Department of biology

2025-2026

((Microbial Physiology))

Stage (-3-)

LEC- ((9))

Fermentation

By

Asst.Lec Dhuha.s. Al-khafaji

Fermentation

Energy can also be produced anaerobically through fermentation reactions, in which organic compounds act as both electron donors and electron acceptors. One example of fermentation is lactic acid fermentation, in which the bacterium Streptococcus lactis breaks down glucose molecules into lactic acid, which accumulates in the environment as the main end product of fermentation.

This process occurs similarly to anaerobic glycolysis, where pyruvic acid is formed. Pyruvic acid is then converted into lactic acid during fermentation through the action of NADH + H^+, which is generated earlier during glycolysis.

—

Other Sources of Energy

A. Lipid Catabolism

Although glucose is considered the most commonly used source for energy production in living cells, many microorganisms utilize alternative energy sources such as lipids and proteins when carbohydrates are depleted.

Lipids are hydrolyzed in the presence of the enzyme lipase with the addition of water, producing fatty acids and glycerol. Glycerol is metabolized to form dihydroxyacetone phosphate (DHAP), which enters the glycolytic pathway as an intermediate compound, leading to the production of pyruvic acid, which then enters the Krebs cycle.

Fatty acids, on the other hand, are oxidized through β-oxidation, producing multiple molecules of acetyl-CoA, which enter the Krebs cycle to complete their oxidation.

—

B. Protein Catabolism

Proteins serve as sources of carbon and nitrogen for many heterotrophic microorganisms. Protein molecules are relatively large and cannot pass through the cell membrane unless they are first broken down into smaller units.

Bacterial cells secrete extracellular proteolytic enzymes known as proteases, which break proteins into smaller fragments called peptides. These peptides can cross the cell membrane. Once inside the cell, bacteria secrete enzymes known as peptidases, which further hydrolyze the peptides into amino acids.

These amino acids can enter the Krebs cycle as intermediate compounds such as acetyl-CoA, α-ketoglutarate, fumarate, or succinate, where they undergo complete oxidation through the electron transport chain.

—

Uses of Energy

The energy produced in the form of ATP from the previously mentioned energy-yielding reactions is utilized in various cellular pathways that serve the cell itself. These include vital biological processes such as the synthesis of macromolecules, including nucleic acids and proteins.

Energy is also used in the construction of cellular components such as enzymes, lipids, and carbohydrates, as well as in the transport of nutrients across the cytoplasmic membrane and the maintenance of the cell's physical activities.

In fact, most metabolic pathways that are considered catabolic pathways (energy-releasing) are simultaneously anabolic pathways, meaning they serve dual purposes.

The intermediate compounds produced during catabolic pathways are reused, in the presence of ATP, to synthesize various anabolic compounds essential for maintaining cellular continuity and viability.

Thus, while catabolic reactions (energy release) occur within the cell, anabolic reactions necessary for cellular maintenance occur simultaneously.