Proteins as Enzymes

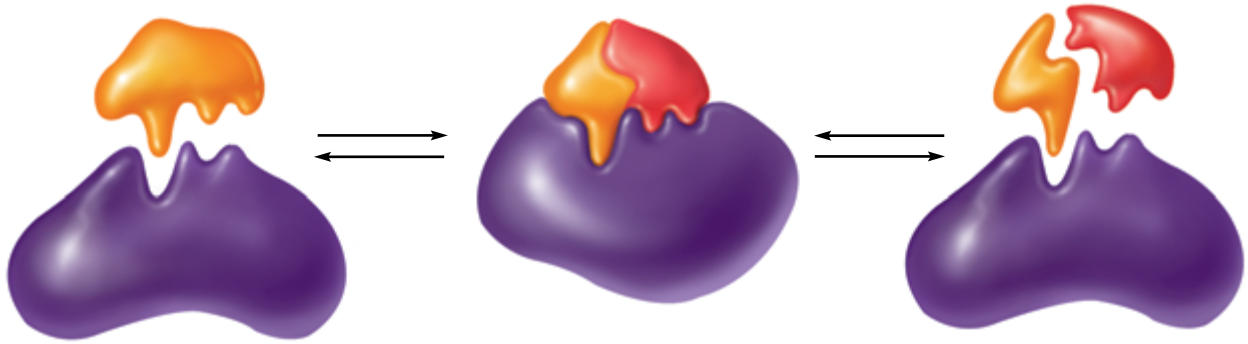
An **enzyme** *is a protein that catalyzes a biochemical reaction.* Enzymes make up the largest and most highly specialized class of proteins. All living things have enzymes; as many as 3000 enzymes can be found in a single cell. Most enzymes are water-soluble, globular proteins. The amino acid side chains and the three-dimensional shape of enzymes play a very important role in the enzymatic activity. You will remember from Chapter 17 that catalysts speed up a reaction but do not change as a result of the reaction. An enzyme also does not change the amount of product that is formed in a reaction; it only decreases the time it takes to form the product. Enzymes catalyze both decomposition and synthesis reactions.

Enzymes are also very efficient. For example, the enzyme *carbonic anhydrase* acts on carbonic acid to break it down into carbon dioxide and water. A single molecule of carbonic anhydrase can break down 36 million carbonic acid molecules in 1 minute! Carbon dioxide is carried from all the parts of the body to the lungs as carbonic acid in the blood. In the lungs, carbonic acid is broken down by carbonic anhydrase into CO_2 and water vapor and then is removed from the lungs as a person exhales.

Enzyme Specificity

In addition to being highly efficient, enzymes are very specific. Often, they catalyze just a single reaction as carbonic anhydrase does. In another example, the enzyme peroxidase is responsible only for the decomposition of hydrogen peroxide to water and oxygen. Have you ever put hydrogen peroxide on a minor cut? In the bottle, hydrogen peroxide is relatively stable, but as soon as it comes into contact with your wound, the peroxidase enzyme in the blood catalyzes its decomposition. You see bubbling, which is the result of the gaseous oxygen from the decomposing hydrogen peroxide. As you can see in **Figure 12,** enzymes act by binding to a specific *substrate* molecule. For example, hydrogen peroxide is the substrate in the

FIGURE 12



(a) The enzyme reacts with the substrate in a fast, reversible reaction.

(b) The substrate-enzyme complex can either revert to the reactants or . . .

(c) . . . proceed to the products.