Energy storage in the cell

All biochemical events taking place in the cell are dynamic, i.e. the events by which energy is obtained and consumed. As a living organism, the cell has the ability to manage its own energy, store it or use it again from the stored reserves.

Metabolism

Metabolism is a concept that includes all the enzymatic reactions controlled by a living organism. Metabolism can be further divided into catabolic reactions, defined as reactions that involve breaking down larger molecules into smaller structures, and anabolic reactions, whose task is to build more complex substances from smaller blocks for a certain purpose. Catabolic reactions result in energy gain while anabolic reactions consume energy.

In terms of energy gain, organisms are divided into two large groups:

- Phototrophic organisms: obtain chemical energy from light (mostly includes plants).
- Organotrophic organisms: obtain energy from chemical reactions (eg animals).

There is a symbiotic relationship between these two groups of organisms, which could be referred to as the basic concept of metabolism and bioenergetics.

Phototrophic organisms use light energy to construct sugars and oxygen from molecules of water and carbon dioxide. This in turn serves heterotrophic organisms, which oxidize sugars with the help of oxygen through the process of internal respiration, leading to the production of energy. Every living object constantly requires a supply of energy from its surroundings for vital processes. From a bioenergetics perspective, the essence of these processes is the transformation of one type of energy into another. There is a state of balance between the supply and demand of energy.

The balance between anabolic and catabolic processes can vary in both directions over time, and the following cases can occur:

- The organism consumes energy or there is a demand for an energy source in the organism. Energy is produced as catabolic processes prevail over anabolic ones
- The organism's energy intake is greater than its output - energy accumulates and the supply is greater than the demand. The organism has to somehow deal with such an amount of excess, in other words - it has to store it (meaning anabolic processes will prevail over catabolic one).

The essence of energy storage in the cell

This concept can be illustrated nicely using the example of food processed by the organism after intake.

The sugars, or glucose, is brought to the liver. About half of the substance is converted into glycogen while the rest passes through the liver into the blood. Glucose enters erythrocytes and the CNS. This is done without the need for insulin and glucose is then further metabolized there to produce energy. The remaining glucose also enters skeletal muscle cells, although it requires the aid of insulin in this case. Here it is either consumed or stored in the form of glycogen as an energy reserve. After the liver's capacity for glycogen synthesis is exceeded, glucose is converted into triacylglycerols and stored as an energy reserve in adipose tissue.

Amino acids (created by the breakdown of proteins) are also transported by the blood to the liver and other tissues. In the liver and other tissues, they serve as basic building blocks for protein synthesis, with others being transported into the blood by binding to specific carriers. There is no organ in the organism that serves as a reservoir of amino acids or nitrogen. Therefore, the excess of amino acids is mainly broken down into glucose, and the nitrogenous residue is excreted as urea.

Lipids enter the blood as chylomicrons via the lymphatic system. When associated with specific proteins, lipids are transported by the blood and absorbed by tissues for metabolic needs or transported to fat tissue, where they are stored.

Postprandial nutrient metabolism

If a person is lying down and at rest after a meal, the largest part of the nutrients transferred into the body will be converted into stored fats during digenstion. In particular, it occurs after exceeding the capacity for glycogen synthesis (in the liver and muscles). Additional excess glucose (whether received in the pure form of glucose or substances converted into glucose secondarily) is stored in the form of triacylglycerols in adipose tissue. This happens because the concentration of ATP prevails over ADP in the cells (if no work is done, no ATP is consumed) and both the process of glycolysis and the process of aerobic phosphorylation are greatly slowed down in this state. However, if motor activity begins to develop after a meal, then the way nutrients are transformed changes significantly. Nutrients will primarily be used as a source of energy. These reserves of primarily usable nutrients are used up and only then can the energy reserves, which the cell has stored in a reserve of mainly fats – i.e. reserve triacylglycerols from adipose tissue, be depleted.

Links

References

- Biochemistry in pictures and diagrams; Prof. MD RNDr. Jan Musil, DrSc., Avicenum 1990
- Harper's Biochemistry; Murray K. Robert, Daryl K. Granner; Publishing house HaH, 2002