Subject Name: Biochemistry

Study stage: First Stage

Lecture title

Metabolism of Carbohydrates

lecture number: 2

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Metabolism of Carbohydrates

Metabolism = Anabolism + Catabolism

Anabolism (Anabolic Pathway)

- The anabolic pathway is also called a biosynthesis pathway. In an Anabolic reaction, small and simple precursors are synthesis into larger and more complex molecules including lipids, polysaccharides, proteins, and nucleic acids.
- The anabolic reaction requires an input of energy.

Catabolism (Catabolic pathway)

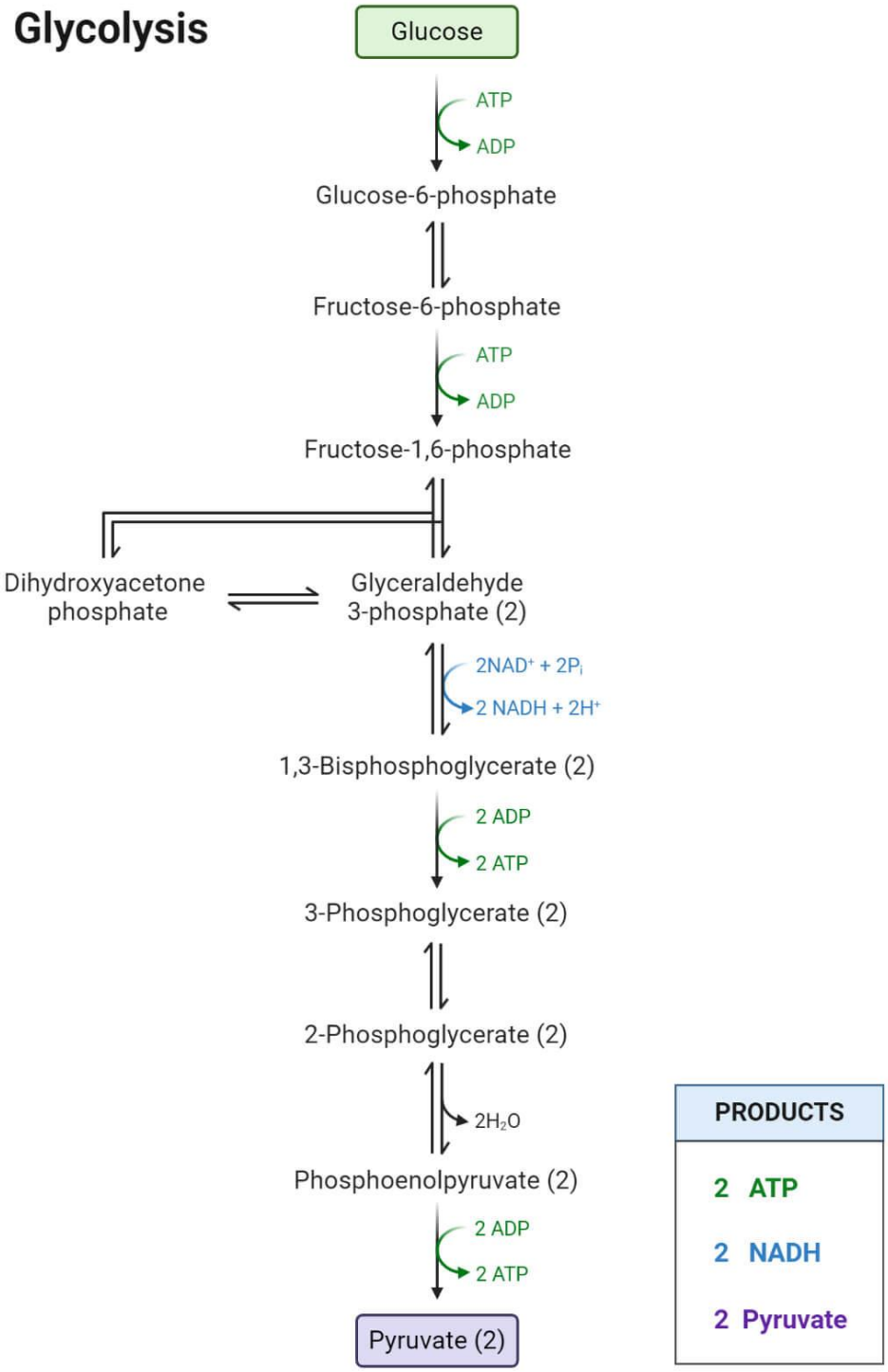
- Catabolism is the process of the breakdown/degradative condition of metabolism in which organic nutrients molecules carbohydrates, lipids, and protein are transformed into small and simple end products.
- Catabolic reactions release energy.

• Glycolysis and Gluconeogenesis

Glycolysis is the process of breakdown of glucose, while gluconeogenesis is the synthesis of glucose. Gluconeogenesis is the opposite of glycolysis with some bypass steps.

Glycolysis

Glycolysis is a breakdown of one molecule of glucose into 2 molecules of pyruvate through a series of enzyme-catalyzed reactions, and ATP & NADH are produced. This is a ten-step process.


Glycolysis
Glucose
ATP
ADP
Glucose-6-phosphate
Fructose-6-phosphate
ATP
ADP
Fructose-1,6-phosphate
Dihydroxyacetone phosphate
Glyceraldehyde 3-phosphate (2)
2NAD+ + 2Pi
2 NADH + 2H+
1,3-Bisphosphoglycerate (2)
2 ADP
2 ATP
3-Phosphoglycerate (2)
2-Phosphoglycerate (2)
2H2O
Phosphoenolpyruvate (2)
2 ADP
2 ATP
Pyruvate (2)
PRODUCTS
2 ATP
2 NADH
2 Pyruvate

Step first – In this step glucose is converted into glucose 6-phosphate by hydrolysis of one ATP into ADP in presence of hexokinase enzyme, it is an irreversible reaction.

Step second – This is a step of isomerization, glucose 6-phosphate covert into fructose 6-phosphate in presence of enzyme phosphohexoisomerase.

Step third – During this step again irreversible hydrolysis of ATP into ADP takes place, and fructose 6-phosphate convert into fructose 1,6-phosphate, in presence of phosphofructokinase.

Step fourth – It is a step of cleavage of six-carbon compound fructose 1,6-bisphosphate into two triose phosphate namely glyceraldehyde 3-phosphate and dihydroxyacetone phosphate, by aldolase enzyme.

Step fifth – Dihydroxyacetone phosphate is isomerized into glyceraldehyde 3-phosphate by triose phosphate isomerase.

Step sixth – Here oxidation of 2 molecules of glyceraldehyde 3-phosphate into 1,3-bisphosphoglycerate by use of two inorganic phosphates, in presence of glyceraldehyde 3-phosphate dehydrogenase enzyme and reduction of 2NAD+ into 2NADH, H+.

Step seventh – It is the first step of ATP production, here 2 molecules of 1,3-bisphosphoglycerate converted into two molecules of 3-phosphoglycerate with libration of 2ATP by use of 2ADP in presence of phosphoglycerate kinase.

Step eighth – In this step 2 molecules of 3-phosphoglycerate change into 2 molecules of 2-phosphoglycerate by phosphoglycerate mutase.

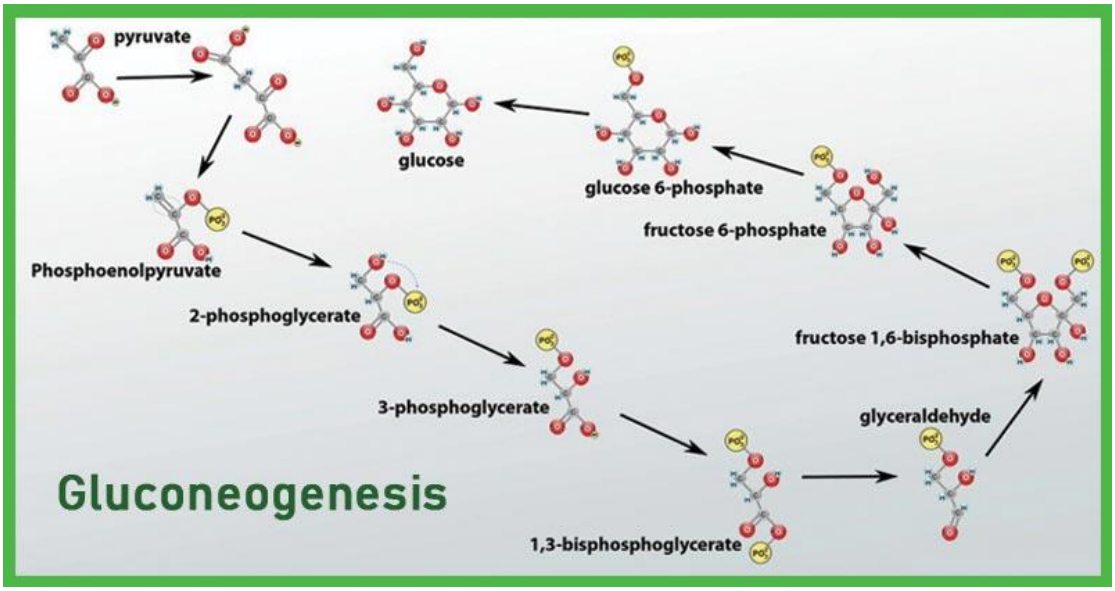
Step ninth – Now in presence of enolase enzyme 2 molecules of 2-phosphoglycerate convert into 2 molecules of phosphoenolpyruvate by libration of 2 molecules of water.

Step tenth – It is the second step of ATP production and the third irreversible reaction of this pathway. Here 2 molecules of phosphoenolpyruvate change into 2 molecules of pyruvate with libration 2ATP and use of 2ADP in presence of pyruvate kinase enzyme.

Number of ATP

ATP produced from glycolysis = 2 ATP

2 NADPH (3 ATP each in ETC)= 6 ATP in ETC



Gluconeogenesis

It is the reverse reaction of glycolysis from pyruvate to glucose with 3 bypass steps. Here we study only about 3 passed steps, other steps have a reverse reaction of glycolysis so no need to describe.

- **First bypass step**

The first step to be bypassed is pyruvate to phosphoenolpyruvate, in this step pyruvate does not simply change into PEP, but it is through the bypassed step. Firstly 2molecules of pyruvate change into 2 molecules of oxaloacetate with the hydrolysis of 2ATP by pyruvate carboxylase enzyme. Then PEP carboxykinase enzyme converts 2 molecules of oxaloacetate into 2 molecules of PEP with the hydrolysis of 2GTP.

- **Second bypass step**

The second step to be bypassed is fructose 1,6-bisphosphate to fructose 6-phosphate, this is also not reversible, so it is bypassed by fructose 1,6-bisphosphatase enzyme by removal of phosphate from first carbon of fructose 1,6-bisphosphate changing it into fructose 6-phosphate.

- **Third bypass step**

The third step to be bypassed is glucose 6-phosphate to glucose, this step is also not simply reversible, and bypassed by glucose 6-phosphatase by removal of phosphate from sixth carbon of glucose, releasing free glucose.