**Light Reaction**

**Steps of Light Reaction:**

1-Light absorption.

2-Photolysis of water.

3-Electron transport and photophosphorylation.

Q (primary electron acceptor)

 Q

 2e\_

 PQ

 2e\_ 2e\_

2e\_ Cytochrome bf

 Complex 2e\_

 Fd

 2e\_

 PC 2e\_

 NADP+

 2e\_ NADP2e +2H+

 (reductase)

 NADPH+

p680 p700 H+

**2-Calvin Cycle/Dark Reaction**

The series of reactions catalysed by respective enzymes by which the carbon is fixed and reduced in the synthesis of sugar during the dark reaction of P/S is called Calvin cycle.

3CO2 + 6NADPH + 9ATP (CH2O)3 + 6NADP + 9ADP + 9Pi + 3H2O

**Steps of Dark Reaction:**

**1-Carboxylation**

RuBP + CO2 3PGA

**2-Reduction**

3PGA 1,3 bis PGA G3P

**3-Regeneration**

G3P Ru5B RuBP

 CO2



(Glyceraldehyde 3 Phosphate) G3P

 Glucose and other organic matter  containing a large number of chloroplast. The bundle sheath is surrounded by many layers of mesophyll cells. The cells of mesophyll also contain chloroplast but these are of smaller size than those present in the cells of bundle sheath because the bundle sheath surrounds the vascular tissue all around, therefore the substances that move b/w mesophyll cells and vascular tissue must pass through the bundle sheath. The chloroplast of mesophyll cell in C4

Plants are without Rubisco (ribulose 1, 5\_bisphosphate carboxylase oxygenise) this

Anatomical arrangement of cell is called KRANZ ANATOMY

**C4\_ Pathway**

1. Carboxylation PEP in mesophyll cells.
2. OAA is reduced into malate or aspirate.
3. Malate or aspirate is translocated to bundle sheath cells.
4. Malate is decarboxylated (CO2 in B.S.C).
5. The process of Calvin cycle in B.S.C.
6. P.A transported back to mesophyll

**Mesophyll ` Bundle sheath cells** .

PEP=phosphoenol private, OAA = oxaloacitic acid

**Significance of C4  cycle**

 The significance of C4 cycle lies in high CO2 affinity of PEP carboxylase which enables this enzyme to act at low concentration than Rubisco carboxylase. When C4 plants are illuminated in an air tight container, they can lower the eternal CO2 concentration to 0\_5 PPm, while C3 plants can lower it only to 50\_70 PPm. Another characteristic of C4 plants is that they are efficient in their use of water, being able to synthesize 2\_4 time more dry matter per unit mass of water transpirated then C3 plants.C4 metabolism may be regarded as an adaptation to warm climates. The conservation of ATP per molicules of CO2 over and above the ATP required in the C3 cycle alone. The C4 cycle is advantageous under condition where CO2 is limiting rather than light and the C4 species are native to tropical and subtropical habitats where high irradiance and high temperature would tend to bring about CO2 limitation.

**CAM Plants**

A third group of plants fix CO2 by CAM, crassulacean acid metabolism. Due to this these are known as CAM plants. The CAM plants are mainly succulent of hot and arid climates; the name is derived from the family crussulaceae, which contains many succulent members. Although CAM is by no means confined to this family, e.g. cacti (family cactaceae) are CAM plant.

**Characteristics**

**Structural**

1. They have thick succulent leaves.
2. They have very low surface to volume ratio.
3. They have very low transpiration rate.

**Cellular adaptation**

1. The cells of these plants have very large control vacuole.
2. They have very thin layer of cytoplasm around the vacuole.
3. They have lack of palisade mesophyll arrangement.
4. Most of the leaves and stem cell of these plants have spongy mesophyll cells.
5. In these plants B.S.C are present but similar to mesophyll cells.

**Stomatal Behaviour**

 Stomata remain close during the day time while open during night time.

**Biochemical adaptation**

 During night time CO2 fixed by PEP carboxylase as in C4 plants into malate but malate is stored in vacuoles. The p/s cells of CAM plants typically possess large vacuoles and the vacuoler PH fall steeply at night (dark acidification) during the day time malate disappears and is converted into CO2 and starches, the CO2 is refined via Calvin cycle. Biochemically CAM resembles C4 P/s but where as in C4 plants CO2 fixation by PEP carboxylase and RUBP carboxylase occur, simultaneous but separated in space, in CAM plants the two enzymes act in the same cells, but sequentially separated in time. CAM is obviously an adaptation to hot and dry condition. It enables the plant to conserve water by keeping stomata close in the heat of the day when transpiration would be most rapid, and CAM plants are extremely economically on water. Their rate of net P/s per unit area of plant or ground, and their growth rate are however very low. The small surface to volume ratio of the succulent organs is un favourable for gas exchange.