Definition of phosphate pentose pathways

The pentose phosphate pathway (also called the phosphogluconate pathway and the hexose monophosphate shunt) is a metabolic pathway parallel to glycolysis. It generates NADPH and pentoses (5- carbon sugars) as well as ribose 5-phosphate, a precursor for the synthesis of nucleotides.



Description:

Pentose phosphate pathway also called **HMP pathway**that stands for Hexose Mono- Phosphate Pathway. It is very different from the other pathways, where it neither releases ATP nor consumes ATP during the process. It is a metabolic pathway that occurs in all types of cells and tissues.

In the liver, 30% of glucose is metabolized by the Pentose phosphate pathway. The HMP pathway primarily occurs in the **Cytoplasm**. It produces **NADPH**, whose 50% is utilized by the cells in the synthesis of fatty acids.

1. [Pentose Phosphate Pathway Steps](https://biologyreader.com/pentose-phosphate-pathway.html#PentosePhosphatePathwaySteps)
	* [Oxidative Phase](https://biologyreader.com/pentose-phosphate-pathway.html#OxidativePhase)
	* [Non-oxidative Phase](https://biologyreader.com/pentose-phosphate-pathway.html#Non-oxidativePhase)

Oxidative Phase

The oxidative phase of HMP pathway includes the following series of reactions:

**Step-1**: First, six glucose 6-phosphate molecules will oxidize into 6-phosphoglucolactone in the presence of six coenzyme NADP molecules. **Glucose 6-phosphate dehydrogenase** catalyzes the conversion of the first step in PPP (Pentose phosphate pathway) and results in the release of six NADPH2molecules.



**Step-2**: Then, the six 6-phosphoglucolactone molecules hydrolyze into 6-phosphogluconic acid by the water. **Lactonase** catalyzes this conversion.


**Step-3**: Later, six 6-phosphogluconic acid molecules undergo oxidative carboxylation into ribulose 5-phosphate in the presence of six NADP (coenzyme) molecules. An enzyme **phosphogluconic acid dehydrogenase** catalyzes this conversion. This step releases six NADPH2 molecules.



Non-oxidative Phase

**Step-4**: After that, six ribulose 5-phosphate molecules undergo isomerization by an enzyme **ribulose phosphate 3-epimerase** and **pentose phosphate isomerase** into four xylulose 5-phosphate molecules and two ribose 5-phosphate molecules, respectively.


**Step-5**: Then, two xylulose 5-phosphate molecules and two ribose 5-phosphate molecules combine to form 2 molecules each of sedoheptulose 7-phosphate and 3-phosphoglyceraldehyde. This reaction is catalyzed by **transketolase**.



**Step-6**: After that, two sedoheptulose 7-phosphate molecules and 3- phosphoglyceraldehyde molecules combine to form 2 molecules each of fructose 6-phosphate and erythrose 4-phosphate, respectively. This reaction is catalyzed by **transaldolase**.



**Step-7**: Then, a molecule of 3- phosphoglyceraldehyde isomerizes into dihydroxyacetone-phosphate by an enzyme **phosphotriose isomerase**.



**Step-8**: Then, a molecule of 3- phosphoglyceraldehyde combines with the dihydroxyacetone-phosphate and converts into fructose 1,6-biphosphate by an enzyme **aldolase**. Fructose 1, 6-biphosphate further converts into fructose 6-phosphate by an enzyme “**phosphatase**”.



**Step-9**: At last, five fructose 6-phosphate molecules convert into five glucose 6-phosphate molecules via an enzyme **phosphohexose isomerase**.



**Net production**: The net production in the HMP pathway includes six CO2molecules and 6 NADPH2molecules.

Significance

Pentose phosphate pathway is an **alternative pathway** for the carbohydrate degradation or breakdown as it directly oxidizes the glucose 6-phosphate without entering into the glycolysis cycle. Ribulose 5-phosphate being a primary acceptor of CO2, it participates in the**CO2 fixation** of the photosynthetic organisms during the Calvin-cycle. Ribulose 5-phosphate also helps in the synthesis of Riboflavin.

Another intermediate of PPP is ribose 5-phosphate, which helps in the **nucleotide** and**nucleic acid synthesis**. Erythrose 4-phosphate helps in the synthesis of**phenylalanine**,**tryptophan**, **tyrosine** etc. Sedoheptulose 7-phosphate helps in the synthesis of **heptoses** in the lipopolysaccharide layer of gram-negative bacteria.

The NADPH2 produced in the HMP pathway helps in the **reduction biosynthesis** of fatty acids, steroid hormones etc. The HMP pathway also plays an essential role in the RBCs to produce NADPH2, as they lack mitochondria. It is the only **cytoplasmic pathway** that generates NADPH2 as a sole energy source, but not ATP.