

Calvin cycle and pentose pathway: Chap 20. (I will not ask any questions from this chapter as there is not much time for you to grasp all the materials and produce them in the exam.

Photosynthesis occurs in two parts.

1. Light reactions transform light energy into ATP and NADPH.
2. Dark reactions use ATP and NADPH to synthesize hexoses from carbon dioxide.

Calvin cycle synthesizes hexoses from CO₂ (Fig. 20.1)

Three stages:

- a) fixation of CO₂ by ribulose 1,5-bisphosphate to form two molecules of 3-phosphoglycerate.
- b) Reduction of 3-phosphoglycerate to form hexoses.
- c) regeneration of ribulose 1,5-bisphosphate.

CO₂ fixation: Ribulose bisphosphate carboxylase/oxygenase (Rubisco)

Stage 1: Ribulose 1, 5- bisphosphate is converted to a high energy enol intermediate that reacts with CO₂ forming an unstable 6 carbon intermediate that breaks down to produce two molecules of 3-phosphoglycerate. Page 591. This enzyme has eight large subunits that have catalytic and regulatory sites and eight small subunits that stimulate the catalytic activity of large subunits. It is the most abundant protein in biosphere. You must know the reaction in Fig. 20.4 bottom of p 592 .

(oxygenase reaction is a wasteful reaction Fig. 20.5. Do not worry about it).

Stage 2: 3-phosphoglycerate is converted into fructose 6-P, which then isomerizes to glucose 1-P and glucose 6-P (hexose phosphate pool). The steps are as outlined for gluconeogenesis except for glyceraldehyde-3-phosphate reaction which requires NADPH in chloroplast (unlike the cytosolic enzyme that uses NADH)

Stage 3 : Regeneration of ribulose 1,5-bis P: Figure. 20. 9. It uses two important enzymes – aldolase and transketolase.

Transketolase :

Fructose 6-P + glyceraldehyde-3-P → erythrose 4-P + Xylulose 5-P

Aldolase:

erythrose 4-P + dihydroxyacetone P → Sedoheptulose-1,7-BisP

phosphatase hydrolyzes Sedoheptulose-1,7-BisP to Sedoheptulose-7-P

transketolase:

Sedoheptulose-1,7-BisP + glyceraldehyde-3-P → ribose-5-P + Xylulose-5-P

Phosphopentose isomerase converts ribose-5-P and Xylulose-5-P to ribulose -5-P.

Phosphoribulokinase finally makes ribulose-1.5-bisP from ribulose-5-P.

Pentose phosphate pathway: Important

ATP is first form of cellular currency. The reducing power of NADH and NADPH are the second form of cellular currency. Many endergonic pathways notably reductive biosynthesis of cholesterol and fatty acids require NADPH in addition to ATP.

NADPH and NADH **are not interconvertible**. NADH is used for oxidative phosphorylation and NADPH is used for reductive biosynthesis.

How does cell generate the required NADPH? It is done by hexose monophosphate shunt. Also called pentose pathway. Fig. 20.18. Tissues involved in lipid biosynthesis use this pathway mostly. There are three stages to the pathway:

Stage I

Glucose 6 Phosphate dehydrogenase converts Glucose 6 Phosphate to 6-phosphogluconate using NADP as the cofactor. The resultant 6-phosphogluconate is converted to ribulose 5-phosphate by 6-phosphogluconate dehydrogenase with the production of another molecule of NADPH (and CO₂).



know the reactions

Stage II

Isomerization reactions – conversion of ribulose 5P to ribose 5P and xylulose 5P



Know the reactions

Stage III

C-C bond cleavage and formation:

Two molecules of Xylulose 5 phosphate and one molecule of ribose 5 phosphate are converted into two fructose 6 phosphate and one molecule of glyceraldehyde 3 phosphate.

This is important stage as five carbon skeletons are converted back to 6 carbon skeletons. The conversion of 3 pentoses to two hexoses and one triose involves the juggling acts of transaldolase and transketolase.

Transketolase transfers C2 units. A C2 from Xylulose 5P is transferred to Ribose 5P producing glyceraldehyde 3P and sedoheptulose 7P

Transaldolase transfers C3 unit from sedoheptulose 7P to glyceraldehyde 3P yielding erythrose 4P and fructose 6P.

A second transketolase transfers a C2 from a second molecule of Xylulose 5P to erythrose 4P to produce another molecule of Fructose 6P and one molecule of glyceraldehyde 3P. know the reactions.