

## BOTANY

### M.Sc. (Previous) Botany

There shall be five theory papers each of 100 marks and a Practical Examination of 200 marks.

- I- Paper : Cytology, Genetics, Plant Breeding and Elementary Bio-Statistics.
- II- Paper : Biotechnology and Genetic engineering of microbes and plants.
- III- Paper : Diversity of Viruses, Bacteria, Lichens, Fungi and Elementary Plant Pathology.
- IV- Paper . Diversity of Cyanobacteria, Algae and Bryophytes.
- V- Paper : Diversity of Pteridophytes, Gymnosperms and Palaeobotany.

### M.Sc. (Final) Botany

There shall be five theory papers each of 100 marks and a Practical Examination of 200 marks.

- VI- Paper : Taxonomy, structure and Reproduction of Angiosperm
- VII- Paper : Plant Ecology and Environmental pollution
- VIII- Paper : Plant Resource Utilization and conservation.
- IX- Paper : Physiology and Biochemistry.
- X- Paper . Special papers/Project Work  
Special papers/ Project Work.  
(X a) Cytogenetics, Plant breeding and Biostatistics.  
(X b) Advanced Plant Pathology.  
(X c) Advanced Phycology.  
(X d) Environmental Science.

Students shall have to undertake at least one field trip for field work/collection and submit a report on the same for which a provision of 15 marks shall be made out of the 30 marks allotted for Record/Collection/Herbaria etc.

off of seedlings late blight of potato, red rot of sugarcane, white rust of crucifers, Wheat rust and linseed rust

Integrated pest disease management

## BOTANY

### M.Sc. (Previous) Botany

There shall be five theory papers each of 70 marks and a Practical Examination of 150 marks.

- I- Paper : Cytology, Genetics, Plant Breeding and Elementary Bio-Statistics.
- II- Paper : Biotechnology and Genetic engineering of microbes and plants.
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- VI- Paper Taxonomy, structure and Reproduction of Angiosperm.
- VII- Paper . Plant Ecology and Environmental pollution.
- VIII- Paper . Plant Diversity, Conservation and Microbiology
- IX- Paper Physiology and Biochemistry
- X- Paper . Special papers/Project Work.  
Special papers/ Project Work.  
(X a) Cytogenetics, Plant breeding and Biostatistics.  
(X b) Advanced Plant Pathology  
(X c) Advanced Phycology.  
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Students shall have to undertake at least one field trip for field

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**M.Sc. (Previous) Botany**

**First Paper: Cytology, Genetics, Plant Breeding and Elementary Bio-Statistic.**

**UNIT-I**

**Cytology:** Structural organization of plant cell . Origin structure and importance of cell wall, plasmamembrane, chloroplast, mitochondria, ribosomes endoplasmic reticulum, golgi body, microbodies, lysosomes, nucleus and nucleolus. Cell cycle, cell division and cytokinesis

**Chromosomes:** Structure, packaging of DNA, nucleolus, euchromatic and heterochromatin Specialized type of chromosomes: polytene, lampbrush, B-chromosomes and sex chromosomes.

**UNIT-II**

**Genetics .** Mendelism and gene interaction. Non-Mendelian inheritance

**Variations:** Chromosomal aberrations and their implications in meiosis. Polyploids. Induction and origin Different types of polyploidy and their role in plant breeding and evolution of crop plants.

**Mutations :** Spontaneous and induced mutations. Physical and chemical mutagens molecular basis of mutations. Role of mutations in crop improvement. DNA damage mechanisms and repair. Transposable elements in prokaryotes and eukaryotes. Site directed mutagenesis. The structure and behaviour of different types of DNA and RNA. Genetics of bacteriophages, bacteria and Neurospora.

**Modern concept of genes** Chemical structure, composition and behaviour of different types of DNA and RNA.s Gene action: Genetic code and regulation of gene activity in prokaryotes and eukaryotes.

**UNIT-III**

**Plant Breeding:** Method of plant. breeding, Graft-hybrid and chimeras. Interspecific and intergeneric hybridization. Knowledge of plant breeding work done in India specially with reference of wheat, paddy, sugarcane, cotton, potato, Cajanas, Bengal gram and Brassica. Genetic basis of inbreeding and heterosis Exploitation of hybrid vigour.

**Elementary Bio-Statistics:** Measure of dispersion, variation, standard deviation and error. Test of significance, t-Test, X<sup>2</sup> Test, F-Test, analysis of variance (Mono and bivariate). Regression and co-relation

work/collection and submit a report on the same for which a provision of 10 marks shall be made out of the 20 marks allotted for Record/Collection/Herbaria etc.

**M.Sc. (Previous) Botany**

**First Paper: Cytology, Genetics, Plant Breeding and Elementary Bio-Statistic.**

**UNIT-I**

**Cytology:** Structural organization of plant cell : Origin structure and importance of cell wall, plasmamembrane, chloroplast, mitochondria, ribosomes endoplasmic reticulum, golgi body, microbodies, lysosomes, nucleus and nucleolus Cell cycle, cell division and cytokinesis.

**Chromosomes:** Structure, packaging of DNA, nucleolus, euchromatin and heterochromatin. Specialized type of chromosomes: polytene, lampbrush, B-chromosomes and sex chromosomes

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**Genetics :** Mendelism and gene interaction. Non-Mendelian inheritance.

**Variations:** Chromosomal aberrations and their implications in meiosis Polyploids: Induction and origin. Different types of polyploidy and their role in plant breeding and evolution of crop plants.

**Mutations .** Spontaneous and induced mutations. Physical and chemical mutagens molecular basis of mutations. Role of mutations in crop improvement. DNA damage mechanisms and repair. Transposable elements in prokaryotes and eukaryotes. Site directed mutagenesis. The structure and behaviour of different types of DNA and RNA. Genetics of bacteriophages, bacteria and Neurospora

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**Second Paper : Biotechnology and Genetic Engineering of microbes and plants.**

**UNIT-I**

Biotechnology: Basic concepts, principles, scope and potentials.

**Plant cell and tissue culture:** General Introduction, history, scope, concept of cellular differentiation and totipotency.

**Application of plant tissue culture:** Clonal propagation, synthetic seeds, production of hybrids and somaclones, production of secondary metabolites/natural products, cryopreservation and germplasm storage.

Organogenesis and adventive embryogenesis:

Fundamental aspects of morphogenesis, somatic embryogenesis and androgenesis, gynogenesis, mechanisms, techniques and utility.

**Somatic hybridization:** Protoplast, isolation, fusion and culture, hybrid selection and regeneration, possibilities, achievements and limitations of protoplast research.

**Recombinant DNA technology:** Gene cloning principles and techniques, construction of genome/cDNA libraries, choice of vectors, DNA synthesis and sequencing, ploymerase chain reaction, DNA finger-printing.

**UNIT-II**

Genetic Engineering of plants: Aims, strategies for the development of transgenics (with suitable examples). Agrobacterium in the natural genetic engineering, t-DNA and transposon mediated gene tagging, chloroplast transformation and its utility, intellectual property rights, possible socio-ecological risks and ethical concerns

Microbial genetic manipulations: Bacterial transformation, selection of recombinants and transformants, genetic improvement of industrial microbes and nitrogen fixers, fermentation technology

Genomics and Proteomics: Genetic and physical mapping of genes, molecular markers for introgression of useful traits artificial chromosomes, genome projects, bioinformatics, functional genomics, protein profiling and its significance.

**UNIT-III**

Tools and Techniques for Biology. Principles and uses of analytical instruments-pH meter, calorimeter, spectrophotometer, ultracentrifuge.

**Elementary Bio-Statistics:** Measure of dispersion, variation, standard deviation and error. Test of significance, t-Test, X<sup>2</sup> Test. F-Test: analysis of variance (Mono and bivariate) Regression and co-relation.

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densitometer, atomic absorption spectrophotometer, Microscopy – Principles and uses of light and electron microscopes. Microphotography. Microbial techniques – media preparation, inoculation and growth monitoring, biochemical mutants and their uses, microbial essays. Cryotechniques – Cryopreservation of cells tissues and organisms. Separation techniques in biology – Chromatography, Electrophoresis, Organelle separation by centrifugation. Density gradient centrifugation. Radio-active isotope tracer techniques.

**Third Paper : Diversity of viruses, Bacteria, Lichens, Fungi and Elementary Plant Pathology.**

#### UNIT-I

**Bacteria:** Archaeobacteria and Eubacteria. General account of bacteria, their occurrence, ultra-structure, nutrition, forms, reproduction, classification and economic importance.

**Viruses:** A general account of plant viruses with special reference to their nature, ultrastructure, symptomatology, methods of transmission, multiplication and importance, Bacteriophages, TMV

**Mycoplasma:** General characteristics, structure and their role in causing plant diseases.

**Lichens :** A general account of lichens with particular reference of their mode of life, structure, reproduction, classification, nutrition and economic importance. A brief account of *Cladonia*, *Parmelia*, *Usnea*, *Peltigera*, *Rocella*.

#### UNIT-II

**Fungi :** General characteristic of fungi and substrate relationship. Cell ultra-structure, unicellular and multicellular organizations Cell wall composition, nutrition (saprobic, biotrophic, symbiotic). Reproduction (vegetative, asexual and sexual). Heterothallism, heterokaryosis and parasexuality. Phylogeny, inter-relationship and recent trends in classification. Economic importance of fungi. Mycorrhiza, Rhizosphere.

**A brief study of following types :** Myxomycetes *Physarum*, *Dictyostelium* or any other allied form **Phycomycetes;** *Synchytrium*, *Allomyces*, *Monoblepharis*, *Saprolegnia*, *Pythium*, *Phytophthora*, *Perenospora*, *Sclerospora*, *Albugo*, *Entomophthora* & *Mucor*, **Ascomycetes;** *Taphrina* (*Exoascus*), *Protomyces*, *Aspergillus*, *Neurospora*, *Penicillium*, *Erysiphe*, *Xylaria*, *Claviceps*, *Ascobolus*, *Peziza*, *Morchella* **Basidiomycetes.**

#### UNIT-III

**Tools and Techniques for Biology:** Principles and uses of analytical instruments-pH meter, calorimeter, spectrophotometer, ultracentrifuge, densitometer, atomic absorption spectrophotometer, Microscopy – Principles and uses of light and electron microscopes Microphotography Microbial techniques – media preparation, inoculation and growth monitoring, biochemical mutants and their uses, microbial essays. Cryotechniques – Cryopreservation of cells tissues and organisms. Separation techniques in biology – Chromatography, Electrophoresis, Organelle separation by centrifugation. Density gradient centrifugation. Radio-active isotope tracer techniques.

**Third Paper : Diversity of viruses, Bacteria, Lichens, Fungi and Elementary Plant Pathology.**

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**Viruses:** A general account of plant viruses with special reference to their nature, ultrastructure, symptomatology, methods of transmission, multiplication and importance, Bacteriophages, TMV.

**Bacteria:** Archaeobacteria and Eubacteria. General account of bacteria, their occurrence, ultra-structure, nutrition, forms, reproduction, classification and economic importance.

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**A brief study of following types :** **Myxomycotina:** *Physarum*, *Dictyostelium* or any other allied form **Phycomycotina;** *Allomyces*, *Monoblepharis*, *Saprolegnia*, *Pythium*, *Phytophthora*, *Perenospora*,

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*Ustilago, Tolyposporium, Sphacelotheca, Urocystis, Graphiola, Melempsora, Puccinia, Phragmidium, Uromyces, Polyporus, Coprinus, Lycoperdon, Deuteromycetes; Colletotrichum, Helminthosporium, Alternaria, Cercospora, Fusarium*

**Elementary Plant pathology** : General principles, classification of plant diseases, symptoms of fungal bacterial and viral diseases. Disease management, forecasting and defense mechanism. Principles of plant disease control (chemical and biological).

#### Fourth Paper : Diversity of Cyanobacteria, algae and Bryophytes

##### UNIT-I

**Cyanobacteria and Algae** : A general account of occurrence, structure, nutrition, reproduction and life cycles and classification. Ultra-structure of cell, flagella, eye-spot and chloroplast. Pigmentation and reserve food material. Origin, evolution, phylogeny and classification – endosymbiotic theory of origin of algal cell. Salient feature of major phyla of algae. Algal blooms, bio-fertilizers and Economic importance of algae. Toxic algae. Bioluminescence and Fossil algae.

**A brief study of the following types** : *Microcystis, Oscillatoria, Lyngbya, Nostoc, Anabaena, Gloeotrichia, Scytonema Porphyra, Batrachospermum, Gelidium, Corallina, Gracillaria, Polysiphonia, Chlamydomonas, Gonium, Pandorina, Eudorina, Chlorococcum, Chlorella, Scenedesmus, Oocystis, Pediastrum, Hydrodictyon, Ulva, Sphaeroplea, Stigeoclonum, Draparnaldiopsis, Frittschiella, Cladophora, Pithophora, Valonia, Coleochaete, Oedogonium, Bryopsis, Caulerpa, Codium, Helimeda, Acetabularia, Trentopohlia, Zygnema, Mougeotia, Sirogonium, Cosmarium, Chara and Nitella, Botrydium, Navicula, Cutleria, Laminaria, Sphacelaria, Dictyota.*

##### UNIT-II

**Bryophytes** : Morphology, structure reproduction, life history and distribution of Bryophytes. Fossil history, origin, evolution.

*Sclerospora, Entomophthora, Ascomycotina; Taphrina (Exoascus), Protomyces, Aspergillus, Neurospora, Penicillium, Erysiphe, Xylaria, Claviceps, Ascobolus, Peziza, Morchella Basidiomycotina; Ustilago, Tolyposporium, Sphacelotheca, Urocystis, Graphiola, Melempsora, Puccinia, Phragmidium, Uromyces, Polyporus, Coprinus, Lycoperdon, Deuteromycotina; Colletotrichum, Helminthosporium, Alternaria, Cercospora, Fusarium.*

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##### UNIT-II

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phylogeny affinities and inter-relationships. A general account of Calobryales, Marchantiales, Jungermanniales, Anthocerotales, Sphagmiales, Funariales and Polytrichales. Economic and ecological importance of Bryophytes.

A brief study of structure and reproduction of following types: Hepaticopsida: *Sphaerocarpos*, *Riella*, *Marchantia*, *Lunularia*, *Targionia*, *Plagiochasma*, *Cyathodium*, *Dumortiera*, *Conocephalum*, *Fimbriaria*, *Pellia*, *Riccardia*, *Madotheca*, *Calobryum*. Anthocerotopsida, *Anthoceros*, *Notothylus*, *Bryopsida*, *Sphagnum*, *Andreaea*, *Funaria*, *Buxbaumia*, *Pogonatum*.

### Fifth Paper : Diversity of Pteridophytes, Gymnosperms and Palaeobotany

#### UNIT-I

**Pteridophyta** : Morphology, anatomy, reproduction and life histories, Evolution of Stellar system. Heterospory and evolution of seed habit. A general account of fossil Pteridophytes. Affinities and classification. Economic importance of Pteridophytes.

A brief study of following types: Psilophytopsida: *Rhynia*, *Horneophyta*, *Psilophyton*, *Zosterophyllum*. Psilopsida: *Psilotum*, *Tmesipteris*. Lycopsida: *Protolpidodendron*, *Lycopodium*, *Selaginella*, *Isoetes*, *Lepidodendron*, *Bothrodendron*, *Pleuromeia*, *Lepidocarpon*, *Miadesmia*. Sphenopsida: *Hyenia*, *Calamophyton*, *Sphenophyllum*, *Cherostrobis*, *Calamites*, *Equisetum*. Pteropsida: *Botryopteris*, *Stauropteris*, *Etapteris*, *Ophioglossum*, *Botrychium*, *Marattia*, *Angiopteris*, *Osmunda*, *Schizaea*, *Lygodium*, *Gleichenia*, *Matonia*, *Dicksonia*, *Cyathea*, *Polypodium*, *Alsophila*, *Dryopteris*, *Adiantum*, *Asplenium*, *Marsilea*, *Salvinia*, *Azolla*.

#### UNIT-II

**Gymnosperms** : A general account of occurrence, morphology, anatomy and reproduction, origin, evolutionary trends, affinities, inter-relationships and classification of gymnosperms. Distribution of Gymnosperms in India. Economic importance of gymnosperms.

Bryophytes : Morphology, structure reproduction, life history and distribution of Bryophytes, Fossil history, origin, evolution, phylogeny affinities and inter-relationships. A general account of Calobryales, Marchantiales, Jungermanniales, Anthocerotales, Sphagmiales, Funariales and Polytrichales. Economic and ecological importance of Bryophytes.

A brief study of structure and reproduction of following types: Hepaticopsida: *Sphaerocarpos*, *Riella*, *Marchantia*, *Lunularia*, *Targionia*, *Plagiochasma*, *Cyathodium*, *Dumortiera*, *Conocephalum*, *Asterella*, *Pellia*, *Riccardia*, *Porella*, *Calobryum*, Anthocerotopsida, *Anthoceros*, *Notothylus*, Bryopsida, *Sphagnum*, *Andreaea*, *Funaria*, *Buxbaumia*, *Pogonatum*.

### Fifth Paper : Diversity of Pteridophytes, Gymnosperms and Palaeobotany

#### UNIT-I

**Pteridophyta** : Morphology, anatomy, reproduction and life histories, Evolution of Stellar system. Heterospory and evolution of seed habit. A general account of fossil Pteridophytes. Affinities and classification. Economic importance of Pteridophytes. Molecular classification of ferns allies Smith (2006).

A brief study of following types: Psilophytopsida: *Cooksonia*, *Rhynia*, *Aglaophyton*, *Horneophyta*, *Psilophyton*, *Zosterophyllum*. Psilopsida: *Psilotum*, *Tmesipteris*. Lycopsida: *Protolpidodendron*, *Lycopodium*, *Selaginella*, *Isoetes*, *Lepidodendron*, *Bothrodendron*, *Pleuromeia*, *Lepidocarpon*, *Miadesmia*. Sphenopsida: *Hyenia*, *Calamophyton*, *Sphenophyllum*, *Cherostrobis*, *Calamites*, *Equisetum*. Pteropsida: *Coenopteridales*, *Botryopteris*, *Stauropteris*, *Etapteris*, Monographic studies of *Ophioglossum*, *Botrychium*, *Angiopteris*, *Osmunda*, *Lygodium*, *Gleichenia*, *Matonia*, *Dicksonia*, *Cyathea*, *Polypodium*, *Dryopteris*, *Adiantum* and aquatic ferns, *Marsilea*, *Salvinia*, *Azolla*.

#### UNIT-II

**Gymnosperms** : A general account of occurrence, morphology, anatomy and reproduction, origin, evolutionary trends, affinities.

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**A brief account of structure and reproduction of following types :**  
 Pteridospermales : *Lyginopteris, Heterangium, Medulosa, Trigonocarpus.* Caytoniales: *Caytonia.* Cycadales: *Cycas,* Nilsoniales: *Nilsonia.* Bennettitales: *Williamsonia,* Pentoxylales : *Pentaxylon.* Cordaitales: *Callixylon, Cordiataes, Poroxylon,* Ginkgoales: *Ginkgo.* Coniferales: *Lebachia, Pinus, Abies, Cedrus, Araucaria, Cryptomeria, Taxodium, Cupressus, Thuja, Podocarpus, Cephalotaxus, Taxus.* Ephedrales: *Ephedra.* Welwitschiales : *Welwitschia.* Gnetales: *Gnetum.*

### UNIT-III

**Palaeobotany :** Formation of plant fossils, modes of preservation, methods of fossil study and their importance in stratigraphy and economic geology, Nomenclature, reconstruction, and age of fossils. Index fossils. Fossiliferous beds of India and Palaeoclimate. Standard stratigraphy scale, succession of representative floras in different geological area and their bearing on plant morphology and evolution.

#### Scheme of M.Sc. Previous Practical Examination

The Practical examination shall be of twelve hours during spread over two days and will consist of following :

1. Isolation and study of any four of the component of the mixture (A) provided. Identification of the material with the help of suitable temporary preparations diagrams and comments. 16
2. A monographic study of the provided material (B) with he help of temporary slides, comments and anatomical diagrams (Bryophytes). 14
3. Identification and study of the provided material (C) with he help of suitable doubles stained preparation, sketches and comments (Pteridophytes). 12
4. A monographic study of the provided material (D) with the help of suitable double staining permanent preparation. Identification of the material giving diagrams, comments and reasons (Gymnosperms). 18

inter-relationships and classification of Gymnosperms. Distribution of Gymnosperms in India. Economic importance of Gymnosperms.

**A brief account of structure and reproduction of following taxonomic groups, Progymnosperm Pteridospermales :**  
*Medullosales, Caytoniales: Cycadales: Nilsoniales: Glossopteridales. Bennettitales: Pentoxylales : Cordaitales: Ginkgoales: Coniferales: fossilo & living genera, Pinus, Abies, Cedrus, Araucaria, Cryptomeria, Taxodium. Cupressus, Thuja, Podocarpus, Cephalotaxus, Taxus. Ephedrales: Ephedra. Welwitschiales : Welwitschia. Gnetales: Gnetum.*

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1. Isolation and study of any four of the component of the mixture (A) provided. Identification of the material with the help of suitable temporary preparations diagrams and comments. 3x4=12
2. A monographic study of the provided material (B) with he help of temporary slides, comments and anatomical diagrams (Bryophytes). 8
3. Identification and study of the provided material (C) with he help of suitable doubles stained preparation, sketches and comments (Pteridophytes). 8
4. A monographic study of the provided material (D) with the help of suitable double staining permanent preparation. Identification of the material giving diagrams, comments and reasons (Gymnosperms). 12

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5. Study of host parasite relationship in the provided material (E) and identification of the parasite with the help of temporary preparations giving suitable diagrams, reasons and comments (Parasitic fungi). 15
6. Study and identification of the given material (F) with the help of temporary preparations, diagrams, reasons and comments. (Saprophytic Fungi). 10
7. Preparation of acetocarmine smear of the provided material (G). Tracing out of any two stages/sub-stages of cell division, their identification giving suitable sketches and comments. 10
8. Working out of the given genetical/biostatistical problems. 10
9. Emasculation of given floral bud (H) and descriptions of the technique with suitable sketches. 5

OR

10. Exercise on Chromatographic separation of pigments/amino-acids. 5
11. Exercise on tools and techniques. 5
12. Minor project on course prescribed for 2<sup>nd</sup> paper. 10
13. Spotting : 1- 10 spots (Two drawn from each paper) 20
14. Viva-voce 20
15. Seasonals, Records, Collection, Field trips etc. 30

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6. Study and identification of the given material (F) with the help of temporary preparations, diagrams, reasons and comments. (Saprophytic Fungi). 8
7. Preparation of acetocarmine smear of the provided material (G). Tracing out of any two stages/sub-stages of cell division, their identification giving suitable sketches and comments. 10
8. Working out of the given genetical problems. 5
9. Emasculation of given floral bud (H) and descriptions of the technique with suitable sketches. 5

OR

Exercise on Chromatographic separation of pigments/amino-acids.

10. One exercise on biostatistics. 5
11. Exercise on tools and techniques. 5
12. Minor project on course prescribed for 2<sup>nd</sup> paper. 10
13. Spotting : 1- 10 spots (Two drawn from each paper) each spot of one & half marks. 15
14. Viva-voce 15
15. Seasonals, Records, Collection, Field trips etc. 20

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## SUGGESTED LABORATORY EXERCISES

(As suggested by U.G.C.)

### 1. Paper First.

1. Chromosomes techniques, pre-treatment, fixation and staining techniques.
2. Study of various stages of meiosis and mitosis in suitable plant material.
3. Linear differentiations of chromosomes through banding techniques, such as G-banding, C-banding, Q-banding.
4. Orcein and Fielgen of Salivary gland chromosomes.
5. Characteristics and behaviour of B-chromosomes using maize or any other appropriate material.
6. Induction of polyploidy using colchicines, different methods of application of colchicine.
7. Estimation of nuclear DNA content through microdensitometry.
8. Exercise on emasculation and pollination in the available plant material.
9. Study of floral biology of suitable material.
10. Numerical problems on Mendelian principles/Non-Mendelian inheritance.
11. Biostatistical problems based on mean deviation, standard deviation and error,  $X^2$ , 't', F-test, variance and correlation.

### 2. Paper Second

1. Exercises on Chromatographic techniques.
2. Demonstration, exercise and use of available tools and techniques detailed in Theory paper.
3. Isolation of micro-organisms from different sources.
4. Gram's staining in Bacteria.
5. Growth characteristics of Escherichia coli using planting and

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(As suggested by U.G.C.)

### 1. Paper First.

1. Chromosomes techniques, pre-treatment, fixation and staining techniques.
2. Study of various stages of meiosis and mitosis in suitable plant material.
3. Linear differentiations of chromosomes through banding techniques, such as G-banding, C-banding, Q-banding.
4. Orcein and Fielgen of Salivary gland chromosomes.
5. Characteristics and behaviour of B-chromosomes using maize or any other appropriate material.
6. Induction of polyploidy using colchicines, different methods of application of colchicine.
7. Estimation of nuclear DNA content through microdensitometry.
8. Exercise on emasculation and pollination in the available plant material.
9. Study of floral biology of suitable material.
10. Numerical problems on Mendelian principles/Non-Mendelian inheritance.
11. Biostatistical problems based on mean deviation, standard deviation and error,  $X^2$ , 't', F-test, variance and correlation.

### 2. Paper Second

1. Exercises on Chromatographic techniques.
2. Demonstration, exercise and use of available tools and techniques detailed in Theory paper.

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turbidimetric method.

6. Visits to various laboratories & research institutions and preparation of a report on the following exercises till facilities for the same are arranged : Isolation of protoplast from various plant tissues and testing of their viability, Demonstration of androgenesis in Dhatura, DNA Finger-printing and population mapping, Preparation of various types of culture media and cultures.

### 3. Paper Third

1. A study of structure symptomology and reproduction of the available parasitic fungi prescribed in theory courses.
2. A stud of structure, culture characteristics and reproduction of saprophytic fungi prescribed in theory course.
3. Identification of available fungal culture.
4. Identification of diseases caused by viruses, mycoplasmas and bacteria (symptomology and transmission).
5. Study and identification of available Lichens prescribed in theory course.

### 4. Paper Fourth

1. Morphological and/or anatomical study of vegetative and reproductive structures and identification of the available materials prescribed in theory courses (Algae & Bryophytes)

### 5. Paper Fifth

1. Morphological and anatomical study of vegetative and reproductive structures and identification of the available materials prescribed in theory courses (Gymnosperms and Pteridophytes).
2. Study and identification of fossil specimens and/or fossil-slides.

3. Isolation of micro-organisms from different sources.

4. Gram's staining in Bacteria.

5. Growth characteristics of Escherichia coli using planting and turbidimetric method.

6. Visits to various laboratories & research institutions and preparation of a report on the following exercises till facilities for the same are arranged : Isolation of protoplast from various plant tissues and testing of their viability, Demonstration of androgenesis in Dhatura, DNA Finger-printing and population mapping, Preparation of various types of culture media and cultures.

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M.Sc. (Final) Botany

Sixth Paper : Taxonomy, structure and Reproduction of Angiosperms

UNIT-I

**Taxonomy of Angiosperms :**

**The species concept:** Taxonomic hierarchy, species, genus, family and other categories, principles used in assessing relationship, delimitation of taxa and attribution of rank. Fossil history and phylogeny of Angiosperms.

Salient feature of the International Code of Botanical Nomenclature.

**Taxonomic evidence :** Morphology, anatomy, palynology, embryology, cytology, phytochemistry, genome analysis, and nucleic acids hybridization.

**Taxonomic tools :** Herbarium, floras, histological, cytological, phytochemical, serological, biochemical and molecular techniques. Botanical garden, Herbaria. Botanical survey of India.

Systems of angiosperm classification : Phenetic versus phylogenetic systems, relative merits and demerits of major systems of classification, relevance of taxonomy to conservation. Recent trends of classification.

UNIT-II

A study of following families:

1. Dicotyledons: Magnoliaceae, Annonaceae, Rosaceae, Fabaceae, Casuarinaceae, Moraceae, Nyctaginaceae, Capparidaceae, Tamaricaceae, Violaceae, Cucurbitaceae, Caricaceae, Cactaceae, Teliaceae, Sterculiaceae, Malvaceae, Linaceae, Euphorbiaceae, Myrtaceae, Salvadoraceae, Oleaceae, Loranthaceae, Euphorbiaceae, Sapotaceae, Rutaceae, Meliaceae, Anacardiaceae, Apocynaceae, Asclepiadaceae, Rubiaceae, Bignoniaceae, Pedaliaceae, Verbenaceae, Ranunculaceae, Nymphiaceae, Piperaceae, Papavaraceae, Caryophyllaceae, Polygonaceae, Chenopodiaceae, Amarathaceae, Lythraceae, Primulaceae, Apiaceae, Asteraceae, Solanaceae.

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Convolvulaceae, Scrophulariaceae, Acanthaceae, Oxalidaceae, Boraginaceae, Lamiaceae.

2. **Monocotyledons** : Hydrocharitaceae, Commelinaceae, Musaceae, Zingiberaceae, Liliaceae, Araceae, Lemnaceae, Amaryllidaceae, Palmaceae, Orchidaceae, Cyperaceae, Poaceae.

### UNIT-III

Morphology and Morphogenesis: Meristems, organization of root and shoot apices, Anatomy of nodes, internodes. Primary and secondary structures of stem. Anomalous secondary growth. Cork cambium and its derivatives, function of cork, commercial cork. Anatomy of roots (primary and secondary structure), velamen. Anatomy of leaf, distribution and systematic significance of stomatal and cuticular structures. Morphological nature of the flower with special reference to stamen and carpel. Placentation, Organogeny and ontogeny of floral organs.

**Embryology:** Stamen, Anther, microsporogenesis and microgametogenesis. Gynocium, ovule, megasporogenesis and megagametogenesis, its organization and nutrition. Fertilization. Endosperm, its haustoria and its morphological nature. Embryos (monocot and dicot), Apomixis, Polyembryony and artificial induction of adventive embryos, control of fertilization, induced parthenogenesis, induced parthenocarpy, ovary culture and embryogeny in relation to taxonomy.

### Seventh Paper : Plant Ecology and Environmental Pollution

#### UNIT-I

**Climate, soils and vegetation patterns of the world** : Life zones, major biomes and major vegetation of the world. Soils, its origin, development, classification, structure, properties and fertility. Soil microflora and fauna. Chief soil types of India. problem soils and their reclamation.

**Vegetation Organization** : Origin of intrapopulation variations, Population and environment, ecads and ecotypes, evolution and

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differentiation of species, various models. Concepts of community and continuum, analysis of communities (analytical and synthetic characters), community coefficients, inter-specific associations, ordination, concept or ecological niche.

**Vegetation development** : Temporal changes (cyclic and non-cyclic), mechanism of ecological succession (relay floristics and initial floristic composition, facilitation, tolerance and inhibition models), changes in ecosystem properties during succession.

**Ecosystem organization** : Structure and functions, primary production (methods of measurement, global pattern, controlling factors), energy dynamics (trophic organization, energy flow pathways ecological efficiencies), litter fall and decomposition (mechanism substrate quality and climatic factors), global biogeochemical cycles of carbon, nitrogen, phosphorus and sulphur, mineral cycles (pathways, processes, budgets) in terrestrial and aquatic ecosystems.

**Biological diversity** : Concept, levels, importance and role of biodiversity in ecosystem functions and stability, speciation and extinction. IUCN categories of threat, distribution and global patterns. Megadiversity countries. Speciation and extinction and natural longevity of a species and optimum biodiversity. Causes and consequences of degeneration of biodiversity and its repercussions on the future course of evolution.

## UNIT-II

**Pollution of environment** : By organic wastes, pesticides, heavy metals mining and processing wastes and radioactive wastes. Bio-accumulation and bio-magnification, Atmospheric inversion and pollution blankets, Photochemical smog, Acid rains.

**Climatic change** : Accumulation of green house gases, global warming and its causes consequences and control. Pollution of Stratosphere, ozone layer, ozone hole and its consequences and control.

Soil pollution, loss of fertility and degradation of soils. Water pollution by organic wastes, its consequences, treatment and disposal.

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**Vegetation Organization** : Origin of intrapopulation variations. Population and environment, ecads and ecotypes, evolution and differentiation of species, various models. Concepts of community and continuum, analysis of communities (analytical and synthetic characters), community coefficients, inter-specific associations, ordination, concept or ecological niche.

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Eutrophication, the role of nitrogen and phosphorus and algal blooms. Oils spills associated problems and clean up operations.

Noise, Radioactive and thermal pollution.

**Ecosystem stability** : Concept (resistance and resilience), ecological perturbation (natural and anthropogenic) and their impact on plants and ecosystem Ecology of plant invasion. Environmental impact assessment, methods, the cost of damages and its estimation. Ecosystem restoration.

**Ecological management** : Concept, sustainable development and sustainability indicators.

**Concepts of Phytogeography** : Endemism, hotspots and hottest hotspots; plant explorations; invasions and introduction, local plant diversity and its socio-economic importance. Vegetation and floristic regions of India.

**Eighth Paper : Plant resource utilization and Conservation**

#### UNIT-I

**Plant diversity**: Concept and status in India, utilization and concerns.

**Sustainable development**: Basic objectives, concepts and strategies. Sustainable use and management of biotic and abiotic resources.

Origin of agriculture.

**World centers of primary diversity of domesticated plants**: The Indo-Burmese centre, plant introductions and secondary centre of origin.

Origin, evolution, botany, cultivation and uses of: 1. Food forage and fodder crops, 2. Fibre crops, 3. Medicinal plants and 4. Vegetable oil yielding crops.

**Important fire-wood and timber yielding plants and non wood forest products (NWFP)** : Such as bamboo, rattans, raw materials for paper making, gums, tannis, dyes, resins and fruits.

**Green revolution** : Benefits and adverse consequences.

warming and its causes consequences and control. Pollution of Stratosphere, ozone layer, ozone hole and its consequences and control.

Soil pollution, loss of fertility and degradation of soils. Water pollution by organic wastes, its consequences, treatment and disposal. Eutrophication, the role of nitrogen and phosphorus and algal blooms. Oils spills associated problems and clean up operations.

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**Strategies for conservation** : 1. In-situ conservation : Principles, practices, advantages and disadvantages, Ideal protected area, its requirements – sanctuaries, national parks, biosphere reserves, wetlands, mangroves, coral reefs. Short comings in the existing system. Management of a protected area. International efforts and Indian initiative. Protected areas in India- for conservation of wild

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Plants used as avenue trees for shade pollution control and aesthetics.

### UNIT-II

**Principles of conservation :** Extinctions. Environmental status of plants based on International Union for Conservation of nature.

**Strategies for conservation :** 1. In-situ conservation : Principles, practices, advantages and disadvantages, Ideal protected area, its requirements – sanctuaries, national parks, biosphere reserves, wetlands, mangroves, coral reefs. Short comings in the existing system. Management of a protected area. International efforts and Indian initiative. Protected areas in India- for conservation of wild biodiversity. Conservation beyond parks, sanctuaries and reserves. Restoration of degraded habitat.

**Strategies for conservation :** 2. Ex-situ conservation : Principles, practices, advantages and disadvantages. Conservation of biological diversity in botanical gardens, field, gene-banks, seed banks, in-vitro repositories, cryobank. Short coming and controversies. General account of the activities of Botanical survey of India (BSI), National Bureau of Plant Genetic resources (NBPGR), Indian Council of Agricultural Research (ICAR), Council of Scientific and Industrial Research (CSIR), The department of Biotechnology (DBT) for conservation, non-formal conservation efforts.

### Ninth Paper : Physiology and Biochemistry

#### UNIT : I

#### Plant Physiology and metabolism :

Structure of plant cell with special reference to functional aspects of cell, plasmamembrane, chloroplasts, mitochondria, ribosomes, endoplasmic reticulum, gogi bodies, peroxysomes, vacuoles and nuclei.

**Water relations :** water movement (water potential, solute potential, pressure potential, diffusion, osmosis, electro-osmosis). Water relations of cell and tissues with reference to idealized cell with an elastic wall. Water movement through soil across roots, structure

biodiversity. Conservation beyond parks, sanctuaries and reserves. Restoration of degraded habitat.

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### UNIT-II

#### Micorobiology :

Introduction to microbiology, Scope & application of microbiology, microbiology in human welfare, bioterronism, microbial diversity, microbial & phylogeny (5 kingdom & three domain system & classifications.

**Role of microorganisms :** Root nodule, nif gene organization, role of microorganism in soil (decomposition & nutrient cycling), water & air, role in industry-production & antibiotics, biofertilzers & biopesticides. Microbiology in relation to biotechnology – production of alcohol, beverages org. acid, vitamins & enzymes. Role of microorganism in sewage disposal, wter borne pathogenic microbes.

**Microbiology of waste water & solid waste treatment** – waste type solid, liquid, water, effluent treatment technique characterization : physical, chemical, biological, aerobic, anaerobic, primary, secondary and tertiary treatment.

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form and function of water, active and passive water absorption. Water movement through the vascular system of roots, stem and leaves with reference to the recent theories of ascent of sap.

**Transpiration mechanisms:** pathways of water vapour loss, (stomatal, cuticular, lenticular). Theories of stomatal movement, guttation, anti-transpirants, significance of transpiration.

**Ionic relations:** Ion transport and membrane structure (amphipathic membrane constituents, membrane protein and ion transport), Driving forces of ion (electrochemical potential gradient and diffusion, direction of active transport. Theories of ion uptake, active and passive uptake.

**Mineral nutrition :** a brief outline of micro and macronutrients and their deficiency symptoms.

## UNIT-II

**Photochemistry and Photosynthesis :** General concepts and historical background, evolution of photosynthetic apparatus. Photosynthetic pigments and light harvesting complexes, photo-oxidation of water, mechanisms of electron and proton transport. Carbon assimilation and the Calvin Cycle, photo-respiration and its significance, the C<sub>4</sub> cycle, and the CAM pathway physiological and ecological considerations.

**Respiration and lipid metabolism :** Overview of plant respiration, glycolysis, the TCA cycle, electron transport and ATP synthesis, pentose phosphate pathway, glyoxylate cycle, alternative oxidase system.

**Nitrogen fixation, nitrogen and sulphur metabolism :**

Overview, biological nitrogen fixation, nodule formation and nod factor, mechanism of nitrate uptake and reduction, ammonium assimilation, sulphate uptake transport and assimilation.

**Membrane transport and translocation of solutes:**

Comparison of xylem and phloem transport, phloem loading and unloading, membrane transport of proteins.

nuclei

**Water relations :** water movement (water potential, solute potential, pressure potential, diffusion, osmosis, electro-osmosis). Water relations of cell and tissues with reference to idealized cell with an elastic wall. Water movement through soil across roots, structure form and function of water, active and passive water absorption. Water movement through the vascular system of roots, stem and leaves with reference to the recent theories of ascent of sap.

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**Plant growth regulators and elicitors** : Physiological effects and mechanisms of action of auxins, gibberellins, cytokinins, ethylene, abscisic acid, brassinosteroids, polyamines, jasmonic acid and salicylic acid, hormone receptors, signal transduction and gene expression.

**Signal Transduction** : Overview, receptors and G-proteins, phospholipids signaling, role of cyclic nucleotides, calcium-calmodulins cascade, diversity in protein kinesis and phosphatases, specific signaling mechanisms, e.g., two component sensor-regulator system in bacteria and plants, sucrose-sensing mechanisms.

**The flowering process**: Photoperiodism and its significance, endogenous clock and its regulation, floral induction and development of genetic and molecular analysis, role of vernalization.

**Stress physiology** : Plant responses to biotic and abiotic stress, mechanisms of biotic and abiotic stress tolerance, water deficit and drought resistance, salinity stress, metal toxicity freezing and heat stress, oxidative stress.

### UNIT – III

#### Biochemistry :

**Fundamentals of Enzymology** : General aspects, allosteric mechanism, regulatory and active sites isozymes, kinetics of enzymatic catalysis. Michaelis-Menten equation and its significance.

**Energy flow** : Principles of thermodynamics, free energy and chemical potential, redox reaction, structure and function of ATP. A brief outline of classification, function and importance of carbohydrates and lipids.

**Proteins**: Structural organization, classification of aminoacids. Primary secondary and tertiary structure of proteins. Biosynthesis of Proteins.

**Pigments**: Chlorophylls, Phycobiliproteins, carotenes and xanthophylls. Biosynthesis of Chlorophyll a & b.

Chemistry and biosynthesis of Nucleic acids.

assimilation, sulphate uptake transport and assimilation.

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