
بسم الله
الرحمن الرحيم

Enzymes (1)

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Objectives:

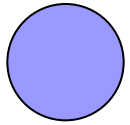
- To define enzyme and to know its importance.
- To be able to mention general properties of enzymes and included definitions.
- To describe Enzymes classification and nomenclatures
- To understand Enzyme kinetics

Enzymes

- Enzymes are specific biological proteins that catalyze biochemical reactions without altering the equilibrium point of the reaction, or being consumed or changed in composition.
- The other substances in the reaction are converted to products.
- Involved in all essential body reactions.

Definition Elements

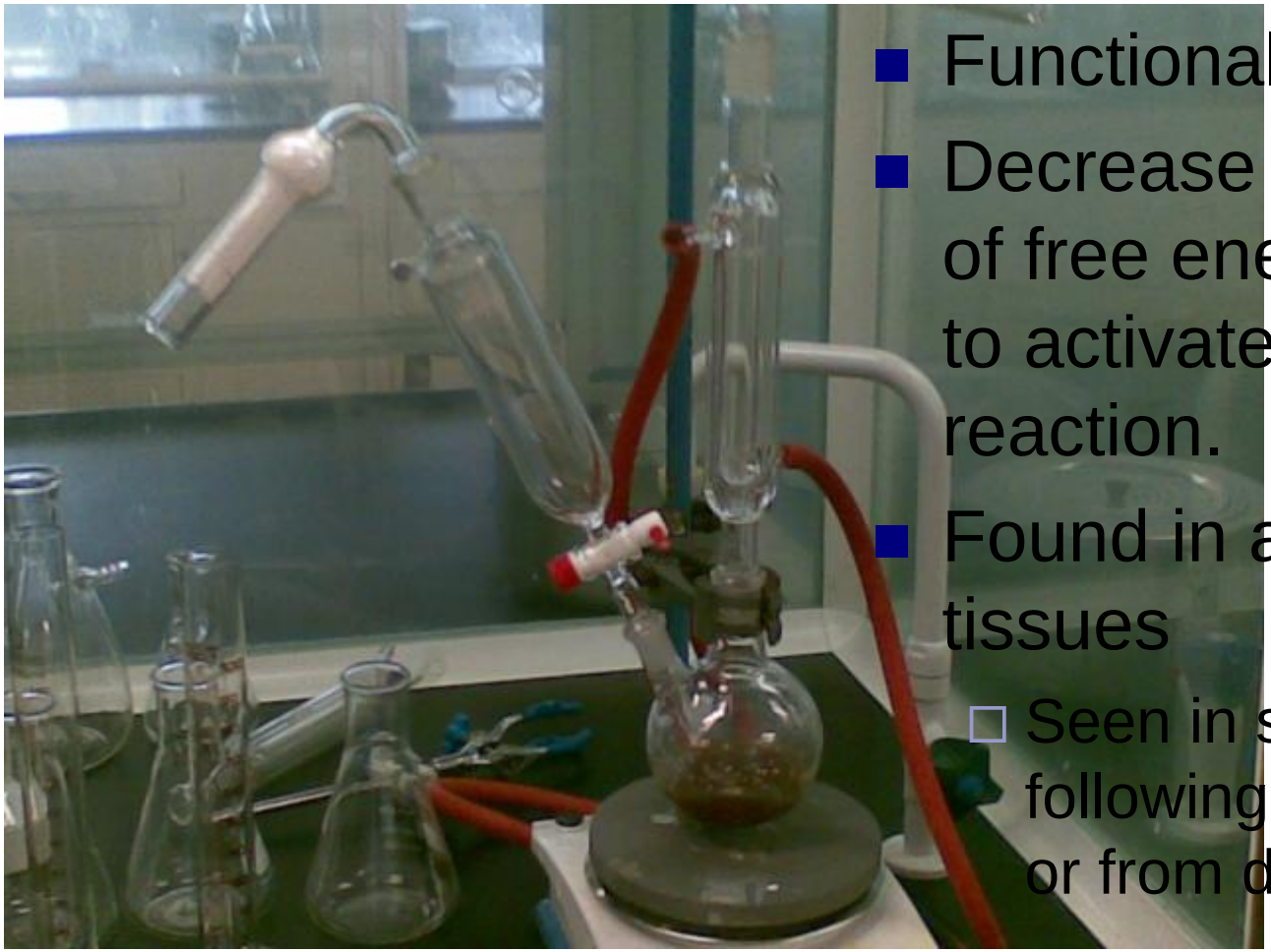
- Enzymes are
  1. specific
  2. biological
  3. proteins
  4. that catalyze biochemical reactions
  5. without altering the equilibrium point of the reaction,
  6. or being consumed or changed in composition.



Why there are enzymes?

- The catalyzed reaction are specific and essential to physiological function, such as energy production, nerve conduction , muscle contraction and nutrition degradation.

Is it important ???



- Functional proteins
- Decrease the amount of free energy needed to activate a specific reaction.
- Found in all body tissues
  - Seen in serum following cellular injury or from degraded cells

Why we are interested in enzymes?

- Enzymes are directly related to health if it is present in place, in normal concentration and without interference in their functional .
- Enzymes are directly related to disease if it is not present in place, or in abnormal concentration or with functional interference.
- Diseases may alter enzymes concentration and or activity as will follow.
- Enzymes assays are essential both in diagnosis and prognosis of so many diseases.

General Properties of Enzymes

1ry ,2ry, 3ry and 4ry Enzyme Structure

1- As a protein each enzyme contains a specific amino acid sequence (primary structure), with the resultant polypeptide chains twisting (secondary structure), which then folds (tertiary structure) and results in structural cavities. If an enzyme contains more than one polypeptide unit , the quaternary structure refers to the special relationships between the subunits.

Enzyme molecular sites

2- Each enzyme contains an active site (often a water-free cavity) where the substance on which the enzyme acts (the substrate) interacts with particular charged amino acid residues. An allosteric site (a cavity other than the active site) may bind regulator.

General Properties of Enzymes……. Cont.

Isoenzyme

3- The enzyme may exist in different forms (isoenzyme) within the same individual (all the forms have the same catalytic function). The different forms may be differentiated from each other based on certain physical properties such as electrophoretic mobility, solubility or resistance to inactivation. The IUB suggesting restricting the use of the term isoenzyme to multiple forms of genetic origin.

Isoform

4- An enzyme isoform results when an enzyme is subjected to post-translational modification in properties and function.

General Properties of Enzymes……. Cont.

Cofactors, activators, coenzymes and prosthetic group.

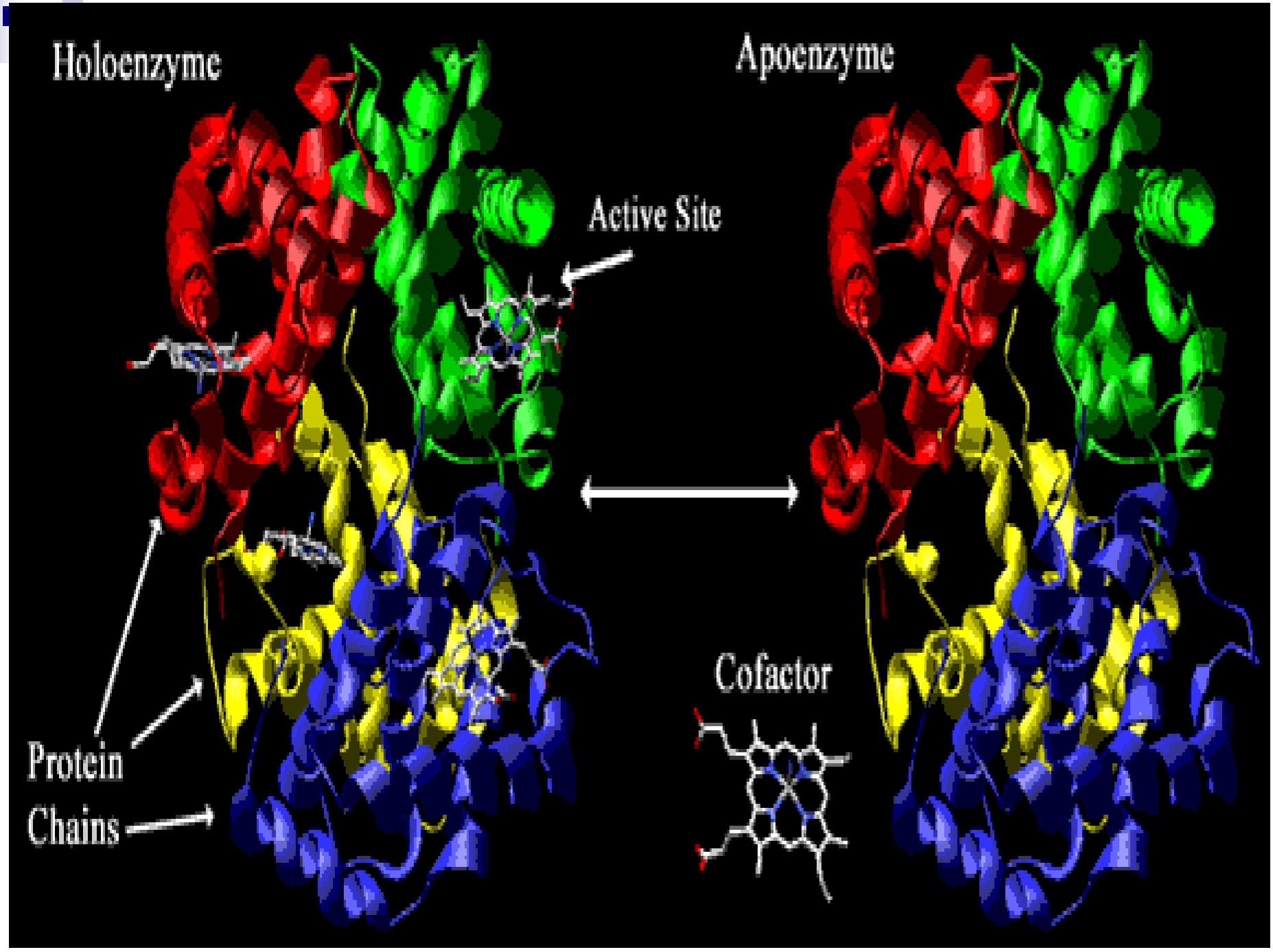
5- In addition to the basic enzyme structure, an non-protein molecule, called a cofactor, may be necessary for enzyme activity. Inorganic cofactor, such as Cl^- , Mg^{2+}, are called activators.

A coenzyme is an organic cofactor, such as NAD. When bound tightly to the enzyme, the coenzyme is called prosthetic group.

Apo, Holo, Proenzyme and zymogen

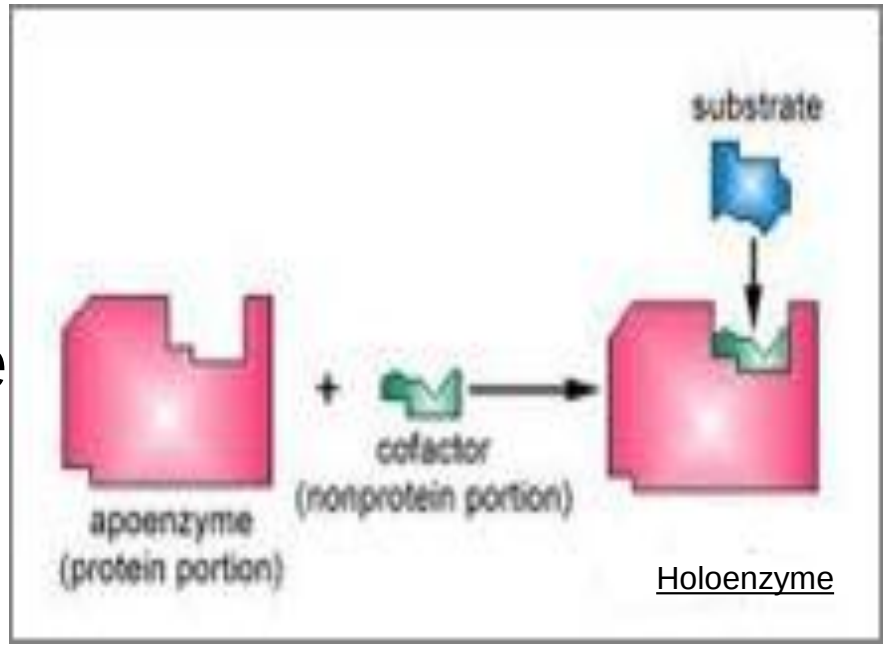
6- The enzyme protein (apoenzyme), with its respective coenzyme forms a complete active system (holoenzyme).

Some enzymes are originally secreted from the organ of production in structurally inactive form, called proenzyme or zymogen.


Holoenzyme
Apoenzyme
Active Site
Protein
Chains
Cofactor

General Properties of Enzymes

- Holoenzyme
  - Functional unit
  - Consists of:
    - Apoenzyme
    - Cofactor/coenzyme
- Proenzyme/zymogen
  - Inactive enzyme

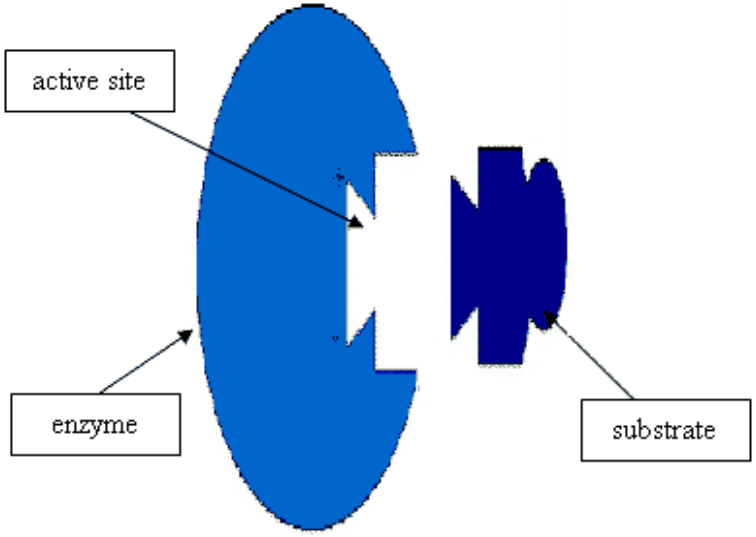


General Properties of Enzymes

- Role
  - Increase reaction rates while not being consumed or altered

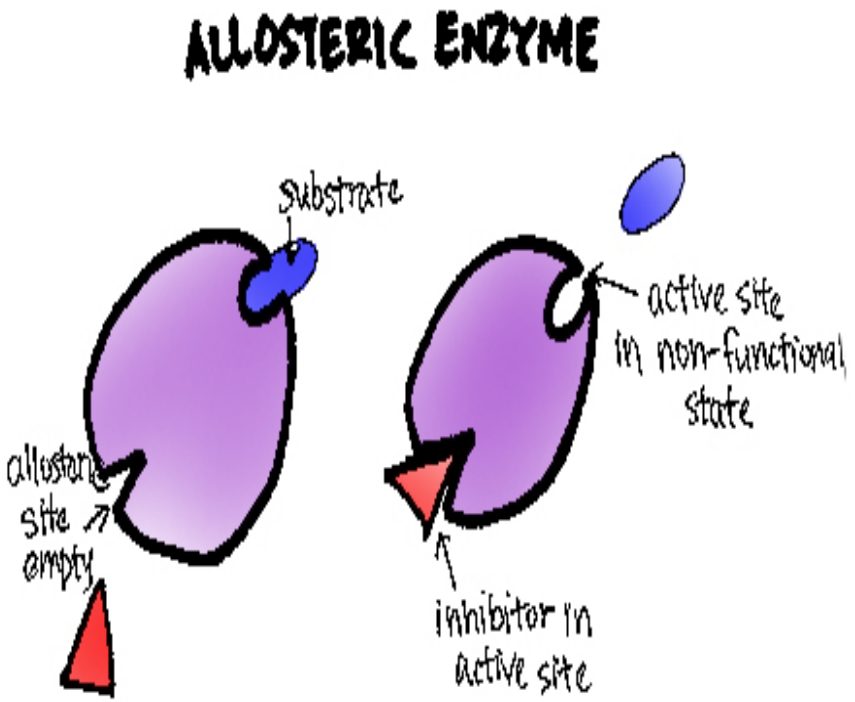
Definitions and Related Terms

- Active site
  - Specific area of the enzyme structure that participates in the reaction(s)/interacts with the substrate



Definitions and Related Terms

- Allosteric site
  - Non-active site
  - May interact with other substances resulting in overall enzyme shape change



Definitions and Related Terms

- Isoenzymes
  - Structurally different enzymes that catalyze the same reaction
    - Multi molecular form
    - Similar catalytic activity
    - Differing biochemical or immunological characteristics
    - Can detect by different electrophoresis patterns, absorption patterns, or reaction with specific antibodies

Definitions and Related Terms

- Cofactor
  - Non-protein substances required for normal enzyme activity
  - Types
    - Activator: inorganic material such as minerals
      - (Ca^{2+}, Fe^{2+})
    - Co-enzymes: organic in nature
      - (ATP, ADP, nicotinamide)


BRAVO !

Enzyme Nomenclature

- Historical
  - ID of individual enzymes was made using the name of the substrate that the enzyme acted upon and adding “ase” as the suffix
  - Modifications were often made to clarify the reaction
  - International Union of Biochemistry (IUB) in 1955 appointed a commission to study and make recommendations on nomenclature for standardization

The six major classes of enzymes

1- Oxidoreductases -catalyze oxidation-reduction reactionstwo between two substrates:

1. **dehydrogenases**
2. **oxidases**
3. **reductases**
4. **peroxidase**
5. **oxygenase (mono, di...)**

2-Transferases -catalyze group-trasfer (other than H) reactions

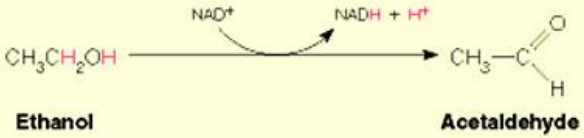
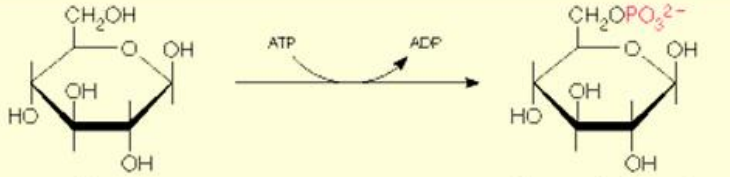
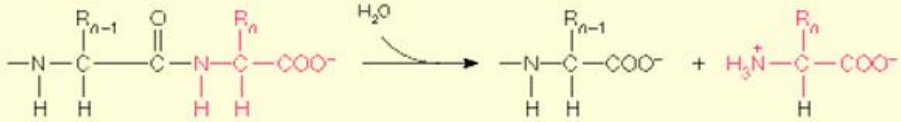
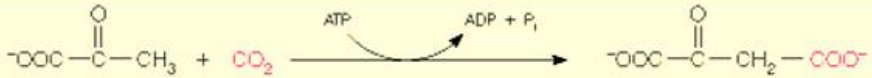
3- Hydrolases -catalyze hydrolysis (esterases, phosphatases, peptidases)

4- Lyases - catalyze lysis of substrate (generating a double bond)

5- Isomerases -catalyse structural change within a single molecule

6- Ligases -catalyze ligation or joining two substrates

Classes of Enzymes

Class	Example (reaction type)	Reaction Catalyzed
1. Oxidoreductases	Alcohol dehydrogenase (EC 1.1.1.1) (oxidation with NAD^+)	 Ethanol — Acetaldehyde
2. Transferases	Hexokinase (EC 2.7.1.2) (phosphorylation)	 D-Glucose — D-Glucose-6-phosphate
3. Hydrolases	Carboxypeptidase A (EC 3.4.17.1) (peptide bond cleavage)	 C-terminus of polypeptide — Shortened polypeptide — C-terminal residue
4. Lyases	Pyruvate decarboxylase (EC 4.1.1.1) (decarboxylation)	 Pyruvate — Acetaldehyde
5. Isomerases	Maleate isomerase (EC 5.2.1.1) (*cis–trans* isomerization)	 Maleate — Fumarate
6. Ligases	Pyruvate carboxylase (EC 6.4.1.1) (carboxylation)	 Pyruvate — Oxaloacetate

Enzyme Nomenclature: IUB

- Components
  - Systematic name
    - Describes the nature of the reaction catalyzed
    - Example: alpha 1,4-glucagon-4-gluconohydrolase
  - Recommended name
    - Working or practical name
    - Example: α amylase
  - Numerical code
    - First digit places enzyme in a class
    - Second and third digit represent subclass(s) of the enzyme
    - Fourth digit specific serial number in a subclass
    - Example: 3.2.1.1

Enzyme Nomenclature: IUB

- Standard Abbreviated name
  - Accompanies recommended name
  - Example: AMS
- Common Abbreviated name
  - Example: AMY

TABLE 12-1 CLASSIFICATION OF FREQUENTLY QUANTITATED ENZYMES

CLASS	RECOMMENDED NAME	COMMON ABBREVIATION	STANDARD ABBREVIATION	EC CODE NO.	SYSTEMATIC NAME
Oxidoreductases	Lactate dehydrogenase	LDH	LDH	1.1.1.27	L-Lactate:NAD^+ oxidoreductase
	Glucose-6-phosphate dehydrogenase	G-6-PDH	G-6-PD	1.1.1.49	D-Glucose-6-phosphate:$NADP^+$ 1-oxidoreductase
	Glutamate dehydrogenase	GLD	GLD	1.4.1.3	L-glutamate:NAD(P) oxidoreductase, deaminase
Transferases	Aspartate amino-transferase	GOT (glutamate oxaloacetate transaminase)	AST	2.6.1.1	L-Aspartate:2-oxaloglutarate aminotransferase
	Alanine amino-transferase	GPT (glutamate transaminase)	ALT	2.6.1.2	L-Alanine:2-oxaloglutarate aminotransferase
	Creatine kinase	CPK (creatine phosphokinase)	CK	2.7.3.2	ATP:creatine *N*-phosphotransferase
	γ-Glutamyl-transferase	GGTP	GGT	2.3.2.2	(5-Glutamyl)peptide: amino acid-5-glutamyltransferase
	Glutathione-*S*-transferase	α-GST	GST	2.5.1.18	Glutathione transferase
	Glycogen phosphorylase	GP	GP	2.4.1.1	1,4-α-D-Glucan: orthophosphate α-D-glucosyltransferase
	Pyruvate kinase	PK	PK	2.7.1.40	Pyruvate kinase
Hydrolases	Alkaline phosphatase	ALP	ALP	3.1.3.1	Orthophosphoric monoester phosphohydrolase (alkaline optimum)
	Acid phosphatase	ACP	ACP	3.1.3.2	Orthophosphoric monoester phosphohydrolase (acid optimum)
	α-Amylase	AMY	AMS	3.2.1.1	1,4-D-Glucan glucanohydrolase
	Cholinesterase	PCHE	CHE	3.1.1.8	Acylcholine acylhydrolase
	Chymotrypsin	CHY	CHY	3.4.21.1	Chymotrypsin
	Elastase-1	E1	E1	3.4.21.36	Elastase
	5-Nucleotidase	NTP	NTP	3.1.3.5	5′-Ribonucleotide phosphohydrolase
	Triacylglycerol lipase		LPS	3.1.1.3	Triacylglycerol acylhydrolase
	Trypsin	TRY	TRY	3.4.21.4	Trypsin
Lyases	Aldolase	ALD	ALD	4.1.2.13	D-D-Fructose-1, 6-bisdiphosphate D-glyceraldehyde-3-phosphate-lyase
Isomerases	Triosephosphate isomerase	TPI	TPI	5.3.1.1	Triose-phosphate isomerase
Ligase	Glutathione Synthetase	GSH-S	GSH-S	6.3.2.3	Glutathione synthase

Adapted with permission from Competence Assurance, ASMT. Enzymology, an educational program. Bethesda, Md.: RMI Corporation, 1980.


Thank
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