

# **A Textbook of** Plant Physiology, Biochemistry and Biotechnology

A magnifying glass with a dark frame is positioned over a DNA double helix. The DNA structure is rendered in a reddish-brown color with visible base pairing. The background of the cover is a dark, textured green with faint, stylized leaf patterns.

**S.K. VERMA**  
**MOHIT VERMA**

**S. CHAND**



# CONTENTS

## PART I : PLANT PHYSIOLOGY

1. **THE CELL** 1 — 53  
Introduction; Definition of Cell; Brief History of Cell; Types of Cells; Structure of Cell under Electron Microscope — Cell Wall; Plasma membrane; Protoplasm; Centrosome; Cilia and Flagella; Endoplasmic Reticulum; Golgi Complex; Lysosomes; Microbodies; Mitochondria; Plastids; Ribosomes; Differences between 70S and 80S ribosomes; Metabolically Inactive Cell Inclusions; Vacuoles; Nucleus; Cell Components and their main functions.
2. **OSMOTIC RELATIONS OF PLANT CELLS** 54 — 70  
Diffusion; Diffusion Pressure of Liquids; Factors affecting the Rate of Diffusion; Importance of Diffusion in Plants; Demonstration of diffusion; Permeability; Preparation of Artificial Semipermeable membrane; Factors affecting Permeability; Osmosis; Demonstration of Osmosis by Simple Osmeter and U-Tube; Diffusion through Artificial and Natural Membranes; Types of Osmosis — Endosmosis and Exosmosis; Difference between Diffusion and Osmosis; Osmotic Pressure; Factors affecting Osmotic Pressure; Significance of Osmosis in Plants; Plant Cell as Osmotic System and Relationship among Turgor Pressure, Wall Pressure and Osmotic Pressure; Inter-relationship among DPD, S.P., O.P., T.P. and W.P.; Water Potential Concept; Differences between DPD and  $\psi$ ; Plasmolysis and Deplasmolysis; Water Potential Changes in Plasmolysis and Deplasmolysis; Advantages of Plasmolysis; Difference between Osmosis and Plasmolysis; Imbibition; Significance of Imbibition, Demonstration of Imbibition; Other Experiments.
3. **ABSORPTION OF WATER** 71 — 80  
Importance of water to the plants; Soil water; Forms of Underground Water; Hygroscopic coefficient; Moisture Equivalent; Wilting and Wilting Coefficient; Water absorbing parts of the Plants; Root System in Plants; Characteristics of Root; Regions of the Root; Internal Structure of Root; Structure of Root Hair; Mechanism of Water Absorption; Active Absorption and Passive Absorption; Path of Water in Roots; Root Pressure; Theories Regarding Development of Root Pressure; Demonstration of Root Pressure; Non-osmotic Active Absorption; Passive Absorption; Difference between Active and Passive Absorption; Apoplast and Symplast Concept; Factors affecting the Rate of Water Absorption.
4. **ASCENT OF SAP** 81 — 84  
Introduction; Path of Ascent of Sap; Experiments; Theories of Ascent of Sap — Vital Theories; Root Pressure Theory; Godlewski Theory; Vital Force Theory; Physical Theories — Imbibition theory, Capillary Force Theory, Cohesion Theory of Dixon and Jolly; Evidences in Support of Cohesion Theory, Criticism; Demonstration of Transpiration Pull.
5. **TRANSPIRATION** 85 — 102  
Introduction; Differences between Transpiration and Evaporation; Kinds of Transpiration — Cuticular, Lenticular and Stomatal; Structure of Stomata; Distribution of Stomata on Leaf; Types of Stomata; Daily Periodicity of Stomatal Movement; Mechanism of Transpiration; Mechanisms of Opening and Closing of Stomata; Theories of Opening and Closing of

Stomata, Theory of Photosynthesis in Guard Cells; Theory of Starch — Sugar Inter-conversion; Theory of Starch - Glucose Inter-conversion, Theory of Glycolate Metabolism; Theory of Proton Transport; Opening and Closing of Stomata in Succulent Plants; Plant Anti-transpirations; Factors Affecting Transpiration; Special Features in Plants to Reduce Transpiration; Benefits of Transpiration to Plants or Importance of Transpiration; Demonstration of Suction Pressure due to Transpiration; Other Methods of Water-loss; Differences between Transpiration and Guttation; Experimental Demonstration of Guttation; Bledding; Demonstration of Transpiration — Experiments.

## 6. MINERAL NUTRITION IN PLANTS

103 — 117

Introduction; Composition of Plant-ash; Essential and Non-essential Elements; Macro-nutrients and Micro-nutrients; Differences between Trace and Tracer Elements; Hydroponics; To Study the Importance of Mineral Elements in Plants— Solution Culture Method and Sand Culture Method; Nutrient Solutions; Precautions during Preparation and use of Nutrient Solution; Inorganic Salts in Soil; Inorganic Salts in Soil-water; General Roles of Mineral Elements in Plants; Differences between Chlorosis and Etiolation; Source; Occurrence and Functions of Essential Elements — Carbon, Hydrogen, Oxygen, Nitrogen, Sulphur, Phosphorus, Potassium, Calcium, Magnesium, Iron, Manganese, Zinc, Boron, Copper, Molybdenum, Chlorine, Vanadium; Methods to Overcome Mineral Deficiency — Soil Application, Foliar Application and Injection Method.

## 7. MINERAL SALT ABSORPTION

118 — 123

Introduction; Passive Absorption — Outer and Apparent Free Space Theory; Ion Exchange; Donnan Equilibrium; Mass Flow; Active Absorption; Mechanism of Active Salt Absorption- Carrier Concept, Cytochrome Pump Theory; Carrier Mechanism Involving ATP; Factors affecting Salt Absorption; Translocation of Mineral Salts.

## 8. TRANSLOCATION AND STORAGE OF FOOD IN PLANTS

124 — 128

Introduction; Translocation of Food; Direction of Translocation; Path of Translocation; Mechanism of Translocation; Diffusion Hypothesis; Protoplasmic Streaming Theory; Munch's 'Mass Flow' Hypothesis; Storage of Food; Food Storage Organs; Forms of Stored Food.

## 9. SPECIAL MODES OF NUTRITION IN PLANTS

129 — 136

Introduction; Types of Plants, Depending upon the Mode of Nutrition; Autotrophic; Heterotrophic; Special Type — Insectivorous (Utricularia, Drosera, Nepenthes and Dionaea).

## 10. PHOTOSYNTHESIS

137 — 183

Brief History; Photosynthetic Apparatus; Photosynthetic Pigments — Chlorophylls, Phycobilins, Carotenoids, Distribution of Pigments; Biosynthesis of Chlorophyll; Definition of Photosynthesis; Photosynthesis as a Chemical Process; Evidences in support of Light and Dark Reaction; Nature of Light — Theories; Mechanism of Absorption of Light; Components of Electromagnetic Spectrum; Absorption Spectrum; Action Spectrum; Mechanism of Photosynthesis; Red Drop and Emerson's Enhancement Effect; Two Pigment Systems — PS I and PS II; Differences Between Pigment System I and Pigment System II; Photo-Oxidation of Water; Production of Assimilatory Powers; ET Chain Components; Non-cyclic Electron Transport System and Non-cyclic

Photophosphorylation; Cyclic Electron Transport System and Cyclic Photophosphorylation; Differences between Non-cyclic and Cyclic Photophosphorylation; Dark Reaction (Calvin Cycle); Hatch-Slack Cycle; Characteristics of C<sub>4</sub> Plants; Significance of C<sub>4</sub> Cycle; Differences Between Calvin Cycle and Hatch-Slack Cycle; Crassulacean Acid Metabolism (CAM Cycle); Significance of CAM; Bacterial Photosynthesis — Non-cyclic Photophosphorylation; Cyclic Photophosphorylation, CO<sub>2</sub> Fixation; Differences between Plant and Bacterial Photosynthesis; Chemosynthesis; Differences between Photosynthesis and Chemosynthesis; Factors Affecting Rate of Photosynthesis; External Factors — Light, CO<sub>2</sub>, Temperature, Water, Internal Factors — Chlorophyll, Protoplasm, Significance of Photosynthesis; Experiments Relating Photosynthesis.

## 11. RESPIRATION

184 — 228

Introduction; History of Respiration; Differences between Respiration and Combustion; Changes Associated with Respiration; Types of Respiration — Aerobic Respiration, Anaerobic Respiration; Differences between Aerobic and Anaerobic Respiration; Classification of living beings based on Respiration; Respiratory Substrate; Mechanism of Respiration; *Glycolysis*; Summary of Glucolysis; *Aerobic Oxidation of Pyruvic Acid*; *Kreb's Cycle*; Summary of Aerobic Respiration of Glucose; ATP production during Aerobic Respiration of one molecule of Glucose; *Electron Transport System*; Terminal Oxidation of reduced Coenzymes; Oxidation of Extramitochondrial NADH — MOA, G-3-P DHAP Shuttles; *Oxidative Phosphorylation*; Its site, ATP Synthetase — Structure and Chemistry; Structure and Function of Electron Carriers Present in ET Chain; Mechanism of Oxidative Phosphorylation — Various Theories; Respiratory inhibitors; Cyanide Resistant Respiration; Adenosine Triphosphate; Causes Differences between Oxidative and Photophosphorylation; Fermentation; Differences between Fermentation and Anaerobic Respiration; Differences between Respiration and Fermentation; Types of Fermentation; Alcoholic Fermentation; Lactic Acid Fermentation; Acetic Acid Fermentation; Butyric Acid Fermentation; Relation between Anaerobic Respiration and Fermentation; Respiratory Quotient; Types and Determination; Photosynthetic Quotient; Differences between RQ and PQ; Factors Affecting the Rate of Respiration; Experiments related with Respiration; Differences between Respiration and Photosynthesis; Demonstration of Fermentation.

## 12. PHOTORESPIRATION

229 — 232

Introduction; Site of Photorespiration; Biochemistry of Photorespiration; Evidences in support of Photorespiration; Significance of Photorespiration; Difference between Photorespiration and Dark Respiration.

## 13. NITROGEN METABOLISM AND NITROGEN CYCLE

233 — 245

Significance of Nitrogen; Nitrogen in Soil; Nitrate reduction in Plants; Nitrogen Fixation — Non-biological and Biological — Non-symbiotic, Symbiotic, Associative; Symbiotic N<sub>2</sub> Fixation in Leguminous plants — Formation of Root Nodules; Biochemistry of N<sub>2</sub> Fixation — Requirements, Nitrogenase Enzyme; Steps in Asymbiotic N<sub>2</sub> Fixation and Symbiotic N<sub>2</sub> Fixation; Sources of N<sub>2</sub> in Insectivorous Plants; Denitrification; N<sub>2</sub> Cycle.

## 14. NUCLEIC ACIDS METABOLISM

246 — 270

Introduction; Nitrogenous bases — Pyrimidines and Purines; Phosphoric Acid; Nucleosides; Nucleotides — Structure, Biosynthesis of Purines —

- IMP, GMP, AMP uric acid; Pyrimidines — CMP, UMP and TMP; DNA — Structure; Watson — Crick Model, Duplication — Methods and Mechanism; Enzymes for DNA Synthesis; DNA unwinding Proteins; RNA, Differences between RNA and DNA, RNA Types — rRNA, mRNA, tRNA, Microchemical for DNA and RNA.
- 15. METABOLISM OF AMINO-ACIDS AND PROTEINS** 271 — 300  
 Biosynthesis of Amino Acids — By Reductive Amination, By Transamination; Biosynthesis of Amino Acids Derived from Pyruvate,  $\alpha$ -Ketoglutarate, Oxaloacetate and Aromatic Amino Acids; Amphoteric Nature of Amino Acids; Isoelectric Point; Biosynthesis of Proteins; Mechanism of Protein Synthesis; Transcription; Maturation of mRNA from HnRNA in Eukaryotes; Translation — Various Steps; Initiation steps in *E. coli* and Eukaryotes; Regulation of Protein Synthesis; Enzyme Induction and Repression; Operon Model; Mechanism of Operon Model — In Inducible System, In Repressible System; Mutations in Controlling Genes and Production of Constitutive Strains; The differences between Regulator Mutant and Operator Mutant; Promoter Gene and Promoter Region; Genetic Code : Properties of Genetic Code : New Genetic Codes In Mitochondria And Ciliate Protozoans, Rule Regarding Codon-anticodon pairing, methods of cracking genetic code; oxidation of proteins.
- 16. LIPID METABOLISM** 301 — 314  
 Introduction; Biosynthesis of Fats — Synthesis of Fatty Acids, Synthesis of Glycerol, Condensation of Fatty Acids and Glycerol; Biosynthesis of Lecithin; Biosynthesis of Cholesterol; Biosynthesis of Sphingosine and Sphingomyelins; Fat Oxiation — Hydrolysis of Fat (Triglyceride) by Lipase; Metabolism of Gluceronol; Oxidation of Fatty Acids;  $\beta$ -oxidation;  $\alpha$ -oxidation;  $\omega$ -oxidation; Conversion of Fats into Carbohydrates (Glyoxylate Cycle).
- 17. CARBOHYDRATE METABOLISM** 315 — 327  
 Introduction; Biosynthesis of Carbohydrates; Oxidation (Catabolism) of Carbohydrates; Direct Oxidation Pathway; Inter-conversions of Monosaccharides; Gluconeogenesis.
- 18. PHOTOPERIODISM AND PHOTOMORPHOGENESIS** 328 — 335  
 Introduction; Critical Day Length; Classification of Plants according to Photoperiodic Reaction; Photoperiodic Induction; CO<sub>2</sub> Supply and Photoperiodic Induction; Perception and Transmission of Stimulus; Importance of Dark Period; Importance of Photoperiod; Flowering Hormone—Florigen; Action Spectrum of Light; Phytochrome—Differences between P<sub>R</sub> and P<sub>FR</sub> Forms; Occurrence, Physico-Chemical Nature, Chromophore, Properties, Mode of Action, Isolation.
- 19. DORMANCY OF SEEDS AND SEED GERMINATION** 336 — 343  
 Introduction; Seed Dormancy; Causes of the Seed Dormancy; Dormancy due to specific light requirement; Dormancy due to germination inhibitors; Methods of breaking Seed Dormancy; Advantages of Seed Dormancy. Changes during Seeds Germination; Light Dependent Germination, Changes in Food Reserves; Factors Affecting Germination.
- 20. VERNALIZATION** 344 — 347  
 Introduction; Perception of the Cold Stimulus; Morphological changes associated with Seed Vernalization; Induced State; Presence of a Floral Hormone; Other conditions necessary for Vernalization; Mechanism of

Vernalization; Devernalization; Vernalization and Gibberellins; Importance of Vernalization.

21. **GROWTH AND METABOLISM OF GROWTH HORMONES** 348 — 370  
Introduction; Course of Growth; Measurement of Growth; Factors affecting the Growth of Plants; Growth Hormones — Auxins, Experiments, Isolation, Extraction, Bioassays, Biosynthesis of Indole Auxins — Indole Pyruvic Acid Pathway, Tryptamine Pathway, Indoleacetaldoxime Pathway and Tryptophol — Pathway. Biosynthesis of Non-indole Auxins, Mechanism of Auxin Action and Affected Processes, Functions of Auxins; Gibberellins — Discovery, Structure, Extraction, Bioassays Methods, Biosynthesis, Functions; Differences between Auxins and Gibberellins; Cytokinins — Structure, Bioassay and Effects; Florigen; Growth inhibitors — Ethylene, Absciscic Acid (ABA) and Morphactins.
22. **PLANT MOVEMENTS** 371 — 386  
Introduction; Law of Summation of Stimuli; Classification of Movements: Movements of Locomotion — Autonomous Movements — Ciliary Movement, Amoeboid Movement, Excretory Movement, Cyclosis; Induced Movements — Phototaxis, Thermotaxis, Chemotaxis, Rheotaxis, Galvanotaxis; Movement of Curvature — Vital Movements: Autonomous, Movements of Variation, Movements of Growth, Nutation, Hyponasty, Ephemeral Movements; Induced Movements — Tropic Movements, Phototropism — Diaphototropism, Photoreceptor Pigment, Location of Photoreceptor, Role of Auxin in Phototropism, First and Second Positive Response, Curry-hypothesis for Phototropism, Demonstration of Phototropism; Geotropism — Types, Effects of Conditions, Steps in Geotropic response, Role of Auxinin Geotropism, Role of Other Hormones, Theories of Geotropism; Hydrotropism, Thigmotropism, Chemotropism, Thermotropism, Aerotropism; Traumatotropism, Rheotropism, Galvanotropism, Osmotropism; Nastic Movements, Seismonastic Movement, Nyctinastic, Photonastic, Thermonastic, Haptonastic, Hydronasty, Chemonasty; Differences between Tropic and Nastic Movements.
23. **STRESS PHYSIOLOGY** 387 — 398  
Physiological Responses in Plants Growing under Stress Conditions (Stress Physiology)—Introduction; Stress and Stress physiology; Types of Stress; Stress resistance; Effects of Stress; Drought Stress; Salt Stress; Temperature Stress; Pollution stress

## **PART II : BIOCHEMISTRY**

1. **METHODS OF BIOCHEMICAL ANALYSIS** 1 — 23  
Chromatography; Introduction; Kinds of Chromatography; Outline Steps in Different Kinds of Chromatography; Chromatographic Methods of Popular Use; Adsorption Column Chromatography; Ion Exchange Chromatography; Partition Chromatography; Paper Chromatography; Thin Layer Chromatography; Laws of Absorption; Colorimetry; Spectrophotometry; Electrophoresis; Centrifugation and Ultra-centrifugation; X-Ray Diffraction; Tracer Technique; Auto-radiography; Experiments related to Chromatography.
2. **CARBOHYDRATES** 24 — 48  
Introduction; Classification of Carbohydrates; Chemistry of Monosaccharides; Isomerism; Ring Structure; Classification of

Monosaccharides; Some Important Reactions of Monosaccharides; Other Sugar Derivatives — Sugar Phosphates; Amino-Sugars; Deoxy sugars; Ascorbic Acid; Reducing and Non-Reducing Sugars; Chemistry of Oligo saccharides; Sucrose; Maltose; Lactose; Cellobiose; Raffinose; Gentianose; Melezitose; Classification and Chemistry of Polysaccharides; Starch; Inulin; Glycogen; Chitin; Cellulose; Agar; Gum ArAbic; Pectins; Mucopoly-Saccharides; Distinction Between Mono-, Oligo- and Poly-saccharides; Significance of Carbohydrates; Some important tests for Carbohydrates; Experiments.

### 3. AMINO ACIDS AND PROTEINS

49 - 64

What are Amino-acids; Classification of Amino-acids; Essential and Non-Essential Amino-acids; Separation of Amino-acids; Proteins; Characteristic Features; Protein Content of the Plant; Classification of Proteins; Chemical Tests of Amino-acids and Proteins; Protein Structure; Peptide Bond; Desulphide Bond; Hydrogen Bonds; Hydrophobic Bonds; Structure of Proteins — Primary; Secondary; Fine Structure, Tertiary and Quarternary Structures; Denaturation and Renaturation of Proteins.

### 4. THE LIPIDS

65 - 77

Introduction; Classification of Lipids — Simple Lipids; Compound Lipids, Classification of Fatty Acids; Properties of Fatty Acids and Fats; Waxes; Phosph- Lipids; Glycoproteins; Lipo-Proteins; Derived lipids (steroids); Importance of Lipids; Tests for Lipids.

### 5. THE ENZYMES

78 - 100

*Introduction Occurrence; Nomenclature and Classification; Major Clases of Enzymes; Isoenzymes; Isolation and Purification of Enzymes; Chemical Nature of Enzymes; Mode of Action of Enzymes; Derivation of Michaelis Constant; Models for Explaining Enzyme Action; Energy of Activation in the Mechanism of Enzyme Action; Properties of Enzymes; Enzyme Inhibition; Factors Affecting Enzyme Activity, Key to Numbering and Classification of Enzymes; Differences between Enzymes and Hormones; Tests for Some Enzymes.*

### 6. COENZYMES

101 - 118

Introduction; Structure and Classification; Action of Coenzymes; Some Important Coenzymes — NAD and NADP, Riboflavin Coenzymes, Coenzyme - A; Lipoic Acid; Thiamine Pyrophosphate, Cytochromes, Biotin, Pyridoxal Phosphate; Ascorbic Acid; Tetrahydrofolic Acid; Cytidine Di-Phosphate; Uridine-Di-Phosphate, Cyanocobalamine, Coenzyme - Q.

### 7. VITAMINS

119 - 133

Introduction ; General Characteristics of Vitamins; Vitamins and other related Compounds; Vitamins and Hormones; Differences between Vitamins and Hormones; Nomenclature and Classification; Fat Soluble Vitamins — Vitamin-A, Vitamin-D, Vitamin-E, Vitamin-K; Water Soluble Vitamins — Vitami- C, Vitamin-B<sub>1</sub>, Vitamin-B<sub>2</sub>, Niacin, Vitamin-B<sub>6</sub>; Vitamin-B<sub>3</sub>, Vitamin-H, Vitamin-B<sub>12</sub>; Lipoic Acid; Folic Acid; Summary of Vitamins.

### 8. PLANT GROWTH SUBSTANCES

134 - 154

Introduction; Auxins; Gibberellins; Differences between Auxins and Gibbereflines; Cytokinis; Absciscic Acid; Ethylene; Morphactins; Other Hormones.

Introduction; Nitrogenous Bases – Pyrimidine Bases, Purine Bases; Chemistry of Structure of Bases; Free Purines and Pyrimidines; Pentose Sugars; Phosphoric Acid; Nucleosides; Inter-conversions of the Nucleosides; The Nucleotides; Free Nucleotides; The Nucleoside di- and tri-Phosphates; Coenzyme Nucleotides; Properties of Nucleotides; Biosynthesis of Nucleotides – Purine nucleotides, Biosynthesis of TMP, GMP, AMP and Uric acid, Biosynthesis of Pyrimidine nucleotides – CMP and TMP; DNA – Structure of DNA, Classes of DNA – Molecular Structure of DNA, Watson and Crick Model of DNA, Forms of double stranded DNA; DNA Duplication – Watson and Crick Model and Meselson and Stahl's Theory, Mechanism of DNA Replication; Mitochondrial- DNA, Chloroplast- DNA, Single Stranded DNA and Circular DNA, Distinguishing Features between Native DNA and Single Stranded (SS) DNA, Circular DNA, Single Stranded Circular DNA, Double Stranded circular DNA Molecular Weight of DNA, Denaturation and Renaturation of DNA, Hydrolysis of DNA, RNA – Differences between RNA and DNA; Types of RNA, Hydrolysis of RNA, Test for the presence of DNA and RNA in Plants.

## 10. INTRODUCTION TO BIO-ENERGETICS

201 – 208

Energy; Free Energy; Energetic Coupling; Energy Rich Compounds; Cases of Energy Richness of ATP; Other Energy Rich Compounds; Laws of Thermodynamics; First Law of Thermodynamics and its Applications; Entropy; Physical Significance of Entropy; Concept of Entropy in Living Systems; Chemical Equilibrium; Thermodynamic Equilibrium; Dynamic Equilibrium and Steady State.

## 11. BIOLOGICAL OXIDATION AND REDUCTION

209 – 218

Introduction; Oxidation and Reduction; Redox Reactions in Biological Systems; Oxidation - Reduction Potential and Its Measurements; Biologically Important Redox Systems.

## 12. SECONDARY METABOLITES

219 – 238

Terpenoids — Structure, Types and Sources, Biosynthesis of various terpenoids, Functions of Terpenoids; Alkaloids — Types, Distribution and Localization, Biosynthesis of various alkaloids, Biological functions of Alkaloids; Flavonoids.

*Part III – BIOTECHNOLOGY*

## 1. GENETIC ENGINEERING

1 – 64

Introduction; steps involved in gene transfer; RECOMBINANT DNA TECHNOLOGY-Tools involved in R-DNA technology: ENZYMES-Exonucleases, Endo-nucleases, Restriction enzymes, modification by methylation, Nomenclature of RE, OTHER ENZYMES-DNA ligases, Alkaline phosphatase,  $S_1$  nuclease, DNA polymerase, Reverse transcriptase; FOREIGN DNA; VECTORS: Natural-Plasmids, experimental procedure for formation of hybrid plasmid, pBR322; PHAGES as vectors, Insertion and Replacement phage vectors; VIRUSES as vectors-Simian virus 40(SV40); Reconstituted Vectors-Cosmids, Phasmids. Techniques involved in R-DNA technology – Palindromes and staggered cut method, Addition of poly dA at 3' end of the vector and poly dT at 3' end of DNA clone, Blunt end ligation by  $T_4$  DNA ligase. Cloning vectors. cDNA libraries, GENOMIC LIBRARIES; Methods to pick up correct desired clone from a library– colony hybridization, DNA Probes, Single plaque hybridization, by antibodies directed against the gene encoded protein;



Gene cloning technique—in bacteria and eukaryotes. SOME IMPORTANT TECHNOLOGIES IN GENETIC ENGINEERING: Hybridoma technology and production of monoclonal antibodies; Blotting techniques—Southern, Northern and Western, DNA finger Printing; PCR technique; Protoplast fusion technique; Techniques of gene transfer—Microprojectile bombardment, Microinjection, Liposome mediated gene transfer, Electroporation, Ultrasonication, Coprecipitation of DNA with calcium phosphate, using DNA complexes, Laser microbeam technique. Gene transfer in cultured cells, plants, animals and production of transgenic individuals. TRANSPOSABLE ELEMENTS—IS elements; Transposons—in prokaryotes and eukaryotes, Classes on the basis of mechanism of transposition, Transposable elements in *Drosophila*, Yeast and corn; Retroelements, Mechanism of transposition. TECHNIQUES OF DNA SEQUENCING: Maxam and Gilbert procedure, Sanger' procedure; Technique of genetic mapping—Chromosome Walking.

## 2. BIOTECHNOLOGY:

65 – 100

Introduction and functional definition; Uses of biotechnology; Some foreign biotechnology companies; CETUS; Biotechnology Boards, Institutes and Centres in India; NBT; Techniques of Biotechnology. BASIC ASPECTS OF PLANT TISSUE CULTURE: Brief history; Requirements for *in vitro* cultures—Tissue culture laboratory, maintenance of aseptic environment, Nutrient media; Callus and suspension cultures: Methods of plant tissue culture (Basic steps); Some important plant material cultures—Explant culture, Callus cultures, Root culture, Shoot or meristem culture, Cell and suspension cultures, Anther and pollen culture, Embryo culture, Ovary culture; Cryopreservation. CELLULAR TOTIPOTENCY, DIFFERENTIATION AND MORPHOGENESIS—Micropropagation. BIOLOGY OF AGROBACTERIUM: *Agrobacterium Ti* and *Ri* plasmids or vectors for gene delivery, *Ti* plasmids, *Ri* plasmids, their properties, Gene transfer in explants through *Agrobacterium*, Mechanism of T-DNA transfer. MARKER GENES—TK, DHFR, XGPRT, NPT, CDA protein. SALIENT ACHIEVEMENTS IN CROP BIOTECHNOLOGY—Genetic engineering in cloning of *nif* genes; Transfer of *nif* genes and production of biofertilizers; Gene transfer in dicots, Gene transfer in monocots, Transgenic plants—herbicide resistant, Insect resistant, Viral resistant, Bacterial and Fungal resistant. Disadvantages or Potential hazards of Genetic engineering and Biotechnology.