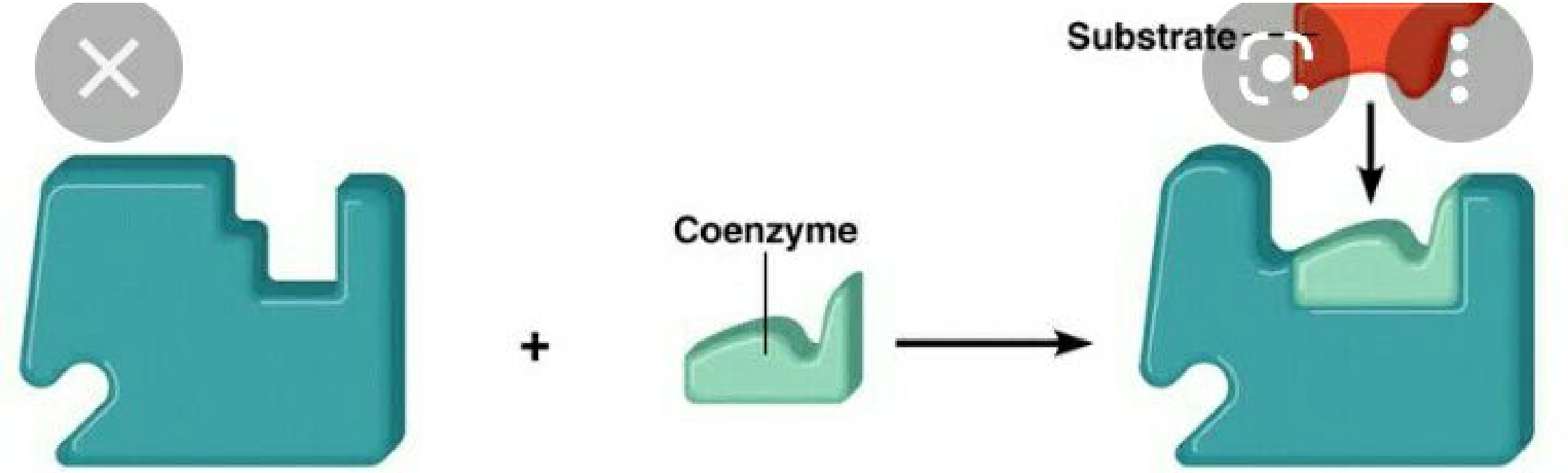
HOLOENZYME

- A completely active enzyme with all its quality t fit with a substrate & to accelerate a reactio rate is known as "Holoenzyme"
- They contain a protein and non-protein par Both parts must be present before the enzym can function.
- The protein part is called the "apoenzyme" an the non-protein (organic part) is calle "coenzyme".

HOLOENZYME = APOENZYME

- Some enzymes require molecules other than proteins for enzymatic activity.
- The term **holoenzyme** refers to the **active** enzyme with its **nonprotein** component.
- The term **apoenzyme** is **inactive** enzyme without its **nonprotein** part.
- If the **nonprotein part** is a **metal ion** such as Zn 2+ or Fe2+, it is called a **cofactor**.
- If it is a **small organic molecule**, it is termed a **coenzyme.**



Apoenzyme (protein portion), inactive

Cofactor (nonprotein portion), activator

Holoenzyme (whole enzyme), active

Apoenzyme Definition

What is apoenzyme? **Apoenzyme** is the protein part of an enzyme. The non-protein part cofactor together with the protein part apoenzyme forms a ***holoenzyme***. Apoenzymes are important for enzymatic activity since they are responsible for the specificity of enzymes to their substrates. Apoenzymes alone are not active enzymes; they must bind to an organic or inorganic cofactor in order to be activated.

Apoenzyme in DNA polymerase

Apoenzymes are essential for a holoenzyme to function properly. One of the most important holoenzymes is DNA polymerase which is composed of a cofactor and an apoenzyme. DNA polymerase catalyzes DNA formation through the polymerization of deoxyribonucleotides. It

Apoenzyme in RNA polymerase

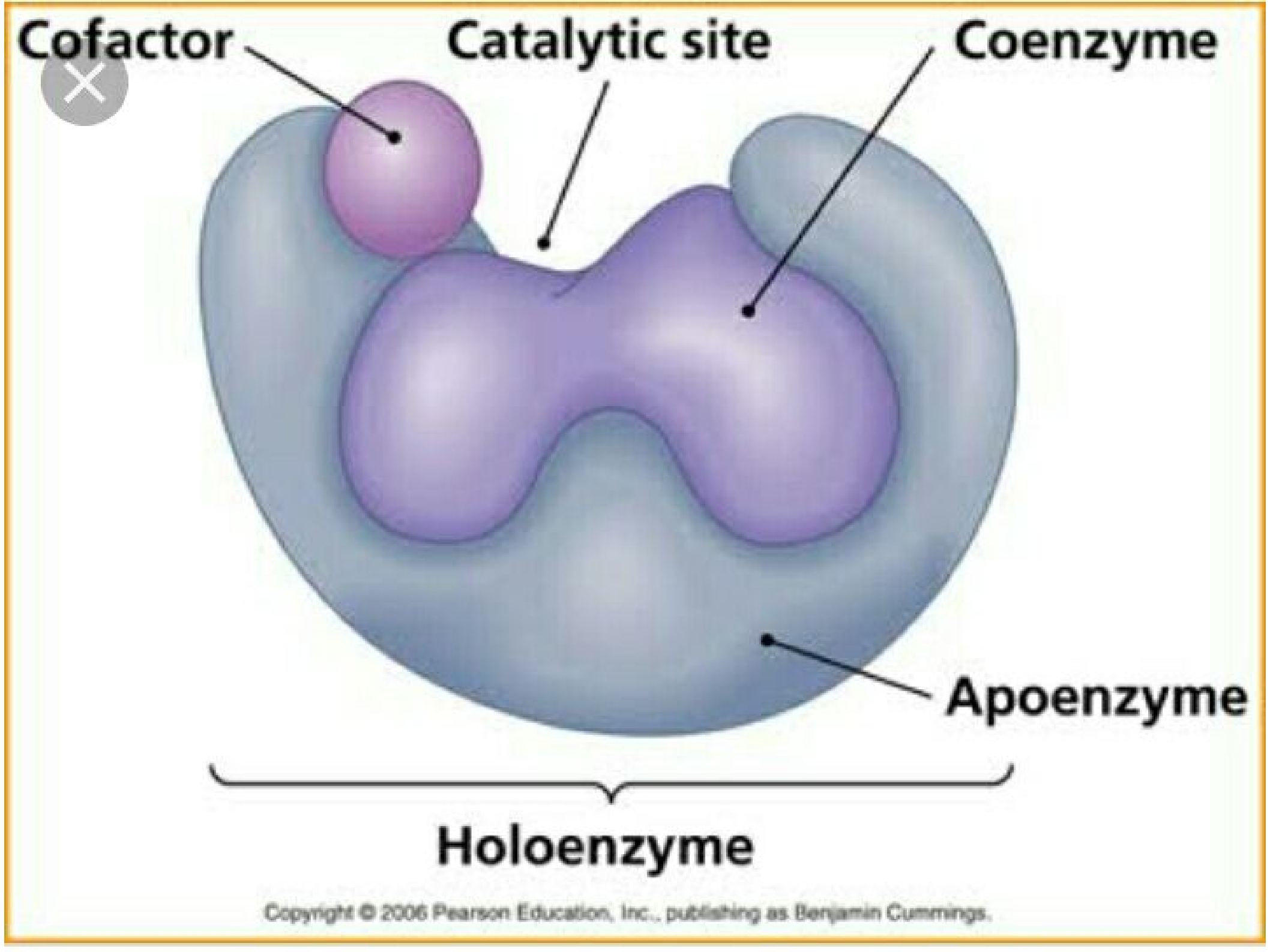
RNA polymerase is another holoenzyme composed of a cofactor and apoenzyme. RNA polymerase uses DNA templates to construct RNA chains in a process known as transcription.

Importance of Apoenzymes

Synthetic cofactors and apoenzymes are being developed in order to produce new holoenzymes with improved activity or new functions.

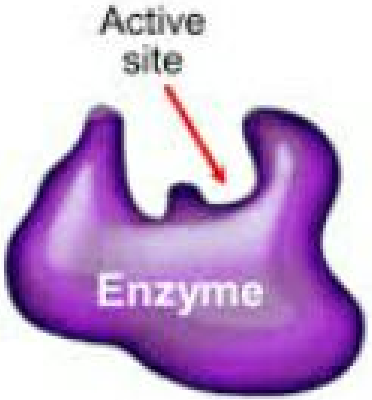
apoenzymes are being developed in order to produce new holoenzymes with improved activity or new functions.

Apoenzymes bind to coenzymes forming a holoenzyme to catalyze the formation of an active vitamin from the inactive form.

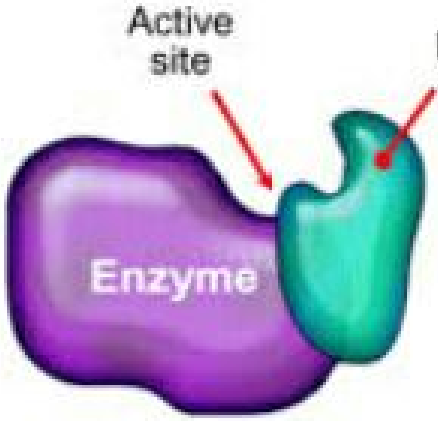


Enzyme Cofactors

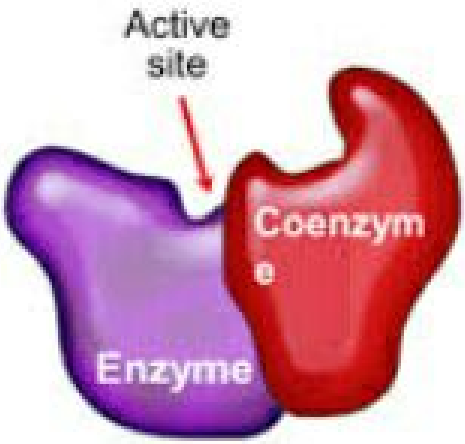
- Some enzymes require **cofactors** to be active.
- Cofactors are a **nonprotein** component of an enzyme. Cofactors can be:
  - **organic molecules** (coenzymes).
  - **inorganic ions** (e.g. Ca^{2+}, Zn^{2+}).
- Cofactors may be:
  - **Permanently attached**, in which case they are called **prosthetic** groups.
  - **Temporarily attached coenzymes**, which detach after a reaction, and may participate with another enzyme in other reactions.



Enzyme is protein only
Example: lysozyme



Enzyme + prosthetic group
Example:
flavoprotein + FAD



Enzyme + coenzyme
Example:
dehydrogenases + NAD

Coenzyme: A substance that enhances the action of an enzyme. (An enzyme is a protein that functions as a catalyst to mediate and speed a chemical reaction).

Coenzymes are small molecules. They cannot by themselves catalyze a reaction but they can help enzymes to do so. In technical terms, coenzymes are organic nonprotein molecules that bind with the protein molecule (apoenzyme) to form the active enzyme (holoenzyme).

Benefits of Vitamin D

Vitamin D can boost your immune system, support muscle function, keep your heart healthy, and aid in brain development. Vitamin D may also reduce your risk of multiple sclerosis and depression.

Foods High in Vitamin D

- Fatty fish such as salmon or mackerel
- Beef liver
- Egg yolks
- Milk
- Orange juice fortified with vitamin D
- Fortified cereals
- Infant formulas

Holoenzyme	Apoenzyme
Holoenzyme refers to the apoenzyme along with the cofactor which is complete and catalytically-active	Apoenzyme refers to the inactive form of the enzyme which activates upon the binding of a cofactor
Inactive form of the enzyme	Catalytically-active form of the enzyme
Consists of the protein part of the enzyme	Consists of the apoenzyme and one or several cofactors
Incomplete enzymes that are less complex	Complete and complex enzymes
Ex: catalytic components of DNA polymerase enzyme are considered as apoenzymes	Ex: multi-subunit complex of DNA polymerase is considered as the holoenzyme

COENZYME VERSUS COFACTOR

Coenzyme	Cofactor
Coenzyme is a small, organic, non-protein molecules that carry chemical groups between enzymes	Cofactor is a non-protein chemical compound that tightly and loosely binds with an enzyme or other protein molecules
Is a type of cofactor	Coenzymes and prosthetic groups are the two types of cofactors
Moelcules	Chemical compound
Organic molecules	Inorganic compounds
Loosely bound to enzymes	Some are covalently bound to an enzyme
Assist biological transformations	Aid the function of the relative enzyme
Serve as carriers to the enzymes	Increase the rate of the reaction that is catalyzed by the enzyme
Can be removed from the enzyme easily	Can only be removed by denaturing the enzyme
Examples include vitamins, biotin, coenzyme A	Examples include metal ions like Zn^{2+}, K^{+} and Mg^{2+}

ENZYME VERSUS COENZYME

ENZYME	COENZYME
A substance produced by living organisms to act as a biological catalyst to bring about a specific biochemical reaction	A non-protein compound necessary for the functioning of an enzyme
Large molecules	Small molecules
Mainly globular proteins	Organic molecules
Serve as biological catalysts	Bind to the active site of the enzyme, activating it
Do not change their structure during the reaction	Change their structure during the reaction by binding to functional groups released from the reaction
Very specific to the reactions they catalyze	Less specific