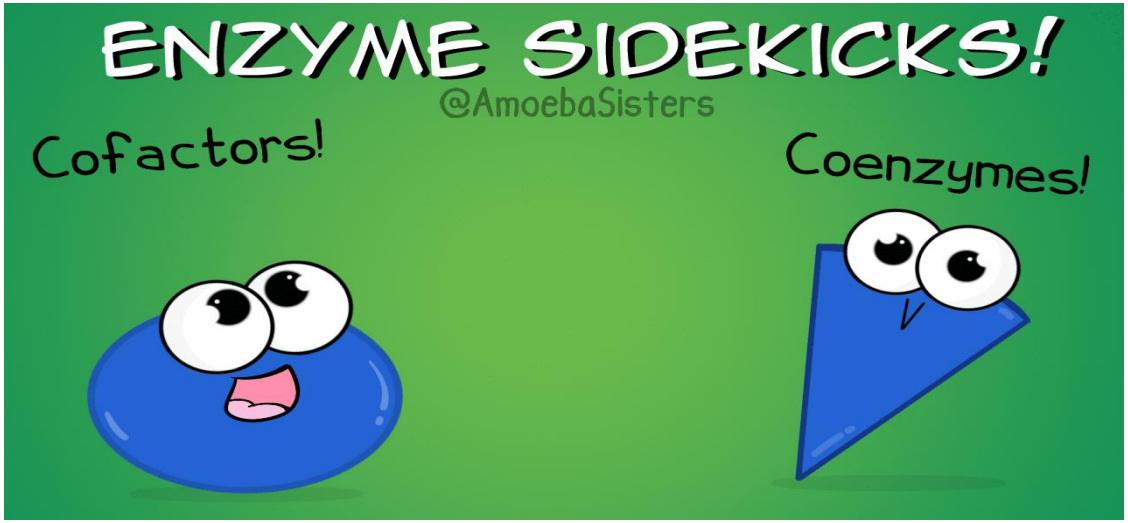
Coenzymes



1st YEAR MBBS
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DEPTT OF BIOCHEMISTRY
KGMC

Objectives

- Types of enzymes
- Define coenzymes,cofactors
- Explain the functions of cofactors
- Enlist different types of cofactors
- Classification of coenzymes
- Mechanism of action of coenzymes

TYPES OF ENZYMES

- Enzymes are chemically divided into two groups:
- Simple protein enzymes : those containing simple proteins
- Complex protein enzymes : in which a specific prosthetic group is attached such as carboxylases.

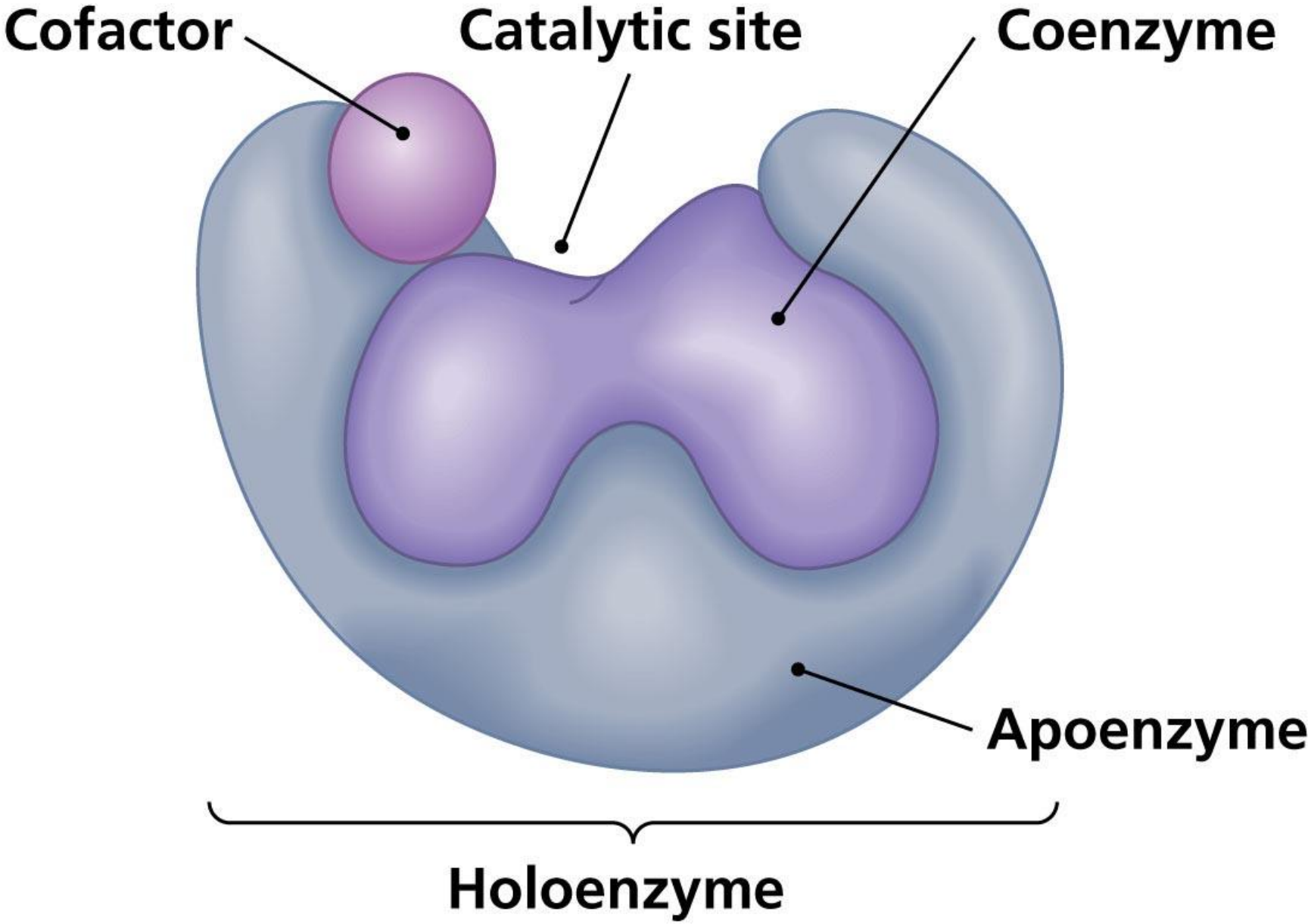
Cofactors , coenzymes , prosthetic groups

- Many enzymes contain small non-protein molecules and metal ions that participate directly in substrate binding or catalysis.
- These are termed as
- prosthetic groups
- cofactors
- coenzymes

CO-FACTORS

- Complete functional complex of enzyme and co-factor is called HOLO-ENZYME
- The protein part free of cofactor is called APO-ENZYME.
- Co-factors bind in a transient, dissociable manner either to the enzyme or to a substrate such as ATP.
- Co-factors therefore must be present in the medium surrounding the enzyme for catalysis to occur.

- The most common co-factors also are metal ions.
- Enzymes that require metal co-factors are termed metal-activated enzymes to distinguish them from the metallo-enzymes for which metal ions serve as prosthetic groups.



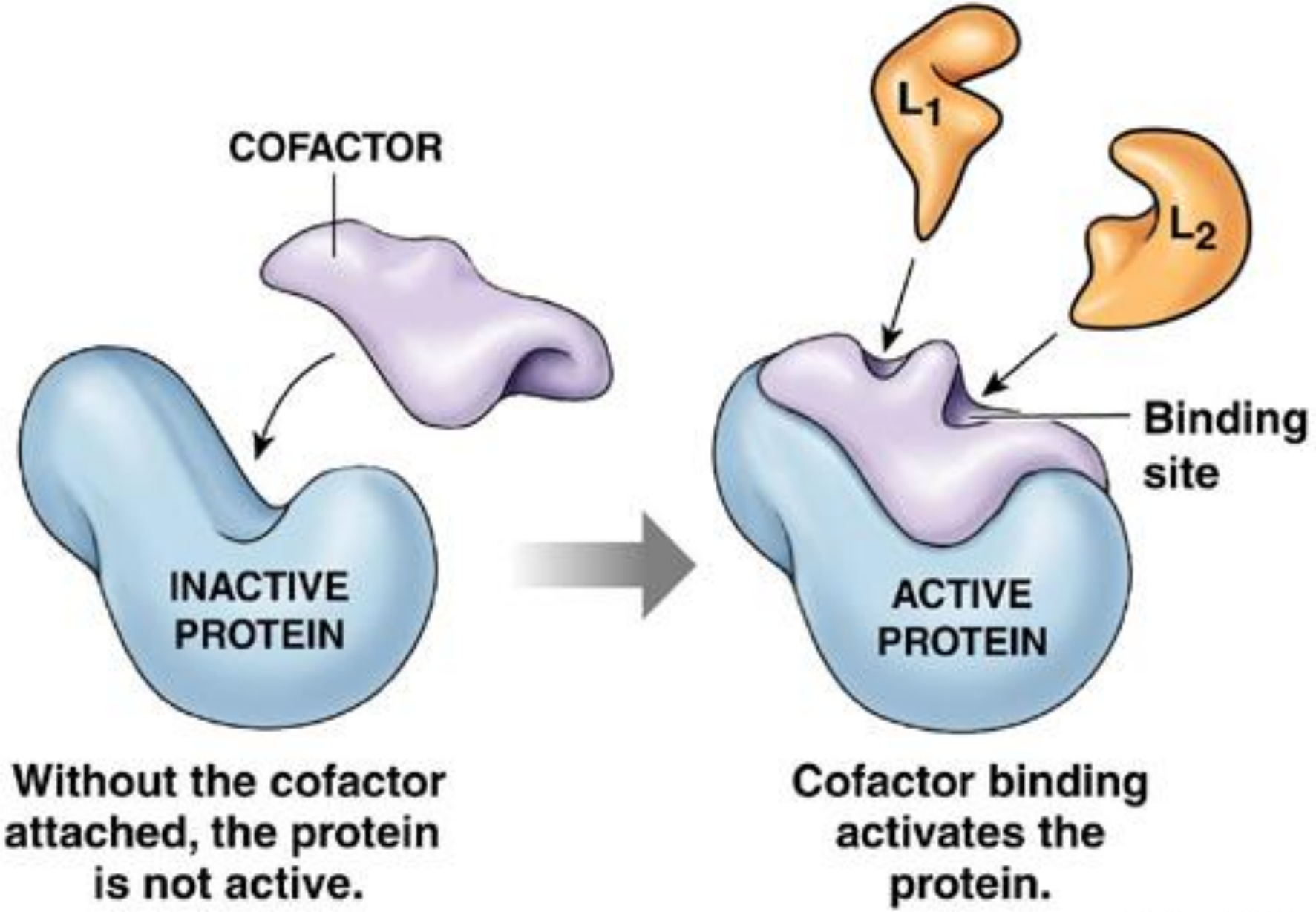
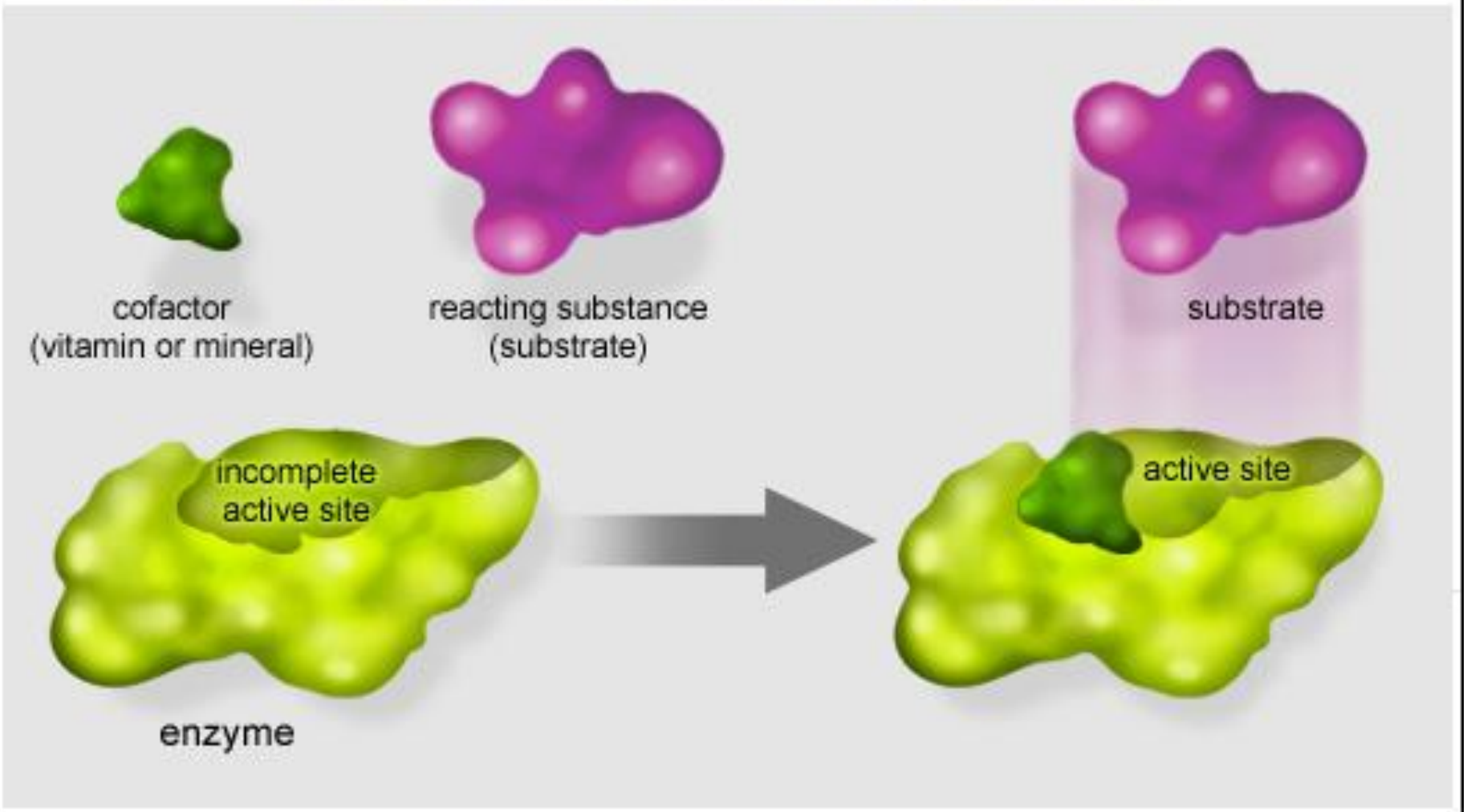


Fig. 2-18

Vitamin and mineral cofactors make enzymes work

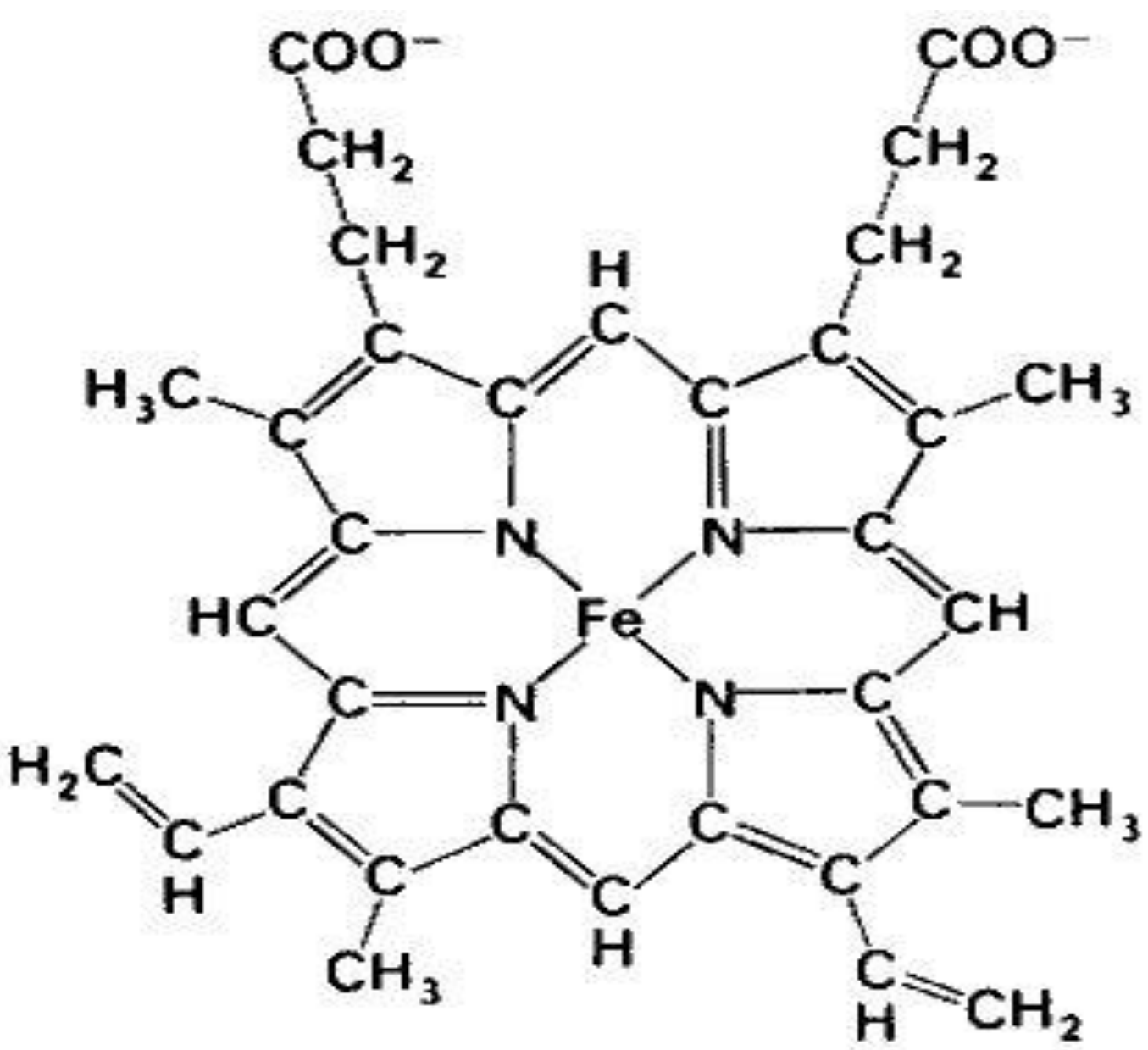


Many enzymes need a cofactor (vitamin or mineral) to activate them. Without the cofactor, the enzyme can't lock the reacting substance (substrate) into its active site, so the reaction can't take place. Most vitamin deficiency diseases happen this way.

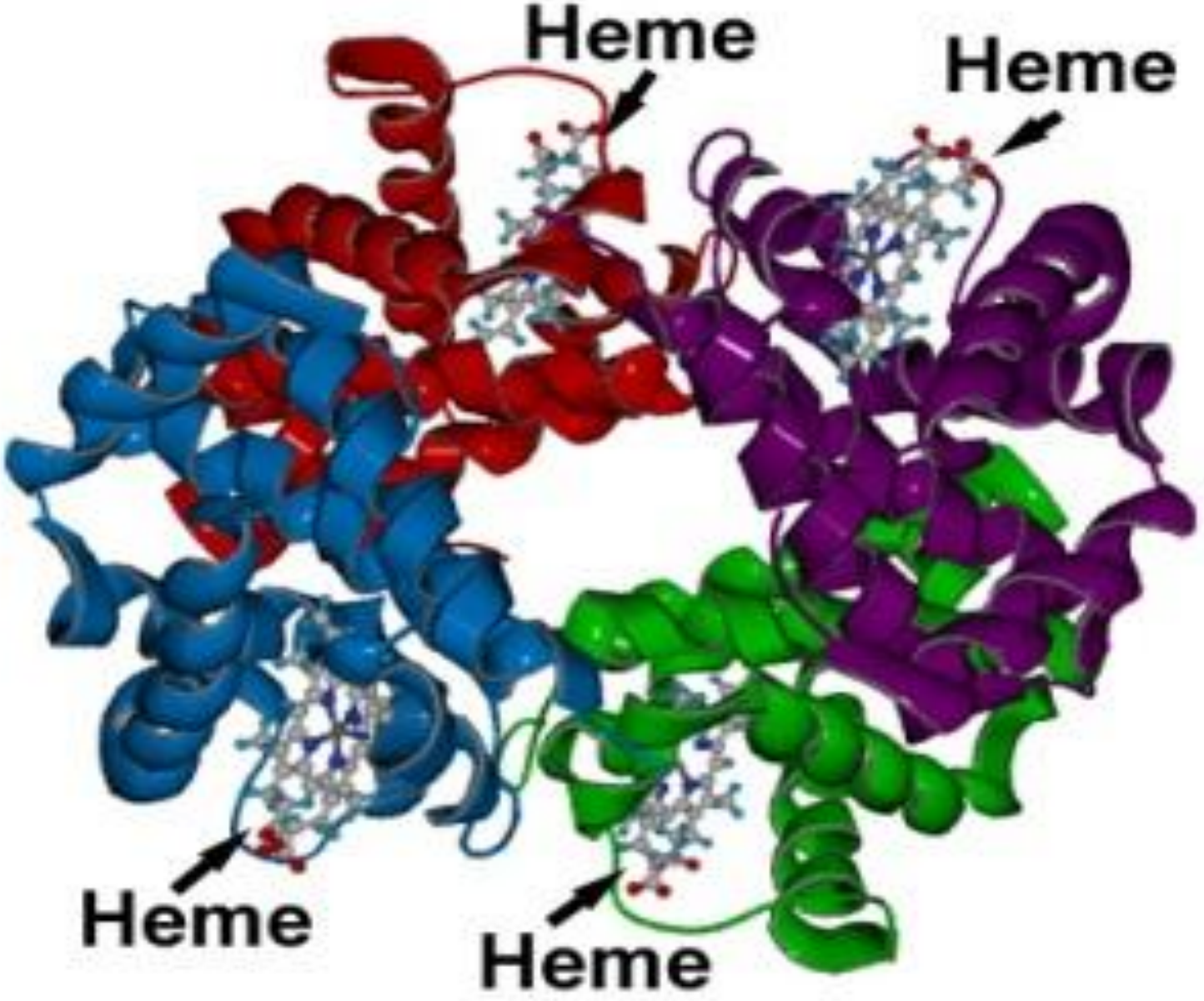
- PROSTHETIC GROUPS :
- These are distinguished by their tight,stable incorporation into a protein’s structure by covalent or non-covalent forces.e.g pyridoxal phosphate,flavin mono-nucleotide FMN,thiamine,and the metal ions Co,Cu,Mg,Mn and Zn.

- Metals are the most common prosthetic groups. The roughly one third of all enzymes that contain tightly bound metal ions are termed metallo-enzymes.

- Metals may also facilitate the binding and orientation of substrate.



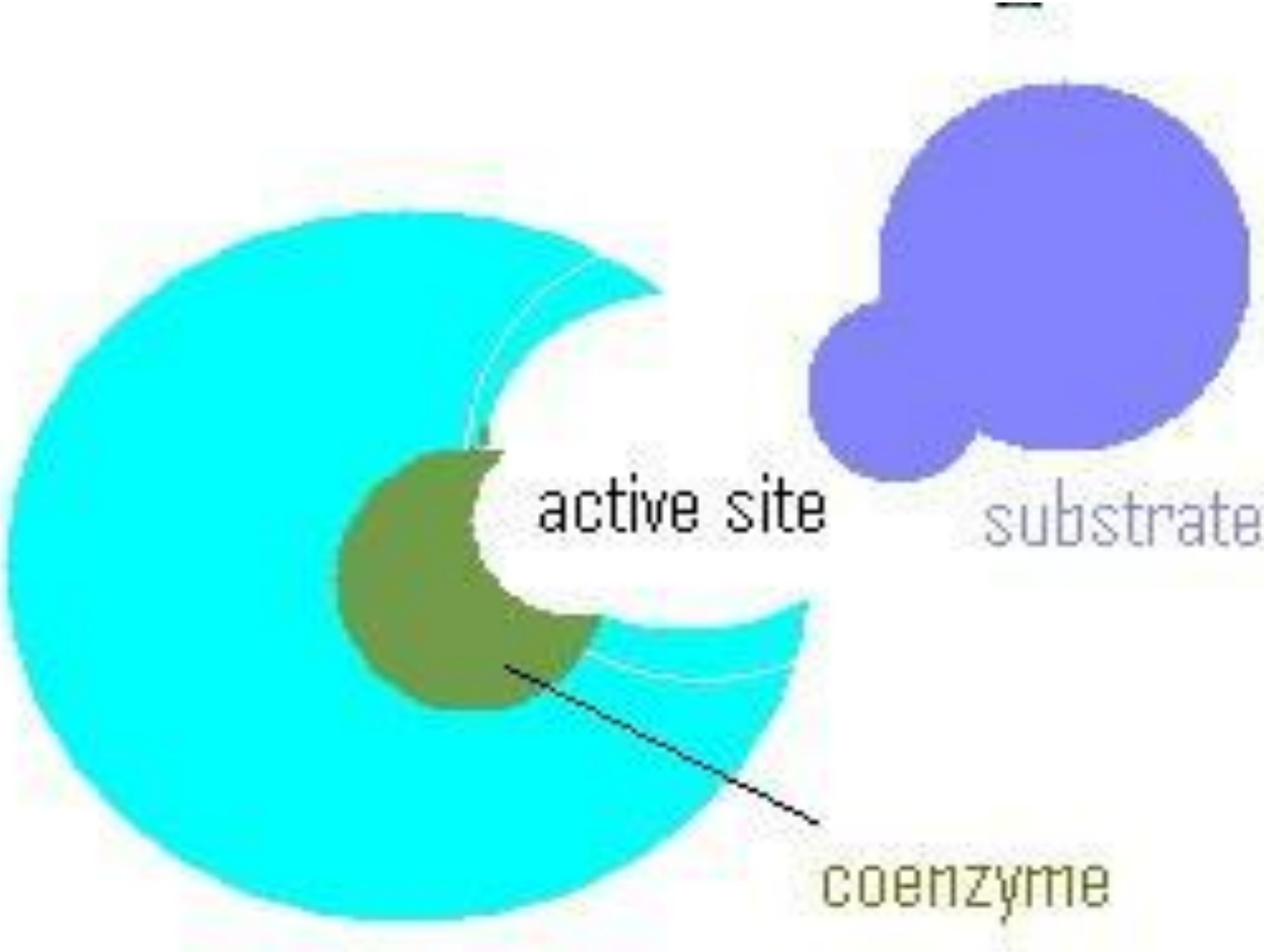
Heme
(Fe-protoporphyrin IX)

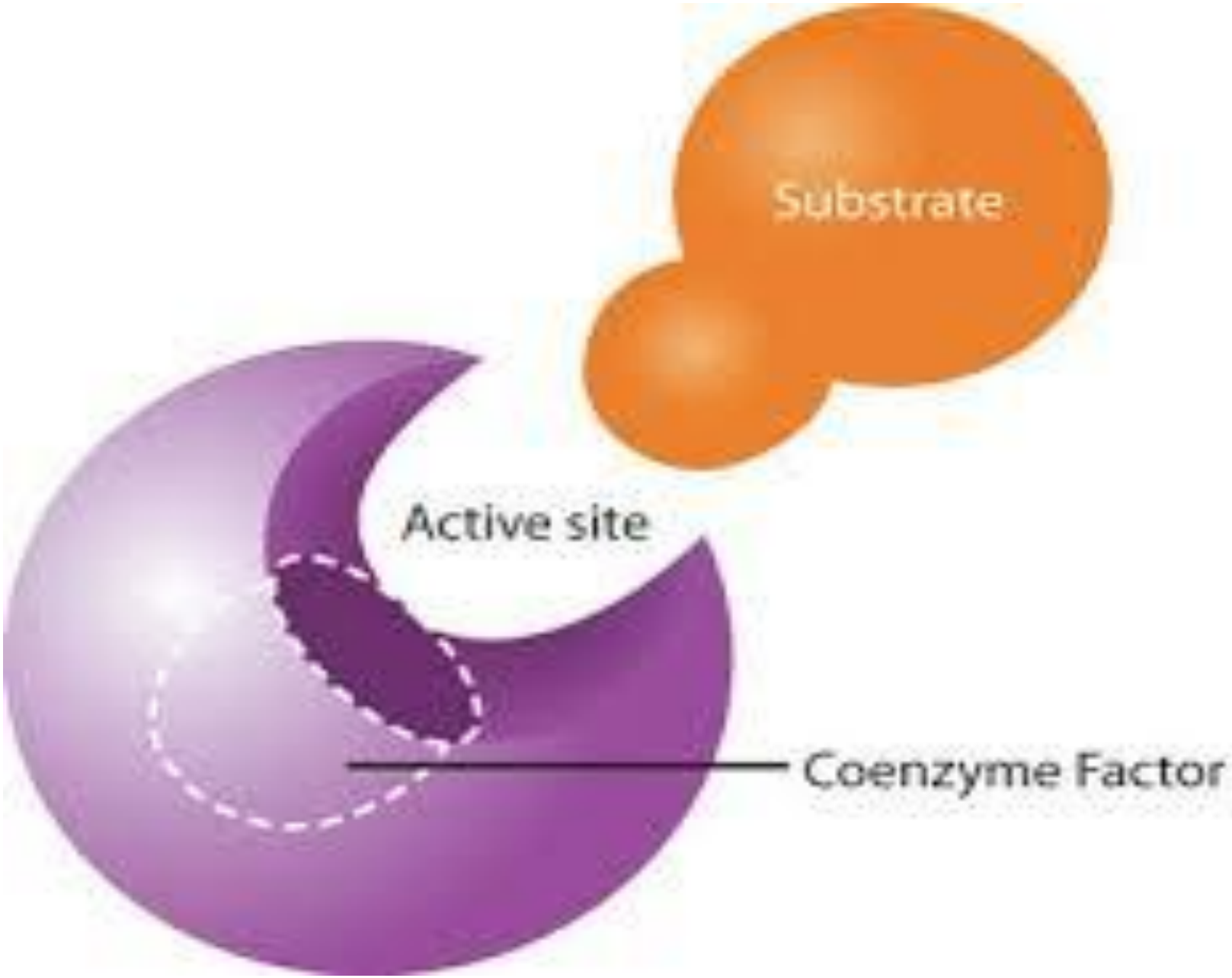

Heme
Heme
Heme
Heme

CO-ENZYMES

- Many enzymes catalyze their substrate reactions only in the presence of a particular non-proteinous components called CO-ENZYMES
- Co-enzymes are the non-proteinous organic compounds of large molecular wt attached to the active sites of an enzyme by weak vonder wall forces or electrostatic interactions.

- Coenzymes serve as recyclable shuttles or group transfer agents that transfer many substrates from their point of generation to point of utilization.
- Coenzymes help in supplying groups of atoms to the substrate or accept group of atoms from it e.g NAD accepts a hydride ion H
- Some coenzyme like transaminase remove amino groups from substrate.


active site
substrate
coenzyme


Substrate
Active site
Coenzyme Factor

CHARACTERISTICS OF COENZYMES:

- Frequently contain vit B as part of their structure that participate directly in enzymatic reactions.
- Act as co-substrates
- Heat stable
- Participate in electron transfer rxns e.g NAD,NADH,FAD, etc.
- Group transfer rxns e.g CoA,TPP,Biotin,cobamide Co-enzyme,lipoic acid.

Classification of CO-enzymes

- Coenzymes are classified into two main categories:
- 1) According to the group they are transferring
- a) electron transfer reactions
- b) group transfer reactions

- 2) According to the Vitamins solubility
- a) water soluble
- b) fat soluble

1) According to the Group they are transferring

a) ELECTRON TRANSFER REACTIONS:

- Examples are as follows:

CO-ENZYMES	REACTIONS	FUNCTIONS
NAD	OXIDATION REDUCTION	HYDROGEN TRANSFER
NADP	OXIDATION REDUCTION	HYDROGEN TRANSFER
FAD	-do-	-do-
FMN	-do-	-do-

- ***b) GROUP TRANSFER REACTIONS***

- Examples are as follows:

CO-ENZYMES	REACTIONS	FUNCTIONS
TPP	ALDEHYDE TRANSFER REACTION	ACETYL GROUP TRANSFER
BIOTIN	CARBOXYLATION	CARBOXYL GROUP TRANSFER
CO-ENZYME A	TRANSAMINATION	ACYL GROUP TRANSFER AMINO GROUP TRANSFER
PYRIDOXAL PHOSPHATE		
COBAMIDE CO-ENZYME	ALKYLATION	ALKYL GROUP TRANSFER
LIPOIC ACID	ACYLATION	ACYL GROUP TRANSFER

B) CLASSIFICATION BASED ON VITAMINS SOLUBILITY

- ***A) WATER SOLUBLE***

VITAMIN	CO-ENZYME
VITAMIN B	TPP
RIBOFLAVIN (B2)	FMN FAD
NICOTINIC ACID (B3)	NAD NADP
PANTOTHENIC ACID (B5)	CO-ENZYME A

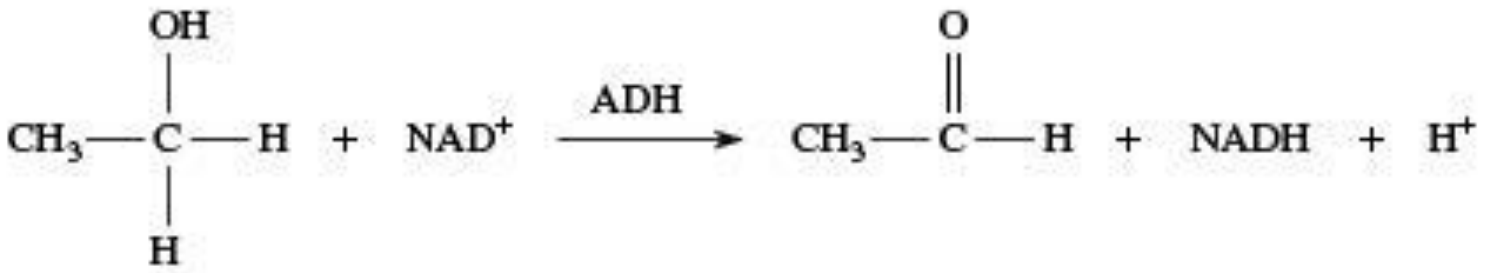
- ***b) FAT SOLUBLE:***
- Vitamin K is the only one that acts as a classical coenzyme

Retinal, a derivative of vitamin A, is a prosthetic group

Mechanism of action of coenzymes

- The mechanism of action of coenzymes involves two types:

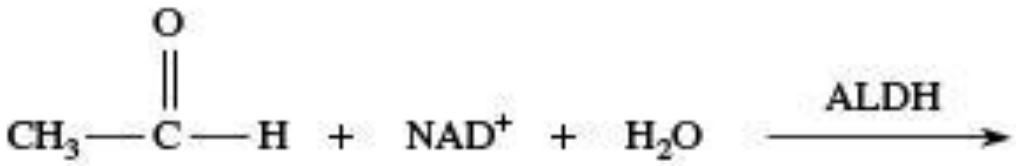
1) Either coenzymes will function as ultimate acceptor of hydrogen e.g



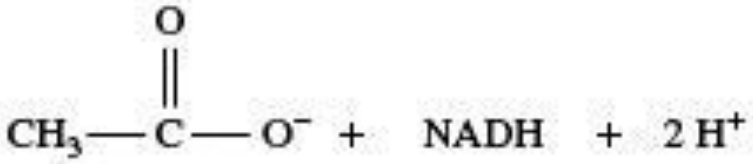
ethanol

acetaldehyde

ADH = alcohol dehydrogenase



acetaldehyde

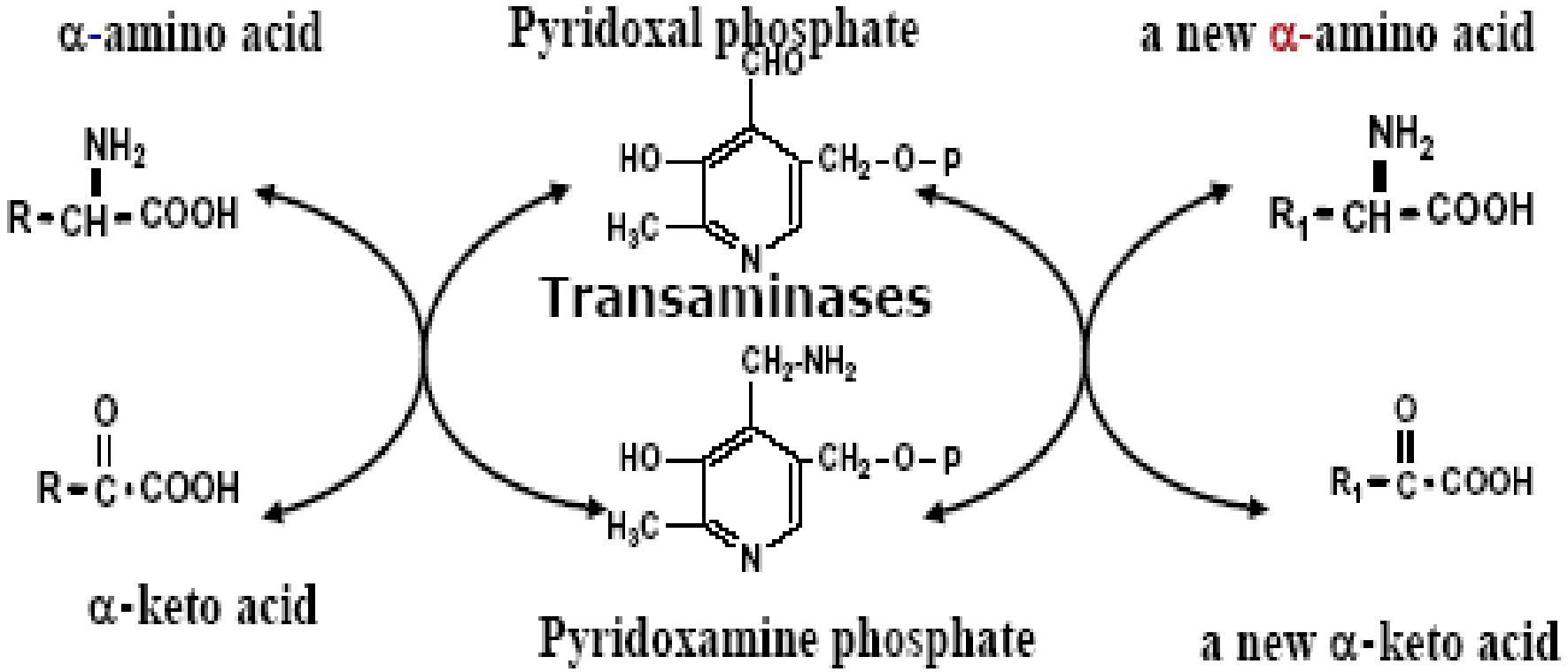


acetate

ALDH = aldehyde dehydrogenase

2) Coenzyme will act as an intermediate e.g Pyridoxal phosphate which is a coenzyme involved in the transfer of amino group from one molecule to another,an important step in protein biosynthesis.

- The amino group is transferred from the donor to the coenzyme,and then from the coenzyme to the ultimate acceptor.


α-amino acid
Pyridoxal phosphate
a new α-amino acid
Transaminases
α-keto acid
Pyridoxamine phosphate
a new α-keto acid

THE END