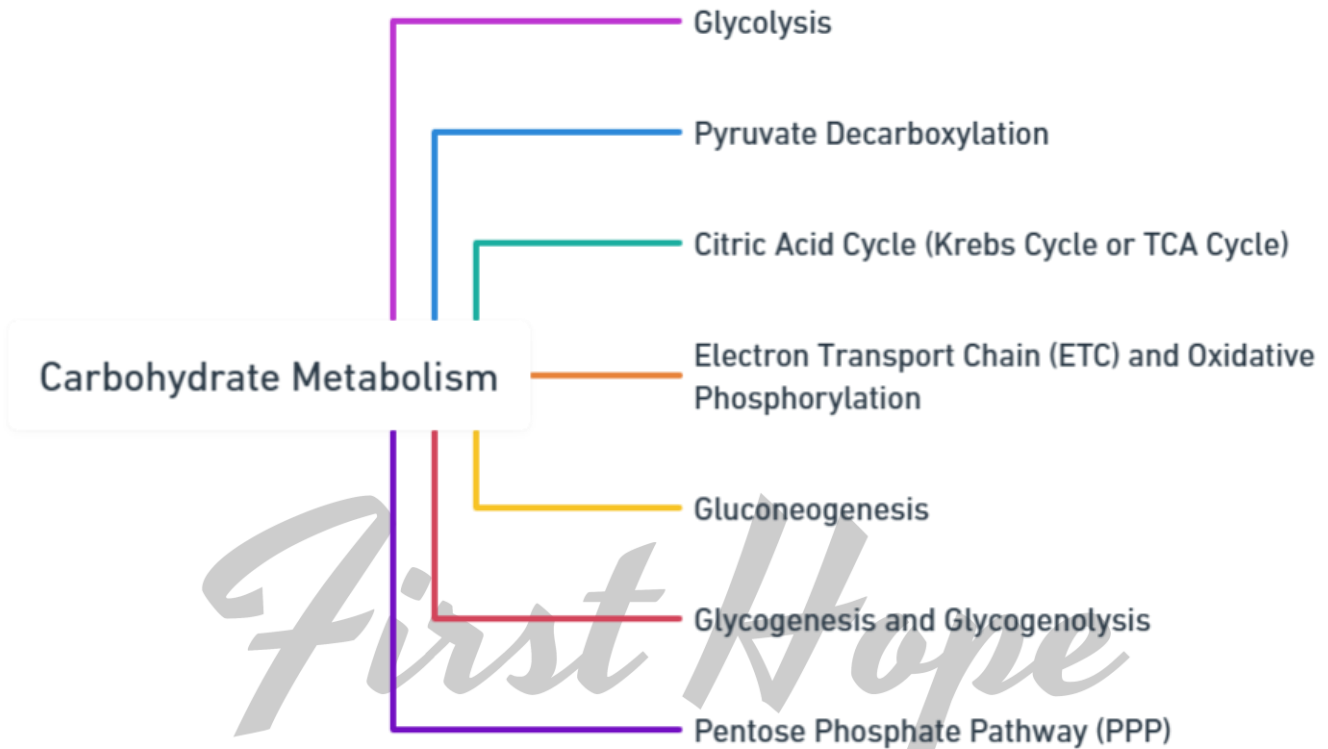


Carbohydrate metabolism

Carbohydrate Metabolism: Key Stages

- Carbohydrate metabolism involves synthesis, breakdown, and transformation of carbohydrates, primarily for energy production.

Let's delve into the key stages of carbohydrate metabolism in a detailed and organized manner:



1. Glycolysis

- **Location:** Cytoplasm of the cells
- **Process:** The conversion of glucose (a six-carbon molecule) into two molecules of pyruvate (three carbons each).
- **Energy Yield:** 2 ATP (net gain) and 2 NADH per molecule of glucose.
- **Key Points:** Glycolysis is an anaerobic process (does not require oxygen) and is the initial step in the utilization of glucose, providing substrates for further metabolic pathways.

2. Pyruvate Decarboxylation

- **Location:** Mitochondria
- **Process:** Conversion of pyruvate into acetyl CoA via the pyruvate dehydrogenase complex.
- **Outcome:** Production of acetyl CoA, which is a critical intermediate that feeds into the citric acid cycle.
- **Significance:** This step links glycolysis to the citric acid cycle and is crucial for aerobic respiration.

3. Citric Acid Cycle (Krebs Cycle or TCA Cycle)

- **Location:** Mitochondrial matrix
- **Process:** Acetyl CoA enters the cycle, undergoing a series of enzyme-catalyzed reactions that produce NADH, FADH₂, and GTP/ATP.
- **Energy Yield:** Each acetyl CoA molecule results in 3 NADH, 1 FADH₂, and 1 GTP (or ATP), contributing to significant ATP production through oxidative phosphorylation.
- **Role:** Central metabolic pathway that generates high-energy electron carriers for the electron transport chain.

4. Electron Transport Chain (ETC) and Oxidative Phosphorylation

- **Location:** Inner mitochondrial membrane
- **Process:** Utilizes NADH and FADH₂ to generate a proton gradient across the membrane, driving the synthesis of ATP through ATP synthase.
- **Energy Yield:** The majority of ATP in cellular respiration is produced here, with approximately 34 ATP molecules generated per glucose molecule.
- **Mechanism:** Electrons from NADH and FADH₂ pass through a series of complexes, ultimately reducing oxygen to water.

5. Gluconeogenesis

- **Location:** Mainly in the liver and to some extent in the kidneys
- **Process:** Synthesis of glucose from non-carbohydrate sources, such as lactate, glycerol, and amino acids.
- **Importance:** Essential during fasting or prolonged exercise to maintain blood glucose levels.

6. Glycogenesis and Glycogenolysis

- **Glycogenesis:** The synthesis of glycogen from glucose, primarily occurring in the liver and muscle cells for energy storage.
- **Glycogenolysis:** The breakdown of glycogen back into glucose, providing a rapid source of glucose when needed by the body.
- **Regulation:** These processes are tightly regulated by hormones (e.g., insulin promotes glycogenesis, while glucagon stimulates glycogenolysis).

7. Pentose Phosphate Pathway (PPP)

- **Location:** Cytoplasm
- **Process:** An alternative glucose metabolic pathway that generates NADPH (for biosynthetic reactions and antioxidant defense) and ribose-5-phosphate (a precursor for nucleotide synthesis).
- **Significance:** Provides essential components for fatty acid synthesis, nucleotide biosynthesis, and maintenance of reduced glutathione levels.

Regulation and Hormonal Control

- **Insulin:** Promotes glucose uptake, glycogenesis, and fat synthesis.
- **Glucagon:** Stimulates glycogenolysis and gluconeogenesis to raise blood glucose levels.

Glycolysis – Pathway, energetics, and significance

Pathway of Glycolysis

- Glycolysis is the first step of cellular respiration, where one molecule of glucose (6-carbon) is broken down into two molecules of pyruvate (3-carbon).
- It occurs in the cytoplasm of all cells and does not require oxygen (anaerobic).
- Glycolysis is divided into two phases:

Phase 1: Energy Investment Phase (Steps 1–5)

- This phase uses 2 ATP molecules to activate glucose and convert it into two molecules of glyceraldehyde-3-phosphate (G3P).

1. Hexokinase/Glucokinase:



(Phosphorylation of glucose, trapping it inside the cell)

2. Phosphoglucose Isomerase:



(Isomerization from aldose to ketose sugar)

3. Phosphofructokinase-1 (PFK-1):



(Key regulatory step; highly regulated, irreversible)

4. Aldolase:



(Cleavage of 6-carbon sugar into two 3-carbon sugars)

5. Triose Phosphate Isomerase:



(Only G3P continues in glycolysis, so DHAP is converted)

Phase 2: Energy Payoff Phase (Steps 6–10)

- Each G3P molecule is oxidized to form **pyruvate**, producing **ATP and NADH**.

1. Glyceraldehyde-3-phosphate dehydrogenase:





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