

21.3: An Overview of Metabolism and Energy Production

Learning Objectives

- Describe the stages of catabolism from food to ATP.

Metabolism describes all of the chemical reactions that take place in an organism. A *metabolic pathway* is a series of interconnected biochemical reactions that convert a substrate molecule or molecules, step-by-step, through a series of metabolic intermediates, eventually yielding a final product or products. In the case of sugar metabolism, the first metabolic pathway synthesized sugar from smaller molecules, and the other pathway broke sugar down into smaller molecules. These two opposite processes—the first requiring energy and the second producing energy—are referred to as anabolic (building) and catabolic (breaking down) pathways, respectively. Consequently, metabolism is composed of building (**anabolism**) and degradation (**catabolism**).

It is important to know that the chemical reactions of metabolic pathways don't take place spontaneously. Each reaction step is facilitated, or catalyzed, by enzymes. Enzymes are important for catalyzing all types of biological reactions—those that require energy as well as those that release energy. See a simple graphic below, (Figure 21.3.1).

Metabolic pathways

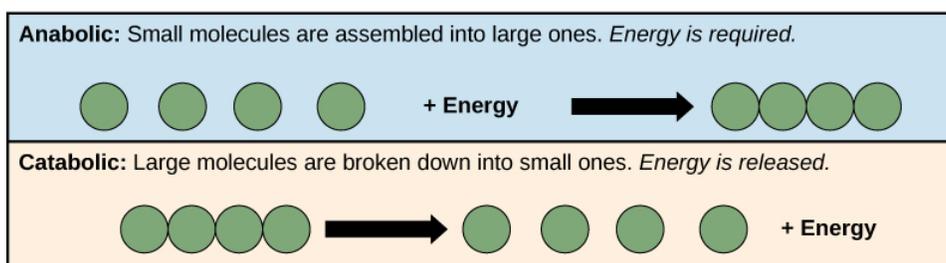


Figure 21.3.1: Anabolic pathways are those that require energy to synthesize larger molecules. Catabolic pathways are those that generate energy by breaking down larger molecules. Both types of pathways are required for maintaining the cell's energy balance.

We can think of catabolism as occurring in three stages (Figure 21.3.1). In stage I, carbohydrates, fats, and proteins are broken down into their individual monomer units: carbohydrates into simple sugars, fats into fatty acids and glycerol, and proteins into amino acids. One part of stage I of catabolism is the breakdown of food molecules by hydrolysis reactions into the individual monomer units—which occurs in the mouth, stomach, and small intestine—and is referred to as **digestion**.

In stage II, these monomer units (or building blocks) are further broken down through different reaction pathways, one of which produces ATP, to form a common end product, **Acetyl-coenzyme A**, that can then be used in stage III to produce even more ATP. In this chapter, we will look at each stage of catabolism—as an overview and in detail.

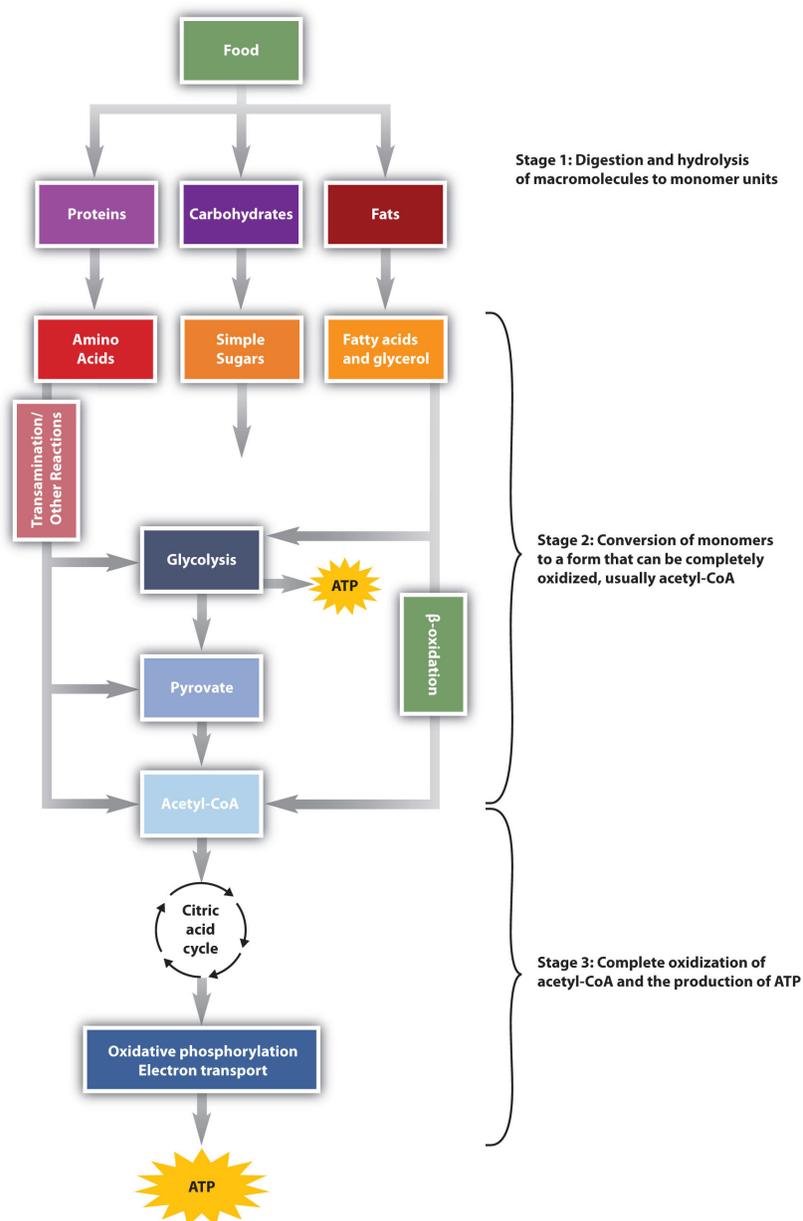


Figure 21.3.1: Energy Conversions. The conversion of food into cellular energy (as ATP) occurs in three stages.

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