6.1C: Metabolic Pathways

An anabolic pathway requires energy and builds molecules while a catabolic pathway produces energy and breaks down molecules.

Learning Objectives

- Describe the two major types of metabolic pathways

Key Points

- A metabolic pathway is a series of chemical reactions in a cell that build and breakdown molecules for cellular processes.
- Anabolic pathways synthesize molecules and require energy.
- Catabolic pathways break down molecules and produce energy.
- Because almost all metabolic reactions take place non-spontaneously, proteins called enzymes help facilitate those chemical reactions.

Key Terms

- **catabolism**: destructive metabolism, usually including the release of energy and breakdown of materials
- **enzyme**: a globular protein that catalyses a biological chemical reaction
- **anabolism**: the constructive metabolism of the body, as distinguished from catabolism
Metabolic Pathways

The processes of making and breaking down carbohydrate molecules illustrate two types of metabolic pathways. A metabolic pathway is a step-by-step series of interconnected biochemical reactions that convert a substrate molecule or molecules through a series of metabolic intermediates, eventually yielding a final product or products. For example, one metabolic pathway for carbohydrates breaks large molecules down into glucose. Another metabolic pathway might build glucose into large carbohydrate molecules for storage. The first of these processes requires energy and is referred to as anabolic. The second process produces energy and is referred to as catabolic. Consequently, metabolism is composed of these two opposite pathways:

1. **Anabolism** (building molecules)
2. **Catabolism** (breaking down molecules)

Figure 1: Anabolic and catabolic pathways: Anabolic pathways are those that require energy to synthesize larger molecules. Catabolic pathways are those that generate energy by breaking down larger molecules. Both types of pathways are required for maintaining the cell’s energy balance.

Anabolic Pathways

Anabolic pathways require an input of energy to synthesize complex molecules from simpler ones. One example of an anabolic pathway is the synthesis of sugar from CO₂. Other examples include the synthesis of large proteins from amino acid building blocks and the synthesis of new DNA strands from nucleic acid building blocks. These processes are critical to the life of the cell, take place constantly, and demand energy provided by ATP and other high-energy molecules like NADH (nicotinamide adenine dinucleotide) and NADPH.

Catabolic Pathways

Catabolic pathways involve the degradation of complex molecules into simpler ones, releasing the chemical energy stored in the bonds of those molecules. Some catabolic pathways can capture that energy to produce ATP, the molecule used to power all cellular processes. Other energy-storing molecules, such as lipids, are also broken down through similar catabolic reactions to release energy and make ATP.

Importance of Enzymes

Chemical reactions in metabolic pathways rarely take place spontaneously. Each reaction step is facilitated, or catalyzed, by a protein called an enzyme. Enzymes are important for catalyzing all types of biological reactions: those that require energy as well as those that release energy.