Carbohydrate Metabolism

Presented By,

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Carbohydrate Metabolism

Carbohydrate metabolism is the body's process of breaking down carbohydrates for energy.

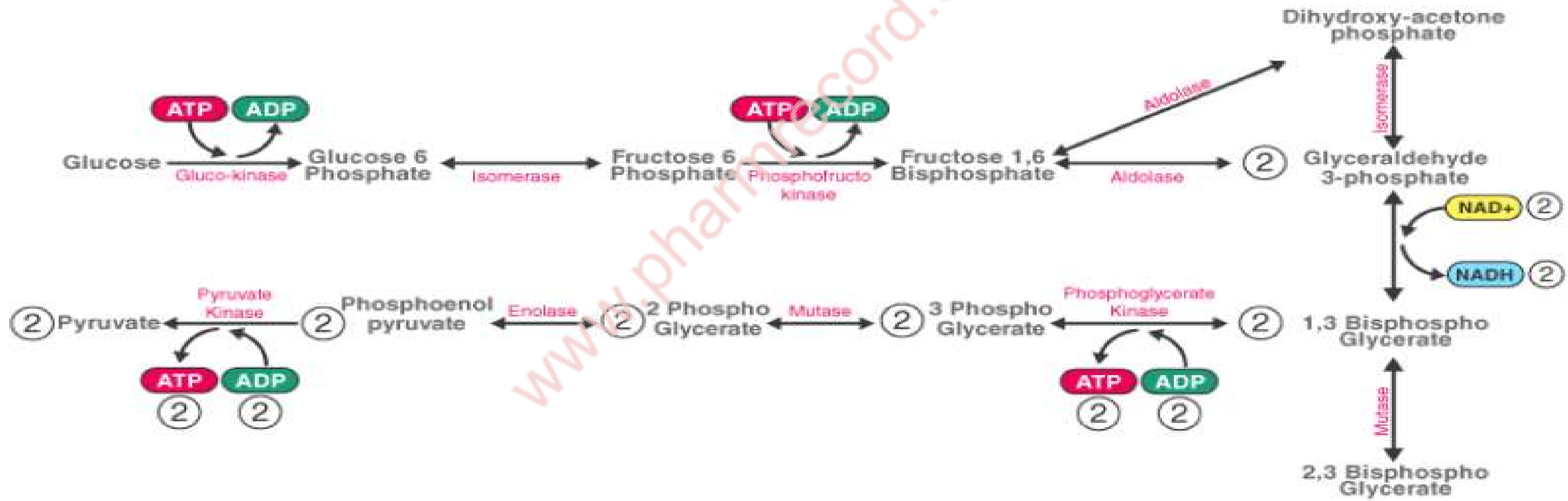
$$\text{Carbohydrate} \xrightarrow{\text{Break down}} \text{Energy}$$

1.Glycolysis

Glycolysis is a fundamental metabolic pathway that breaks down glucose into pyruvate, generating energy in the form of ATP

$$\text{Glucose} \xrightarrow{\text{Break down}} \text{Pyruvate + Energy (ATP)}$$

Glycolysis Pathway



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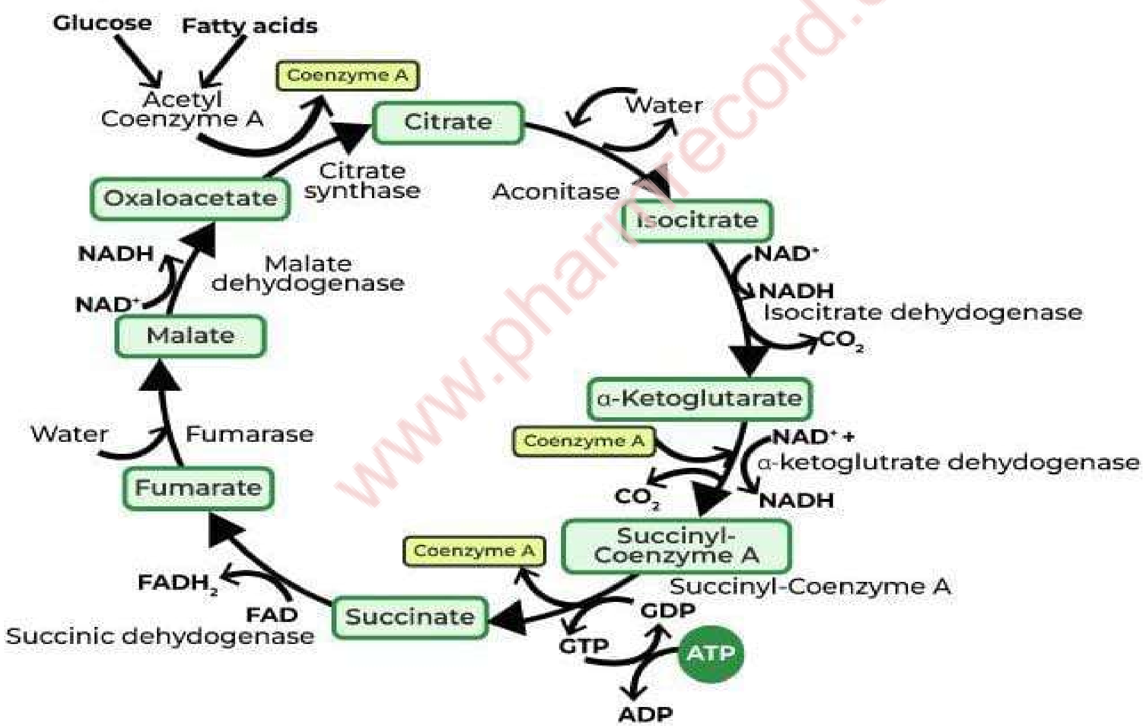
Significance of glycolysis

- It's a major pathway for generating ATP from glucose, providing essential energy for cellular functions.
- It's the initial step in both aerobic and anaerobic cellular respiration.
- It produces vital intermediate molecules used in other metabolic pathways, such as fatty acid and amino acid synthesis.
- The end product Pyruvate is a key molecule that then can be used in other metabolic pathways.

2.Citric Acid Cycle

The **citric acid cycle**, also known as the **Krebs cycle** or **tricarboxylic acid (TCA) cycle**, is a crucial metabolic pathway that oxidizes acetyl-CoA, derived from carbohydrates, fats, and proteins, to release energy in the form of ATP, NADH, and FADH2.

Citric Acid Cycle / Kerbs Cycle / TCA Cycle



Significance of Citric Acid Cycle

- The citric acid cycle serves as the final common pathway for the oxidation of carbohydrates, fats, and proteins.
- It generates high-energy molecules like NADH and FADH2, which are then used in the electron transport chain to produce ATP, the cell's primary energy currency.
- The provides crucial intermediate molecules that are used in various biosynthetic pathways, including the synthesis of amino acids, fatty acids, and other essential compounds.
- It is a vital component of aerobic respiration, the process by which cells extract maximum energy from food in the presence of oxygen.

3.HMP Shunt

- The hexose monophosphate (HMP) shunt, also known as the pentose phosphate pathway or phosphogluconate pathway, is a metabolic pathway that runs parallel to glycolysis. This pathway produces NADPH and intermediates required for the synthesis of nucleic acids and amino acids.

HMP Shunt pathway

The hexose monophosphate (HMP) shunt, also known as the pentose phosphate pathway, is an alternative metabolic pathway to glycolysis that produces NADPH and pentose sugars (like ribose-5-phosphate).

Key Products:

- **NADPH:** A reducing agent crucial for biosynthesis (e.g., fatty acid and cholesterol synthesis) and protecting against oxidative stress.
- **Ribose-5-phosphate:** A precursor for nucleotide and nucleic acid synthesis.

Phases: The HMP shunt pathway consists of two phases:

- **Oxidative Phase:** This phase generates NADPH and converts glucose-6-phosphate to ribulose-5-phosphate.
- **Non-Oxidative Phase:** This phase involves inter-conversions of various sugars to produce ribose-5-phosphate and other metabolites.

Significance of HMP Shunt

- **NADPH performs several functions in the body.**
- **It takes part in the synthesis of steroids and fatty acids.**
- **It is an important component within phagolysosomes in the immune response.**
- **Glutathione is reduced by NADPH in the presence of glutathione reductase. This helps in quenching free oxygen radicals and peroxides from cells.**
- **The glyceraldehyde 3-phosphate and fructose 6-phosphate produced in the pathway are intermediates for glycolysis and gluconeogenesis.**

Glucose-6-phosphate dehydrogenase (G6PD) Deficiency

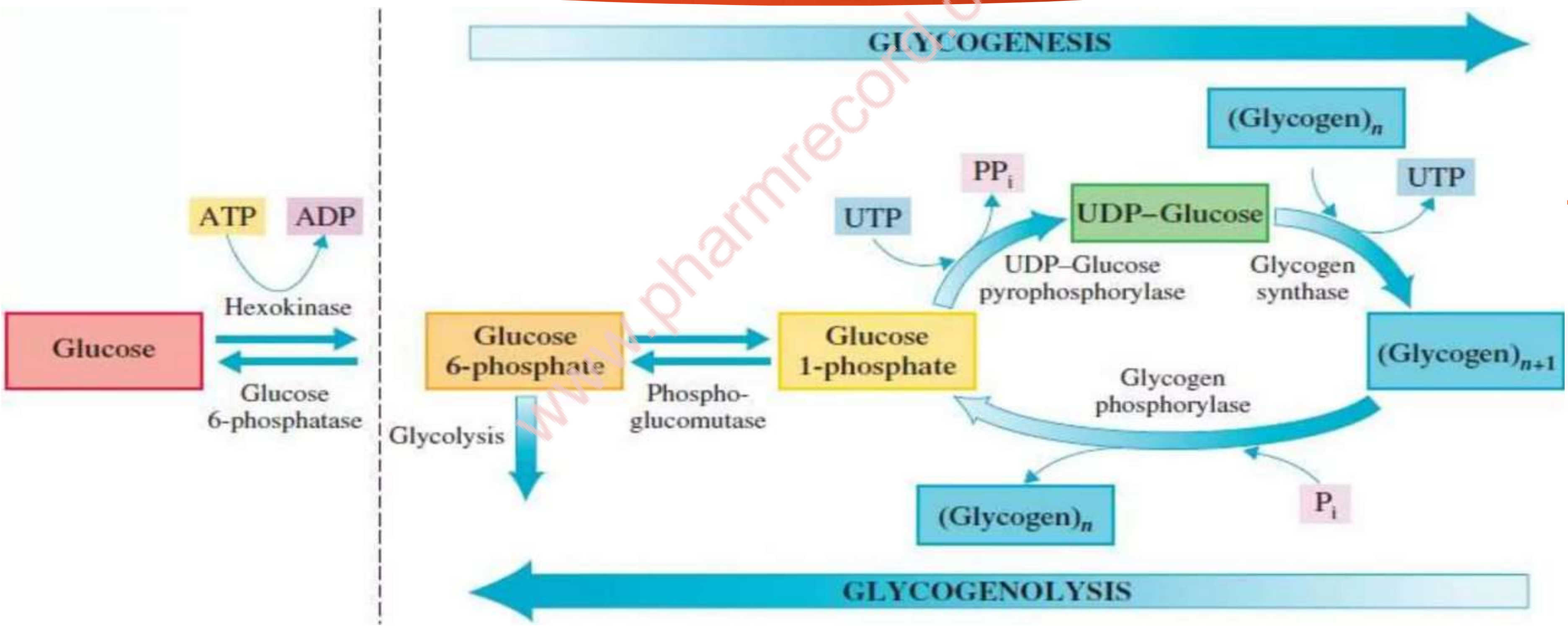
G6PD deficiency is a genetic abnormality that results in an not sufficient amount of glucose-6-phosphate dehydrogenase (G6PD) in the blood. This is a very important enzyme (or protein) that regulates various biochemical reactions in the body.

G6PD is also responsible for keeping red blood cells healthy so they can function properly and live a normal life span. Without enough of it, red blood cells break down prematurely.

4. Glycogenesis Metabolic Pathway

Glycogen metabolism, involving both synthesis (glycogenesis) and breakdown (glycogenolysis), is crucial for maintaining blood glucose levels and energy storage, with key enzymes like glycogen phosphorylase and glycogen synthase playing vital roles.

Glycogenesis Metabolic Pathway



Significance Glycogenesis Metabolic Pathway

- Glycogen to maintain blood glucose levels, especially during fasting
- Glycogen to provide energy for muscle contraction, especially during exercise.

Hormonal Regulation Of Blood Glucose Level And Diabetes Mellitus

Hormones like insulin and glucagon, secreted by the pancreas, play a crucial role in regulating blood glucose levels, and imbalances in their secretion or action lead to diabetes mellitus.

Insulin:

- Produced by the beta cells of the pancreas.
- Lowers blood glucose levels by facilitating the uptake of glucose into cells, especially muscle and fat cells.
- Promotes the storage of glucose as glycogen in the liver and muscles.
- Stimulated by high blood glucose levels (e.g., after a meal).

Glucagon:

- Produced by the alpha cells of the pancreas.
- Raises blood glucose levels by stimulating the breakdown of glycogen into glucose in the liver (glycogenolysis) and promoting the synthesis of new glucose (gluconeogenesis).
- Stimulated by low blood glucose levels (e.g., during fasting).

Glycogen Storage Diseases

The most common types of GSD ;-

- **Von Gierke disease.** This is the most common form of GSD. People with type I don't have the enzyme needed to turn glycogen into glucose in the liver. Glycogen builds up in the liver. Symptoms often appear in babies around 3 to 4 months old. They may include low blood sugar (hypoglycemia) and a swollen belly because of an enlarged liver.
- **Cori disease.** People with type III don't have enough of an enzyme (the debranching enzyme) that helps break down glycogen. The glycogen can't fully break down. It collects in the liver and in muscle tissues. Symptoms include a swollen belly, delayed growth, and weak muscles.
- **Andersen disease.** People with type IV form abnormal glycogen. Experts think the abnormal glycogen triggers the body's infection-fighting system (immune system). This creates scarring (cirrhosis) of the liver and other organs, such as muscle and the heart. People with type IV disease may develop liver failure at a young age or develop heart failure.

5.Glyconeogenesis

- Gluconeogenesis is the process that allows the body to form glucose from non-hexose precursors, particularly glycerol, lactate, pyruvate, propionate, and glucogenic amino acids.

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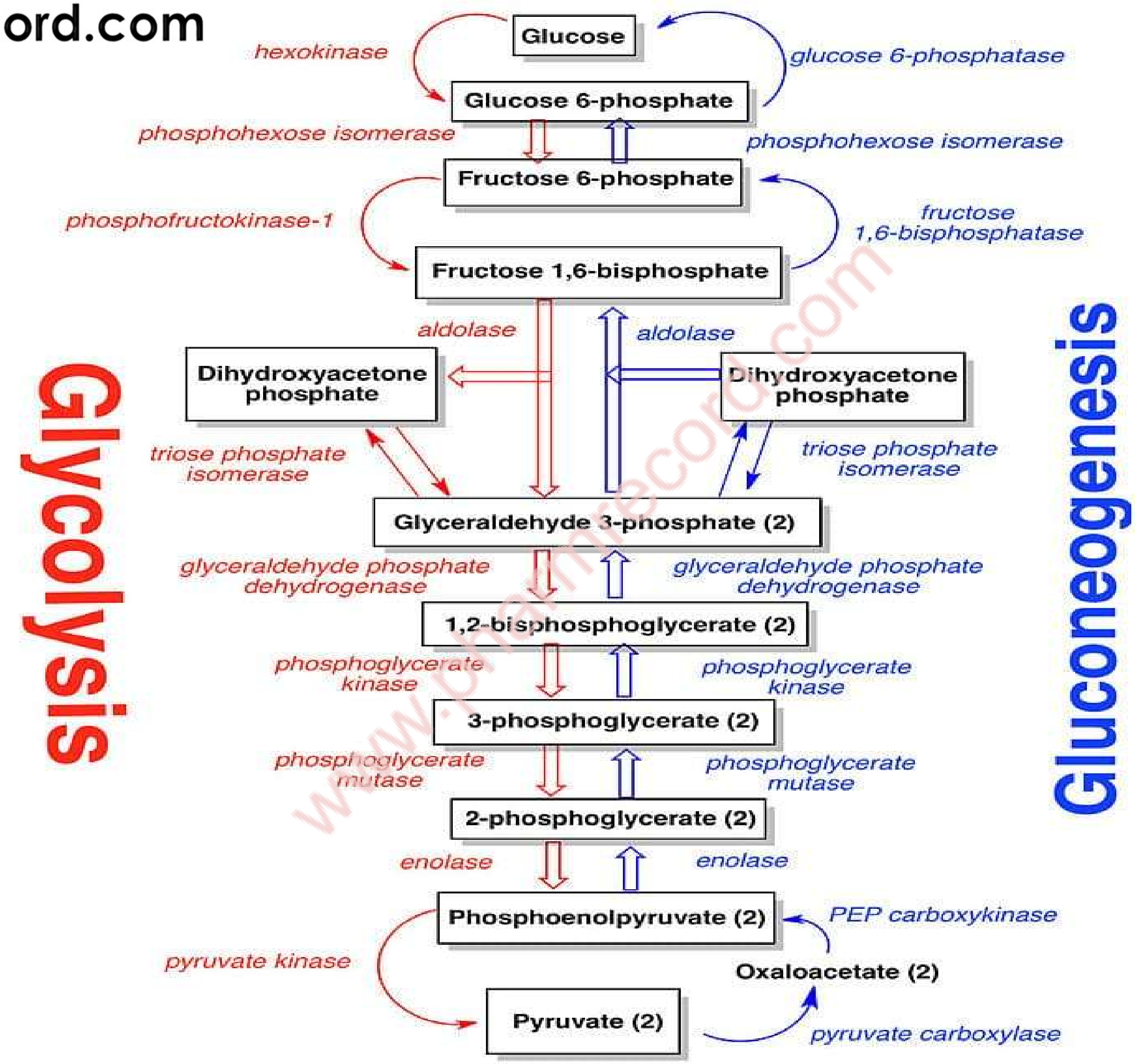

Significances Glyconeogenesis

- The brain and other tissues rely heavily on glucose for energy, and gluconeogenesis ensures a constant supply.
- When carbohydrate intake is low, gluconeogenesis provides an alternative energy source by converting other molecules into glucose.

Thank you

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