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Subject ——— Botany

Semester ——— B.Sc. II

Paper ——— Photosynthesis (Dark reaction)

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Lecture No: 12

Dark reaction / C_3 cycle / Calvin cycle / Blackman's reaction

Dark reaction of photosynthesis occurs in the stroma of the chloroplast. As the reaction does not require the presence of light that is why it is called as dark reaction or non photochemical reaction.

The existence of dark reaction of photosynthesis was investigated by Blackman. Thus in his honour this dark reaction is also called as Blackman reaction.

The details of the dark reaction were investigated in connexion with C_3 plants by Calvin and his coworkers (1951; 1955) with the help of a tracer technique and paper chromatography.

The following are the steps involved in the synthesis of sugar during dark reaction in C_3 plants.

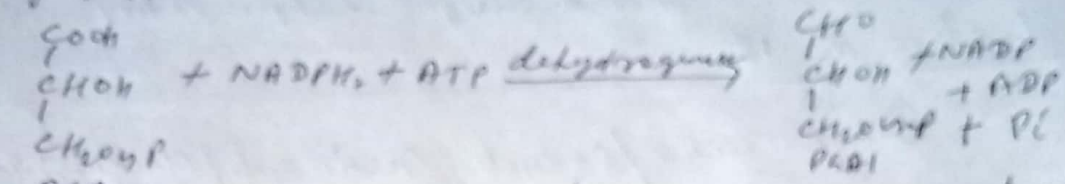
A (I) Fixation of CO_2 :-

In this step a molecule of CO_2 is accepted by a molecule of Ribulose diphosphate (RuDP). This reaction is catalysed by the enzyme "Carboxy dis mutase". A molecule of water is also consumed in this reaction. The result of this reaction is the formation of two molecules of PGA. (phosphoglyceric acid).

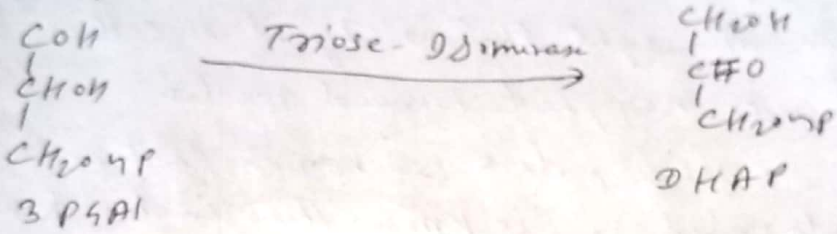
$$\begin{matrix} CH_2OP \\ | \\ C=O \\ | \\ (CHOH)_2 \\ | \\ CH_2OP \end{matrix} + CO_2 + H_2O \xrightarrow[\text{dis mutase}]{\text{Carboxy}} 2 \begin{matrix} COOH \\ | \\ CHOH \\ | \\ CH_2OP \\ \text{PGA} \end{matrix}$$

II. Reduction of PGA into PGAL :-

The reduction of a molecule of PGA requires a molecule of $NADPH_2$ and a molecule of ATP. The enzyme which catalyses the reaction is dehydrogenase. The result of the reaction is the formation of a molecule of PGAL.

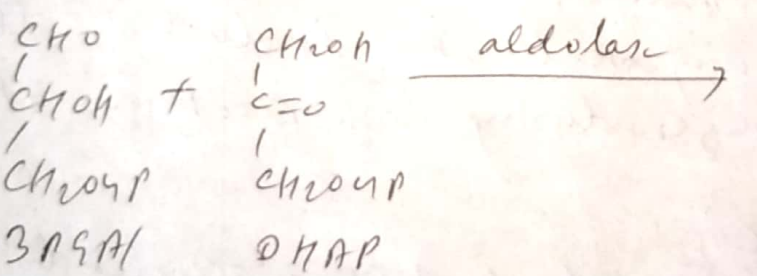


Out of two molecules of PGAL so formed one is isomerised into dihydroxy acetone phosphate.

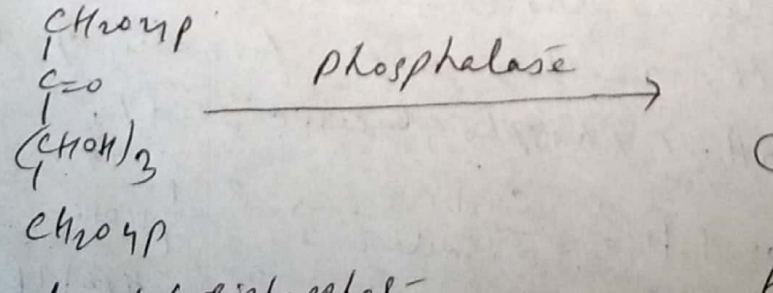


III. Formation of Sugar

Now a molecule of PGAL and a molecule of dihydroxy acetone phosphate reacts in the presence of enzyme "aldolase" to form a molecule of Fructose 1,6 diphosphate.



Thereafter this fructose 1,6 diphosphate loses a phosphate radical from C-I to form fructose-6 phosphate in the presence of enzyme "phosphatase".

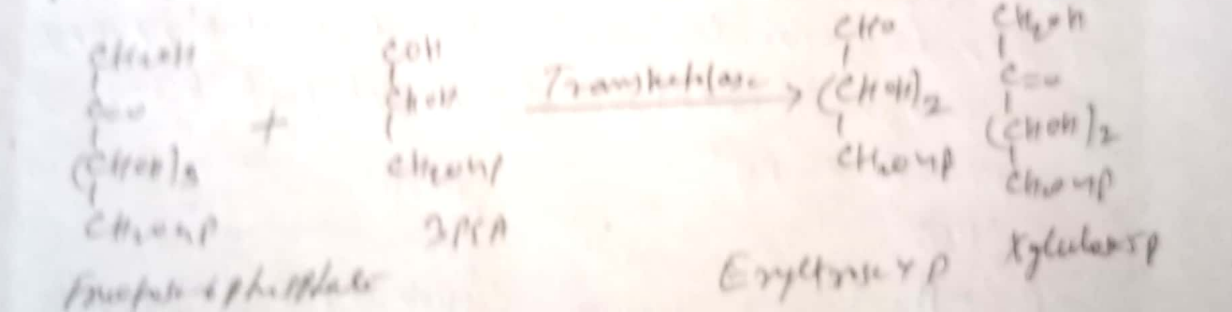


Now this fructose 6 phosphate is isomerised into glucose 6 phosphate by the influence of enzyme hexose isomerase. This glucose 6 phosphate is then converted into glucose 1 phosphate.

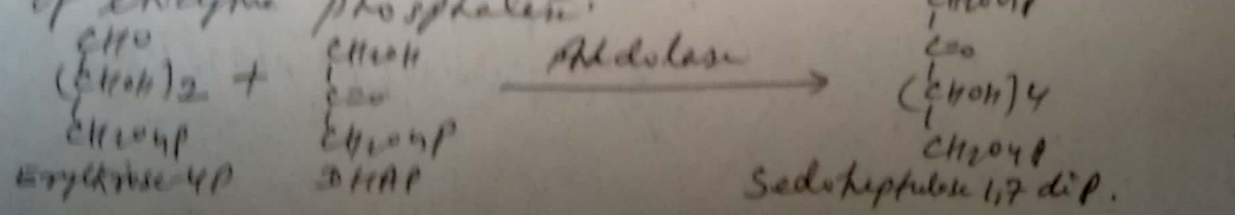
This glucose 1 phosphate reacts with ATP and UTP in the presence of enzyme ADP glucose phosphorylase to form ADP glucose and UDP glucose respectively. This ADP glucose and UDP glucose give sucrose residue. This sucrose is the first stable sugar in the photosynthesis. Ultimately this sucrose is converted into starch.

B. Regeneration of Co2 acceptor

During regeneration reaction, first of all a molecule of fructose 6 phosphate reacts with a molecule of 3PGAL in the presence of enzyme transketolase. The reaction results into the formation of Erythrose 4 phosphate and Xylulose-5 phosphate.



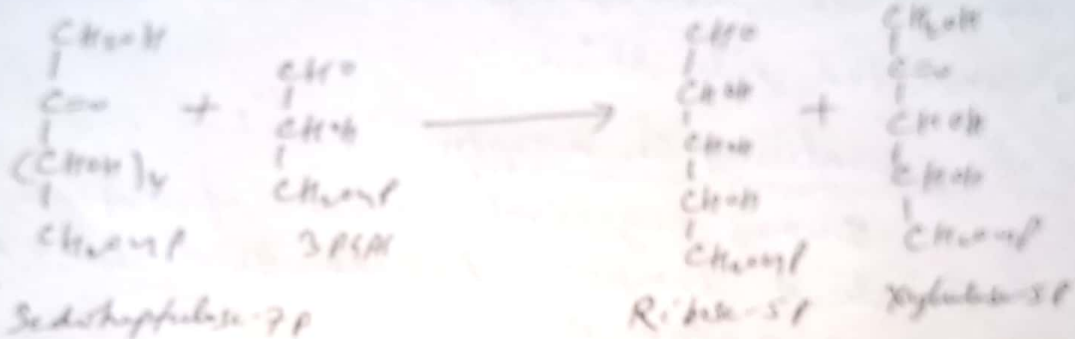
There after this erythrose-4 phosphate reacts with a molecule of Dehydroxy acetone phosphate in the presence of enzyme "aldolase". It from Sedoheptulose 1,7 diphosphate. This Sedoheptulose 1,7 diphosphate loses one of its phosphate radical from Carbon no. 1. under the influence of enzyme phosphatase.



Sedo heptulose 1,7 diphosphate

Sedo heptulose 7 P.

Now this Sedo heptulose 7 phosphate reacts with a molecule of TPGAL in the presence of enzyme "transketolase". This reaction results into the formation of a molecule of Xylulose-5 phosphate(5C) and Ribose-5 phosphate.

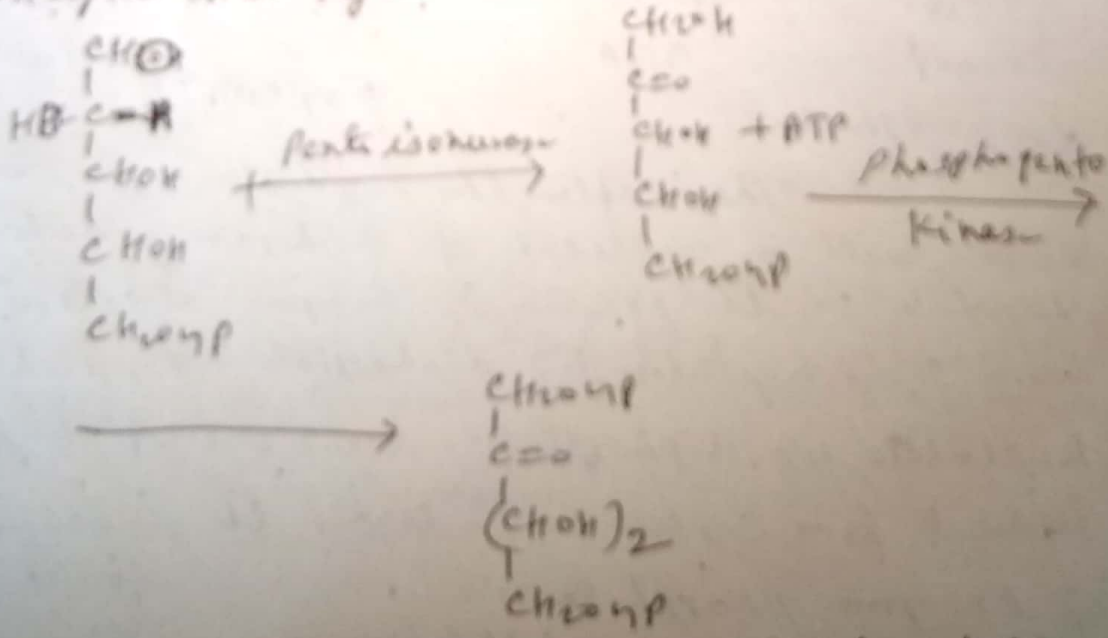


Sedoheptulose-7P

Ribose-5P

Xylulose-5P

This ribose-5P is then isomerised into ribulose-5 Phosphate in presence of enzyme pentoisomerase. The ribulose-5 phosphate reacts with a molecule of ATP to generate ribulose 1,5-diphosphate (RuDP). The reaction is catalysed by phosphopentokinase enzyme and Mg^{++}.



Ribulose, 1,5 diphosphate.