# CLASS-XI

## Work Book Cum Question Bank with Answers

# BOTANY

SCHEDULED CASTES & SCHEDULED TRIBES
RESEARCH & TRAINING INSTITUTE (SCSTRTI)
ST & SC DEVELOPMENT DEPARTMENT
BHUBANESWAR

# WORK BOOK CUM
# QUESTION BANK WITH ANSWERS

# BOTANY

## CLASS - XI

*Compiled by :*

**Dr. Barada Kanta Misra,** M.Sc., Ph.D.
Formerly, Member Secretary,
State Pollution Control Board, Odisha, Bhubaneswar

**SCHEDULED TRIBE & SCHEDULED CASTE DEVELOPMENT DEPARTMENT**
**GOVERNMENT OF ODISHA**

*Prepared by*

**SCHEDULED CASTES & SCHEDULED TRIBES RESEARCH AND TRAINING INSTITUTE**
**BHUBANESWAR – 751OO3**

**2020**

# Contents

# BOTANY (1st Year) Syllabus

## I. Diversity in Living World

(b) **Five Kingdom classification :** Salient features and classification of Monera, Protista and Fungi into major groups; Lichens; Viruses and Viroids.

(c) **Salient features and classificatin of plants into major groups :** Alagae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms (three to five salient and distinguishing features and at least two examples of each category); Angiosperms- classification up to class, characteristic features and examples.

## II. Structural Organization in Animals and Plants

(a) **Morphology and modification in plants;** Tissues; Anatomy and functions of different parts of flowering plants- Root, stem, Leaf; inflorescence- cymose and racemose; flower, fruit and seed (Tobe dealt along with the relevant practical of the Practical Syllabus).

## III. Cell Structure and Function

(a) **Cell theory and cell as the basic unit of life;** Structure of prokaryotic and eukaryotic cell; Plant cell and animal cell; Cell envelope, cell membrance, cell wall; Cell organelles structure and function; Endomembrance system- endoplasmic reticulum, Golgi bodies, lysosomes, vacuoles; mitochondria, ribosomes, plastids, microbodies; Cytoskeleton, cilia, flagella, centrioles (ultra structure and function); necleus' neclear membrance, chromatin, necleolus.

(b) **Chemical constituents of living cells :** Biomolecules - structure and function of proteins, carbohydrates, lipid, nucleic acids; Enzymes-types, properties, enzyme action.

**Cell division :** Cell cycle, mitosis, meiosis and theirsignificance.

## IV. Plant Physiology

a. **Transport in Plants :** Movement of water, gases and nutrients; Cell to cell transport- Diffusion, facilitated diffusion, active transport; Plant-water relations- Imbibition, water potential, osmosis, plasmolysis; Long distance transport of water- Absorption, apoplast, symplast,transpiration pull, root pressure and guttation; Transpiration Opening and closing of Stomata; Uptake and translocation of mineral nutrients, Transport of food, phloem transport, Mass flow hypothesis; Diffusion of gases (brief mention).

b. **Mineral Nutrition :** Exchange of gases; Cellular respiration- glycolysis, fermentation(anaerobic), TCA cycle and electron transport system (aerobic); Energy relation - Number of ATP molecules generated; Amphibolic pathways; Respiratory quotient.

**c. Plant growth and Development :** Seed germination; Phases of plant growth and plant growth rate; Conditions of growth; Differentiation, defifferentiation and redifferentiation; Sequence of developmental process in plant cell; Growth regulators-auxin, gibberellin, cytokinin,ethylene, Abscilic acid (ABA); Seed dormancy; Vernalisation; Photoperiodism.

## QUESTION PATTERN OF CHSE

Theory : 35 marks

Practical : 15 marks

**Total: 50 marks**

**Group - A : Objective Type Compulsory**

1. Multiple choice / One word answer [1 x 5 = 5 marks]

2. Correct the sentences / Fill up the blanks [1 x 5 = 5 marks]

**Group - B : Short Answer Type**

3. Answer within three sentences [2.5 x 3 = 7.5 marks]
   (3 bits to be answered out of 5 bits)

4. Difference between (3 important differences) [3.5 x 1 = 3.5 marks]
   (1 bit to be answered out of 3 bits)

**Group - C : Long Answr Type**

5. Answer two questions out of four [7 x 2 = 14 marks]

**TOTAL** **35 marks**

# SUMMARY

## Chapter - I

## CLASSIFICATION OF LIVING ORGANISMS

- First scientific attempt by Linnaeus to classify the living world into two kingdoms - Plantae and Animalia.
- Three and Four kingdom classifications were also attempted, but were not universally accepted.
- Most widely accepted is the **Five-Kingdom Classification** proposed by R. H. Whittaker in 1969 based on characters like (a) Cell structure, (b) Body organisation and (c) Mode of nutrition.
- I **Monera** - Bacteria and Blue-green algae
- II **Protista** - Protozoa, Slime molds, Euglenoids.
- III **Fungi (Mycota)** - Yeast, *Mucor, Rhizopus, Penicillium*.
- IV **Plantae** - Multicellular, eukaryotic, chlorophyll containing organisms - plants.
- V **Animalia** - Heterotrophic, eukaryotic organisms - Animals.
- Viruses treated as a separate group.

## Chapter - II

## CLASSIFICATION OF PLANT KINGDOM

- Traditionally classified as Algae, Bryophyta, Pteridophyta, Gymnosperms and Angiosperms.
- **Algae -** Chlrophyll bearing green, thalloid eukaryotic organisms. Depending on the type of pigment present, they are further divided as Chlorophyceae (green), Phaeophyceae (brown) and Rhodophyceae (red).
- **Bryophyta -** Nonvascular thallose/foliose gametophytic bodies. Considered as first land plants and archegoniates. Further classified as Hepaticae (Liver worts), Anthocerotae (Horn worts) and Musci (mosses).
- **Pteridophyta -** First vascular landplants with independent sporophyte, differentiated into stem, root and leaves. Sporophytic phase is dominant phase of life cycle. Ferns are the most conspicuous.
- **Gymnosperms -** These are naked-seeded plants with well developed vascular system. Ovules are not enclosed by ovary walls. Main plant body is a sporophyte with male and female cones. Cycas, Pinus and Gnetum are common examples.
- **Angiosperms -** Most advanced and highly developed closed seed plants. Double fertilization and triple fusion are unique characteristics. Further classified as monocotyledons (one cotyledon in the embryo) and dicotyledons (two cotyledons).

## Chapter - III

## PLANT MORPHOLOGY AND ANATOMY

***(Covered in practical classes. Representative Questions from Tissues and Tissue System only)***

- Fundamentally, tissues are of two types - **Meristematic** and **Permanent**.
- **Meristematic tissue -** Young, undifferentiated mass of thin walled living cells present in growing regions like shoot and root apex.
- **Permanent tissue -** Fully matured, do not divide - have achieved definite size and shape. Divided into simple and complex tissues.
  - * **Simple -** Parenchyma, Collenchyma and Schlerenchyma.

    ***Parenchyma -*** Thin walled cells with isodiametric, oval, spherical, round shapes or may be elongated. Found in cortex, pith, mesophyll of leaves and other softer regions. It is the major component of living tissue.

    ***Collenchyma -*** Thin-walled cells with oval, spherical or polygonal shape that often contain chloroplasts. These are living tissues, but their outercellular spaces have deposits of cellulose or pectin.

    ***Selerenchyma -*** Cells are long narrow with deposition of lignin on cell walls. These are dead cells and on the basis of variation in form Schlerenchyma can be either fibres or schlereids.
  - * **Complex -** Xylem and Phloem.

    ***Xylem -*** Tracheids, vessels, wood fibres and wood parenchyma constitute xylem. Of these, wood parenchyma is living and the rest are dead. Xylem provide mechanical support and channel for water transport from roots.

    ***Phloem -*** Sieve tubes, companion cells, phloem parenchyma and bast fibres constitute phloem. Of these, bast fibres are dead cells. Phloem tissues support transport of nutrients from leaves.
- On the basis of location and structure, the tissue system is divided into three types - Epidermal, Ground or Fundamental and Vascular or conducting.

## Chapter - IV

## CELL STRUCTURE AND FUNCTION

- **Cell Theory -** Cell is the basic unit of life proposed by Schleiden and Schwann (1839).
- **Prokaryotic Cell -** Simple, without membrane - bound organelles. Include bacteria, viruses.
- **Eukaryotic Cell -** Seen in plants and animals. Cell structure is complex with membrane - bound organelles and the nucleus enclosing the genetic material (DNA).
- The plant cell has a unit membrane and cell organelles like endoplasmic reticulum, golgi apparatus, microbodies (lysosomes, peroxisomes etc.), mitochondria, ribosomes, chlroplasts, nucleus and a large vacuole (typical of plants).
- Nucleus is the dominant organelle, which controls all activities of the cell. Chromosomes, present in the nucleus contain the genetic material (DNA) and protein. Chromosome number is specific for a particular species.

## Biomolecules

- Besides water and mineral ions, organic components of the cell which are important for continuity of life include carbohydrates, proteins, lipids, nucleic acids and enzymes - these are called biomolecules.
- **Carbohydrates** are made up of carbon (C), hydrogen (H) and oxygen (O) atoms. They are long chains of sugars, therefore called polysaccharides. They are divided into three classes - monosaccharides, oligosaccharides and polysaccharides.
  - *Monosaccharides* - simple sugars - having less than ten carbon atoms. Trioses (3-C), Pentoses (5-C), hexoses (6-C) etc. Ex.- glucose.
  - *Oligosaccharides* - 2-10 monosaccharide units, Ex.- Sucrose, Maltose (disaccharide).
  - *Polysaccharides* - More than ten monosaccharides, Ex.- starch, cellulose, glycogen.
- **Proteins** are composed of simpler components called amino acids. There are twenty naturally occuring amino acids. Each amino acid has one amino ($-NH_2$) group and one carboxyl (-COOH) group. Aminoacids are joined by peptide bonds. Polymers of amino acids forming a polypeptide chain in linear sequence is the primary structure of protein. Protein molecules fold into one or more spatial conformations to be able to perform their biological functions. Based on levels of complexcity, proteins may have primary, secondary, tertiary and quarternary structures. Based on shape they can be globular or fibrous proteins.
- Fats and their derivatives together are known as **lipids**. They are insoluble in water, but soluble in organic solvents like ether, chloroform and benzene. Lipids contain carbon, hydrogen and oxygen, (proportionately less oxygen). They can be simple, compound or derived.
  - *Simple lipids* - Include fats, oils and waxes.
  - *Compound lipids* - They contain fatty acids, alcohol and one prosthetic group - Phospholipids, Glycolipids.
  - *Derived lipids* - They are not straight chains, but contain fused hydrocarbon rings and other side chains - Steroids (cholesterol), hormones, vitamins and alkaloids.
- **Nucleic acid** is a polymer of nucleotides, hence a polynucleotide. A nucleotide is composed of (a) a pentose sugar, (b) a nitrogenous base and (c) a phosphate group. The pentose sugar can be ribose (as in RNA)) or deoxyribose (as in DNA). Nitrogenous bases are of two types (i) Purines - Adenine (A), Guanine (G) and (ii) Pyrimidines - Thymine (T), Cytosin (C). Deoxyribonucleic acid (DNA) has a double helical structure as proposed by Watson & Crick in 1953 with sugar-phosphate back bone and connected together by hydrogen bonds between A - T and G - C. RNA or Ribo Nucleic Acid is single-stranded and it has uracil (U) in place of thymine.

  Pentose sugar + Nitrogenous base $\rightarrow$ Nucleoside

  Nucleoside + Phosphate $\rightarrow$ Nucleotide

  Nucleotides $\rightarrow$ Nucleic acid
- Ribo Nuclei Acid (RNA) can be - messenger RNA (mRNA), ribosomal RNA (rRNA) or transfer RNA (tRNA). tRNA is the smallest of the three and has a clover-leaf struture. DNA is the genetic material of eukaryotes. Plasmids have a circular DNA.

- **Enzymes** are biocatalysts that accelerate the rate of reactions in living cells, by lowering the activation energy. Enzymes are proteins, therefore they are produced through the process of translation.

  Apoenzyme + Cofactor $\rightarrow$ Holoenzyme
  (Inactive) (Active)

  Cofactors can be metal ions, coenzymes or prosthetic groups which are tightly bound. Enzymes are fairly large molecules that contain many functional active sites. Specific substrate molecules get attached to form enzyme-substrate complex. Enzyme-substrate complex converts the substrate to products and the enzyme is released for reuse.

  $E + S \rightleftharpoons ES \rightarrow P + E$

  Enzymes are classified as per the scheme of nomenclature adopted in 1961 by the Enzyme Commisison of the International Union of Biochemistry into six classes :

  (a) Oxidoreductases, (b) Transferases, (c) Hydrolases, (d) Lyases, (e) Isomerases and (f) Ligases.

  Enzyme catalysed reactions are explained by the Lock & Key hypothesis (Emil Fischer, 1890) and Induced - Fit hypothesis (Koshland, 1958).

## Chapter - V

## CELL STRUCTURE AND FUNCTION (CELL DIVISION)

**Cell Division**

- All multicellular organisms contain two types of cells - somatic cells and reproductive cells. Somatic cells divide repeatedly, resulting in the growth of organism. This division is called Mitosis. The other type of division taking place in the reproductive cells, resulting in formation of reprodcutive units, is called Meiosis. In Meiosis, Chromosome number is reduced to half.
- Dividing somatic cells show four phases : Gap Phase - I ($G_1$), Synthetic phase (S), Gap Phase-II ($G_2$) and Mitotic Phase (M). Together they constitute the cell cycle. The first three phases ($G_1$, S & $G_2$) form the interphase, also called the resting phase. During interphase, the cell synthesizes all basic raw materials and prepares for the next division, the mitotic phase.
- **Mitosis** - It includes division of the nucleus (karyokinesis) and division of the cytoplasm (cytokinesis). Karyokinesis is completed in four stages : (i) Prophase, (ii) Metaphase, (iii) Anaphase, and (iv) Telophase. Parent cell, on division produces two identical daughter cells, which have chromosome number identical with the parent cell.
- **Meiosis -** Meiotic division or reduction division takes place in the reproductive organs producing germ cells. It includes division-I, which is heterotypic or reductional and division-II, which is homotypic or equational. In division-I, the prophase is prolonged and can be studied in five substages like leptotene, zygotene, pachytene, diplotene and diakinesis. During division -I, the diploid (2n) cell is reduced to two haploid (n) cells. The two daughter cells undergo divsion-II, a mitotic division, producing four identical daughter cells containing 'n' number of chromosomes (haploid).

# Chapter - VI

# TRANSPORT IN PLANTS

- Transport in plants occurs at three levels - cellular (within the cells), cell to cell (through plasmodesmata) and long distance (between the roots and leaves).
- Water regularly moves in or out of the living cell through processes like diffusion, osmosis and imbibition.
- Diffusion is a slow and random process of movement of solid, liquid or gases from higher to lower concentration. It can be simple or facilitated diffusion.
- Osmosis is a process by which solvent (water) molecules move from a solution of lower concentration to a solution of higher concentration across a semi permeable membrane. Water potential of pure water, $\psi$ (Psi) under standard temperature and atmospheric pressure is taken as zero. Terms like osmotic pressure (OP), turgor pressure (TP) and Diffusion Pressure Deficit (DPD) need to be undrestood and correlated.

  DPD = OP - TP
- Imbibition is a special type of diffusion, where water is absorbed by solids causing increase in volume. It is a physical process. Dry seeds when placed in water, imbibe water and get swollen.
- Absorption of water by roots is of two types - active absorption and passive absorption. Active absorption can also be osmotic or non-osmotic. Metabolic energy is consumed in the process of active absorption. When rate of transpiration is high, a transpirational pull is established, the root cells remain passive and the water moves upwards by virtue of the force created by the transpirational pull. That is called passive absorption.
- Water moves in the root in three pathways - apoplast pathway, symplast pathway and vacuolar or transmembrane pathway.
- Translocation of water or upward movement of water from the roots to the leaves is called ascent of sap. This movement is explained by vital theory (no more accepted), root pressure theory and the cohesion-tension theory. Cohesion-tension theory was proposed by Dixon and Joly in 1894.
- Transpiration is a physiological process, by which the excess amount of water present in the plant is lost from its aerial parts in the form of water. It can be stomatal or foliar, cuticular and lenticular. Stomatal transpiration which is most common, takes place by opening and closing of stomata or stomatal movement. Stomatal movement is explained by (a) the theory of Starch-glucose interconversion and (b) the Potasium ion theory.
- Transpiration is very important in plant life. It helps in absorption of $CO_2$ necessary for photosynthesis and facilitate gaseous exchange. It helps to keep the plant from being overheated and distribution of minerals, absorbed by the roots.
- Guttalion is a phenomenon seen in plants like tomato, colocasia etc. where excess water is removed in the form of liquid through special structures called hydathodes.

## Chapter - VII

## MINERAL NUTRITION

- Out of 92 natural elements, nearly 40 elements are found in living cells. Of these 17 are essential elements. Those elements which are needed in greater quantities by the plants are called **Macronutrients** - they are carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, potassium, magensium and calcium.
- Mineral elements which are required is small amounts or traces are called **Micronutrients** - they are copper, boron, managanese, zinc, molybdenum, iron, chlorine and nickel.
- Deficiency of any of these elements leads to a variety of symptoms.
- Nitrogen is an essential macroelement and is the main constituent of many biomolecules. Plants can not utilise atmospheric nitrogen in its gaseous form. Only certain organisms like bacteria and blue-green algae can fix nitrogen. This is called biological nitorgen fixation. Plants use them, once they are converted into $NO_3^-$ and $NH_4^+$ ions. Biological nitrogen fixation is of two types - symbiotic and asymbiotic nitrogen fixation.

## Chapter - VIII

## PHOTOSYNTHESIS

- Photosynthesis is the process by which chlorophyll containing organisms synthesize carbohydrates from carbon dixoide and water using solar-energy. In the process oxygen is released.
- Chloroplast of the green plants is the site of photosynthesis. Chlrophyll is the main photosynthetic pigment. However, accessory pigments like : carotenoids and phycobillins also porlicipate is the process. These pigments are confined to the grana (thylakoids), where primary photochemical reactions take place. Dark or biochemical reactions take place in the stroma or the matrix.
- Light reaction which is faster than dark reaction includes (i) absorbption of light by the pigments, (ii) transfer of light energy to the reaction centres, (iii) photolysis of water and (iv) electron transport with production of assimilatory power (NADPH+ATP). Photosynthetic pigments are organised into two systems like PS I and PS II. During electron transport, phosphorylation takes place and assimilatory power is produced. Only non-cyclic photophosphorylation yields $O_2$ evolution and reducing power.
- Dark reaction or Blackman's reaction indicates the path of carbon in photosynthesis. It is independent of light. $CO_2$ is reduced here to form carbohydrate, utilising NADPH and ATP produced in the light reaction.
- Melvin Calvin who studied the path of carbon using radioactive $C^{14}$, succeeded in formulating a complete metabolic path known as Calvin cycle. It is a cyclic sequence of three phases - carboxylative phase, reductive phase and regenerative phase.
  - In the carboxylation phase RUBP reacts with $CO_2$ to form two molecules of PGA. This reaction is catalysed by the enzyme, ribulose - 1,5 - bisphosphate carboxylase oxygenase (Rubisco). The first stable prodcut being a 3-carbon compound, the cycle is known as $C_3$ cycle.
  - In the reductive phase PGA undergoes a series of reactions leading to formation of glucose.
  - In the regenerative phase, RUBP is generated which takes part in the next cycle.

  For every $CO_2$ entering Calvin Cycle, 3 molecules of ATP and 2 molecules of NADPH are utilised. 6 molecules of $CO_2$ is reduced to make one molecule of hexose-6-P.

- In certan tropical plants like maize, sugarcane, the first stable product of photosynthetic carbon dioxide fixation is a 4-carbon compound called, oxaloacetic acid (OAA). Distinction between the mesophyll and bundle sheath photosynthetic cells, known as **Kranz anatomy** is the characteristic feature of these plants - therefore known as $C_4$ plants. **The $C_4$-Cycle** is completed in four phases - carboxylation phase, transport phase, decarboxylation phase and regeneration phase. The $C_4$-cycle is also called Hatch-Slack - Kortschack (HSK) cycle, named after the three scientists, who discovered it. $C_4$ plants tolerate high temperature. They also lack photorespiration and have greater productivity.
- Another mechanism of $CO_2$ fixation was discovered in some members of Crassulaceae, often known as **Crassulacean Acid Metabolism** (CAM pathway). In hot habitats, the stomata of these succulent plants remain closed during day time and open only during the night. $CO_2$ entering stomata during night is stored as organic acid. During the day time, the organic acid is decarboxylated to release $CO_2$, which again get refixed through $C_3$ pathway.
- The light dependent $CO_2$ evolution and $O_2$ consumption called **photorespiration** is carried out and completed involving three organelles such as chloroplast, peroxisome and mitochondrion. It is prevalent in $C_3$ plants and almost absent in $C_4$ plants. Low ratio of $CO_2/O_2$ concentration favours fixation of $O_2$ by the enzyme rubisco (Ribulose bis-phosphate carboxylase oxygenase) and leads to formation of Phosphoglycolic acid in the chloroplast. Phosphoglycolic acid in a series of reactions in the peroxisomes and mitochondira result in release of $CO_2$.

## Chapter - IX

## RESPIRATION

- Respiration is the biochemical process in which the cells of an organism obtain energy by combining oxygen and glucose, resulting in release of $CO_2$, water and ATP.
- Oxidation of organic compounds takes place at body temperature in several steps under the control of numerous enzymes.
- Depending on the availability of oxygen, there can be two types of respiration - aerobic and anaerobic. Fermentation is also known as anaerobic respiration.
- Glycolysis is common to all the three types where oxidation of carbohydrates (glucose) leads to formation of pyruvic acid. The entire set of reactions operates in the cytoplasm and does not require molecular oxygen. This pathway is also known as Embden - Meyerhoff - Parnass (EMP) pathway.
- In anaerobic respiration and fermentation, glucose undregoes incomplete oxidation, producing lactic acid (lactic acid bacteria) or ethanol (yeast) + $CO_2$.
- In aerobic respiration, pyruvate upon entering mitochondrion loses a molecule of $CO_2$ and is converted to acetyl CoA in presence of NAD and CoA. Acetyl CoA undergoes complete oxidation in a cyclic chain of reactions producing $CO_2$ and $H_2O$ and releasing a large amount of energy. This cycle is also called TCA cycle or Krebs cycle named after Hans Krebs, who discovered it in 1937. The first product of this cycle being citric acid, a tricarboxylic acid, the cycle is also known as Citric acid cycle.
- The reduced electron acceptors produced in TCA cycle, like NADH and $FADH_2$ finally transfer electrons to $O_2$ during flow of electrons in ETS to produce ATP. The ETS is located in the inner membrane of mitochondrion, which is arranged into folds (cristae). The electron carriers with their associated enzymes are organised into four large complexes and two mobile carriers. The process is called oxidative phosphorylation.

- **Summary of energy calculation :**

| | | |
|---|---|---|
| 1. | Oxidation of pruvate (3 x 2) | - 6 ATP |
| 2. | Krebs Cycle | |
| | Direct substrate level phosphorylation | - 2 ATP |
| | Three NADH from each cycle (3 x 3 x 2) | - 18 ATP |
| | One $FADH_2$ from each cycle (2 x 2) | - 4 ATP |
| 3. | From Glycolysis (net) | - 6 ATP |
| | | 36 ATP |

## Chapter - X

## PLANT GROWTH AND DEVELOPMENT

- Growth in plants is the result of cell division, enlargement of new cells and their differentiation into different types of tissues. Increase in size of shoots and roots takes place due to the activity of meristems. Growth is usually measured in terms of increase in dry weight. The phases of growth or grand period of growh is triphasic -

  (i) Formative or **Lag phase**,

  (ii) Elongation or **Log phase**,

  (iii) Maturation or **Stationary phase**

  The initial **lag phase** is slow and very small. The **log phase,** also known as **exponential phase** is very rapid. In the **stationary phase,** growth remains static. When the growth rate is plotted against time, a S - shaped curve is obtained called **Sigmoid growth curve.**

- **Growth regulators** are organic compounds, naturally synthesized in plants. They are required in very small quantities, but they affect a variety of physiological activities. These growth regulators are called **phytohormones**. They are of following types :

  **Auxin** - Example - Indole Acetic Acid (IAA), 2, 4-D, IBA. Promotes cell elongation and division in shoots and rooting in stem cuttings.

  **Gibberellins -** Example - Gibberellic Acid (GA) - GA, $GA_2$, $GA_3$ etc. - responsible for breaking dormancy.

  **Cytokinins -** Example - Kinetin, 6, benzylaminopurine (BAP), zeatin etc. - responsible for cell division.

  **Abscissic acid (ABA) -** Promotes abscision of leaves.

  **Ethylene -** A gaseous hormone, soluble in water, effective in fruit ripening.

- **Photoperiodism -** The response of plants to the photoperiod or relative day length is known as photoperiodism. There are three categories - Short Day Plants, Long Day Plants, Day Neutral Plants. **Phytochrome,** a proteinaceous pigment ($P_R/P_{FR}$) controls photoperiodism in plants.

- **Vernalization -** It is the induction of a plant's flowering process by expsoure to low tempreature.

***

# GROUP - A

# OBJECTIVE TYPE QUESTIONS

## 1. *Fill in the blanks selecting the appropriate term(s) given under each bit :*

### Chapter - I

### Classification of Living Organisms

1. Cell Wall of bacteria is mainly composed of _____.

(a) chitin (b) cellulose
(c) lipoprotein (d) peptidoglycan

2. Fungi show _____ mode of nutrition.

(a) ingestive (b) autotrophic
(c) holozoic (d) absorptive

3. Major reserve food materials of animals is _____.

(a) starch (b) cellulose
(c) glycogen (d) lipopolysaccharides

4. Unicellular eukaryotes are clasified under the Kingdom _____.

(a) monera (b) protista
(c) fungi (d) plantae

5. Cell wall is absent in all the members of _____.

(a) monera (b) protista
(c) fungi (d) animalia

6. Bacterial cell does not contain any cell organelle other than _____.

(a) chloroplast (b) mitochondria
(c) ribosome (d) nucleus

7. Fungal Thallus is called _____.

(a) gamete (b) callus
(c) mycelium (d) sporangium

8. Coenocytic cells are mostly seen in _____.

(a) fungi (b) protista
(c) plantae (d) animalia

9. The core of virus is composed of only _____.

(a) vitamins (b) carbohydrate
(c) nucleic acid (d) lipid

10. Five kingdom system of classification was proposed by _____.

(a) Whittaker (b) Copeland
(c) Haeckel (d) Linnaeus

11. Blue green algae are also known as _____.

(a) mycota (b) diatoms
(c) cyanobacteria (d) slime molds

12. Protozoa come under the kingdom _____.

(a) monera (b) protista
(c) fungi (d) plantae

13. The most primitive bacteria are grouped together as _____.

(a) eubacteria (b) archebacteria
(c) cyanobacteria (d) mycoplasma

### Chapter - II

### Classification of Plant Kingdom

14. Thallose structure is seen among the members of _____.

(a) pteridophyta (b) algae
(c) gymnosperms (d) angiosperms

15. Cell wall of plants is mainly composed of _____.

(a) cellulose (b) chitin
(c) pectin (d) peptidoglycan

16. Presence of _____ is a fern character seen in gymnosperms.
(a) seed (b) flower
(c) archegonia (d) pollen sac

17. Presence of _____ is an angiospermic character seen in gymnosperms.
(a) sori
(b) multiflagellate spermatozoids
(c) seed
(d) archegonia

18. The plant group _____ are vasular cryptogams.
(a) algae (b) bryophytes
(c) pteridophytes (d) gymnosperms

19. In _____, zygote does not give rise to embryo.
(a) pteridophytes (b) gymnosperms
(c) algae (d) angiosperms

20. Naked - seeded plants come under _____.
(a) Angiosperms (b) Gymnosperms
(c) Bryophyta (d) Algae

21. Early stage of moss gametophyte is called _____.
(a) spore (b) rhizoid
(c) protonema (d) capsule

22. Aquatic habit is a common feature of _____.
(a) Algae (b) Pteridophytes
(c) Gymnosperms (d) Angiosperms

23. A leaf that bears sporangia is called _____.
(a) Sporophore (b) Sporangiophore
(c) Sorus (d) Sporophyll

24. Gymnosperms differ from angiosperms in having _____.
(a) no secondary growth
(b) no seeds
(c) naked seeds
(d) seeds covered by pericarp

25. In seed plants pollen grain is a _____.
(a) Megaspore (b) Microspore
(c) Microspore mother cell
(d) Megagametophyte

26. Spores of fern are _____
(a) haploid (b) diploid
(c) triploid (d) tetraploid

## Chapter - III

## Plant Morphology and Anatomy

27. Meristems are not present in the _____.
(a) root tip (b) stem tip
(c) leaf tip (d) wood

28. Simple, but dead permanent tissue is the characteristic feature of _____.
(a) Parenchyma (b) Collenchyma
(c) Sclerenchyma (d) Chlorenchyma

29. A simple permanent tissue with thin walled living cells and intercellular spaces is the characteristic feature of _____.
(a) sclerenchyma (b) tracheids
(c) parenchyma (d) bast fibres

30. Of the four constituents, _____ is the only living cell present in xylem.
(a) tracheids (b) vessels
(c) wood fibres (d) wood parenchyma

31. Vascular bundles are part of _____ tissue system.
(a) epidermal (b) ground
(c) conducting (d) peripheral

32. The epidermal tissue system originates from _____.
(a) protoderm (b) periderm

(c) procambium (d) subsidiary cells

33. Sclerenchyma helps in _____.

(a) absorption (b) conduction

(c) mechanical support (d) photosynthesis

34. Sieve tubes are found in _____.

(a) xylem (b) phloem

(c) epidermis (d) bark

35. Thickening of cell walls of sclerenchyma is due to _____.

(a) lignin (b) pectin

(c) chitin (d) inulin

36. Root tip has an actively dividing tissue known as _____.

(a) epidermis (b) meristem

(c) xylem (d) phloem

## Chapter - IV

## Cell Structure and Function

37. Plasma membrane is principally composed of lipids and _____.

(a) starch (b) proteins

(c) nucleotides (d) aminoacids

38. Cell sap is present in _____.

(a) mitochondria (b) chloroplast

(c) nucleus (d) vacuole

39. Protein synthesis takes place at _____.

(a) golgi bodies (b) lysosome

(c) ribosome (d) chloroplast

39. Chlroplast is essential for _____.

(a) photosynthesis

(b) transpiration

(c) respiration

(d) protein synthesis

40. The chemical substance, _____ is called the energy currency of the cell.

(a) ADP (b) RNA

(c) DNA (d) ATP

41. A watery substance present in the vacuole of a plant cell is _____.

(a) protoplasm (b) nucleoplasm

(c) vacuolar cytoplasm (d) cell sap

42. Cell theory was proposed by _____ in 1839.

(a) Golgi

(b) Schleiden and Schwann

(c) Huxley

(d) Brown

43. Presence of _____ distinugishes animal cells from plant cells.

(a) centrosome (b) nucleus

(c) mitochondira (d) ribosome

44. The main controlling centre of the cell is _____.

(a) ribosome (b) chloroplast

(c) mitochondrion (d) nucleus

45. The smallest cytoplasmic organelle in a plant cell is _____.

(a) chloroplast (b) lysosome

(c) mitochondrion (d) ribosome

46. Tonoplast is a differentially permeable membrane surrounding _____ in a plant cell.

(a) chloroplast (b) mitochondria

(c) vacuole (d) nucleus

47. Of the various types, _____ is the smallest RNA.

(a) tRNA (b) mRNA

(c) Chromosomal RNA (d) r-RNA

48. A nitrogenous base does not contain _____.
(a) nitrogen (b) carbon
(c) phosphorus (d) hydrogen

49. Of the following, _____ is not a reducing sugar.
(a) glucose (b) sucrose
(c) lactose (d) maltose

50. Unsaturated fatty acids contain one or more _____.
(a) double bond(s) (b) ionic bond(s)
(c) hydrogen bond(s) (d) peptide bond(s)

51. Nucleic acid is a polymer of _____.
(a) nucleosides (b) sugar phosphates
(c) nitrogen bases (d) nucleotides

52. Proteins are polymers of _____.
(a) reducing sugars (b) amino acids
(c) phospholipids (d) organic acids

53. tRNA has a _____ leaf like structure.
(a) bay (b) palm
(c) clover (d) banana

54. Of the following, _____ is an example of heteropolysaccharide.
(a) cellulose (b) starch
(c) pectin (d) glycogen

55. Cell organelle _____ is called a "suicidal bag".
(a) ribosome (b) mitochondria
(c) golgi body (d) lysosome

56. Foldings of inner mitochondrial membrane are called _____.
(a) grana (b) sacs
(c) cristae (d) symplasts

57. The pentose sugar present in DNA is known as _____.
(a) Deoxyribulose (b) Ribose
(c) Deoxyribose (d) Ribulose

58. Sucrose is composed of glucose and _____.
(a) fructose (b) galactose
(c) lactose (d) maltose

59. In a DNA molecule, adenine pairs with _____.
(a) guanine (b) thymine
(c) cytosine (d) uracil

60. Peroxidase belongs to _____ class of enzymes.
(a) Hydrolases (b) Transferases
(c) Ligases (d) Oxidoreductases

61. Enzymes are mainly composed of _____.
(a) carbohydrates (b) proteins
(c) lipids (d) nucleic acids

## Chapter - V
## Cell Structure and Function
## (Cell Divison)

62. Chromosomes remain arranged in the equitorial plate during _____ stage of mitosis.
(a) prophase (b) metaphase
(c) anaphase (d) telophase

63. As part of the cell cycle, replication of DNA occurs during _____ phase.
(a) $G_1$ (b) $G_2$
(c) S (d) M

64. The process of crossing over takes place during _____ substage of prophas-I of meiosis.
(a) zygotene (b) pachytene
(c) diplotene (d) diakinesis

## Chapter - VI

## Transport in Plants

65. In facilitated diffusion across cell membrane, _____ acts as a carrier.

(a) lipid (b) protein

(c) carbohydrate (d) vitamins

66. Water potential of pure water is taken as _____.

(a) 0 (b) 1

(c) - 1 (d) - 2

67. When sodium chloride is dissolved in water, its water potential _____.

(a) increases (b) decreases

(c) is not affected (d) becomes zero

68. When a cell is placed in pure water, it becomes fully turgid and its _____ becomes zero.

(a) OP (b) TP

(c) DPD (d) WP

69. When starch is converted to glucose in the guard cells of stomata, their water potential _____.

(a) becomes zero (b) increases

(c) decreases (d) is not affected

70. Ascent of sap in a tall tree is best explained by _____.

(a) root pressure

(b) cohesion-tension theory

(c) potassium ion theory

(d) capillary force

71. Ascent of sap takes place through _____.

(a) xylem

(b) phloem

(c) cambium

(d) both xylem and phloem

72. Transpiration is regulated by the movement of _____ cells of the leaves.

(a) epidermal (b) subsidiary

(c) guard (d) mesophyll

73. Guttation takes place through _____.

(a) stomata (b) hydathodes

(c) lenticels (d) cuticle

74. Translocation of food materials in plants takes place by _____.

(a) epidermis (b) pith

(c) xylem (d) pholoem

## Chapter - VII

## Mineral Nutrition

75. Of the following, _____ is a micronutrient.

(a) potassium (b) magnesium

(c) boron (d) calcium

76. Of the following, _____ is a macronutrient.

(a) iron (b) sulphur

(c) nickel (d) zinc

77. Most of the plants absorb nitrogen from the soil in the form of _____.

(a) nitrate (b) nitrite

(c) free $N_2$ (d) nitrogen peroxide

78. Symbiotic nitrogen fixation is done by _____.

(a) *Azotobacter* (b) *Clostridium*

(c) *Nostoc* (d) *Rhizobium*

79. Root nodules formed in the leguminous plants have a red pigment called _____.

(a) hemoglobin

(b) leghemoglobin

(c) phycocyanin

(d) ferredoxin

80. The process of conversion of ammonia into nitrate is called _____.

(a) ammonification
(b) transcription
(c) denitrification
(d) nitrification

## Chapter - VIII
## Photosynthesis

81. The reaction centre of PS II is _____.

(a) $P_{600}$ (b) $P_{680}$
(c) $P_{700}$ (d) $P_{750}$

82. Electron donor to PS I is _____.

(a) Cyt b (b) Cyt $b_6$
(c) Ferredoxin (d) Plastocyanin

83. In higher plants the reaction centre of PS I is _____.

(a) $P_{600}$ (b) $P_{680}$
(c) $P_{700}$ (d) $P_{750}$

84. The end product of cyclic photophosphorylation is _____.

(a) ADP (b) $O_2$
(c) NADPH (d) ATP

85. Primary electron acceptor of PS II is _____.

(a) Cyt $b_6$ (b) Ferredoxin
(c) Pheophytin (d) $A_0$

86. In $C_4$ plants, the fist stable product of $CO_2$ fixation in mesophyll cells is _____.

(a) 3-PGA (b) OAA
(c) DHAP (d) PEP

87. Kranz anatomy is seen in _____.

(a) $C_4$ plants (b) CAM plants
(c) $C_3$ plants (d) gymnosperms

88. The primary $CO_2$ fixation product in $C_3$ plants is _____.

(a) OAA (b) PGA
(c) RuBP (d) PEP

89. In mesophyll tissues of $C_4$ plants $CO_2$ is received by _____.

(a) RuBP (b) PGA
(c) PEP (d) OAA

90. The primary $CO_2$ acceptor in $C_3$ plants is _____.

(a) RuBP (b) PEP
(c) PGA (d) OAA

91. In the $C_4$ plants, OAA is formed in _____ phase.

(a) transport (b) carboxylation
(c) decarboxylation (d) regeneration

92. In the order of events, _____ takes place first during photosynthesis.

(a) Photolysis of Water
(b) Excitation of chlrophyll
(c) ATP formation
(d) $CO_2$ fixation

93. The bundle sheath cells of $C_4$ plants lack the enzyme _____.

(a) rubisco
(b) phosphoglycerate kinase
(c) PEP carboxylase
(d) glyceraldehyde-3-P dehydrogenase

94. Photosynthesis is maximum in _____.

(a) continuous strong light
(b) continuous weak light
(c) intermittent light
(d) continuous darkness

95. Splitting of water in photosynthesis is called _____.

(a) photorespiration

(b) photophosphorylation

(c) photolysis

(d) dark reaction

96. $O_2$ released during photosynthes comes from $H_2O$ and not from $CO_2$ was conclusively proved by _____.

(a) Red drop phenomenon

(b) Hill reaction

(c) Emerson effect

(d) Calvin cycle

## Chapter - IX
## Respiration

97. Glycolysis takes place in _____ of the cell.

(a) mitochondria

(b) endoplasmic reticulum

(c) golgi bodies

(d) cytoplasm

98. Glycolysis converts _____.

(a) protein to glucose (b) fat to clucose

(c) glucose to pyruvate (d) glucose to fructose

99. The reactions of Krebs Cycle take place in _____.

(a) nucleus (b) vacuole

(c) mitochondria (d) cytoplasm

100. The respiratory substrate _____ produces per mole the highest number of ATP molecules.

(a) glucose (b) sucrose

(c) starch (d) fatty acid

101. The first reaction of glycolysis that converts glucose to glucose-6-P is catalysed by the enzyme _____.

(a) Pyruvate kinase

(b) Phosphoglycerate kinase

(c) Phosphofructo kinase

(d) Hexokinase

102. The respiratory quotient, when carbohydrates are used as respiratory substrate is _____.

(a) around 1 (b) more than 1

(c) 0 (zero) (d) 0.1

103. The reaction that links glycolysis with Krebs Cycle is catalyzed by _____.

(a) glutamate dehydrogenase

(b) pyruvate kinase

(c) pyruvale dehydrogenase complex

(d) aconitase

104. In the mitochondrial electron transport chain approximately _____ ATP molecule(s) are synthesized per each molecule of NADH oxidized.

(a) 1 (b) 2

(c) 3 (d) 4

105. First reaction of Krebs Cycle produces a 6-C organic acid called _____.

(a) oxaloacetate (b) fumarate

(c) malate (d) citrate

106. Oxidation of one molecule of pyruvate inside mitochondrion produces _____.

(a) $3CO_2$ (b) $4CO_2$

(c) $2CO_2$ (d) $1CO_2$

107. The key molecule that links glycolysis with Krebs Cycle during aerobic respiration is _____.

(a) pyruvate (b) oxaloacetate
(c) acetyl CoA (d) Citrate

108. When two electrons are transported from NADH to oxygen, _____ number of protons are transferred.

(a) 6 (b) 8
(c) 10 (d) 12

109. In the mitochondrial electron transport chain the terminal electron acceptor is _____.

(a) Ubiquinone (b) Cytochrome c
(c) Cytochrome b (d) Molecular oxygen

110. Chemiosmotic hypothesis was proposed by _____.

(a) Hans Krebs (b) Peter Mitchell
(c) C. R. Slack (d) Gustav Embden

111. In the TCA Cycle, succinate undergoes dehydrogenation to form fumarate and in the process a molecule of _____ gets reduced.

(a) NAD (b) NADP
(c) FAD (d) CoA

## Chapter - X

## Plant Growth and Development

112. Apical dominance is promoted by _____.

(a) auxin (b) kinetin
(c) gibberellin (d) vitamins

113. Abscisic acid causes _____.

(a) dormancy of seeds (b) leaf fall
(c) flowering (d) initiation of roots

114. A floral hormone called _____ is said to be responsible for photoperiodic stimulus.

(a) vernalin
(b) cytochrome
(c) florigen
(d) ethylene

115. $P_R$ and $P_{FR}$ are photochemically interconvertible forms of the pigment _____.

(a) phycoerythin
(b) phycocyamin
(c) ferredoxin
(d) phytochrome

116. 2, 4-D is generally used as a _____.

(a) pesticide
(b) weedicide
(c) fungicide
(d) flowering agent

117. Of the following _____ is a growth inhibitor

(a) GA (b) kinetin
(c) ABA (d) auxin

118. Ethylene is synthesized in the plants from the amino acid _____.

(a) methionine (b) proline
(c) tryptophan (d) lysine

119. Indole Acetic Acid (IAA) is a naturally occuring _____.

(a) cytokinin (b) gibberellin
(c) auxin (d) enzyme

120. Gibberellins were first discovered from _____.

(a) algae (b) fungi
(c) bryophytes (d) gymnosperms

## 2A. Correct the statements of each bit, if necessary, by changing the underlined word(s) only :

### Chapter - I

### Classification of Living Organisms

1. The core of virus is composed of protein.
2. Three-kingdom system of classification was proposed by Copeland.
3. Lichen consists of two separate entities, an alga and a protozoa.
4. Sexual reproductive units of *Pencillium* are called conidia.
5. Binomial system of classification was proposed by Lamarck.

### Chapter - II

### Classification of Plant Kingdom

6. Cryptogams are ordinarily classified into thallophyta, bryophyta and spermatophyta.
7. Members of the class *Hepaticae* are called hornworts.
8. Double fertilisation and triple fusion are unique to gymnosperms.
9. A gellifying substance called tannin is produced from the red algae, *Gracilaria*.
10. In angiosperms, the life cycle pattern is haplontic.

### Chapter - III

### Plant Morphology and Anatomy

11. Vascular bundles with xylem and phloem patches arranged separatly on alternate radii are called conjoint.
12. Hypodermis lies just below the endodermis.
13. The cells of promeristem that give rise to primary permanent tissues, are differentiated into dermatogen, periblem and epiblema.
14. Epidermal tissue system originates from the outermost layer of procambium.
15. In roots, pith is the seat of origin of lateral roots.
16. Group of cells in a shoot tip that are in a continuous state of division can be called permanent tissue.
17. In a tall plant the principal water conducting tissue is the phloem.
18. A vascular bundle having phloem on both sides of xylem in a dicot stem is called colateral.
19. Vascular tissue is derived from periblem.
20. Periblem gives rise to epidermis.

### Chapter - IV

### Cell Structure and Function

21. Tonoplast is the differentially permeable membrane surrouding nucleus.
22. Foldings of inner mitochondrial membrane are called grana.
23. Lysosomes ae responsible for digestion of cell's own cytoplsomic constituents by a process called autotrophy.
24. When the position of centromere is at the terminal end of the chromosome, it is called acrocentric.
25. A cell that possesses a well organized nucleus is called a prokaryotic cell.
26. When we say fruit sugar, it ordinarly refers to glucose.
27. Maltose or malt sugar is composed of two units of D-galactose.
28. The polysaccharide found as reserve food in most plants in glycogen.
29. Lipids are esters of amino acids with alcohol.
30. The linkage by which two amino acids are joined together is called glycosidic bonds.
31. In a polynucleotide chain, nucleotides are joined by peptide bonds.

32. The first enzyme purified and crystalised is sucrase.

33. Emil Fischer proposed induced-fit hypothesis in 1890 to explain to formation of enzyme-substrate complex.

34. Enzymes that catalyze formation of products which are isomers of substrates come under the class Oxidoreductases.

## Chapter - V

## Cell Structure and Function (Cell Divison)

35. In mitosis anaphase begins with complete disappearance of nuclear membrane.

36. As part of the cell cycle, the correct sequence of events (phases) can be stated as M-S-$G_1$-$G_2$.

37. During meiosis-I, crossing over takes place during zygotene of Prophase-I.

38. Colchicine, which prevents formation of nuclear membrane in the dividing cells, is used to induce polyploidy.

## Chapter - VI

## Transport in Plants

39. Water potential of pure water is taken as one.

40. Ascent of sap with inorganic solutes takes place through phloem.

41. Guttation takes place through stomata.

## Chapter - VII

## Mineral Nutrition

42. The root nodules of leguminous plants have a red pigment called phycocyanin.

43. The process of conversion of ammonia into nitrate is called ammonification.

44. The enzyme nitrate reductase is responsible for reducing molecular nitrogen ($N_2$) to $NH_3$ in the process of nitrogen fixation.

## Chapter - VIII

## Photosynthesis

45. In higher plants, the reaction centre Chlrophyll of photosystem I (PSI) is **$P_{680}$**.

46. Primary electron acceptor of PS II is plastocyanin.

47. The first stable product of $CO_2$ fixation reaction in Calvin Cycle is Glyceraldehyde-3-phosphate.

48. In $C_4$ plants, the first stable product of photosynthetic $CO_2$ fixation is Malic acid.

49. Photorespiratory metabolism in carried out in the cell involving three organelles such as chloroplast, ribosome and mitochondria.

## Chapter - IX

## Respiration

50. The reactions of Krebs cycle take place inside Chloroplast.

51. The molecular mechanism of ATP Synthesis during oxidative phosphorylation is best explained by Lock and Key hypothesis.

52. Under aerobic conditions, pyruvate enters mitochondrial matrix where it undregoes oxidative decarboxylation to form ethyl alcohol.

53. The sugar present in ATP is a triose sugar.

54. A total of six protons are transferred when two electrons are transported through the mitochondrial electron transport chain from NADH to oxygen molecule.

## Chapter - X

## Plant Growth and Development

55. The first natural cytokinin to be isolated was Kinetin.

56. Fruit ripening is induced by the hormone, 2, 4-D.

57. The requirement of low temperature treatment for accelerating flowering is called breaking of dormancy.

## 2B. Fill in the blanks.

### Chapter - I
### Classification of Living Organisms

1. Five-kingdom system of classification was proposed by _____.
2. As per 5-kingdom classification, yeast comes under the kingdom _____.
3. The reserve food material of animals is _____.

### Chapter - II
### Classification of Plant Kingdom

4. The thalloid, free living fern gametophyte is called _____.
5. Duckweeds, coming under the genus _____ are the smallest flowering plants on earth.
6. Spirally arranged sporophylls of *Pinus* constitute a _____.

### Chapter - III
### Plant Morphology and Anatomy (Tissues & Tissue System)

7. A thin strip of primary meristem lying in between xylem and pholem is called _____.
8. In stems, _____ is the seat of origin of adventitious roots.
9. Parenchymatous cells with well developed air cavities as in floating hydrophytes are called _____.
10. Hypodermis is part of _____ tissue system.

### Chapter - IV
### Cell Structure and Function

11. Singer and Nicholson proposed the _____ model for explaning the structure of plasma membrane.
12. Cytoplasmic bridges between adjacent cells that develop through cell walls are called _____.
13. Due to presence of large number of hydrolytic enzymes, lysosomes are called _____ bags.
14. The membrane surrounding the vacuole is known as _____.
15. Plastids present in coloured petals and fruits are known as _____.
16. Chromosomes with complete absence of centromere are known as _____ chromosomes.
17. Ribosomes are composed of rRNA and _____.
18. Proteins are polymers of _____.
19. The amino acid, _____ is also referred to as imino acid.
20. When the cofactor is removed from holoenzyme, it is called _____.
21. The pentose sugar present in DNA is known as _____.
22. In members of Compositae family, the storage polysaccharide is _____.
23. A sugar with an open chain form and a free hemiacetall hemiketal group is called _____ sugar.

### Chapter - V
### Cell Structure and Function (Cell Divison)

24. The drug, _____ which prevents formation of spindle fibres, is used to induce polyploidy in dividing cells.
25. In cell division, karyokinesis refers to divison of the _____.
26. In mitosis, centromere divides during _____.
27. If *Allium cepa* has 16 chromosomes in each somatic cell, the daughter cells at the end of meiosis will have _____ number of chromosomes.

## Chapter - VI
## Transport in Plants

28. Stomata open when guard cells become _____.
29. Water potential of pure water is taken as _____.
30. Shrinkage of protoplasm away from the cell wall due to exosmosis is called _____.
31. Exudation of liquid water from hydathodes of certain plants like Balsam is called _____.
32. Cohesion-tension theory of ascent of sap in plants was proposed by _____ in 1894.
33. Theory of starch-sugar inter conversion explains the opening and closing of _____.

## Chapter - VII
## Mineral Nutrition

34. Mineral elements like boron, manganese etc. needed by plants in very small amount are called _____.
35. The technique of growing plants with their roots immersed in nutrient solution is called _____.
36. Atmospheric nitrogen ($N_2$) fixation takes place by nitrogen fixing bacteria in the present of enzyme _____.

## Chapter - VIII
## Photosynthesis

37. In higher plants the reaction centre Chlorophyll of PSI is _____.
38. The fist product of photosynthetic carbon reduction (PCR) cycle is $C_3$ plants is _____.
39. In $C_4$ plants, rubisco is present in the chloroplasts of _____ cells.
40. The accepter of $CO_2$ during photosynthesis in bundle sheath cells of $C_4$ plants is _____.

## Chapter - IX
## Respiration

41. ATP synthesis involving direct transfer of phosphate group from a substrate molecule to ADP is called _____ phosphorylation.
42. The end product of glycolysis is _____.
43. The reactions of Krebs cycle take place inside _____, called the power house of cell.
44. The first product of Krebs Cycle is _____.
45. The molecular mechanism of ATP synthesis during oxidative phospherylation is best explained by _____ hypothesis.

## Chapter - X
## Plant Growth and Development

46. Fruit ripening is induced by the hormone _____.
47. The amino acid _____ is the precursor of Indole-3-Acetic Acid.
48. In plants ethylene is synthesized from the amino acid _____.

# GROUP - A

## ANSWERS

### 1. *Fill in the blanks selecting the appropriate term(s) given under each bit :*

### Chapter - I

### Classification of Living Organisms

1. (d) peptidoglycan
2. (d) absorptive
3. (c) glycogen
4. (b) protista
5. (d) animalia
6. (c) ribosome
7. (c) mycelium
8. (a) fungi
9. (c) nucleic acid
10. (a) Whittaker
11. (c) cyanobacteria
12. (b) protista
13. (b) archebacteria

### Chapter - II

### Classification of Plant Kingdom

14. (b) algae
15. (a) cellulose
16. (c) archegonia
17. (c) seed
18. (c) pteridophytes
19. (c) algae
20. (b) Gymnosperms
21. (c) protonema
22. (a) Algae
23. (d) Sporophyll
24. (c) naked seeds
25. (b) Microspore
26. (a) haploid

### Chapter - III

### Plant Morphology and Anatomy

27. (d) wood
28. (c) Sclerenchyma
29. (c) parenchyma
30. (d) wood parenchyma
31. (c) conducting
32. (a) protoderm
33. (c) mechanical support
34. (b) phloem
35. (a) lignin
36. (b) meristem

### Chapter - IV

### Cell Structure and Function

37. (b) proteins
38. (d) vacuole
39. (c) ribosome

39. (a) photosynthesis
40. (d) ATP
41. (d) cell sap
42. (b) Schleiden and Schwann
43. (a) centrosome
44. (d) nucleus
45. (d) ribosome
46. (c) vacuole
47. (a) tRNA
48. (c) phosphorus
49. (b) sucrose
50. (a) double bond(s)
51. (d) nucleotides
52. (b) amino acids
53. (c) clover
54. (c) pectin
55. (d) lysosome
56. (c) cristae
57. (c) Deoxyribose
58. (a) fructose
59. (b) thymine
60. (d) Oxidoreductases
61. (b) proteins

## Chapter - V

## Cell Structure and Function (Cell Divison)

62. (b) metaphase
63. (c) S
64. (b) pachytene

## Chapter - VI

## Transport in Plants

65. (b) protein
66. (a) 0 (zero)
67. (b) decreases
68. (c) DPD
69. (c) decreases
70. (b) cohesion-tension theory
71. (a) xylem
72. (c) guard
73. (b) hydathodes
74. (d) pholoem

## Chapter - VII

## Mineral Nutrition

75. (c) boron
76. (b) sulphur
77. (a) nitrate
78. (d) *Rhizobium*
79. (b) leghemoglobin
80. (d) nitrification

## Chapter - VIII

## Photosynthesis

81. (b) $P_{680}$
82. (d) Plastocyanin
83. (c) $P_{700}$
84. (d) ATP
85. (c) Pheophytin
86. (b) OAA

87. (a) $C_4$ plants
88. (b) PGA
89. (c) PEP
90. (a) RuBP
91. (b) carboxylation
92. (b) Excitation of chbrophyll
93. (c) PEP carboxylase
94. (c) intermittent light
95. (c) photolysis
96. (b) Hill reaction

## Chapter - IX

## Respiration

97. (d) cytoplasm
98. (c) glucose to pyruvate
99. (c) mitochondria
100. (a) glucose
101. (d) Hexokinase
102. (a) around 1
103. (c) pyruvale dehydrogenase complex
104. (c) 3
105. (d) citrate
106. (a) $3CO_2$
107. (c) acetyl CoA
108. (c) 10
109. (d) Molecular oxygen
110. (b) Peter Mitchell
111. (c) FAD

## Chapter - X

## Plant Growth and Development

112. (a) auxin
113. (b) leaf fall
114. (c) florigen
115. (d) phytochrome
116. (b) weedicide
117. (d) ABA
118. (a) methionine
119. (c) auxin
120. (b) fungi

## *2A. Correct the statements of each bit, if necessary, by changing the underlined word(s) only :*

### Chapter - I

### Classification of Living Organisms

1. nucleic acid / RNA / DNA
2. Haeckel
3. fungus
4. ascospores
5. Linnaeus

### Chapter - II

### Classification of Plant Kingdom

6. pteridophyta
7. liverworts
8. angiosperms
9. agar-agar/agar
10. diplontic

### Chapter - III

### Plant Morphology and Anatomy

11. radial
12. epidermis
13. plerome
14. Protoderm/Dermatogen
15. pericycle
16. meristematic
17. xylem
18. bicollateral
19. plerome
20. cortex

### Chapter - IV

### Cell Structure and Function

21. vacuole
22. cristae
23. autophagy/autolysis
24. telocentric
25. eukaryotic
26. fructose
27. D-glucose
28. Starch
29. fatty acids
30. peptide
31. phosphoester
32. urease
33. Lock and Key
34. Isomerases

### Chapter - V

### Cell Structure and Function (Cell Divison)

35. metaphase
36. $M\text{-}G_1\text{-}S\text{-}G_2$
37. pachytene
38. spindle fibres

### Chapter - VI

### Transport in Plants

39. zero
40. xylem
41. hydathode

### Chapter - VII
### Mineral Nutrition

42. leghemoglobin
43. nitricfication
44. nitrogenase

### Chapter - VIII
### Photosynthesis

45. $P_{700}$
46. phaeophytin
47. 3-Phosphoglyceic acid / 3-PGA
48. Oxaloacetic acid
49. peroxisome

### Chapter - IX
### Respiration

50. mitochondria
51. Chemiosmotic
52. acetyl CoA
53. pentose
54. ten

### Chapter - X
### Plant Growth and Development

55. Zeatin / BAP
56. ethylene
57. vernalization

## *2B. Fill in the blanks :*

### Chapter - I
### Classification of Living Organisms

1. R. H. Whittaker
2. Fungi
3. glycogen

### Chapter - II
### Classification of Plant Kingdom

4. prothallus
5. Wolffia
6. Cone/strobilus

### Chapter - III
### Plant Morphology and Anatomy (Tissues & Tissue System)

7. Cambium
8. pericycle
9. aerenchyma
10. ground/fundamental

### Chapter - IV
### Cell Structure and Function

11. Fluid-Mosai model
12. plasmodesmata
13. suicidal
14. tonoplast
15. Chromoplasts
16. acrocentric
17. proteins
18. amino acids
19. proline
20. apoenzyme
21. deoxyribose
22. inulin
23. reducing

## Chapter - V

## Cell Structure and Function

## (Cell Divison)

24. Colchicine
25. nucleus
26. anaphase
27. 8 (eight)

## Chapter - VI

## Transport in Plants

28. turgid
29. zero
30. plasmolysis
31. guttation
32. Dixon & Jolly
33. stomata

## Chapter - VII

## Mineral Nutrition

34. micronutrients
35. hydroponics
36. nitrogenase

## Chapter - VIII

## Photosynthesis

37. $P_{700}$
38. 3-PGA/3-Phospho Glyceric Acid
39. bundle sheath
40. RuBP / Ribulose 1, 5-Bis Phosphate

## Chapter - IX

## Respiration

41. substrate - level
42. pyruvate / pyruvic acid
43. mitochondria
44. citrate / citric acid
45. Chemiosmotic

## Chapter - X

## Plant Growth and Development

46. ethylene
47. tryptophan
48. methionine

# GROUP - B

# SHORT TYPE QUESTIONS

## 3. *Write notes on*

1. Protista
2. Mycoplasma
3. Viruses
4. Nutrition of Fungi
5. Reproduction in Algae
6. Vascular Cryptogams
7. Gymnosperms
8. Parenchyma
9. Sclerenchyma
10. Phloem
11. Xylem
12. Lateral Meristem
13. Plasma Membrane
14. Ribosome
15. Nucleus
16. Chromosomes
17. Nucleotide
18. Peptide Bond
19. Reducing Sugar
20. tRNA
21. Fatty Acids
22. Classification of Enzymes
23. Mechanism of enzyme action
24. Lock & Key hypothesis
25. Induced-Fit hypothesis
26. Osmotic Pressure
27. Water Potential
28. Imbibition
29. Diffusion Pressure Deficit (DPD)
30. Plasmolysis
31. Opening and Closing of Stomata
32. Photolysis of Water
33. Hill Reaction
34. Chemiosmotic Hypothesis
35. CAM Plants
36. Alcoholic Fermentation
37. Oxidative Phosphorylation
38. Respiratory Quotient
39. Auxins
40. Vernalization
41. Photosystem
42. Kranz anatomy
43. Acetyl CoA
44. Proton - Motive Force
45. Lactic acid fermentation
46. Dormaney of seeds

## 4. Differentiate between :

1. Monera and Protista
2. Plants and Animals
3. Gymnosperms and Angiosperms
4. Dicotyledons and Monocotyledons
5. Permanent Tissue and Meristematic Tissue
6. Nucleus an Nucleolus
7. Prokaryotic Cell and Eukaryotic Cell
8. Deoxy-ribo Nucleic Acid (DNA) and Ribo Nucleic Acid (RNA)
9. Mitosis and Meiosis
10. Nucletotide and Nucleoside
11. Diffusion and Osomosis
12. Imbibition and Osomosis
13. Cyclic Photophosphorylation and Non-cyclic Photophosphorylation
14. $C_3$-Plants and $C_4$-Plants
15. $C_3$ Pathway and $C_4$ Pathway
16. Apoplast and Symplast
17. Asymbiotic nitrogen fixation and Symbiotic nitrogen fixation
18. Micronutrients and Macronutrients
19. Transpiration and Translocation
20. Phototropism and Photoperiodism
21. Comptetitive inhibitors and Non-competitive inhibitors

# GROUP - B
## ANSWERS

### 3. *Write notes on*

1. **Protista :**

- These are unicellular, aquatic, eukaryotes classified as a separate kingdom under the five-kingdom system.
- They include Dinoflagellates, euglenoids, Slime molds and Protozoans.
- The organisms are mostly autotrophic and reproduce both asexually and sexually.

2. **Mycoplasma :**

- Mycoplasma is a genus under bacteria which completely lacks cell wall.
- They can live without oxygen and are pathogenic to humans and animals.
- They are heterotrophs. Some live as saprophytes, but majority are parasites of plants and animals.

3. **Viruses :**

- These are non-cellular ultramicroscopic structures.
- They grow and multiply only inside living cells, therefore can cause infection to all types of organisms, plants, animals, bacteria and humans.
- A complete virus particle or virion consists of nucleic acid (RNA/DNA) surrounded by a protective coat of protein. Some species have an outer envelope of lipid bilayer studded with proteins.

4. **Nutrition of Fungi :**

- The fungi are heterotrophs. They can be saprophytes, or parasites. When is association, they can be symbionts as in lichen or live in root systems of higher plants, called mycorrhiza.
- They digest their food outside the body and then absorb it. They are decomposers. As parasites they draw nutrients from their hosts.
- Some soil fungi are predators. They have specialised mycelia that prey on worms and absorb their nutrients.

5. **Reproduction in Algae :**

- Algae are thallose, eukaryotic organisms. They reproduce both asexually and sexually.
- Asexual reproduction takes place by motile zoospores or nonmotile aplanospores.
- Sexual reproduction may be isogamous, anisogamous or oogamous. Male and female gametes unite to from zygote, which undergoes meiosis to regenerate gameto-phytic generation.

6. **Vascular Cryptogams :**

- Cryptogamae is a lower plant group that reproduces without flowers or seeds.
- Pteridophytes are called vascular crytogams as they reproduce through spores, but have well developed vascular tissues like xylem and phloem. Example - Lycopodium, Selaginella and Ferns.

7. **Gymnosperms :**

- Gymnosperms are naked seeded plants. The ovules are not covered with ovary wall before or after fertilization.
- The body is differentiated into root, stem and leaves. Fertile leaves called sporophylls aggregate to form strobili. Vascular system is well developed, often with secondary growth. Example - Cycas, Pinus, Ginkgo etc.

8. **Parenchyma :**

- This is a simple living tissue. The cells are of various sizes and shapes.
- The cell wall is thin with a lot of intercellular spaces. It is found in the cortex, pith, mesophyll of leaves and other softer regions of the plant.
- Parenchyma with air spaces are called aerenchyma, a characteristic feature of hydrophytes.

9. **Sclerenchyma :**

- This is a simple tissue, made of dead cells, which are long, narrow and thick-walled. As such they give mechanical strength to the plant.
- They yield fibres of commercial importance like hemp, flax etc.

10. **Phloem :**

- Phloem is a complex tissue, consisting of sieve-tubes, companion cells, bast (phloem) fibres and phloem parenchyma. Of these only bast fibres are made of dead cells.
- Sieve-tubes are meant for translocation of food material.
- Phloem is the source of fibres of commercial importance in many plants like - jute, flax and hemp etc.

11. **Xylem :**

- It is a complex tissue, consisting of tracheids, vessels, xylem parenchyma and wood (xylem) fibres. It is also kown as wood. Out of these, only xylem parenchyma is living and the rest are dead.
- Xylem provide mechanical support to the plant and are responsible for transport of water and minerals from the root system to different parts of the plant.

12. **Lateral Meristem :**

- Meristems can be - apical, intercalary and lateral. Lateral meristems are present on the radial side of the stem or root and help in increasing the thickness.
- They are secondary meristems. Cork cambium and vascular cambium are the two types of lateral meristem.
- Vascular cambium gives rise to wood and cork cambium to periderm which replaces epidermis.

13. **Plasma membrane :**

- Plasma membrane or cell membrane is found in all cells. Cell membrane is selectively permeable and is composed of lipids and proteins with small amount of carbohydrates.
- The unit membrane concept proposed by Robertson in 1959 suggests it to be a bimolecular lipid layer sandwiched between two layers of protein.
- The more accepted Fluid-Mosai model as proposed by Singer and Nicolson in 1972 proposes a more dynamic model with a bimolecular lipid layer, interspersed with proteins.

14. **Ribosome :**

- It is a non-membranous particle made up of rRNA and protein. It occurs freely in the cytoplasm or attached to the endoplasmic reticulum.
- Prokaryotes have 70s ribosomes, whereas eukaryotes have 80s ribosomes.
- Each ribosome has two subunits, one small and a large one. It is the site of protein synthesis in the cell.

15. **Nucleus :**

- It is the largest organelle of the cell, surrounded by a nuclear membrane. It controls all cellular activities.
- The nucleus has nucleoplam (sap), nuclear ribosome, nucleolus and chromatin network or chromosomes. Nucleolus controls cell division and other metabolic activities.

- The chromosomes carry all the genetic information of the organism and are responsible for inheritance of characters.

16. **Chromosomes :**

- These are filamentous bodies present in the nucleus. They appear prior to and during cell division, but appear as threads or reticulum in all other times.
- Individuals of a particular speices have the same number of chromosomes and are ordinarily diploid (2n).
- Depending on the position of centromere, it can be metacentric, sub-metacentric, acro-centric and telocentric. In eukaryotic cells, chromosomes are DNA - complexed with histone proteins. They are bearers of hereditary characters.

17. **Nucleotide :**

- Each nucleotide consists of an organic nitrogenous base, a pentose sugar and a phosphate molecule. A nitrogenous base and the pentose sugar constitute nucleoside. Therefore, nucleotides are phosphoric esters of nucleosides.
- Nitrogen bases belong to two separate groups like (i) purines and (ii) pyrimidines. Adenine and Guanine are the purines whereas Cytosine and Thymine are the pyromidines. In RNA, Thymine is replaced by Uracil.
- Pentose sugar can be a ribose or a deoxy-ribose. Nucleotides combine to form nucleic acids like Deoxyribo Nucleic Acid (DNA) and Ribo Nucleic Acid (RNA). Some meleotides like Adenosine Triphosphate (ATP) remain free in the cell.

18. **Peptide bond :**

- When a carboxylic group (-COOH) of one amino acid reacts with the amino group ($-NH_2$) of another amino acid with elimination of a molecule of water, a peptide bond is formed. The compound formed is a dipeptide.
- A polypeptide chain is formed when a large number of aminoacids are joined together by peptide bonds. Polypeptide chain is the primary structure of all proteins.

19. **Reducing Sugar :**

- All monosaccharides and some disaccharides like lactose, maltose etc. are reducing sugars.
- Any sugar that has a free aldehyde or keto (hemiacetal/hemiketal) functional group in its molecular structure serves at a reducing agent. A reducing sugar is easily oxidized by a weak oxidizing agent.
- All polysaccharides are non-reducing sugars.

20. **tRNA :**

- Like DNA, RNA is a polynucleotide, but it has nitrogenous base uracil is place of thymine. RNAs are single stranded and are of three types mRNA, rRNA and tRNA.
- Transfer RNA or tRNA is the smallest of the three with 75 to 100 nucleotides. It has a clover leaf like structure with three loops and a variable arm.
- 3'-end acts as the aminoacid attachment site. tRNA transfers amino acids from the cytoplasm to the ribosome, the site of protein synthesis.

21. **Fatty Acids :**

- Lipids are esters of fatty acids with alcohols. Fatty acids are long chain of carbon atoms with an acid (-COOH) group at one end.
- They can be saturated or unsaturated. Fatty acids are said to be saturated when they do not possess any double bond. Example - Linolenic acid.
- They provide structural framework of living tissues and are of great medicinal and commercial importance.

22. **Classification of Enzymes :**

- The Enzyme Commission of the International Union of Biochemistry recognises six major classes of enzymes based on the type of reactions they catalyse :

(i) Oxidoreductases. Ex. - Catalase, Peroxidase.

(ii) Transferases. Ex. - Hexokinase.

(iii) Hydrolases. Ex. - Phosphatase, Urease.

(iv) Lyases (addition of groups) and Vice versa Ex. - Decarboxylase.

(v) Isomerases. Ex.- Triose phosphate isomerase.

(vi) Ligases (joining or ligation). Ex. - Thiokinase.

- Each enzyme is assigned with a four digit number called the EC (Enzyme Commision) number. For example, enzyme hexokinase is assigned with the number - EC 2.7.1.1.

23. **Mechanism of enzyme action :**

- All biochemical reactions are energy dependent. Enzymes lower the activation energy of reactants (substrates) by forming ENZYME-SUBSTRATE (ES) complex, so that reaction can be possible at a lower energy level.
- Michaelis and Menten in 1913 explained this with the help of an equation, called Michaelis - Menten equation.

$v = \frac{V\,max\,[S]}{[S] + Km}$, where

v = initial velocity

Vmax = maximum veocity

Km = Michaelis constant

[S] = Substrate concentration.

24. **Lock & Key hypothesis :**

- This hypothesis was proposed by Emil Fischer in 1890. It explains the binding of a substrate molecule in the active site of an enzyme.
- The active site is said to be a fixed structure like lock which exactly matches the structure of a specific substrate, the key, forming the ES complex.
- The substrates undergo change to form products and the enzyme is released unchanged.

25. **Induced - Fit hypothesis :**

- Induced - fit hypothesis was proposed by Koshland in 1958.
- As per this hypothesis, the enzyme moulds itself to the shape of the substrate molecule when the active site comes in contact with the proper substrate, so as to enhance or inhibit a particular reaction.

26. **Osmotic Pressure :**

- The amount of pressure which is just sufficient to stop osomsis to take place when a solution of separated from its solvent by a semipermeable membrane is the Osomtic Pressure of the said solution.
- It is denoted by the symbol $\pi$ (Pi) and is measured in terms of atmos/bars/megapascal.

27. **Water Potential :**

- It is defined as the difference in free chemical energy of molecules of pure water and such energy of water in other systems (like plant cell system). It is denoted by the symbol $\psi$ (Psi).
- Water potential of pure water at atmospheric pressure is taken as 0 (zero) and water potential of all solutions in water is always less than zero.

28. **Imbibition :**

- Imbibition is a physical process. It is a special type of diffusion that takes place by seeds or even dry pieces of woods, when they absorb water and swell up.
- There is great affinity between imbibant and imbibing substance.

29. **Diffusion Pressure Deficit (DPD) :**

- Diffusion Pressure Deficit is the pressure difference between pure water and a solution.
- DPD is the absorbing capacity of any cell. DPD = OP - TP, when OP is Osmotic Pressure and TP is Turgor Pressure. In a fully turgid cell DPD is zero and in a fully flaccid cell, TP is zero, therefore DPD = OP.

30. **Plasmolysis :**

- Plasmolysis occurs when water moves out of the cell and there is shrinkage of protoplasm. It happens when a cell is placed in a hypertonic solution and there is exosmosis.
- The cell loses its original form and the cell is said to be plasmolysed.

31. **Opening and Closing of Stomata :**

- Opening and closing of stomata is brought about by changes in the guard cells. When they absorb water from surrounding cells, they become turgid, making the outer thin walls stretch outwards, so that stomata opens. Conversely, when the cells are flaccid by loss of water, the stomata closes.
- Various theories are put forward to explain this phenomenon. Starch - glucose inter conversion theory and Potassium ion theory are the two important ones that reasonably explain as to why stomata open during daytime and close during the night.

32. **Photolysis of Water :**

- This takes place during light reaction of photosynthesis. When photosystem II (PSII) receives solar energy, water molecules are split into $H^+$ and $OH^-$. This is called photolysis and the process is carried out by an "Oxygen evolving complex", associated with PSII.
- $[OH]^-$ ions, so released unite to form molecular $O_2$ with release of electrons. In the process some water molecules are formed back.

$$4H_2O \rightarrow 4H^+ + 4[OH]^-$$

$$4[OH]^- \rightarrow 2H_2O + O_2 + 4e^-$$

- The electrons, so released, pass through the electron transport system to generate NADPH and ATP.

33. **Hill Reaction :**

- Before 1930s it was believed that $O_2$ released in photosynthesis comes from $CO_2$. Robert Hill in 1937 obsrved that isolated Chlroplasts if illuminated in presence of 2, 6 - dichlorophenol indophenol (DCPIP) and in complete absence of $CO_2$ can release $O_2$.
- DCPIP is a hydrogen acceptor, which helped the reaction to proceed in the absence of $CO_2$. From this experiment, Hill proved that $O_2$ comes from $H_2O$ and not from $CO_2$. This is known as Hill Reaction.

34. **Chemiosmotic Hypothesis :**

- The molecular mechanism of ATP synthesis during respiration and photosynthesis is explained by chemiosmotic hypothesis.
- Peter D. Mitchell proposed this hypothesis in 1961. As per this hypothesis, a Proton Motive Free (PMF) is said to be created by the electron transport chain which acts as a proton pump to facilitate movement of ions across the semi permeable membrane down their electrochemical gradient. The free energy difference is used to phosphorylate ADP to form ATP.

35. **CAM Plants :**

- In certain suculent plants like *Opuntia*, *Bryophyllum*, stomata remain closed during day time to minimize water loss by transpiration. A separate mechanism of $CO_2$ fixation reaction is seen in these plants.

- This mechanism of photosynthetic $CO_2$ fixation pathway was first elucidated in members of the family *Crassulaceae*. These plants are therefore, called Crassulacean Acid Metabolism (CAM) plants and the pathway, CAM pathway.
- In these plants, $CO_2$ that enters into the leaves during the night is converted into organic acids like Oxalocaetate, which gets decarboxylated during day time to release $CO_2$ to be utilised in the Calvin Cycle to form Carbohydrates.

36. **Alcoholic Fermentation :**

- Pyruvic acid is the end product of glycolysis. In the absence of molecular oxygen, yeast and several other micro organisms produce ethanol from pyruvate through a process of fermentation.
- In the first step, pyruvate undergoes decarboxylation to produce acetaldehyde by the enzyme pyruvate decarboxylase. In the second step, acetaldehyde is reduced to ethanol by the enzyme alcohol dehydrogenase in the presence of NADH.

$$C_6H_{12}O_6 \xrightarrow{\text{Yeast}} 2C_2H_5OH + 2CO_2$$

37. **Oxidative Phosphorylation :**

- Oxidative phosporylation is the process in which ATP is formed as a result of the transfer of electrons from NADH or $FADH_2$ to $O_2$ by a series of electron carriers present in the mitochondrial electron transport chain.
- Molecular mechanism of this process is best explained through the Chemiosmotic hypothesis.
- The essential feature of this hypothesis is that a proton gradient is formed across the membrane with generation of a proton motive force (PMF). PMF drives the synthesis of ATP when protons force their way through the integral membrane protein complex, called ATP synthase.

38. **Respiratory Quotient :**

- During aerobic respiration $O_2$ is consumed and $CO_2$ is released. The ratio of the amount of $CO_2$ evolved to the amount of $O_2$ consumed in respiration is called respiratory quotient.

$$RQ = \frac{\text{amount of } CO_2 \text{ evolved}}{\text{amount of } O_2 \text{ consumed}}$$

- The value of RQ depends on the type of substrate, used for respiration. For carbohydrates the RQ is 1. For proteins and fats the RQ value is less than one.

39. **Auxins :**

- Auxins are phytohormones that are produced in the shoot and root apices. They promote growth along longitudinal axis of plant.
- Naturally occuring auxins present in the plant include Indole-3-Acetic Acid (IAA), Indole-3-Butyric Acid (IBA) etc.
- They influence a series of physiological functions like :
  - (i) acceleration of apical growth and inhibiton of growth of lateral buds.
  - (ii) initiation of root development.
  - (iii) facilitating parthenocarpy etc.

40. **Vernalization :**

- Certain plants require low temperature treatment during early stages of life cycle, for subsequent flowering. This is called vernalization. It shortens the vegetative period of plants.
- Age of the plant, duration of exposure, availability of oxygen and water are important conditions necessary for vernalization.

41. **Photosystem**

- Photosystems are strucutral and functional units involved in the process of photosynthesis. They are located in the thylakoid membranes of chloroplasts as Photosystem I (PS I) and Photosystem II (PS II).
- Each photosystem has a photosynthetic reaction centre chlorophyll, associated with other pigments like carotenoids, xanthophylls etc. and other cofactors.
- They carry out primary photochemical reactions like - absorption of light and transfer of electrons.

42. **Kranz anatomy**

- It is a specialized leaf anatomy with two separate photosynthetic tissues found in $C_4$ plants like maize, sugarcane etc.
- Here, large thick-walled bundle sheath cells are clustered around the vascular bundles like rings. They have large number of chloroplasts. The mesophyll cells are loosely arranged between vascular bundles.
- In $C_4$ plants photorespiration is suppressed. Therefore, productivity is higher than $C_3$ plants.

43. **Acetyl CoA**

- It is a key molecule that participates in many biochemical reactions.
- During aerobic respiration, pyruvic acid enters mitochondria, where it is decarboxylated, oxidized and combines with CoA to form acetyl CoA.
- Acetyl CoA delivers the acetyl group to Citric Acid Cycle (Krebs Cycle) to be oxidized for energy production.

44. **Proton - Motive Force**

- As per Mitchell's chemiosmotic theory, electron transport through Electron Transport Chain generates a proton gradient in the inner mitochondrial membrane.
- Movement of protons across the inner membrane into the matrix catalyzes phosphorylation of ADP, in presence of enzyme ATP Synthase, to produce ATP.
- Proton-Motive Force (PMF) is the force that promotes movement of protons.

45. **Lactic acid fermentation**

- Lactic acid fermentation is a metabolic process by which glucose and other sugars are converted into two molecules of lactic acid and cellular energy.

  $\text{Glucose} + 2\text{ADP} + 2\text{ Pi} \rightarrow 2\text{ Lactate} + 2\text{ ATP}$

- It is a type of anaerobic respiration that occurs in some bacteria and in muscle cells.
- Lactate dehydrogenase is the enzyme that catalyzes conversion of phyruvate to lactate.

46. **Dormaney of seeds**

- Many angiospermic seeds undergo a period of dormancy or resting before they germinate, even under suitable conditions. This is called seed dormancy.
- The causes may be due to
  i) the nature of seed-coat
  ii) the condition of the embryo
  iii) the presence of some chemicals and growth regulators.

## 4. *Differentiate between :*

1. **Monera and Protista**

| Monera | Protista |
|---|---|
| • The kingdom Monera includes prokaryotes like bacteria and blue-green algae, the most primitive life forms.<br>• Bacteria have very simple cell structure. True nucleus and cell organellss other than ribosome are absent.<br>• Bacteria mainly reproduce by fission. The members are mostly heterotrophic. | • The kingdom Protista includes unicellular eukaryotes like protozoa, slime molds and euglenoids. Cell boundaries are not well defined. Cell wall may or may not be present.<br>• But the cell has a true nucleus and other cell organelles. The organisms may be autotrophic or heterotrophic.<br>• They may have motile appendages like cilia or flagella. They reproduce both asexually and sexually. |

2. **Plants and Animals**

| Plants | Animals |
|---|---|
| • Kingdom plantae includes multicellular, eukaryotic chlorophyll-containing organisms, called plants.<br>• A typical plant cell has cell wall, true nucleus and other cell organelles. Matured plant cells contain large vacuoles.<br>• The cell wall is mainly composed of cellulose. Green plants are called producers, because they prepare food by the process of photosyntheis. | • Kingdom Animalia is represented by multicellular, eukaryotic and heterotrophic organisms. Animal cells lack cell walls.<br>• They depend on plants for their food. The reserve food is mostly glycogen. All parts of animals grow equally and they show locomotion.<br>• Reproduction is mostly sexual in higher forms. |

3. **Gymnosperms and Angiosperms**

| Gymnosperms | Angiosperms |
|---|---|
| • Gymnosperms are naked seeded plants i.e. ovules are not covered by ovary wall.<br>• Plant body is differentiated into roots, stems and leaves and is a sporophyte. Vascular system is well developed with secondary growth. Fertile leaves are called sporophylls, which aggregate to form strobili.<br>• These are medium sized trees, but also include giant Sequoias, one of the tallest plants. | • Plant body is diploid and is well differentiated into roots, stems and leaves.<br>• Reproduction is highly developed with male and female reproductive units borne in flowers.<br>• Sexual reproduction is called double fertilisation and triple fusion resulting in formation of zygote and primary endosperm nucleus. |

4. **Dicotyledons and Monocotyledons**

| Dicotyledons | Monocotyledons |
|---|---|
| • These group of angiospermic plants are characterized by the presence of two cotyledons in the embryo.<br>• Leaves are dorsiventral mostly with reticulate venation. Intrafascicular cambium is usually present in vascular bundles, which are present in rings in the stem.<br>• Flowers are pentamerous. Root system develops from the tap root, which remains intact. | • Monocotyledonous plants belong to another class under angiosperms, characterised by the presence of a single cotyledon in the embryo.<br>• Leaves are isobilateral with mostly parallel venation. Vascular bundles are scattered in the stem and without any intrafascicular cambinm.<br>• Floral parts are in sets of three or trimerous. Tap root gets modified to fibrous roots. |

5. **Permanent Tissue and Meristematic Tissue**

| Permanent Tissue | Meristematic Tissue |
|---|---|
| • These are fully differentiated mature cells, that have lost power of division.<br>• Permanent tissues are of three types-simple, complex and special or secretory tissues. Permanent tissues can be primary and secondary tissue. Secondary xylem, secondary phloem and cork etc. are examples of secondary permanent tissue.<br>• Simple tissues can be parenchyma, Collechyma and Sclerehchyma. Xylem and pholoem constitute the complex tissues. Laticiferous and glandular tissues are the special or secretory tissues. | • These are young, immature undifferentiated thin-walled living cells, which have power of continuous division.<br>• They occur in the growing regions of the plant body like stem apices, root tips etc. Meristems can be primary or secondary meristems.<br>• Secondary meristems develop from primary permanent tissues at a later stage. Examples are cork cambium, inter-fasciular cambium etc. Based on position it can be apical, intercalary and lateral meristem. |

6. **Nucleus an Nucleolus**

| Nucleus | Nucleolus |
|---|---|
| • Eukaryotes have a prominent well defined nucleus with a double layered nuclear membrane and nuclear fluid or nucleoplasm. Nucleus is the dominant organelle, which controls all the activities of the cell.The nucleoplasm contains a spherical structure called nucleolus and chromosomes.<br>• Chromosomes contain genes, which are the bearers of hereditary characters. | • Nucleolus is a spherical structure present inside the nucleus. It is produced from and is assocaited with a nucleolar organizing region (NOR) on a chromosome.<br>• There can be more than one nucleolus in the nucleus. The main role of nucleolus is to process ribosomal RNAs and assemble ribosomal components. Fine structure of nucleolus includes three components - granular portion, fibrillar portion and amorphous matrix. |

7. **Prokaryotic Cell and Eukaryotic Cell**

| Prokaryotic Cell | Eukaryotic Cell |
|---|---|
| • The cell does not have a well defined nucleus. DNA is naked, not complexed with histones.<br>• Cell organelles other than ribosome are absent. Ribosomes are free in the cytoplasm and are of 70s type. | • It has a well defined nucleus with nuclear envelope.<br>• DNA is complexed with histone and non-histone proteins to form chromatin fibres.<br>• Cytoplasm contains many organelles like mitochondia, ER, golgi bodies, lysosomes etc.<br>• Green plant cells have chloroplast.<br>• Most ribosomes are attached to endoplasmic reticulum but some are free. Ribosomes are of 80s type. |

8. **Deoxy-ribo Nucleic Acid (DNA) and Ribo Nucleic Acid (RNA)**

| Deoxy-ribo Nucleic Acid (DNA) | Ribo Nucleic Acid (RNA) |
|---|---|
| • It is a long chain polymer of deoxyribonucleotides linked by phosphodiester bonds. It is usually double stranded.<br>• It is composed of deoxyribose sugar, phosphoric acid and four types of nitrogenous bases - Adenine, guanine, Cytosin and Thymin.<br>• It regulates cellular metabolism through enzymes.<br>• A-form, B-form and Z-form are the three major forms of DNA. | • It is a long chain polymer of ribonucleotides linked by phosphodiester bonds.<br>• It is single stranded and is composed of a ribose sugar, phosphoric acid and four types of nitrogenous bases - Adenine, Guanine, Cytosine and Uracil (in place of Thymine of DNA).<br>• mRNA, r-RNA and t-RNA are the three types found in the cell. It takes part in protein synthesis and is dependent on DNA for its synthesis. |

9. **Mitosis and Meiosis**

| Mitosis | Meiosis |
|---|---|
| • It takes place in vegetative cells, therefore called somatic cell division. Chromosome number remains the same after division.<br>• Nuclear division occurs once only with replication of the genetic material.<br>• Each division results in formation of two daughter cells which are identical in genetic makeup. This division is necessary to increase the number of somatic cells, required for body growth. | • It is restricted to reproductive tissues/cells. During this divison chromosome number is reduced to half in the daughter cells, called gametes.<br>• Nuclear division occurs twice in close succession forming four nuclei/cells. Meiosis-I is reductional divison and Meiosis-II is equational division. The four haploid cells vary in genetic make up from the parent cells.<br>• The purpose of this division is to produce male and female reproductive cells, which combine during reproduction to form a diploid set of chromosome in the offspring. |

10. **Nucletotide and Nucleoside**

| Nucletotide | Nucleoside |
|---|---|
| • A nucleotide is composed of three units - a pentose sugar, one of the four nitrogenous bases and a phosphate group. The pentose sugar can be ribose or deoxyribose. Nitrogenous bases are of two types - purines and pyrimidines.<br>• In DNA the purines are adenine and guanine and the pyrimidines are cytosine and thymine. In RNA, uracil is present in place of thymine.<br>• Nucleotides are phosphoresters of nucleosides. | • Nucleosides are formed by the linkage of carbon 1 of pentose with nitrogen 9 of purine base or nitrogen 1 of pyrimidine base.<br>• The sugar can be a ribose or a deoxyribose depending on whether it is part of RNA or DNA.<br>• Nucleotides are phosphoesters of nucleosides. |
| Example - If nitrogenous base is Adenine and the sugar is deoxyribose then :<br>base — nucleoside — nucleotide<br>Adenine ——— Deoxyadenosine ——— Deoxyadenosine monophosphate | |

11. **Diffusion and Osmosis**

| Diffusion | Osomosis |
|---|---|
| • It is a physical process in which solid, liquid or gas molecules of any substance move from a region of higher concentration to the region of its lower concentration.<br>• The rate of diffusion depends upon temperature, pressure and other factors. | • It is essentially a phenomenon of diffusion, but takes place through a selctively (semi) permeable membrane.<br>• It is a physiological process in which solvent (water) molecules move from a region of higher concentration of solvent to the region of its lower concentration, when two solutions are separated by a semipermeable membrane.<br>• In plants, this process takes palce in absorption and movement of water in the roots/shoots. |

12. **Imbibition and Osmosis**

| Imbibition | Osmosis |
|---|---|
| • It is a special type of diffusion. Seeds when placed in water, swell up by absorbing water. It invovles diffusion and capillary action.<br>• Imbibition does not require any membrane (semipermeable) nor does it require osmosis.<br>• Due to imbition, water is adsorbed on the dry surface of imbibants, the dry seeds, whose walls are made of cellulose. Colloidal nature of protoplasm also takes some amount of water. | • The process of osmosis is essentially a phenomenon of diffusion but requires a semipermeable membrane.<br>• In plant cells, the plasma membrane and the tonoplast separating the vacuolar sap act as semipermeable membrane and play significant role in absorption and movement of water across the cells.<br>• It is a physiological process. |

13. **Cyclic Photophosphorylation and Non-cyclic Photophosphorylation**

| Cyclic Photophosphorylation | Non-cyclic Photophosphorylation |
|---|---|
| • Formation of ATP molecules coupled with light-driven transfer of electrons in the thylakoid membranes of chloroplasts is known as photophosphorylation.<br>• Photosystem I (PSI) may transport electrons independent of PS-II. This is known as cyclic photophosphorylation.<br>• In this process only ATP is produced and NADPH is not generated. This is an additional source of ATP synthesis to support chloroplast activities. | • NADPH and ATP molecules are the main products of light reactions of photosynthesis. Formation of ATP coupled with non-cyclic electron transfer in the thylakoid membranes of chloroplast is known as non-cyclic photo-phosphorylation.<br>• Here, electron transport takes place continuously from water to NADPH. Both PS I and PS II participate in this electron transport chain, the components of which are arranged in a Z-scheme.<br>• Both NADH and ATP are generated here. |

14. **$C_3$-Plants and $C_4$-Plants**

| $C_3$-Plants | $C_4$-Plants |
|---|---|
| • Plants that assimilate $CO_2$ solely through Calvin cycle are generally known as $C_3$ plants.<br>• The first stable product of photosynthetic carbon fixation reaction is a 3-carbon compound, 3-Phospho Glyceric Acid (3-PGA), hence Calvin Cycle is also called $C_3$ cycle.<br>• Wheat, rice, barley, tobacco etc. are examples of $C_3$ plants. Rate of photorespiration is high in these plants. | • In certain tropical plants like maize, sugarcane, sorghum, amaranths etc. the first stable product of photosynthetic $CO_2$ fixation reaction is a 4-Carbon compound, called oxaloacetic acid. The plants are therefore called $C_4$ plants and the pathway $C_4$ pathway.<br>• These plants show a particular leaf anatomy called Kranz anatomy, where vascular bundles are surrounded by a layer of bundle sheath cells. The enzyme Ribulose 1, 5 Bisphosphate carboxylase-oxygenase is absent in mesophyll cells of these plants, but only present in bundle-sheath cells.<br>• These plants tolerate high temperature and lack photorespiration hence there is greater productivity. |

15. **$C_3$ Pathway and $C_4$ Pathway**

| $C_3$ Pathway | $C_4$ Pathway |
|---|---|
| • In most of the green plants and algae, $CO_2$ is reduced to carbohydrates in a series of reactions, known as photosynthetic carbon reduction (PCR) cycle or Calvin Cycle.<br>• The cycle begins with carboxylation of ribulose-1, 5-bisphosphate (RuBP) to yield two molecules of 3-PGA. This reaction is catalyzed by the enzyme, ribulose-1, 5-bisphosphate carboxylase - oxygenase (rubisco). Since the first stable product is a 3-C compound, the cycle is also called $C_3$ cycle.<br>• In a series of enzymatic reactions taking place in the Chloroplast stroma, RuBP is regenerated that again participates in the $CO_2$ fixation. | • In certain tropical plants like maize, sugarcane, sorghum etc. the first stable product of photosynthetic $CO_2$ fixation reaction is a 4-C compound, oxalocetic acid. Therefore, the pathway is called $C_4$ pathway or Hatch-Slack-Kortschack (HSK) pathway, named after the scientists who discovered it.<br>• These plants show a typical laf anatomy called *Kranz anatomy*.<br>• The enzyme rubisco is absent in mesophyll cells, therefore, PEP is carboxylated to form oxaloacetic acid. Oxaloacetate enters the bundle sheath cells to release $CO_2$ which is again fixed to form carbohydrate. |

16. **Apoplast and Symplast**

| Apoplast | Symplast |
|---|---|
| • Apoplast is the non-living space outside plasma membrane within which material can diffuse freely.<br>• It is the route, water moves from root hair through cell walls and inter cellular spaces to the xylem in the root cortex.<br>• Water movement mainly occurs by passive diffusion. | • Symplast of a plant is the inner side of plasma membrane in which water and other solutes can freely move between cells through the plasmodesmata.<br>• It is composed of living parts.<br>• Water movement occurs by osmosis. |

17. **Asymbiotic nitrogen fixation and Symbiotic nitrogen fixation**

| Asymbiotic nitrogen fixation | Symbiotic nitrogen fixation |
|---|---|
| • Fixation of $N_2$ by microorganisms, living freely is called asymbiotic or non-symbiotic biological nitrogen fixation.<br>• Anaerobic bacteria like *Clostridium,* aerobic bacteria like *Azotobacter* and cyanobacteria like *Anaebina, Nostoc* can fix nitrogen.<br>• Atmospheric $N_2$ is converted to ammonia. | • Fixation of $N_2$ by microorganisms, living symbiotically inside plant roots is called symbiotic nitrogen fixation.<br>• Some bacteria like *Rhizobium* penetrate the roots of leguminous plants like peas, beans etc. and form root nodules. The root hodules contain a red pigment called leghemoglobin.<br>• These root nodules are the sites, where $N_2$ is converted to ammonia. |

18. **Micronutrients and Macronutrients**

| Micronutrients | Macronutrients |
|---|---|
| • These are plant-based nutrients, which are required in very small quantities or in traces.<br>• They include minerals like copper, boron, manganese, zinc, molybdenum, iron etc. and vitamins.<br>• Deficiency causes diseases. | • These are plant based nutrients, which are required in large quantities and are not produced in the plant body.<br>• Macronutrients include carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, potassium, magnesium and calcium etc.<br>• Deficiency impairs growth and causes disease. |

19. **Transpiration and Translocation**

| Transpiration | Translocation |
|---|---|
| • Loss of water in the form of vapour from aerial parts of the plant is called transpiration.<br>• It always occurs against gravity.<br>• Transpiration facilitates inward movement of water in the xylem. | • Transport of soluble products of photosynthesis (mainly sucrose) from leaves to other parts of the plant is called translocation.<br>• It can occur in any direction.<br>• It is carried out by the phloem. |

20. **Phototropism and Photoperiodism**

| Phototropism | Photoperiodism |
|---|---|
| • Phototropism is the movement of plants in response to light.<br>• When the movement is towards the source of light, it is positive phototropism and when movement is away from light, it is negative photototropism.<br>• Phototropism induces curvature in plants. | • Photoperiodism is the response of plants to the lengths of light and dark periods (photoperiods) in a day.<br>• Photoperiodism induces flowering in plants.<br>• It occurs irrespective of the direction of light. |

21. **Comptetitive inhibitors and Non-competitive inhibitors**

| Comptetitive inhibitors | Non-competitive inhibitors |
|---|---|
| • Its structure is similar to that of substrates.<br>• It attaches at the active site of an enzyme and affects the initial rate of reaction.<br>• The reaction can be reversed by increasing substrate concentration. | • Its structure is entirely different from that of substrates.<br>• It attaches at a point other than active site and affects the maximum rate of reaction.<br>• The reaction can not be reversed by increasing substrate concentration. |

# GROUP - C

## LONG TYPE QUESTIONS

1. Give an account of 5-Kingdom system of classification.
2. Give an account of classification of meristems.
3. Describe the organization of tissue system in plants.
4. Draw a labelled diagram depicting the ultrastructureof a typical plant cell.
5. Describe the double helical structure of DNA.
6. Discuss the mechanism of enzym action.
7. Describe the non-cyclic photophosphorylation with a Z-scheme.
8. Describe the steps of Calvin Cycle.
9. Describe the reaction steps of HSK Pathway.
10. Describe the reaction steps of glycolysis.
11. Give an account of the reaction steps of Krebs Cycle.
12. Describe respiratory electron transport chain and the mechanism of ATP Synthesis.
13. Give an account of the physiological effects of anxins in plants.

# GROUP - C

# ANSWERS

*(Salient Points for Answers)*

1. **Give an account of 5-Kingdom system of classification.**

- R. H. Whittaker proposed this system of classification in 1969.
- The main criteria of classification used by him - (i) cell structure, (ii) body organization and (iii) mode of nutrtion.
- The kingdoms recognized in this system are (i) Monera, (ii) Protista, (iii) Fungi, (iv) Plantae and (v) Animalia.
- Inspite of several advantages the five-kingdom classifcation still has some demerits like, virus is not assigned any place.

2. **Give an account of classification of meristems.**

- Meristematic tissues or meristems are present in the shoot and root apices of plants.
- Meristems comprise of young, undifferentiated mass of thin-walled living cells.
- Meristems can be divided based on stage of development, origin, position, function and plane of division.
- Further calssification may be elaborated with examples.

3. **Describe the organization of tissue system in plants.**

- On the basis of structure and location, there are three types of tissue systems - (i) epidermal, (ii) ground or fundamental and (iii) vascular or conducting tissues systems.
- Epidermal tissue system - It comprises of epidermis, stomata, epidermal appendags, root hairs etc. Individual characters and function may be described.
- Ground or Fundamental tissue system - It is the tissue in between the epidermis and vascular tissues i.e. cortex, pericycle, pith and medullary rays. Its structure and function may be elaborated.
- Vascular tissue system - The components are xylem and phloem, which together form the vascular bundle. Vascular bundles can be open or closed based on the presence of cambium. Details of structure and function may be elaborated.

4. **Draw a labelled diagram depicting the ultrastructure of a typical plant cell.**

- Carefully draw the diagram by a pencil. The diagram should be neat, proportionate and it should be properly labelled on the right side with parallel lines.
- No description is required.

5. **Describe the double helical structure of DNA.**

- There are two types of nucleic acids - deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).
- Description of pentose sugar, nitrogen bases. Composition of nucleosides and nucleotides and primary structure of DNA.
- Double helical structure of DNA as proposed by Watson and Crick - its main features.

6. **Discuss the mechanism of enzyme action.**

- Enzymes are proteins with a non-protein part known as cofactor.

  Apoenzyme + Cofactor = Holoenzyme
  (inactive) (active)

  A cofactor can be a metal ion or a small organic molecule called coenzyme. Coenzymes, when tightly bound are called prosthetic groups.

- Formation of enzyme - substrate complexes at specific sites, called active site.

  $E + S \rightleftharpoons ES \rightarrow P + E$

- Enzymes lower the activation energy of the reactants, so that reaction can proceed with available supply of energy. Michaelis & Menten (1913) equation explains the velocity of enzymatic reactions.

$$v = \frac{V\,max\,[S]}{[S] + Km}$$

  Where

  v = initial velocity

  Vmax = maximum veocity

  [S] = Substrate coch.

  Km = Michaelis constant

- Lock and Key / Induced-fit hypothesis may be briefly stated.

7. **Describe the non-cyclic photophosphorylation with a Z-scheme.**

- Discuss cyclic and non-cyclic photophosphorylation.
- Draw a Z-scheme depicting the flow of electrons from water to NADP.\
- Explain Chemiosmotic hypothesis to explain the synthesis of ATP.
- Discuss its significance in photosynthesis.

8. **Describe the steps of Calvin Cycle.**

- Calvin Cycle is the Photosynthetic Carbon Reduction (PCR) Cycle that reduces $CO_2$ to carbohydrates during the dark reaction. The first stable product is 3-PGA, therefore the Cycle is also called $C_3$ Cycle.
- It has three stages - (i) carboxylation, (ii) reduction and (iii) regeneration linked with one another in a cyclic manner.
- Each molecule of $CO_2$ reduced in Calvin Cycle requires 2 molecules of NADPH and 3 molecules of ATP. Details of the reaction steps to be described by drawing a diagram.

9. **Describe the reaction steps of HSK Pathway.**

- In some tropical plants like maize, sugarcane etc. the leaf anatomy shows a special feature - called Kranz anatomy. Here, the vascular bundle is surrounded tightly by bundle sheath cells.
- The mesophyll cells lack rubisco, responsible for carboxylation of RuBP, therefore the $CO_2$ acceptor is Phospho Enol Pyruvate (PEP) forming Oxaloacetic acid. The cycle is completed in four phases - carboxylation, transport, decarboxylation and regeneration phase.
- The first stable product is a 4-C compound, therefore it is also called $C_4$-Pathway. Hatch Slack and Kortschack discovered this pathway, therefore it is also called HSK Pathway. The cycle may be shown schematically in a diagram.

10. **Describe the reaction steps of glycolysis.**

- Respiration is an oxidation-reduction process in which substrates like carbonhydrates are oxidised to $CO_2$ with release of energy. It is accomplished in three steps, the first one is glycolysis.

- Glycolysis consists of a series of steps resulting in the oxidation of carbohydrates to Pyruvic acid. All the reactions operate in the cytoplasm and does not require molecular oxygen at any level. The pathway is also known as Embden-Meyerhoff - Parnass (EMP) pathway.
- The process is completed in two phases - Preparatory phase and Pay off phase. The pathway starts with phosphorylation of glucose moelcule to form Glucose-6-Phosphate, which undergoes a series of reactions to form 2 moelcules of 3-C compound, Pyruvic acid. Detail steps may be elaborated.
- Glycolysis is both common to aerobic and anaerobic respiration.

11. **Give an account of the reaction steps of Krebs Cycle.**

- Acetyl CoA is the starting point of Krebs Cycle or TCA (Tri Carboxylic Acid) cycle. Under aerobic conditions, pyruvic acid enters mitochondrial matrix, where it is decarboxylated and oxidized. The resultant acetyl group is transferred to CoA to form acetyl CoA, which participates in the TCA cycle.
- The first reaction is condensation of acetyl CoA with oxaloacetate (4C) to from citrate (6C). Citrate undergoes a series of cyclic reactions to regenerate oxaloacetate. In the process NAD is reduced to NADH and FAD to $FADH_2$. Various steps of the cycle may be elaborated and their significance may be stated.

12. **Describe respiratory electron transport chain and the mechanism of ATP Synthesis.**

- Electron transport chain is located in the inner membrane of mitochondria. The electron carriers are organised into four large complexes and two mobile carriers.
- Electrons move from NADH to molecular oxygen passing through the electron carrier complexes and in the process ATP is synthesized.

  ATP synthesis, in this process of oxidative phosphorylation is best explained by chemiosmotic hypothesis. Diagramatic representation of the electron transport chain in the mitochondrial membrane alongwith the events, assocaited may be described in detail.

  Significance of ETS in the context of aerobic respircation may also indicated.

13. **Give an account of the physiological effects of auxins in plants.**

- Auxins are a group of phytohormones that promote growth along the longitudinal axis of the plant. they are produced in the shoot and root apices and then migrate to the zone of elongation. Naturally occuring auxins include Indole-3-Acetic Acid (IAA) and Indole-3-Butyric Acid (IBA).
- Primary physiological effects of auxin are cell division and cell elongation in shoots. Auxins do influence apical dominance, abscission, root incitiation, parthenocarpy etc. Synthetic auxins like 2, 4-Dichloro Phenoxy Acetic Acid (2, 4-D) are also used as weedicides. The physiological effects, stated above may be further elaborated.

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