Glycolysis

Glucose, a carbohydrate, undergoes glycolysis to make intermediate sugars metabolically available and is the primary source of energy in animals. Hexokinase and glucokinase convert glucose into glucose-6-phosphate. Glucose-6-phosphate is isomerized into fructose-6-phosphate. Phosphofructokinase 1, or PFK-1, is the rate-limiting enzyme of glycolysis and allows for the conversion of fructose-6-phosphate into fructose-1-6-bisphosphate in an ATP-requiring step. Fructose-1-6-bisphosphate is then converted by aldolase into dihydroxyacetone-phosphate (DHAP) and glyceraldehyde-3-phosphate (G3P). Glyceraldehyde-3-phosphate is catalyzed in a reaction to produce two molecules of 1,3-bisphosphoglycerate. 1,3-bisphosphoglycerate loses a phosphate group, producing ATP and 3-phosphoglycerate. Mutase relocates the phosphate in the next reaction to produce 2-phosphoglycerate. Next, enolase reacts to produce water and phosphoenolpyruvate (PEP). In the last step of glycolysis, PEP is converted by pyruvate kinase to form pyruvate in an ATP-producing step. Pyruvate must then continue on as a part of either anaerobic or aerobic respiration. Inside mitochondria, pyruvate is transformed by pyruvate dehydrogenase into Acetyl-CoA. Acetyl-CoA then moves on to enter the citric acid cycle, where the acetyl group is further oxidized to carbon dioxide and water, and the released energy is captured in the form of 11 ATP.



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Characteristics

Glucose
Glue-bottle
Glucose is a sugar that is ingested and formed from other ingested sugars. It circulates in the blood of humans and serves as an energy source via aerobic or anaerobic respiration.

Hexokinase or Glucokinase
Hexagon-kite-ace and Glue-kite-ace
These enzymes facilitate the conversion of glucose to glucose-6-phosphate (G6P) in a reaction requiring ATP. Hexokinase (HK) is found in most tissues, while glucokinase (GK) is generally only found in the liver and in beta-cells of the pancreas. GK is an isozyme of HK.

Glucose-6-phosphate
Glue-bottle (6) Sax Fonz-fairy
G6P is a glucose sugar which has been phosphorylated on the sixth carbon. The enzyme phosphoglucose isomerase (PGI) isomerizes this sugar into fructose-6-phosphate (F6P) in the beginning of glycolysis.

Fructose-6-phosphate
Fruit Toast (6)-Sax Fonz-fairy
F6P is a fructose sugar phosphorylated at the sixth carbon site. In an ATP-dependent step, F6P is phosphorylated by phosphofructokinase-1, or PFK-1, to the sugar fructose-1,6-bisphosphate (F1,6BP).

Phosphofructokinase-1 (PFK-1)
Fonz-Fairy-Fruit-Toast-Kite-Ace
PFK-1 is an enzyme that phosphorylates the sugar F6P, forming F1,6BP in glycolysis. This step requires ATP and is one of the key regulatory and rate-limiting steps of glycolysis.

Fructose-1,6-bisphosphate
Fruit-Toast mixed by (1) Wand in (6) Sax by 2 Fonz-Fairies
F1,6BP is formed after phosphorylation of F6P. It is broken down into two compounds in glycolysis: glyceraldehyde-3-phosphate (G3P) and dihydroxyacetone-phosphate (DHAP).

Aldolase
Aldo-in-Lace
There are three forms of the enzyme aldolase (ALDO): aldolase A is expressed in muscle and brain tissue, aldolase B in the liver and kidney, and aldolase C in the brain. Those with a deficiency of aldolase B often present with the disorder hereditary fructose intolerance. Within glycolysis, ALDO converts F1,6BP into G3P and DHAP.

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Glyceraldehyde-3-Phosphate

Glitter-Pie (3)-Tree Fonz-Fairy

G3P is formed, along with DHAP, by the conversion of F1,6BP by ALDO in a reversible reaction. Later in glycolysis, G3P is used as a substrate for 1,3-bisphosphoglycerate (1,3BPG). DHAP works as an intermediate that can leave the cycle and form fat or be converted into G3P by the enzyme triosephosphate isomerase (TPI) for entry back into the cycle.

1,3-bisphosphoglycerate

(1)-Wand (3)-Tree with 2 Fonz-Fairies with Glitter

1,3BPG is an intermediate compound of glycolysis and signifies the beginning of the “payoff” phase of glycolysis, which creates energy-rich molecules. Two molecules are formed from the conversion of G3P by the enzyme glyceraldehyde phosphate dehydrogenase (GAPDH). 1,3BPG is important because of its ability to form ATP by phosphorylating adenosine diphosphate (ADP). Remember that products in each subsequent step should be doubled or accounted for two times since two molecules were created in this step.

3-phosphoglycerate

(3)-Tree Fonz-Fairy with Glitter

In an ATP-producing step, 1,3BPG is dephosphorylated by the enzyme phosphoglycerate kinase (PGK), forming 3-phosphoglycerate (3PG).

2-phosphoglycerate

(2)-Tutu on Fonz-Fairy with Glitter

The enzyme phosphoglycerate mutase (PGM) catalyzes a transfer of a phosphate group from the third carbon to the second carbon on 3PG, working to convert it to 2-phosphoglycerate (2PG).

Phosphoenolpyruvate (PEP)

Fonz-Fairy-Eats-Pie-with-Roots

Phosphoenolpyruvate, or PEP, is formed when the enzyme enolase (ENO) acts on 2PG. PEP contains the highest-energy phosphate bond found in living organisms, and when it is dephosphorylated by pyruvate kinase (PK), ATP is formed.

Pyruvate Kinase

Pie-with-roots-Kite-Ace

The enzyme PK acts to remove the phosphate group from PEP, forming ATP and pyruvate.

Pyruvate

Pie-with-Roots

Pyruvate is formed from the dephosphorylation of PEP by the enzyme PK. It is an alpha-keto acid, and after glycolysis, this molecule is decarboxylated by the enzyme pyruvate dehydrogenase (PDH) to form acetyl-CoA.

Pyruvate Dehydrogenase

Pie-root Dehydrator

Pyruvate dehydrogenase is a multi-enzyme complex that catalyzes the oxidative decarboxylation of pyruvate into acetyl-CoA, producing NADH and CO? in the process. It is a key link between glycolysis and the citric acid cycle but is not a step of glycolysis.

Acetyl-CoA

Seagull CoA-purse

Acetyl-CoA is formed from the decarboxylation of pyruvate by the enzyme PDH. This molecule then enters the tricarboxylic acid (TCA) cycle, also known as the citric acid cycle and Krebs cycle, where the acetyl group is further oxidized to carbon dioxide (CO2) and H2O. Subsequently, the energy that is released is captured in the form of 11 ATP.

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