

Pentose Phosphate Pathway 26/10/24

Hexose ^{or} Monophosphate Shunt ① (HMP SHUNT)

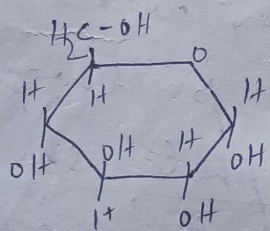
In normal pathway, glucose is oxidatively decarboxylated through glycolysis and kreb's cycle for ATP (Adenosine TriPoy) synthesis. But there exists another pathway of oxidative decarboxylation of glucose, which doesnot generate reduced NAD or ATP but generates reduced NADP and ribose-5-Poy. as intermediate metabolite. The end products of this pathway are Fructose-6-Poy and glyceraldehyde 3 Poy which are recycled for gluconeogenesis. This pathway is called Hexose Monophosphate shunt (HMP)

shunt or Pentose phosphate pathway. This pathway is very important for biosynthetic processes in the cells. This pathway is very important as the reduced NADP generated during the pathway is used for synthesis of Fatty acids, steroids and ribose-5-Poy is utilised for synthesis of nucleotides and nucleic acids. The enzyme system of this pathway is in the cytosol of the liver cells, adipose tissues, Mammary gland cells and steroidogenic cells of testis, ovary, placenta and adrenal cortex.

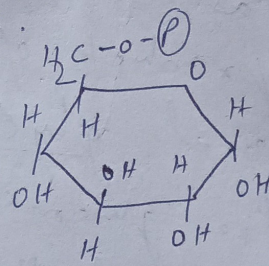
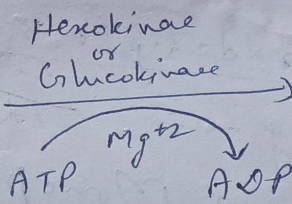
The HMP pathway though near some early reactions of glycolysis, is entirely different from glycolysis. The entire pathway involves

8 steps —

- (1) Phosphorylation of glucose — The enzyme hexokinase or glucokinase, as in glycolysis, brings about phosphorylation of carbon-6 of glucose. ATP in the presence of Mg^{2+} provides both phosphate and energy for phosphorylation. Three such glucose molecules are simultaneously used in this pathway, generating three molecules of glucose-6-P₄.



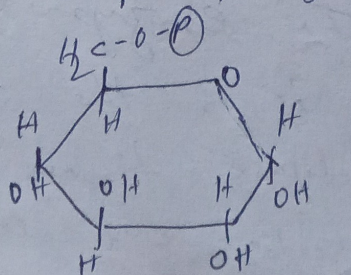
Glucose



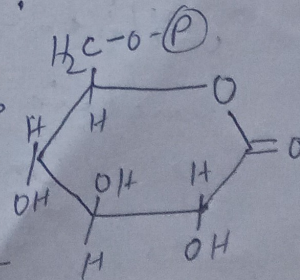
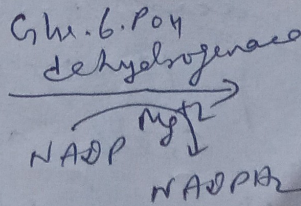
Glucose-6-P₄

- (2) Dehydrogenation of glucose-6-P₄ — Glucose-6-P₄ is

oxidised by the enzyme glucose-6-P₄ dehydrogenase. Carbon-1 of glucose-6-P₄ loses the hydrogen pair that goes to coenzyme NADP⁺ resulting NADPH₂ and also 6-phosphogluconolactone.

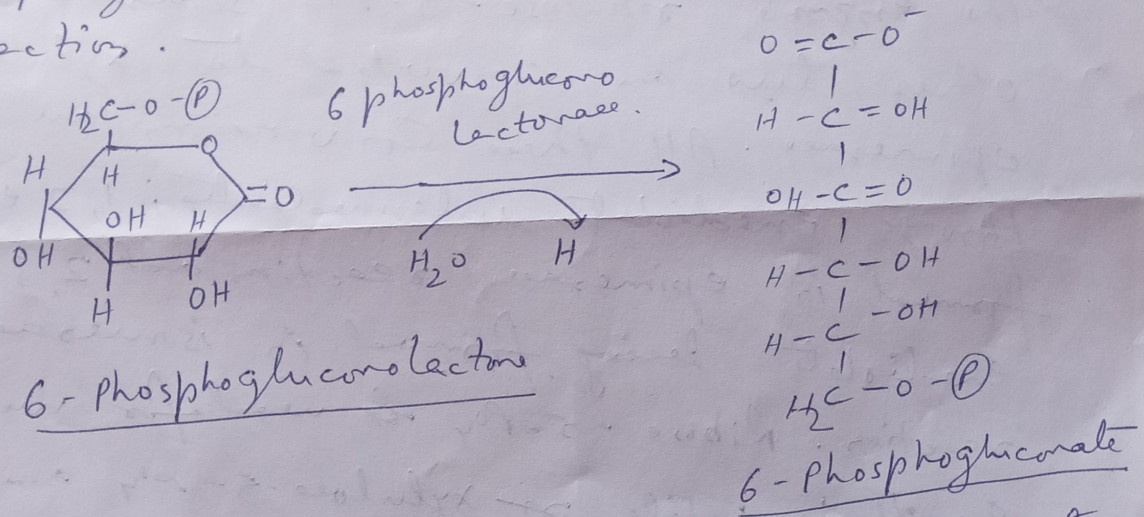


Glucose 6-P₄



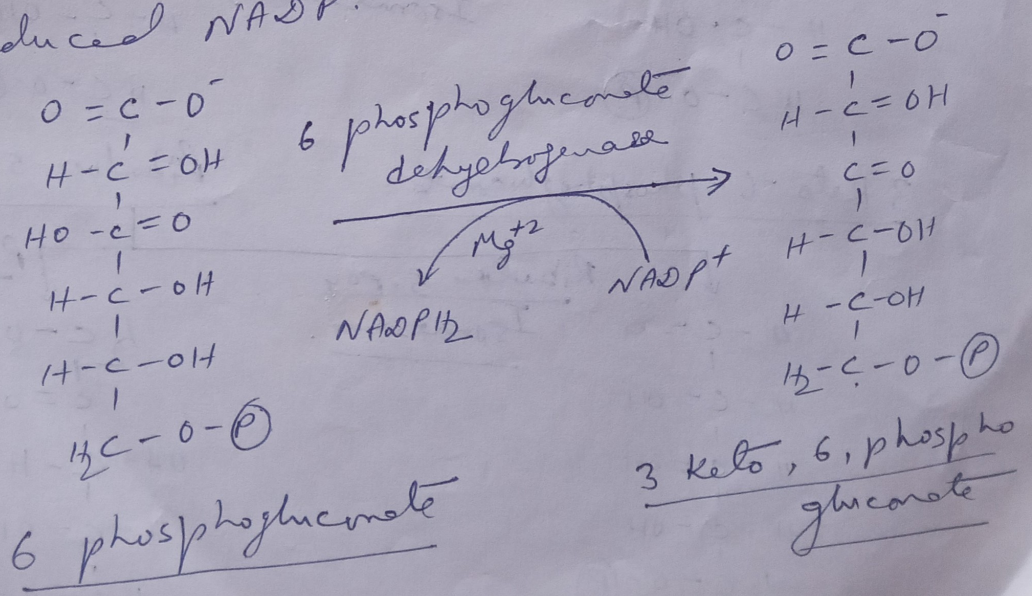
6-phosphogluconolactone

③ Hydrolysis of 6-phosphogluconolactone - Hydrolysis of 6-phosphogluconolactone to 6-phosphogluconate is a non-enzymatic reaction, but the enzyme 6-phosphogluconolactonase enhances the rate of reaction.

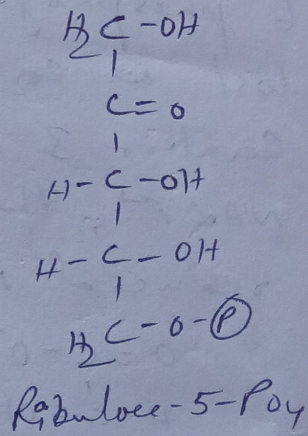
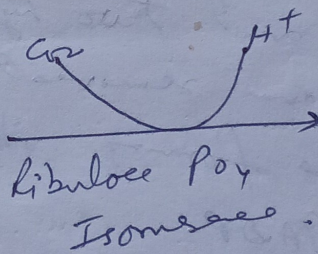
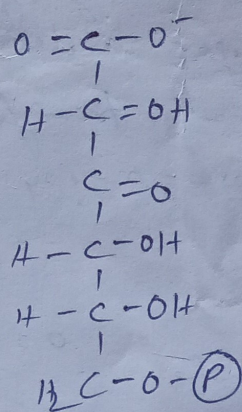


④ Oxidative decarboxylation of 6-phosphogluconate -

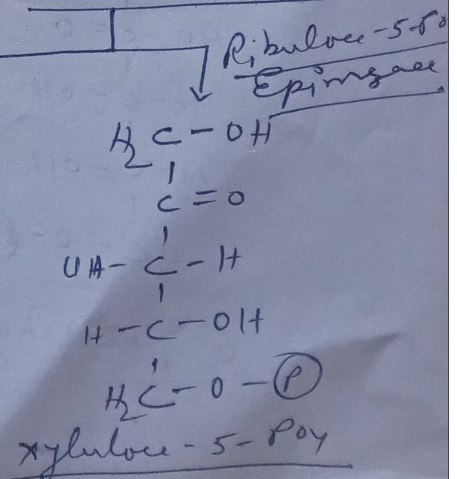
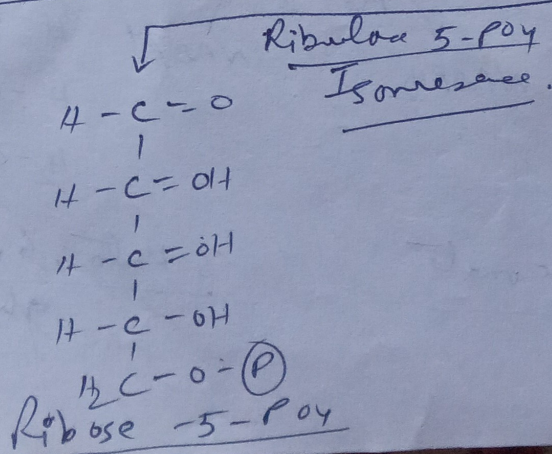
The enzyme 6-phosphogluconate dehydrogenase brings about oxidative decarboxylation of 6-phosphogluconate. The carboxyl group is lost as CO₂ and two hydrogens are removed and transferred to NADP⁺, thus forming ribulose-5-P_{4y} and reduced NADP.



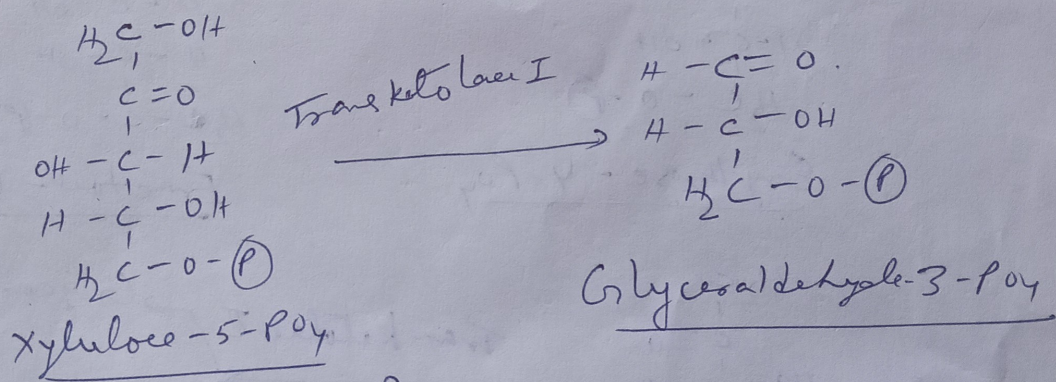
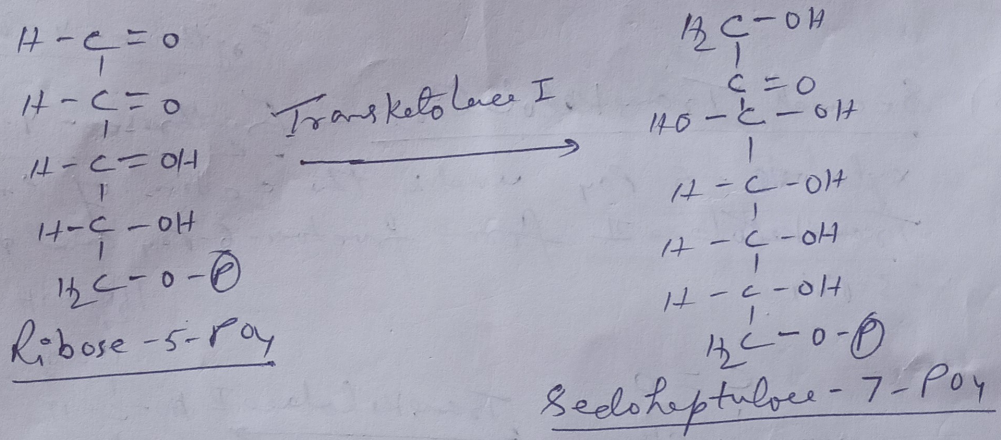
⑤ Isomerization and Epimerization of Ribulose-5-P₄ to Ribose-5-P₄ and Xylulose-5-P₄ → out of these ribulose-5-P₄ one is converted to ribose-5-P₄ by the enzyme ribulose-5-P₄ isomerase and other two are converted to xylulose-5-P₄ by epimerase. All these conversions are mediated through enediolate intermediates; 1,2-enediolate formed is epimerase reaction and 2,3-enediolate being formed is isomerase reaction. Ribose-5-P₄ is used for nucleotide synthesis while ~~or~~ xylulose-5-P₄ are used for synthesis of fructose-6-P₄ and glyceraldehyde-3-P₄ through transketolation and transaldolation reactions.



3 keto-6-phosphogluconate

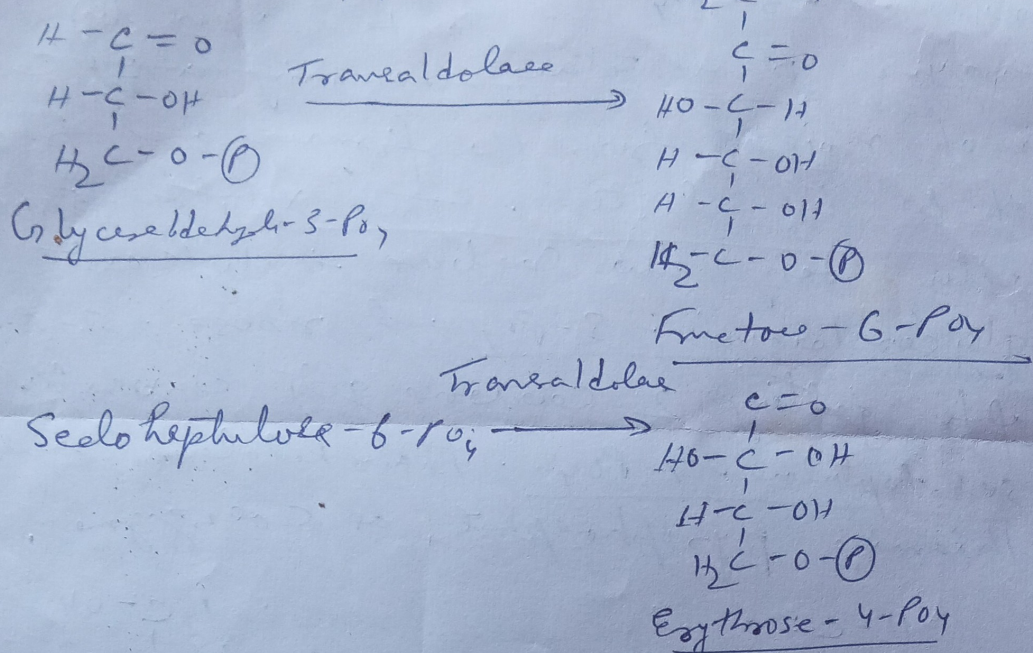


⑥ First Transketolation - The ribose-5-P₄ and one of two molecules of xylulose-5-P₄ are acted upon by the enzyme transketolase removing a 2 carbon moiety from the former and transfers it to the latter. Thus xylulose-5-P₄ after losing two carbons is left out as glyceraldehyde-3-P₄ and ribose-5-P₄ after getting 2 carbons gets converted to sedoheptulose-7-P₄. Transketolase requires thiamine pyrophosphate as coenzyme.

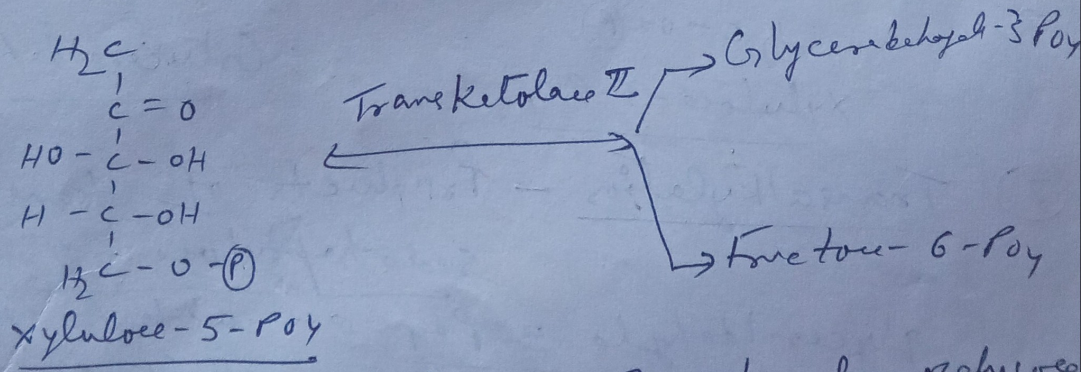
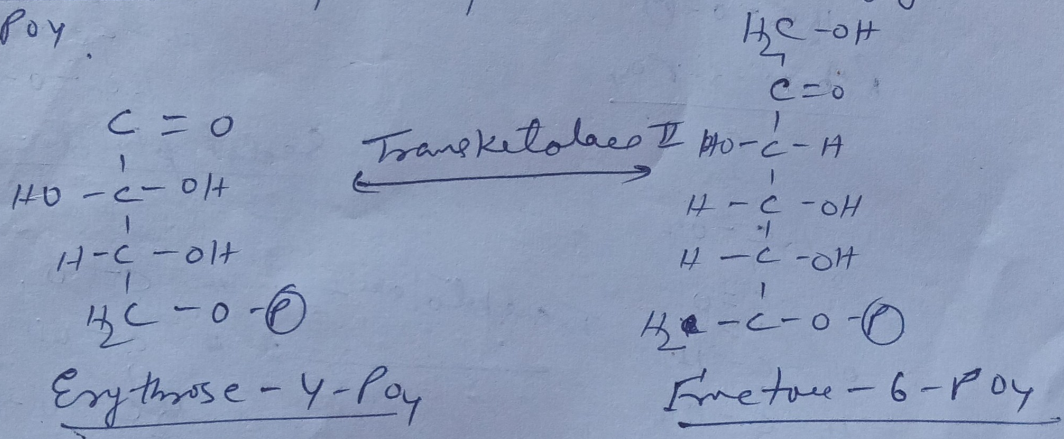


⑦ Transalkylation - Products of transketolations sedoheptulose-7-P₄ and glyceraldehyde-3-P₄ are acted upon by the enzyme transaldolase that removes a 3-carbon moiety from the former and transfers it to the latter, thus forming fructose-6-P₄. The sedoheptulose-7-P₄

after losing 3-carbon moiety is left out as erythrose-4-P₄.



⑧ Second Transketolations - Erythrose-4-P₄ & xylulose-5-P₄ under the action of enzyme Transketolase II forms fructose-6-P₄ and glyceraldehyde-3-P₄.



Hence, In this pathway, 3 molecules of glucose generate two molecules of fructose-6-P₄, one molecule of glyceraldehyde-3-P₄ and two molecules of NADP, besides releasing one CO₂.