protein.[10] Since that time, thousands of enzymes have been identified as key mediators of a wide range of biological functions such as signal transduction, muscle contraction, cell size regulation, viral infection, and fluorescence. Six classes of enzymes have been identified to date (Figure 3.10). Given their wide range of function and importance, it

Classification	Function	Examples
Oxidoreductases	Catalyzes redox chemistry, transfering electrons from one molecule to another, often with use of a cofactor	HMG-CoA Reductase, Cyclooxygenase, Monoamine Oxidase, Alcohol Dehydrogenase
Transferase	Catalyzes the transfer of a functional group from one compound to another.	Tyrosine kinase, Reverse Transcriptase, DNA Methyltransferase, Glycosyltransferases
Hydrolase	Catalyzes the hydrolysis of a chemical bond.	HIV Protease, Tyrosine Phosphatase, Carboxypeptidases, Influenza Neuraminidase
Lyase	Catalyzes the cleavage of a chemical bond in a manner other than hydrolysis or oxidation, often forming a double bond or ring.	Adenylate Cyclase, Pyruvate Decarboxylase, Maleate Hydratase, Isocitrate Lyase
Isomerase	Catalyzes structural rearrangement to form isomers of the substrate.	Topoisomerase, Retinol Isomerase, Mannose Isomerase, Isocitrate Epimerase
Ligase	Catalyzes the joining of large molecules with a chemical bond.	DNA Ligase, RNA Ligase, E3 Ubiquitin Ligase, Tyrosine—tRNA Ligase

FIGURE 3.10 Representative examples of six classes of enzymes.

should be no surprise that enzymes are often the target of drug discovery programs.

Structurally, enzymes are composed of a series of amino acids that folds and twists to form a specific three-dimensional shape based on the chemical interactions described earlier. The number of amino acids required for enzymatic activity is highly variable. One of the smallest enzymes, 4-oxalocrotonate tautomerase, which converts 2-hydroxymuconate into 2-oxo-3-hexenedioate, is comprised of just 62 amino acids.[11] On the other hand, fatty acid synthase, a key enzyme in the synthesis of fatty acids, is one of the largest enzymes with over 2500 amino acid residues.[12]

Despite their potentially immense size, enzymes are highly specific in nature, typically catalyzing only a single reaction on a very narrow range of substrates, and the business section of the protein, the active site, is only a small portion of the full length enzyme (Figure 3.11).[13] The remainder of the enzyme is essentially scaffolding required to create the active site, much in the same manner as framework of a building provides structural support that creates rooms within a building. The active site itself can be viewed as a cleft or crevice within the framework of an enzyme created by the residues surrounding the site. The amino acids that form the walls of the active site dictate an enzyme's specificity using the same kinds of interactions that drive the shape of the overall protein. The walls of the active site provide steric limitation on what will physically fit within the active site, and the various amino acid side chains can form positive interactions with a substrate. Aromatic side chains (e.g., phenylalanine) provide opportunities for π-stacking and π-cation interactions