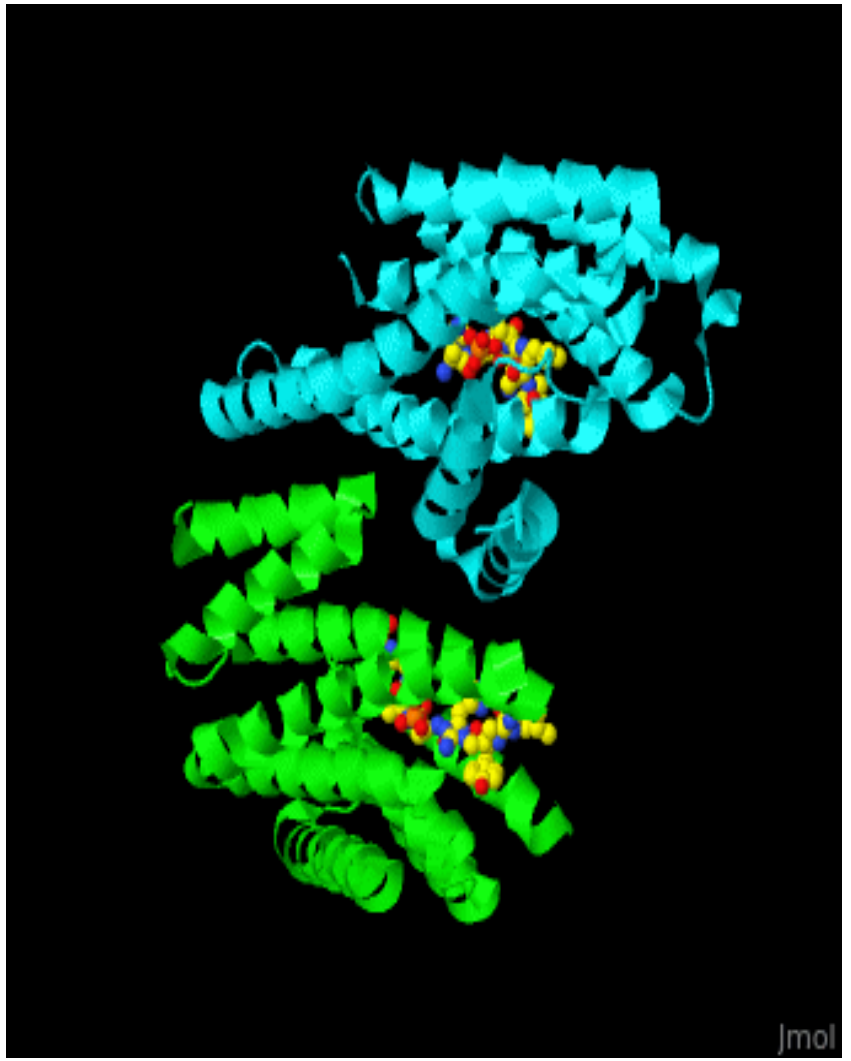
IIT Guwahati

Lecture 19

Course BT 631

Protein Structure, function and Crystallography



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Enzyme

The term enzyme was coined by F.W. Kuhne in 1878.

F.W. Kuhne

The name *enzyme* (In Greek, *en* = in; *zyme* = yeast) means "in yeast".

This was referred to denote the production of ethyl alcohol and CO_2 that involved "zymase" present in yeast.

This reaction is most popularly known as alcoholic fermentation by yeast.

Enzymes were then designated as Biological catalysts.

Enzyme

Catalyst: A substance that increases the rate of a chemical reaction without itself undergoing any permanent chemical change.

Substrate: A substance or material on which an enzyme acts.

Enzymes (Biological Catalysts)

1. **Shared properties with chemical catalysts**
   a. Enzymes are neither consumed nor produced during the course of reaction.
   b. Enzyme do not cause reaction to take place, but they greatly enhance the rate of reaction that would proceed much slower in their absence.
   c. They alter the rate but not the equilibrium constant of reaction that they catalyze.

Enzyme

2. Differences between enzyme and chemical catalysts

i. Enzymes are proteins or RNA.

ii. Enzymes are highly specific and produce only the expected products from the given reactants or substrate (i.e. there are no side reactions).

iii. Enzymes may show a high specificity towards one substrate or exhibit a broad specificity, using more than one substrate.

iv. Enzymes usually function within a moderate pH and temperature range.

Enzyme

Enzymes execute two basic functions in a biological system.

They are i) Catalytic and ii) Regulation.

Catalytic efficiency

- **Most of the enzyme-catalyzed reaction are highly efficient, proceeding from 10^3 to 10^8 times faster than un-catalyzed reactions.**
- **Typically, each enzyme molecule is capable of transforming 100 to 1000 substrate molecule into product each second.**
- **The number of molecules of substrate converted to product per enzyme molecule per second is called the Turnover number.**

Regulation

Enzyme activity can be regulated – that is, the enzyme can be activated or inhibited so that the rate of product formation responds to the needs of the cell.

Enzyme Classification

Classification of enzymes

New enzymes are classified by the Nomenclature Committee of IUBMB. (International Union of Biochemistry and Molecular Biology)

Enzyme nomenclature classifies the catalytic activities, not the protein structure.

The Enzyme Commission Number (EC Number) is a numerical classification scheme for enzymes, based on the chemical reactions they catalyze.

The chemical reaction catalyzed is a specific property that distinguishes one enzyme from the other.

EC numbers specify the enzyme-catalyzed reactions.

Enzyme System of Classification

All Enzymes are placed in 6 classes with numerous sub-classes and sub-sub-classes, of which only the most important are given below in the Table. *The sub-class and sub-sub-class normally define the nature of the reaction more precisely*, or specify a particular set of donor or acceptors.

Class	Reaction type	Style of systemic name (example)	Principle sub-classes
1. Oxido-reductase	Oxidation/ Reduction	Donor: acceptor oxidoreductase (EC1.1.1.1, alcohol: NAD^+ Oxido-reductase) EC1.1.1.27 Lactate dehydrogenase	1.1 acting on CH-OH group of donors. 1.2 acting on aldehyde or oxo group of donors 1.3 Acting on CH-CH group of donors 1.4 Acting on CH-NH_2 group of donor Reduction of pyruvate to lactate with formation of NAD^+
2. Transferase	Group Transfer Reaction	Donor: acceptor group transferase (EC 2.1.3.2, carbamoyl phosphate: L- aspartate carbamoyltransferase	2.1 Transferring one-carbon groups 2.3 Acyl transferases 2.4 Glycosyltransferases 2.6.1 Transaminases 2.7 Transferring Phosphate groups 2.7.1 -OH group as accepter
3. Hydrolase	Hydrolysis reaction	Substrare Hydrolysis (E.C. 3.1.1.7, acetylcholine acetylhydrolase)	3.1 Esterases acting on ester bonds. 3.2 Glycosidases 3.4 Peptidases

EC 2.-.-.- 2 is class for Transferases.
EC 2.7.-.- 7 is sub-class for Transferring phosphorous-containing groups.
EC 2.7.1.- 1 is sub-sub-class for Phosphotransferases with an alcohol (OH) group as acceptor.
EC 2.7.1.11 11 is the number assigned to 6-Phosphofructokinase.

Enzyme System of Classification

Class	Reaction type	Style of systemic name (example)	Principle sub-classes
4. Lyases	Elimination Reaction	Substrate Group- Lyase EC 4.3.1.5 Phenyl-alanine ammonia lyase	4.1 Carbon-carbon lyases 4.2 Carbon-oxygen lyases 4.3 Carbon-Nitrogen lyases Splits Phenylalanine into Ammonia and trans-cinnamate.
5. Isomerase	Isomerization Reactions	Substrate Reactionase (E.C. 5.3.1.1, D-glyceraldehyde-3-Phosphate ketol-isomerase)	5.1 Racemases and epimerases 5.3 Intra-molecular oxidoreductases 5.4 Intra-molecular transferases (mutases)
6. Ligases	Bond Synthesis Coupled to hydrolysis (e.g. ATP)	X-Y ligase (Product Forming) EC 6.5.1.1 T4 DNA Ligase	6.1 Forming carbon-oxygen bonds 6.2 Forming carbon-sulfur bonds 6.3 Forming carbon-nitrogen bonds 6.5 Phosphodiester bond formation and conversion of ATP into AMP