VIDYASAGAR UNIVERSITY

MIDNAPORE - 721 102

POST-GRADUATE SYLLABUS

IN

BOTANY & FORESTRY

2009

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M.Sc. Syllabus of Botany & Forestry

Semester-I

Theory

Paper	Subject	Marks
BO/1/1/01	Phycology + Bryology	25+25=50
BO/1/1/02	Computer + Biostatistics	25+25=50
BO/1/1/03	Mycology + Plant Pathology	25+25=50
BO/1/1/04	Microbiology	50
		Total: 50+50+50+50= 200

Practical

Paper	Subject	Marks
BO/1/1/15	Phycology & Bryology + Computer	30+20= 50
BO/1/1/16	Mycology & Plant Pathology + Microbiology	25+25=50
		Total: 50+50=100

Semester-II

Theory

Paper	Subject	Marks
BO/1/2/07	Plant Taxonomy & Biosystematics	50
BO/1/2/08	Silviculture + Forest Mensuration	25+25=50
BO/1/2/09	Pteridophytes + Gymnosperms	25+25=50
BO/1/2/010	Cytogenetics, Molecular Biology & Biotechnology	50
		Total: 50+50+50+50=200

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Practical

Paper	Subject	Marks
BO/1/2/111	Plant taxonomy & Biosystematics + Forest mensuration	30+20= 50
BO/1/2/112	Pteridophytes & Gymnosperms + Cytogenetics,	25+25 =50
		Total: 50+50=100

Semester-III

Theory

Paper	Subject	Marks
BO/2/1/013	Plant Physiology + Plant Biochemistry	25+25=50
BO/2/1/014	Forest Surveying & Silviculture system + Forest Management	25+25
BO/2/1/015	Plant Ecology	50
BO/2/1/016	Palaeobotany + Palynology & Reproductive Biology	25+25=50
		Total: 50+50+50+50=100

Practical

Paper	Subject	Marks
BO/2/1/117	Plant Physiology, Biochemistry + Forest Surveying	30+20= 50
BO/2/1/118	Plant Ecology + Palaeobotany, Palynology & Reproductive Biology	25+25 =50
		Total: 50+50

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Semester-IV

Paper	Subject	Marks
BO/2/2/019	Economic & Applied Botany	50
BO/2/2/020	Elective (Special)	50
		Total: 50+50=100

Practical

Paper	Subject	Marks
BO/2/2/121	Special papers	50
BO/2/2/122	Review/Project /Dissertation including Viva-voce (Special papers)	50
BO/2/2/123	Seminar (topic other than project work/ Dissertation)	50
BO/2/2/124	Comprehensive Viva (on all branches of syllabus)	50
		Total: 50+50+50+50=200

Name of the Special Papers:

1. Advanced Plant Taxonomy
2. Ecology and Biodiversity
3. Mycorrhizal Biology
4. Palaeobotany and Palynology.
5. Plant Genetics and Biotechnology

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SEMESTER-I

PAPER-I

PHYCOLOGY AND BRYOLOGY

PHYCOLOGY (Theoritical)

UNIT- I **Full Marks 25**

1. A general account of classification of algae
2. Parameters used for classifying algae in the past and present.
3. Significance and contribution of molecular biology in the classification of algae.
4. Parallelism in algae.
5. Salient features of the divisions – Cyanophyta, Prochlorophyta, Glaucophyta, Rhodophyta, Heterokontophyta, Euglenophyta and Chlorophyta.
5. Evolutionary trends in Chlorophyta.
6. Reclamation of soil by algae: Nature and causes of sterility of soil in India, types of sterile soils, algal species reclaiming soil fertility, roles of algal members in reclamation.
7. Phycocolloids – source, chemistry and their uses.
8. Algae in Pisciculture.
9. Single Cell Protein – definition, sources, properties, uses, prospects and limitations.
10. Pheromone in algae.
11. Significance of algae as prospective progenitor of land plants.

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BRYOLOGY (THEORETICAL)

Unit II **Full Marks: 25**

1. **Introduction :** Diversity in forms, habitats and values
2. **Classification :** Out line of classification and evolutionary trends among the different groups of bryophytes–traditional Classification (with reference to Hepaticopsida, Anthocertopsida and Bryopsida) and modern systems of Classification (with reference to Marchantiophyta, Anthocerophyta and Bryophyta)
3. **Characteristics :** affinities and systematic position of Calobryales, Takakiales and Sphagnales
4. **Cytogenetics of bryophytes :** taxonomic implication of chromosome numbers and sex chromosome.
5. **Bryophyte ecology :** substrate colonized by bryophytes, growth forms, ecotypes
6. **Bryophyte as site indicators** : Responses of bryophyte to environmental pollution, Bryomonitoring
7. **Bryophyte chemistry :** Bryophyte-chemical and taxonomic implications, Biotechnology of Bryophytes

Suggested reading:

1. Chopra, R.N. (1998). Tropics in Bryology. Allied Publ. Ltd.
2. Chopra, R.N. and Kumra (2004). Biology of Bryophytes, New Age International, New Delhi.
3. Mondal, A.K. and Mondal (Parui), s (in Press) : Advanced Bryology, New Central Book Agency Pvt. Ltd. Kolkata.
4. Parihar, N.S. (1991). Bryophyta. Central Book Depot, Allahabad.

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5. Puri, P. (1980). Bryophytes. Atma Ram & sons, Delhi.
6. Rashid, A. (2000). An Introduction to Bryophyta. Vikash and Hall.
7. Schofield, W.B. (1985). Introduction to Bryology. MacMillan Publ. New York.
8. Shaw, A.J. & Goffinet, B. (2000). Bryophyte Biology. Cambridge University Press.
7. Smith, A.J.E. (1982). Bryophyte Ecology. Chapman and Hall.

SEMESTER – I

Paper-II

(Theoretical Computer and Biostatistics)

COMPUTER APPLICATION IN BIOLOGY

Unit : I **Full Marks: 25**

1. Importance of computer application in biological sciences.
2. Brief history of development of computer, computer generations, classification of computer- analogue, digital, hybrid; micro, mini, mainframe and super computers.
3. Computer hardware: basic components of computer – CPU, peripheral devices, computer memory, and computer buses.
4. Software – Types of software – monitor program, operating system, utility program, application program, language processor. Computer languages – machine language, Assembly language, High-level languages.
5. Problem solving and flow charts – symbols, structure, methods of drawing of flowcharts. Application in biological problems.
6. Principle of programming in high level language, simple

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programs for solving biological problems and statistical analysis of biological data.

7. Simulation and modeling of different botanical items in taxonomy, plant physiology, biochemistry, forestry, drug design etc.

8. Word processor – basic operation and its application in biological sciences; MS Excel – basic operation and it application in biological sciences; MS PowerPoint – steps of PowerPoint presentation, slide preparation for biological items.

9. Basic concept of email, Internet – components of internet, www, searching biological information from internet, library-searching technique, LAN.

10. Concept of bioinformatics – field of application common biological databases, brief idea about database management in bioinformatics.

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SEMESTER – I

Paper-II

Theoretical

BIOSTATISTICS

Unit : II **Full Marks: 25**

1. Definition and scope
2. Cultural tendency, measures of dispersion.
3. Measures of Skewness and Kurtosis.
4. Propability and probability distribution (Bionomial, Poisson and Normal) correlation and regression.
5. Chi-square test and test of significance and their application in Bio-informatics.

SEMESTER – I

Paper – III : Theoretical

Unit : I Mycology **Full Marks : 25**

1. Unique features of fungi : modern concept regarding placement of fungi in separate kingdom. Any modern classification with characters upto phylum.
2. Fungal growth, nutritional and physical factors operating growth, idea of saprotrophs, biotrophs, hemibiotrophs, merotrophs, symbionts.
3. Sporulation – types factor affecting sporulation, sporeliberation and dispersal.
4. Homothallism, heterothallism, physiological and molecular basis of mating systems, para sexuality.
5. Mycotoxins – a general account with reference to aflatoxins.
6. Lichens – types, idea of phyco and mycobionds, nature of relationship between two partners.

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7. Applied mycology. Use of fungi in antibiotics, organic acids and food production, role of fungi in biotechnology, including vaccine production etc role of fungi in agriculture and forestry, mushroom cultivation, its food value.

SEMESTER – I

Paper – III : Theoretical

Unit : II Plant Pathology **Full Marks : 25**

1. Plant disease, diagnosis, Koch's rule, modern methods.
2. Production, liberation and dispersal of inoculums, inoculum potential.
3. Host pathogen interactions – mechanism of penetration, role of cell wall degrading enzymes, toxins and growth regulators.
4. Defense mechanism of host – pre and post infectional structural as well as biochemical defense with reference to role of phytoalexins and PR-proteins : systemic acquired resistance.
5. Control of plant diseases – exclusion, eradication, physical, biological and chemical control, concept of integrated disease management.
6. Epidemiology (concept only).
7. Role of biotechnology in plant pathology.
8. Selected plant diseases: Blast of rice, Tungro disease of rice, Black stem rust of wheat, Wilt of pigeon pea; Anthracnose of Jute, Crown gall diseases, scab of potato.
9. Selected tree diseases : Stem wilt of casuarina, Spike disease of sandal wood, Root rot of khair, Pink disease of Eucalyptus.
10. Myconhiza – definition, types, occurrence, origin and evolution, advantages of myconhizal associations in agriculture and forestry. Myconhiza and disease control.

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SEMESTER – I

Paper – IV : Theoretical

MICROBIOLOGY

Full Marks: 50

1. History; discoveries and contributions; differences between prokaryotes and eukaryotes; five kingdom concept; classification of microbes; scopes and areas of microbiology. (3)
2. Nutrition of microbes; principles behind formulation of media; enrichment culture technique; anaerobic culture principles (3)
3. Principle, characteristics used in the classification and identification of microbes; Bergey's manual of determinative bacteriology. (5)
4. Methods of sterilization; dry and moist heat; UV and X-ray; Food sterilization. (3)
5. Growth curve; mathematical nature and expression of growth; exponential and arithmetic growth; generation time; growth curve parameters-yield; exponential growth rate and duration of lag phase; effect of nutritional concentration on growth; synchronous cyclic batch culture and continuoues growth. (4)
6. Morphology; fine structure & chemical nature of capsule; cell wall, flagella, pili, genome, cytoplasmic membrane (PLP and fluid mosaic model) and cytoskeletal elements of bacterial cell; idea of the principle of gram staining; reserve substances; endospore. (6)
7. Microbial metabolism; respiration and fermentation,

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fermentation pathway (ED pathway etc.); Nitrification; sulfur oxidation; nitrogen fixation. (4) (schematically)

8. Organization and replication of genetic material in bacteria, plasmids; genetic recombination-conjugation, transformation, and transduction and gene-mapping. (5)
9. Genetic Engineering, vectors, restriction endonucleases, host restriction modification, gene cloning, applications of Genetic Engineering in agriculture, health, industry and environmental stability. (6)
10. Viruses; structural organization and chemistry of viruses; viral replication (TMV) and bacteriophage; assay of viruses; classification; cultivation; viruses as disease producing agents; oncogenesis; antiviral drugs; lytic and lysogenic cycle. (5) HIV and its importance.
11. Applied microbiology; production of alcohol, wine, beer, Penicillin, SUFU. (4)
12. Chemotherapy; fundamentals, chemistry, mechanism of action and therapeutic uses of penicillin, non-medical use of antibiotics, bioassay of antibiotics. (3) Antiviral drugs, sulfa drugs.
13. Microscopy; light and Electron, AFM
14. Immunology; general idea of immunity; types of immunity; properties of antigen and antibodies; nature of immunological reaction; diagnostic application; monoclonal antibody, ELISA; Toxin. (7)

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SEMESTER – I

Paper – V : (Practical)

Phycology and Bryology

PHYCOLOGY

Unit : I **Full Marks : 15**

1. Study of vegetative structures of gametophytic and sporophytic plant bodies of the members from different taxa of algae.
2. Study of reproductive and other perennating structures of different members of algae.
3. Finding out the characters ideal for identification of the algal members.
4. Ecological significance of the studied characters of algal members.

SEMESTER – I

Paper – V : (Practical)

BRYOLOGY

Unit : I **Full Marks : 15**

1. Methods of collection and preservation of Bryophytes
2. Comparative morphology and anatomy of the gemetophytes and sporophytes of the different groups of Bryophyta (Hepaticopsida to Bryopsida)
3. Study of peristome structures of Nematodonteae and Arthrodonteae of the Bryopsida
4. tudents are required to submit field and laboratory records, preserved and dried specimens and permanent slides

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SEMESTER – I

Paper – V : Practical

Unit : II – Computer **Full Marks : 20**

1. Basic operation of computer – different operations of WINDOWS; Data entry, Printing of programs and results.
2. Programming with a high level language for solving biological problems:
   a. Simple programs – computation of sum and mean values of some biological data.
   b. Arrangement of biological data – ascending order, descending order, highest value, lowest value.
   c. Tabulation of biological data.
   d. Species / Genera mapping in an area.
   e. Characterization of plants.
   f. Numerical taxonomy.
   g. Statistical analysis of biological data – Mean, SD, SE. t-test, correlation coefficient percentile values etc.
3. Operation of MS Excel – tabulation of biological data, simple computation of different groups of data, making charts with MS Excel – bar diagram, line diagram, pie diagram for representing biological data.
4. Operation of word processor – text presentation, editing, formatting and printing, making table with MS Word.
5. Operation of MS Power Point – making slide for slide for any biological topic.

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SEMESTER – I

Paper - VI

MICROBIOLOGY, MYCOLOGY & PLANT PATHOLOGY

Full Marks : 50

MICROBIOLOGY

1. Methods of sterilization, idea about microbiological instruments and laboratory.
2. Negative staining technique.
3. Gram staining.
4. Study of curd-organisms and spore staining.
5. Isolation of spore producers from bacteria, PDA for fungi.
6. Sterilization of media and glass goods.
7. Inoculation techniques.

MYCOLOGY

8. Study of morphological characters and reproductive structures of some genera (Clavaria, Puccinia, Peziza, Erisyphyae, Alternaria, Fusarium, Cercospora, Saprolegnia, Albugo, Perenospora).
9. Isolation of yeasts from some fruits
10. Local tour for collection of Fungi.

PLANT PATHOLOGY

11. Study of diseased specimen.
12. Isolation, Purification and simple culture of pathogens.
13. Use of selective media.
14. Study of Black stem rust of wheat, Red rot of sugarcane.
15. Study of Ectomy corrhiza.
16. Study of VAM in root.

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SEMESTER – II

Paper – V II : Theoretical

TAXONOMY OF ANGIOSPERMS & BIOSYSTEMATICS

Full Marks : 50

1. **Introduction** : Definition of terms: Systematics, Taxonomy, Classification, Nomenclature, Identification.
2. **Classification** : History and current systems of classification with Putative Relationships: Takhtajan and Cronquist system of classification, Salient features, evolutionary trends and phylogeny in Magnoliidae, Hamamelidae, Caryophyllidae, Rosideae, Asteridae, Alismatidae and Liliidae (*sensu* Cronquist, 1981) and APG-I System of plant classification, concepts of palaeoherbs, eudicots.
3. **Taxonomic hierarchy** : Species, genus, family and other categories; delimitation of taxa and attribution of rank.
4. **ICBN :** Salient features of the International code of Botanical Nomenclature, Phylocodes
5. **Biosystematics** : Definition, principles, methods, categories and differences with classical taxonomy.
6. **Taxonomic evidence** : Ultrastructure (SEM and TEM), Palynology, Phytochemistry.
7. **Biodiversity** : Definition, importance, Hotspots, megadiversity centers; conservation- needs and methods.
8. **Ethno-botany** : Definition, branches, relevance, methods and status in India.

Suggested Reading :

1. Davis, P.H. and Heywood, V.H. (1973). *Principles of Angiosperms Taxonomy*. Robert E. Kreiger Pub. Co., New York.

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2. Erdtman, G. (1969). *Handbook of Palynology. Munksgaard*, Copenhagen.
3. Erdtman, G. (1986). *Pollen Morphology & Plant Taxonomy: Angiosperms*. E.J. Brill, London.
4. Hills, D.M. Montz, C.M. & Mable, B.K. (1996). *Molecular Systematics*. 2nd Edition. Sinauer Associates, Sunderlad.
5. Judd, W.S., C.S. Campbell, E.A. Kellogg, P.E. Stevens, (2002). *Plant Systematics: A Phylogenetic approach*, Sinauer Associate Ins., Sunderland, Massachusetts, U.S.A.
6. Lawrence, G.H.M. (1951). Taxonomy of Vascular Plants. MacMillan, New York.
7. Mondal, A.K. (2005). *Advanced Plant Taxonomy*. New Central Book Agency Pvt. Ltd. Kolkata.
8. Radford, A.E. (1986). *Fundamentals of Plant Systematics*. Harper and Ros Publishers, New York.
9. Singh, G. (1999). *Plant Systematics: Theory and Practice*. Oxford & IBH Pvt. Ltd., New Delhi.
10. Stace, Clive A. (1989). *Plant Taxonomy and Biosystematics*, Arnold Publishers, Bangalore, India.

SEMESTER – II

Paper – VIII : Theoretical

SILVICULTURE, FOREST MENSURATION

Unit- I : Silviculture **Full Marks : 25**

1. Introduction, definition, Forestry as land use practice
2. Growth and development of trees
3. Forest types
4. Silviculture : Definition, scope and objective
5. Classification of Forest, Farm forestry, Social forestry and Agro-forestry
6. Factors of locality : climatic (light, temperature & frost)

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7. Topographic (Affect of Altitude, Aspect & Exposure)
8. Edaphic : General, parental rock influence on vegetation, Pan formation
9. Biotic : Influence of plants, insects, wild animals, man and his animals
10. Natural regeneration of forest
11. Artificial regeneration of forest
12. Concept of competition, thinning.

SEMESTER - I
Paper – VIII : Theoretical

Unit-II : Forest mensuration. **Full Marks : 25**

1. Introduction : definition, object and scope
2. Diameter/ Girth : Measurement of diameter /girth
3. Breast height – Rules of diameter measurement, diameter and girth class
4. Height of tree : Principles of height measurement (similar triangle, trigonometric)
5. Instrument of height measurement
6. Form factor : Derivations and significance
7. Volume : Measurement of volume of felled trees, volume table
8. Age of trees : Determination of age of the trees.
9. Crop measurement : Determination of diameter and height of forest crop, top height and its significance
10. Forest inventory & stand table.

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SEMESTER – II

Paper – IX : Theoretical

PTERIDOPHYTES & GYMNOSPERMS

Unit- I: Pteridophytes **Full Marks-25**

1. Introductory idea about pteridophytes:
2. Characteristic features, geological distribution, evolutionary trends and interrelationships of Rhyniopsida, Zosterophyllopsida, Trimerophytopsida, Psilotopsida, Lycopsida and Sphenopsida.
3. An idea about the system of classifications of ferns by Copeland (1947) and Pichi-Sermolli (1977).
4. A comparative study of the members belonging to the following taxonomic groups and also their systematic treatments, evolutionary tendencies and affinities:
   a) Cladoxylales b) Coenopteridales c) Marratiales d) Ophioglossales e) Osmundales f) Filicales (Schizaeaceae, Gleicheniaceae, Cyatheaceae, Polypodiaceae) g) Salviniales h) Marsileales.
5. Stelar organization in pteridophytes and its evolution.
6. Soral evolution in ferns.
7. Mating systems in ferns, sexuality in homosporous ferns, apospory & apogamy, vivipary in pteridophytes.

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Unit-II : Gymnosperms — Full Marks : 25

1. Concept of Gymnospermae, general features of gymnosperms
2. Origin of seed habit.
3. Progymnospermopsida.
4. Classification of gymnosperms
5. Diagnostic features, classification, distribution in time and space and evolutionary trends in the following orders : a) Pteridospermales, b) Cycadales, c) Cycadeoidales, d) Caytoniales, e) Glossopteridales, f) Pentoxycales, g) Ginkgoales, h) Coniferales i) Gnetales.
6. Economic importance of gymnosperms.

Paper-X (Theoretical Paper)
CYTOGENETICS, MOLECULAR BIOLOGY AND BIOTECHNOLOGY

Full Marks : 50

1. Cell cycle – Stages, their respective significance, regulation and events in M phase. Check points and their significance. Cyclins, cyclin dependent kinases and their roles.
2. Ultrastructures and significance of different parts of eukaryotic chromosomes – euchromatin, heterochromatin, centromere, telomere and NOR.
3. Karyotype; chromosome banding [G banding, fluorescence banding, FISH (chromosome painting) and GISH].
4. Genetics of metric characters (definition with examples and their distinctive features); oligogenes and polygenes.
5. Extranuclear inheritance (definition, types and respective examples).
6. Sex determination – types, dosage compensation, sex linked inheritance; sex linked, sex influenced and sex limited characters.

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7. Population genetics – Hardy Weinberg genetic equilibrium, factors affecting allele frequency in population (mutation, migration and selection), genetic drift and inbreeding depression.
8. Concept of speciation – definition of different types.
9. Transposable elements (transposon and retroposon) – definition, characteristic features of IS element, Ac-Ds, copia and *Alu* sequence.
10. DNA replication (only outline procedure), requisite factors and their roles.
11. RNA processing (basic steps only); *cis* and *trans* splicing.
12. Vectors in genetic engineering – definition, pBR322, M13, Ti plasmid, cosmid and shuttle vector.
13. Restriction enzymes, RFLP, RAPD, AFLP, Blotting techniques, PCR, DNA fingerprinting, Chromosome walking, Chromosome jumping, Microarray, Gel electrophoresis, 2D gel and Mass Spectroscopy (outline procedures – all for short questions and notes only).
14. Plant breeding methods – Plant Introduction, Pure Line selection, Back Cross, Pedigree Selection, Mass Selection and Clonal Selection. Composite and Synthetic Varieties. Heterosis.
15. Plant Tissue Culture – basic requisites, MS and White's media and their compositions. Roles of macro and micro elements.
16. Principles, Procedure and Utility of Callus Culture, Organogenesis, Micropropagation, Protoplast isolation, culture and Somatic hybridization.
17. Transgenic Plants – achievements and prospects.

SEMESTER-II

Paper-XI : Practical

TAXONOMY OF ANGIOSPERMS & BIOSYSTEMATIC

Unit : I **Full Marks : 30**

1. Drawing and description of a specimen from locally available representative families, identification up to species.
2. Comparative morphological description of taxa and preparation of artificial key.

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3. Comparative study of the pollen grains, fruit and seed morphology
4. Field trips for familiarization with and study of vegetation types and floras of areas outside the state. Training in collection and preservation methodologies, Submission of field and laboratory records.

Paper-XI
Practical
Forest Mensuration

Unit : II **Full Mark : 20**

1. Measurement of diameter and girth
2. Girth class distribution
3. Regeneration survey methods
4. Measurement of height of a tree
5. Volume calculation
6. Practical records.

Paper – XII
Practical
PTERIDOPHYTES AND GYMNOSPERMS

Pteridophytes : **Full Mark : 25**

$12^{1}/_{2}$

1. A comparative study of the vegetative and reproductive parts of some extant pteridophytes included in the theoretical syllabus.
2. Study of some fossil pteridophytes included in the theoretical syllabus.
3. Field work.
4. Submission of field and laboratory records including permanent slides).

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Gymnosperms: **Full Mark : $12^{1}/_{2}$**

1. A comparative study of the vegetative and reproductive parts of some extant gymnosperms included in the theoretical syllabus.
2. Study of some fossil gymnosperms included in the theoretical syllabus.
3. Field work.

[Submission of field and laboratory records including permanent slides.]

Paper – XII
CYTOGENETICS, MOLECULAR BIOLOGY AND BIOTECHNOLOGY
(Practical Paper)

Cytology : **Unit-II** **Full Marks : 25**

1. Knowledge about and preparation of Pre-treating agents, Fixatives and Stains for cytological uses.
2. Identification of different stages of Mitosis with respect to their salient features and in relation to the significance of their functions.
3. Study of Meiosis in Pollen Mother Cells. (not for performing at examination).
4. Study of abnormalities of cell division and chromosomal morphology.
5. Identification of normal and abnormal stages of Mitosis, stages of Meiosis (both from plants and animals; for examination only the types shown in practical classes).
6. Karyotyping. (to be performed in examination from supplied drawing or photograph).
7. Acquaintance with gel electrophoretic apparatus, principle and procedure. (only for recording in exercise book, to be asked in viva voce and not for performing at examination).
8. Demonstration of the usage of laminar air flow for the purpose of plant tissue culture. (*only for recording in exercise book, to be asked in viva voce and not for performing at examination*).

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Biometry:

1. Measure of Dispersion – Standard Deviation (calculation, merits and demerits), Standard Error (calculation and significance).
2. Chi Square test for Goodness of Fit of – (i) Fixed Ratio Hypothesis, (ii) Contingency Table and (iii) Homogeneity of Ratio.

SEMESTER-III
PAPER-XIII
THEORETICAL
PLANT PHYSIOLOGY & BIOCHEMISTRY
Marks-25+25=50
Unit - I

Plant Physiology **Full Marks : 25**

1. **Bioenergetic principles :** Concept of free energy, exergonic and endergonic reactions, biological redox systems, oxidative phosphorylation, energy currency in plant system.
2. **Photosynthesis :** Oxygemic and anoxygemic photo systhesis, Fluorescence, phosphorescence, chemiluminescence, photochemical reactions, photophosphorylation, path of carbon in photosynthesis, regeneration of RuBP in dark reaction, regulation of photosynthesis, photosynthetic inhibitors and promoters.
3. **Photorespiration :** Compartmentalization of photorespiratory reactions in subcellular particles, experimental evidences of the occurrence of photorespiration, special characters of photorespiring plants, crassulacean acid metabolism.
4. **Plant growth substances :** Definition and present concept of phytohormones and plant growth regulators (PGRs), members

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of phytohormone family, growth promoting and retarding chemicals; a general account of auxins, gibberellings, cytokinins, ethylene and abscisic acid with reference to their chemistry, physiological roles and bioassay.

5. **Nitrogen fixation :** Symbiotic and nonsymbitic nitrogen fixing agents, nodulation process, biochemistry of nitrogen fixation.
6. **Flowering and photoperiodism :** Definitions, hormonal concept of flowering critical day length concept experimental evidence to prove the mobile nature of flowering stimulus, ABC module of flowering on the basis of photoperiodic responses, role of phytochromes in flowering.
7. **Germination and dormancy :** Definitions, important events of seed germination process, types of seed dormancy, mechanism of dormancy, physical and chemical methods of breaking seec dormancy, significance of dormancy.

BIOCHEMISTRY

Unit : II **Full Marks : 25**

1. **Elemetary principles of chemistry** : Chemical bonds, reaction orders, law of mass action, pH, buffer, entropy.
2. **Carbohydrates** : Classification, chemical constituents, structures of monosaccharides, oligosaccharides and polysaccharides.
3. **Amino acids** : Protein and nonprotein amion acids, classification and structures of protein amino acids, essential amino acids.
4. **Proteins** : Classification, primary and higher order structures of protein, formation of peptide bonds, properties and purification of proteins.
5. **Fats and fatty acids:** Definitions of fats, lipids, oils, saponification number, saturated and unsaturated fatty acids; classification of lipids, B-oxidation.

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6. **Enzymes :** Classification, definitions of isozymes, allosteric enymes, feedback inhibition, competitive and non-competitive inhibition of enzymes, mechanisms of enzyme action , enzyme kinetics.
7. **Instrumentation :** Colorimetry, Spectrophotometry, Centrifuges (ordinary and ultra), Thin layer chromatography (TLC), Gas liquid chromatography, Electrophoresis, HPLC.

Paper-XIV
THEORITICAL
Silviculture system Forest, Surveying and Forest Management.

Full Marks : 50

Unit-I : Forest Surveying. Full Marks 10

1. Forest surveying: Object, scope and classification, two great princles of survey
2. Scales : Characteristics of good graphical scale, Diagonal scale
3. Linear measurement : Chain Survey, Plane table survey.
4. Prismatic compass, W.C.B, Quadrantal bearing. Back and Fore bearing.

Siliviculture system Full Marks : 15

1. Classification and objective
2. Clear felling system : clear strip and alternate strip system. Regeneration by Taungya and /or departmental plantation.
3. Uniform system : Shelter wood system, kinds and pattern of felling, Periodic Block, Indian Irregular shelter wood system
4. Group system : Defenition, pattern of felling and character of crop.
5. Selection system
6. Coppice – System : Simple, Coppice with Standard
7. Appliction of Silviculture system

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Unit-II ; Forest management — Full Marks : 25

1. Principles and objective of Forest conservation and management
2. Forest Policy 1988 and concept of Forest Acts. (No details)
3. Legal classification of Forest : Reserve, Protected and unclassed forest. Status of Forest Territotrial classification of forest, Block, compartment and sub comparatment
4. Management classification : Working plan, working circle, Felling series.
5. Sustained yield and progressive yield
6. Rotation (Production period) : Types, objective and application.
7. Normal forest : Basic factors of normality, kinds of abnormality
8. Increment : Current annual increment and Mean annual increment (CAI & MAI)
9. Growing stock : Normal G.S. in clearfelling system based on (a) MAI and (b) yield table.
10. Joint Forest Management : Concept, working and sustainability.

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SEMESTER-III
PAPER-XV
THEORITICAL
PLANT ECOLOGY (GENERAL)

Full Marks : 50

1. Significance and scope of ecology; concept in ecology- deep ecology and shallow ecology.
2. Structure and functions of ecosystems – primary production, energy flow, ecological pyramids, food chair.
3. Environmental problems in India and World.
4. Environmental Movements (Silent valley, Chipko) and debates (*Eucalyptus)* and dams in India.
5. Shifting cultivation – its ecological impact.
6. Plant Adaptations, Aquatics, Xerophytes and Halophytes.
7. Plant succession – types and climax concept.
8. Coastal vegetation with species reference to Sunderbans mangroves.
9. General account of Environmental pollution, Acid vain, ozone depletion, Green house effect and Global warring.
10. General account of Biodiversity and its Conservation.

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SEMESTER - III

PAPER – XVI

PALAEOBOTANY, PALYNOLOGY & REPRODUCTIVE BIOLOGY

PALAEOBOTANY

Unit : I **Full Marks : 25**

1. Definition and types of plant fossils according to their mode of preservation; concept of form genus.
2. Principles of correlation and stratigraphy; dating of rocks.
3. Geologic time scale, major events of plant life through geologic time.
4. Origin of life, early life forms recovered from Precambrian strata.
5. Plant life through Indian Gondwana.
6. Outline idea about continental drift with reference to plate tectonics

Unit : II Palynology and Reproductive Biology Full Marks : 25

1. Microspore tetrads, polarity of spores and pollen grains, spore-pollen morphology, apertural patterns, exine stratification, structure and sculpture; LO- analysis and edge analysis.
2. Chemical nature of sporopollenin, Ubisch body.
3. Extraexinous material – perine, viscin- threads, pollen-kitt.
4. Application of palynology – palynology in relation to taxonomy, palaeopalynology, melissopalynology, pollinosis and forensic palynology.

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5. Pollination Biology: Pollen dispersal units; pollination types; contrivances for cross- and self-pollination; pollen vectors, pollination modes and floral organization; evolutionary trends in pollination modes.
6. Breeding systems; self incompatibility and compatibility control with reference to pollen-pistil interactions.

SEMESTER – III

Practical

Paper- XVII

PLANT PHYSIOLOGY AND BIOCHEMISTRY

UNIT : I **Full Marks : 30**

1. Determination of percentage seed viability of TTC test.
2. Effect of respiratory promoters/inhibitors on the rate of aerobic respiration.
3. Effect of photosynthetic promoters/ inhibitors on the rate of photosynthesis.
4. Determination of isotonic concentration and osotic pressure of cell sap.
5. Isolation of chloroplasts and demonstration of Hill reaction.
6. Determination of isoelectric points of protein.
7. Extraction and comparative study of chlorophyll levels in leaves of different chronologicals ages.
8. Preparation of a standard curve for proteins and determination of protein levels in unknown samples using Folin-phenol reagent.
9. Preparation of a standard curve for amino acid and determination of amino acid levels in unknown samples using ninhydrin reagent.

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10. Preparation of a standard curve for carbohydrates and determination of carbohydrate levels in unknown samples using anthrone reagent.
11. Preparation of a standard curve for IAA and determination of IAA levels in unknown samples using Salkowsky reagent.
12. Comparative study on the activities of catalase enzymes in different plant samples.
13. Comparative study on the activities of amylase enzymes in different plant samples.
14. Studies on paper chromatography of amino acids.

FOREST SURVEYING & MANAGEMENT

Unit : II **Full Marks : 20**

1. Preparation of diagonal scale
2. Study of chain and linear measurement
3. Study of Prismatic compass. Measurements of bearing.
4. Surveying by plane table methods.
5. Field visit / records etc.

SEMESTER-III
PAPER-XVIII
PRACTICAL

Unit : I **Plant Ecology (General)** **Full Marks : 25**

1. Study of Raunkier's life forms and biological spectrum.
2. Study of frequency, abundance and density of plants following standard method.
3. Ecological study on plant adaptation.
4. Ecological field study (excursion) of a Given area and preparation of records.
5. Laboratory note book.

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Unit : II- Palaeobotany, Palynology & Reproductive Biology

Palaeobotany : **Full Marks : $12^{1}/_{2}$**

1. Palaeobotanical field work.
2. Study of representative megafloral assemblages and determination of age.

** (Submission of field and laboratory records).

Palynology and Reproductive Biology : **Full Marks : $12^{1}/_{2}$**

1. Pollen morphological studies of some pteridophytes, gymnosperms and angiosperms representing different morphological types using acetolysis / alkali maceration method.
2. Extraction of pollen grains from honey samples and study of the frequency of different morpho-types.
3. Study of *in vivo* and *in vitro* germination of pollen grains.
4. Morpho-anatomical study of stigma and style.
5. Study of the growth of pollen tube through stigma and style.

** (Submission of laboratory records including permanent slides).

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SEMESTER-IV

PAPER-XIX

THEORY

ECONOMIC AND APPLIED BOTANY

Full Marks : 50

1. Non timber forest produces (fibre and flosses; grass oil, oil seeds; grasses, bamboos and canes; tans, dyes and gum; resins and oleoresins; drugs, spices, poisons; edible products). Importance of NTFP.
2. Endangered and threatened medicinal plants (IUCN). Invasive economic plants.
3. Honey – Sources, Physical properties chemical constituents, collection, processing, food value, medicinal importance and prospect.
4. Sacred tress and sacred groves – socio economic importance.
5. Clonal propagation, germplasm conservation – strategies, significance and application, cryopreservation.

Paper - XX

SPECIAL PAPER

ADVANCED PLANT TAXONOMY

Full Marks : 50

1. **History of Taxonomic study in India**: Contributions and taxonomic literature in relation to Angiosperms.
2. **International Code of Botanical Nomenclature**: The rules and recommendations, application of ICBN with examples and problems. Phylocode: History of phylogenetic nomenclature, properties and advantages

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3. **Taxonomic Evidences :** Role of embryology, cytology, genetics, and micro characters (SEM, TEM).
4. **Chemotaxonomy :** Use of micro and macromolecules, genetic homology of chemical characters, chemical markers and different ranks, phytochemistry in plant taxonomy.
5. **Molecular systematics :** Molecular characters (Chloroplast, Mitrochondrial and nuclear gene), Types of molecular data and analysis, use of molecular markers at different ranks in Angiosperm phylogeny
6. **The Angiosperms Phylogeny Group (APG) system of flowering plant classification :** Phylogeneric relationships of Angiosperms. Concepts of palaeoherbs, eudicots;
7. **Numerical phenetic taxonomy :** Objectives, principles, construction of taxonomic groups (OTU and Unit Characters), estimation of resemblances, cluster analysis, merits, demerits and application of numerical taxonomy.
8. **Cladistics**: Principles and methods, Use of morphological, Phytochemical and molecular data in cladistics
9. **Remote sensing technology :** Principles and types of remote sensing, advantages and limitation, GIS and application in plant classifications.
10. **Biodiversity :** Definition, importance, kinds/ levels, concerns- extinction and threats (IUCN categories) Hotspots, Megadiversity centers, **conservation** strategies (*in-situ and ex-situ),* concept and types of protective areas, role of Botanic gardens and gene banks in conservation.
11. **Phytogeography :** Biogeographic zones of India, Endemism (Theories, types and distribution of endemic plant families), disjunction: Invasions and Introductions.

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12. **Systematic studies :** Distribution, Adaptive features and Phylogeny of special life form classes: Parasitic plants, Insectivorous, Mangrove Taxa.

13. **Palyno-Taxonomy** : Scope, branches, structure, types and evolution of pollen grains; applications/ importance

Suggested Readings :

1. Bailey, L.H. (1940). *Manual of Cultivated Plants*. The McMillan Company, New York.
2. Cole, A.J. (1969). *Numerical Taxonomy*. Academic Press, London.
3. Davis, P.H. and Heywood, V.H. (1973). *Principles of Angiosperms Taxonomy*. Robert E. Kreiger Pub. Co., New York.
4. Dobson, Andrew P., (1996). *Conservation and Biodiversity*. Scientific American Library, New York.
5. Erdtman, G. (1969). *Handbook of Palynology. Munksgaard*, Copenhagen.
6. Erdtman, G. (1986). *Pollen Morphology & Plant Taxonomy: Angiosperms*. E.J. Brill, London.
7. Faegri, K. & Pijl, L. van der. (1979). *The Principles of Pollination Ecology*. Pergamon Press. Oxford.
8. Friis, E.M. Willam, G. Chaloner and P.R. Crane. (1987). *The origin of Angiosperms and their biological consequences*. Cambridge University Press. Cambridge.
9. Fucclio, D.L. Sears & P. Stapleton. (1997). *Biodiversity in Trust*. Cambridge, U.K.
10. Grant, W.F. (1994). *Plant Biosystematics*. Academic Press, London.
11. Heywood, V.H. and Moore, D.M. (1984). *Current concepts in Plant Taxonomy*. Academic Press, London.
12. Hills, D.M. Montz, C.M. & Mable, B.K. (1996). *Molecular Systematics*. 2nd Edition. Sinauer Associates, Sunderlad.
13. Jain, S.K. (1987). *A Manual of Ethnobotany*. Scientific Publishers. Jodhpur, India.

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14. Jeffrey, C. (1982). *An Introduction to Plant Taxonomy*. Cambridge University Press, Cambridge, London.
15. Jones, A.D. and Luchsinger, A.E. (1986). *Plant Systematics* (2nd Edition). Mc-Graw-Hill Book Co. New Delhi.
16. Joysey, K.A. & A.E. Friday. (1982). *Problems of Phylogenetic Recontruction*, Academic Press Ltd., London.
17. Judd, W.S., C.S. Campbell, E.A. Kellogg, P.E. Stevens, (2002). *Plant Systematics: A Phylogenetic approach*, Sinauer Associate Ins., Sunderland, Massachusetts, U.S.A.
18. Kitching, I.J., P.L. Forey, C.J. Humphries & D.M. Willams, (1998). *Cladistics: The Theory and Practice of Parsimony Analysis*. Oxford University Press, Inc., New York.
19. Kumar, U. & Asija, J. (2000). *Bidiversity: Principals and Conservation*, Agrobios (India), Jodhpur.
20. Lawrence, G.H.M. (1951). Taxonomy of Vascular Plants. MacMillan, New York.
21. Mondal, A.K. (2005). *Advanced Plant Taxonomy*. New Central Book Agency Pvt. Ltd. Kolkata.
22. Naik, V.N. (1984). *Taxonomy of Angiosperms*. Tata Mcgraw Hill, New Delhi.
23. Nordenstam, B., ElpGazaly, G. and Kassas, M. (2000). *Plant Systematics for 21st Century*. Portland Press Ltd. London.
24. Quicke, Donald L.J. (1997). *Principles and Techniques of Contemporary Taxonomy*, Blackie Academic & Professional, London.
25. Radford, A.E. (1986). *Fundamentals of Plant Systematics*. Harper and Ros Publishers, New York.
26. Singh, G. (1999). *Plant Systematics: Theory and Practice*. Oxford & IBH Pvt. Ltd., New Delhi.
27. Sneath, Peter H.A. & Robert R. Sokal. (1973). *Numerical Taxonomy*, W.H. Freeman & Company, San Francisco.
28. Solbring, Otto, T. (1970). *Principles and Methods of Plant Biosystematics*, The McMillan, Tornoto, Ontario.
29. Soltis, D.E., Soltis, P.E. & Doyle, J.J. (eds.) (1988). Molecular Syatematics of Plants. II. DNA Sequencing, Kluwer, Boston.
30. Stace, Clive A. (1989). *Plant Taxonomy and Biosystematics*,

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Arnold Publishers, Bangalore, India.
31. Takhtajan, A.L. (1997). *Diversity and Classification of Flowering Plants*. Columbia University Press, New York.
32. Thomas, B.A. & Robert, A. Spicer. (1987). *The Evolution and Paleobiology of Land Plants*, Dioscorides Press, Portland, Oregon.
33. Woodland, D.W. (1991). *Contemporary Plant Systematics*. Prentice Hall, New Jersey.

Paper – XX

THEORETICAL

ECOLOGY OF BIRDIVENITY AND BIODIVERSITY

Full Marks : 50

1. Relevance and current concept of ecology.
2. Structure and Function of Forest Wetland and Mangrove ecosystems:
3. Population ecology-growth curves, carrying capacity, environmental resistance, population regulation, age structure, Gauge's principle, r-and k-strategy.
4. Global environmental issues – Acid rain, ozone depletion, green house effect, difforestation, soil erosion, biological invasion, pesticide resistance.
5. Environmental disasters-forest fire, flood, *Elnino, Minamata, itai itai* disease charnobyl, Bhopal tragedy.
6. Environmantal diary – Ramsar convention, stockholn conference, Montreal protocol, Basel convention, Earth sunnit, Kyoto protocol.
7. Air, water and soil borne environmental pollutants (biological, chemistry and physical) corrosive, metabolic, monogenic, neurotoxin and teratogenic poisons.

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8. Biodiversity-definition, significance, levels, reasons for loss of biodiversity and conservation strategic.
9. Phytoremedition – signification and scope.
10. Plant responses to environmental stresses – drought, water logging, high and low temperatures and pollution.
11. Sustainable development.

Paper-XX
THEORETICAL
Elective (Special)
MYCORRHIZAE BIOLOGY

Full Marks : 50

Introduction : Soil environment, soil microorganisms, rhizosphere, symbiosis.

Mycorrhiza : Definition, occurrence, origin and evolution, fossil records, types of mycorrhiza and their structure.

Ectomycorrhiza : Morpho-anatomical features, characterization, Ectomycorrhizal fungi, classification and distribution, Isolation, Inoculation of ectomycorrhizal fungi in nursery raised seedings; Sources of inoculum, multiplication. Mineral nutrition and other benefits of ectomycorrhizal associations.

Vesicular-arbuscular-mycorrhiza (VAM)

Occurrence and specificity. VAM forming fungi-classification. Isolation, and multiplication. Soil sterilization and inoculation. Mineral nutrition and other benefits of VA- mycorrhizal association.

VAM under stress conditions – effects pf pH, alkalinity, salinity, water stress and pollution.

VAM in agriculture and forestry-effect of fungicides, herbicides,

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insecticides and agrochemicals on VAM.
Mycorrhizae and disease control.
Interaction of VAM with rhizospheric microorganisms.
National and International staus of mycorrhizal research.

Paper – XX
THEORETICAL
Elective (Special)
PALAEOBOTANY AND PALYNOLOGY

Full Marks : 50

1. a) Outline classification of rocks, diastrophic changes in sedimentary strata (dip-strike, fold, fault); unconformity.
   a) Principles of correlation and stratigraphy, stratigraphic systems and the units of classification, geochronology; standard Geologic Time Scale.
2. International code of Botanical Nomenclature with special reference to the nomenclature of fossil plants.
3. Prebiotic environment; chemical evolution and origin of life; Precambrian life forms, Indian Precambrian stratigraphy; palaeobiology of Vindhyans.
4. a) Palaeofloristics: Siluro-Devonian land floras; Permo-carboniferous floral provinces.
   b) Concept of Indian Gondwana Sequence, stratigraphy and correlation of Gondwana Sequence in Peninsular Indian basins, mega-and miofloristics of Peninsular Indian Gondwana formation; Indian perigondwana floras.
   c) Distribution of tertiary strata in India; palaeogene (Deccan

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Intertrappean), palaeofloistics and palaeoecoloty of peninsular India; Neogene palaeofloristics and palaeoecology of Peninsular (Cuddalore Group and Bengal Basin) and Extrapeninsular (Siwalik) India.

5. Pollen analysis with reference to Quaternary vegetational history of India: Pleistocene Vegetational history of Kashmir valley, Holocene vegetational history of Western India and Bengal Basin.
6. Continental Drift hypothesis, sea-floor spreading, plate Tectonics.
7. Life as a fuel maker; sources of natural fuels, peat, coal and its varieties, constitution of coal, coal palynology; petroleum, its origin, migration and concentration, palynology in oil exploration.
8. Archaeobotany of Indian cultivated plants.
9. Palaeobotany in relation to palaeoclimatology and palaeoecology.

Paper-XX

THEORETICAL

(Special paper)

PLANT GENETICS AND BIOTECHNOLOGY (Theory Paper)

Full Marks **50 (25 + 25)**

Plant Genetics

Unit : I **Full Marks : 25**

1. Chromosomal characteristics across the plant kingdom – an introductory approach in terms of chromosome number, ploidy, structural changes, sex chromosomes, repeat sequences, synteny etc.
2. Variation in nuclear DNA content in plant evolution.

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3. B chromosome – definition, cases and significance.
4. Sex determining chromosomes and genes in plants.
5. Karyotype concept: concepts; trends of karyotype evolution in plant; symmetric, asymmetric and bimodal karyotypes; role of apomixes in evolution.
6. Polyploid crops – origin, genetic analysis, evolution (case studies of wheat and ground nut).
7. Roles of chromosomal changes in biodiversity: ploidy and structural changes.
8. Genetics of Photosynthesis.

Plant Biotechnology

Unit : II **Full Marks : 25**

9. Plant Tissue Cultural methods and utilities – cell suspension culture, single cell culture, somatic embryogenesis, haploid culture, embryo culture, protoplast culture and somatic hybridization.
10. Transgenesis of plants by biological and physical means- Ti plasmid mediated, electroporation, particle gun and microinjection. Application of transgenesis of plants – examples of virus resistance, herbicide resistance, insect resistance and abiotic stress tolerance.
11. In vitro production of secondary metabolites; biotransformation. A brief idea about molecular farming/ pharming (carbohydrate, lipid and protein).
12. Metabolic Engineering: a brief idea with only a few examples from primary metabolites (carbohydrate, lipid and protein) and secondary metabolites (alkaloids, flavonoids, lignins, phytoalexins and terpenoids) and its significance.

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Suggested readings:

1. Archana Sharma and Sumitra Sen, 2002. *Chromosome Botany*, Oxford & IBH Pub. Co. Ltd. Kolkata, India.
2. Sumitra Sen and Dipak Kar, 2005. *Cytology and Genetics*. Narosa, India.
3. K. G. Ramawat, *Plant Biotechnology*, S. Chand and Co. Ltd. New Delhi, India.
4. G. L. Stebbins, 1971. *Chromosomal Evolution in Higher Plants*, Arnold, London.
5. A. Slater, N. Scott and M. Fowler, 2003. *Plant Biotechnology: The genetic manipulation of plants*. Oxford University Press.
6. M. K. Razdan, 2000. *An Introduction to plant Tissue Culture*. Oxford & IBH Pub. Co. Ltd. Kolkata, India.
7. L. D. VijendraDas, 2005. *Genetics and Plant Breeding*. New Age International (P) Ltd. Pub.

Paper XXI
ADVANCED PLANT TAXONOMY
Practical (Special Paper)

Full Marks : 50

1. Taxonomic study of unknown plants of local flora, for identification up to species level by using suitable literature.
2. Acquaintance with taxonomic literature (Index Kewensis, Dictionaries, Manuals, Bibliographies and Flora) and their use
3. Application of ICBN with examples and problems.
4. Workout of inter/ and intraspecific morphological variations
5. Comparative study of the starch grains on different storage organs, Stomata.
6. Work out the pollen morphology of angiospermic taxa (Acetolysis methods) Preparation of glycerin gelly.

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7. Demonstration of different techniques in chemotaxonomy and molecular systematics: Chromatography (Paper and Thin Layer Chromatography), Polyacrylamide gel electrophoresis (PAGE and SDS-PAGE) for proteins, PAGE for Isozyme (Peroxidase) and Agarose gel electrophoresis for DNA.
8. Field study (both local and Phyto-geographically different areas in India): Collection, processing of plant specimens for herbarium, preservation and presentation

PAPER-XXI
PRACTICAL
Ecology Pridivensity (Special)

Full Marks : 50

1. Sudy plant community by different methods (quadrates and transects)
2. Determination of IVI
3. Study on Ecological Anatomy
4. Physio-chemical studies on soil and water.
5. Field-based, ecological studies (excursion) on different ecological areas.
6. Field records/ reports and Laboratory note book.

PRACTICAL
PAPER XXI
(SPECIAL PAPER)
ELECTIVE, MYCORRHIZAL BIOLOGY

Full Marks : 50

1. Isolation and identification of VAM spores from soil.
2. Characterization of Ectomycorrhiza.
3. Study of root for VAM estimation.
4. Sterilization of soil.

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5. Sterilization of Glassware.
6. Sterillization of seed.
7. Pot culture method of VAM multiplication.
8. Method of inoculation of VAM.
9. Method of inoculation of Ectomycorrhiza.
10. Study of inoculation effect of mycorrhiza on plants-stem diameter, leaf area and chlorophyll

Paper – XXI

Elective (Special) – Practical

PALAEOBOTANY AND PALYNOLOGY

Full Marks : 50

1. Field Techniques in Palaeobotany.
2. Study of megafossil assemblages from different geological horizons especially from India.
3. Study of spore / pollen morphology of some extant representatives of pteridophytes, gymnosperms and angiosperms.
4. Laboratory extraction techniques of spores and pollen grains from coal, shale and other sedimentary rocks. Quantitative analysis of spore-dispersal in rock samples from different geologic horizons. Graphic representation of data for the determination of strata.
5. Extraction, identification and quantitative analysis of spore / pollen assemblages from air honey and soil.

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SEMESTER-IV

Paper – XXI

Elective Paper

PLANT GENETICS AND BIOTECHNOLOGY

(Practical Paper)

Full Marks : 50

1. Study of Cytological Abnormalities.
2. Study of Karyotypes.
3. Study of Meiosis in Pollen Mother Cells.
4. Isolation and Colorimetric estimation of DNA and RNA.
5. SDS PAGE of Seed Storage Protein/ PAGE of Isozyme.
6. Preparation of Plant Tissue Culture media.
7. Inoculation and Culture of Plant Tissues.
8. Regression Analysis.
9. Analysis of Variance (One Way ANOVA).

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