**Pentose phosphate pathway (PPP) or Hexose mono-phosphate (HMP) shunt**

• Pentose phosphate pathway is an alternative pathway to glycolysis and TCA cycle for oxidation of glucose.
• It is a shunt of glycolysis
• It is also known as hexose monophosphate (HMP) shunt or phosphogluconate pathway.
• It occurs in cytoplasm of both prokaryotes and eukaryotes
• Pentose phosphate pathway starts with glucose and it is a multi-steps reaction.



• The sequence of reactions are divided into two types.

I) oxidative reaction phase
II) Non-oxidative reaction phase

## http://www.onlinebiologynotes.com/wp-content/uploads/2017/09/oxidative.jpg

* First four reactions are irreversible and oxidative in which glucose molecule is oxidized twice generating two molecules of NADPH and glucose is converted into Ribose-5 phosphate.

**1st reaction: conversion of glucose to glucose-6 phosphate.**

* This reaction is catalyzed by the enzyme hexokinase and a molecule of ATP is utilized. This reaction is actually a primary step of glycolysis.

**2nd reaction: conversion of glucose-6 phosphate to 6-phosphogluconolactone.**

* This reaction is catalyzed by an enzyme glucose-6 phosphate dehydrogenase (G6PD) in the presence of Mg++ ion.
* In this reaction a molecule of NADPH is produced.

**3rd reaction: conversion of 6-phosphogluconolactone to 6-phosphogluconate**

* This reaction is a hydrolysis reaction catalyzed by hydrolase enzyme

**4th reaction: conversion of 6-phosphogluconate to ribose-5 phosphate**

* This reaction is catalyzed by the enzyme 6-phosphogluconate dehydrogenase to produce 3-keto-6-phosphogluconate which undergoes decarboxylation to produce ribulose-5 phosphate.
* In this reaction a molecule of NADPH is generated.

## Non oxidative phase:http://www.onlinebiologynotes.com/wp-content/uploads/2017/09/non-oxidative.png

* Oxidative reactions is followed by a series reversible sugar phosphate inter-conversion reaction.
* **Ribulose-5-phosphate** is epimerized to produce**xylulose 5-phosphate** in the presence of enzyme phosphor pentose epimerase. Similarly ribulose-5-phosphate is also keto-isomerized into ribose 5-phosphate.
* Xylulose-5-phsphate transfer two carbon moiety to ribose 5-phospahate in the presence of enzyme transketolase to form **sedoheptulose-7-phosphate** and **glyceraldehyde 3—phosphate.**
* Sedoheptulose -7-phosphate transfer three carbon moiety to glyceraldehyde -3-phosphate to form **fructose 6-phopsphate** and**erythrose 4-phosphate** in the presence of enzyme transaldolase.
* Transketolase enzyme catalyse the transfer of two carbon moiety from Xylulose-5-phsphate to erythrose-4- phosphate to form fructose-6-phosphate and glyceraldehyde-3-phosphate.
* Fructose-6-phosphate and glyceraldehyde-3-phosphate is later enter into glycolysis and kreb’s cycle.
* The rate and direction of reversible reaction depends upon the needs of cell.
* If cell needs only NADPH then fructose-phosphate and glyceraldehyde-3-phosphate are converted back to glucose by reverse glycolysis, otherwise converted to pyruvate and enter TCA cycle generating ATPs.

## Significance of Pentose phosphate pathway

* HMP is only the cytoplasmic pathway that generates NADPH
* NADPH is produced in this pathway acts as reducing agent during biosynthesis of various molecules eg. Fatty acids.
* This pathway generates 3, 4, 5, 6 and 7 carbon compounds which are precursors for biosynthesis of other molecules. eg nucleotides are synthesized from ribose-5-phsophate.
* Pentose phosphate pathway is very essential for cell lacking mitochondria (eg.RBCs) for generation of NADPH.
* Triose, tetrose, pentose, hexose and heptose sugar are generated as intermediate products in pentose phosphate pathway.
* NADPH is also used to reduce (detoxify) Hydrogen peroxide in cell.
* Resistance to malaria in some Africans are associated with deficiency of glucose-6-phosphate dehydrogenase enzyme because malarial parasites depend upon HMP shunt to reduce glutathione in RBCs.