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STEPS AND SIGNIFICANCE OF GLYCOLYSIS

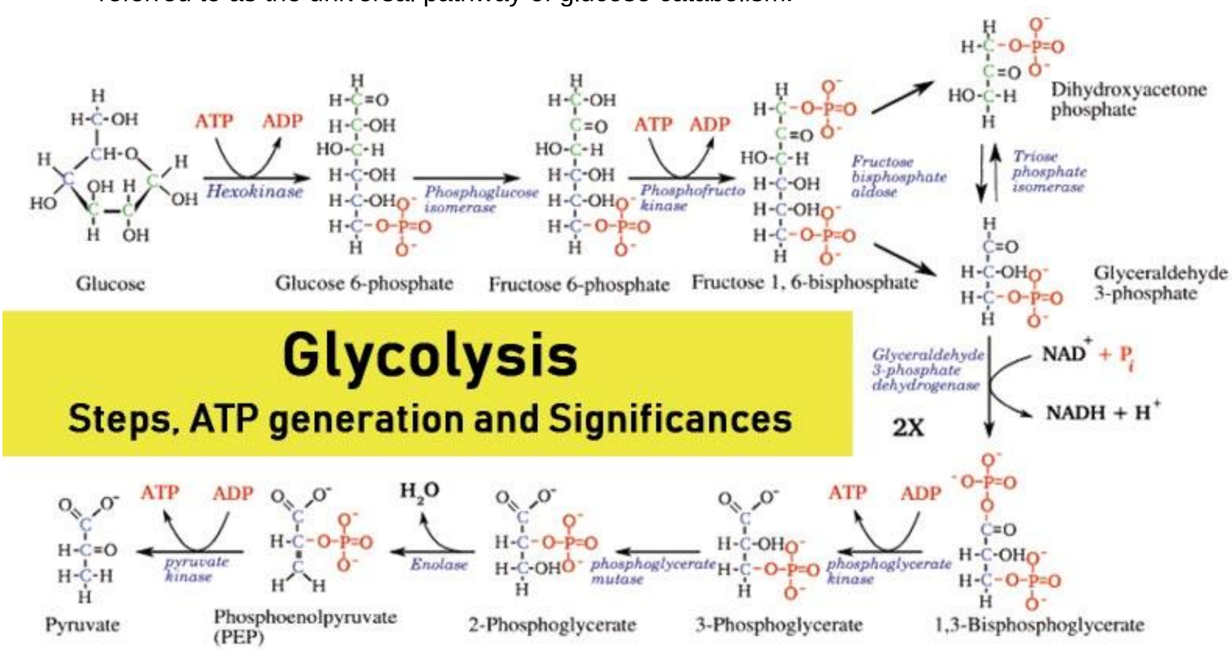
What is glycolysis?

Glycolysis is a series of reactions that extract energy from glucose by splitting it into two three-carbon molecules called pyruvates. Glycolysis is an ancient metabolic pathway, meaning that it evolved long ago, and it is found in the great majority of organisms alive today superscript.

In organisms that perform cellular respiration, glycolysis is the first stage of this process. However, glycolysis doesn't require oxygen, and many anaerobic organisms—organisms that do not use oxygen—also have this pathway.

Glycolysis- Steps, ATP generation and Significance

- Fermentation and respiration are two major strategies for energy conservation in chemoorganotrophs.
- The glycolytic pathway is a major metabolic pathway for microbial fermentation which involves the catabolism of glucose into pyruvate.
- It is also called the **Embden–Meyerhof–Parnas pathway** for its major discoverers.
- Regardless of whether glucose is fermented or respired, it travels through this pathway thus it is referred to as the universal pathway of glucose catabolism.

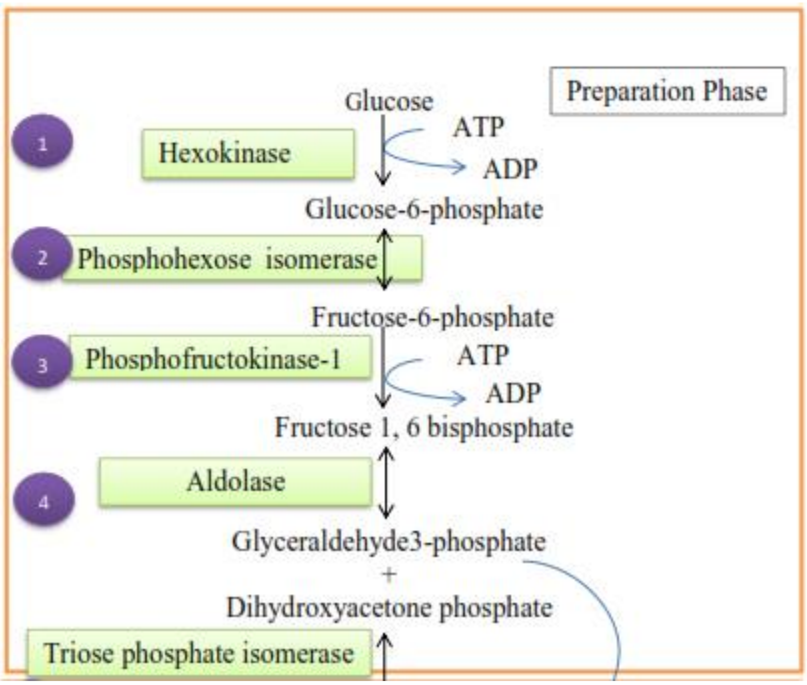


Location
Glycolysis takes place in the cytoplasm of cells in most body tissues.

- In glycolysis, a molecule of glucose is degraded in a series of enzyme catalyzed reactions to yield two molecules of the carbon compound – pyruvate.
- The fermentation of glucose through the glycolytic pathway can be divided into two stages, each requiring several independent enzymatic reactions.
- Phase I comprises of “preparatory” reactions : These are not redox reactions and do not release energy but instead form a key intermediate of the pathway.
- In Stage II, redox reactions occur, energy is conserved, and two molecules of pyruvate are formed.

Phase I: Energy investment phase (Preparatory phase)

- irst five reactions of the pathway.
- Converts one glucose molecule to two glyceraldehyde-3- phosphate.
- Consumes two ATP.
- Includes rate-limiting step of the conversion of fructose-6-phosphate to fructose-1,6-bisphosphonate as catalyzed by phosphofructokinase.



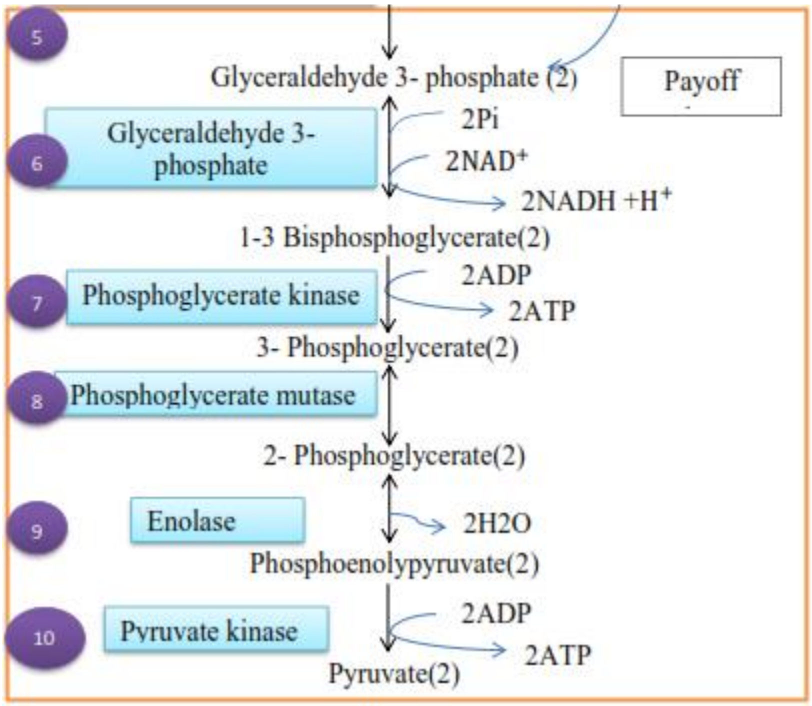
Involved reactions

1. Glucose is phosphorylated with the use of ATP by hexokinase, yielding glucose 6-phosphate.
2. Glucose 6-phosphate is then isomerized to fructose 6-phosphate by phosphoglucose isomerase.
3. Second phosphorylation leads to the production of fructose1,6-bisphosphate by phosphofructokinase 1 (PFK-1), which is the rate-limiting enzyme of glycolysis. The reaction uses 1 ATP.

4. The enzyme aldolase then splits fructose 1,6-bisphosphate into two 3-carbon molecules, glyceraldehyde 3-phosphate and its isomer, dihydroxyacetone phosphate, which is ultimately converted into glyceraldehyde 3-phosphate.

Phase II: Energy production phase (Pay-off phase)

- Converts two G3P to two pyruvate.
- Produces four ATP and two NADH.

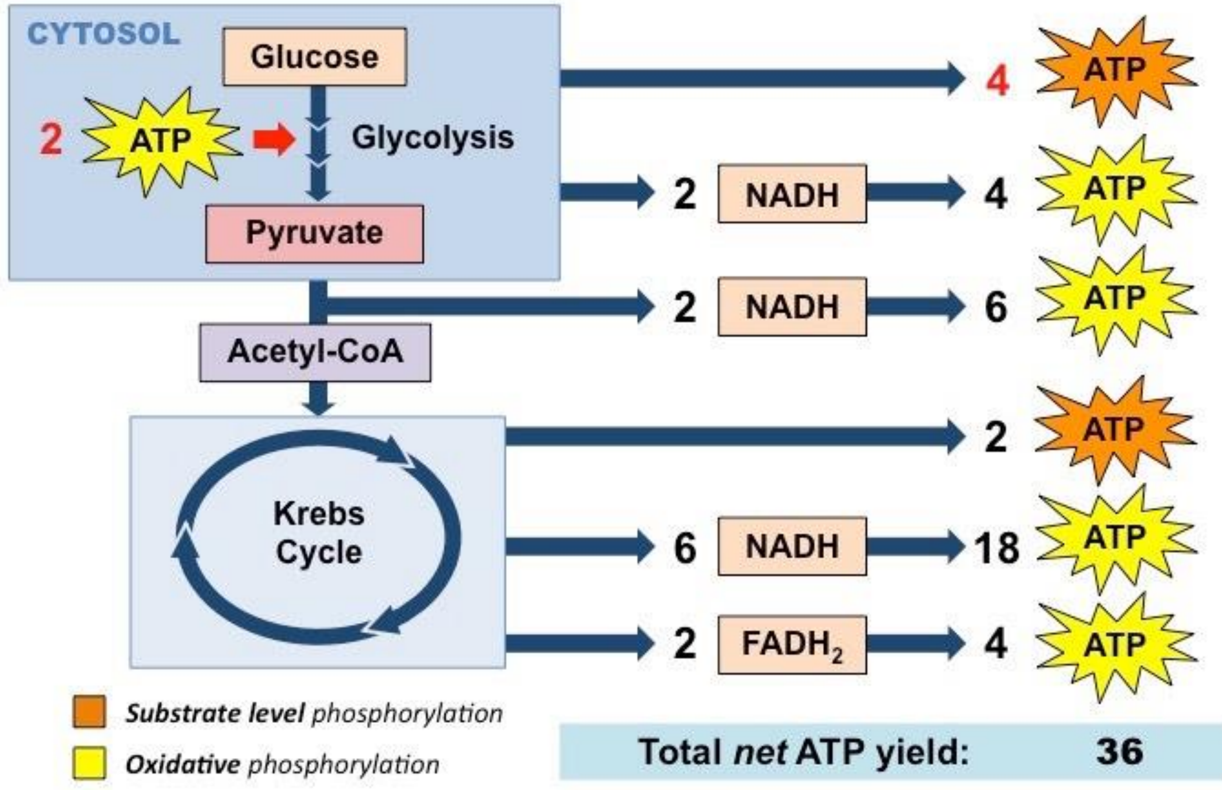


Involved reactions

1. The first redox reaction is the oxidation of glyceraldehyde 3-phosphate to 1,3 bisphosphoglyceric acid by glyceraldehyde 3-phosphate dehydrogenase using NAD + as a cofactor.
2. 1, 3-bisphosphoglyceric acid is converted to 3-phosphoglyceric acid by phosphoglycerate kinase. This reaction generates 2 ATP per glucose molecule.
3. Reversible conversion of 3-phosphoglyceric acid to 2-phosphoglyceric acid by phosphoglycerate mutase.
4. Reversible conversion of 2-phosphoglycerate to phosphoenolpyruvate (PEP) by enolase.
5. Regulated, irreversible reaction involving the conversion of PEP to pyruvate by pyruvate kinase. There is a net gain of 2 ATP per glucose molecule in this reaction

ATP generation

- During Stages I and II of glycolysis, **two ATP** molecules are consumed and **four ATP** molecules are synthesized.
- Thus, the net energy yield in glycolysis is **two molecules of ATP** per molecule of glucose fermented.



- However, maximal ATP yield from oxidation of glucose is **36 to 38 ATP**.
- The maximum yield of ATP per glucose molecule depends on coupling of glycolysis with the citric acid cycle by means of pyruvate dehydrogenase.

Significance of Glycolysis Pathway

1. The glycolytic pathway is employed by all tissues for the breakdown of glucose to provide energy in the form of ATP.
2. Important pathway for the production of energy especially under anaerobic conditions.
3. It is crucial for generation of energy in cells without mitochondria.
4. It forms products that are intermediates for other metabolic pathways.
5. Glycolysis interfaces with glycogen metabolism, the pentose phosphate pathway, the formation of amino sugars, triglyceride synthesis (by means of glycerol 3-phosphate), the production of lactate (a dead-end reaction), and transamination with alanine.

Associated Diseases:

Deficiency in any of the glycolytic enzymes leads to hemolytic anemia because RBCs depend on glycolysis for energy production and will lyse if their energy demands are not met as a result of faulty glycolysis.

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