ENZYMOLOGY

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ENZYMES

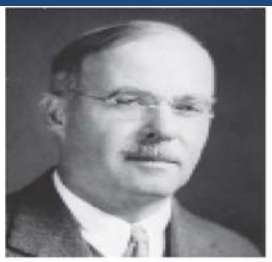
- With the exception of a small group of catalytic RNA molecules, all enzymes are **proteins**.
- Enzymes, like other proteins, have molecular weights ranging from about 12,000 to more than 1 million.
- Some enzymes require no chemical groups for activity other than their amino acid residues. Others require an additional chemical component called a **cofactor** (inorganic ions, such as Fe2, Mg2, Mn2, or Zn2) , or a complex organic or metalloorganic molecule called a **coenzyme**.
- Some enzymes require *both a coenzyme* and one or more metal ions for activity.

A coenzyme or metal ion that is very tightly or even covalently bound to the enzyme protein is called a **prosthetic group.**

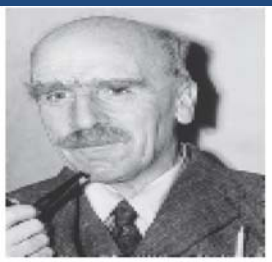
The protein part of such an enzyme is called the **apoenzyme or apoprotein.**

A complete, catalytically active enzyme together with its bound coenzyme and/or metal ions is called a **holoenzyme.**

Eduard Buchner, 1860–1917



James Sumner, 1887–1955



J. B. S. Haldane, 1892–1964

TABLE 6–1 Some Inorganic Elements That Serve as Cofactors for Enzymes

Cu^{2+}	Cytochrome oxidase
Fe^{2+} or Fe^{3+}	Cytochrome oxidase, catalase, peroxidase
K^{+}	Pyruvate kinase
Mg^{2+}	Hexokinase, glucose 6-phosphatase, pyruvate kinase
Mn^{2+}	Arginase, ribonucleotide reductase
Mo	Dinitrogenase
Ni^{2+}	Urease
Se	Glutathione peroxidase
Zn^{2+}	Carbonic anhydrase, alcohol dehydrogenase, carboxypeptidases A and B

TABLE 6–2 Some Coenzymes That Serve as Transient Carriers of Specific Atoms or Functional Groups

Coenzyme	*Examples of chemical groups transferred*	*Dietary precursor in mammals*
Biocytin	CO_2	Biotin
Coenzyme A	Acyl groups	Pantothenic acid and other compounds
5′-Deoxyadenosylcobalamin (coenzyme B_{12})	H atoms and alkyl groups	Vitamin B_{12}
Flavin adenine dinucleotide	Electrons	Riboflavin (vitamin B_2)
Lipoate	Electrons and acyl groups	Not required in diet
Nicotinamide adenine dinucleotide	Hydride ion ($:H^-$)	Nicotinic acid (niacin)
Pyridoxal phosphate	Amino groups	Pyridoxine (vitamin B_6)
Tetrahydrofolate	One-carbon groups	Folate
Thiamine pyrophosphate	Aldehydes	Thiamine (vitamin B_1)

Enzymes Are Classified by the Reactions They Catalyze

TABLE 6–3 International Classification of Enzymes

No.	*Class*	*Type of reaction catalyzed*
1	Oxidoreductases	Transfer of electrons (hydride ions or H atoms)
2	Transferases	Group transfer reactions
3	Hydrolases	Hydrolysis reactions (transfer of functional groups to water)
4	Lyases	Addition of groups to double bonds, or formation of double bonds by removal of groups
5	Isomerases	Transfer of groups within molecules to yield isomeric forms
6	Ligases	Formation of C—C, C—S, C—O, and C—N bonds by condensation reactions coupled to ATP cleavage

- **Enzyme Commission number (E.C. number)**

- The E.C. number for hexokinase or ATP:glucose phosphotransferase is 2.7.1.1.
- The first number (2) denotes the class name (transferase);
- The second number (7), the subclass (phosphotransferase);
- The third number (1), a phosphotransferase with a hydroxyl group as acceptor;
- The fourth number (1), D-glucose as the phosphoryl group acceptor.