The Pentose Phosphate Pathway
Functions of This Pathway:

- Provides ribose-5-phosphate for nucleotide biosynthesis
- Provides NADPH for fatty acid and cholesterol biosynthesis and photosynthesis
- Occurs in 2 stages: oxidative and non-oxidative
Oxidative Stage:

Glucose-6-phosphate $\rightarrow$ ribulose-5-phosphate

Non-Oxidative Stage:

ribulose-5-phosphate $\leftrightarrow$ fructose-6-phosphate

G-3-P

ribose-5-phosphate is an intermediate
Glu-6-PO\(_4\) D’hase

Glu-6-PO\(_4\) \(\rightarrow\) NADP\(^+\) \(\rightarrow\) NADPH

NADPH

6-phosphogluconolactonolactone

6-phosphogluconate

Oxidative Stage
NON-OXIDATIVE STAGE

• PROVIDES 5-CARBON SUGARS FOR BIOSYNTHESIS

• INTRODUCES SUGAR PHOSPHATES INTO GLYCOLYSIS OR GLUCONEOGENESIS
precursor to ribose in DNA and RNA

ribulose-5-phosphate

phosphopentose isomerase

ribose-5-phosphate

phosphopentose epimerase

xylulose-5-phosphate
**Transketolase:** transfers a 2-carbon unit from a ketose phosphate to an aldose phosphate

**Transaldolase:** Transfers a 3-carbon unit from a ketose phosphate to an aldose phosphate
xylulose-5-phosphate + ribose-5-phosphate → transketolase →

G-3-P + sedoheptulose-7-phosphate


\[ \text{fructose-6-phosphate} + \text{sedoheptulose-7-phosphate} \rightarrow \text{erythrose-4-phosphate} \]
xylulose-5-phosphate + erythrose-4-phosphate → fructose-6-phosphate
OVERALL REACTION:

$3 \text{GLUCOSE-6-PO}_4 + 6 \text{NADP}^+ + 3 \text{H}_2\text{O} \rightleftharpoons 6 \text{NADPH} + 6 \text{H}^+ + 3 \text{CO}_2 + 2 \text{FRUCTOSE-6-PO}_4 + \text{GAP}$
• G-3-P and Fructose-6-phosphate feed into glycolysis or gluconeogenesis

• Combining the generation of G-3-P and Fructose-6-phosphate by the pentose phosphate pathway with gluconeogenesis from these intermediates results in a cyclic pathway with stoichiometry of:

\[
6 \text{ glucose-6-phosphate} \\
5 \text{ glucose-6-phosphate} + 6\text{CO}_2 + 12 \text{ NADPH} + \text{Pi}
\]
• It takes 6 cycles of the pentose phosphate pathway and gluconeogenesis to convert 1 molecule of glucose-6-phosphate to $6\text{CO}_2$ with the concomitant generation of 12 NADPH molecules.

• When the need for ribose-5-phosphate is greater than the need for NADPH, G-3-P and fructose-6-PO$_4$ can be diverted from the glycolytic pathway for use in the synthesis of ribose-5-phosphate via reversal of the transaldolase and transketolase reactions.