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SYLLABUS IN BOTANY

(3-year General & Honours Courses)

UNIVERSITY OF NORTH BENGAL

RAJA RAMMOHUNPUR

UNIVERSITY OF NORTH BENGAL
B.Sc. Courses in Botany (General)

Total Marks - 400 :: Duration - 3 years

Full Lecture
Marks Period

PART - I

Total Marks - 150 :: Duration - 1 year

Theoretical			
Paper - I	: Diversity of microbes and cryptogams	45	75
Paper - II	: Diversity of seed plants and their systematics, Anatomy	45	75
Practical			
Paper - III	: Corresponding to Paper - I and Paper - II	60	150

PART - II

Total Marks - 150 :: Duration - 1 year

Theoretical			
Paper - IV	: Cell biology and Genetics	45	75
Paper - V	: Plant physiology and biochemistry, Ecology, Plant geography	45	75
Practical			
Paper - VI	: Corresponding to Paper - IV and Paper - V	60	150

PART - III

Total Marks - 100 :: Duration - 1 year

Theoretical			
Paper - VII	: Plant pathology, Plant biotechnology, Plant breeding Utilization of plants	60	170
Practical			
Paper - VIII	: Plant pathology, Microbiology, Plant biotechnology, Plant breeding	40	90

PART - I

Paper - I

✓ Diversity of microbes and cryptogams

- ✓ Prokaryotes and viruses: Prokaryotes- structure, nutrition, reproduction and economic importance; general account of viruses
- ✓ Algae: general characters; classification and economic importance; general account of Cyanophyceae; important features and life history of members of: Chlorophyceae- *Oedogonium*, *Chara*; Xanthophyceae- *Vaucheria*; Phaeophyceae- *Ectocarpus*; Rhodophyceae- *Polysiphonia*.
- ✓ Fungi: general characters; classification and economic importance; important features and life history of members of: Mastigomycotina- *Phytophthora*; Zygomycotina- *Rhizopus*; Ascomycotina- *Saccharomyces*; *Ascobolus*; Basidiomycotina- *Puccinia*
- Bryophytes: amphibians of plant kingdom displaying alteration of generations; structure, reproduction and classification of Hepaticopsida (*Marchantia*); Anthocerotopsida (*Anthoceros*); Bryopsida (*Funaria*)
- Pteridophytes: important characteristics of Psilopsida, Lycopsida, Sphenopsida and Pteropsida; structure, reproduction in *Rhynia*, *Psilotum*, *Lycopodium*, *Equisetum*, and *Marsilea*

Paper - II

Diversity of seed plants and their systematics

- ✓ Characteristics of seed plants; evolution of the seed habit; seed plants with (angiosperms) and without (gymnosperms) fruits
- General features of gymnosperms and their classification; geological time scale; fossilization; fossil gymnosperms
- Morphology of vegetative and reproductive parts; anatomy of root, stem and leaf; reproduction and life cycle of *Pinus*, *Cycas*, and *Gnetum*
- Inflorescence: definition; types of racemose and cymose inflorescences
- Flower: types and forms; cohesion and adhesion of stamens; placentation; ovule (typical); self and cross pollination; pre-fertilization changes and fertilization process; endosperm and embryo (dicot); fruit and seed types and their dispersal
- Principles of nomenclature; identification and classification of plants; importance of herbaria
- Systems of classification: Bentham and Hooker's and Engler & Prantl's systems
- Diagnostic characters and economic importance of the following families with examples: Magnoliaceae, Brassicaceae, Malvaceae, Fabaceae (s.l.), Asteraceae, Solanaceae, Verbenaceae, Lamiaceae, Apiaceae, Orchidaceae, and Poaceae

Anatomy

- Mechanical tissue
- Root-stem transition
- Secondary growth- normal and anomalous

Paper - III (Practical)

Work out, drawing, description, microscopic preparation and identification of the following:

- Algae: *Nostoc*, *Oedogonium*, and *Chara*
- Fungi: *Rhizopus*, *Ascobolus*/ *Peziza*, and *Puccinia*
- Bryophytes: *Marchantia* and *Funaria*
- Pteridophytes: *Lycopodium*, *Equisetum*, and *Marsilea*

Gymnosperms

Morphological identification of megasporophyll and microsporophyll of *Cycas* and male female cone of *Pinus*

T. S. of *Cycas* leaflet and *Pinus* needle; L.S. of ovule of *Gnetum* (from permanent slides)

Taxonomy of angiosperms

- ✓ Dissection, drawing, and description of angiospermic plants with floral parts, floral formulae and floral diagrams of the following families: Brassicaceae, Fabaceae (s.l.), Malvaceae, Solanaceae, Verbenaceae, and Lamiaceae

Spot identification of locally available plants from the families included under theory syllabus

Anatomy

Anatomical studies following double staining method of the following materials:

Stem: sunflower, cucurbit, maize, and *Mirabilis*

Root: gram, orchid, and *Arum*

Leaf: *Nerium*

PART – II

Paper – IV

✓ Cell Biology and Genetics

The cell envelopes: plasma membrane- lipid bilayer structure; functions; the cell wall

Structure and function of other organelles: Golgi complex, ER, ribosomes, nucleus peroxisomes, vacuoles

Chromosome organization: morphology; ultrastructure, centromere and telomere; chromosome structural alterations; variations in chromosome number – aneuploidy, polyploidy; sex chromosomes

DNA: structure; replication; model; genetic code

Cell division: mitosis; meiosis

Genetic inheritance: Mendelism; preliminary idea of linkage and crossing over; allelic and non-allelic interactions

Gene expression: structure of gene; protein biosynthesis

Genetic variations: mutations; spontaneous and induced; transposable genetic elements

Extranuclear genome: presence and function of mitochondrial and plastid DNA; plasmids

Paper – V

✓ Plant physiology and biochemistry

Mechanisms of absorption of water and minerals; transpiration- definition and types, mechanism and significance

Mineral nutrition: essential elements and their role

Translocation of organic solutes, ascent of sap

Respiration: types; aerobic and anaerobic; fermentation; glycolysis; Krebs's cycle; electron transport system; R.Q.

Photosynthesis: photosynthetic pigments; mechanism; C₃ and C₄ pathway, law of limiting factors

Biological nitrogen fixation

Photoperiodism: definition; long-day and short-day plants with examples

Plant hormones: definition; role of IAA, gibberellin, cytokinin, and abscissic acid

Carbohydrates: mono-, di- and oligo-saccharides – elementary idea

Proteins: primary, secondary and tertiary structures – elementary idea
Enzymes – definition and properties

Ecology

Factors affecting vegetation
Plant succession
Adaptations of hydrophytes, xerophytes, and halophytes
Study of ecosystem
Conservation of forest

Plant geography

Phytogeographical regions of India (D. Chatterjee, 1960)
Characteristic regions of Sunderbans and Eastern Himalayas

Paper – VI (Practical)

Cytology

Study of mitotic stages from squash preparation (root tip of onion)
Identification of following meiotic stages from permanent slides: diakinesis, metaphase I, anaphase I, metaphase II, and anaphase II

Plant physiology

Demonstration of plasmolysis
Measurement of leaf area (graphical method) and determination of rate of transpiration per unit area by weighing method
Imbibition of water by dry seeds- proteinaceous and fatty seeds
Determination of evolution of oxygen during photosynthesis (using graduated tubes) against dark control
Evolution of carbon dioxide during aerobic respiration and measurement of volume

Biochemistry

Qualitative determination of glucose, starch, tartaric acid, and citric acid

PART – III

Paper – VII

Plant pathology

Terms and definitions: disease; inoculum; pathogenicity; resistance; Koch's postulate; plant quarantine
Symptoms, causal organism and control of: late blight of potato, brown spot of rice, rust of wheat, and stem rot of jute

Plant biotechnology

Recombinant DNA technology: a preliminary idea of restriction enzymes, vectors, cloning, selection, and identification; application in plant improvement
Tissue culture: totipotency; techniques of embryo culture; pollen culture and meristem culture; application

Plant Breeding

Propagation: cloning; grafting; bonsai; and aquaculture

Utilization of plants

Bio-fertilizers: N_2 -fixing microbes; VAM fungi; *Azolla* and their role in agriculture
Study of economically important plants (scientific names, families, parts used, and uses) as follows: Food plants- rice, wheat, and potato
Fibres- cotton and jute
Vegetable oils- groundnut and mustard
Spices- ginger and cumin
Beverages- tea and coffee
Medicinal plants: use and phytochemistry of *Cinchona*, *Citronella*, *Catharanthus*, and *Azadirachta*
Cultivation of edible mushroom- *Pleurotus*

Paper – VIII (Practical)

Plant pathology, Microbiology, Plant breeding, Plant biotechnology

Acquaintance of common laboratory equipment: balances, autoclave, incubator, and centrifuge
Identification of diseased plant specimens and causal organisms as described in theoretical syllabus
Demonstration of preparation of media and sterilization process
Demonstration of sub-culturing and isolation of pathogen
Histopathological studies on any four diseases of major crop plants
Preparation of curd and study of curd organisms
Spawn preparation and cultivation of mushroom
Demonstration of grafting and layering
Visit to local agricultural farms (2)

Model question format and marks break-up in Practical papers

PART - I

Paper III: Cryptogams, Gymnosperms, Taxonomy of angiosperms, Anatomy

Full marks: 60

1. Work out – algae/ fungi	8
2. Work out – bryophyte/ pteridophyte	8
3. Work out of angiospermic plant (as per syllabus)	12
4. Anatomy- work out	10
5. Identification of gymnosperms (macroscopic /microscopic) – 3	6
6. Spot identification of angiospermic plant (genus/family) - 2	2
7. Laboratory and field records	8
8. Viva voce	6

Note: There should be submission of 10 selected herbarium sheets of angiosperms.

PART - II

Paper - VI: Cytology, Plant physiology, Biochemistry

Time: 5 h

Full Marks: 60

1. Cytology (root tip)	17
2. Plant physiology experiment	15
3. Biochemistry – qualitative detection (1 sample)	10
4. Identification of slides (meiotic stages) – 3	6
5. Laboratory records	6
6. Viva voce	6

PART - III

Paper VI: Plant Pathology, Microbiology, Plant Breeding, Plant Biotechnology

Time: 5 h

Full marks: 40

1. Histopathological studies of one specimen	8
1. Demonstration of subculturing / isolation (any one)	6
2. Study of curd microflora	8
3. Demonstration of grafting/layering	5
4. Identification of diseased specimen (herbarium sheet) – 2	3
5. Laboratory and field records	6
6. Viva voce	4

Note: There should be at least three excursions, one in each year.

Suggested Readings

- Kumar, H.D. – Phycology
Vashista, P.C. – Algae, S.C. Chand
Gangulee, H.C. and Kar, A.K. – College Botany, Vol. I and II
Mehrotra and Aneja – Introduction to Mycology
Singh, R.S. – Plant Disease
Singh, R.S. – Plant Pathology
Mehrotra – Plant Pathology
Schlegel, H.G. – General Microbiology, Cambridge University Press
Pelczar, Chan and Kreig – Microbiology
Vashista, B.R. – Bryophyte
Puri, P. – Bryophyte
Sporne, K.R. – A Morphology of Pteridophyte.
Vashista, P.C. – Pteridophyte
Vashista, B.R. – Gymnosperm

Datta, S. C. - Systematic Botany
Mukherjee, S. - College Botany, Vol. III
Maheshwari, P. - An introduction to Embryology of Angiosperms
Bhojwani and Bhatnagar - The Embryology of Angiosperms
Mitra, Guha and Choudhuri - Studies in Botany. Vol. II
Malik and Srivastava - Plant Physiology
Gupta, P.K. - Genetics
Verma and Agarwal - Concept of Cell Biology
Verma and Agarwal - Concept of Molecular Biology
Singh, B.D. - Plant Breeding

B.Sc. Courses in Botany (Honours)

Total Marks - 800 :: Duration - 3 years

Full Lecture
Marks Period

PART - I

Total Marks - 200 :: Duration - 1 year

Theoretical			
Paper - I	: Phycology, Mycology, Bryology, Pteridology	70	130
Paper - II	: Gymnology, Palaeobotany, Morphology, Anatomy	70	130
Practical			
Paper - III	: Corresponding to Paper-I and Paper-II	60	260

520

PART - II

Total Marks - 200 :: Duration - 1 year

Theoretical			
Paper - IV	: Systematics of angiosperms, Utilization of plants, Ecology, Plant geography	70	130
Paper - V	: Cell biology, Plant biochemistry	70	130
Practical			
Paper - VI	: Corresponding to Paper-IV and Paper-V	60	260

520

PART - III

Total Marks - 400 :: Duration - 1 year

Theoretical			
Paper - VII	: Genetics, Plant breeding, Molecular biology	80	120
Paper - VIII	: Plant physiology, Biostatistics	80	120
Paper - IX	: Microbiology, Plant pathology, Plant biotechnology	80	120
Practical			
Paper - X	: Genetics and Plant breeding, Plant physiology, Biostatistics	80	225
Paper - XI	: Microbiology, Plant pathology	80	225

810

PART - I

Paper - I

Phycology

Occurrence and distribution; range of thallus structure; economic and ecological importance
 Classification; general characters and life cycles of typical genera of Chlorophyta (*Zygnema*, *Oedogonium*, *Chara* and *Trentepohlia*), Xanthophyta (*Vaucheria*), Phaeophyta (*Ectocarpus* and *Fucus*), and Rhodophyta (*Batrachospermum* and *Polysiphonia*). General account of Cyanophyta and Bacillariophyta
 Origin and evolution of sex

Mycology

Classification (Ainsworth's); fungal hyphae and their modifications; cell wall; nutrition; spore forms; life cycle patterns and reproduction
 Diagnostic characters of Myxomycotina, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, and Deuteromycotina; life cycles of *Phytophthora*, *Rhizopus*, *Saccharomyces*, *Eurotium*, *Neurospora*, *Peziza*, *Puccinia*, and *Agaricus*
 Mycorrhiza: ecto- and endo-mycorrhiza; their role in agriculture and forestry
 Mushroom: cultivation and food value
 Lichens: general account; ecological and economic importance

Bryology

Classification; habit and habitat; morphology and structural organization of gametophytes and sporophytes; reproductive mechanisms; trends in evolution in main groups; origin
 Life cycles of *Riccia*, *Marchantia*, *Anthoceros*, *Sphagnum*, and *Funaria*
 Ecological aspects and economic importance

Pteridology

Classification and general features; origin- telome theory; stelar evolution; heterospory and seed habit
 Life history of *Psilotum*, *Lycopodium*, *Selaginella*, *Isoetes*, *Equisetum*, *Ophioglossum*, *Marsilea*, and *Adiantum*
 General account of fossil genera- *Rhynia*, *Psilophyton*, *Lepidodendron*, *Lepidocarpon*, *Calamites*, and *Archaeopteris*

Paper - II

Gymnology

Classification; ontogeny and structure of seed; evolution of seed habit; economic importance
 Life-history of *Cycas*, *Pinus*, *Ephedra*, and *Gnetum*

Palaeobotany

General account of fossil groups
 Fossil types- *Williamsonia*, *Cordaites*, *Glossopteris*; nomenclature; process of fossilization
 Geological time scale; and major events of plant life through geological times
 Methods of determination of age of fossils

Phytology

water: cohesion; adhesion; aestivation; ovule types; placentation; floral formula; floral diagram
concepts of flower as a modified shoot
evolution: types and contrivances
fruits and seeds: general concept, types and dispersal
embryology: microsporogenesis; megasporogenesis; microgametogenesis; megagametogenesis;
development and types of embryo sacs; fertilization; development of embryo in dicot; endosperm
development and its types

Anatomy

meristems and development: shoot apical meristem; root apical meristem; lateral meristems and their
functions; theories of origin
epidermis and its emergences; stomatal types and ontogeny
range of form and structure of stem, leaf and root; their tissues and functions; stelar types and evolution;
root-stem transition
secondary body of the plant: vascular cambium; secondary xylem; secondary phloem; periderm
anomalous secondary growth with examples

Paper - III (Practical)

Phycology: study of representative genera from different classes such as *Anabaena*, *Nostoc*, *Volvox*,
Oscillatoria, *Oedogonium*, *Chara*, *Vaucheria*, *Ectocarpus*, and *Polysiphonia*
Mycology: study of *Rhizopus*, *Ascobolus* / *Peziza*, *Agaricus*, and *Polyporus*.
Bryology: study of morphology, anatomy and reproductive structures in *Riccia*, *Marchantia*, *Anthoceros*,
and *Funaria*
Pteridology: study of morphology, anatomy and reproductive structures in *Lycopodium*, *Selaginella*,
Equisetum, *Marsilea*, *Dryopteris*, and *Pteris*
Gymnology: study of morphology, anatomy and reproductive structures in *Cycas*, *Pinus*, and *Gnetum*.
Palaeobotany: study of fossil slides of: *Lepidodendron*, *Lepidocarpon*, *Sphenophyllum*,
Lyginopteris, *Medullosa*, and *Glossopteris*
Morphology: study of morphological structures with special reference to peculiarities.
Anatomy: organization of shoot and root apical meristem (from whole mounts / vertical sections);
microscopic studies of trichomes, stomata, sclereids, raphides, cystolith, starch grains, and lenticels;
anatomy of root, stem (*Leucus/Leonurus*), and leaf (*Nerium*); study of xylem and phloem by
maceration technique; study of anomalous secondary growth in *Tinospora*, *Bignonia*, *Boerhaavia*,
Tecoma, and *Strychnos*

PART - II

Paper - IV

Systematics of angiosperms

Principles of nomenclature: elementary knowledge of ICUN; rules of priority; typification; conservation;
effective and valid publications
Systems of classification: Bentham & Hooker's, Hutchinson's, Engler & Prantl's, and Takhtajan's
systems

Phylogeny of angiosperms: general account of the origin and evolution of angiosperms
 (special reference to Bennettitalean, Gnetalean, Caytonalean and herbaceous origin theories)
 Modern trends in taxonomy: supporting evidences/inputs for taxonomy; taxonomy in relation to anatomy, palynology, ecology, cytology, and secondary metabolites in plants (chemotaxonomy); numerical taxonomy
 Systematics in practice: importance of herbarium specimens and their preparation; role of herbaria and botanical gardens; documentation; keys for identification of plants; value of computers and data bases for identification
 Diagnostic features and systematic positions of Magnoliaceae, Ranunculaceae, Malvaceae, Fabaceae (s.l.), Euphorbiaceae, Apiaceae, Apocynaceae, Solanaceae, Scrophulariaceae, Acanthaceae, Lamiaceae, Rubiaceae, Cucurbitaceae, Asteraceae, Commelinaceae, Alistamaceae, Poaceae, Orchidaceae, and Araceae

Utilization of plants

Scientific names, families, plant parts used and purpose of use of the following:

Cereals and millets- rice, wheat, maize, sorghum, and bajra

Pulses- soybean, chickpea (Bengal gram), red gram (arahar), masur, and mung

Vegetable oil sources- mustard, groundnut, coconut, and sunflower

Plant fibers- cotton, jute, and coir

Timber- teak, sal, sissoo, and mahogany

Medicinal- at least ten plants including sarpagandha, neem, kalmegh, tulsi, *Ipecac*, thankuni, arjun, and *Swertia chirayita*

Spices – turmeric, ginger, cumin, pepper, coriander, cardamom, and cinnamon

Fruits- mango, orange, banana, guava, pineapple, jackfruit, and grape

Volatile oil- Lemon grass, *Eucalyptus*, *Mentha*, and clove oil

Latex- rubber and *Euphorbia*

Beverages- tea and coffee

Narcotics- opium and ganja

Vegetables

Ecology

Organismal ecology/biotic components: individuals, species, populations, communities and their characteristics

Ecosystems: concepts; homeostasis; structure and functions of ecosystem; energy flow; cycling of C, N and P; the biotic and abiotic components and their inter-relationships; processes within the ecosystem; the trophic organization- autotrophy, heterotrophy, parasitism, detritus, and decomposition

Ecological succession: mechanisms and type; food chains and food webs; ecological pyramids

Ecological adaptations: hydrophytes, xerophytes, halophytes, and epiphytes

Plant geography

Phytogeographical regions of India (D. Chatterjee, 1960)

Characteristic regions of Sunderbans, Eastern Himalayas, and Western Himalayas

Paper – V

Cell biology

The cell: historical background; cell theory; kingdom-wise cell size and cell structure; viroids and prions; concept of three domains- archaea, prokarya and eukarya; comparative account of prokaryotic and eukaryotic cells

Cell division and its regulation: mitosis and meiosis; various stages of cell division and progression; cytokinesis; role of centromere, kinetochore and spindle apparatus; animal and plant cell cycle; mechanisms of cell cycle control; apoptosis

Nucleus and ribosomes: ultrastructure; nuclear envelope and nuclear pore complex; nuclear matrix and nucleoplasm; DNA and histones; chromosome structure – nucleosome concept, metaphase chromosome, solenoid structure; ribosome structure; prokaryotic, eukaryotic and organellar ribosomes and their functional significance

Mitochondrion and chloroplast: origin of organelles; organelle structure and biogenesis; organelle membranes and organization of macromolecular complexes; variation in size, shape and number.

Structure/function of other sub-cellular structures: Golgi complex; endoplasmic reticulum; lysosomes; microbodies – peroxisomes and glyoxisomes; cytoskeleton

Techniques in cell biology: principles of light and electron microscopy- TEM and SEM; phase contrast and fluorescence microscopy

Plant biochemistry

Cellular chemistry: covalent and non-covalent interactions; hydrogen bond; electrostatic interactions; hydrophobic interactions; Van der Waals forces and their significance; structure, properties of water and its biological significance; pH and its significance; pH scale; Henderson-Hasselbach equation; buffers

Bioenergetics and enzymology: laws of thermodynamics; concept of free energy; energy transfer and redox potential; classification and nomenclature of enzymes; kinetics of enzyme action – Michaelis-Menton equation; significance of K_m ; factors affecting enzyme activity; enzyme inhibitors; allosteric modification and feed back regulation

Amino acids and proteins: structure, characteristics and classification of amino acids; peptide bonds and polypeptide chain; higher order structures of proteins; amino acid biosynthesis- GS/GOGAT cycle; protein biosynthesis and its regulation

Carbohydrates: classification; structures of representative examples of mono-, di- and polysaccharides; stereoisomers; enantiomers and epimers; functions – storage & structural.

Lipids: classification; saturated and unsaturated fatty acids; triglycerides

Nucleic acids: composition of nucleic acids; DNA structure; A, B and Z forms of DNA; denaturation and renaturation of DNA; DNA replication; DNA polymerases; different forms of RNA and their roles

Paper – VI (Practical)

Systematics of angiosperms

Study of the morphology of locally available plants of following families including floral formula, floral diagram and their identification up to genus by following published keys (eg., Bengal Plants by David Prain, 1903): Malvaceae, Fabaceae (s.l.), Euphorbiaceae, Apiaceae, Apocynaceae, Solanaceae, Scrophulariaceae, Acanthaceae, Lamiaceae, Rubiaceae, Cucurbitaceae, and Commelinaceae

Spot identification up to species, mentioning families of all locally available plants included under the theoretical syllabus

Utilization of plants

Study of whole drug-yielding medicinal plants (live or from herbarium specimen): *Adhatoda vasica*, *Rauvolfia serpentina*, *Solanum khasianum*, *Ocimum sanctum*, *Zingiber officinale*, *Azadirachta indica*, *Andrographis paniculata*/Swertia *chirata*, *Holarrhena antidysenterica*, *Allium cepa*, and *Centella asiatica*

Study of dye-yielding plants- morphology and identification of plant parts; study of stem of jute with special reference to origin and nature of fibre

Ecology

To study soil properties by spot test: texture, pH, carbonate, and nitrate

Estimation of dissolved CO₂ in water from different sources

To study ecological adaptations (morphological and anatomical) in plants (hydrophytes, xerophytes, and epiphytes)

To determine minimum area of sampling unit (quadrat) for the study of communities

Cell biology

Study of cell structure from onion leaf peels; demonstration of staining and mounting methods and preparation of stains

Comparative study of cell structure in onion cells, *Hydrilla* and *Spirogyra*; study of cyclosis in *Tradescantia* staminal hairs/other materials

Study of mitotic cell division and mitotic index of *Allium cepa* by aceto-orcein squash technique

Study of somatic complement of at least three of the following: *Allium cepa*, *A. sativum*, *Aloe vera*, *Lens esculenta*, and *Sagittaria sagittifolia*

Study of meiosis of *Allium cepa*, *Rhoeo* and *Sagittaria* by aceto-carmin smear technique

Plant biochemistry

Preparation of buffers

Determination of pH of plant juices

Qualitative tests for organic acids (oxalic, citric, tartaric, and malic), carbohydrates (reducing, non-reducing) and proteins from laboratory samples

Quantitative estimation of proteins by Biuret method

Quantitative determination of reducing sugars by arseno-molybdate method

Qualitative detection of catalase, peroxidase, and amylase

PART - III

Paper - VII

Genetics

Mendel's experiments and principles of inheritance: Mendelism— principles, history, significance, chromosomal basis; back cross and test cross; gene interactions and modified dihybrid ratios— complementary, supplementary, duplicate, and epistatic factors

Allelism: concept of alleles; multiple alleles; pseudoalleles; human blood groups

Quantitative genetics: Hardy-Weinberg law; quantitative traits and quantitative genetics; heritability

Linkage and recombination: linkage and crossing over; three-point crosses and chromosome mapping; interference and coincidence; molecular basis of crossing over; RecA protein

Sex determination and sex differentiation: chromosomal basis of sex determination in *Drosophila*, man, silkworm and *Melandrium*; sex-linked inheritance; sex-limited characters; modern concept of sex determination.

Mutations: spontaneous and induced mutations; mutagens—types and mode of action; transitions, transversions and frame-shift mutations; detection of mutations

Alterations in chromosome structure and number: origin, types and effects of duplications, deletions, inversions and translocations; origin, types and effects of auto and allopolyploid; origin and meiosis in nullisomics and trisomics

Plant breeding

Vegetative propagation methods: cutting, grafting, layering, cloning

Hybridization techniques: inter-specific and inter-generic; male sterile lines; and heterosis

Maintenance of germplasm: gene bank; pollen bank; and seed bank

Methods of plant improvement: pure line and mass selection; hybridization in self and cross pollinated crops; introduction and acclimatization

Molecular biology

Gene structure, expression and regulation: gene organization and regulation in prokaryotes and eukaryotes; operon concept; inducible, repressible, positive and negative gene regulation; interrupted genes in eukaryotes; RNA splicing; mRNA stability

Recombinant DNA technology: restriction endonucleases; prokaryotic and eukaryotic cloning vectors; genomic and cDNA libraries; Southern and northern analyses; techniques of gene mapping and DNA fingerprinting (RFLP, RAPD, AFLP); PCR; DNA sequencing

Paper - VIII

Plant physiology

Plant-water relations: water transport processes; diffusion and osmosis; absorption of water and transport; transpiration and its significance; factors affecting transpiration; mechanism of stomatal movement

Mineral nutrition: criteria of essentiality of elements; macro-and micro-nutrients; role and deficiency symptoms of essential elements; nutrient uptake and transport mechanisms

Photosynthesis: photosynthetic pigments and accessory pigments; organization of photosystems; photochemical reactions; electron transport in chloroplast membrane and photophosphorylation; the C_3 , C_4 , and CAM cycles; photorespiration

Respiration: glycolysis; conversion of pyruvate to acetyl-CoA; Krebs cycle; ETS; oxidative pentose phosphate pathway

Nitrogen metabolism: biological nitrogen fixation; reduction of N_2 into ammonia; elementary idea of *nif* and *nod* genes; nitrate and ammonium assimilation

Plant growth regulators: role and application of auxin, gibberellin, kinetin, ABA, and ethylene

Physiology of dormancy and germination

Physiology of flowering: vernalization; photoperiodism; concept of biological clock and biorhythm

Biostatistics

Knowledge of sampling, mean, median, mode, standard deviation, and standard error

Probability; t-test; goodness of fit by chi-square analysis

Preliminary knowledge of correlation coefficient and regression

Paper - IX

Microbiology

Discovery of microorganisms: systematic position of microorganisms in the biological world; classification of microorganisms, and characteristic features of different groups

Cellular organization of bacteria: cell wall; membrane; pili; flagella; chromosome; endospore; and ribosome

Genetic recombination in prokaryotes: conjugation, transformation, and transduction

Principles and modern approach to bacterial taxonomy: numerical taxonomy; DNA-DNA and DNA-RNA hybridization; DNA and RNA fingerprinting

Viruses: properties and classification; characteristic features of host-virus interaction; bacteriophage T4; tobacco mosaic virus

General account of mycoplasmas and actinomycetes

Role of microorganisms in biogeochemical cycling of nitrogen and carbon; biological N_2 fixation.

Industrial application of microorganisms: organic acids- citric and glutamic acids; alcohol; food processing; milk products; antibiotics; biopesticides

Plant pathology

Terms and definitions: disease, symptoms, causal complex, primary and secondary inocula, penetration, infection, pathogenesis, resistance, immunity, Koch's postulate, and plant quarantine

Pathogen attack and defense mechanisms: physical, physiological, biochemical, and molecular aspects

Plant disease epidemiology: transmission and spread of plant pathogens; disease cycles; epidemics; modelling and disease forecasting

Genetics of resistance and susceptibility: genes for virulence and avirulence; molecular diagnosis; induced resistance (immunization); molecular manipulation of resistance

Plant disease management: chemical, biological, IPM systems; development of transgenics; biopesticides

Symptoms, causal organisms, disease cycle and control measures of: brown spot, tungro virus, and bacterial blight of rice; loose smut and rust of wheat; late blight of potato; stem rot of jute; and blister blight of tea

Application of Information technology in plant pathology: simulation of epidemics; programmes for diagnosis; prediction of disease control decisions

Plant biotechnology

Cellular differentiation and totipotency; organogenesis and embryogenesis; protoplast isolation and culture; somatic hybridization; clonal propagation

Genetic engineering of plants: vectors for gene delivery; methods of gene delivery; selectable markers and reporter genes

Agrobacterium- the natural genetic engineer

Salient achievements in crop biotechnology (with suitable examples) and prospects

Paper - X (Practical)

Genetics and Plant breeding

Determination of chromosome count from dividing pollen mother cell, root tips and pollen grains

Study of meiotic slides with chromosomal abnormalities (from permanent slides)

Study of special chromosomes- salivary gland chromosomes, and lampbrush chromosomes

Preparation of serial microscopic sections of cytological materials using microtome

Emasculation and bagging of flowers

Plant physiology

Effect of detergents and temperature on permeability of plasma membranes (major)

Determination of osmotic potential of cell by plasmolytic method (minor)

Determination of ratio of water absorption and transpiration (major)

Determination of RQ of different types of seeds using Ganong's respirometer or respiroscope (major)

Determination of stomatal index, stomatal frequency; effect of KNO_3 on stomatal closure (minor)

Effect of light and CO_2 on rate of photosynthesis (major)

Separation of plant pigments by paper chromatography (major)

Determination of total titrable acidity of cell sap (major)

Determination of rate of evolution of CO_2 during aerobic respiration (major)

Biostatistics

Measurement of central tendency: mean, median, and mode

Measurement of dispersion: variance, standard deviation, and standard error
Determination goodness of fit
Student's t-test

Paper – XI (Practical)

Microbiology

Isolation of microorganisms: streaking on agar plates/pour plate method; isolation of colonies; preservation
Determination of growth of a microorganism (model organism *Escherichia coli*); effects of nutrients- glucose, fructose, and sucrose
Determination of microbial population size: use of haemocytometer and serial dilution technique; relation between dilution and cell count
Gram staining technique: Identification of Gram positive and negative bacteria
Isolation of bacteroids from root nodules/curd and Gram staining

Plant pathology

Isolation and culture of plant pathogens (*Colletotrichum*, *Fusarium*, and *Alternaria*) and establishment of Koch's postulate and their pathogenicity
Histopathological study of important plant diseases- brown spot of rice, loose smut of wheat, rust of wheat, wart of potato, late blight of potato, and stem rot of jute
Study on antagonism *in vitro* between isolated antagonists and plant pathogens
Demonstration of antibiosis using a bacterial culture and known antibiotics
Demonstration of biopesticides (essential oils, neem, and garlic) against some pathogens

Suggested question format and marks break-up in Practical papers

PART – I

Paper - III: Phycology, Mycology, Bryology, Pteridology, Gymnology, Palaeobotany, Morphology, Anatomy

Time: 6 h

Full marks: 60

- | | |
|---|----|
| 1. Work out one specimen – alga/ fungus (camara lucida drawing in case of alga and measurement of spore size in case of fungus) | 8 |
| 2. Work out the vegetative and reproductive structures with suitable staining of one bryophyte/ pteridophyte | 10 |
| 3. Anatomy- transverse sections of sample with double staining | 10 |
| 4. Identification (gymnosperms- 3 specimens, and fossil slides- 2) | 10 |
| 5. Comment on morphology (3 specimens) | 6 |
| 6. Submission (laboratory and field records, slides) | 10 |
| 7. Viva voce | 6 |

PART - II

Paper - VI: Systematics of angiosperms; Utilization of plants, Ecology, Cell biology, Plant biochemistry

Time: 6 h

Full marks: 60

1. Work out one angiospermic plant (as per syllabus) 12
2. Study of somatic chromosomes from root tip 10
3. Estimation of dissolved CO₂/ soil carbonate/ nitrate 6
4. Qualitative detection of organic acids (oxalic, citric, tartaric, malic), carbohydrates (reducing, non-reducing), proteins or enzymes (any 2) 6
or
Quantitative estimation of proteins/ reducing sugars from laboratory samples (standard curve to be provided)
5. Identification of cytological slides with meiotic stages (2) 4
6. Identification of whole plant/ plant parts used of economically important plants (2) 4
7. Identification of adaptations (morphological/ anatomical) of 2 specimens 4
8. Spotting (2 plants) 2
9. Submission (laboratory and field records, slides) 6
10. Viva voce 6

Note: There should be 25 selected herbarium sheets on angiospermic specimens.

PART - III

Paper - X: Genetics and Plant breeding, Plant physiology, Biostatistics

Time: 6 h

Full marks: 80

1. One major physiological experiment 15
2. One minor physiological experiment 10
3. Microtomy - demonstration (material-embedded paraffin block to be supplied) 12
4. Biostatistics - (mean, median, mode/ variance, standard deviation, standard error/ t-test / goodness of fit) 10
5. Study of special chromosomes/ chromosome count 8
6. Identification of chromosomal aberration in meiotic slides (from permanent slides- 3) 6
7. Demonstration of emasculation and bagging 6
8. Submission (laboratory records) 5
9. Viva voce 8

Paper - XI: Microbiology, Plant pathology

Time: 6 h

Full marks: 80

7. Gram staining of bacteria to be supplied as a suspension of a pure culture 20
8. Staining and morphological comments of bacteria in curd / bacteroids from root nodule 12
2. Histo-pathological studies of one diseased specimen 16
3. Demonstration of sub-culturing/ isolation 8
4. Identification of plant pathological specimens (4 including 2 herbarium sheets) 8
8. Submission (laboratory and field records, slides) 8
9. Viva voce 8

Note: There should be at least three excursions, one in each year.

Suggested Readings:

Algae

- Kumar, H. D. - Phycology: Algae Cell Biology
Lee, Robert - Phycology
Sharma, O. P. - Text Book of Algae, Tata McGraw-Hill
Vashista, P. C. - Algae, S. C. Chand
Gangulee, H.C and Kar, A.K. - College Botany, Vol. II

Fungi and pathology

- Chopra and Verma - A Text Book of fungi
Dubey - An Introduction to fungi, Vikash Publishing House.
Mehrotra and Aneja - Introduction to Mycology
Alexopoulos and Mims - Introductory Mycology
Singh, R. S. - i) Plant Disease ii) Plant Pathology
Vashisthya - Fungi and Pathology
Mehrotra - Plant Pathology
Gangulee, H.C and Kar, A.K. - College Botany, Vol. II

Microbiology

- Atlas, R. M. - Principles of Microbiology, McGraw-Hill
Schlegel, H.G. - General Microbiology, Cambridge University Press
Prescott, L.M., Harley, J.P. and Klein, D.A. - General Microbiology, McGraw-Hill
Pelczar, Chan and Kreig - Microbiology
Stainier, Adelberg, Ingraham - General Microbiology
Talaro and Talaro - Microbiology

Bryophytes

- Vashishta, B. R. - Bryophyte, S. C. Chand
Gangulee, H.C and Kar, A.K. - College Botany, Vol. II
Puri, P. - Bryophyte

Pteridophytes

- Sporne, K.R. - A Morphology of Pteridophyte, Hutchinson Publishing
Vashistha .P. C. - Pteridophyte, S. C. Chand
Gangulee, H.C and Kar, A.K. - College Botany, Vol. II
Mukherjee and Chakraborty - An Introduction to Vascular Histograms (Pteridophyte)

Gymnosperms

- Sporne, K. R. - The Morphology of Gymnosperms
Vashista, B. R. - Gymnosperm, S. C. Chand

Palaeobotany

- Arnold, A. C. - An Introduction to Palaeobotany, Agrobios (India)

Anatomy

- Esau, K. - Anatomy of seed Plants, John Wiley & Sons
Gangulee, H.C and Kar, A.K. - College Botany, Vol. I
Ganguly, Das and Datta - College Botany, Vol. II

Cell Biology/ Genetics/ Plant breeding/ Biometry/ Tissue culture

- De Robertis and De Robertis - Cell and Molecular Biology
Rastogi, V.B. - Genetics
Gupta, P.K. - Genetics
Verma and Agarwal - Concept of Molecular Biology, S. Chand
Verma and Agarwal - Concept of Cell Biology, S. Chand
Singh, B.D. - Plant Breeding
Bhojwani and Rajdan - Plant Tissue culture: Theory and Practice, Elsevier
Sheeler and Bianchi - Cell and Molecular Biology

Taxonomy

Datta, S. C. - Systematic Botany

Mukherjee, S. - College Botany, Vol. III

Mitra, Guha and Chowdhuri - Studies in Botany, Vol. I

Morphology and Embryology:

Maheshwari, P. - An Introduction to Embryology of Angiosperms.

Bhojwani and Bhatnagar - The Embryology of Angiosperms

Ecology and Plant geography

Shukla and Chandal - Plant Ecology

Verma and Agarwal - Concept of Ecology

Odum - Fundamentals of Ecology

Mani - Plant Geography of India

Mitra, Guha and Chowdhuri - Studies in Botany, Vol. II

Physiology and biochemistry

Salisbury and Ross - Plant Physiology

Ghosh and Mukherjee - Plant Physiology

Stryer - Biochemistry

Devlin - Plant Physiology

RECOMMENDED BOOKS

1. Advanced Organic Chemistry – Finar Vol. 1&2.
2. Basic Principles of Organic Chemistry – Roberts & Ceserio.
3. Organic Chemistry – Cram, Hammond, Hendrickson, Pyne (4th edition)
4. Organic Chemistry – Morrison & Boyd.
5. Advanced Organic Chemistry – March.
6. Advanced Organic Chemistry – Carey & Sandberg.
7. Guide book to Mechanism in Organic Chemistry – Sykes.
8. Structure and Mechanism in organic Chemistry – Gould.
9. Highlights of Organic Chemistry – Nobel.
10. Modern Synthetic Organic Chemistry – House.
11. Organic Chemistry – Ghosh.
12. Principles of Organic Synthesis – Norman.
13. The Chemistry of Carbonyl Compounds – Gutsche.
14. Organic Synthesis- Ireland.
15. The Modern Structural theory of Organic Chemistry – Ferguson.
16. Reaction Mechanism in Organic Chemistry – Mukherjee & Singh.
17. Experiments in Organic Chemistry – Fieser & Williamson, 5th Edn.
18. Unitized Experiments in organic Chemistry – Brewster & McEwen.
19. Elementary Practical Organic chemistry pt. I-II, Vogel.
20. Experimental Organic Chemistry- Singh, Gupta & Bajpai.
21. A Hand book of Organic Analysis – Clarke.
22. Advance Inorganic Chemistry- Cotton & Wilkinson.
23. Advanced Inorganic Chemistry – Durrant & Durrant.
24. The Nature of Chemical Bonds – Pauling.
25. Electronic Structure and Chemical Bonding – Sebera.
26. Chemical Periodicity – Sanderson.
27. Inorganic Chemistry – Sanderson.
28. Valence-Coulson.
29. Valence and Molecular structure Cartmell & Fowles.
30. Inorganic Chemistry – Haslop & Robinson.
31. Theoretical Inorganic chemistry- Day & Selbin.
32. Source Book of Atomic Energy – Glasstone.
33. Concise Inorganic chemistry – Lee.
34. Inorganic Chemistry – Moeller.
35. Modern Aspects of Inorganic chemistry – Emeleus & Anderson.
36. Inorganic Reactions and Structure- Gould.
37. Qualitative Inorganic Analysis- Vogel.
38. Semi Micro Analysis – Sarkar & Saha.
39. Quantitative Inorganic Analysis – Vogel.
40. Quantitative Inorganic Analysis – Charlot.
41. Physical chemistry – Alberty & Daniels.
42. Physical Chemistry – Barrow.
43. Physical Chemistry – Moore.
44. Elementry Physical Chemistry – Glasstone.
45. Theoretical Chemistry – Glasstone.
46. Text book of Physical chemistry – Glasstone.
47. Electrochemistry – Glasstone.

48. Physical Chemistry – Rakshit.
49. Thermodynamics – Rakshit.
50. Understanding Physical Chemistry – Adamson.
51. Physical Chemistry – Moelwyn Hughes.
52. Practical Physical Chemistry – Findlay.
53. Practical Physical Chemistry – Gurtu & Kapoor.
54. Practical Physical Chemistry – De & Palit.
55. Spot tests in Inorganic Analysis – Feigl & Anger.
56. Industrial Chemistry – Riegel.
57. Industrial Chemistry – Shreve & Similar other books on Industrial Chemistry.
58. A Text Book of Physical chemistry – (Vol. 1-4) K.L. Kapoor.
59. Physical Chemistry Experiments – S. Dutta.
60. Fundamentals of Analytical chemistry- D.A. Skoog and D.M. West.
61. Organic spectroscopy (3rd ed.) – W. Kemp.
62. Spectroscopy – G. chatwal and S. Anand.
63. Biochemistry – Debajyoti Das.
64. Fundamentals of molecular spectroscopy – Banwell.
65. Physical chemistry – Atkins.
66. Physical Chemistry – S.R. Palit.
67. Industrial Chemistry – B.K. Sharma.
68. Industrial Chemistry –B.N. Chakraborty.
69. Biochemistry – C.B. Power and G. R. Chatwal.
70. Applications of Absorption Spectroscopy of Organic compounds.- R.Dyer
71. Spectrometric identification of Organic compounds (4th ed.) – R. M. ilverstein, G.C. Bossies & T.C. Morrill.
72. Stereochemistry of carbon compounds – E.L.Eliel.
73. Sterochemistry of organic compound – D Nasipuri.