B 4. WATER RELATIONS OF PLANTS (10 marks)

One mark questions:

Q. Define diffusion

A: "It is a process of movement of molecules from the region of their higher concentration to the region of their lower concentration along concentration gradient."

Q. Define Osmosis

"It is a process of movement of solvent molecules (water) from the region of their higher concentration to the region of their lower concentration through a semi permeable membrane."

Two mark questions:

Q. Write a note on imbibition

"Adsorption of water by hydrophilic substances like starch, cellulose, hemicellulose, lignin,
pectin, gum, gelatin etc… is called imbibition."

A substance which exhibits imbibition is called imbibant. The liquid that is adsorbed is called imbibate. The pressure created during imbibition is called imbibition pressure. During imbibition, solution is not formed. During Imbibition, water molecules loose their kinetic energy in the form of heat. This is called heat of wetting. Imbibition causes swelling of the imbibant.

Q. Write the significance of Diffusion

A: Significanceof diffusion :

1. Diffusion is involved in absorption of minerals by the plants
2. Cell to cell conduction of minerals is due to diffusion.
3. Exchange of gases b/w the plants and the environment is due to diffusion.
4. Translocation of organic solutes from the production area (leaf) to the consumption area (root tip or shoot tip) is due to diffusion.

Q. Differentiate Endosmosis and Exosmosis

Endosmosis	Exosmosis
Entry of water into the cell when kept in hypotonic solution is called Endosmosis. It leads to turgidity of cell.	**Loss of water** by the cell when kept in Hypertonic solution is called exosmosis. It leads to flaccidity of cell.

Q. Differentiate Hypotonic, isotonic and Hypertonic solution

Hypotonic solution	Isotonic solution	Hypertonic solution
It is a solution having A **lower osmotic concentration** (more salts) than that of cell sap.	A solution having the **same osmotic concentration** as that of cell sap is called isotonic solution.	It is a solution having A **higher osmotic concen tration** than that of the cell sap.

Q. Write a note on Water potential (Ψ- Psi)

Ans

1. It refers to the difference in the free energy of water molecules in pure water with respect to free energy of water molecules in a solution. It is the measurement of capacity of water to do work.
2. Water potential is denoted by the symbol Ψ (Psi). It is measured in Bars or atmospheres.
3. Pure water has maximum water potential and is equal to zero. Thus the water potential of the cell sap or solution is less than zero.
4. Ψ (Psi) is calculated by the formula :

$$\Psi = \Psi_s + \Psi_p + \Psi_m$$

where

Ψ =water potential of a cell,

Ψ s = osmotic potential
Ψ p = Pressure potential
Ψ m =matric potential*

} components of water potential

Osmotic potential is also called solute potential. It refers to the decrease in the chemical potential of water over its pure state due to the presence of solutes. It has negative value.

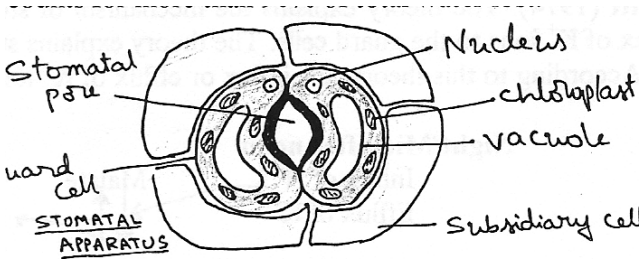
E.g., Solute potential of a non-electrolyte is –22.4 atm
Solute potential of an electrolyte is –43.3 atm

Pressure potential is also called turgor pressure. It is the positive value that refers to the pressure exerted by the protoplasm against the cell wall due to endosmosis.

Q. Structure of stomatal apparatus:

Ans:

a. Stomatal pore is guarded by two bean shaped cells called guard cells.
b. The guard cells have differential thickenings of the cell wall. The cell wall towards the stomatal pore is thick.
The cells are nucleated and possess chloroplasts.
c. Guard cells are surrounded by epidermal cells. These cells are called subsidiary cells.

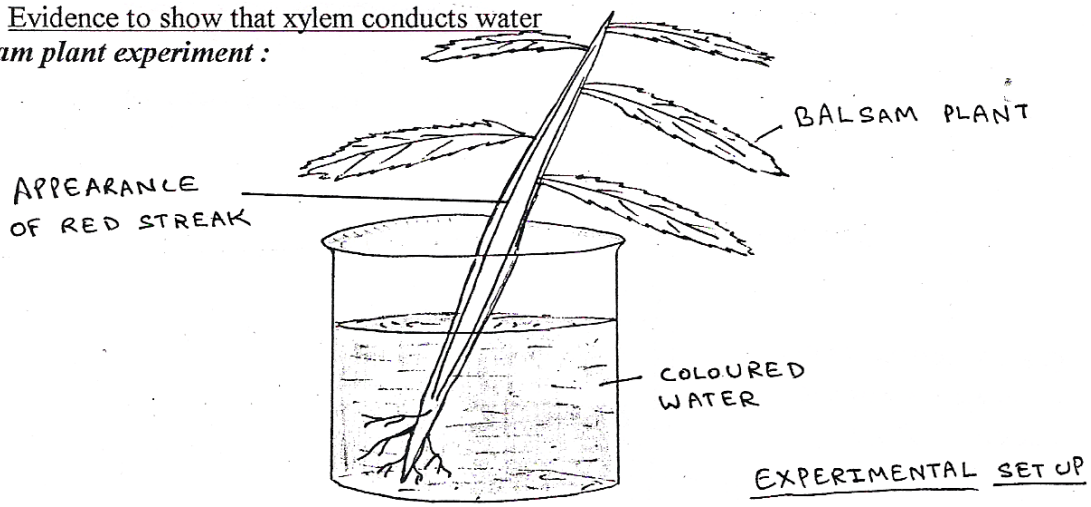


d. The osmotic changes in the guard cells regulate the opening and closing of stomata.

Q.

3.1 Evidence to show that xylem conducts water

ılsam plant experiment :



Aim : to show that xylem conducts water

Materials required : Beaker, coloured water, Balsam plant.

Procedure : Coloured water is taken in a beaker. The Balsam plant is removed from the soil and the root system is washed to remove the soil particles. The plant is then introduced into a beaker containing coloured water. The set up is kept as it is for some time.

Observation: When the plant is viewed under sunlight, it shows the presence of red streaks. When the stem is sectioned and viewed under the microscope, the xylem vessels are found to be coloured.

Inference: Ascent of sap is the process of upward conduction of water from root to shoot through xylem. In this experiment, when the balsam plant is introduced in the coloured water, is absorbs the water through root hairs and laterally conducts the same to the xylem. Due to transpiration in the shoot system, a transpiration pull is created resulting in ascent of sap. When the stem is viewed under sunlight, appearance of red streaks indicates the conduction of water by the xylem. This can be confirmed by observing the section of stem under the microscope. In a cross section, the xylem tissue is found to be coloured indicating that it is the pathway of ascent of sap.

Q) Justify the statement: "Transpiration is a necessary evil".

Transpiration has both merits and de-merits.

Merits of transpiration:

1. Transpiration gives cooling effect.
2. It is a means of absorption of minerals from the soil along with water.
3. Transpiration allows the loss of excess water.
4. It is responsible for ascent of sap.
5. Maintains optimum turgidity of a cell.
6. Excessive transpiration leads to sweetening of fruits.

Demerits of transpiration:

1. If the rate of transpiration is more than the rate of absorption, the plant suffers from wilting.

Temporary wilting followed by permanent wilting leads to death.

2. Excessive transpiration leads to wastage of energy.
3. Closing of stomata blocks the entry of CO_2. This affects photosynthesis.

Thus, according to Curtis, "Transpiration is a necessary evil".

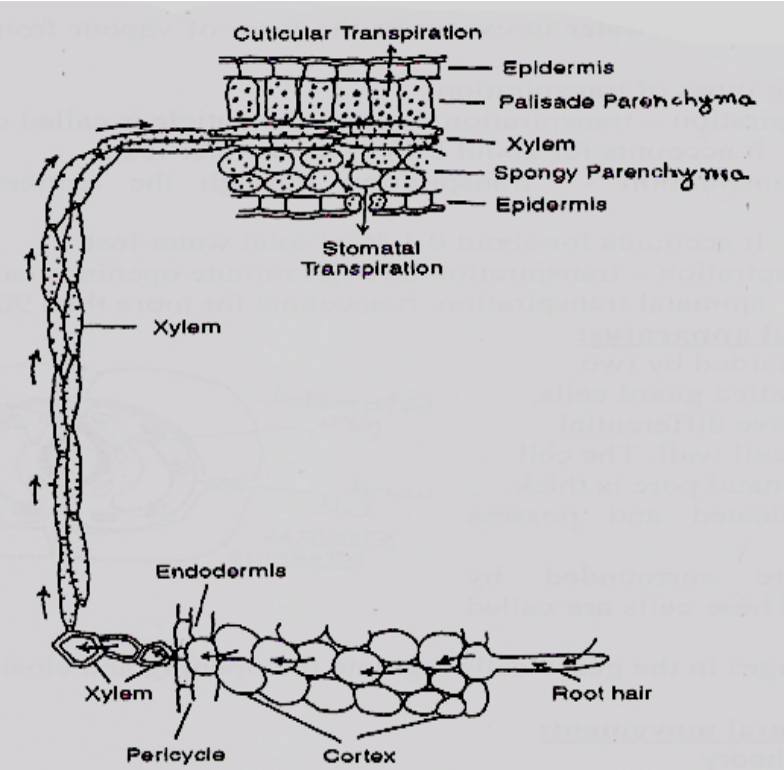
5 mark questions:

Q. Explain <u>TCT theory (Transpiration Cohesion Tension theory)</u>

1. It is a theory proposed by Dixon and Joly (1894) to explain the mechanism of Ascent of sap.
2. It is a physical force theory. According to this, living cells are not involved in ascent of sap.
3. Water has two properties - adhesion & cohesion. Due to adhesion the water molecules stick to the walls of xylem. Due to cohesion, they stick to each other and form a continuous unbroken column of water from root to leaf.
4. When transpiration takes place, water is lost from the mesophyll cells of leaves, it results

   in transpiration tension / transpiration pull (decreased water potential). To compensate the loss, mesophyll draws water

   from the veins and veins from the midrib



Path of ascent of sap in response to transpiration pull.

5. The combined deficiency of all the leaves makes them draw water from the xylem vessels of stem. Thus there is movement of water from stem to leaf, root to stem soil to root. The combined negative force is called transpiration pull.

Merits:

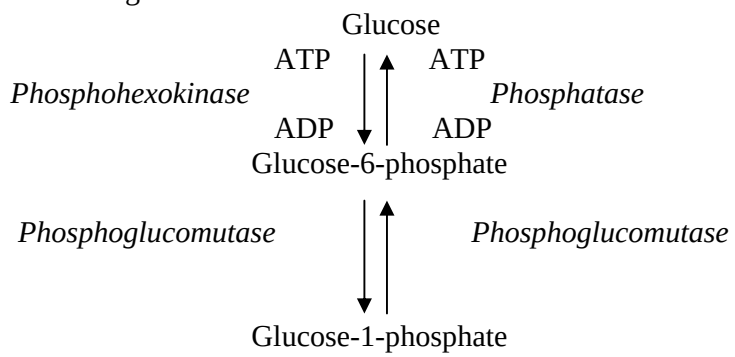
1. It is the most accepted theory and according to this theory, transpiration is the guiding force of ascent of sap. It does not require metabolic energy.
2. Transpiration pull can create a tension of up to –80 bars which is enough to hold the water column in the tallest tree.
3. Dead xylem elements provide low resistance to water movement than living cells.
4. Water column due to cohesive force that is built is very strong and unbreakable.
5. Rate of transpiration is equal to the rate of absorption of water.

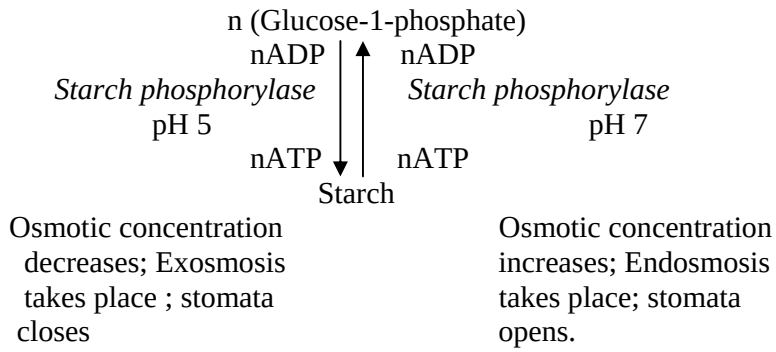
Demerits:

1. The theory supports the idea that tracheids are more efficient than trachea in conducting water since their transverse walls provide stability. But in advanced plants, tracheids are replaced by trachea. The evolutionary trend does not support the theory.
2. Xylem exhibits a process called cavitation due to the formation of gas bubbles. Cavitation results in a break in the water column which prevents ascent of sap. Water column may also break due to freezing or mechanical breakage.

Q. Starch Hydrolysis theory

1. It was proposed by Sayre (1923), **Steward** (1964) and others to explain the mechanism of stomatal movement. It was first proposed by **Lloyd (1908)**.
2. According to this theory, opening & closing of stomata is due to inter-conversion of starch and sugar





3. During night time, in the absence of light, CO_2 present in the guard cells dissolve in the

cytoplasm to form carbonic acid. The pH of the guard cells becomes acidic.

4. The enzyme phosphohexokinase converts glucose into glucose-6-phosphate. This is further converted to glucose-1-phosphate in the presence of enzyme phosphoglucomutase.

5. In the acidic pH, the enzyme **'starch phosphorylase'** converts glucose-1-phosphate molecules into starch. Stomata is osmotically inactive. So, osmotic concentration of guard cells decrease; exosmosis takes place & stomata close

6. During day time, in the presence of sunlight, carbonic and dissociates to form CO_2 and

water. The pH of guard cells increases to 7. In the increased pH, the enzyme starch phosphorylase converts the starch into glucose-1-phosphate. This is further converted to glucose-6-phosphate in the presence of enzyme phosphoglucomutase. The enzyme phosphatase converts glucose-6-phosphate into glucose. In the presence of sunlight more glucose is synthesized. Osmotic concentration of guard cells increases due to this; endosmosis takes place & stomata open.

Antitranspirant:

It is a substance which reduces the rate of transpiration without affecting the other physiological processes. It can be a physical barrier or a physiological one.

Physical barrier:

It is applied over the leaf surface to block the stomatal openings. Such antitranspirant should be permeable to gases and should allow penetration of light. Materials like liquid paraffin, silicon oil, colour less plastic, low viscosity waxes etc., has been tried as physical antitranspirant.

Physiological antitranspirant:

Chemicals like aspirin, hormones like abscissic acid, oxyethylene, decenyl succinic acid, aspirin, fungicides like phenyl mercuric acetate are known to cause partial closure of stomata when applied on leaves. Thus, they can be used as physiological antitranspirants.

B 5. BIOENERGETICS

One mark questions:

Q. Define photosynthesis

Ans

Photosynthesis is an anabolic process during which simple carbohydrates like glucose is produced by using raw materials like CO_2 and water in the presence of sunlight and chlorophyll

2 mark questions

Q. Write a note on RQ:

RQ or respiratory quotient is the ratio of volume of CO_2 released to the volume of O_2 consumed during respiration. It is also called respiratory ratio.

So, $$RQ = \frac{\text{Volume of } CO_2 \text{ released}}{\text{Volume of } O_2 \text{ consumed}}$$

The value of R Q varies according to the food substrate being utilized.

When carbohydrate is the respiratory substrate, the value of RQ is **one**.

When protein / fat is the respiratory substrate, the value of RQ is **less than one**.

When organic acid is the respiratory substrate, the value of RQ is **more than one**. E.g., Oxalic acid, Malic acid etc.,

R Q value of human diet is 0.85

R Q value of fermentation is infinity.

Q. Significance of Photosynthesis: -

Ans

1. It is a mechanism of synthesis of organic compounds from inorganic raw materials.
2. It converts radiant energy to chemical energy.
3. Organisms that perform photosynthesis are called producers. They are the initial link of many food chains. The consumers consume them.
4. Plants yield many photosynthesis derived products like oil, gum, timber etc.,
5. They reduce percentage of CO_2 and reduce green house effect.
6. They increase percentage of O_2. They purify air by taking CO_2 and releasing O_2. Thus plants are called lungs of nature.

Q Differences between light and dark reaction:

Ans:

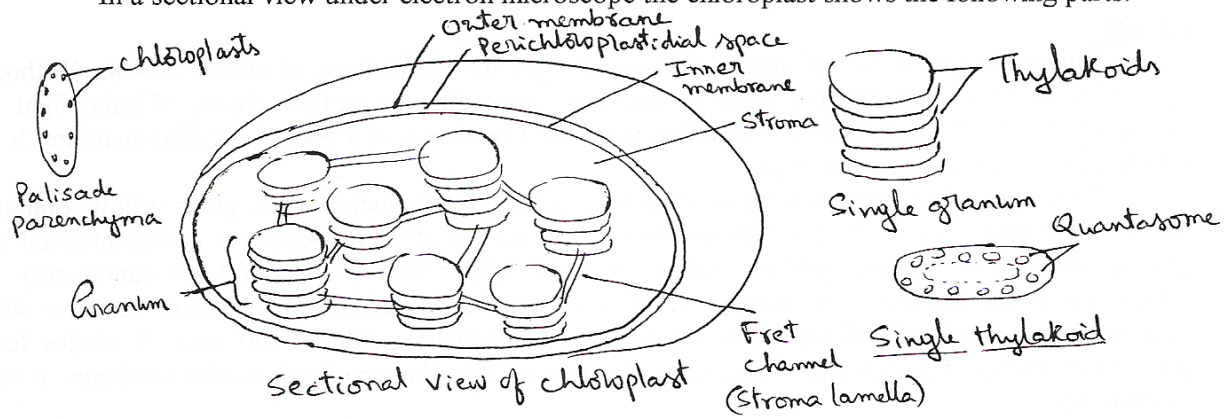
Light reaction	Dark reaction
1. Light reaction is a light – dependent process .	1. Dark reaction is light independent.
2. It takes place during daytime	2. Can be carried out during day/night time .
3. It takes place in the grana of chloroplast	3. Takes place in the stroma of the chloroplast.
4. Two important reactions namely Photophosphorylation and Photolysis of water take place. They require light and water as inputs.	4. Carboxylation and hydrogenation processes are followed by condensation step to yield glucose as the product.
5. ATP and $NAPH_2$ are produced with O_2 as byproduct	5. Products of light reaction are utilized to produce when CO_2 is fixed.
6. Does not require Carbon dioxide .	6. Requires carbon dioxide.

5 mark questions:

Q. Ultra structure of Chloroplast:

chloroplasts are membrane bound organelles found on the cells of leaves, shoot tip etc; the process of photosynthesis takes place inside the chloroplast.

In a sectional view under electron microscope the chloroplast shows the following



1. chloroplast is covered by 2 membranes- outer and inner membrane. The membranes enclose a cavity called stroma. Dark reaction of photosynthesis takes in the stroma region of chloroplast.
2. stroma encloses number of plate like structures piled one above the other. Each such group is called Granum. Each granum is made up of plates called thylakoids. Thylakoids are membranous and disc like. Light reaction of photosynthesis takes place in the grana region of chloroplast. The acceptors and enzymes of light reaction are present here
3. Each thylakoid encloses number of pigments. These photosynthetic pigments are arranged in functional groups called quantasomes/ photosynthetic units. Each quantosome contains around 250 chlorophyll and carotenes.
4. The grana are connected to each other by fret channel/ stroma lamellae.

Q.

Factors affecting the rate of Photosyntheses :-

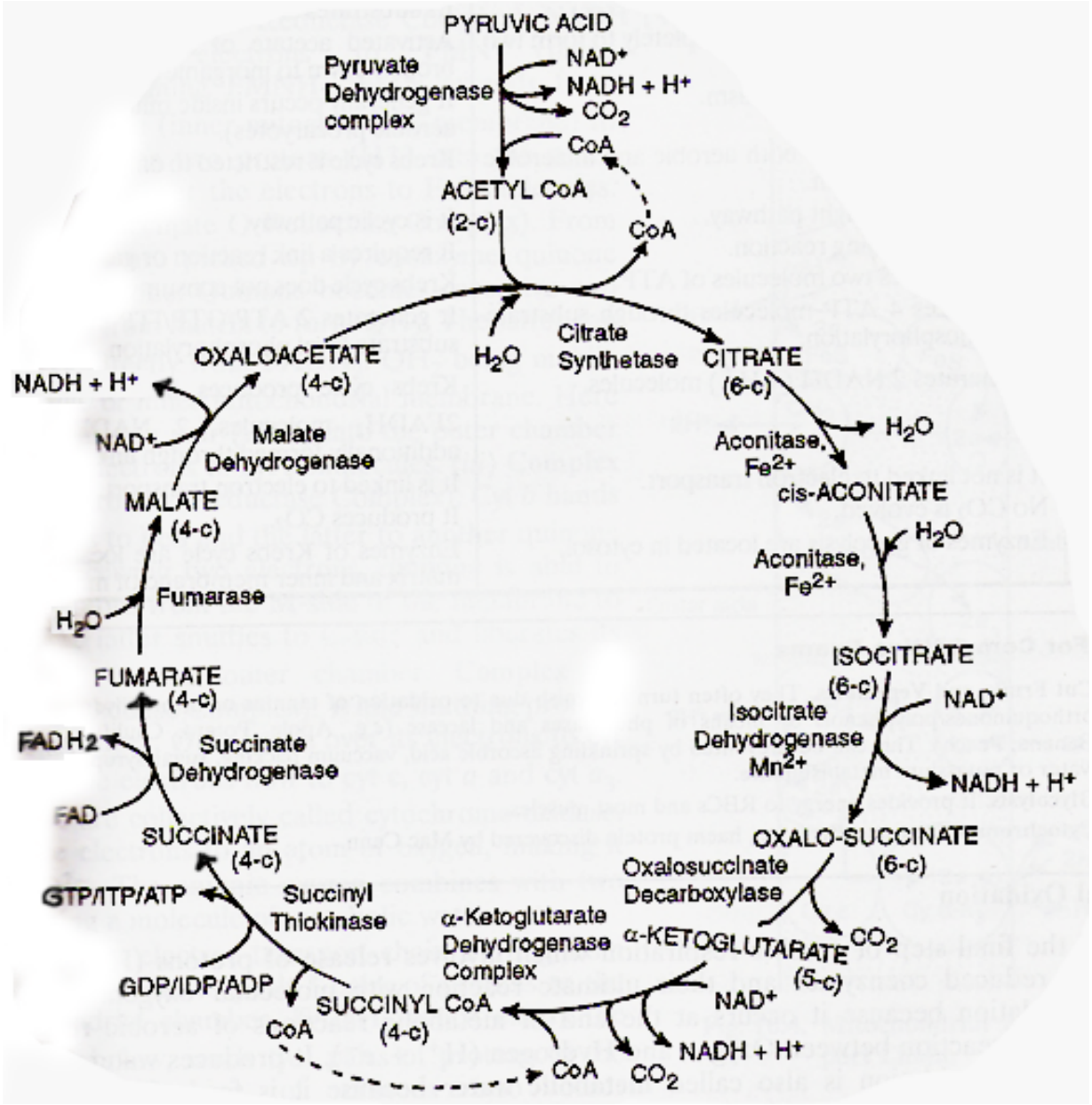
Ans:

1. Light: - Light is required for the excitation of Chlorophyll molecules. The intensity, quality and duration of the light decide the rate of photosynthesis. As the intensity increases, up to an optimum level, photosynthetic rate also increases. Maximum utilization of energy takes place in the Red and blue region of visible spectrum. Light between 400-700nm wavelength constitutes the photosynthetically active radiation (PAR). Infrared and ultra – violet light adversely affects the plants.

2. Temperature: - Photosynthesis takes place a rapid rate between 10^0 to 35^0 C. For every 10^0 rise in temperature up to 35^0 C, the rate of photosynthesis almost doubles. Afterwards, the rate falls. Very high temperature results in solarization. It refers to oxidation of chlorophyll pigments in the presence of high intensity sunlight. High temperature also leads to inactivation of enzyme. At high temperature, photorespiration is also activated.

3. Carbon dioxide :- Since CO_2 is constantly present in the atmosphere , it does not seriously affects photosynthesis . Increase in CO_2 level up to an optimum (0.5 %) level increases the rate of photosynthesis. But very high concentration of CO_2 is toxic to plants.
4. Soil water: - Less than 1% of total water absorbed is utilized for photosynthesis . When H_2O becomes a limiting factor, the turgidity of stomatal cells is lost and the stomata close. Thus the entry of CO_2 stops and photosynthesis is affected.
5. Chlorophyll: Chlorophyll-a is the important pigment required to perform light reaction. In case of variegated leaves, it is observed that non-green part of leaf fails to perform photosynthesis.
6. Oxygen : Oxygen inhibits photosynthesis in C_3 plants. This is called Warburg's effect.
7. Minerals: Mineral elements like Mg, Fe, Cu, Cl, Mn, P etc., are associated with important reactions of photosynthesis. Therefore, deficiency of these minerals ultimately reduces the rate of photosynthesis.
8. Air pollutants: Dust, smoke, fly ash, CO, Oxides of nitrogen and sulphur reduce the rate of photosynthesis by reducing light, clogging stomata and inhibiting electron transport, enzymes and other components of photosynthesis.
9. Age of leaves: Ageing of leaves reduces the chlorophyll content and causes the deactivation of the enzymes. This leads to reduced photosynthesis.
10. Hormones: Cytokinins, auxins and gibberellins stimulate photosynthesis. Abscissic acid reduces the rate of photosynthesis more commonly by causing closure of stomata.

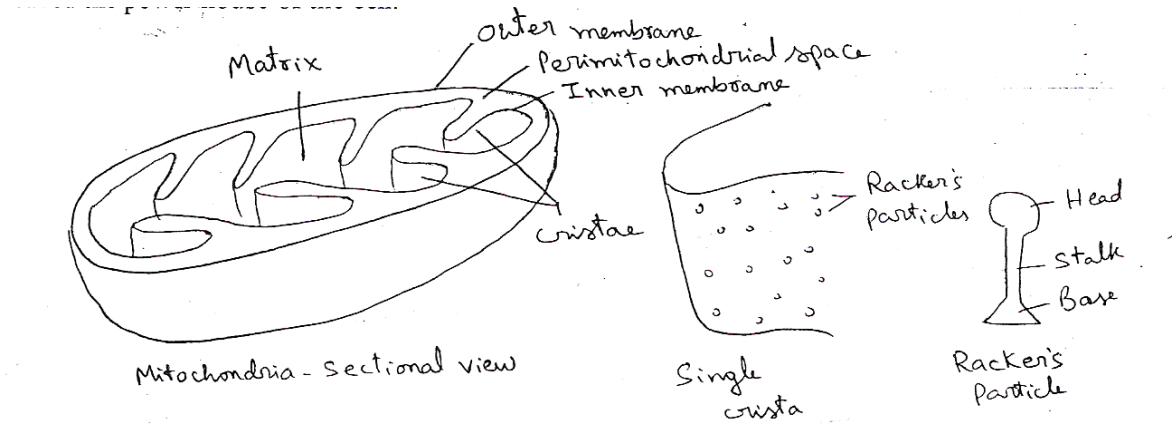
Q.Kreb's cycle / Citric acid cycle / TCA (Tricarboxylic acid) cycle:



Q. Ultra structure of Mitochondria(Chondriosomes): -

Mitochondria were first discovered by Kolliker (1880) and named by Benda (1897).

Features : They are present in all eukaryotic cells. They are of various shapes and sizes and number. The number of mitochondria in a cell varies depending the metabolic state of the cell. A sea-urchin egg consists of 13,000- 15,000 mitochondria. Plant cells contain less mitochondria. Mitochondria are called the power house of the cell.



Mitochondria are bound by double membrane. A perimitochondrial space is present between two membranes. The outer membrane is smooth and inner membrane is folded inwards to form cristae. The cristae contains Racker's particle / elementary particles. Each elementary particle is made up of a basal plate, a stalk and a head. Cristae enclose mitochondrial matrix. The matrix contains DNA, RNA and enzymes for cellular respiration.

Mitochondria performs Kreb's cycle (Citric acid cycle / TCA cycle)- the second step of cellular respiration. It takes place in the matrix of mitochondria. Racker's particles are involved in terminal oxidation where energy-rich particles like $NADH_2$ and $FADH_2$ get oxidised to produce ATP – the energy currency of body.

Functions :

1. It is the centre of cellular oxidation. It oxidises the carbohydrates and fats completely to yield ATPs.
2. When ribosomes are associated with the outer membrane of mitochondria, they are involved in protein synthesis.

Q.Applications of fermentation:

1. **Production of beverages:**
   Low alcohol drinks like beer, whisky, wine, cider, toddy etc., is produced by fermenting malt/ molasses in the presence of *Saccharomyces cerevisiae* (Yeast)
2. **Production of industrial alcohol :**
   Ethanol / industrial alcohol is used as a solvent in many industries. It is one of the important products of fermentation. It is obtained from fermentation of molasses (byproduct of sugar industry) by using strains of *Saccharomyces cerevisiae*.
3. **Production of lactic acid:**
   Lactic acid is a raw material for production of plastics, calcium lactate etc., Lactic acid is obtained from fermentation of molasses using *Lactobacillus* variety of bacteria.
4. **Production of acetone, butanol:**

Substances like molasses, potato, corn etc., are fermented using *Clostridium* bacteria to obtain acetone and butanol. Acetone is used in the manufacture of explosives whereas butanol is used in automobiles.

5. **Fermentation technology in baking industry:**
   Baker's yeast leavens the dough and makes it fluffy. During baking, alcohol and CO_2 evaporate and the bread becomes spongy.
6. **Dairy industry:** Curd is formed from milk by fermentation activity of Lactobacillus acidophilus. The bacterium changes milk sugar lactose into lactic acid. It coagulates milk protein casein and converts milk into curd. Products like yogurt, butter milk and cheese are all formed by fermentation by bacteria.
7. **Curing:** Tea and tobacco leaves; coffee and cocoa beans loose their bitterness and develop aroma due to fermentation by bacteria.
8. **Organic acids:** Fermentation by microbes yield organic acids like citric acid, gallic acid, gluconic acid etc.,
9. **Ensilage:** It is preserved fodder. The preservation is carried out by fermentative activity of bacteria.
10. **Cleaning of hides:** When raw hides are immersed in water, fermenting bacteria bring about decomposition of tissue fats and hair attached to them.
11. **Retting of fibres:** Plant fibres like jute are separated from soft tissues through bacterial fermentation.
12. **Supplementary respiration:** Anaerobic respiration supplements aerobic respiration during periods of oxygen deficiency.
13. **Regulation of activity:** Accumulation of lactic acid during anaerobic respiration reduces activity.

Q.

Factors affecting the rate of respiration:

1. **Temperature:**
   Respiration is maximum at about $25^0 – 35^0$ C . At low temperature, respiration is retarded due to lowered enzyme activity. At high temperature, enzymes get degraded and respiration is retarded.
2. **CO_2 concentration:**
   At high CO_2 concentration, stomata closes and leads to reduced O_2 availability. In fruits, increased CO_2 levels induce dormancy. This helps in storage.
3. **Light:**
   Blue light is known to reduce respiration by influencing cyto b and cyto a / a_3 complex.
4. **Moisture:**
   Respiration is minimum in dry seeds where moisture content is 12- 18%.
5. **Mechanical stimulation and injury:**
   Injury or infection increases the rate of respiration. It is meant for mobilization of resources and providing energy for correcting stress condition.
6. **Inorganic salts:**
   Absorption of inorganic salts requires energy. This energy is mobilized by increased respiration in root cells. This is called salt respiration.
7. **Inhibitors:**
   Cyanides, CO, azides etc., inhibit various types of enzymes and inhibit respiration.
8. **Hormones:**
   Auxins, cytokinins, gibberellins increase respiration whereas ABA depress respiration.
9. **Oxygen:**

The availability of Oxygen is directly proportional to the rate of aerobic respiration.

10. **State of cell:**
    Meristematic cells show high rate of respiration when compared to mature cells. They contain more amount of protoplasm. They require more energy for cell division and show high metabolic activity.
11. **Respiratory substrate:**
    Within limits, the rate of respiration rises with the availability of respiratory substrate.
12. **Age:**
    Respiration is high at the time of seed germination, flower formation and fruit formation as compared to vegetative phase.

B 6. GROWTH AND GROWTH REGULATORS IN PLANTS

2 mark questions:

Q.Physiological effects of auxins :

Ans:

1. **Cell division and elongation**: Auxin induces cell division and differentiation in the cambium. Thus it is responsible for success in grafting, wound healing, internodal elongation etc.
2. **Apical dominance** : As long as terminal / apical bud is present, axillary buds do not sprout. This is called apical dominance. When the apical bud of a plant is removed, the axillary buds present in the leaf axil will sprout. It is caused by auxins.
3. **Prevention of abscission** : Flowers and young fruits fall prematurely due to the formation of a corky tissue called abscission layer. The phenomenon is called Abscission. Auxins prevent the formation of abscission layer.
4. **Tropism** : Tropism refers to movement of the plant parts under the influence of light (**phototropism**), gravity (geotropism) or water (**hydrotropism**). The shoot tip bends towards unilateral direction of light since auxins are inactivated by light (photoinactivation).In roots, auxins show inhibitory action and thus cause positive **geotropism** / gravitropism.
5. **Fruit development** : Pollination and fertilization in a flower results in embryo formation. Embryo is the source of auxins and the auxins induce fruit formation.

Q. Practical application of ethylene :

Ans

1. Induces ripening of fruits in apple, mango, Banana, etc. Thus, fruits can be made to ripe earlier than their normal course by spraying ethylene (ethepon).
2. Induces **synchronized flowering in pineapple** plants
3. It can be used to **break dormancy of storage organs like tubers**, rhizomes, corms, bulbs etc.,.
4. It can be sprayed on fruits like orange to remove chlorophyll pigment **(degreening)**. This will increase the market value of fruits.