Bioenergetics of the cell

Cell bioenergetics deals with the **flow of energy** in living systems. It is an active area of biological research that includes the study of a thousand different processes in the cell - for example, cellular respiration , metabolic processes that lead to the production and consumption of energy, for example in the form of ATP .

Characteristics

Growth, development and metabolism are some of the main events that bioenergetics investigates in cells and living organisms. The basic prerequisite for the implementation of these events is the **availability and sufficient energy**. A characteristic feature of living organisms is the ability to obtain energy through the transformation of substances in metabolism. In living systems, chemical bonds are constantly formed and destroyed as part of energy transformation.

Obtaining energy is possible from **inorganic and organic sources** . Humans belong to the so-called **heterotrophic organisms** , which means that they obtain energy by oxidizing organic substances. The amount of energy a person gets from food is actually lower than the actual energy contained in the food. The lower energy gain is caused by the loss of heat, which is released during the processing of food in the body.

Living systems need a constant supply of energy to keep the organism running. Through metabolism, the cell obtains and uses energy to perform various functions. The principle lies in two mutually complementary aspects of metabolism - **catabolism and anabolism** .

Catabolism

Catabolism is a part of metabolism, when **simpler molecules are created from more complex molecules by splitting them with energy gain** (an example can be the breakdown of glucose through the process of glycolysis and the subsequent oxidation of pyruvate).

Anabolism

Anabolism is the process of synthesizing more complex molecules from simpler blocks with the consumption of energy (an example can be the biosynthesis of fatty acids).

Energy

From the point of view of energy, chemical reactions can be divided into two groups:

- **Exergonic** are reactions in which **heat is released** (thermodynamically they are preferred); **Gibbs energy = ΔG < 0**.
- **Endergonic** are reactions in which **heat is consumed** (they are most often thermodynamically disadvantageous and therefore need to be coupled with some exergonic reaction in which energy is released, e.g. the splitting of an ATP molecule) **ΔG > 0** .

Gibbs energy is expressed as: **ΔG = ΔH - TΔS** (G = Gibbs energy, H = enthalpy, T = temperature, and S = entropy).

Enzymes as regulators of metabolism

Metabolism **must be regulated** , this role is performed by specific types of **enzymes** with catalytic activity and a number of other substrates. An enzyme is a simple or complex protein with catalytic activity. Enzymes determine the nature and speed of chemical reactions and control most biochemical processes in the body of all living organisms - including humans.

The enzymatic reaction itself usually takes place in the so-called **active site of the enzyme** . There are a huge number of enzymes and it is possible to classify them into six groups: **oxidoreductase, transferase, hydrolase, lyase, isomerase and ligase** . They all share a catalytic function; t**hey reduce the activation energy (Ea)** necessary for the reaction to take place. Enzymes are highly specific and usually convert one or a few substrates in one defined way. Enzyme activity is mainly dependent on substrate concentration, temperature, pH and the presence of activators and inhibitors.

The basic component of enzymes are **proteins** , to which other additional molecules known as cofactors or prosthetic groups involved in catalysis are very often bound.

Coenzymes

Nicotinamide adenine dinucleotide , NAD, is a coenzyme consisting of nicotinamide, adenine, two ribose molecules and two phosphates linked to each other as nucleotides (adenosine diphosphate, to which ribose is attached and nicotinamide after it). In connection with the respiratory chain , the nicotinamide part is important,

which appears in oxidized (NAD+) or reduced (NADH) form

Nicotinamide adenine dinucleotide phosphate (NADP+) is a coenzyme occurring as part of the metabolism of organisms. It is an oxidized form of the reducing agent NADPH .

Chemiosmotic theory

The chemiosmotic theory explains the **synthesis of ATP** from ADP and Pi (residue of phosphoric acid) in balancing the proton gradient – the difference in concentration of hydrogen cations H+, which arises during photosynthesis (between the stroma and the thylakoid cavity) and during cellular respiration. Balancing the difference occurs with ATP synthase and drives the phosphorylation of ADP to ATP, which is actually a reversal of the proton pump mechanism.

The electron transport chain is a cascade of molecules through which electrons are transferred as their energy gradually decreases. This drop in energy can subsequently be linked to a number of important biochemical processes – the electron transport chains in the mitochondria and in the thylakoids of the chloroplasts are used to create a proton gradient across the membrane, which subsequently enables the **synthesis of ATP** . (Cytochrome is the name for proteins bound to membranes and containing heme groups in their molecule ensuring the transfer of electrons so that bound iron ions are alternately reduced and oxidized from Fe2+ to Fe3+ and back.)

Links

Related Articles

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- Metabolism
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- Enzymes
- Cell Energy
- Energy storage in the cell

References

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