GLYCOLYSIS

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WHAT IS GLYCOLYSIS?

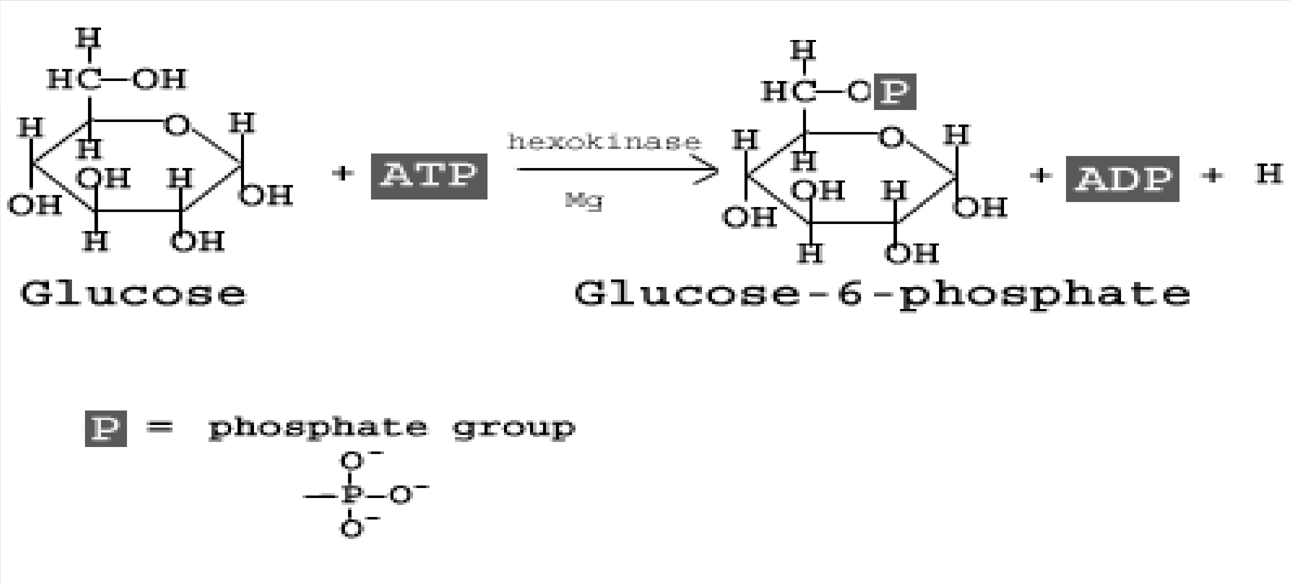
- Glycolysis is the metabolic process that serves as the foundation for both aerobic and anaerobic cellular respiration. In glycolysis, glucose is converted into pyruvate. The overall reaction of glycolysis which occurs in the cytoplasm is given as:
- $C6H12O6 + 2NAD_+ +2ADP\ 2P$ ----→2 Pyruvic acid + 2ATP +2NADH+ $2H_+$
- So what are the steps involves in glycolysis?

STEP 1: HEXOKINASE

The first step in glycolysis is the conversion of D-glucose into glucose-6-phosphate. The enzyme catalyzing this reaction is “hexokinase”. In this first step, the glucose ring is phosphorylated.

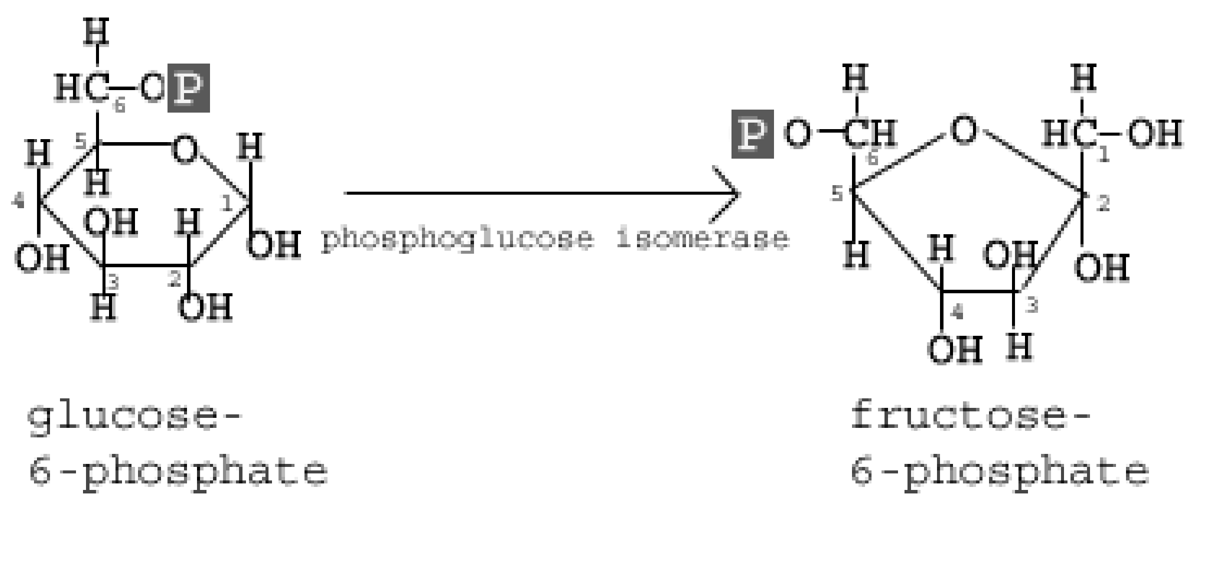
Phosphorylation is the process of adding a phosphate group to a molecule derived from ATP. As a result, 1 molecule of ATP has been consumed. Mg in the process, helps to shield the negative charges from the phosphate groups on the ATP molecule.

The result of this phosphorylation, is a molecule called glucose-6-phosphate(G6P).It is so called because the 6’ carbon of the glucose acquires the phosphate group.



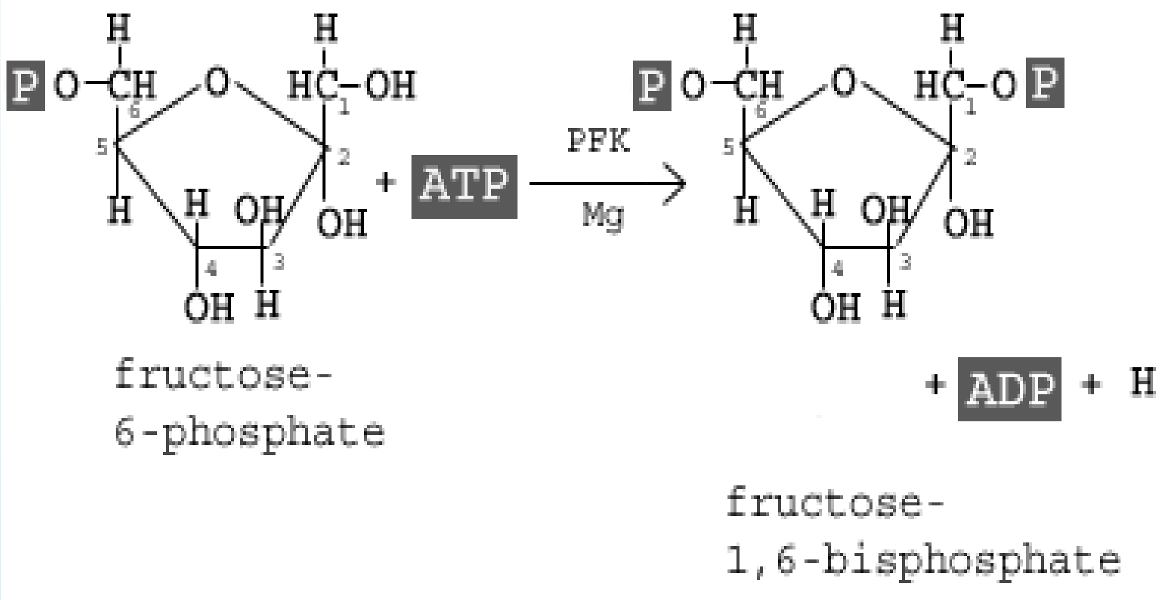
STEP 2: PHOSPHOGLUCOSE ISOMERASE

- The second step of glycolysis is the rearrangement of glucose-6-phosphate into fructose-6-phosphate(F6P) by an enzyme known as glucose phosphate isomerase (Phosphoglucose isomerase).
- As the name implies, this reaction involves an isomerization reaction. Here, the carbon-oxygen bond is rearranged to transform the six-mebered ring into a five-membered ring. This rearrangement occurs when the six-membered ring opens and then closes in such a way that the first carbon now becomes an extra ring.



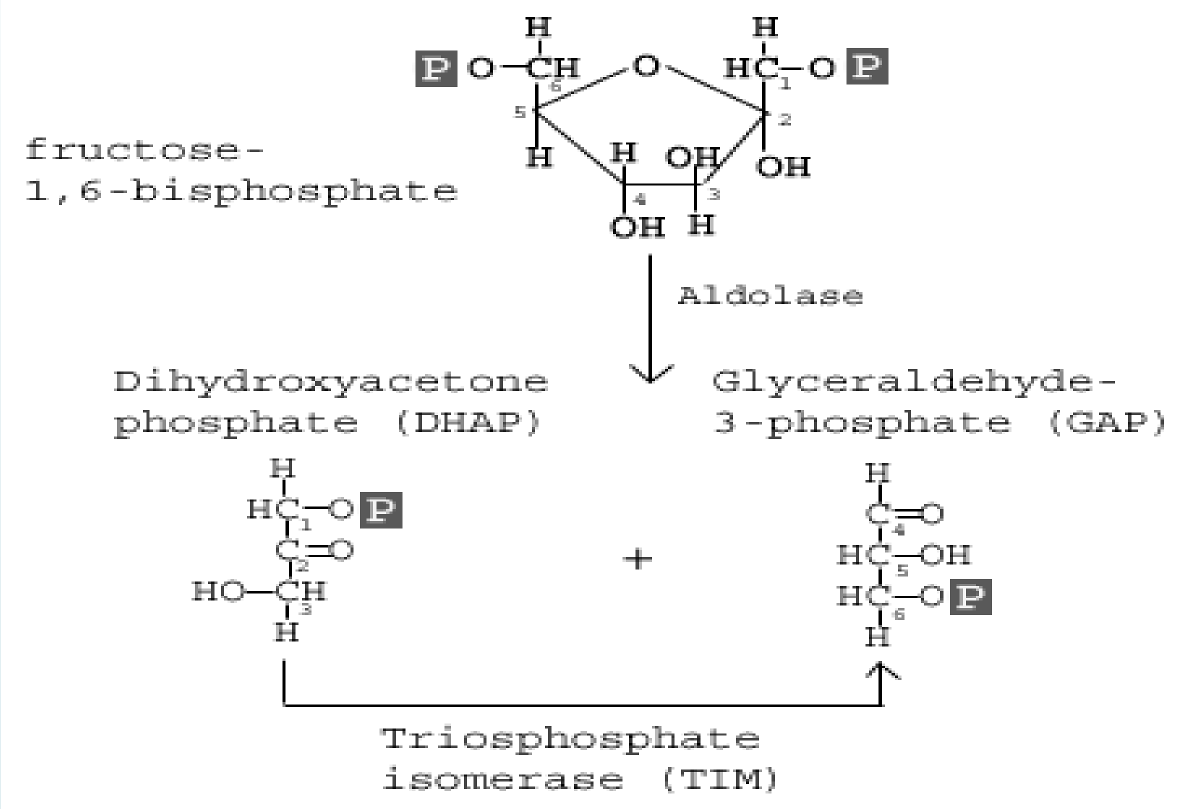
STEP 3: PHOSPHOFRUCTOKINASE

- Phosphofructokinase, with magnesium as a cofactor, changes fructose-6-phosphate into fructose 1,6-biphosphate.
- Similar to step 1, a second molecule of ATP provides the phosphate group that is added on the F6P molecule. The enzyme responsible for this is phosphofructokinase(FPK). Magnesium there helps to shield negative charges.



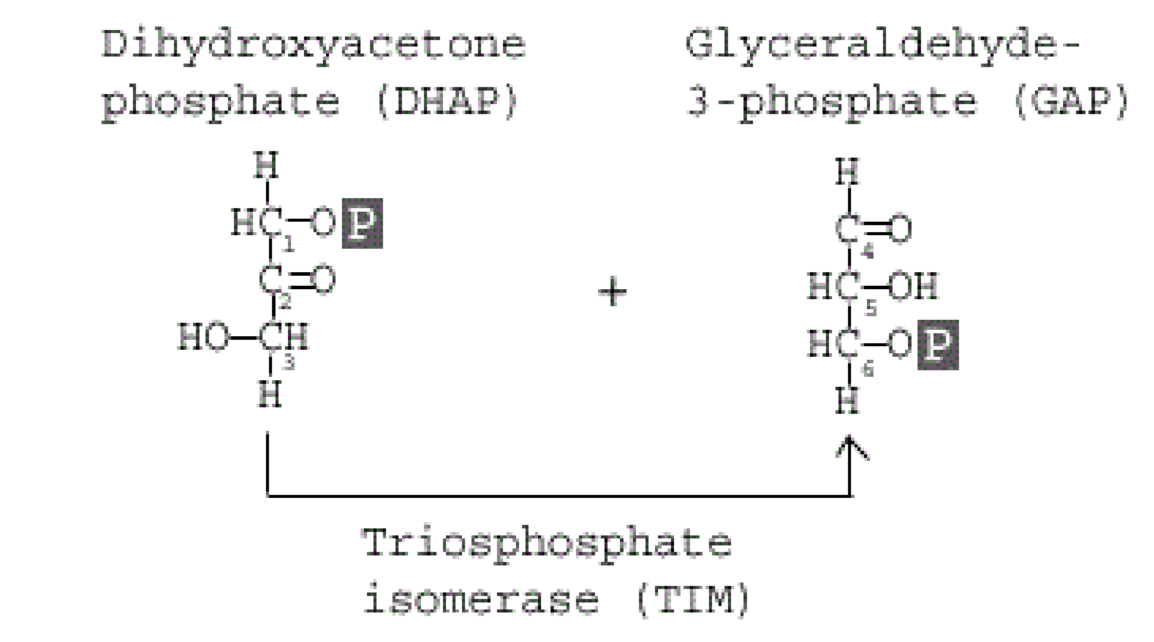
STEP 4: ALDOLASE

- This step utilizes the enzyme aldolase, which catalyzes the FBP to yield two 3-carbon molecules. One of these molecules is called glyceraldehyde-3-phosphate(GAP) and the other is called dihydroxyacetone(DHAP).
- The enzyme Aldolase splits fructose1,6-biphosphate into two sugars as stated above. These two sugars GAP and DHAP are isomers of each other.



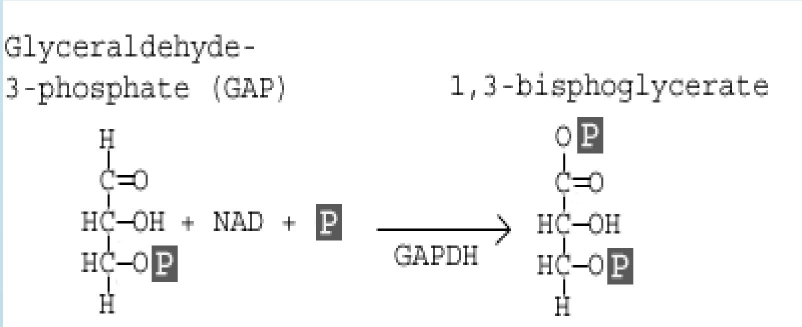
STEP 5: TRIOSEPHOSPHATE ISOMERASE

- GAP is the only molecule that continues in the glycolytic pathway. As a result of that, all DHAP molecules produced are further acted on by the enzyme Triosephosphate isomerase(TIM), which reorganizes the DHAP into GAP so it can continue in glycolysis.
- At this point in the glycolytic pathway, we have two 3-carbon molecules, but have not yet fully converted glucose to pyruvate.



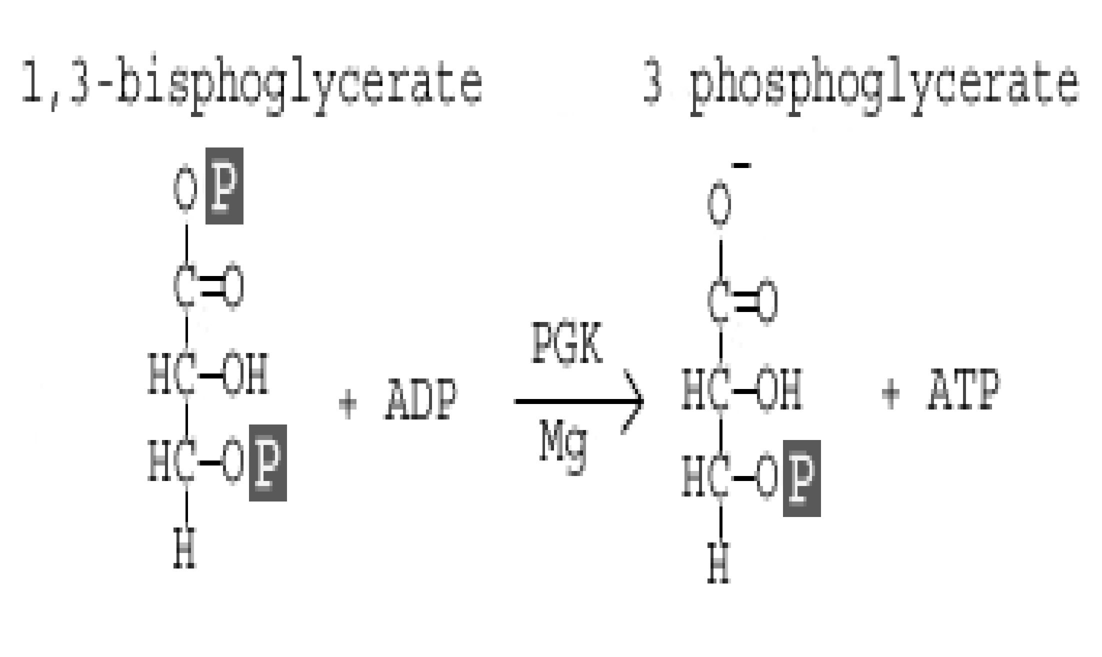
STEP 6: GLYCERALDEHIDE-3-PHOSPHATE DEHYDROGENASE

- In this step, two main events take place:
- Glyceraldehide-3-phosphate is oxidized by coenzyme nicotinamide adenine dinucleotide(NAD).
- The molecule is phosphorylated by the addition of a free phosphate group. The enzyme that catalyzes this reaction is glyceraldehyde-3-phosphate dehydrogenase(GAPDH).
- The enzyme GAPDH contains appropriate structures and holds the molecule in a conformation such that it allows the NAD molecule to pull a hydrogen off the GAP molecule, converting the NAD to NADH. The phosphate group then attacks the GAP molecule and releases it from the enzyme to yield 1,3-bisphoglycerate,NADH,and a hydrogen atom.



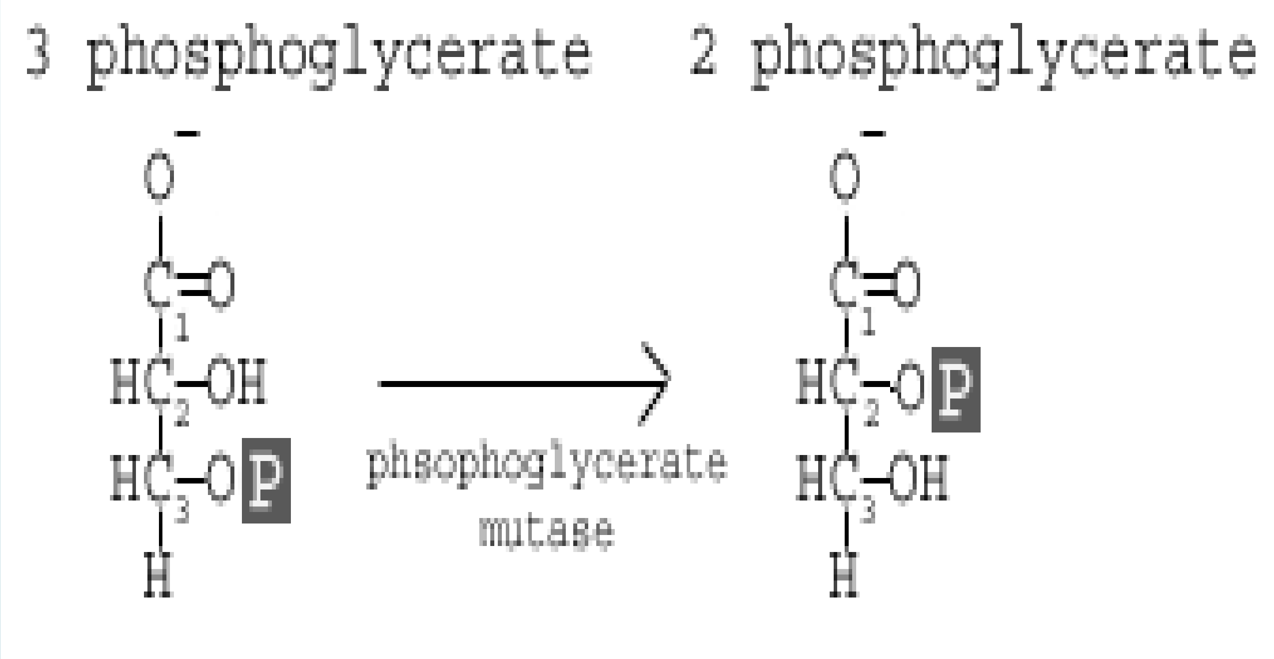
STEP 7: PHOSPHOGLYCERATE KINASE

- In this step,1,3 bisphoglycerate is converted to 3-phosphoglycerate by the enzyme phosphoglycerate kinase(PGK). This reaction involves the loss of a phosphate group from the starting material. The phosphate now is transferred to a molecule of ADP that yields our first ATP.
- Since we actually have two molecules of 1,3 bisphoglycerate,we actually synthesize two molecules of ATP at this step. With this synthesis, we have canceled the first two molecules of ATP that we used, leaving us with 0 molecules of ATP.



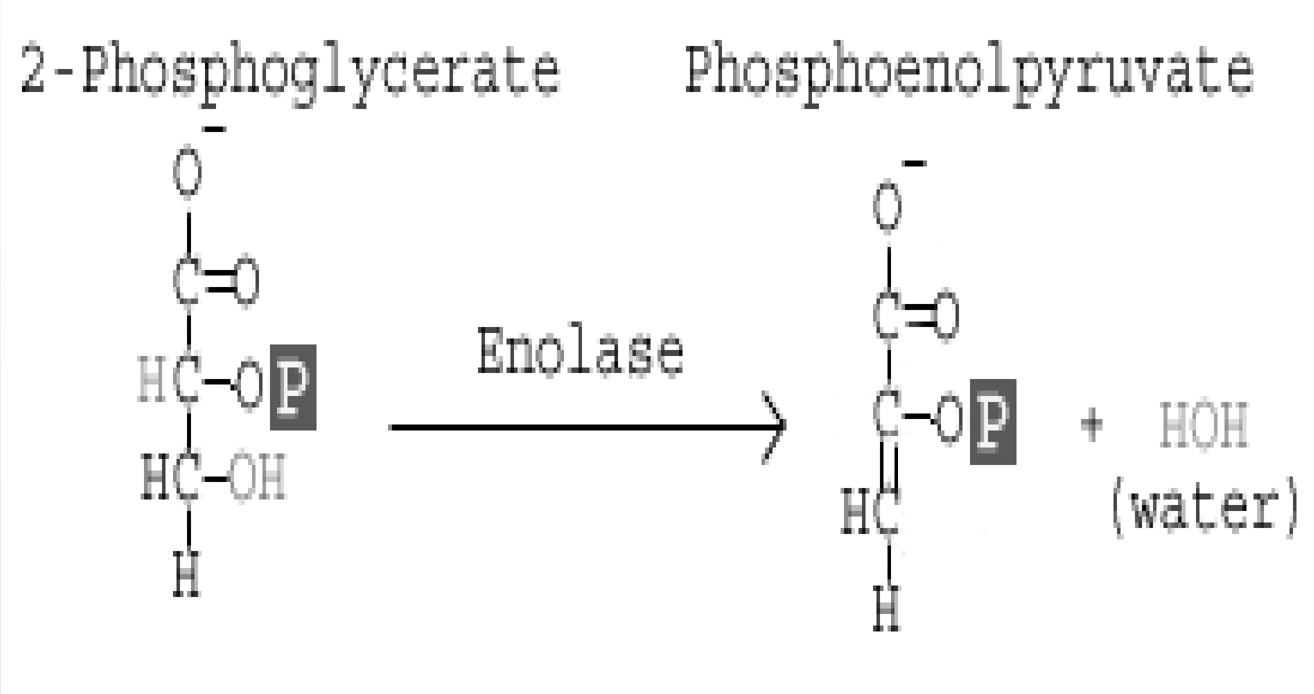
STEP 8: PHOSPHOGLYCERATE MUTASE

- The enzyme phosphoglycerate mutase(PGM) relocates the P from 3-phosphoglycerate from the third carbon atom to the second carbon atom to form 2-phosphoglycerate
- This step involves a simple rearrangement of the position of the phosphate group on the 3-phosphoglycerate molecule, making it 2-phosphoglycerate.



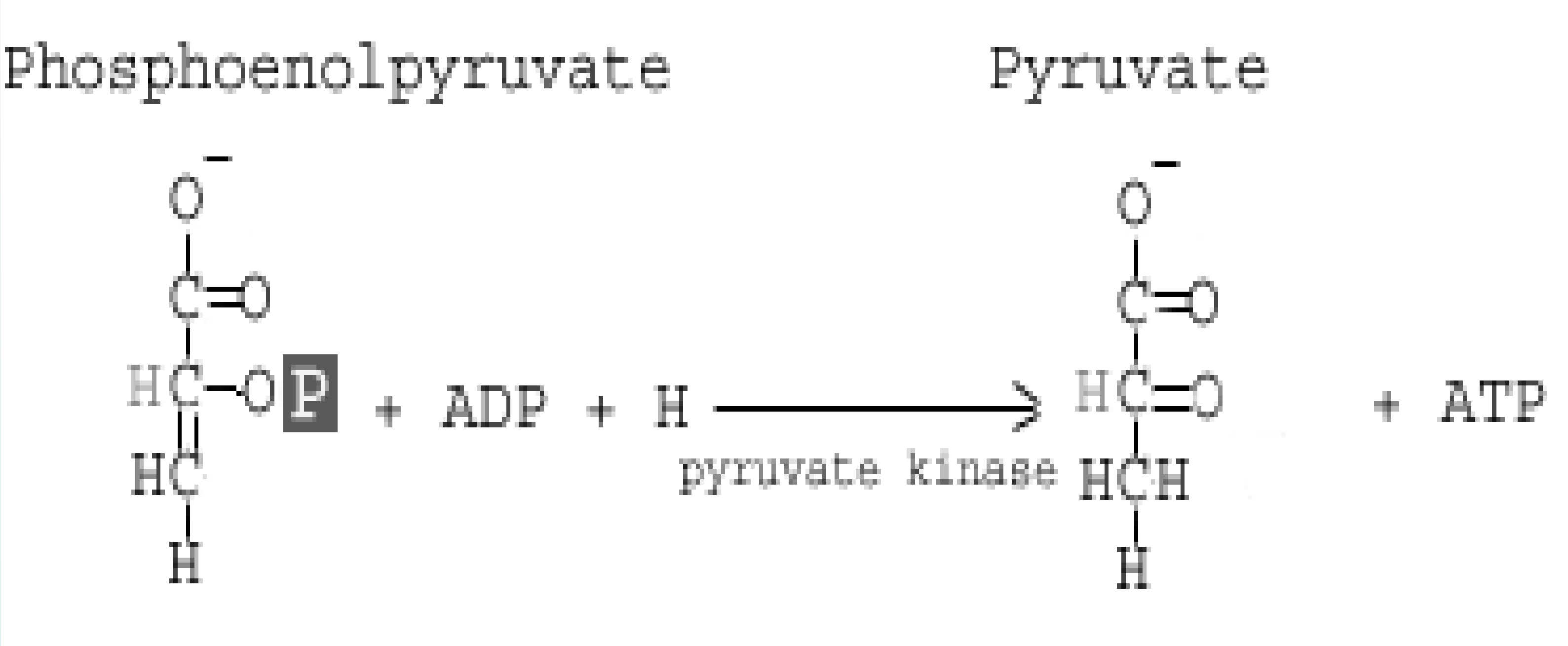
STEP 9: ENOLASE

- This step invoves the conversion of 2 phosphoglycerate to phosphoenolpyruvate (PEP). The reaction is catalyzed by enolase.
- Enolase works by removing a water group or by dehydrating the 2 phosphoglycerate.
- The enzyme enolase removes a molecule of water from 2-phosphoglycerate to form phosphoenolpyruvic acid(PEP)



STEP 10: PYRUVATE KINASE

- The final step of glycolysis converts phosphoenolpyruvate (PEP) into pyruvate with the help of the enzyme pyruvate kinase. As the enzyme's name suggests, this reaction involves the transfer of a phosphate group.
- The phosphate group attached to the 2'carbon of the PEP is transferred the molecule of ADP, yielding ATP. Again, since there two molecules of PEP, here we actually generate two ATP molecules.



CONCLUSION

- Immediately upon finishing glycolysis, the cell must continue respiration in either aerobic or anaerobic direction; this choice being dependent on the circumstances of the particular cell.
- A cell that can perform aerobic respiration and which finds itself in the presence of oxygen will continue on to the aerobic citric acid cycle in the mitochondria.
- A cell able to perform anaerobic respiration which finds itself in a situation where there is no oxygen will move into a type of anaerobic respiration called homolactic fermentation.

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THANK YOU FOR YOUR TIME AND ATTENTION.

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