19.3: Enzyme Classification

Learning Objectives

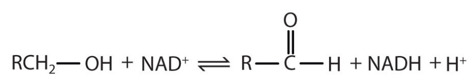
- Objective 1
- Objective 2

Hundreds of enzymes have been purified and studied in an effort to understand how they work so effectively and with such specificity. The resulting knowledge has been used to design drugs that inhibit or activate particular enzymes. An example is the intensive research to improve the treatment of or find a cure for acquired immunodeficiency syndrome (AIDS). AIDS is caused by the human immunodeficiency virus (HIV). Researchers are studying the enzymes produced by this virus and are developing drugs intended to block the action of those enzymes without interfering with enzymes produced by the human body. Several of these drugs have now been approved for use by AIDS patients.

Enzyme Nomenclature

Most enzymes can be recognized because they have the family name ending *–ase*. However, the first enzymes to be discovered were named according to their source or method of discovery. The enzyme *pepsin*, which aids in the hydrolysis of proteins, is found in the digestive juices of the stomach (Greek *pepsis*, meaning “digestion”). *Papain*, another enzyme that hydrolyzes protein (in fact, it is used in meat tenderizers), is isolated from papayas.

In addition to the family name, more systematic enzyme names will give two sepcific pieces of information: the first part is the *substrate* upon which the enzyme acts, and the second part is the *type of reaction* it catalyzes. For example, alcohol dehydrogenase (Figure $19.3.1$) catalyzes the *oxidation* of an *alcohol* to an aldehyde.



Enzyme Classification

As more enzymes were discovered, chemists recognized the need for a more systematic and chemically informative identification scheme. In the current numbering and naming scheme, under the oversight of the Nomenclature Commission of the International Union of Biochemistry, enzymes are arranged into *six groups* according to the general type of reaction they catalyze (Table $19.3.1$), with subgroups and secondary subgroups that specify the reaction more precisely.

Each enzyme is assigned a four-digit number, preceded by the prefix EC—for enzyme classification—that indicates its group, subgroup, and so forth. This is demonstrated in Table $19.3.2$ for alcohol dehydrogenase.

Table 19.3.1: Classes of Enzymes

Main Class	Type of Reaction Catalyzed	Subclasses	Examples
Oxidoreductases	oxidation-reduction reactions	*Dehydrogenases* catalyze oxidation-reduction reactions involving hydrogen.	Alcohol dehydrogenase
		Oxidases catalyze oxidation by addition of O_2 to a substrate.	
		Reductases catalyze reactions in which a substrate is reduced.	
Transferases	transfer reactions of functional groups	*Transaminases* catalyze the transfer of amino group.	
		Kinases catalyze the transfer of a phosphate group.	Phosphofructokinase
Hydrolases	reactions that use water to break a chemical bond	*Lipases* catalyze the hydrolysis of lipids	

Main Class	Type of Reaction Catalyzed	Subclasses	Examples
		Proteases catalyze the hydrolysis of proteins	
		Amylases catalyze the hydrolysis of carbohydrates	
		Nucleases catalyze the hydrolysis of DNA and RNA	
Lyases	reactions in which functional groups are added or removed without hydrolysis	*Decarboxylases* catalyze the removal of carboxyl groups.	
		Deaminases catalyze the removal of amino groups.	
		Dehydratases catalyze the removal of water.	
		Hydratases catalyze the addition of water.	Fumarase
Isomerases	reactions in which a compound is converted to its isomer	*Isomerases* may catalyze the conversion of an aldose to a ketose.	Triose Phosphate Isomerase
		Mutases catalyze reactions in which a functional group is transferred from one atom in a substrate to another.	
Ligases	reactions in which new bonds are formed between carbon and another atom; energy is required	*Synthetases* catalyze reactions in which two smaller molecules are linked to form a larger one.	
		Carboxylases catalyze the addition of CO_2 using ATP	Pyruvate Carboxylase

Table 19.3.2: Assignment of an Enzyme Classification Number

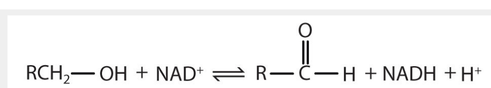
Alcohol Dehydrogenase: EC 1.1.1.1	
The first digit indicates that this enzyme is an oxidoreductase; that is, an enzyme that catalyzes an oxidation-reduction reaction.	
The second digit indicates that this oxidoreductase catalyzes a reaction involving a primary or secondary alcohol.	
The third digit indicates that either the coenzyme NAD^+ or $NADP^+$ is required for this reaction.	
The fourth digit indicates that this was the first enzyme isolated, characterized, and named using this system of nomenclature.	
The systematic name for this enzyme is *alcohol:NAD$^+$ oxidoreductase*, while the recommended or common name is alcohol dehydrogenase.	
Reaction catalyzed:	

***Figure 19.3.1*:** *Structure of the alcohol dehydrogenase protein (E.C.1.1.1.1) (EE ISOZYME) complexed wtih nicotinamide adenini dinulceotide (NAD) and zinc (PDB: 1CDO).*

Summary

An enzyme is a biological catalyst, a substance that increases the rate of a chemical reaction without being changed or consumed in the reaction. A systematic process is used to name and classify enzymes.
