

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.
- 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 70 marks and a Practical Examination of 150 marks.

- 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.
(X d) Environmental Science.

Students shall have to undertake at least one field trip for field

Amu

Gul

Shaf

Subey

Adams -9

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, X² 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

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.

Green

Gul

SNF

Subey

Adams

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, polymerase 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, X² Test. F-Test: analysis of variance (Mono and bivariate) Regression and co-relation.

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, polymerase chain reaction, DNA finger-printing.

UNIT-II

Genetic Engineering of microbes and 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.

Arjun

Arjun

Arjun

Arjun

Arjun 11

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.

Lichenes : 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.

UNIT-I

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.

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

Lichenes : 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 : **Myxomycotina:** *Physarum*, *Dictyostelium* or any other allied form **Phycomycotina;** *Allomyces*, *Monoblepharis*, *Saprolegnia*, *Pythium*, *Phytophthora*, *Perenospora*,

Lucan

Gm

Snof

Subey

Adarsh

Ustilago, Tolyposporium, Sphacelotheca, Urocystis, Graphiola, Melemptora, 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, Melemptora, Puccinia, Phragmidium, Uromyces, Polyporus, Coprinus, Lycoperdon, Deuteromycotina; Colletotrichum, Helminthosporium, Alternaria, Cercospora, Fusarium.

Elementary Plant pathology : General principles, classification of plant diseases, symptoms of fungal bacterial and viral diseases. Disease management. 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

Cellu

Gub

Sharf

Subey

Adarsh

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*. **Lycopside:** *Protolepidodendron*, *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*. **Lycopside:** *Protolepidodendron*, *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.

Leam *G. -* *Shaf* *Shaf*

Adam 14

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*, *Cordaites*, *Poroxyton*, 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 the help of temporary slides, comments and anatomical diagrams (Bryophytes). 14
3. Identification and study of the provided material (C) with the help of suitable double 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*.

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. 3x4=12
2. A monographic study of the provided material (B) with the help of temporary slides, comments and anatomical diagrams (Bryophytes). 8
3. Identification and study of the provided material (C) with the help of suitable double 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

Handwritten signatures and marks at the bottom of the left page.

Handwritten signature and mark at the bottom of the right page.

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 2nd 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

[Handwritten signatures: Gaur, Singh, Dubey]

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). 12
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 2nd 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

[Handwritten signature: Adarsh]

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 Fuelgen 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

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 Fuelgen 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.

Green *Gul* *Shaf* *Shay*

Adarsh

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.

3. Paper Third

6. A study of structure symptomology and reproduction of the available parasitic fungi prescribed in theory courses.
7. A stud of structure, culture characteristics and reproduction of saprophytic fungi prescribed in theory course.
8. Identification of available fungal culture.
9. Identification of diseases caused by viruses, mycoplasmas and bacteria (symptomology and transmission).
10. Study and identification of available Lichens prescribed in theory course.

4. Paper Fourth

2. 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

3. Morphological and anatomical study of vegetative and reproductive structures and identification of the available materials prescribed in theory courses (Gymnosperms and Pteridophytes).

Adarsh
Gub
Shaf
Subang

Adarsh

BOOKS SUGGESTED FOR M.Sc. Part I

- Alberts B., Bray D., Lewis J., Raft M., Roberts K., Watson I.D., 1999, Molecular biology of cell. Garland Publ.Co., Inc., NY.
- Alexopoulos C.J., Mims C.W., Blackwell M., 1996, Introductory Mycology, John Wiley & Sons Inc.
- Asthana D.K. and Asthana M., 2001, Environment: Problems and Solutions. 2nd Edition, S. Chand and Co. New Delhi.
- Atherly A.G., Girton J.R., McDonald J.F., 1999, The Science of Genetics. Saunders College Publ. Fort Worth, USA.
- Bhatnagar S.P., Moitra A., 1966, Gymnosperms, New Age International Pvt. Ltd., New Delhi.
- Buchanan B.B., Gruissem, W., Jones R.L., 2000 Biochemistry and Molecular Biology of plants. American Society of Plant Physiologists. Maryland, USA.
- Burnham C.R., 1962, Discussion in Cytogenetics. Burgess Publishing Co., Minnesota.
- Busch H., Rothblum L., 1982, Volume X: The Cell Nucleus rDNA. Part A. Academic Press.
- Clifton A., 1958. Introduction to the Bacteria. McGraw-Hill Book Co., NY.
- De D.N., 2000. Plant cell Vacuoles: An Introduction. CSIRO Publication, Collingwood, Australia.
- Fukui K., Nakayama S., 1996, Plant Chromosomes: Laboratory Methods. CRC Press, Boca Raton, Florida.
- Glick, B.R., Thompson J.E., 1993. Methods in Plant Molecular Biology and Biotechnology CRC Press, Boca Raton Florida.
- Glover D.M., Hames B.D. (Eds), 1995. DNA cloning 1: A practical approach. Core Techniques, 2nd Edn. PAS, IRL pPress at Oxford University Press, Oxford.
- Gunning B.E.S., Steer M.W., 1996, Plant cell biology; Structure and

4. Study and identification of fossil specimens and/or fossil-slides.

BOOKS SUGGESTED FOR M.Sc. Part I

- Alberts B., Bray D., Lewis J., Raft M., Roberts K., Watson I.D., 1999, Molecular biology of cell. Garland Publ.Co., Inc., NY.
- Alexopoulos C.J., Mims C.W., Blackwell M., 1996, Introductory Mycology, John Wiley & Sons Inc.
- Asthana D.K. and Asthana M., 2001, Environment: Problems and Solutions. 2nd Edition, S. Chand and Co. New Delhi.
- Atherly A.G., Girton J.R., McDonald J.F., 1999, The Science of Genetics. Saunders College Publ. Fort Worth, USA.
- Bhatnagar S.P., Moitra A., 1966, Gymnosperms, New Age International Pvt. Ltd., New Delhi.
- Buchanan B.B., Gruissem, W., Jones R.L., 2000. Biochemistry and Molecular Biology of plants. American Society of Plant Physiologists. Maryland, USA.
- Burnham C.R., 1962, Discussion in Cytogenetics. Burgess Publishing Co., Minnesota.
- Busch H., Rothblum L., 1982, Volume X: The Cell Nucleus rDNA. Part A. Academic Press.
- Bhattacharya, K. 2011 A text book of Palynology New Central book agency.
- Clifton A., 1958, Introduction to the Bacteria. McGraw-Hill Book Co., NY.
- De D.N., 2000. Plant cell Vacuoles: An Introduction. CSIRO Publication, Collingwood, Australia.
- Fukui K., Nakayama S., 1996, Plant Chromosomes: Laboratory Methods. CRC Press, Boca Raton, Florida.
- Glick, B.R., Thompson J.E., 1993. Methods in Plant Molecular

Handwritten signatures: Gaurav, Gaurav, Gaurav, Gaurav

Handwritten signature: Adarsh 19

function. Jones and Bartlett Publ., Boston, Mass.

Hackett P.B., Fuchs J.A., Messing J.W., 1988. An Introduction to Recombinant DNA techniques: Basic experiments in gene manipulation. The Benjamin/Cummings Publ. Co., Inc Mento Park, California.

Hall J.L., Moore A.L., 1983. Isolation of Membranes and Organelles from Plant cell. Academic Press, London.

Harris N., Oparka K.J., 1994. Plant Cell Biology: A practical Approach. IRL Press, Al Oxford Univ. Press, Oxford, UK.

Hart D.L., Jones E.W., 1998, Genetics: Principles and Analysis (4th Edition). Jones and Bartland Publ. Massachestts.

Karp G., 1999, Cell and Molecular Biology, Concepts and Experiments. John Wiley & Sons Inc. USA.

Khush G.S., 1973, Cytogenetics of Aneuploids. Academic Press, New York, London.

Kleinsmith L.J., Kish V.M., 1995. Principles of cell and Molecular Biology (2nd Ed.) Harper Collins College Publishers, NY

Krishnamurthy K.V., 2000. Methods in cell wall cytochemistry CRC Press. Boca Raton, Florida.

Kumar H.D., 1988, Introduction to Phycology, Affiliated East-West Press Ltd., New Delhi.

Lewin B., 2000, Genes VII. Oxford Univ. Press. New York.

Lewis R., 1997, Human Genetics : Concepts and Applications (2nd Edn.) WCB Mc Graw Hill, USA

Lodish H., Berk A., Zipursky S.L., Matsudaira P., Baltimore D., Darnell J., 2000. Molecular Cell Biology. Freeman and Co., NY.

Malacinski G.M. and Freidfelder D., 1998, Essentials of Molecular Biology (3rd Edn.) Jones and Bartlet Publishers Inc. London.

Mandahar C.L., 1978, Introduction to Plant Viruses, S. Chand Co.

Biology and Biotechnology. CRC Press, Boca Raton Florida.

Glover D.M., Hames B.D. (Eds), 1995. DNA cloning 1: A practical approach. Core Techniques, 2nd Edn. PAS, IRL pPress at Oxford University Press, Oxford.

Gunning B.E.S., Steer M.W., 1996, Plant cell biology; Structure and function. Jones and Bartlett Publ., Boston, Mass.

Hackett P.B., Fuchs J.A., Messing J.W., 1988, An Introduction to Recombinant DNA techniques: Basic experiments in gene manipulation. The Benjamin/Cummings Publ. Co., Inc Mento Park, California.

Hall J.L., Moore A.L., 1983. Isolation of Membranes and Organelles from Plant cell. Academic Press, London.

Harris N., Oparka K.J., 1994. Plant Cell Biology: A practical Approach. IRL Press, Al Oxford Univ. Press. Oxford, UK.

Hart D.L., Jones E.W., 1998, Genetics: Principles and Analysis (4th Edition). Jones and Bartland Publ. Massachestts.

Karp G., 1999, Cell and Molecular Biology, Concepts and Experiments. John Wiley & Sons Inc. USA.

Khush G.S., 1973, Cytogenetics of Aneuploids. Academic Press, New York, London.

Kleinsmith L.J., Kish V.M., 1995. Principles of cell and Molecular Biology (2nd Ed.) Harper Collins College Publishers, NY

Krishnamurthy K.V., 2000. Methods in cell wall cytochemistry. CRC Press. Boca Raton, Florida.

Kumar H.D., 1988, Introduction to Phycology, Affiliated East-West Press Ltd., New Delhi.

Lewin B., 2000, Genes VII. Oxford Univ. Press. New York.

Lewis R., 1997, Human Genetics : Concepts and Applications (2nd Edn.) WCB Mc Graw Hill, USA

Lodish H., Berk A., Zipursky S.L., Matsudaira P., Baltimore D., Darnell J., 2000. Molecular Cell Biology. Freeman and Co.,

Green *Gub* *2007* *2007*

11/04/04 20

Ltd. Delhi.

Mehrotra R.S., Aneja R.S., 1998, An Introduction to Mycology New Age International Press.

Morris I., 1996, An Introduction to Algae, Cambridge University Press, UK.

Pandey S.N., Sinha B.K., Plant Physiology, Plant Physiology, Latest Edn. Vikas Publ. New Delhi.

Pandeyh S.N., Chadha A., Plant Anatomy and Embryology. Latest Edn. Vikas Pbl. New Delhi.

Pandey S.N., Chadha A., Economic Botany. Latest Edn. Vikas Publ. New Delhi.

Pandeyh S.N., Trivedi P.S., A Text Book of Algae. Latest Edn. Vikas Publ. New Delhi.

Parihar N.S., 1991, Bryophyta, Central. Book Depot., Allahabad.

Parihar N S., 1996, Biology and Morphology of Pteridophytes, Central Book Depot, Allahabad.

Puri P., 1980, Bryophytes. Atma Ram & Sons, New Delhi.

Rangaswamy G., Mahadevan A., 1999, Diseases of crop plants in India (4th Edn.) Prentice-Hall of India. Pvt. Ltd. New Delhi.

Rost T., et al, 1998. Plant Biology. Wadsworth Publishing Co., California.

Round F.E., 1986, The Biology of Algae. Cambridge Univ. Press, Cambridge.

Russel P.J., 1998. Genetics (5th Edn.) The Benjamin/Cummings Publ. Co. Inc. USA.

Sharma A.K., Sharma A., 1999, Plant Chromosomes: Analysis, Manipulations and Engineering. Harwood Academic Publ. Australia.

Shaw C.H. (Ed.), 1988. Plant Molecular Biology : A practical Approach. IRL Press, Oxford.

NY.

Malacinski G.M. and Freidfelder D., 1998, Essentials of Molecular Biology (3rd Edn.) Jones and Bartlett Publishers Inc. London.

Mandahar C.L., 1978, Introduction to Plant Viruses, S. Chand Co. Ltd. Delhi.

Mehrotra R.S., Aneja R.S., 1998, An Introduction to Mycology New Age International Press.

Morris I., 1996, An Introduction to Algae, Cambridge University Press, UK.

Pandey S.N., Sinha B.K., Plant Physiology, Plant Physiology, Latest Edn. Vikas Publ. New Delhi.

Pandeyh S.N., Chadha A., Plant Anatomy and Embryology. Latest Edn. Vikas Pbl. New Delhi.

Pandey S.N., Chadha A., Economic Botany. Latest Edn. Vikas Publ. New Delhi.

Pandeyh S.N., Trivedi P.S., A Text Book of Algae. Latest Edn. Vikas Publ. New Delhi.

Parihar N S., 1991, Bryophyta, Central Book Depot., Allahabad.

Parihar N.S., 1996, Biology and Morphology of Pteridophytes, Central Book Depot., Allahabad.

Puri P., 1980, Bryophytes. Atma Ram & Sons, New Delhi.

Rangaswamy G., Mahadevan A., 1999. Diseases of crop plants in India (4th Edn.) Prentice-Hall of India. Pvt. Ltd. New Delhi.

Rost T., et al, 1998. Plant Biology Wadsworth Publishing Co., California.

Round F.E., 1986, The Biology of Algae. Cambridge Univ. Press, Cambridge.

Russel P.J., 1998. Genetics (5th Edn.) The Benjamin/Cummings Publ. Co. Inc. USA.

Sharma A.K., Sharma A., 1999. Plant Chromosomes: Analysis,

Sharma *Gupta* *Sharma* *Pandey*

Adarsh 21

Snustad D.P., Sommons M.J., 2000 Principles of Genetics (2nd Edn.). John Viley and Sons Inc. USA.

Sporne K.K., 1991, The Morphology of Pteridophytes. B.I. Publishing Pvt. Ltd., Bombay.

Stewart W.N., Rathwell G.W., 1993, Palaeobotany and the Evolution of Plants. Cambridge University Press, Cambridge.

Webster, J., 1985, Introduction to Fungi. Cambridge University Press, Cambridge.

Wolfe S.L., 1993, Molecular and Cellular Biology. Wadsworth Publ. Co., California.

Manipulations and Engineering. Harwood Academic Publ. Australia.

Shaw C.H. (Ed.), 1988. Plant Molecular Biology : A practical Approach. IRL Press, Oxford.

Snustad D.P., Sommons M.J., 2000 Principles of Genetics (2nd Edn.). John Viley and Sons Inc. USA.

Sporne K.K., 1991, The Morphology of Pteridophytes. B.I. Publishing Pvt. Ltd., Bombay.

Stewart W.N., Rathwell G.W., 1993, Palaeobotany and the Evolution of Plants. Cambridge University Press, Cambridge.

Udar, R. 1976. Bryology in India Chronic Botanica Co.

Vashishta, B.R., A.K. Sinha & V.P. Singh, 2012 Botany for Degree Students : Algae. S. Chand & Co.Ltd., New Delhi.

Vashishta, B.R., A.K. Sinha & Anil Kumar, 2010 Botany for Degree Students : Fungi. S. Chand & Co.Ltd., New Delhi.

Vashishta, B.R., A.K. Sinha & Adarsh Kumar, 2014 Botany for Degree Students : Bryophyta. S. Chand & Co.Ltd., New Delhi.

Vashishta, P.C., A.K. Sinha & Anil Kumar, 2006 Botany for Degree Students : Pteridophyta. S. Chand & Co.Ltd., New Delhi.

Vashishta, P.C., A.K. Sinha & Anil Kumar, 2006 Botany for Degree Students : Gymnosperm. S. Chand & Co.Ltd., New Delhi.

Webster, J., 1985, Introduction to Fungi. Cambridge University Press, Cambridge.

Wolfe S.L., 1993, Molecular and Cellular Biology. Wadsworth Publ. Co., California.

Handwritten signatures and initials:
 [Signature] [Initials] [Signature] [Signature]

Handwritten signature:
 [Signature]

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.

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, Ranunculaceae, Annonaceae, Nymphiaceae, Rosaceae, Fabaceae, Casuarinaceae, Moraceae, Nyctaginaceae, Capparidaceae, Tamaricaceae, Violaceae, Cucurbitaceae, Caricaceae, Cactaceae, Teliaceae, Sterculiaceae.

Green *Gul* *Saf* *Subay*

Aden

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

2. **Monocotyledons** : Hydrocharitaceae, Commelinaceae, Musaceae, Zingiberaceae, Liliaceae, Araceae, Lemnaceae, Amarylidaceae, 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

Malvaceae, Linaceae, Euphorbiaceae, Myrtaceae, Salvadoraceae, Oleaceae, Loranthaceae, Sapotaceae, Rutaceae, Meliaceae, Anacardiaceae, Apocynaceae, Asclepiadaceae, Rubiaceae, Bignoniaceae, Pedaliaceae, Verbenaceae, Piperaceae, Papavaraceae, Caryophyllaceae, Ploygonaceae, Chenopodiaceae, Amarathaceae, Lythraceae, Primulaceae, Apiaceae, Asteraceae, Solanaceae, Convolvulaceae, Scrophulariaceae, Acanthaceae, Oxalidaceae, Boraginaceae, Lamiaceae.

2. **Monocotyledons** : Hydrocharitaceae, Commelinaceae, Musaceae, Zingiberaceae, Liliaceae, Araceae, Lemnaceae, Amarylidaceae, 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,

Acclm *Gub* *San* *Shrey*

Alara 24

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 9cyclic 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.

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 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 9cyclic 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

Sum *Gul* *Shaf* *Shah*

Adam 25

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.

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 Diversity, Conservation & Microbiology

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.

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. Shortcomings in the existing system. Management of a protected area. International efforts and Indian initiative. Protected areas in India- for conservation of wild

Sum

Ch

Shaf

Shay

Adams

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.

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.

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, biofertilizers & 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.

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

Alam

Gul

Shaf

Shay

Adarsh 27

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 C₄ 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.

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 C₄ 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

Lucas

Gib

Zarif

Zubey

Adam 28

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.

Membrane transport and translocation of solutes:

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

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

Amu *Gul* *Sharf* *Subay*

Adnan 29

Tenth Paper : Special papers/Project Work.

- (X a) Advanced Plant Pathology.
- (X b) Cytogenetics and Plant Breeding.
- (X c) Advance Phycology.
- (X d) Environmental Science.
- (X a) Advanced Plant Pathology.

UNIT-I

1. History of plant Pathology. Concept and component of plant diseases. Types and causes of plant diseases.
2. Production and dispersal of inoculum and predisposition (Its development in relations to Environment).
3. Physiology of parasitism (Pre-penetration, penetration. post-penetration phase).
4. Role of Enzymes and toxins in disease development.
5. Defence mechanism (structural and biochemical).
6. Epiphytotics and disease forecasting.
7. Management of Disease : Prophylaxis and immunization. Plant quarantine, Physical methods of plant disease control. Biological control, Fungicides and Chemotherapy. Means of securing resistant varieties.
8. Preparation of media : Koch's postulates, Isolation, inoculation and pathogenicity.
9. Genetics of Pathogenesis.
10. Breeding for disease resistance.

UNIT-II

Plant diseases and their control:

Wheat : Rust (Black Yellow and Brown), Loose smut, Bunt, Alternaria leaf spot, Tondu, Ear cockle. **Barley** : Covered smut, Molya disease. **Paddy**: Blast disease, Helminthosporium leaf spot.

Proteins.

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

Chemistry and biosynthesis of Nucleic acids.

Tenth Paper : Special papers/Project Work.

- (X a) Advanced Plant Pathology
- (X b) Cytogenetics and Plant Breeding.
- (X c) Advance Phycology.
- (X d) Environmental Science.
- (X a) Advanced Plant Pathology.

UNIT-I

1. History of plant Pathology. Concept and component of plant diseases. Types and causes of plant diseases.
2. Production and dispersal of inoculum and predisposition (Its development in relations to Environment).
3. Physiology of parasitism (Pre-penetration, penetration. post-penetration phase).
4. Role of Enzymes and toxins in disease development.
5. Defence mechanism (structural and biochemical).
6. Epiphytotics and disease forecasting.
7. Management of Disease : Prophylaxis and immunization. Plant quarantine, Physical methods of plant disease control. Biological control, Fungicides and Chemotherapy. Means of securing resistant varieties.
8. Preparation of media : Koch's postulates, Isolation, inoculation and pathogenicity.
9. Genetics of Pathogenesis.
10. Breeding for disease resistance.

Amur

Gub

Prof

Barley

Adams

false smut, bacterial leaf blight, bunt, khaira, pansukh (tip-burn), ufra disease. **Maize:** Smut. **Sorghum:** Grain smut, head smut. **Bajra:** Green ear disease, smut, ergot. **Gram:** Rust, Blight. **Pea :** Powdery mildew, rust. **Arhar:** Wilt, yellow mosaic. **Bean:** Anthracnose. Ground nut: Tikka disease. Linseed : Rust, wilt. Brassica: Club root, White rust, Alternaria blight. **Sesamum:** Phyllody. **Sugarcane :** Red rot, whip smut, red strip, grassy shoot, mosaic. **Potato :** Late blight, mosaic, leaf roll, brown rot. **Cotton:** Angular leaf spot wilt. **Tobacco:** Mosaic. Cucurbita: Downy mildew, posdery mildew, mosaic disease. **Cabbage :** Alternaria blight, root knot. **Tomato:** Blight, leaf curl. **Bhindi:** Yellow vein. Brinjal: Little Leaf. Coriander: Stem gall. Turmeric: Leaf spot (*Taphrina maculans*). Chillies: Anthracnose, die back, leaf curl. **Onion:** Smut **Mango:** Anthracnose, black tip. Grapes: Downy mildew. **Papaya:** Leaf curl. **Banana:** Bunchy top and Panama disease. **Citrus:** Canker, curling, gummosis.

(X b) Cytogenetics and Plant breeding:

UNIT-I Cytogenetics

Chromosomes: Structure and function normal prokaryotic and eukaryotic chromosomes, Karyotype analysis and their bearing on evolution. Chromosome banding patterns. Special forms of chromosomes: ptylene, lampbrush, B-chromosomes and sex chromosomes. Cell cycle and behaviour of chromosomes during meiotic division, mechanisms and theories of crossing over, recombination models, cytological basis and role of synaptonemal complex.

Structural changes in chromosomes: Deficiencies and duplication, inversion and translocation, their cytological consequences, gene mapping and other uses.

Numerical variations in Chromosomes: Aneuploidy and Euploidy, classification, Cytogenetics, segregations, evolutionary significance and uses in basic and applied research. Synthesis of natural and new ploidyploids. Haplontic, Diplontic barriers and means to over come them.

Mendelian principles: Gene interactions, qualitative and quantitative characters, multiple allele hypothesis. Isoalleles, pseudoalleles and

UNIT-II

Plant diseases and their control:

Wheat : Rust (Black Yellow and Brown), Loose smut, Bunt, Alternaria leaf spot, Tundu, Ear cockle. **Barley :** Covered smut, Molya disease. **Paddy:** Blast disease, Helminthosporium leaf spot, false smut, bacterial leaf blight, bunt, khaira, pansukh (tip-burn), ufra disease. **Maize:** Smut. **Sorghum:** Grain smut, head smut. **Bajra:** Green ear disease, smut, ergot. **Gram:** Rust, Blight. **Pea :** Powdery mildew, rust. **Arhar:** Wilt, yellow mosaic. **Bean:** Anthracnose. Ground nut: Tikka disease. Linseed : Rust, wilt. Brassica: Club root, White rust, Alternaria blight. **Sesamum:** Phyllody. **Sugarcane :** Red rot, whip smut, red strip, grassy shoot, mosaic. **Potato :** Late blight, mosaic, leaf roll, brown rot. **Cotton:** Angular leaf spot wilt. **Tobacco:** Mosaic. Cucurbita: Downy mildew, posdery mildew, mosaic disease. **Cabbage :** Alternaria blight, root knot. **Tomato:** Blight, leaf curl. **Bhindi:** Yellow vein. Brinjal: Little Leaf. Coriander: Stem gall. Turmeric: Leaf spot (*Taphrina maculans*). Chillies: Anthracnose, die back, leaf curl. **Onion:** Smut **Mango:** Anthracnose, black tip. Grapes: Downy mildew. **Papaya:** Leaf curl. **Banana:** Bunchy top and Panama disease. **Citrus:** Canker, curling, gummosis.

(X b) Cytogenetics and Plant breeding:

UNIT-I Cytogenetics

Chromosomes: Structure and function normal prokaryotic and eukaryotic chromosomes, Karyotype analysis and their bearing on evolution. Chromosome banding patterns. Special forms of chromosomes: ptylene, lampbrush, B-chromosomes and sex chromosomes. Cell cycle and behaviour of chromosomes during meiotic division, mechanisms and theories of crossing over, recombination models, cytological basis and role of synaptonemal complex.

Structural changes in chromosomes: Deficiencies and duplication, inversion and translocation, their cytological consequences, gene mapping and other uses.

Numerical variations in Chromosomes: Aneuploidy and Euploidy,

Handwritten signatures and marks at the bottom left of the page.

Handwritten signature and marks at the bottom right of the page.

pleiotropism. Linkage, linkage detection and estimation in various organisms (Virus, Bacteria, Fungi and Eukaryotes). Mechanism of sex determination, sex-linked and sex influences and sex limited traits.

Modern concept of genes: Genetic material – nature, organization, fine structure of DNA, RNA. DNA content variations. Types of DNA sequences, unique and repetitive sequences. VNTRs minisatellites and microsatellites. DNA packaging in eukaryotic chromosomes, Genomics in prokaryotes and eukaryotes. Organelle genome, gene amplification and its significance. Mechanisms of DNA replication and recombination in prokaryotes and eukaryotes. DNA sequencing, split genes, alternative splicing, trans-splicing, pseudogenes, overlapping genes, nested genes.

Mechanism of transcription and its regulation in prokaryotes and eukaryotes, enhancers, suppressors, transcriptomes, transcription factors and their role. mRNA processing, ribozymes and RNA editing. Translation or protein synthesis in prokaryotes and eukaryotes, ribosomes, tRNA and translational factors, proteiomics.

Genetic codes : gene regulation in prokaryotes and eukaryotes Environmental influence on gene expression, transposases and their influence on gene expression.

Extra-chromosomal inheritance, interactions among nuclear, mitochondrial and chloroplast genomes.

Population genetics: Hardy Weinberg equilibrium, changes in genes and genotypes frequencies under selection, migration, mutation and genetic drift. Quantitative inheritance.

Mutation : a general account with special reference to gene mutations. Experimental mutagenesis – physical and chemical mutagens and mode of their action. Somatic variations, biochemical mutations, frame shift. Repair of mutagenic damage. Screening techniques and selection procedures of induced mutations.

classification, Cytogenetics, segregations, evolutionary significance and uses in basic and applied research. Synthesis of natural and new ploidyploids. Haplontic, Diplontic barriers and means to over come them.

Mendelian principles: Gene interactions, qualitative and quantitative characters, multiple allele hypothesis. Isoalleles, pseudoalleles and pleiotropism. Linkage, linkage detection and estimation in various organisms (Virus, Bacteria, Fungi and Eukaryotes). Mechanism of sex determination, sex-linked and sex influences and sex limited traits.

Modern concept of genes: Genetic material – nature, organization, fine structure of DNA, RNA. DNA content variations. Types of DNA sequences, unique and repetitive sequences. VNTRs minisatellites and microsatellites. DNA packaging in eukaryotic chromosomes, Genomics in prokaryotes and eukaryotes. Organelle genome, gene amplification and its significance. Mechanisms of DNA replication and recombination in prokaryotes and eukaryotes. DNA sequencing, split genes, alternative splicing, trans-splicing, pseudogenes, overlapping genes, nested genes.

Mechanism of transcription and its regulation in prokaryotes and eukaryotes, enhancers, suppressors, transcriptomes, transcription factors and their role. mRNA processing, ribozymes and RNA editing. Translation or protein synthesis in prokaryotes and eukaryotes, ribosomes, tRNA and translational factors, proteiomics.

Genetic codes : gene regulation in prokaryotes and eukaryotes Environmental influence on gene expression, transposases and their influence on gene expression.

Extra-chromosomal inheritance, interactions among nuclear, mitochondrial and chloroplast genomes.

Population genetics: Hardy Weinberg equilibrium, changes in genes and genotypes frequencies under selection, migration, mutation and genetic drift. Quantitative inheritance.

Mutation : a general account with special reference to gene mutations. Experimental mutagenesis – physical and chemical

Adarsh

Gurpreet

Shaf

Arshdeep

Adarsh

UNIT-II Plant breeding:

Methods and Objectives of Plant Breeding:

Introduction, domestication and acclimatization. Patterns of evolution in crop plants. Centres of origin, gene pool, concept and gene introgression. Plant genetic resources, collection, evaluation and conservation of germplasm. Gene banks.

Selections: different methods of selection, criteria of selection, selection limits, multitrait selection and construction of selection index.

Hybridization : Breeding methods of self, cross pollinated and vegetatively crops, pedigree and bulk selection. Mass selection, recurrent selection and population improvement. Breeding composite and synthetic populations. Methods of breeding for disease, pest and drought resistance.

Heterosis – concept and theories. Inbreeding depression. Development and improvement of heterotic pools and inbred lines. Genetics of self-incompatibility. Production of hybrid seeds. Male sterility and its restoration mechanisms in hybrid seeds. Male sterility and its restoration mechanisms in hybrid breeding. Genetic characteristic of pureline, inbred lines, hybrids, clones, mixtures and multilines composites and synthetics, their maintenance and multiplication Heritability and genetic advance.

Mutation breeding and distant hybridization in plant breeding. Use of ployploidy in plant breeding.

Biotechnology and genetic engineering in relation to crop improvement.

Crop improvement in wheat, maize, paddy, sugar cane, pulses, oil seeds, potato and cotton with reference to work done in India.

(X c) Advanced Phycology UNIT-I General Aspects

1. Nature of Oceanic algal life.
2. Distribution pattern of marine algal forms on Indian sea coast.

mutagens and mode of their action. Somoclonal variations, biochemical mutations, frame shift. Repair of mutagenic damage. Screening techniques and selection procedures of induced mutations.

UNIT-II Plant breeding:

Methods and Objectives of Plant Breeding:

Introduction, domestication and acclimatization. Patterns of evolution in crop plants. Centres of origin, gene pool, concept and gene introgression. Plant genetic resources, collection, evaluation and conservation of germplasm. Gene banks.

Selections: different methods of selection, criteria of selection, selection limits, multitrait selection and construction of selection index.

Hybridization : Breeding methods of self, cross pollinated and vegetatively crops, pedigree and bulk selection. Mass selection, recurrent selection and population improvement. Breeding composite and synthetic populations. Methods of breeding for disease, pest and drought resistance.

Heterosis – concept and theories. Inbreeding depression. Development and improvement of heterotic pools and inbred lines. Genetics of self-incompatibility. Production of hybrid seeds. Male sterility and its restoration mechanisms in hybrid seeds. Male sterility and its restoration mechanisms in hybrid breeding. Genetic characteristic of pureline, inbred lines, hybrids, clones, mixtures and multilines composites and synthetics, their maintenance and multiplication Heritability and genetic advance.

Mutation breeding and distant hybridization in plant breeding. Use of ployploidy in plant breeding.

Biotechnology and genetic engineering in relation to crop improvement.

Crop improvement in wheat, maize, paddy, sugar cane, pulses, oil

Handwritten signatures and initials: Gmb, snuf, and others.

Handwritten signature: 33

3. Isolation, purification, culture and mass culture of algae.
4. Ecological habitats of algae and influence of ecological factors on growth of algae
5. Water blooms their importance in nature and control of algal nuisance.
6. Symbiotic associations with algae.
7. Biochemistry of algal pigments, reserve food material and cell wall composition.
8. Ultrastructure of algae of different phyla and modern systems of classification.

UNIT-II

1. Role of algae as food and fodder.
2. Role of algae in Industry.
3. Study of soil communities and role of terrestrial algae in relation to user land reclamation.
4. Role of algae in agriculture with reference to rice fields and biological nitrogen fixation.
5. Extra-cellular products of algae, growth promoting and growth inhibiting substances of algae with special reference to their role in the production of antibiotics.
6. Algae and environmental pollution with reference to water pollution and its role in municipal water supplies and industrial effluents. Algae as ecological indicators.
7. Sewage biology and role of algae in purification of sewage.
8. Effect of water pollutants especially industrial effluents on quantitative, qualitative growth and composition.
9. Study algal virus with special reference to isolation and assay of cyanophages.
10. Control of undesirable algae.

seeds, potato and cotton with reference to work done in India

(X c) Advanced Phycology UNIT-I General Aspects

1. Nature of Oceanic algal life.
2. Distribution pattern of marine algal forms on Indian sea coast.
3. Isolation, purification, culture and mass culture of algae.
4. Ecological habitats of algae and influence of ecological factors on growth of algae.
5. Water blooms their importance in nature and control of algal nuisance.
6. Symbiotic associations with algae.
7. Biochemistry of algal pigments, reserve food material and cell wall composition.
8. Ultrastructure of algae of different phyla and modern systems of classification.

UNIT-II

1. Role of algae as food and fodder.
2. Role of algae in Industry.
3. Study of soil communities and role of terrestrial algae in relation to user land reclamation.
4. Role of algae in agriculture with reference to rice fields and biological nitrogen fixation.
5. Extra-cellular products of algae, growth promoting and growth inhibiting substances of algae with special reference to their role in the production of antibiotics.
6. Algae and environmental pollution with reference to water pollution and its role in municipal water supplies and industrial effluents. Algae as ecological indicators.
7. Sewage biology and role of algae in purification of sewage.

Handwritten signatures and initials: Gurpreet, Singh, Dubey

(X d) Environmental Sciences

UNIT-I

A brief outline of earth's environment and its evolution

Atmosphere, the aquatic environment, lotic and lentic systems, their physio co-chemical and biological characteristics.

Lithosphere, its composition and characteristics. The rocks of earth's crust, their decomposition and the development of soil, its chemical and biological nature and properties.

Biosphere, its components, trophic structure and the impact of human activity on its constitution. Biological diversity, its importance, pattern of degeneration, causes and consequences of its diminution. Likely changes in future climate and their repercussions on the biological diversity and future course of evolution. Strategies for the conservation of biological diversity. A brief outline of the national and international conservation efforts being carried out by governments and non-government organizations.

Natural Resources : their types (fertile soils, fresh water, mineral and energy resources, live-stock, fisheries, forests and wild life). Finite nature of natural resources, their over exploitation and consequences thereof.

UNIT-II

Pollution of environment : Major types of pollutants – biodegradable, non-degradable and persistent pollutants. Metabolism and environmental fate of pollutants. Bio-accumulation, bio-magnification and degradation of waste material. Bio-geochemical cycles of carbon, oxygen, nitrogen, phosphorus sulphur and changes induced by man and consequences thereof Efforts being done to stabilized the biogeochemical cycles.

Air pollution : Meteorological conditions and air pollution. Major pollutants of the atmosphere (Oxides of carbon, nitrogen and sulphur, ozone, hydrocarbons and particulates), their origin, effects on plant and animal life and clearance from the atmosphere. Causes, consequences and control of Global warming. Stratospheric ozone

8. Effect of water pollutants especially industrial effluents on quantitative, qualitative growth and composition.

9. Study algal virus with special reference to isolation and assay of cyanophages.

10. Control of undesirable algae.

(X d) Environmental Sciences

UNIT-I

A brief outline of earth's environment and its evolution

Atmosphere, the aquatic environment, lotic and lentic systems, their physio co-chemical and biological characteristics.

Lithosphere, its composition and characteristics. The rocks of earth's crust, their decomposition and the development of soil, its chemical and biological nature and properties.

Biosphere, its components, trophic structure and the impact of human activity on its constitution. Biological diversity, its importance, pattern of degeneration, causes and consequences of its diminution. Likely changes in future climate and their repercussions on the biological diversity and future course of evolution. Strategies for the conservation of biological diversity. A brief outline of the national and international conservation efforts being carried out by governments and non-government organizations.

Natural Resources : their types (fertile soils, fresh water, mineral and energy resources, live-stock, fisheries, forests and wild life). Finite nature of natural resources, their over exploitation and consequences thereof.

UNIT-II

Pollution of environment : Major types of pollutants – biodegradable, non-degradable and persistent pollutants, Metabolism and environmental fate of pollutants. Bio-accumulation, bio-magnification and degradation of waste material. Bio-geochemical cycles of carbon, oxygen, nitrogen, phosphorus sulphur and changes induced by man and consequences thereof. Efforts being done to

Handwritten signatures and marks at the bottom left of the page.

Handwritten signature and the page number 35 at the bottom right of the page.

depletion, Photochemical smog and Acids rains.

Water Pollution : Domestic effluents, their characteristics, primary, secondary and tertiary methods of their treatment and disposal. Industrial effluents, their characteristics, treatment and disposal. Crude oil pollution, problems caused by oil spills and their clean up operations. Effects of water pollution on aquatic life. Effect of pollution on productivity of the aquatic system and recovery from pollution.

Soil pollution : Origin, behaviour, treatment and disposal of pollutants of the soil with special reference to municipal garbage, pesticides, heavy metals (Lead, Mercury, Cadmium, Chromium, Arsenic, Copper and lead). Mining and processing wastes. Biological aspects of sanitary land fills and composting.

Thermal and noise pollution : Its causes and consequences and impact on living systems

Radio-activity, its persistence and affects on biological systems. Consequences of enhanced levels of radio-activity on the biosphere.

Environmental degradation, emergence of public awareness and evolution of National and International Legal Framework to prohibit activities leading to degradation of environment and wild life.

UNIT-III

Environmental Management : Sustainable development – objectives and strategies. Control of environmental pollution, conservation of natural resources and wild-life.

Environmental monitoring : Monitoring of air, water and soil to assess the state deterioration of environmental quality. Biomonitoring and use of biological indicators of environmental quality.

Exposure of biological systems to environmental contaminants, its fate, absorption, behaviour and elimination. Exposure risk and Environmental impact assessment.

stabilized the biogeochemical cycles.

Air pollution : Meteorological conditions and air pollution. Major pollutants of the atmosphere (Oxides of carbon, nitrogen and sulphur, ozone, hydrocarbons and particulates), their origin, effects on plant and animal life and clearance from the atmosphere. Causes, consequences and control of Global warming, Stratospheric ozone depletion, Photochemical smog and Acids rains.

Water Pollution : Domestic effluents, their characteristics, primary, secondary and tertiary methods of their treatment and disposal. Industrial effluents, their characteristics, treatment and disposal. Crude oil pollution, problems caused by oil spills and their clean up operations. Effects of water pollution on aquatic life. Effect of pollution on productivity of the aquatic system and recovery from pollution.

Soil pollution : Origin, behaviour, treatment and disposal of pollutants of the soil with special reference to municipal garbage, pesticides, heavy metals (Lead, Mercury, Cadmium, Chromium, Arsenic, Copper and lead). Mining and processing wastes. Biological aspects of sanitary land fills and composting.

Thermal and noise pollution : Its causes and consequences and impact on living systems.

Radio-activity, its persistence and affects on biological systems. Consequences of enhanced levels of radio-activity on the biosphere.

Environmental degradation, emergence of public awareness and evolution of National and International Legal Framework to prohibit activities leading to degradation of environment and wild life.

UNIT-III

Environmental Management : Sustainable development – objectives and strategies. Control of environmental pollution, conservation of natural resources and wild-life.

Environmental monitoring : Monitoring of air, water and soil to assess the state deterioration of environmental quality. Biomonitoring and use of biological indicators of environmental quality.

Green *G* *Surf* *Subay*

Adarsh 36

Scheme of M.Sc. Final Practical examination;

M.Sc. Final practical examination shall be of 12 hours duration spread over two days and shall consist of a set of exercises of 150 marks for papers VI to IX and of 50 marks for special/elective papers/project work.

Time : 12 hours

Max. Marks : 200

1. Description of two plant specimen provided in semitechnical language and their assignment to their respective systematic position (up to family level) giving suitable sketches, reasons, floral formula and diagrams. 4+4=8
2. Preparation of double stained permanent slide of the angiospermic material. Description of the characters of anatomical interest. Identification giving reasons for the same. 8
3. One exercises on embryology/morphology.
4. One exercise on provided material with the help of sections to study features of ecological interest. 4
5. One exercise on the ecological experiment provided or experimental data provided. 8
6. Two exercises or experiments on Environmental factors 4+ 4 = 8
7. One exercise on Physiological experiment to be set up and described by the candidate. 10
8. Description of the principles involved and comments on one physiological experiment which has already been set. 6
9. One exercise on biochemistry. 6
10. One exercise on morphology/anatomy/microchemical test on food and forage crop. 6
11. One exercise on morphology/structure/microscopic study of any two fibres. 4+4=8
12. Comments, identification importance and uses of any two plants of medicinal value. 8

Exposure of biological systems to environmental contaminants, its fate, absorption, behaviour and elimination. Exposure risk and Environmental impact assessment.

Scheme of M.Sc. Final Practical examination;

M.Sc. Final practical examination shall be of 12 hours duration spread over two days and shall consist of a set of exercises of 110 marks for papers VI to IX and of 40 marks for special/elective papers/project work.

Time : 12 hours

Max. Marks : 150

1. Description of two plant specimen provided in semitechnical language and their assignment to their respective systematic position (up to family level) giving suitable sketches, reasons, floral formula and diagrams. 4+4=8
2. Preparation of double stained permanent slide of the angiospermic material. Description of the characters of anatomical interest. Identification giving reasons for the same. 7
3. One exercise on provided material with the help of sections to study features of ecological interest. 4
4. One exercise on the ecological experiment provided or experimental data provided. 4
5. One experiment on Environmental pollution. 4
6. One experiment on soil science to be set up and described by the candidate 3
7. Gram staining. 8
8. Isolation and identification of microbes. 7
9. Perform physiological experiment to be set up and described by the candidate. 6
10. Description of the principles involved and comments on one

[Handwritten signatures]

[Handwritten signature] 37

13. Practicals on Special/Elective Papers which shall consist of laboratory/field exercises, separate spotting and project work etc.	50
14. Spotting (1-10 spots each of 2 marks).	20
15. Viva-voce	20
16. Record/Collections/Field trip/Project work etc.	30

SUGGESTED PRACTICAL EXERCISES FOR M.Sc. FINAL

VI- Papers:

1. Detailed description and identification of locally available flowering plants of the families prescribed in theory course.
2. Study and observation on anatomy (normal and anomalous) of plant parts by sectioning, staining and preparation of permanent slides.
3. Preparation of smears for study of gametophytes and micro-dissections for study of embryos
4. Study of various stages of reproduction in angiosperms from permanent slides.
5. Study of epidermal peels of Tradescantia /maize/wheat leaves etc. to understand trichomes, glands and stomata.
6. Study of leaf anatomy of C_3 and C_4 plants.
7. Study of live shoot apices by micro-dissections and sections.

VII – Paper :

1. Study of vegetation by point, transect and quadrant methods.
2. Study of environmental factors: Observations on selected physico-chemical parameters of air, water and soil quality.
3. Phytogeographical field trip to study natural vegetation of India.
4. Determination of water holding capacity of different types of soils.

physiological experiment which has already been set.	5
11. One exercise on biochemistry.	4
12. Practicals on Special/Elective Papers which shall consist of laboratory/field exercises, separate spotting and project work etc.	40
13. Spotting (1-10 spots from VI to IX paper each spot of 1 and 1/2 marks).	15
14. Viva-voce	15
15. Record/Collections/Field trip/Project work etc.	20

SUGGESTED PRACTICAL EXERCISES FOR M.Sc. FINAL

VI- Papers:

1. Detailed description and identification of locally available flowering plants of the families prescribed in theory course.
2. Study and observation on anatomy (normal and anomalous) of plant parts by sectioning, staining and preparation of permanent slides.
3. Preparation of smears for study of gametophytes and micro-dissections for study of embryos.
4. Study of various stages of reproduction in angiosperms from permanent slides.
5. Study of epidermal peels of Tradescantia /maize/wheat leaves etc. to understand trichomes, glands and stomata.
6. Study of leaf anatomy of C_3 and C_4 plants.
7. Study of live shoot apices by micro-dissections and sections.

VII – Paper :

1. Study of vegetation by point, transect and quadrant methods.
2. Study of environmental factors: Observations on selected physico-chemical parameters of air, water and soil quality.

[Handwritten signatures]

[Handwritten signature]

5. Estimation of chlorophyll content in SO₂ fumigated and unfumigated leaves.

VIII – Paper :

1. **Food crops :** Morphology, anatomy and micro-chemical tests for stored food material in wheat rice maize, chick pea (Bengal gram), potato, tapioca, sweet potato and sugar cane.
2. **Fodder crop :** Study of live or preserved fodder crops of the locality.

3. **Medicinal plants:** Study of live or preserved or herbaria specimen or charts and photographs of the following medicinal plants to familiarize the students with the resource concerned:

Papaver somniferum, Atropa belladonna, Catharanthus roseus, Adhatoda ceylonica (syn A. vasica), Allium sativum, Rauvolfia serpentina, Withania somnifera, Phyllanthus amarus, Andrographis paniculata, Aloe barbadense, Mentha arvensis, Rosa s. Pogostemon cablin, Origanum vulgare, vetiveria zizanioides, Jasminium grandifolium, Cymbopogon sp. Pandanus odoratissimus

4. **Vegetable oils :** Study of morphology and microscopic structure of oil yielding tissues of mustard, groundnut, soyabean, coconut, sunflower, castor etc. and determination of iodine number.
5. **Fibres :** Morphology anatomy and microscopic study of whole fibre, using appropriate staining procedures of cotton, jute, linen, sun-hemp, coir and silk.
6. Observations on tissues associated with production of gums, resins, tannins and dyes.
7. Minor projected and field survey and visits to research laboratories. The students are expected to write a well illustrated report on the same.

IX – Paper :

1. To find out the O.P. of plant cell by plasmolytic methods.
2. To determine the D.P.D. (Water potential) of Potato tuber tissues

3. Phytogeographical field trip to study natural vegetation of India.
4. Determination of water holding capacity of different types of soils.
5. Estimation of chlorophyll content in SO₂ fumigated and unfumigated leaves.

VIII – Paper :

1. Isolation identification & microbes
2. Culture of Bacteri & fungi
3. Gram Staining
4. Determination of colony, forming units (CFU) using haematocytometer
5. Dimensions of microbes using ocular and stage microscope.
6. Isolation, identification of air fungi & specific spoils from soil.

IX – Paper :

1. To find out the O.P. of plant cell by plasmolytic methods.
2. To determine the D.P.D. (Water potential) of Potato tuber tissues by weighing method.
3. To determine the D.P.D. of storage tissues by density method.
4. To determine the structure size and frequency of stomata in mesophytic and xerophytic leaves.
5. To determine the rate of transpiration of plant twig: 1. Weight, 2. Potometer method.
6. To determine the rate of transpiration by Cobalt chloride method and to calculate transpiration index, transpiration efficiency of various leaves.
7. To study the effect of various factors on transpiration.
8. To measure the rate of photosynthesis in aquatic plants by

Sub. Prof. Sub. Prof.

Adm. Officer

<p>by weighing method.</p> <ol style="list-style-type: none"> To determine the D.P.D. of storage tissues by density method. To determine the structure size and frequency of stomata in mesophytic and xerophytic leaves. To determine the rate of transpiration of plant twig: 1. Weight, 2. Potometer method. To determine the rate of transpiration by Cobalt chloride method and to calculate transpiration index, transpiration efficiency of various leaves. To study the effect of various factors on transpiration. To measure the rate of photosynthesis in aquatic plants by Willmotts's bubble counting method. To study the effect of different factors on the rate of photosynthesis in aquatic plants. To study the effect of different factors on the rate of photosynthesis in leaves of land plant. To extract major plant pigment from green leaves by differential solubility method. To determine the chlorophyll a /chlorophyll b ratio in C₃ and C₄ plants. To determine the Q₁₀ for photosynthesis at two light intensities. To compare the R.Q. of different plant material. To separate the major plant pigments by paper chromatography. To estimate the pigment content of plant tissues by Calorimetric method. To extract free amino acids from germinating seedling by two dimensional paper chromatography. To measure the amylase activity in germinating bean seedlings and to study the effect of substrate concentration, pH and 	<p>Willmotts's bubble counting method.</p> <ol style="list-style-type: none"> To study the effect of different factors on the rate of photosynthesis in aquatic plants. To study the effect of different factors on the rate of photosynthesis in leaves of land plant. To extract major plant pigment from green leaves by differential solubility method. To determine the chlorophyll a /chlorophyll b ratio in C₃ and C₄ plants. To determine the Q₁₀ for photosynthesis at two light intensities. To compare the R.Q. of different plant material. To separate the major plant pigments by paper chromatography. To estimate the pigment content of plant tissues by Calorimetric method. To extract free amino acids from germinating seedling by two dimensional paper chromatography. To measure the amylase activity in germinating bean seedlings and to study the effect of substrate concentration, pH and temperature on enzymes. To measure the activity of enzyme catalase by titration method. To extract and test the presence of reducing sugars by Benedict Test. <p>X- Paper : Special Papers/Elective papers/Projects</p> <p>(X a) – Advanced Plant Pathology:</p> <ol style="list-style-type: none"> A study of symptomology, histopathology and identification of pathogen included in the course. A study of symptomology of bacterial virfal and MLO diseases. Methods of culture media preparation, sterilization and isolation of pathogens.
--	---

Sub. 8mof Suby

Adams

temperature on enzymes.

19. To measure the activity of enzyme catalase by titration method.
20. To extract and test the presence of reducing sugars by Benedict Test.

X- Paper : Special Papers/Elective papers/Projects

(X a) – Advanced Plant Pathology:

1. A study of symptomology, histopathology and identification of pathogen included in the course.
2. A study of symptomology of bacterial viral and MLO diseases.
3. Methods of culture media preparation, sterilization and isolation of pathogens.
4. Inoculation and pathogenicity experiments.
5. Measurement of fungal spores.
6. Viral disease, mechanical transfer experiment.
7. Use of biological and chemical fungicides for disease control.
8. Demonstration of plant protection appliances.
9. Field collection of diseased plants and preparation of related projects.

(X b) – Applied Cytogenetics and Plant Breeding.

1. Exercises on mono and trisomy and plant genotype, fertility and meiotic behaviour.
2. Meiosis of complex translocation heterozygotes.
3. Problems on Mendelian and non-Mendelian inheritance.
4. Problems on Gene-interaction linkage and gene-mapping.
5. Analysis of quantitative inheritance.
6. Identification of various stages of meiosis, study of diakinesis.
7. Demonstration of crossing over/chiasmata.

4. Inoculation and pathogenicity experiments.
5. Measurement of fungal spores.
6. Viral disease, mechanical transfer experiment.
7. Use of biological and chemical fungicides for disease control.
8. Demonstration of plant protection appliances.
9. Field collection of diseased plants and preparation of related projects.

(X b) – Applied Cytogenetics and Plant Breeding.

1. Exercises on mono and trisomy and plant genotype, fertility and meiotic behaviour.
2. Meiosis of complex translocation heterozygotes.
3. Problems on Mendelian and non-Mendelian inheritance.
4. Problems on Gene-interaction linkage and gene-mapping.
5. Analysis of quantitative inheritance.
6. Identification of various stages of meiosis, study of diakinesis.
7. Demonstration of crossing over/chiasmata.
8. **Karyotypic studies:** preparation of mitotic metaphase plates and drawing camera lucida drawing of chromosomes and study of chromosome morphology.
9. Cytological analysis of haploids (maize as a model crop).
10. Analysis of chromosome pairing in wheat and Ry hybrids.
11. Male sterility detection and maintenance of self-incompatibility.
12. Estimation, heritability, genetic advance and variance with the help of given data.
13. Study of floral biology in relation to pollination in the available crop plants.

(X c) – Advanced Phycology :

1. Analytical study of Physical and Chemical characteristics of water

Handwritten signatures and initials: Gub, Suf, Subey

Handwritten signature: Adarsh

<p>8. Karyotypic studies: preparation of mitotic metaphase plates and drawing camera lucida drawing of chromosomes and study of chromosome morphology.</p> <p>9. Cytological analysis of haploids (maize as a model crop).</p> <p>10. Analysis of chromosome pairing in wheat and Ry hybrids.</p> <p>11. Male sterility detection and maintenance of self-incompatibility.</p> <p>12. Estimation, heritability, genetic advance and variance with the help of given data.</p> <p>13. Study of floral biology in relation to pollination in the available crop plants.</p> <p>(X c) – Advanced Phycology :</p> <ol style="list-style-type: none"> 1. Analytical study of Physical and Chemical characteristics of water and soils. 2. Culture and mass culture aspects of algal flora. 3. Isolation and identification of two components from a given algal mixture and comments on their economic importance. 4. Camera-lucia diagrams of algae with their measurements and identification of the species. 5. Project work on: a Seasonal variations in algal flora of aquatic bodies, b. Influence of industrial effluents on growth and composition of algal flora, c. Maintenance of culture and mass culture of selected algae, d. Report on excursion trips for fresh water or marine algal forms. <p>(X d) – Environmental Science :</p> <ol style="list-style-type: none"> 1. An Analysis of physicochemical parameters of environmental quality (air, water and soil) with reference to selected parameter. 2. Biological examination of polluted water: 1. Microscopic examination, 2. Microbial examination. 3. Project work on the allotted topic which shall involve collection of information, data, related to the local problems of environment, 	<p>and soils.</p> <ol style="list-style-type: none"> 2. Culture and mass culture aspects of algal flora. 3. Isolation and identification of two components from a given algal mixture and comments on their economic importance. 4. Camera-lucia diagrams of algae with their measurements and identification of the species. 5. Project work on: a Seasonal variations in algal flora of aquatic bodies, b. Influence of industrial effluents on growth and composition of algal flora, c. Maintenance of culture and mass culture of selected algae, d. Report on excursion trips for fresh water or marine algal forms. <p>(X d) – Environmental Science :</p> <ol style="list-style-type: none"> 1. An Analysis of physicochemical parameters of environmental quality (air, water and soil) with reference to selected parameter. 2. Biological examination of polluted water: 1. Microscopic examination, 2. Microbial examination. 3. Project work on the allotted topic which shall involve collection of information, data, related to the local problems of environment, wildlife and its conservation. 4. Comparative study of floristic/morphological/anatomical characteristics of vegetation/plants from polluted and localities. 5. Seasonal variations in the biological/physicochemical quality of water from different localities. 6. Study of air microflora and particulate material in different seasons of the year.
--	---

Chen *Gul* *Sarf* *Nahey*

Adarsh

wildlife and its conservation.

4. Comparative study of floristic/morphological/anatomical characteristics of vegetation/plants from polluted and localities.
5. Seasonal variations in the biological/physicochemical quality of water from different localities.
6. Study of air microflora and particulate material in different seasons of the year.

BOOKS SUGGESTED FOR M.Sc. Part II

- Anonymous 1997, National Gene Bank: Indian Heritage on Plant Genetic Resources (Booklet). National Bureau of Plant Genetic Resources, New Delhi.
- Anonymous, 1993, The Plant Cell. Special Issue on Reproductive Biology of Plants. The American society of Plant Physiologists, Rokville, Maryland, USA.
- Arora R.K., Nayer E.R., 1984, Wild relatives of crop plants in India, NBPGR science Monographs No. 7.
- Asthana D.K. and Asthana M., 2001, Environment: Problems and Solutions. 2nd Edition, S. Chand and Co. New Delhi.
- Atwell B.J., Kriedermann P.E., Jurnbull C.G.N. (Eds), 1999, Plants in Action: Adaptation in Nature, Performance in Cultivation. McMillan Education, Sydney Australia.
- Bajracharya D., 1999, Experiments in Plant Physiology: A Laboratory Manual. Narosa Publishing House. New Delhi.
- Baker H.G., 1978, Plants and Civilization (3rd Ed.) C.A. Wadsworth, Belmont.
- Begon M., Harper J.L., Townsend C.R., 1996, Ecology. Blackwell Scientific Publications, Cambridge, USA.
- Bewley J.D., Black M., 1994, Seeds: Physiology of Development and germination. Plenum Press, NY.

BOOKS SUGGESTED FOR M.Sc. Part II

- Aneza, K.R., 2017, Experiments in Microbiology, Plant Pathology, Tissue Culture and Microbial Biotechnology, New Age International, New Delhi.
- Anonymous 1997, National Gene Bank: Indian Heritage on Plant Genetic Resources (Booklet). National Bureau of Plant Genetic Resources, New Delhi.
- Anonymous, 1993, The Plant Cell. Special Issue on Reproductive Biology of Plants. The American society of Plant Physiologists, Rokville, Maryland, USA.
- Arora R.K., Nayer E.R., 1984, Wild relatives of crop plants in India, NBPGR science Monographs No. 7.
- Asthana D.K. and Asthana M., 2001, Environment: Problems and Solutions. 2nd Edition, S. Chand and Co. New Delhi.
- Atwell B.J., Kriedermann P.E., Jurnbull C.G.N. (Eds), 1999, Plants in Action: Adaptation in Nature, Performance in Cultivation. McMillan Education, Sydney Australia.
- Bajracharya D., 1999, Experiments in Plant Physiology: A Laboratory Manual. Narosa Publishing House. New Delhi.
- Baker H.G., 1978, Plants and Civilization (3rd Ed.) C.A. Wadsworth, Belmont.
- Balick, M.J. & Cox, P.A., 1996, Plant, people and culture : Science of Ethnobotany, Scientific American Library.
- Begon M., Harper J.L., Townsend C.R., 1996, Ecology. Blackwell Scientific Publications, Cambridge, USA.
- Bewley J.D., Black M., 1994, Seeds: Physiology of Development and

[Handwritten signatures]

[Handwritten signature] 43

Bhojwani S.S., Bhatnagar S.P., 2000, The Embryology of Angiosperms (4th Ed.), Vikas Publishing House, New Delhi.

Bhojwani S.S., Razdan M.K., 1996. Plant Tissue culture. Theory and Practice (Revised Ed.) Elsevier Science Publishers, NY, USA.

Bole P.V., Vaghani Y., 1986. Field guide to common India Trees. Oxford University Press, Mumbai.

Brady N.C., 1990, The Nature and Properties of Soils. MacMillan.

Brown T.A., Genomes. John Wiley & Sons (Asia) Pvt. Ltd. Singapore.

Buchanan B.B., Gruissem W., Jones R.L., 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.

Burgess J., 1985, An Introduction to Plant Cell Development. Cambridge University Press, Cambridge.

Chandel K.P.S., Shukla G., Sharma N., 1996, Biodiversity in Medicinal and Aromatic Plants in India: conservation and Utilization. Nation Bureau of Plant Genetic Resources. New Delhi.

Chopra V.L., 2001, Plant Breeding: Field Crops. "Oxford IBH Pvt. Ltd. New Delhi.

Chopra V.L., 2001, Plant Breeding : Theory and Practice. Oxford IBH Pvt. Ltd. New Delhi.

Chrispeels M.J., Sadava D, 1977, Plants Food and People. W.H. Freeman and Co. San Francisco.

Cole A.J., 1969, Numerical Taxonomy, academic Press, London.

Conway G., 1999, The Doubly Green Revolution: Food for all in 21st Century. Penguin Books.

Conway G., Barbier E., 1994, Plant, Genes and Agriculture. Jones and Barlett Publishers, Boston.

Cooper T.G., 1977. Fools in Biochemistry. John Wiley, New York.

germination. Plenum Press, NY.

Bhojwani S.S., Bhatnagar S.P., 2000. The Embryology of Angiosperms (4th Ed.), Vikas Publishing House, New Delhi.

Bhojwani S.S., Razdan M.K., 1996. Plant Tissue culture. Theory and Practice (Revised Ed.) Elsevier Science Publishers, NY, USA.

Bole P.V., Vaghani Y., 1986. Field guide to common India Trees. Oxford University Press, Mumbai.

Brady N.C., 1990, The Nature and Properties of Soils. MacMillan.

Brown T.A., Genomes. John Wiley & Sons (Asia) Pvt. Ltd. Singapore.

Buchanan B.B., Gruissem W., Jones R.L., 2000, Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.

Burgess J., 1985, An Introduction to Plant Cell Development. Cambridge University Press, Cambridge.

Chandel K.P.S., Shukla G., Sharma N., 1996, Biodiversity in Medicinal and Aromatic Plants in India: conservation and Utilization. Nation Bureau of Plant Genetic Resources. New Delhi.

Chopra V.L., 2001, Plant Breeding: Field Crops. "Oxford IBH Pvt. Ltd. New Delhi.

Chopra V.L., 2001, Plant Breeding : Theory and Practice. Oxford IBH Pvt. Ltd. New Delhi.

Chrispeels M.J., Sadava D, 1977, Plants Food and People. W.H. Freeman and Co. San Francisco.

Cole A.J., 1969, Numerical Taxonomy, academic Press, London.

Conway G., 1999, The Doubly Green Revolution: Food for all in 21st Century. Penguin Books.

Conway G., Barbier E., 1994, Plant, Genes and Agriculture. Jones and Barlett Publishers, Boston.

Sub. Prof. Sanyal

Aditya 44

USA.

- Davis P.H., Heywood V.H., 1973, Principles of Angiosperm Taxonomy. Robert E. Kreiger Pub. Co., NY
- Dennis D.T., Turpin D.H., Lefebvre D.D., Layzell D.B. (Eds.) 1997, Plant Metabolism (2nd Edn.). Longman, Essex, London.
- Devi P. 2000. Principles and Methods of Plant Molecular Biology, Biochemistry and Genetics. Agrobios Jodhpur India.
- Dryer R.L., Lata G.F., 1989, Experimental Biochemistry. Oxford University Press, NY.
- Fageri K., Van der P.J.J.L., 1979, Principles of Pollination Ecology.
- Fahn A. 1982, Plant Anatomy (3rd Edn.) Pergamon Press, Oxford.
- Fosket D.E., 1994, Plant growth and Development. A molecular Approach. Academic Press San Diego.
- Frankel O.H., Brown A.H.D., Burdon J.J., 1995, The Conservation of Plant Diversity. Cambridge University Press, Cambridge.
- Galston A.W., 1989, Life Processes in Plants. Scientific American Library. Springer-Verlag, NY. USA.
- Grant V., 1971, Plant Speciation. Columbia University Press, NY.
- Grant W.F., 1984, Plant Biosystematics. Academic Press, London.
- Harrison H.J., New Concepts in Flowering Plant Taxonomy. Hieman Educational Books Ltd., London.
- Haslop-Harrison J., 1967. Plant Taxonomy. English Language Book Soc. & Edward Arnold Pub. Ltd. UK.
- Heywood V.H., Moore D.M., 1984. Current concepts in Plant Taxonomy. Academic Press London.
- Heywood V.H., Watson R.T., 1995, Global Biodiversity Assessment. Cambridge University Press.
- Hill M.K., 1997, Understanding Environmental Pollution. Cambridge University Press, Cambridge.
- Hooyakaas P.J.J., Hall M.A., Lebbenga K.R. (Eds.), 1999,

Cooper T.G., 1977, Tools in Biochemistry. John Wiley, New York, USA.

Davis P.H., Heywood V.H., 1973, Principles of Angiosperm Taxonomy. Robert E. Kreiger Pub. Co., NY

Dennis D.T., Turpin D.H., Lefebvre D.D., Layzell D.B. (Eds.) 1997, Plant Metabolism (2nd Edn.). Longman, Essex, London.

Devi P. 2000, Principles and Methods of Plant Molecular Biology, Biochemistry and Genetics. Agrobios Jodhpur India.

Dryer R.L., Lata G.F., 1989, Experimental Biochemistry. Oxford University Press, NY.

Duby, R.C. & Maheswari, D.K. A text book of Microbiology, S.Chand Pvt.Ltd., New Delhi.

Fageri K., Van der P.J.J.L., 1979, Principles of Pollination Ecology.

Fahn A. 1982, Plant Anatomy (3rd Edn.) Pergamon Press, Oxford.

Fosket D.E., 1994, Plant growth and Development. A molecular Approach. Academic Press San Diego.

Frankel O.H., Brown A.H.D., Burdon J.J., 1995, The Conservation of Plant Diversity. Cambridge University Press, Cambridge.

Galston A.W., 1989, Life Processes in Plants. Scientific American Library, Springer-Verlag, NY. USA.

Ghosh, A.K., 2013. Indigenous knowledge of Ethnobotany, Astral International, Daya Publishing House, New Delhi.

Grant V., 1971, Plant Speciation. Columbia University Press, NY.

Grant W.F., 1984, Plant Biosystematics. Academic Press, London.

Harrison H.J., New Concepts in Flowering Plant Taxonomy. Hieman Educational Books Ltd., London.

Haslop-Harrison J., 1967. Plant Taxonomy. English Language Book Soc. & Edward Arnold Pub. Ltd. UK.

Heywood V.H., Moore D.M., 1984, Current concepts in Plant Taxonomy. Academic Press London.

Callu Gub. - Samp

Subey

Adnan

<p>Biochemistry and Molecular Biology of Plant Harmones. Elsevier, Amsterdam, The Netherlands.</p> <p>Hopkins W.G., 1995, Introduction to Plant Physiology. John Wiley & Sons Inc. NY, USA.</p> <p>Howell S.H., 1998, Molecular Genetics of Plant Development Cambridge University Press, Cambridge.</p> <p>Jones A.D., Wilbins A.D., 1971, Variations and Adaptations in Plant Species. Heinman & Co., Educational Books Ltd. London.</p> <p>Jones S.B. Jr., Luchsinger, A.E., 1986, Plant Systematics (2nd Edn.), McGraw-Hill Book Co. NY. Kormondy J.L., 1996, Concepts of Ecology. Prentice-Hall of India Pvt. Ltd., New Delhi.</p> <p>Kothari A., 1997, Understanding Biodiversity: Life sustainability and equity. Orient Longman.</p> <p>Krebs C.J., 1989, Ecological Methodology. Harper and Row, NY.</p> <p>Leins P., Tucker S.C., Endress P.K., 1988, Aspects of Floral Development. J. Cramer, Germany.</p> <p>Lodish H., Berk A., Zipursky S.L., Matsudaira P., Baltimore D., Darnell J., 2000, Molecular Cell Biology. Freeman and Co., NY.</p> <p>London R.F., 1990, Plant Development : The Cellular Basis. Unwin Hyman, London.</p> <p>Magurran A.E. 1988, Ecological diversity and its measurement. Chapman and Hall, London.</p> <p>Mason C.F., 1991, Biology of Freshwater Pollution. Longman.</p> <p>Misra R., 1968. Ecology Workbook. Oxford & IBH New Delhi.</p> <p>Molden B., Billharz S., 1997, Sustainability Indicators. John Wiley & sons, NY.</p> <p>Moore P.W., Chapman S.B., 1986, Methods in Plant Ecology. Blackwell Scientific Publications.</p> <p>Moore T.C., 1974, Research Experiments in Plant Physiology: A</p>	<p>Heywood V.H., Watson R.T., 1995, Global Biodiversity Assessment. Cambridge University Press.</p> <p>Hill M.K., 1997, Understanding Environmental Pollution. Cambridge University Press, Cambridge.</p> <p>Hooyakaas P.J.J., Hall M.A., Lebbenga K.R. (Eds.), 1999, Biochemistry and Molecular Biology of Plant Harmones. Elsevier, Amsterdam, The Netherlands.</p> <p>Hopkins W.G., 1995, Introduction to Plant Physiology. John Wiley & Sons Inc. NY, USA.</p> <p>Howell S.H., 1998, Molecular Genetics of Plant Development. Cambridge University Press, Cambridge.</p> <p>Jain. A.K., 2016, Indian Ethnobotany. Emerging Trends, Scientific Publishers, New Delhi.</p> <p>Jain, S.K., 2010, Manual of Ethnobotany, Scientific Publishers, New Delhi.</p> <p>Jain. S.K. & Shastri, A.R.K., 1984 (Ed. & Compile), The Indian Plant of Red Data Book, Published by Botanical Survey of India.</p> <p>Jones A.D., Wilbins A.D., 1971, Variations and Adaptations in Plant Species. Heinman & Co., Educational Books Ltd. London.</p> <p>Jones S.B. Jr., Luchsinger, A.E., 1986, Plant Systematics (2nd Edn.), McGraw-Hill Book Co. NY. Kormondy J.L., 1996, Concepts of Ecology. Prentice-Hall of India Pvt. Ltd., New Delhi</p> <p>Kothari A., 1997, Understanding Biodiversity: Life sustainability and equity. Orient Longman.</p> <p>Krebs C.J., 1989, Ecological Methodology. Harper and Row, NY.</p> <p>Kumar, U., 2013, An introduction to Ethnobotany, Agribios, New Delhi.</p> <p>Leins P., Tucker S.C., Endress P.K., 1988, Aspects of Floral Development. J. Cramer, Germany.</p>
--	--

[Signature]



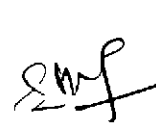

[Signature]

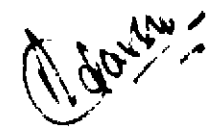
[Signature]

[Signature]

[Signature]

<p>Laboratory Manual. Springer-Verlag, Berlin.</p> <p>Moore T.C., 1989, Biochemistry and Physiology of Plant Hormones (2nd Edn.) Spriger-Verlag, NY.</p> <p>Muller-Dombois D., Ellenberg H., 1974, Aims and Methods of vegetation ecology. Wiley, New York.</p> <p>Murphy T.M., Thompson W.F., 1988. Molecular Plant Development. Prentice Hall, New Jersey.</p> <p>Nobel P.S., 1999, Physiochemical and Environmental Plant Physiology, (2nd Edn.0, Academic Press.</p> <p>Nordenstam B., El Gazally G., Kansas M., 2000, Plant Systematics for 21st Century. Portland Press Ltd. London.</p> <p>Odum E.P., 1971, Fundamentals of ecology. Saunders, Philadelphia.</p> <p>Odum E.P., 1983, Basic Ecology. Saunders, Philadelphia.</p> <p>Pielou E.C. 1984, The Interpretation of ecological data. Wiley, New York.</p> <p>Plummer D.T., 1988. An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.</p> <p>Proctor M., Yeo P., 1973. The Pollination of Flowers. William Collins Sons, London.</p> <p>Purohit S.S., 2002. Agricultural Biotechnology. (2nd Edn.) Agrobios, Jodhpur.</p> <p>Radford A.E., 1986, Fundamentals of Plant Systematics. Harper & Row Publications, USA.</p> <p>Raghavan V., 1997, Molecular Embryology of Flowering Plants. Cambridge University Press, Cambridge.</p> <p>Raghavan V., 1999, Development Biology of Flowering Plants (5th Edn.). Worth, New York.</p> <p>Salsbury F.B. and Ross C.W., 1992. Plant Physiology, 4th Edn. Wadsworth Publishing Co. California. San Diego, USA.</p> <p>Sedgely M., Griffin A.R., 1989, Sexual Reproduction of Tree Crops.</p>	<p>Lodish H., Berk A., Zipursky S.L., Matsudaira P., Baltimore D., Darnell J., 2000, Molecular Cell Biology. Freeman and Co., NY.</p> <p>London R.F., 1990, Plant Development : The Cellular Basis. Unwin Hyman, London.</p> <p>Magurran A.E. 1988, Ecological diversity and its measurement. Chapman and Hall. London.</p> <p>Mason C.F., 1991, Biology of Freshwater Pollution. Longman.</p> <p>Michael Pelczar, 1998. Microbiology, Tata McGraw Hill at Delhi.</p> <p>Misra R., 1968. Ecology Workbook. Oxford & IBH New Delhi.</p> <p>Molden B., Billharz S., 1997, Sustainability Indicators. John Wiley & sons, NY.</p> <p>Moore P.W., Chapman S.B., 1986, Methods in Plant Ecology. Blackwell Scientific Publications.</p> <p>Moore T.C., 1974, Research Experiments in Plant Physiology: A Laboratory Manual. Springer-Verlag, Berlin.</p> <p>Moore T.C., 1989, Biochemistry and Physiology of Plant Hormones (2nd Edn.) Spriger-Verlag, NY.</p> <p>Muller-Dombois D., Ellenberg H., 1974. Aims and Methods of vegetation ecology. Wiley, New York.</p> <p>Murphy T.M., Thompson W.F., 1988. Molecular Plant Development. Prentice Hall, New Jersey.</p> <p>Nair, P.K.K., 1985 Essential of Palynology, Today & Tomorrow Printers & Publishers, New Delhi.</p> <p>Nair, P.K.K., 1995 Vistas in Palynology, Perspectives & Prospects, Today & Tomorrow Printers & Publishers, New Delhi.</p> <p>Nobel P.S., 1999, Physiochemical and Environmental Plant Physiology, (2nd Edn.0, Academic Press.</p> <p>Nordenstam B., El Gazally G., Kansas M., 2000, Plant Systematics for 21st Century. Portland Press Ltd. London.</p>
--	--

Handwritten signatures and initials:    

Handwritten signature and page number:  47

Academic Press, London.	Odum E.P., 1971, Fundamentals of ecology. Saunders, Philadelphia.
Shivanna K.R., Johri B.M., 1985, The Angiosperm Pollen: Structure and Function. Wiley Eastern Ltd. NY.	Odum E.P., 1983, Basic Ecology, Saunders, Philadelphia.
Shivanna K.R., Rangaswamy N.S., 1992, Pollen Biology: A laboratory Manual. Springer-Verlag, Berlin.	Pawar, C.B. & Dangiwal, 1982, General Microbiology. Vol.II. Himalayan Publishing House, New Delhi.
Shivanna K.R., Sawhney V.K. (Eds). 1997, Pollen Biotechnology for crop production and improvement. Cambridge University Press, Cambridge.	Pielou E.C. 1984, The Interpretation of ecological data Wiley, New York.
Singh H., 1978, Embryology of Gymnosperms. In Encyclopaedia of Plant Anatomy . Gebruder Bortraeger, Berlin.	Plummer D.T., 1988. An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
Singhal G.S., Renger G., Sopor S.K., Irrgang K.D., Govindji, 1999, Concepts in Photobiology: Photosynthesis and Photomorphogenesis, Narosa Publishing House New Delhi.	Proctor M., Yeo P., 1973, The Pollination of Flowers. William Collins Sons, London.
Smith R.H., 2000. Plant Tissue Culture; Techniques and Experiments. Academic press NY.	Purohit S.S , 2002. Agricultural Biotechnology. (2 nd Edn.) Agrobios, Jodhpur.
Smith R.L., 1996, Ecology and Field Biology. Harper Collings, NY.	Radford A E., 1986, Fundamentals of Plant Systematics. Harper & Row Publications, USA.
Solbrig O.T., Solbrig D.J., 1970, Population Biology and Evolution. Addison-Wesley Publishing Co. Inc. USA.	Raghavan V., 1997, Molecular Embryology of Flowering Plants. Cambridge University Press, Cambridge.
Stace C.A. 1989, Plant Taxonomy and Biosystematics (2 nd Edn.) Edward Arnold Ltd. London.	Raghavan V., 1999, Development Biology of Flowering Plants (5 th Edn.). Worth, New York.
Stebbins G.L., 1974, Flowering plant – Evolution above species level. Edward Arnold Ltd. London.	Rao, A.S., 1997, Introduction to Microbiology. Printice Hall of India.
Steeves T.A., Sussex I M., 1989, Patterns in Plant Development (2 nd Edn.), Cambridge University Press Cambridge.	Salsbury F.B. and Ross C.W., 1992. Plant Physiology, 4 th Edn. Wadsworth Publishing Co. California. San Diego, USA.
Taiz L., Zeiger E., 1998. Plant Physiology (2 nd Edn.) Sinauer associates Inc. Publishers. Massachusetts.	Sedgely M., Griffin A.R., 1989, Sexual Reproduction of Tree Crops. Academic Press, London.
Takhtajan A.L., 1997, Diversity and Classification of Flowering plants. Columbia University Press, NY.	Shivanna K.R., Johri B.M., 1985. The Angiosperm Pollen: Structure and Function. Wiley Eastern Ltd. NY.
Thomas B., Vince-Prue D. 1997, Photoperiodism in Plants (2 nd Edn). Academic Press, San Diego, USA.	Shivanna K.R., Rangaswamy N.S., 1992, Pollen Biology: A laboratory Manual. Springer-Verlag, Berlin.
	Shivanna K.R., Sawhney V.K. (Eds), 1997, Pollen Biotechnology for crop production and improvement. Cambridge University Press, Cambridge.

Shivanna *Gub* *Sawhney*

Shivanna

Shivanna 48

Treshow M. 1985, Air Pollution and Plant Life. Wiley Interscience

Waisel Y., Eishel A., Kafkaki U. (Eds.). 1996, Plant Roots: The Hidden Hall (2nd Edn.) Marcel Dekke NY.

Walter K.S., Gillet H.J. 1998, 1997 IUCN Red List of Threatened Plants. IUCN: The world Conservation Union. Gland Switzerland and Cambridge, UK.

Westhoff P., 1998, Molecular Plant Development: From Genes to Plant. Oxford University Press, Oxford, U.K.

Wilson K., Walker J., 1994, Practical Biochemistry: Principles and Techniques (4th Edn.) Cambridge University Press, Cambridge, UK.

Woodland D.W., 1991, Contemporary Plant Systematics. Prentice Hall, New Jersey.

Singh H., 1978, Embryology of Gymnosperms. In Encyclopaedia of Plant Anatomy. Gebruder Borntraeger, Berlin.

Singhal G.S., Renger G., Sopor S.K., Irrgang K.D., Govindji, 1999, Concepts in Photobiology: Photosynthesis and Photomorphogenesis, Narosa Publishing House. New Delhi.

Smith R.H., 2000, Plant Tissue Culture; Techniques and Experiments. Academic press NY.

Smith R.L., 1996, Ecology and Field Biology. Harper Collings, NY.

Solbrig O.T., Solbrig D.J., 1970, Population Biology and Evolution. Addison-Wesley Publishing Co. Inc. USA.

Stace C.A. 1989, Plant Taxonomy and Biosystematics (2nd Edn.) Edward Arnold Ltd. London.

Stebbins G.L., 1974, Flowering plant – Evolutionini above species level. Edward Arnold Ltd. London.

Steeves T.A., Sussex I.M., 1989, Patterns in Plant Development (2nd Edn.), Cambridge University Press Cambridge.

Taiz L., Zeiger E., 1998, Plant Physiology (2nd Edn.) Sinauer associates Inc. Publishers. Massachusetts.

Takhtajan A.L., 1997, Diversity and Classification of Flowering plants. Columbia University Press, NY.

Thomas B., Vince-Prue D. 1997, Photoperiodism in Plants (2nd Edn). Academic Press, San Diago, USA.

Treshow M. 1985, Air Pollution and Plant Life. Wiley Interscience.

Waisel Y., Eishel A., Kafkaki U. (Eds.), 1996, Plant Roots: The Hidden Hall (2nd Edn.). Marcel Dekke NY.

Walter K.S., Gillet H.J. 1998, 1997 IUCN Red List of Threatened Plants. IUCN: The world Conservation Union. Gland Switzerland and Cambridge, UK.

Westhoff P., 1998, Molecular Plant Development: From Genes to Plant. Oxford University Press, Oxford, U.K.

Handwritten signatures and initials:
 Gmb. ...
 Suf
 Suber

Handwritten signature: Adaku

	<p>Wilson K., Walker J., 1994, Practical Biochemistry: Principles and Techniques (4th Edn.) Cambridge University Press, Cambridge, UK.</p> <p>Woodland D.W., 1991, Contemporary Plant Systematics. Prentice Hall, New Jersey.</p>
--	--

Ali *Gul* *Zaf* *Asubey*



Dr. ADARSH KUMAR
 Convener, Board of Studies in Botany
 CSJM University, Kanpur

Adarsh
26/7/18