SEMESTER I

Theory

PAPER I: Phycology and Microbiology **Marks: 60**

Group A: Phycology (30 marks) **Lecture Periods: 35**

1. Evolution and biodiversity of algae: Evolution of algae at Morphological and Ultrastructural level. Algal diversity of different habitat and their Conservation
2. Criteria for classification: Pigments, Reserve foods, Flagella
3. Phylogenetic Relationship of Pro- and Eukaryotic Algae: Recent developments in algal classification, special emphasis on emerging trends in molecular phylogeny and inter relationship of principal groups of algae. Symbiosis theory – Primary, Secondary and Tertiary endosymbiosis; Fan shaped phylogenetic tree
4. Cyanobacteria: Cyanobacterial genetics, Soil and rice field reclamation, Heterocyst – ultrastructure, biochemistry and *nif* - gene regulation
5. General overview of Algal divisions: Prochlorophyta, Glaucophyta, Cryptophyta, Haptophyta, Chlorarchniophyta
6. Cytomorphology and Ultrastructure of Algal cell: Flagellar motor, Photoreceptor Apparatus, Nuclear division
7. Phytoplankton Ecology: Types of phytoplankton, Primary Production, Species Diversity Index, Physical Environment (Light, Heat, Turbulence), Chemical Environment (Nitrogen, Phosphorus, Silicon, Carbon), Nutrient Uptake Models (Michaelis-Menten and Monod-Droope Model)
8. Algal phenomenon and their ecological significance: Algal bloom and red tide, bioluminescence, heterotropism, Algal toxin
9. Algal Biotechnology: Aquaculture (micro and macro algae cultivation), recent developments and future of algal biotechnology, bioremediation, Algal biofuels – algal biodiesel, bio-ethanol and biological hydrogen production; Algae in global warming – carbon capture by algae

Group B: Microbiology (30 marks) **Lecture Periods: 35**

1. Architecture and function of bacterial cell envelope; Flagella
2. Bacterial growth, growth curve and its kinetics; factors regulating growth
3. Bacterial metabolism, fermentation types, photosynthetic and chemoautotrophic bacteria
4. Bacterial sporulation and its regulation
5. Bacterial genome, genetic recombination, molecular mechanism of conjugation, transformation and transduction
6. Bacterial pathogenicity, adhesion, invasion, extracellular enzymes, endo and exotoxins, antibacterial antibiotics and antibiotic resistance
7. Fundamental of immunology-innate and acquired immunity, humoral and cell mediated immunity, antigen-antibody hypersensitivity and different classes of immunoglobulins and application of immunological techniques
8. Plant viruses and its classification with its different genomic structures, plant viral diseases, transmission of plant viruses and its control

9. Replication of viruses with special references to HIV and HBV, regulation of lysogeny; culture, isolation and purification of virus particles, virusoids, viroids and prions

PAPER II: Mycology and Plant Pathology **Marks: 60**

Group A: Mycology (30 marks) **Lecture Periods: 40**

1. Introduction: Distinctive features of fungi and its current status in living world
2. Physiology of fungi: a) Fungal growth: Measurement and kinetics of growth; physical and nutritional factors affecting the growth, b) Reproduction: Sporulation, biochemical and molecular changes accompanying sporulation; Spore Liberation and dispersal, dormancy and germination of spores
3. Ecology of fungi: a) Mycorrhiza, types, relationship between the partners, nutritional physiology, application as biofertilizers, biocontrol and decomposers, b) Lichen: photobionts and mycobionts, physical and physiological relationhship between the partners
4. Fungal Cytogenetics: Cell organelles- woronin body, spitzenkorper, spindle pole body, lomasome, filasome, nucleus, nucleolus; nuclear division; cell cycle control in yeast
5. Physiology and molecular basis of heterothallism; Parasexuality
6. Medical mycology: Mycoses, mycotoxicoses and allergies of man and animals caused by fungi; mycetismus
7. Mushroom cultivation: Edible and medicinal mushrooms, biological value of mushrooms, bioconversion of lignocellulosic wastes; cultivation practices-pure culture, spawn production, composts and their preparation, technique of cultivation of button mushroom

Group B: Plant Pathology (30 marks) **Lecture Periods: 40**

1. Concept of plant diseases, pathogens, parasites, historical perspective and economic importance of plant diseases
2. Molecular diagnosis of plant disease
3. Host pathogen interaction: Mechanisms and site of actions of enzymes, toxins, growth regulators and other biochemical pathogen weapons involved in disease development
4. Host defense and Resistance: Types and systems of host defense in plant kingdom; Genetic, molecular and biochemical basis of host defense against pathogens; Hypersensitive reaction-mechanisms and biomolecules involved; Genetics of virulence in pathogens and resistance in hosts; Genetic and biochemical manipulation of hosts for imparting resistance to pathogens
5. Plant disease epidemiology: Environmental factors affecting disease development, element of plant epidemics, pattern of epidemics and mathematical relations, disease forecasting, new tools in epidemiology
6. Plant disease management: Principles and methods of plant disease management; Exclusion and eradication, protection and therapy including immunization: Regulatory, culture and biological methods of disease control, chemical control with fungicides-protectants and systemic fungicides including antibiotics with their mechanism of actions
7. Application of plant biotechnology in plant pathology
8. Study of plant diseases:
    a) Diseases caused by viruses: Cucurbit mosaic and tomato leaf curl

b) Diseases caused by bacteria and mycoplasmas: Pseudomonas wilt of solanaceous vegetables and little leaf of brinjal
c) Disease caused by nematode: Root knot of vegetables
d) Diseases caused by fungi: Club root of crucifers, White rust of crucifers, Downy mildew of cucurbits, Powdery mildew of peas, Loose smut of barley, Rust of peas, Rust of linseed, Blister blight of tea, Fusarial wilt of banana, Blast disease of rice, Early and late leaf spot of groundnut

Practical

PAPER III: Phycology and Microbiology **Marks: 30**

Group A: Phycology (15 marks)

1. Algal Diversity Study: Identification of members of different groups (maximum 5 genera from each group) – Cyanophyta, Chlorophyta, Bacillariophyta, Euglenophyta
2. Sea weed Identification (any 10): *Enteromorpha, Ulva, Halimeda, Caulerpa, Bryopsis, Macrocystis, Sargassum, Padina, Dictyota, Catenella, Kappaphycus, Gracilaria*
3. Phytoplankton sampling and Identification
4. General principles of Culturing Algae in laboratory, raising pure culture

Group B: Microbiology (15 marks)

1. Different sterilization methods
2. Preparation of bacteriological media
3. Preparation of slant, stab and pouring petriplate
4. Subculturing of bacteria by streak plate method
5. Bacterial staining: Gram staining and Endospore staining
6. Bacterial population count of soil and water samples
7. Study of root nodule bacteria
8. Determination of bacterial growth by turbidimetric method

PAPER IV: Mycology and Plant Pathology **Marks: 30**

Group A and B

1. Instruments (Autoclave, Hot-air-oven, Incubator, Laminar air flow, Colorimeter, Spectrophotometer, Chromatography, Electrophoresis (Gel apparatus), Centrifuge;
2. Micrometry (Standardization)
3. Different methods of sterilization
4. Preparation of media (natural, semisynthetic and synthetic)
5. Isolation of pathogen from diseased tissue (leaf, stem, wood and fruit)
6. Enumeration of fungi from air, water and soil
7. Techniques of monosporous, polysporous and fungal tissue culture
8. Study of effect of temperature and pH on spore germination
9. Fungicidal assay: Determination of ED 50 by spore germination test
10. Biological control by dual culture technique
11. Preparation of spawn and cultivation of *Pleurotus*

12. Study of morphology and reproductive structures of *Plasmodiophora, Albugo, Saccharomyces, Taphrina, Xylaria, Daldinia, Agaricus, Lentinus, Clavaria, Guepinia, Auricularia, Puccinia, Fusarium, Alternaria, Colletotrichum, Cercospora, Rhizoctonia, Cladosporium and Curvularia*
13. Symptology and histopathology of the following diseases : White rust of crucifer, Club root of crucifer, Early blight of potato, *Alternaria* leaf spot of *Brassica*, Powdery mildew of cucurbits, Rust of wheat, Rust of pea, Rust of Linseed, Blast disease of rice, Brown spot of rice

PAPER V: Grand Viva **Marks: 20**

SEMESTER II

Theory

PAPER VI: Bryophytes, Pteridophytes, Gymnosperms, Paleobotany and Palynology

Marks: 80

Group A: Bryophytes (20 marks) and Pteridophytes (20 marks)

Bryophytes **Lecture Periods: 20**

1. Introduction; Amphibian nature and matrotrophic adaptation; Diversity-Ecology and gametophytic structure
2. Classification: Traditional and current concept
3. Ancestory and current concept: Charophycean ancestry of bryophytes and phylogeny of early bryophytes
4. Characteristics, affinities and systematic position: Sphaerocarpales and Takakiales
5. Brief ideas about:
   a) Bryophytes through geological ages
   b) Growth and life form of bryophytes
   c) Apospory and apogamy in bryophytes
   d) Photoperiodism in bryophytes
   e) Economic and ecological significance of bryophytes
   f) Bryophyte chemistry and taxonomic implications
   g) Cytogenetics of bryophytes
   h) Protoplast culture in bryophytes
   i) Water transport in bryophytes

Pteridophytes **Lecture Periods: 20**

1. Concept of Pteridophyta as a single taxonomic unit and its origin
2. Diversities of first land plants: Rhyniophyta, Zosterophyllophyta and Trimerophytophyta
3. Diversities within arborescent Lycopods, origin, growth patterns, reproductive biology and causes of extinction
4. Extinct and extant Sphenophyta, their origin and variation in reproductive structures
5. Structural variation in the vegetative and reproductive organs and taxonomy of extinct and extant Filicophyta

6. Cytogenetics and reproductive biology of ferns-polyploidy, apospory, apogamy, apomixes and hybridization
7. Economic importance: Use of pteridophytes as source of food, fodder, medicine, manure, pesticide and hyperaccumulator of metal pollutants

GROUP B: Gymnosperms (20 marks), Palaeobotany and Palynology (20 marks)

Gymnosperms **Lecture Periods: 20**

1. Concept of gymnosperm as a taxonomic unit and the origin of the group progymnospermopsida
2. Origin and evolution of seed habit, evolution of gymnospermous pollen
3. A brief account of fossil gymnosperms (Lyginopteridaceae, Medullosaceae, Callystophytaceae, Glossopteridales, Pentoxylales, Bennettitales, Cordaitales)
4. A brief account of different families of living conifers including pollen biology and pollination mechanism, female gametophyte and embryogeny and evolution of ovuliferous scales
5. Variation of reproductive structures of *Ephedra, Gnetum, Welwitschia,* and Angiosperm features within the group
6. Karyology and phytochemistry of important taxa
7. Global and Indian distribution of extant gymnosperms in relation to ecology

Palaeobotany and Palynology **Lecture Periods: 20**

1. Origin of Life: Early atmosphere, chemical evolution on early earth, biogenesis, origin of life, precambrian life, stromatolites, kerogen and fossil DNA
2. Dating of rocks: Relative dating, absolute dating and radiometric dating
3. Indian Gondwana stratigraphy with mega and micro floral evidence
4. Application of palynology including palaeo-neopalynology (brief account)
5. Palynology: Spores, prepollen, pollen morphology, Spore-pollen wall: Chemistry, stratification and ornamentation, evolution of aperture types

PAPER VII: Taxonomy of Angiosperms **Marks: 45**

Lecture Periods: 40

1. Introduction: Definitions of terms: Systematics, taxonomy, classification, identification, nomenclature, aims and scope of taxonomy, history and phases of taxonomy
2. Data sources of Taxonomy: Relevance of embryology, palynology, photochemistry, ultra structure and molecular taxonomy
3. Tools of Taxonomy: Functions of field, herbarium, botanic gardens, floras/taxonomic literature, concepts of e-flora, GIS (geographic information system).
4. Biosystematics: Definition, procedures and methods, categories, relationship with classical taxonomy
5. Concepts of Taxonomical Hierarchy: Species/genus/family and other categories, species concept. (Taxonomical/Biological/Evolutionary/Phylogenetic/Ecological)
6. Nomenclature: History of ICBN/ICN, aims and principles, rules and recommendations
7. Concepts and Principles of Assessing Relationship: Phenetic Classification: numerical taxonomy- principles, philosophies, methods, merits and demerits

8. Evolutionary aspects: Definitions of Cladistics, anagenesis, cladogenesis and stasigenesis; primitive and advanced characters, homology, morphocline, homoplasy, monophyly(holophyly and paraphyly), polyphyly
9. Recent systems of angiosperm classification: Cronquist (1988), Takhtajan(1997) and Thorne(2000),outlines up to subclasses, their merits and demerits
10. Angiosperm Phylogeny Group of Classification: a brief concept
11. Angiosperm diversity: Salient features, evolutionary trends and phylogeny in Magnollidae, Hamamelidae, Caryophyllidae, Asteridae, Alismatidae and Liliidae (sensu Cronquist, 1981), concepts of palaeoherbs, eu-dicots etc.

PAPER VIII: Plant Physiology and Biochemistry **Marks: 60**

Group A: Plant Physiology (30 marks) **Lecture Periods: 30**

1. Photosynthesis: Structure and function of PSI and PSII, light harvesting complexes, mechanism of electron transport and ATP synthesis, carbon concentrating mechanisms in C1, C4 and CAM plants, Regulation of Calvin cycle
2. Genetic dissection of rubisco: Structure and function
3. Respiration: Gluconeogenesis, electron transport & ATP synthesis, Q cycle and alternative oxidase, regulation of glycolysis and citric acid cycle
4. Nitrogen metabolism: assimilation of nitrate and ammonium, biological N_2 fixation, *nif* and *nod* genes
5. Plant growth regulators: Action of auxins, auxin induced genes, biosynthesis of gibberellins, gibberellin signaling, biosynthesis of cytokinin, cellular and molecular modes of cytokinin action, cytokinin receptor and signaling, biosynthesis of ethylene, ethylene regulation of gene expression, biosynthesis of ABA, ABA regulation of gene expression
6. Sensory photobiology: Structure, function and mechanism of phytochrome and cryptochrome, photoperiodism and biological clock
7. Stress physiology: Response of plants to biotic and abiotic stresses; mechanisms of tolerance to biotic and abiotic stresses. Stress inducible genes and proteins

Group B: Biochemistry (30 marks) **Lecture periods: 30**

1. Structure of atoms, molecules and chemical bonds, pH and buffer; principles of thermodynamics and reaction kinetics
2. Biomolecules: Composition, structure and function of carbohydrates, proteins, lipids, nucleic acids, vitamins and coenzymes
3. Proteins: Primary, secondary, tertiary and quaternary structures; domains; motif and folds; Ramachandran plot
4. Lipids: Oxidation of fatty acids
5. Enzymology: Enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, enzyme inhibition, isozymes, allosteric enzyme, ribozyme and abzyme
6. Secondary metabolites: Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles

Practical

PAPER IX: Bryophytes, Pteridophytes, Gymnosperms, Palaeobotany and Palynology

Marks: 40

Group A: Bryophytes (10 marks) and Pteridophytes (10 marks)

Bryophytes

1. Work out and identification of ;
    a. Marchantiophyta (Preferably: *Lunularia, Asterella, Dumortiara, Plagiochasma, Conocephalum/Targionia*)
    b. Bryophyta(Hepaticopsida and Bryopsida): Representing nematodontous, haplolepidous and diplolepidous groups
2. Identification (Macroscopic): *Lunularia* (with gemmae cup), *Targionia* (with sporophytes), *Pellia* (with sporophytes), *Fossombronia* (Gametophytes), *Notothylus* (with Sporophytes), *Fissidens* (Gametophytes), *Rhodobryum* (Gametophyte and Sporophyte), *Lyellia* (with sporophyte), *Porella* (with leaf arrangement), *Sphagnum* (leaf).
3. Identification (Microscopic): Reproductive structures of Liverworts, hornworts and mosses.

Pteridophytes

1. Study of external morphology of vegetative and external and internal structures of the reproductive parts of the following genera: *Lygodium, Dicranopteris, Nephrolepis, Adiantum, Cyathea, Drynaria, Pteris, Asplenium, Pyrossia, Marsilea, Salvinia, Microsorus*. Mention primitive and evolved characters of these genera
2. External identifying characteristics of the following genera: *Psilotum, Tmesipteris, Lygodium, Lycopodium selago, Selaginella bryopteris, Helminthostachys, Botrychium, Cheilanthes* and *Blechnum*

Group B: Gymnosperms (10 marks) and Palaeobotany & Palynology (10 marks)

Gymnosperms

1. Study of external morphology with special reference to their male and female reproductive structures, pollen grains: *Cycas, Pinus, Ginkgo, Abies, Cedrus, Thuja, Cryptomeria, Podocarpus, Cephalotaxus, Taxus, Araucaria, Gnetum*
2. Leaf anatomy for resin canal and transfusion tissue of the following: Pinaceae, Taxodiaceae, Cephalotaxaceae, Araucariaceae

Palaeobotany and Palynology

1. Study of shape and aperture types by safranin stained and glycerin jelly mount of the following spores/pollen from fresh material
2. Microscopic characterization of honey (qualitative and quantitative)
3. Study of mega fossils (Stromatolite, Gondwana fossils: (Lower, Middle and Upper) and microfossil
4. Techniques to study fossils (concept only)

PAPER X: Taxonomy of Angiosperms **Marks: 25**

1. Workout of plant specimens and description of vegetative and reproductive character from representative locally available families
2. Training in using local floras and other literature and herbaria for identification of specimens described in the classes
3. Study of major pollen characters through preparation of pollen slides by short term technique
4. Field excursion for familiarization with and study of vegetation types(s) and flora(s) of areas both local and outside the state and training in collection and preservation methodologies, submission of field records and collections of the dried specimens at least 30 from the commonly growing wild species

PAPER XI: Plant Physiology and Biochemistry **Marks: 30**

Group A and B

1. Effect of antitranspirant on the rate of transpiration
2. Effect of uncoupler on the rate of respiration
3. Study of Hill reaction by isolated chloroplast
4. Determination of water potential of plant tissue by Chardakov's method
5. Estimation of IAA and protein by colorimetric method
6. Estimation of Ca, Mg and S
7. Extraction and estimation of enzymes: ascorbic acid oxidase and peroxidase from plant samples

PAPER XII: Grand Viva **Marks: 20**

SEMESTER III

Theory

PAPER XIII: Cell Biology and Genetics **Marks: 60**

Group A: Cell Biology (30 marks) **Lecture Periods: 25**

1. Cell: Ultrastructure; Organelles: ER, GC, plant cell vacuole, Lysosomes and Microbodies; Plasmodesmata: structure and function
2. Biomolecules: Structure, composition, function; transport of ions and macromolecules
3. Nucleus: Envelope and nuclear pore complex; nuclear export and import, ultrastructural features of active and inactive nucleolus, rRNA biosynthesis, sno RNA- structural types, rRNA processing and ribosome biogenesis
4. Cytoskeleton: Organization and role of microtubules, intermediate filaments and microfilaments
5. Mitochondria: Genome organization, male sterility; biogenesis
6. Chloroplast: Genome organization, biogenesis
7. Cell Cycle: Phases, Molecular Control of different checkpoints; brief outline of yeast and mammalian cell cycles; PCD in plants

8. Techniques in Cell Biology: Spectrophotometry, mass spectrometry, NMR, Cytophotometry and flow cytometry; ISH: FISH, GISH, F-GISH
9. RNA editing: RNA interference, antisense RNA, snRNA, microRNA and silencing of RNA

Group B: Genetics (30 marks) **Lecture Periods: 25**

1. Chromosomes: Structure, packaging of DNA and gene activity, Molecular Organization of centromere and telomere, Chromosome banding and karyotype
2. Gene: Molecular structure, fine structure (*cis*/*trans* test)
3. Linkage, Crossing over and Chromosome mapping: Crossing over as a physical basis for recombination, Rec bcd pathway, double strand break model in yeast, mitotic recombination in *Drsophila*, site specific recombination; Diploid mapping, two point and three point test cross; Haploid Mapping, tetrad analysis
4. Replication of DNA: Basic mechanism and Enzymes; Replication in prokaryotes and eukaryotes
5. Mutation and DNA Repair; human diseases due to spontaneous mutation and defects in DNA repair
6. Transposable genetic elements in prokaryotes and eukaryotes: mechanism of transposition
7. Population genetics: Definition of population, Gene frequency, Gene equilibrium, Hardy-Weinberg Equilibrium, Genotype frequency and allele frequency, genetic drift, Genetics of Speciation, DNA typing, Genome evolution in cereals.
8. Developmental Genetics: Homeotic genes, genetics of floral organ differentiation

PAPER XIV: Molecular Biology and Plant Biotechnology **Marks: 50**

Group A: Molecular Biology (25 marks) **Lecture Periods: 25**

1. Organization of eukaryotic genetic material: Fine structure of gene (rII locus), Confirmation of nucleic acids [helix (A,B,Z), t-RNA, micro-RNA], Repititive DNA, Split genes/Interrupted genes, overlapping genes
2. DNA replication: Unit of replication, enzymes involved, replication origin and replication fork, process and termination of replication (mechanism in detail), processivity, fidelity and regulation of replication
3. RNA synthesis and processing: Transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, RNA processing, RNA editing, Splicing and polyadenylation, RNA transport
4. Protein synthesis and processing: Formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, aminoacyl tRNA synthetase, translational inhibitors, Post-translational modifications of proteins

Group B: Plant Biotechnology (25 marks) **Lecture Periods: 25**

1. Biotechnology: Basic concepts, principles and scope

2. Recombinant DNA technology & Gene Manipulation: Vectors, Cloning strategy in *E. coli* (plasmid, phage, cosmid, phagemid) and Yeast vectors (YAC), PCR, different gene transfer methods, reporter genes, Genomic and cDNA library
3. DNA/gene manipulating enzymes: Endonuclease, exonuclease, ligase, polymerase, phosphatase, transcriptase, transferases, topoisomerase
4. Plant tissue culture: Basic principles, tools, totipotency (molecular and biochemical aspects), micropropagation and its types, somatic embryogenesis and somaclonal variations, artificial seed, Haploid culture, callus and suspension cultures, protoplast culture and somatic hybridization, cryopreservation
5. Genetic Engineering of plants: Manipulation of chloroplast and nuclear genome, *Agrobacterium* mediated gene transformation, T-DNA organization and Ti plasmid, horizontal gene transfer
6. Algal and fungal biotechnology: Aquaculture (micro and macro algae cultivation), Algal biofuels. Fermenter and fermentation process, application of fermentation, mycoindustrial production of alcohols, antibiotics (Penicillin and griseofulvin), SCP, alkaloids, phytoremediation

PAPER XV: Ecology, Anatomy and Pharmacognosy **Marks: 45**

Group A: Ecology (25 marks) **Lecture Periods: 25**

1. Biodiversity: Concepts, levels, hotspots, megadiversity centers, status (with special reference to India); Concerns- extinction and threats (IUCN categories), conservation-needs and methods, CITES and TRAFFIC, biosphere reserves, wild life sanctuaries and National Parks-a general concept; Role of Botanic Gardens, Seed, gene and DNA Banks, WWF, MAB, NBPGR and IBPGR
2. IPR Issues: TRIPS Agreement, CBD, biopiracy and bioprospecting
3. Community: Concept of community and continuum, ecological niche, resource partition, character displacement, species diversity management, edges and ecotone, ecological succession
4. Population ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (*r* and *K* selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.
5. Ecosystem: Structure and function, energy dynamics, wetland, forest and grassland ecosystem
6. Evolutionary ecology: Speciation-allopatric and sympatric, convergent evolution, sexual evolution, co-evolution, predator-prey interactions, parasitism, mutualism
7. Biogeography: Concepts and Classification of Biomes, Study of major terrestrial biomes
8. Environment pollution: Major environmental pollutants and their effects on plants

Group B: Anatomy (10 marks) and Pharmacognosy (10 marks) **Lecture Periods: 15**

Anatomy

1. Shoot and root apical organization including cytohistological zonation of shoot apical meristem

2. Ontogeny of differentiation of sclereids and fibers
3. Wood anatomy: Physical and mechanical properties of wood. Structure and evolution of xylem and phloem
4. Secondary growth: Cork cambium and Periderm: Structure, formation and function. Factors influencing cambial activity
5. Ecological plant anatomy
6. Organization of SAM, RAM; leaf development and phyllotaxy
7. Flower development: Floral meristem and floral organ development –modern concept, theories of flower induction

Pharmacognosy **Lecture Periods: 15**

1. Origin of secondary metabolites: A brief account of acetate malonate, acetate mevalonate and shikimic acid pathway
2. Carbohydrates: Starch, cellulose derivatives, gums
3. Glycosides: Classification and uses
4. Alkaloids, definition, properties, classification, *Datura stramonium, Atropa belladona, Rauvolfia, Holarrhena, Catharanthus* - alkaloidal constituents, uses
5. Phenolic compounds produced by plants, types, biological activity, drugs – Senna, Aloe
6. Steroidal compounds, different types, biological activity and pharmaceutical importance
7. Volatile oils, composition, drugs – clove, *Mentha*, *Eucalyptus*
8. Resins, different types, uses
9. Hallucinogenic, allergenic and other toxic plants
10. Production of important secondary metabolites by tissue cell and organ culture
11. Quality control of plant drugs

Practical

PAPER XVI: Cell Biology and Genetics **Marks: 25**

Group A: Cell Biology (10 marks)

1. Isolation of macromolecules: genomic DNA and total protein.
2. Qualitative and quantitative analysis of macromolecules.
3. Demonstration of sophisticated Instruments.

Group B: Genetics (15 marks)

1. Study of orcein, carmine and feulgen staining in plant chromosomes
2. Study of mitosis, mitotic index and karyotype analysis
3. Effect of chemicals on plant chromosomes
4. Study of meiosis

PAPER XVII: Molecular Biology and Plant Biotechnology **Marks: 20**

Group A and B

1. Quantitative estimation of DNA, RNA and protein from standard samples following spectrophotometric analysis

2. Demonstration of instruments/facilities: Different centrifuge, Spectrophotometer, Chromatography, Gel electrophoresis, PCR, Laminar air flow, hot-air oven, autoclave, tissue culture room
3. Extraction of macromolecules: DNA/Protein
4. Sterilization techniques and preparation of media
5. Initiation of aseptic culture from seed, study of callus culture

PAPER XVIII: Ecology, Anatomy and Pharmacognosy **Marks: 20**

Group A: Ecology (10 marks)

1. Determination of frequency, density and abundance of plant community by quadrat method
2. Study of life forms (following Raunkiaer) and determination of Biological spectrum
3. Estimation of dissolved carbon dioxide and oxygen in water

Group B: Anatomy and Pharmacognosy (10 marks)

Anatomy

1. Trichomes, resin canals, laticefars, crystals
2. Nodal anatomy- unilacunar, trilacunar and multilacunar nodes
3. Wood anatomy: T.S., R.L.S. and T.L.S. of wood from C_3 and C_4 plants
4. Bark anatomy: T.S., R.L.S. and T.L.S. of barks
5. Ecological anatomy

Pharmacognosy

1. Choice of solvent for extraction of alkaloids, phenols
2. Chemical tests for the detection of alkaloids, phenols, anthraquinones
3. Study of unorganized drugs: Starches, gums, resins etc.
4. Study of stomatal index, vein islet number, palisade ratio

PAPER XIX: Grand Viva **Marks: 20**

SEMESTER IV

Theory

PAPER XX: Plant Breeding, Biometry, Instrumentation and Computer Application

Marks: 45

Group A: Plant Breeding (15 marks) and Biometry (10 marks) **Lecture Periods: 20**

Plant Breeding

1. Plant introduction and acclimatization
2. Selection: Mass selection, Pure line selection and Clonal selection

3. Hybridization method: Hybridization technique; pedigree method, bulk method, back cross method
4. Heterosis: Genetic basis and application; Inbreeding: a general concept
5. Male sterility: Genetic, cytoplasmic, cytoplasmic-genetic
6. Distant Hybridization: Method, barrier and application

Biometry

1. Sampling method
2. Measure of central tendency: Mean, median and mode
3. Measure of dispersion: Variance, mean deviation, standard deviation and standard error
4. Test of significance: Student's 't' test
5. Correlation and regression
6. ANOVA

Group B: Instrumentation (15 marks) and Computer Application (5 marks)

Instrumentation and Computer Application **Lecture Periods: 20**

1. Microscopy: Light, Fluorescent, Phase- Contrast, Confocal, Electron (SEM, TEM)
2. Centrifuge: Cold, Differential, Density gradient and Ultracentrifuge
3. Molecular Separations: Chromatography (column, gas, thin layer), HPLC, HPLTC
4. Electrophoresis: Agarose gel, Capillary, PAGE (1D and 2D)
5. Chromatin Immunoprecipitation (ChIP)
6. PCR: Semiquantitative and Real time
7. Bioinformatics: Applications, Databases, Sequence analysis, Sequence alignment, BLAST, Homology and Analogy, Phylogenetic analysis
8. Computation Biology: Brief concept, Application in Life Sciences

PAPER XXI: Special Paper **Marks: 100**

- **Cytogenetics and Genomics** **Lecture Periods: 100**

1. Regulation of gene expression in Prokaryotes and Eukaryotes
2. Chromatin Domain: Structural and functional domains; SAR, MAR, LCR, Insulators; Modification of DNA and Histones; Chromatin remodeling complex (CRC); histone code hypothesis
3. Molecular plant breeding: Molecular markers, QTL analysis, Marker assisted breeding
4. Genetics of Cancer: Cancer and Virus, DNA and RNA virus, Oncogenesis; conversion of protooncogenes to oncogenes, tumor suppressor genes, therapeutic interventions in cancer
5. Gene transfer: Concepts and Principles of *in vivo* gene transfer; vertical and horizontal gene transfer- direct and mediated; Direct and Indirect methods of gene transfer
6. Blood Group Genetics
7. Genetic diversity, genetic distance, phylogenetic analysis, multigene families-mechanism of gene expansion, concerted evolution, globin and actin genes; pseudogenes
8. Genetics of sex determination: Dosage compensation
9. Genomics: Structural and functional, biological databases, SAGE, EST, BLAST, Microarray and its application

10. Developmental genetics: Regulatory cascades, cell fate and pattern, spatio temporal gene expression in the development of *Arabidopsis; Arabidopsis* genome
11. Gene therapy and genetic counseling; bioremediation and phytoremediation
12. Inheritance of quantitative traits and heritability

- **Molecular Biology and Plant Biotechnology** **Lecture Periods: 100**

1. Cell signaling: Signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component signaling systems
2. Control of gene expression at transcription and translation level: Regulation of gene expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and silencing
3. Aims, strategies for the development of transgenic: Transformation vectors, Promoters, Terminators, Markers and reporter genes, Molecular genetics of T-DNA transfer from *Agrobacterium* to plants, Direct gene transfer methods, Molecular analysis of transgenics, Marker free technologies, Molecular markers for introgression of useful traits in plants
4. Protein and Nucleic acid sequencing, Strategies for genome sequencing: (Chain termination method, automated sequencing, pyro-sequencing), Sequence assembly: (Clone contig and shotgun approaches), Determination of the functions of genes: gene inactivation (knock-out, anti-sense and RNA interference) and gene overexpression, Approaches to analyze global gene expression: Transcriptome, Serial Analysis of Gene Expression (SAGE), Expressed Sequence Tags (ESTs), microarray and its applications, Methodology to study the proteome, differential display, two hybrid system
5. Recombinant DNA technology and its applications: Types of PCR, Expression of cloned DNA and its analysis, production of recombinant proteins in *E. coli*, their purification and analysis, molecular pharming, Biofertilizers, Bioleaching
6. Biotechnology of crop improvement: Gene addition and gene subtraction, biofortified crops
7. Biotechnology and safety of GMOs, IPR and protection, World Intellectual Property organization, patenting of biotechnological materials
8. Production of secondary metabolites in plants: Tools and techniques

- **Plant Physiology and Biochemistry** **Lecture Periods: 100**

1. Bioenergetics, laws of thermodynamics, redox potential, bioenergetic of ion and water transport, energy rich bonds, coupled reactions, electron transport
2. Phytochrome and light control of development: Photochemical and biochemical properties of phytochrome, phytochrome functional domains, molecular mechanisms of action, PHY genes, blue light response and photomorphogenesis
3. Genetic and molecular regulation of C3 and C4pathways
4. Mitochondrial electron transport system, mitochondrial Fo-F1, ATPase and mechanisn of ATP synthesis, cyanide resistance respiration, characteristics of the alternate pathway, energetics and significance
5. Polyamines: Biosynthesis, metabolism and its importance
6. Amino acid biosynthesis
7. Physiology and biochemistry of seed development, orthodox, and recalcitrant seeds, deposition of stored reserve during seed development, seed viability and seedling vigor

8. Senescence and programmed cell death: types of cell death in plants, role of PCD in plants, senescence associated genes, pigment metabolism during senescence, Impact of photosynthesis and respiration on senescence, crosstalk between plant growth regulators and senescence, apoptosis and ageing
9. Uptake and metabolism of Sulphur, synthesis and importance of glutathione
10. Activation energy and control of enzyme action and regulation of biological N_2 fixation
11. Nucleotide metabolism: An overview
12. Molecular mechanism of fruit ripening
13. Polymerase chain reaction and its applications
14. Signal perception and transduction: An overview, receptors, G-protein and phospholipid signaling, cyclic nucleotides, Calcium and protein kinases
15. Knowledge of recombinant DNA technology, its importance and application in plant physiology and crop improvement

- **Taxonomy of Angiosperms** **Lecture Periods: 100**

1. History of development of taxonomy in India
2. Taxonomic literature
3. International Code of Nomenclature (ICN): Brief introduction; Brief knowledge on Principles, Rules and Recommendations and Appendices, proposed BioCode and PhyloCode
4. Taxonomic Data Sources: Vegetative morphology, Role of leaf architecture and seedling morphology, serology, SEM, TEM characters
5. Centres of origin and diversity of cultivated plants (Vavilov,1926); Indian centres of wild plant genetic resources; Role of IBPGR and NBPGR in conservation of plant genetic resources
6. Vegetation of India: Classification; description of Himalayan, peninsular and desert vegetation
7. Biodiversity: Concept, levels/types, importance
8. Conservation: Principles, methods of conservation-*in situ* and *ex situ*, IUCN categories of threatened plants; types of protected areas; role of botanic gardens and gene banks
9. Palynology: Importance, branches, structure, diversity and evolution of pollen grains; taxonomic evidence
10. GIS and Remote Sensing and their applications in Botany
11. Angiosperm Phylogeny Group (APG) system of Plants classification, Concepts of paleoherbs,eudicots
12. Angiosperm diversity: Salient features, evolutionary affinity and phylogeny of Magnoliidae, Hamamelidae, Caryophyllidae, Asteridae, Alismatidae and Liliidae (sensu Cronquist,1981)
13. Brief knowledge of Botanical survey of India(B.S.I), Central National Herbarium and Indian Botanic Garden in relation to taxonomic studies
14. Molecular Taxonomy and DNA barcoding

Practical

PAPER XXII: Plant Breeding and Biometry **Marks: 15**

1. Emasculation
2. Chi-square analysis
3. Determination of mean, standard deviation and standard error

PAPER XXIII: Special Paper **Marks: 100**

- **Cytogenetics and Genomics**

A. Practical (70 marks)

1. Karyotype analysis: Monocot and dicot species
2. Meiotic chromosome analysis: Monocot and dicot species
3. Isolation of DNA from plant material; spectral analysis, gel electrophoresis
4. Isolation of protein from plant material and qualitative analysis through SDS-PAGE
5. Study of Barr Body
6. Determination of Blood Groups

B. Review/Project Work and Seminar (30 marks)

- **Molecular Biology and Plant Biotechnology**

A. Practical (70 marks)

1. Isolation of Nucleic acids
   a. Plasmid DNA by alkaline lysis method
   b. Plant genomic DNA by CTAB method
2. Measuring nucleic acid concentration and purity by spectrophotometric analysis
3. Isolation of total protein from plant tissue
4. Electrophoretic techniques
   a. Agarose gel electrophoresis for separation of nucleic acids
   b. Molecular separation of protein by SDS-PAGE
5. Recombinant DNA technique and genetic engineering
   a. PCR
   b. Restriction enzyme analysis of plasmid DNA
6. Study of different techniques of plant tissue culture

B. Review/Project Work and Seminar (30 marks)

- **Plant Physiology and Biochemistry**

A. Practical (70 marks)

1. Quantitative estimation of total soluble sugar by anthrone method
2. Estimation of reducing sugar
3. Determination of Km and Vmax of an enzyme isolated from plant sample
4. Separation of amino acids and phenols by TLC

5. Separation of amino acids and plant pigments by paper chromatography
6. Estimation of nitrogen by Nessler's reagent
7. Quantitative estimation of phosphates and amino acids
8. Quantitative estimation of ascorbic acid in plant tissue
9. Quantitative estimation of phosphorus by Fiske-Subbarao's method
10. Determination of the effect of DCMU and Metal Ions on Hill reaction
11. Extraction and estimation of fat from plant materials
12. Quantitative estimation of proline in salt stressed leaf tissues
13. Isolation of protein from plant material and quantitative analysis through SDS PAGE
14. Isolation of DNA from plant material and quantitative analysis through agarose gel electrophoresis

B. Review/Project Work and Seminar (30 marks)

- **Taxonomy of Angiosperms**

A. Practical (70 marks)

15. Familiarity with Taxonomic literature
16. Description and identification of some representative plants from locally available families
17. Study of floral trends using floral characters of flowers in different angiosperm taxa following Hutchinson'dicta
18. Description of seedling morphology of angiosperms from fresh or dry specimens, and preparation of artificial key
19. Preparation of checklist
20. Exercises on nomenclatural problems
21. Work out of pollen morphology of angiosperm taxa and preparation of artificial key
22. Field excursion (both local and long at phytogeographically different areas including high altitude)

B. Review/ Project Work and Seminar (30 marks)