			
	8th BT803C	Paper-23 Theory	4	100 (IA=40 + ESE=60)	Advanced Plant Physiology – I	Advanced Plant Physiology – II	Stress Physiology	Plant Developmental Biology
	8th BT804C	Paper-24A Theory	2	60 (IA=24 + ESE=36)	Intellectual Property Rights	Computer Fundamentals	Bioinformatics-I	Bioinformatics-II
		Paper-24B Practicals	2	40 (IA=16 + ESE=24)	*Based on theory papers 23 & 24A*			

4th YEAR

Botany (Major)

SEMESTER-VII

Paper- 17 (Theory)

BT-701C – Advanced Cryptogamic Botany, Fungal Biology & Modern Plant Pathology-I

Total Mark = 100 (IA = 40 + ESE = 60) **Credit = 04**

Unit-I (Advanced Cryptogamic Botany-I)

1. Ultra structure of flagella in Algae.
2. Algal chloroplast - origin, ultra structure and evolution of chloroplast structure.
3. Algal sexuality – (i) Origin and evolution of sex in Algae, (ii) Regulation of mating types in algae (*Chlamydomonas reinhardtii*).
4. Cyanophyta – (i) Akinets & Heterocysts (structure, formation and function), (ii) N_2 fixation in BG algae, (iii) Complementary Chromatic Adaptation, (iv) Cyanotoxins – Types with examples and importance.
5. Chlorophyta – (i) Structure of Flagellar apparatus, (ii) Algal phototaxis – Eye spot & phototactic movement in green algae, (iii) Origin of green algae - Evolutionary significance of *Prochloron*, (iv) Affinity of Chlorophyta.
6. Dinophyta – General characters, Cell structure, Bioluminescence in dinoflagellates.

Unit-II (Advanced Cryptogamic Botany-II)

1. Origin of Bryophyta (Algal origin and Pteridophytic origin) & Affinities of Bryophyta.
2. Alternation of generations in Bryophyta – Homologous theory and Antithetic theory.
3. Evolution of gametophyte (progressive & retrogressive theories) and sporophyte (theory of progressive sterilization & theory of reduction) in Bryophyta.
4. Spore dispersal mechanism in Bryophytes.
5. Ecological physiology – mechanism of dessication tolerance in bryophytes.
6. Changes in plant life for land adaptation.
7. Origin of land plants (Telome concept).
8. Enation theory and origin of microphylls.
9. Heterospory (definition & significance) and origin of seed habit.

Unit-III (Fungal Biology)

1. Fungal cell wall - Composition, architecture, & synthesis.
2. Mechanism of fungal growth – Budding in yeast and tip growth in filamentous fungi**.**
3. Fungal sexuality **-** Degeneration of sex in Fungi.
4. Homothallism & Heterothallism and its genetic control.
5. Regulation of mating system in fungi (Example – *Saccharomyces cerevisiae*, *Neurospora crassa*).
6. Parasexuality – Stages of parasexual cycle and its significance.
7. Fungal endophytes – Definition & importance (role in plant defence and production of bioactive compounds).
8. Fungi in ecosystem – Important ecological role of fungi in soil formation, nutrient cycling & biodegradation.

Unit-IV (Modern Plant Pathology-I)

1. Stages of disease development in plants – Inoculation (types, sources & arrival of inoculum), Pre-penetration, Penetration (direct penetration & penetration through wounds and opening), Post-penetration (infection process), Dissemination of pathogen & Overwintering / oversummering.
2. Disease development in plant - Role of enzymes and toxins in disease development.
3. Physiology of diseased plants - Effects of dieses on physiological parameters (Photosynthesis, Respiration, Protein synthesis, Nuclic acid metabolism & Phenol metabolism).
4. Factors responsible for disease development – Host resistance, Genetic uniformity of host, Type of crop, Age of Host, Virulence of pathogen, Quantity of inoculum, Mode of pathogen spread, Moisture content & Temperature.
5. Role of pathogenicity genes in plant disease development.

Botany (Major)

SEMESTER-VII

Paper-18A (Theory)

BT-702C – Modern Plant Pathology-II, III & Plant Secondary Metabolism

Total Mark = 60 (IA = 24 + ESE = 36) **Credit = 02**

Unit-I (Modern Plant Pathology-II)

1. Plant Defence system – Non Host resistance, Horizontal resistance & Vertical resistance, Role of R-gene in resistance.
2. Pre-existing structural defence in plants.
3. Pre-existing chemical defence in plants.
4. Induced structural defence in plants – Cell wall defence structure, Formation of cork layer, Formation of abscission layer, Formation of tyloses, Deposition of gums.
5. Necrotic structural defence - Hypersensitive reaction.

Unit-II (Modern Plant Pathology-III)

1. Induced biochemical defence in plants – Role of pathogenesis related proteins, Phenolics & Phytoalexins.
2. Role of 'avr' genes in plant disease resistance.
3. Definition of 'Systemic Acquired Resistance' (SAR) & 'Induced Systemic Resistance' (ISR).
4. Defence elicitors – Definition of defence elicitors and types with example (Abiotic and Biotic).
5. Role of Salicylic acid and Methyl jasmonate on plant defence.

Unit-III (Plant Secondary Metabolism-I)

1. Definition of Secondary metabolites & difference between primary and secondary metabolites.
2. Role (Functions) of following secondary metabolites in plant - Flavonoids, Anthocyanines, Tannins, Lignins, Suberins & Cyanogenic glycosides.
3. Alkaloids – Major classes with their amino acid precursor and example.
4. Types of glycosides – O-glycoside, N-glycoside, S-glycoside & C-glycoside.
5. Biosynthetic pathways of important secondary metabolites – Terpenoid biosynthesis (Mevalonate pathway & MEP pathway), Phenylpropanoid biosynthesis (Shikimic acid pathway).
6. Formation of Lignins, Tannins and Carotenoids.

Unit-IV (Plant Secondary Metabolism-II)

1. Major types of secondary metabolites with source plants and human use:
   i. Alkaloids – Nicotine, Atropine, Reserpine, Cocaine, Colchicine.
   ii. Glycosides – Digitoxin, Chiratin, Glycyrrhizine, Amygdalin.
2. Health benefits of phenolic compounds and source and uses of following phenolics - Caffeic acid, Coumaric acid, Gallic acid, Ferulic acid, & Rosmarinic acid.
3. Source and use (with example) of flavonoids as anticancer drug, antioxidant & cardio protective drug.
4. Tannins (tannic acid) – Source and health benefits (with example).
5. Anthocyanines – Health benefits.
6. Source and use of following essential oils – Peppermint, Eucalyptus, Lemon, Rosemary & Lavender.

Botany (Major)

SEMESTER-VII

Paper-18B (Practicals)

BT-702C

Total Mark = 40 (IA = 16 + ESE = 24) **Credit = 02**

Sl. No.	Practical	Marks
1.	Workout on Algae	**07**
2.	Workout on Fungi	**07**
3	Histological study of plant diseases through hand sectioning. OR Demonstration of isolation of pathogenic fungus from diseased plant part. OR Biochemical detection of secondary metabolites	**04**
4.	Laboratory Note book	**03**
5.	*Viva voce*	**03**
TOTAL		**24**

CONTENTS:

1. Study of algal specimens along with free hand and Camera Lucida drawing of reproductive parts, determination of magnification, and identification of the genus with identifying characters – *Oedogonium, Chara, Vaucheria, Ectocarpus, Polysiphonia*
2. Workout on fungal specimens with measurement of reproductive structures, free hand drawing, and identification of genus with identifying characters - *Ascobolus, Puccinia, Agaricus*
3. Histological study of plant diseases through hand sectioning and identification of the disease - Tikka disease of ground nut, Red rot of sugarcane, Brown spot of rice, Black stem rust of wheat (*Puccinia* from *Justicia* leaf).
4. Demonstration of isolation of pathogenic fungus from diseased plant part.
5. Biochemical detection of secondary metabolites – Alkaloids & Phenol
6. **Laboratory Records:** Student must get the laboratory note books duly signed by the respective teacher during practical classes.
7. Viva voce based on theory and practical syllabus of Paper 17 & 18A.

Botany (Major)

SEMESTER-VII

Paper- 19 (Theory)

BT-703C - Advanced Plant Anatomy, Modern Plant Taxonomy & Angiosperm Evolution

Total Mark = 100 (IA = 40 + ESE = 60) **Credit = 04**

Unit-I (Advanced Plant Anatomy – I)

1. Plant Cell Wall – Origin of cell wall during cell division, Growth and expansion of cell wall.
2. Epidermal tissue – Trichomes (types and functions), Epicuticular waxes – Nature and functions.
3. Mechanical tissues – Functions and the principles governing their distribution in plants.
4. Ontogeny and differentiation of Xylem vessels and Sieve tubes.
5. Organisation of shoot apex (Tunica–Corpus) and Root apex (Korper-Kappe) in angiosperms.
6. Root-stem transition.
7. Bark anatomy – Characters and formation of Periderm, Rhytidome, Lenticels, Polyderm, Ring bark & Scale bark.

Unit-II (Advanced Plant Anatomy – II)

1. Wood anatomy – Formation of wood, Soft wood & Hard wood, Sap wood & Heart wood.
2. Characters of Gymnospermous (Coniferous) wood & Angiospermous (Dicot) wood.
3. Vascular cambium – Structure (Fusiform & Ray initials, Storied & Non-storied cambium).
4. Anomalous secondary growth – Stems of *Boerhaavia*, *Mirabilis*, *Bignonia*, *Nyctanthes* & *Chenopodium*
5. Nodal anatomy – Types.
6. Applications of plant anatomy in Systematics, Forensics and Pharmacognosy**.**

Unit-III (Modern Plant Taxonomy)

1. ICN - Rules of Nomenclature - Type method, Rank of taxa, Rules of Priority, Retention and rejection of names, Author Citation, Effective and valid publication.
2. APG system of classification – Principles of APG system & Brief outline of APG-III
3. Chemotaxonomy – (i) Definition, Important characters used in Chemotaxonomy, and Importance of Chemotaxonomy (explanation with examples), (ii) Serotaxonomy (definition).
4. Cytotaxonomy – Definition, Important characters used in Cytotaxonomy, Importance of Cytotaxonomy (explanation with examples).
5. Numerical taxonomy (Phenetics) – Definition, Principle, Steps, Advantages & Disadvantages.
6. Basics of Phyllogenetic systematics (Cladistics) - Definition of following terms: (i) Cladistics & Cladogram, (ii) Plesiomorphy, Apomorphy, Synapomorphy, & Autapomorphy, (iii) Ingroup, Outgroup & OTU, (iv) Homology, Homoplasy, Convergence & Reversal, (v) Monophyletic group, Paraphyletic group & Polyphyletic group, (vi) Polytomy & Reticulation.

Unit-IV (Angiosperm Evolution)

1. Brief idea about major evolutionary forces - Mutation, Migration, Selection & Genetic drift.
2. Defining angiosperms – Unifying characters of angiosperms.
3. Origin and phyllogeny of Angiosperms – different theories.
4. Basal living Angiosperms and concept of Paleoherbs.
5. Origin and structural evolution of stamen in angiosperms.
6. Structural evolution of pollen grains.
7. Origin and structural evolution of carpel and ovule in angiosperms.
8. Evolution of placentation types.

Botany (Major)
SEMESTER-VII
Paper-20A (Theory)

BT-704C – Pollination Biology, Plant Animal Interaction & Research Methodology

Total Mark = 60 (IA = 24 + ESE = 36) **Credit = 02**

Unit-I (Pollination Biology)

1. Pollination types- Self pollination & Cross pollination (definition, advantages / disadvantages).
2. Contrivances for self pollination.
3. Contrivances of cross pollination.
4. Self Incompatibility – Heteromorphic system & Homomorphic system (Gametophytic & Sporophytic systems), Methods of overcoming self incompatibility.
5. Male sterility (definition, types, importance in plant breeding).
6. Major types of pollinating agents: Pollination syndrome (definition), Traits of flowers pollinated by Water, Air, Bee, Butterfly, Fly, Bird and Bat.
7. Mechanism for pollen reception, pollen tube growth and discharge of male nuclei.
8. Major floral reward for pollinator – Nectar (definition and constituents).
9. Pollinator crisis – Definition, Factors responsible for Pollinator crisis.

Unit-II (Plant-Plant & Plant-Animal Interaction)

1. Types of Plant-animal interactions (explanation with examples) – (i) Mutualism, (ii) Antagonism – Herbivory (Monophagous & Polyphagous), Insectivory, & Parasitism, (iii) Commensalism.
2. Effect of herbivory on plants and community structure.
3. Plant's defence mechanism against herbivory.
4. Controlling herbivores – various techniques of pest control.
5. Effect of parasitism on natural population and community – explanation with example.
6. Coevolutionary relationship between Plant & insect pollinator – Explanation with examples & significance.
7. Plant-Plant Interaction – Facilitation, Competition, Allelopathy & Parasitism (explanation with examples).

Unit-III (Research Methodology-I)

1. Definition and meaning of research.
2. Characteristics of research / Criteria for good research – Objectivity, Reliability, Validity, Credibility, Generalizability, Replicable.
3. Objective / Purpose of research.
4. Some important categories of research – (i) Descriptive & Analytical, (ii) Fundamental & Applied, (iii) Quantitative & Qualitative, (iv) Conceptual & Empirical, (v) Inductive & Deductive, (vi) Action research.
5. Process of Research – (i) Formulating the research problem, (ii) Extensive literature survey (iii) Developing the hypothesis, (iv) Preparing the research design, (v) Determining sample design, (vi) Collecting the data, (vii) Execution of the project, (viii) Analysis of data, (ix) Hypothesis testing, (x) Generalisations and interpretation, (xi) Preparation of the report or presentation of the results (formal write-up of conclusions reached).

Unit-IV (Research Methodology-II)

1. Formulation of research problem: Factors affecting the selection of research problem – (Types of Internal & External factors).
2. Research design – Features of good research design; Three principles of experimental designs: (i) the Principle of Replication; (ii) the Principle of Randomization (iii) Principle of Local Control.
3. Types of sampling – Probability sampling (Simple random sample, Stratified random sample, Cluster sample), Non-probability sampling (Quota sampling, Purposive sampling, Convenience sampling, Snowball sampling).
4. Hypothesis – Features of good hypothesis, Types of hypothesis – Descriptive, Relational, Explanatory, Null hypothesis, Alternative.
5. Variables – Types of variables (Contineous & Discrete, Dependable & Independent Extraneous variable).
6. Data – Primary data & Secondary data; Methods of data collection (Observation, Personal interview, Telephonic interview, Mailed questionnaires, Schedules).
7. Report writing – General layout of report.
8. Bibliography & Reference (definition & difference).
9. Important features of Seminar, Workshop, Symposium, & Conference.

Botany (Major)

SEMESTER-VII

Paper-20B (Practicals)

BT-704C

Total Mark = 40 (IA = 16 + ESE = 24) **Credit = 02**

Sl. No.	Practical	Marks
1.	Study of Anomalous secondary structures with double staining. OR Study of Nodal anatomy. OR Study of xylem vessels by maceration technique.	**07**
2.	Workout on Angiospermic plants.	**09**
3	Study of in vitro pollen germination.	**04**
4.	Laboratory Note book	**02**
5.	*Viva voce*	**02**
TOTAL		**24**

CONTENTS:

1. Study of Anomalous secondary structures with double staining and preparation of permanent slides - Stem of: *Boerhaavia sp., Bignonia sp., Chenopodium sp., Nyctanthes sp.*
2. Study of Nodal anatomy freshly prepared slide/permanent slide – Unilacunar, Trilacunar, Multilacunar.
3. Study of xylem vessels by maceration technique from *Cucurbita* stem.
4. Workout on Angiospermic plants: Flower dissection, diagram of plant parts, description of plant, Floral formula, Floral diagram, identification up to Species level with the help of suitable literature from the families: Solanaceae, Malvaceae, Rubiaceae, Asteraceae, Lamiaceae.
5. Study of in vitro pollen germination.
6. **Laboratory Records:** Student must get the laboratory note books duly signed by the respective teacher during practical classes.
7. Viva voce based on theory and practical syllabus of Paper 19 & 20A.

Botany (Major)

SEMESTER-VIII

Ppaper-21 (Theory)

BT-801C – Advanced Cell and Molecular Biology & Analytical Techniques

Total Mark = 100 (IA = 40 + ESE = 60) **Credit = 04**

Unit-I (Advanced Cell & Molecular Biology-I)

1. Plasma membrane – Types of transport proteins in plasma membrane.
2. Ribosome – Biogenesis and assembly.
3. Cytoskeleton – Structure and functions of Microtubules, Microfilaments, and Intermediate filaments.
4. Eukaryotic DNA replication – Mechanism and role of different protein factors.
5. Transcription in Eukaryotes – Types of RNA polymerases in eukaryotes; Transcription initiation by RNA polymerase II.
6. Eukaryotic pre mRNA processing – mechanism of capping on the 5′ end, polyadenylation of the 3′ end and pre-mRNA splicing.

Unit-II (Advanced Cell & Molecular Biology-II)

1. Transcriptional regulation of gene activity in Eukaryotes – Important regulatory sequences (TATA box & Enhancers) and role of Activators and Repressor proteins.
2. Gene silencing – brief idea (detailed mechanism not required).
3. Cell signalling – (i) Types of receptors (cell surface receptor & intracellular receptor), (ii) Mechanism of G protein linked receptors, (iii) Secondary messenger – Definition and role of cAMP, Ca, IP3 and DAG as second messenger.
4. Apoptosis and cell death – Definition & pathways (intrinsic & extrinsic).
5. Cancer cells – (i) Properties of cancer cells, (ii) Origin of cancer cells – (a) activation of proto-oncogenes, (b) loss of tumour suppressor activity and (c) role of virus infection.
6. Karyotype concept – Definition of Karyotype, Karyogram & Idiogram; Symmetrical & Asymmetrical Karyotype, Definition of Basic number.

Unit-III (Analytical Techniques-I)

1. **Stains and staining:** Objective of staining, Distinction between Stain & Dye, Dyes – Natural & Synthetic (examples), Structural components (nature) of stains (concept of Chromophore & Auxochrome), Mordants, Accentuators & Leuco compounds (definition), Mechanism of Staining, Metachromasia, Types of staining – Simple staining (Direct & Indirect staining) & Differential staining, Progressive staining, Regressive staining, Vital staining
2. **Microscopy:** Microscopy – Concept of magnification, resolution, and contrast; Brief idea of types of microscopes – Bright field microscopy, Dark field microscopy, Phase contrast microscopy, Polarized light microscopy, Fluorescent microscopy, Confocal microscopy, TEM & SEM, Flow Cytometry (principle)
3. **Chromatography:** General principle, Types (principle and use) - Paper chromatography, Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography, Affinity chromatography, Hydrophobic interaction chromatography, Gel Filtration chromatography.
4. **Radiometric dating:** Basic principles of C14 dating.

Unit-IV (Analytical Techniques-II)

1. **Centrifugation:** General principles (concept of sedimentation coefficient), Differential and Density gradient centrifugation, Isopycnic centrifugation, Analytical centrifugation, Ultracentrifugation
2. **Spectrophotometry:** General principle – Distinction between Photometer, Spectrophotometer (Single Beam & Double Beam), and Colorimeter; Definition of Absorbance, Transmittance, Optical density, and Relative transmittance; Beer law, Lambart law, UV-Vis Spectroscopy
3. **Electrophoresis:** General principles, Moving Boundary electrophoresis, Zone electrophoresis, Gel electrophoresis - Horizontal & Vertical Gel electrophoresis, Agarose Gel electrophoresis, PAGE (Native PAGE, SDS PAGE), 2D protein gel electrophoresis.
4. **Blotting –** Basic techniques of Northern, Southern & Western blotting.

Botany (Major)

SEMESTER-VIII

Paper-22A (Theory)

BT-802C – Applied Biotechnology & Environmental Botany

Total Mark = 60 (IA = 24 + ESE = 36) **Credit = 02**

-I (Applied Biotechnology-I)

1. Expression vectors – Definition and example (pGEX)
2. Protein Expression system: Components of *E. coli* expression system.
3. Downstream processing and product recovery –
   - **i.** Solid liquid separation (Flotation, Flocculation, Filtration & Centrifugation).
   - **ii.** Release of intracellular products (Physical, Chemical & Enzymatic cell disruption methods).
   - **iii.** Concentration (Evaporation, Liquid-liquid extraction, Membrane filtration, Precipitation & Adsorption).
   - **iv.** Purification (Chromatography).
   - **v.** Formulation (Drying, Spray drying & Lyophilization).

Unit-II (Applied Biotechnology-II)

1. Pest resistant plant - Bt-cotton (Basic concept).
2. Herbicide resistant plants - Round up Ready soybean.
3. Transgenic crops with improved quality traits - Flavour Savour tomato, Golden rice.
4. Improved horticultural varieties - Moon dust carnations.
5. Role of transgenics in bioremediation - Superbug.
6. Edible vaccines (definition and example).
7. Industrial enzymes (Aspergillase, Protease, Lipase) – Source & application.
8. Genetically Engineered Products - Human Growth Hormone; Humulin.
9. Production of secondary metabolites through Plant Tissue Culture system (including Hairy root culture).

Unit-III (Environmental Botany-I)

1. Structure of atmosphere (layers of atmosphere), Hydrosphere and Lithosphere, Structural characteristics of earth (Core, Mantle & Crust).
2. **Pollution:** (i) Definition and types of pollutants, (ii) Major air pollutants and their sources, control measures, (iii) Effects of Air pollution on plants and animals, (iv) Control measures of air pollution, (v) Water pollution and Land pollution – Causes and effects, (vi) Noise pollution-Source, effects and remedial measures, (vii) Heavy metal pollution – Sources and effects of heavy metal pollution.
3. **Environmental Problems** – (i) Basic concept of Green House Effect and Global Warming (including major GH gases and their source & concept of 'Global Warming Potential'), (ii) Acid rain-Definition, mechanism of formation and effects, (iii) Smog – Concept of classical and Photochemical smog, mechanism of formation of photochemical smog, (iv) Brief idea of La-Nina and El-Nino, (v) Ozone umbrella and Ozone hole - Types of ozone depleting chemicals and their interactions, (vi) Eutrophication.

Unit-4 (Environmental Botany-II)

1. Definition of Bio-entry, Bioaccumulation, Biotransformation and Biomagnificaion.
2. **Phytoremediation** – Definition, application and advantages.
3. **Carbon credit** – Concept and exchange of carbon credits.
4. **Carbon sequestration** - Meaning and importance.
5. **Salient features of important environmental conventions, agreement and protocols –** RAMSAR Convention (1971), Montreal Protocol (1987), Convention on Biological Diversity (1992), Earth Summit (1992), Kyoto Protocol (1997), and Paris agreement (2016).
6. **Salient features of Environment protection acts in India -** Wild life protection act 1972, Forest conservation act 1980, National Environmental Policy -2006.
7. **Environmental movements -** Chipko movement and Silent Valley movement.

Botany (Major)

SEMESTER-VIII

Paper-22B (Practicals)

BT-802C

Total Mark = 40 (IA = 16 + ESE = 24) **Credit = 02**

Sl. No.	Practical	Marks
1.	Study of Mitotic Metaphase chromosome by aceto-orcein staining method and determination of chromosome number.	**08**
2.	Determination of Mitotic index in *Allium cepa*. OR Temporary preparation and study of different stages of meiosis from the flower buds	**06**
3	Demonstration of separation of Chlorophyll pigments by TLC. OR Determination of Molecular Weight of protein from Gel Electrophoresis data.	**06**
4.	Laboratory Note book	**02**
5.	*Viva voce*	**02**
TOTAL		**24**

CONTENTS:

1. Study of Mitotic Metaphase chromosome by aceto-orcein staining method and preparation of permanent slides from the following materials: *Allium cepa, Allium sativum, Lens esculentus, Aloe vera, Pisum sativum, Nigella sp.* and determination of chromosome number (any three).
2. Determination of Mitotic index in *Allium cepa*.
3. Temporary preparation and study of different stages of meiosis from the flower buds of *Allium cepa*.
4. Demonstration of separation of Chlorophyll pigments by TLC. / Principle, requirements, procedure & precaution.
5. Determination of Molecular Weight of protein from Gel Electrophoresis data.
6. **Laboratory Records:** Student must get the laboratory note books duly signed by the respective teacher during practical classes.
7. Viva voce based on theory and practical syllabus of Paper 21 & 22A.

Botany (Major)

SEMESTER-VIII

Ppaper-23 (Theory)

BT-803C – Advanced Plant Physiology, Stress Physiology & Plant Developmental Biology

Total Mark = 100 (IA = 40 + ESE = 60) **Credit = 04**

Unit-I (Advanced Plant Physiology – I)

1. Glyoxylate cycle and its significance.
2. Storage of carbohydrate in plants – Biochemistry of Starch biosynthesis and starch catabolism.
3. Fatty acid metabolism - β-oxidation of fatty acid.
4. Oxidative Phosphorylation and ATP synthesis (chemiosmotic mechanism).
5. Phloem transport - Pressure flow model, Phloem loading and unloading.
6. Signaling in plant - mechanism of auxin, cytokinin & gibberellin signalling.
7. Cryptochrome and Phototropin - Chemical nature and function.

Unit-II (Advanced Plant Physiology – II)

1. Flower development – Induction of floral meristem, Initiation of floral primordia, Specification of floral organs – ABC model.
2. Vernalization (role of low temperature in flowering).
3. Seed dormancy –Hormonal regulation of dormancy.
4. Seed germination– Mobilization of food reserves and role of growth regulators in seed germination.
5. Physiology of Senescence and Ageing – Changes during senescence, Hormonal regulation of senescence.
6. Abscission – Mechanism and hormonal regulation.

Unit-III (Stress Physiology)

1. Definition of stress in respect to plants; Concept of Stress avoidance, Stress tolerance, Acclimation & Adaptation.
2. High Light Stress – Concept of photoinhibition, hypothesises about mechanism of photoinhibition, and photoprotection (mechanical and biochemical protection, photochemical quenching & non-photochemical quenching).
3. Water stress (water deficit and drought resistance) – Effects of water stress on plants and response to water stress (physiological, biochemical & molecular responses).
4. Temperature stress (Heat stress & Heat shock) – Effects of heat stress on plants (on growth, photosynthesis, reproduction, yield, production of reactive oxygen species) and Plant adaptation to heat stress - mechanism of avoidance & mechanism of tolerance, antioxidant defence & role of heat shock proteins (HSPs).
5. Salinity stress – effects of salinity on plants, salt tolerance and its mechanism (Osmotic tolerance, Na^+ exclusion & Tissue tolerance)

Unit-IV (Plant Developmental Biology)

1. Initiation of leaf primordia and development of leaves.
2. Root development – Establishment of primary root meristem, Lateral root development.
3. Root nodule development in legumes – root nodule initiation and development.
4. Tuber development (in potato) – Changes during tuber development.
5. Embryo maturation and seed development – Changes during embryo maturation and seed development and their hormonal regulation.
6. Fruit ripening – climacteric and non-climacteric ripening, changes during ripening (including role of ethylene in ripening).

Botany (Major)
SEMESTER-VIII
Paper-24A (Theory)

BT-804C - Intellectual Property Rights and Computer Fundamentals & Bioinformatics)

Total Mark = 60 (IA = 16 + ESE = 36) **Credit = 02**

Unit-I (Intellectual Property Rights - IPR)

1. Definition of Intellectual Property (IP) & Intellectual Property Right (IPR).
2. Importance of IP in the economic and cultural development of the society.
3. Important categories of IPR:
   - **i)** Patents – Definition of Patent, Conditions for Obtaining a Patent Protection, Rights Associated with Patents, Inventions Eligible for Patenting, Non-Patentable Matters.
   - **ii)** Copyright – Definition of Copyrights, Criteria for Copyright, Ownership of Copyright, Copyright Infringement, Non-Copyright works.
   - **iii)** Trade Marks – Definition of Trade Marks, Eligibility criteria for Trade Marks, Designation of Trade Mark symbol.
   - **iv)** Geographical Indications (GI) – Definition of GI, Rights granted to the holders of GI.
   - **v)** Trade Secrets – Definition of Trade Secrets, Criteria for Trade Secrets, Rights associated with Trade Secrets.
   - **vi)** Traditional Knowledge (TK) – Definition and importance of TK.
   - **vii)** Plant variety – Definition of Plant Variety, Need for plant protection as IP, Conditions for registration of new plant variety, Types of plant varieties registered under PVP & FR act.

Unit-II (Computer Fundamentals)

1. **History of computers** – Characters of first, second, third, fourth & fifth generations of computers.
2. **Computer organization** – (i) CPU (Control unit, ALU & Memory unit), (ii) Computer memory - Cache Memory, Primary Memory/Main Memory (RAM, ROM – PROM, EPROM, EEPROM), Secondary Memory & Registers, (iii) Input devices (Keyboard, Mouse, Scanner, Touchpad, Barcode reader, OMR, Joystick), (iii) Output devices (Monitor, Printers, Plotters, Projector, Speaker, Head Phone).
3. **Computer Language** – Machine language, Assembly language, High level language.
4. **Computer softwares** – (i) System software (Operating system, Compiler, Assembler, & Interpreter) and (ii) Application softwares (Word processing software, Database software, Spreadsheet software, Presentation software, Multimedia software).
5. **Internet** – (i) Types of Networks – LAN, MAN, WAN, (ii) Hardware Requirements for the Internet – Modem, Hub, Bridge, Router, Gateway, (iii) Software Requirements for the Internet – Protocol, IP address, URLs, WEB browsers, Search engines.
6. **Definition** and **example of Computer virus** and **Antivirus**.
7. **Important Computer Security Threats –** Phishing, Spam, Malware, Adware, Spyware, Spoofing, Phraming & Keylogger.

Unit-III (Bioinformatics-I)

1. Definition, Aims and Scope of Bioinformatics, Bioinformatics as interdisciplinary subject.
2. Concept of branches of Bioinformatics – Genomics, Proteomics, Transcriptomics, Systems Biology, Functional Genomics, Metaboliomics, Structural genomics, Cheminformatics, Molecular Phylogeny.
3. Definition of Database and Biological Database, Features of Biological database, Definition of Primary database and Secondary database, Classification of biological database based on data types (brief idea with examples) – Sequence databases, Genome databases, Bibliographic databases, Microarray databases, Metabolic databases, Chemical databases, Structural databases, Disease databases and Enzyme databases.

Unit-IV (Bioinformatics-II)

1. Concept of File format of biological database, File format types (definition and examples) - Sequence file formats and Molecular file formats.
2. Brief idea of BLAST – Standard BLAST and Mega BLAST, Application of BLAST tool in Biological Science.
3. NCBI and its role.
4. Basic concept of Protein Data Bank (PDB).
5. Role of Bioinformatics in industry – Food industry, Agricultural industry and Pharmaceutical industry.

Botany (Major)

SEMESTER-VIII

Paper-24B (Practicals)

BT-804C

Total Mark = 40 (IA = 16 + ESE = 24) **Credit = 02**

Sl. No.	Practical	Marks
1.	Plant Physiological Experiment	**12**
2.	Gram staining of *Rhizobia* from root nodules of leguminous plants.	**06**
3.	Laboratory Note book	**03**
4.	*Viva voce*	**03**
TOTAL		**24**

CONTENTS:

1. **Plant Physiological Experiment:**
    a) Determination of Osmotic Potential of *Rhoeo* leaf by plasmolytic method.
    b) Study of effect of temperature on absorption of water by storage tissue and determination of Q10.
    c) Determination of loss of water per stomata per hour.
    d) Effect of CO_2 on the rate of Photosynthesis.
    e) Measurement of oxygen uptake by respiring tissue (per g/hr).
    f) Study of catalase activity.
    g) Effect of salinity stress / heat stress on the rate of Photosynthesis.
2. Gram staining of *Rhizobia* from root nodules of leguminous plants.
3. Submission of LNB.
4. Viva voce based on theory and practical syllabus of Paper 23 & 24A.

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Tripura University

(A Central University)

Suryamaninagar

West Tripura

Syllabus for

Four Years Undergraduate Programme

Subject: Botany (Minor)

(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 (MINOR)

Year	Semester	Paper	Credits	Total marks	Unit-I	Unit-II	Unit-III	Unit-IV
1st	1st BT101M	Paper-1A Theory	3	60 (IA=24+ ESE=36)	Microbiology	Phycology-I	Phycology-II	Mycology
		Paper-1B Practical	1	40 (IA=16+ ESE=24)	*Based on theory paper 1A*			
	2nd BT201M	Paper-2A Theory	3	60 (IA=24+ ESE=36)	Bryophyta	Pteridophyta	Gymnosperm	Paleobotany
		Paper-2B Practical	1	40 (IA=16+ ESE=36)	*Based on theory paper 2A*			
2nd	3rd BT301M	Paper-3A Theory	3	60 (IA=24+ ESE=36)	Phytopathology	Morphology	Embryology	Plant Anatomy
		Paper-3B Practical	1	40 (IA=16+ ESE=24)	*Based on theory paper 3A*			
	4th BT401M	Paper-4A Theory	3	60 (IA=24+ ESE=36)	Taxonomy-I	Taxonomy-II	Plant Ecology	Phytogeography
		Paper-4B Practical	1	40 (IA=16+ ESE=24)	*Based on theory paper 4A*			
3rd	5th BT501M	Paper-5A Theory	3	60 (IA=24+ ESE=36)	Biochemistry	Plant Physiology-I	Plant Physiology-II	Evolution
		Paper-5B Practicals	1	40 (IA=16+ ESE=24)	*Based on theory paper 5A*			
	6th BT601M	Paper-6A Theory	3	60 (IA=24+ ESE=36)	Cell Biology	Molecular Biology-I	Molecular Biology-II	Genetics
		Paper-6B Practical	1	40 (IA=16+ ESE=24)	*Based on theory paper 6A*			
4th	7th BT701M	Paper-7A Theory	3	60 (IA=24+ ESE=36)	Biometry	Plant Breeding	Economic Botany-I	Economic Botany-II
		Paper-7B Practicals	1	40 (IA=16+ ESE=24)	*Based on theory paper 7A*			
	8th BT801M	Paper-8A Theory	3	60 (IA=24 + ESE=36)	Plant Biotechnology-I	Plant Biotechnology-II	Pharmacognosy	Biodiversity & Sustainable development
		Paper-8B Practicals	1	40 (IA=16+ ESE=24)	*Based on theory paper 8A*			

DETAILED COURSE CONTENT OF BOTANY (MINOR)

1st YEAR

Botany (Minor)

SEMESTER-I

Paper-1A- (Theory)

BT-101M – Microbiology, Phycology & Fungi

Total Marks-60 (IA = 24 + ESE = 36) **(Credits-3)**

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-II: Phycology-I

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

Unit-III: Phycology-II

Life history of the following: *Nostoc, Oedogonium, Chara, Ectocarpus* and *Polysiphonia*.

Unit-IV: Mycology

1. General characters of Fungi including fungal mode of nutrition, Classification of Fungi (Ainsworth, 1973) up to sub-division; Economic importance of fungi.

2. Important characteristics of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, & Deuteromycotina.

3. General characters of Myxomycetes.

4. Life history of *Rhizopus, Penicillium* & *Agaricus.*

5. Mushroom production and harvesting (*Volvoriella s*p. and *Pleurotus* sp).

Botany (Minor)

SEMESTER-I

Paper-1B-(Practical)

BT-101M

Total Marks- 40 (IA = 16 + ESE = 24) **(Credit = 1)**

Sl. No.	Practical	Marks
1.	Workout on Microbiology	**07**
2.	Workout on Algae or Workout on Fungi*	**07**
3	Identification with reasons (2 x 2 marks)	**04**
4.	Laboratory Note book	**03**
5.	*Viva voce*	**03**
TOTAL		**24**

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 drawingonly): *Nostoc* sp.*, Oedogonium* sp.*, Chara sp., Ectocarpus* sp.*, Polysiphonia* sp.

And

Work out of the following Fungi with reproductive structures (Free hand drawing): *Rhizopus* sp.*, Penicillium* sp.*, Agaricus* sp.*, Polyporus* sp.

*****_Algal and fungal specimen should be given alternatively to the students during exam._

4. **Identifications:**

a) **Permanent slides of Algae:** *Nostoc*, *Volvox* colony, *Oedogonium* dwarf male, *Polysiphonia* – cystocarp & tetrasporophyte.

b) **Permanent slides of Fungi:** Zygospore 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 therespective teacher during practical classes.

6. ***Viva voce:*** Questions based on theory and practical syllabus of 1st semester.

Botany (Minor)

Semester-II

Paper-2A (Theory)

BT- 201M – Bryophyta, Pteridophyta & Gymnosperms and Paleobotany

Total Marks-60 (IA = 24 + ESE = 36) **(Credits-3)**

Unit-I: 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-II: 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, Lycopsida, Sphenopsida, Pteropsida.
4. Life history: Sporophyte structure, reproduction and structure of gametophyte of *Lycopodium, Selaginella, Equisetum,* and *Pteris*.

Unit-III: Gymnosperms

1. General characters of Progymnosperms.
2. Gymnosperms - General characters.
3. Outline classification (Sporne, 1965) up to Order with examples.
4. Important characters of three classes – Cycadopsida, Coniferopsida, &Gnetopsida.
5. Economic importance of Gymnosperms with reference to Wood, Resins, Essential oils,and Drugs.
6. Life cycle (Morphology, anatomy and reproduction) of *Cycas, Pinus* and *Gnetum.*

Unit-IV: Paleobotany:

1. Definition of fossil, Conditions required for fossilization, Fossilization process.
2. Types of fossil (Microfossil, Mega fossil and its types on the basis of nature of fossilization); Modes of preservation (after Schopf, 1975).
3. Importance of fossil study.
4. Geological Time scale withdominant plant groups through ages.
5. Study of fossil plants:- *Rhynia, Williamsonia*

Botany (Minor)

Semester-II

Paper-2B (Practical)

BT- 201M

Total Marks- 40 (IA = 16 + ESE = 24) **(Credit = 1)**

Sl. No.	Practical	Marks
1.	Workout on Pteridophyta	**07**
2.	Workout on Gymnosperm	**07**
3	Identification with reasons (2 x 2 marks)	**04**
4.	Laboratory Note book	**03**
5.	*Viva voce*	**03**
TOTAL		**24**

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 respectiveteacher during practical classes.

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

2nd YEAR

Botany (Minor)

Semester-III
Paper- 3A (Theory)

BT- 301M- Phytopathology, Morphology & Plant Anatomy

Total Marks-60 (IA = 24 + ESE = 36) **(Credits-3)**

Unit-I: Phytopathology

1. Terms and concepts (Infection ,disease, Pathogen, Pathogenecity, 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-II: Morphology

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 andadhesion); Carpel (Apocarpous and Syncarpous), Ovary (types), Style (types), Placentation types.
5. Fruits- types.
6. Seed types and their dispersal.

Unit-III: Embryology

1. Microsporogenesis.
2. Megasporogenesis (types – monosporic, bisporic & tetrasporic).
3. Structure of ovule and its type.
4. Process of double fertilization**.**
5. Embryo development (dicot & monocot type),
6. Endosperm development – Nuclear, Cellular & Hellobial types.

Unit-IV: 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.

Botany (Minor)

Semester-III

Paper-3B (Practical)
BT-301M

Total Marks- 40 (IA = 16 + ESE = 24) **(Credit = 1)**

Sl. No.	Practical	Marks
1.	Workout on Anatomy	**08**
2.	Identification with reasons (4 x 2 marks)	**08**
3.	Laboratory Note book	**04**
4.	*Viva voce*	**04**
TOTAL		**24**

CONTENTS

1. **Work out on Plant Anatomy**: Study of Primary structures by preparing temporary slides ofthe 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 3rd semester.

Botany (Minor)

Semester-IV
Paper- 4A (Theory)

BT- 401M - Plant Taxonomy, Plant Ecology & Phytogeography

Total Marks-60 (IA = 24 + ESE = 36) **(Credits-3)**

Unit I: Plant Taxonomy-I

1. Components of Plant taxonomy (identification, nomenclature, classification).
2. Aims and phases of taxonomy.
3. Elementary knowledge of ICN- Principles.
4. Herbaria and Botanical Gardens – Functions of Herbaria and Botanical Gardens , Important Herbaria and Botanical Gardens of India and world (3 each).
5. History of Plant classification: Artificial (Linnaeus), Natural (Bentham & Hooker) and Phylogenetic (Hutchinson).

Unit II: Plant Taxonomy-II

Study of the following families (Diagnostic characters, General characters & Economic importance):

Poaceae, Orchidaceae, Magnoliaceae, Leguminosae (with sub- families Caesalpiniaceae, Mimosaceae, Papilionaceae), Malvaceae, Cucurbitaceae, Brassicaceae, Solanaceae, Apocynaceae, Lamiaceae, Rubiaceae and Asteraceae.

Unit-III: Plant Ecology

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

Unit-IV: 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.

Botany (Minor)

Semester-IV

Paper-4B (Practical)

BT-401M

Total Marks- 40 (IA = 16 + ESE = 24) **(Credit = 1)**

Sl. No.	Practical	Marks
1.	Workout on Angiospermic plant	**08**
2.	Workout on Ecological anatomy	**05**
3	Spot identification of plants (2 x 1 mark)	**02**
4.	Submission of Herbarium sheets	**03**
5.	Laboratory Note book	**03**
6.	*Viva voce*	**03**
TOTAL		**24**

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 thetheory 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 respectiveteacher during practical classes.
6. ***Viva voce*:** Questions based on theory and practical syllabus of 4th semester.

3rd YEAR

Botany (Minor)

Semester-V

Paper- 5A (Theory)

BT-501M - Biochemistry, Plant Physiology & Evolution

Total Marks-60 (IA = 24 + ESE = 36) **(Credits-3)**

Unit-I: 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-II: Plant Physiology-I

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.

Unit-III: Plant Physiology-II

1. Glycolysis, Oxidative decarboxylation, TCA cycle, Mitochondrial electron transport, Oxidative Phosphorylation and ATPsynthesis.
2. Photorespiration; Photoperiodism: Photoperiodic responses and classification of plants.
3. Source, physiological role and mode of action of IAA, Gibberellins and Cytokinins.
4. Nitrogen metabolism: Biological N_2 fixation (nodule formation, role of Nitrogenase and leg hemoglobin), function of *nif* and *nod* genes.

Unit-IV: Evolution

1. Origin of life (Oparin-Haldane concept, Urey-Miller experiment, RNA world hypothesis, Protein first model).
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).

Botany (Minor)

Semester-V

Paper-5B (Practical)

BT-501M

Total Marks- 40 (IA = 16 + ESE = 24) **(Credit = 1)**

Sl. No	Practical	Mark
1.	Detection of Biochemical compound from unknown sample.	**06**
2.	Plant Physiology experiment	**12**
3.	Laboratory Note book	**03**
4.	*Viva voce*	**03**
TOTAL		**24**

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^{th} semester.

Botany (Minor)

Semester-VI

Paper- 6A (Theory)

BT-601M- Cell biology, Molecular Biology & Genetics

Total Marks-60 (IA = 24 + ESE = 36) **(Credits-3)**

Unit-I: 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 (properties).
4. Cell cycle – Various phases & events (G1, S, G2, M), Cell division- Stages of Mitosis & Meiosis.

Unit-II: Molecular Biology-I

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.

Unit-III: Molecular Biology-II

1. Genetic code- Properties.
2. Translation in prokaryotes.
3. Regulation of Gene expression in Prokaryotes - Operon model (general concept), mechanism of lac-operon.
4. Gene mutation- Base substitution (Transition & Transversion) and Frame shift mutation.

Unit-IV: 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, Pleotropism, Phenocopy effect.
4. Linkage (definition of complete, incomplete, coupling phase and repulsion phase linkage, linkage group) and Crossing over & its cytological basis (McClintock experiment).
5. Chromosomal aberration- Numerical changes (aneuploidy and euploidy), Polyploidy types, Structural changes (definition and types of deletion, duplication, inversion and translocation).

Botany (Minor)

Semester-VI

Paper-6B (Practical)

BT-601M

Total Marks- 40 (IA = 16 + ESE = 24) **(Credit = 1)**

Sl. No	Practical	Mark
1.	Work out on Mitotic stages	**10**
2.	Identification with reasons (3 x 2 marks)	**06**
3.	Laboratory Note book	**04**
4.	*Viva voce*	**04**
TOTAL		**24**

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 therespective teacher during practical classes.

4. ***Viva voce*:** Questions based on theory and practical syllabus of 6^{th} semester.

4th YEAR

Botany (Minor)

Semester-VII

Paper- 7A (Theory)
BT- 701M - Biometry, Plant Breeding & Economic Botany

Total Marks-60 (IA = 24 + ESE = 36) **(Credits-3)**

Unit-I: 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 – Bardiagram & Histogram, Pie chart.
2. Measures of central tendency (Mean, Mode, Median).
3. Measuresof 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-II: 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-III: Economic Botany-I

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.

Unit-IV: Economic Botany-II

1. Rice cultivation- Conventional method & SRI system.
2. Jute Cultivation and processing.
3. Tea cultivation and processing (orthodox & CTC methods).
4. Rubber cultivation and processing.

Botany (Minor)

Semester-VII

Paper-7B (Practical)

BT- 701M

Total Marks- 40 (IA = 16 + ESE = 24) **(Credit = 1)**

Sl. No	Practical	Mark
1.	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**
2.	Study of economically important plants (Scientific name, Family, Economically important part, and Uses) as per theory syllabus (2 x 4 marks)	**08**
3.	Laboratory Note book	**04**
4.	*Viva voce*	**04**
TOTAL		**24**

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, Economically important 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 7^{th} semester.

Botany (Minor)

Semester-VIII

Paper-8A (Theory)

BT- 801M - Plant Biotechnology, Pharmacognosy & Biodiversity

Total Marks-60 (IA = 24 + ESE = 36) **(Credits-3)**

Unit-I: Plant Biotechnology-I

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.

Unit-II: Plant Biotechnology-II

1. Definition of Recombinant DNA technology.
2. Enzymes in DNA cloning – Restriction endonuclease (Type I, II & III).
3. Definition of cDNA library and Genomic library.
4. Criteria for good Vector, Brief concept of cloning Vectors (plasmid, lambda phage, YAC).
5. Production of transgenic plant: *Agrobacterium* mediated gene transfer.

Unit-III: 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*, and Tuber of *Dioscoria sp.*

Unit-IV: 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 (definition, example, sources & importance).

Botany (Minor)

Semester-VIII

Paper - 8B (Practical)

BT- 801M

Total Marks- 40 (IA = 16 + ESE = 24) **(Credit = 1)**

Sl. No	Practical	Mark
1.	Demonstration on aseptic explant preparation (from shoot tip and nodes) and aseptic inoculation of explants.	**08**
2.	Study of powdered drugs	**08**
3.	Laboratory Note book	**04**
4.	*Viva voce*	**04**
TOTAL		**24**

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^{th} semester.

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Tripura University

(A Central University)
Suryamaninagar
West Tripura

Syllabus for

Four Years Undergraduate Programme

Subject: Fundamental Botany

(Interdisciplinary course)

(As per NEP-2020)

Year-2023

Tripura University
(A Central University)

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

FUNDAMENTAL BOTANY

(Interdisciplinary Course)

Year	Semester/ Paper code	Paper	Credits	Marks	Unit-I	Unit-II	Unit-III	Unit-IV
1st	1st **BT-101 ID**	Paper-1 Theory	3	100 (IA=40 + ESE=60)	Microbiology	Algae	Fungi & Plant Pathology	Bryophyta & Pteridophyta
2nd	3rd **BT-301 ID**	Paper-2 Theory	3	100 (IA=40 + ESE=60)	Gymnosperms & Paleobotany	Floral Morphology	Taxonomy	Economic Botany
	4th **BT-401 ID**	Paper-3 Theory	3	100 (IA=40 + ESE=60)	Plant Anatomy & Ecology	Cytogenetics	Molecular Biology	Plant Physiology

1st YEAR

Interdisciplinary Course: Fundamental Botany
SEMESTER-I
Paper-1 (Theory)

BT-101 ID - Microbiology & Cryptogamic Botany

Total Marks = 100 (IA = 40 + ESE = 60) **(Credits = 03)**

Unit-I: Microbiology

1. **Virus:** General properties of plant virus, Structure of Bacteriophage (T4 phage), Structure of RNA virus (TMV); Definition of Lytic and Lysogenic cycle.
2. **Bacteria:** General characters of bacteria; Morphological forms, Cell structure, Genetic recombination in bacteria-Transformation, Transduction and Conjugation; Economic importance of bacteria.

Unit-II: Algae

1. **Algae:** General characters, Thallus organization; Reproduction in algae – Vegetative, Asexual (spore types) and Sexual (concept of Isogamy, Anisogamy & Oogamy); Salient features of – Cyanophyceae, Chlorophyceae, Bacillariophyceae, Phaeophyceae and Rhodophyceae; Economic importance of algae.

Unit-III: Fungi and Plant Pathology

1. **Fungi:** General characters including fungal mode of nutrition; Asexual spore forms and Sexual reproduction; General characters of- Phycomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes; Economic importance of Fungi.
2. **Plant Pathology:** Definition of- Host, Pathogen, Pathogenicity, Pathogenesis, Infection, Incubation period, Inoculum, Inoculum potential, Symptom, Causal complex, Disease cycle, Endemic disease, Epidemic disease, Sporadic disease; Koch's postulates, Types of symptoms - Necrotic, Atrophic, Hypertrophic; Symptoms, Casual organisms, symptoms and Control measures of the following diseases: Late blight of Potato, Brown sport of Rice and Black stem rust of Wheat.

Unit-IV: Bryophyta and Pteridophyta

1. **Bryophyta:** General characters including amphibian nature; General idea of Life cycle of Bryophytes; Origin of Bryophytes; Distinctive features of classes – Hepaticopsida, Anthocerotopsida and Bryopsida.
2. **Pteridophyta:** Characteristic features of Pteridophytes; Concept of Homospory and Heterospory; Concept of Eusporangiate and Leptosporangiate pteridophytes; Lifecycle of Pteridophytes (general idea); General characters of the classes Psilophytopsida, Psilotopsida, Lycopsida, Sphenopsida and Pteropsida.

2nd YEAR

Interdisciplinary Course: Fundamental Botany
SEMESTER-III
Paper-2 (Theory)

BT-301 ID - Gymnosperms, Paleobotany, Taxonomy & Economic botany

Total Marks=100 (IA =40 + ESE= 60) **(Credits=03)**

Unit-I: Gymnosperms and Paleobotany

1. **Gymnosperms:** General characters; Important characters of three classes- Cycadopsida, Coniferopsida, & Gnetopsida; Economic importance of Gymnosperms with reference to Wood, Resins, Essential oils, and Drugs; Distinctions and similarities between- Pteridophytes & Gymnosperms, Gymnosperms & Angiosperms; Distribution of species of *Cycas*, Pinus *& Gnetum* in India.

2. **Paleobotany:** Definition of Fossil; Types of fossils (Microfossil, Mega fossil and its types on the basis of nature of fossilization); Importance of fossil study; Geological time scale with dominant plant groups with ages.

Unit-II: Floral Morphology

1. **Floral morphology:** Inflorescence – Racemose & Cymose; Definition of Peduncle & Flower; Flower types, Floral parts-Calyx (types & modifications), Corolla(types & forms), Aestivation; Androecium - Stamen, Union of stamens; Gynoecium – Carpel (Apocarpous & Syncarpous), Ovary (superior & inferior), Placentation types; Process of double fertilization; Endosperm–Nuclear, Cellular and Hellobial types.

Unit-III: Taxonomy

1. **Taxonomy:** Definition of Taxonomy & Systematics, Definition of Identification, Nomenclature & Classification, Definition and example of Artificial, Natural and Phylogenetic system of classification; Principles of ICN; Herbarium and its function, Botanical Gardens and its importance; Important Herbaria and Botanical Gardens of India and world (3 each); Diagnostic characters and economically important plants of the families – Poaceae, Orchidaceae, Magnoliaceae, Solanaceae, Cucurbitaceae, Leguminosae, Compositae.

Unit-IV: Economic Botany

1. Scientific name, family, part used, and uses of following plants: **Cereal**–Rice, Wheat; **Pulses**–Moong and Lens; **Beverages**– Tea and Coffee; **Fruits**– Mango, Citrus and Papaya; **Drug yielding**–Rauwolfia, Digitalis and Andrographis; **Spices**– Ginger, Cumin and Clove; **Oil yielding**–Mustard and Groundnut; **Vegetables**–Potato, Radish and Cabbage; **Fibre yielding**– Cotton and Jute; **Timber yielding**–Teak and Sal; **Sugar yielding**– Sugarcane.

2. **Cultivation of-** Rice (conventional method) and Rubber.

Interdisciplinary Course: Fundamental Botany
SEMESTER-IV
Paper- 3 (Theory)

BT-401 ID - Anatomy, Ecology, Genetics, Molecular Biology & Plant physiology

Total Marks = 100 (IA = 40 + ESE = 60) **(Credits = 03)**

Unit-I: Plant Anatomy and Ecology

1. **Plant Anatomy:** Chemical composition and gross structure of Cell wall; Meristematic tissue – Classification on the basis of position, origin and function; Simple permanent tissues – Structure, distribution and function of parenchyma, collenchyma and sclerenchyma; Cell types of Xylem and Phloem; Vascular bundle types; General anatomical characters of monocot stem and root, Dicot stem and root.
2. **Ecology:** Basic ecological concepts of-Trophic levels, Food chain, Food web, Ecological pyramids, Energy flow; Habitat and Ecological Niche; Definition of- Population, Community and Ecological succession; Adaptations of Hydrophytes, Xerophytes and Halophytes.

Unit-II: Cytogenetics

1. **Cell Biology:** Cell cycle - various phases and events, Cell division – Mitosis and Meiosis; Structure and function of cell organelles–Plasma membrane, Nucleus, Mitochondria, Chloroplast and Ribosome; Chromosome morphology, Nucleosome concept, Euchromatin and Heterochromatin.
2. **Genetics:** Mendelian genetics - Principles of segregation and independent assortment; Concept of Dominance, Incomplete dominance & Codominance; Dominant epistasis; Linkage - Definition of complete and incomplete linkage; Crossing over, Definition of Aneuploidy, Euploidy & Polyploidy.

Unit-III: Molecular Biology

1. **Molecular Biology:** Nucleoside and Nucleotide, Watson and crick model of DNA structure; Prokaryotic DNA replication (General properties), Central dogma of molecular biology, Prokaryotic Transcription, Genetic code (properties) and Translation (prokaryotic).

Unit-IV: Plant Physiology

1. Definition of water potential, osmosis, diffusion and plasmolysis; transpiration and antitranspirants.
2. **Photosynthesis:** Light reaction– PSI & PSII, Cyclic and Non-cyclic photophosphorylation; CO_2 fixation - C3 cycle, C4 cycle.
3. **Respiration:** Glycolysis and TCA cycle.
4. **Photoperiodism:** Photoperiodic responses and classification of plants.
5. **Physiological roles of**: IAA, Gibberellin and Cytokinin.
6. **Biological Nitrogen fixation**: Root nodule formation, role of Nitrogenase and leg haemoglobin.

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6. Webster, J. and Weber, R. (2007), Introduction to Fungi, Cambridge University Press, Cambridge.

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5. Puri, P. Bryophyte, Latest Ed., Atmaram & Sons.
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