

Regulation and function of glucose metabolism in health and diseases

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Description

Glucose, often referred to as the “fuel of life,” is a simple sugar that serves as the primary source of energy for cells in the human body. It plays a central role in the complex process of glucose metabolism, where it undergoes a series of intricate biochemical reactions to produce Adenosine Tri Phosphate (ATP), the cellular energy currency.

■ The role of glucose

Glucose is a carbohydrate derived from the foods, particularly those rich in carbohydrates like sugars and starches. After ingestion, these carbohydrates are broken down into glucose during digestion and released into the bloodstream. From there, glucose is transported to various cells throughout the body to provide the necessary energy for vital cellular processes.

■ Insulin and glucagon: Hormonal regulators of glucose metabolism

The levels of glucose in the bloodstream are tightly regulated by two key hormones: insulin and glucagon, both produced by the pancreas.

Insulin: When blood glucose levels rise, as is often the case after a meal, the pancreas releases insulin into the bloodstream. Insulin acts as a key that unlocks the cell's ability to take up glucose from the blood. It facilitates the transport of glucose into the cells, where it can be used for energy production or stored as glycogen for future use.

Insulin also suppresses the production of glucose in the liver, further helping to lower blood sugar levels.

Glucagon: On the other hand, when blood glucose levels drop between meals or during periods of fasting, the pancreas releases glucagon. Glucagon stimulates the liver to break down glycogen into glucose and release it into the bloodstream, raising blood sugar levels to maintain energy supply.

Glycolysis (breaking down glucose for energy): Once inside the cell, glucose undergoes a series of chemical reactions known as glycolysis, the first step in glucose metabolism. During glycolysis, a molecule of glucose is broken down into two molecules of pyruvate, generating a small amount of ATP and high-energy electrons that will be used in later stages of energy production.

Electron Transport Chain (ETC)-ATP production in bulk: Electron carriers convey the high-energy electrons generated during glycolysis and the citric acid cycle to the Electron Transport Chain (ETC), the last stage in the metabolism of glucose. The majority of the ATP is produced by the ETC, which is found in the inner mitochondrial membrane, by an action known as oxidative phosphorylation.

■ Regulation of glucose metabolism

To keep blood glucose levels within a specific range, the complex process of glucose metabolism is tightly regulated. This delicate equilibrium can

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be upset, resulting in a number of health issues.

Type 1 diabetes: The insulin-producing beta cells in the pancreas are wrongly attacked and destroyed in type 1 diabetes by the body's immune system. Hyperglycemia results from a lack of sufficient insulin levels to control blood glucose levels.

Type 2 diabetes: Type 2 diabetes is characterized by insulin resistance, where the body's cells do not respond effectively to insulin, requiring higher insulin levels for glucose uptake. Over time, the pancreas may not produce enough insulin, leading to chronically elevated blood sugar levels.

Hypoglycemia: Hypoglycemia occurs when blood glucose levels drop too low. This can happen in individuals with diabetes who take insulin or certain medications that lower blood sugar levels.

Glycogen storage diseases: These are genetic

disorders that affect enzymes involved in glycogen synthesis or breakdown, leading to abnormal glycogen storage in the liver and muscles, impacting glucose metabolism.

Glucose metabolism is a fundamental process that sustains life by converting glucose into ATP, the energy currency of cells. This complex interplay of biochemical reactions ensures a constant supply of energy required for the proper functioning of organs and tissues throughout the body. The regulation of blood glucose levels by insulin and glucagon is crucial for maintaining this balance.

Understanding glucose metabolism is essential not only for individuals with diabetes but for overall health and wellness. Balanced nutrition, regular physical activity, and proper medical management for those with diabetes are key elements in supporting healthy glucose metabolism.