Figure 6-10

The catalytic cycle is an enzyme. Enzymes increase the speed with which chemical reactions occur but are not altered themselves as they do this. In the reaction illustrated here, the enzyme is splitting the sugar sucrose (the sugar present in most candy) into its two parts, the simpler sugars glucose and fructose. After the enzyme releases the resulting glucose and fructose fragments, it is then ready to bind another molecule of sucrose and run through the catalytic cycle once again.

which catalysis occurs. For catalysis to occur, the molecule on which the enzyme acts, called a substrate, must fit precisely into the surface depression so that many of its atoms nudge up against atoms of the enzyme. The substrate fits into the active site of the enzyme like a foot into a tight-fitting shoe, in very close contact. Proteins are not rigid, however, and in some cases the binding of substrate may induce the protein to adjust its shape slightly, allowing a better fit.

When a substrate molecule binds to the active site of an enzyme, amino acid side groups of the enzyme are placed against certain bonds of the substrate, just as when you sit in a chair, certain parts of you press against the seat (Figure 6-10). These amino acid side groups chemically interact with the substrate, usually by stressling or distorting a particular bond, lowering the activation energy needed to break the bond.

Enzymes typically catalyze only one or a few different chemical reactions because they are very “picky” in their choice of substrate. The active site of each kind of enzyme is shaped so that only a certain substrate molecule will fit into it.

Factors Affecting Enzyme Activity

The activity of an enzyme is affected by any change in conditions that alters its three-dimensional shape, including changes in temperature or pH or the binding to the protein of specific chemicals that regulate the enzyme’s activity.

Temperature. The shape of a protein is determined by hydrogen bonds that hold its arms in particular positions and also by the tendency of noncharged (“nonpolar”) segments of the protein to avoid water. Chemists call interactions of this second kind hydrophobic, or water-hating, interactions. Both hydrogen bonds and hydrophobic interactions are easily disrupted by slight changes in temperature. Most human enzymes function best within a relatively narrow temperature range between 35° and 40° C (close to body temperature). Below this temperature level, the bonds that determine protein shape are not flexible enough to permit the induced change in shape that is necessary for catalysis; above this temperature, the bonds are too weak to hold the protein’s arms in the proper position. In contrast, bacteria that live in hot springs have proteins with stronger bonding between their arms and therefore can function at temperatures of 70° C or higher (Figure 6-11, A).

pH. A third kind of bond that acts to hold the arms of proteins in position is the bond that forms between op-