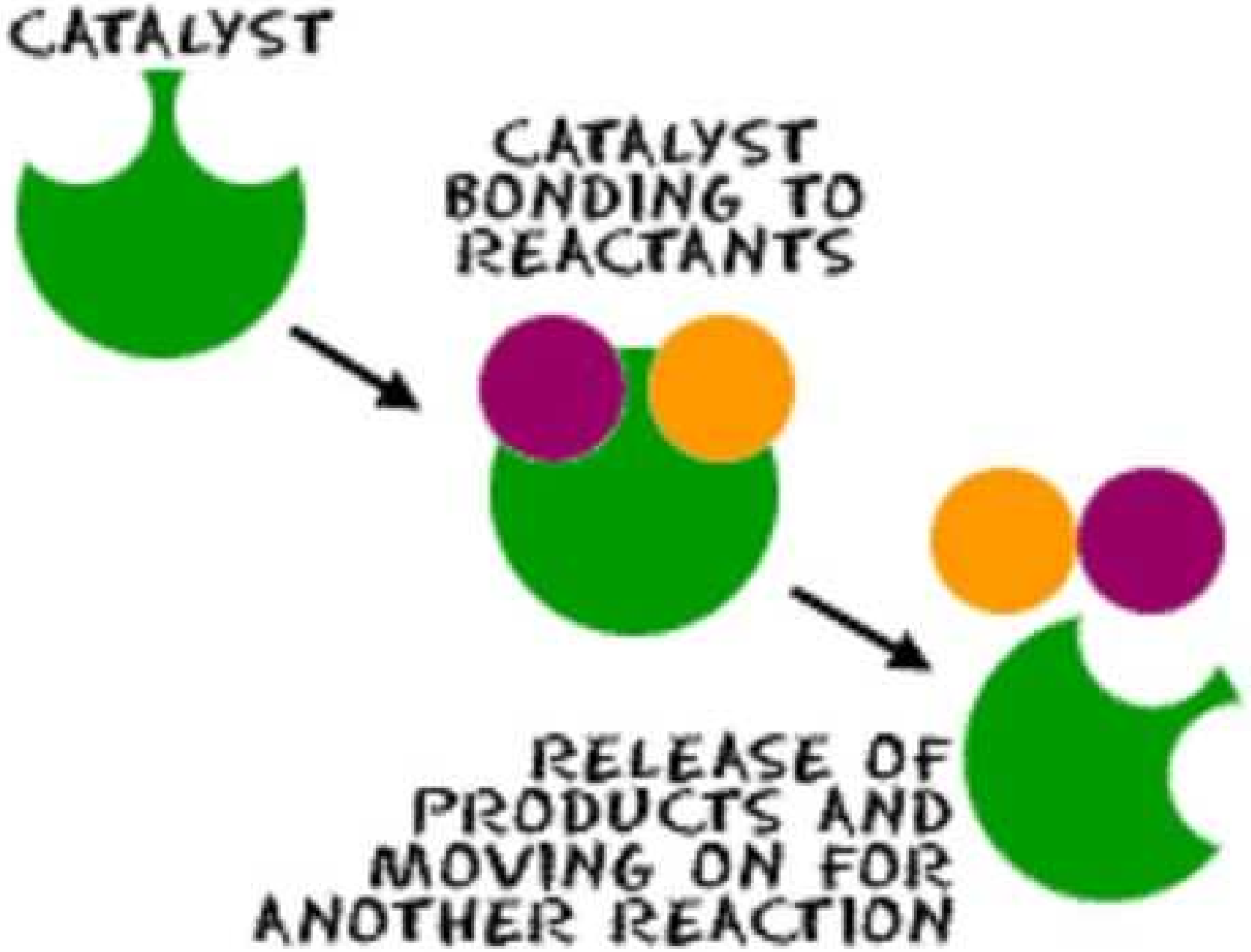
# CATALYSTS


CATALYST
CATALYST BONDING TO REACTANTS
RELEASE OF PRODUCTS AND MOVING ON FOR ANOTHER REACTION

# Catalysts

- **Catalysts** are molecules that speed up the rate of a reaction without themselves being used up or permanently altered .

- ***Catalysts speed up reaction by reducing the activation energy.***

Catalysts have four important features ;

1. ***They speed up reaction.***
2. ***Catalysts cannot cause energetically unfavourable reactions to occur***

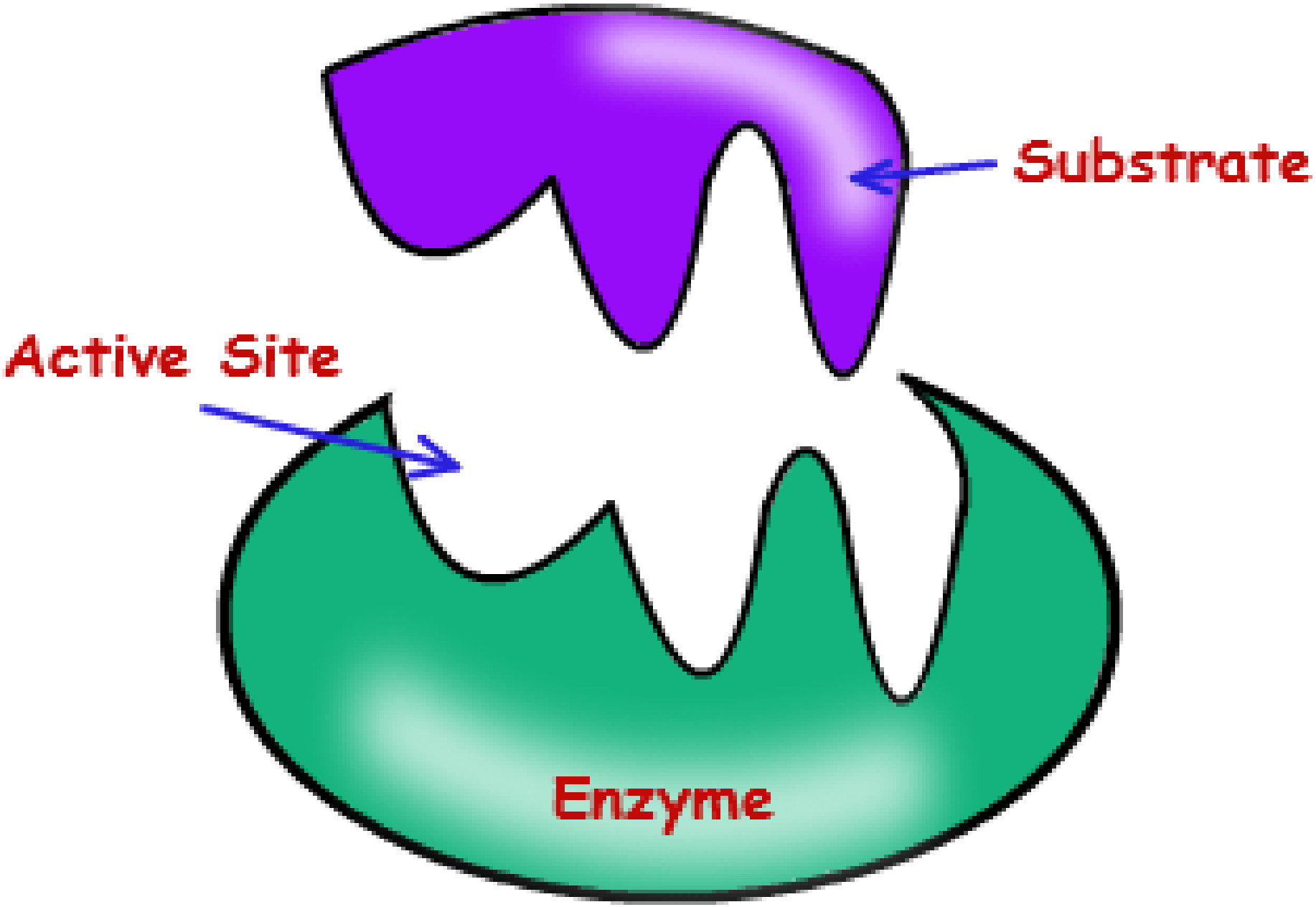
   ( i.e they cannot speed up endergonic reactions);

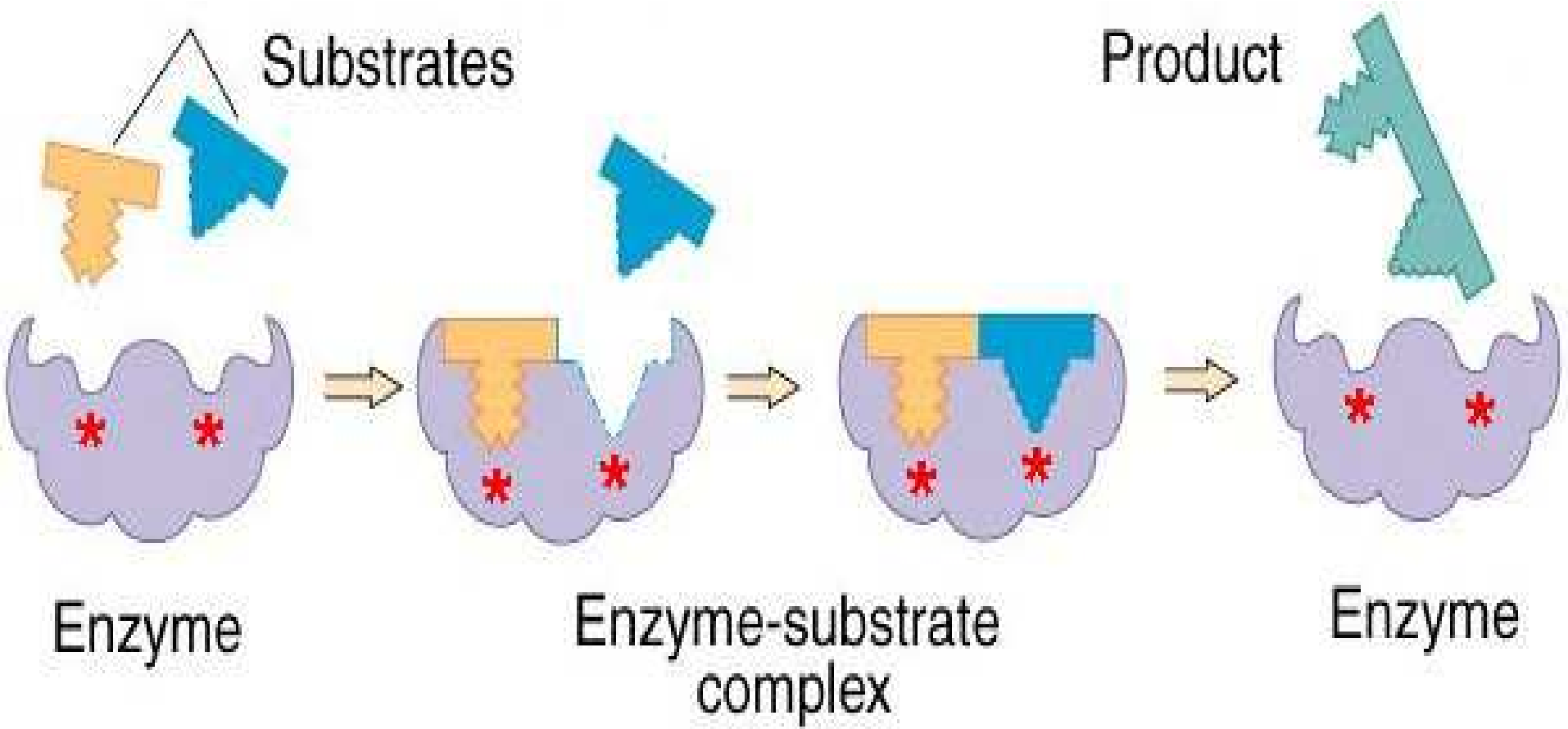
   Catalysts only facilitate reactions that would occur spontaneously .

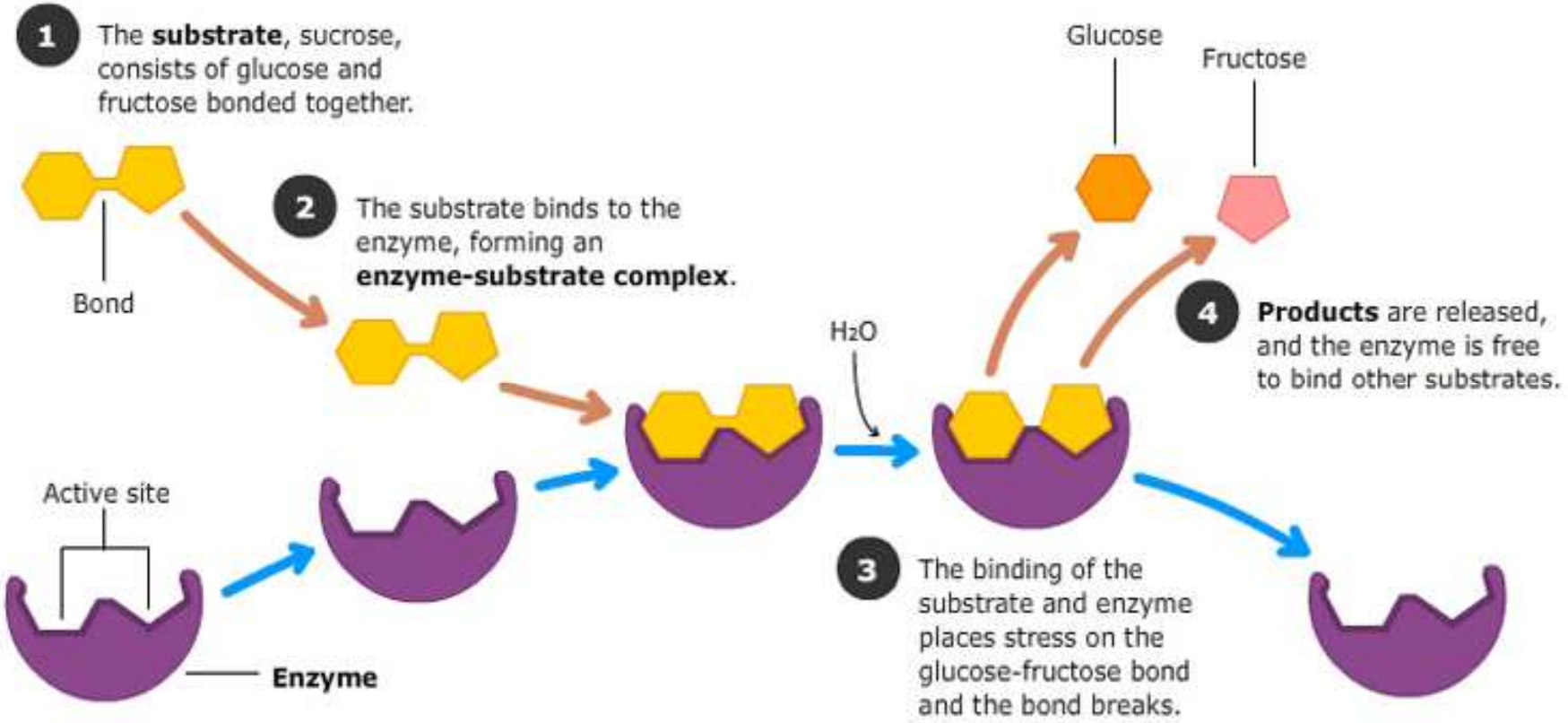
- 3 . ***Catalysts do not change the equilibrium point of a reaction .***

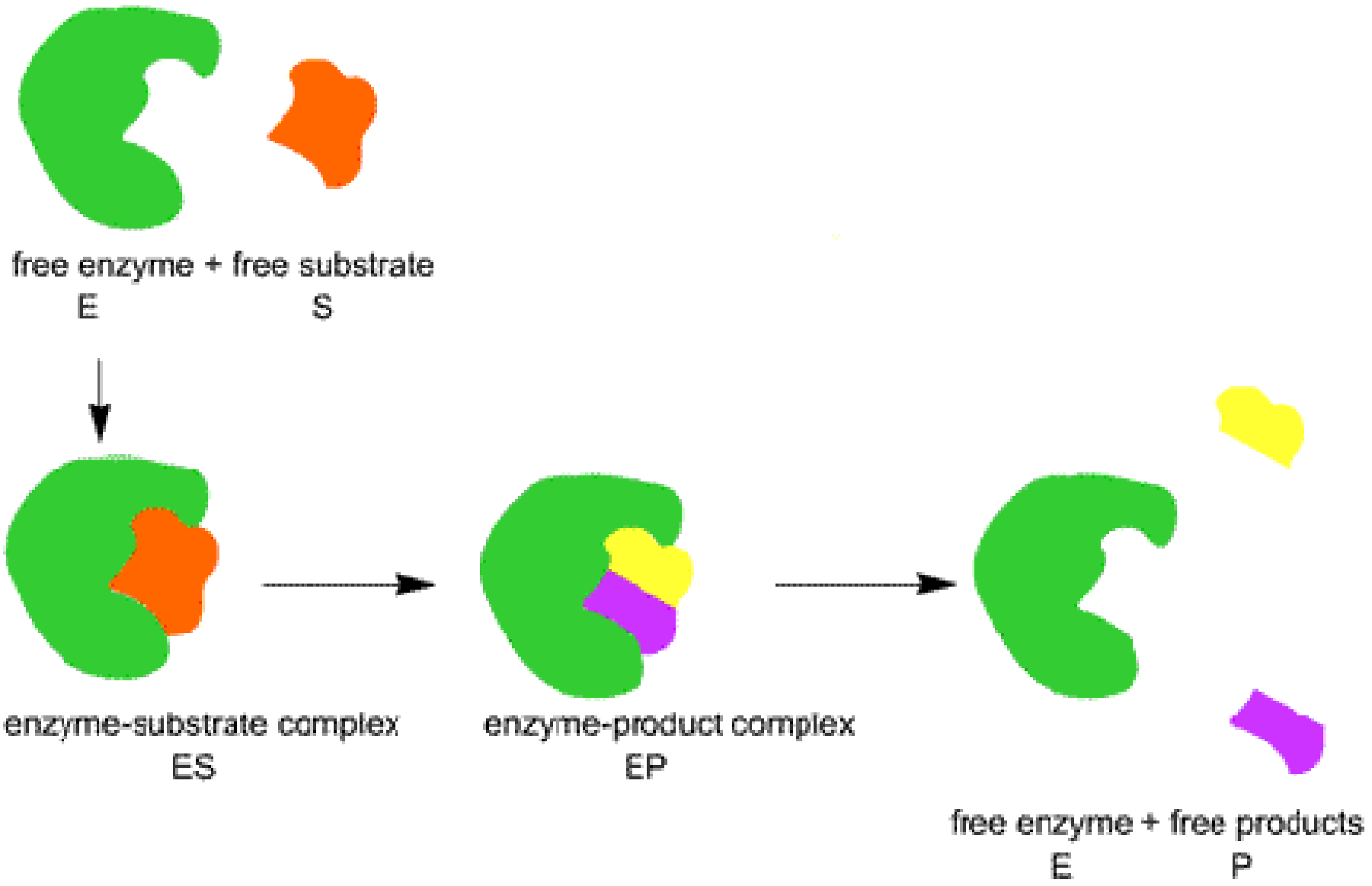
- 4. ***Catalysts are not consumed in the reaction they promote.***

# ENZYMES


Substrate
Active Site
Enzyme


Substrates
Product
Enzyme
Enzyme-substrate complex
Enzyme




free enzyme + free substrate
E
S
enzyme-substrate complex
ES
enzyme-product complex
EP
free enzyme + free products
E
P

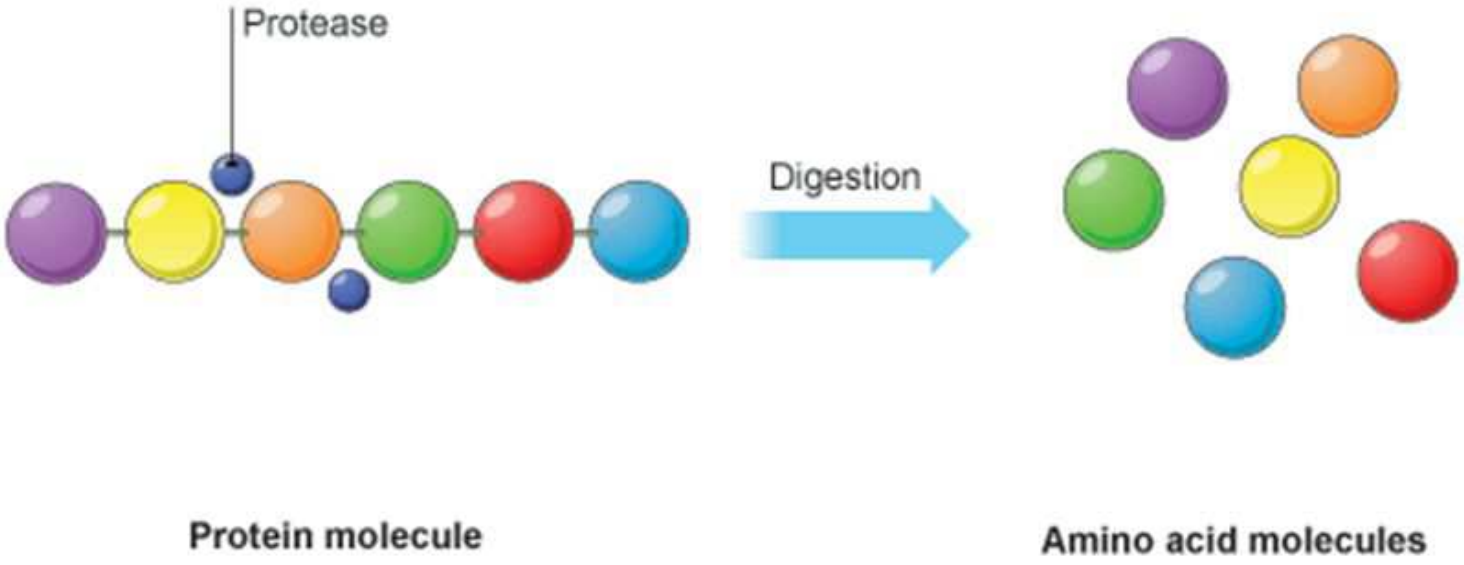
# ENZYMES

- Proteins that act as catalysts for chemical reactions in living organisms are known as enzymes.
- The majority of chemical reactions in living organisms require enzymes.
- Enzymes are highly specific for certain reactants: the compound acted upon by the enzyme is known as the substrate.

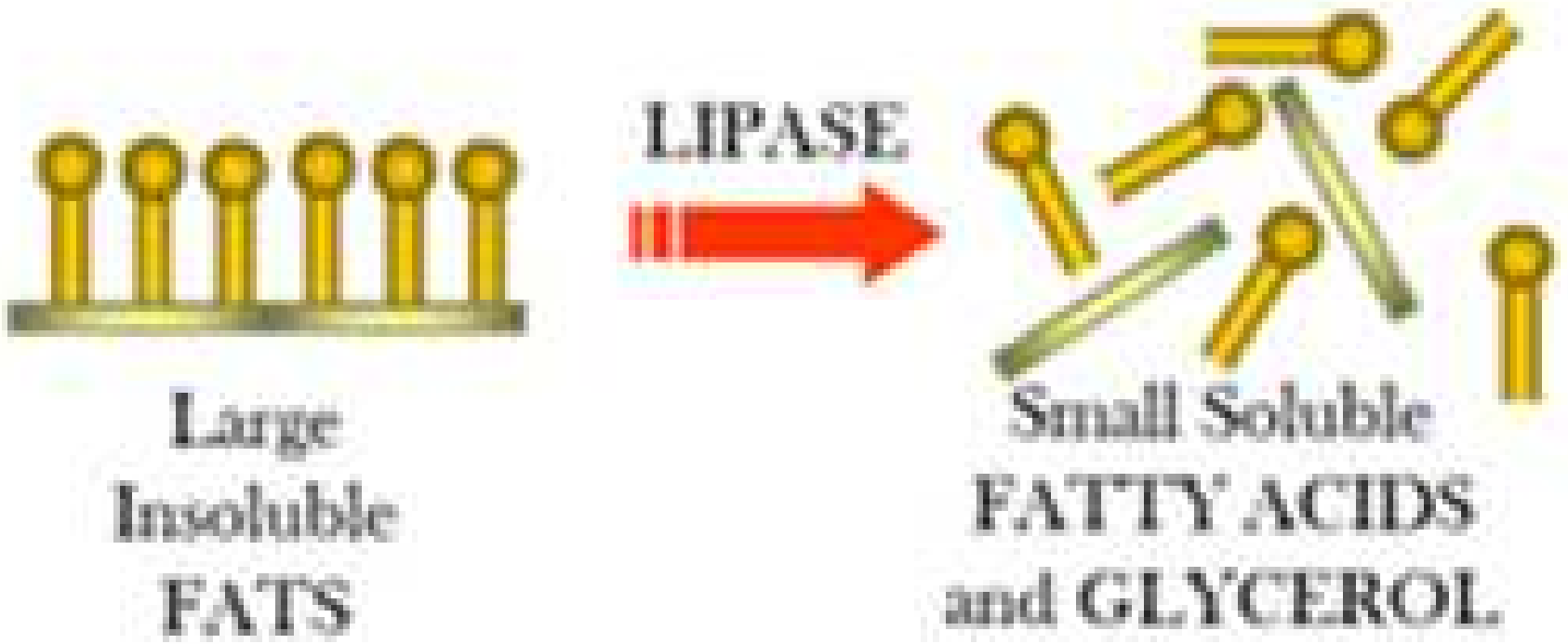
- The names of enzymes most commonly end in the suffix-ase, which is sometimes appended to the name of the substrate or the type of reaction.
- Some enzymes function properly only in the presence of cofactors or coenzymes.

# Proteins

- **Protease** enzymes break down **proteins** into **amino acids**



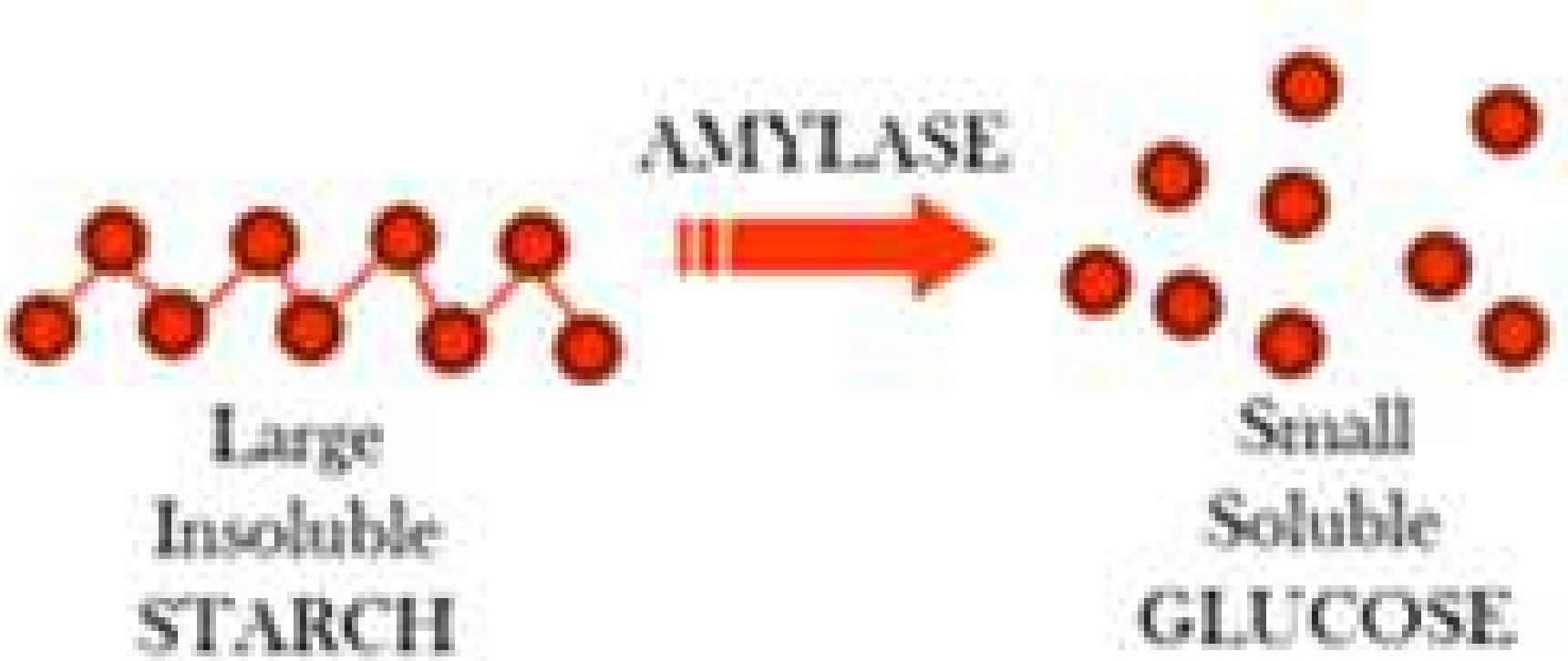

PROTEASE
Large
Insoluble
PROTEIN
Small Soluble
AMINO
ACIDS


LIPASE
Large
Insoluble
FATS
Small Soluble
FATTY ACIDS
and GLYCEROL

- Cofactors are inorganic, often metallic, ions (such as Mg++ and Mn++ ), while organic molecules (such as NAD, NADP, and some vitamins)are coenzymes.
- Both cofactors and coenzymes are loosely associated with enzymes; however, prosthetic groups are nonprotein molecules that are attached to some enzymes and are necessary for enzyme action.

- They possess the four features listed above.
- However, enzymes have additional attributes that set them apart from catalysts:

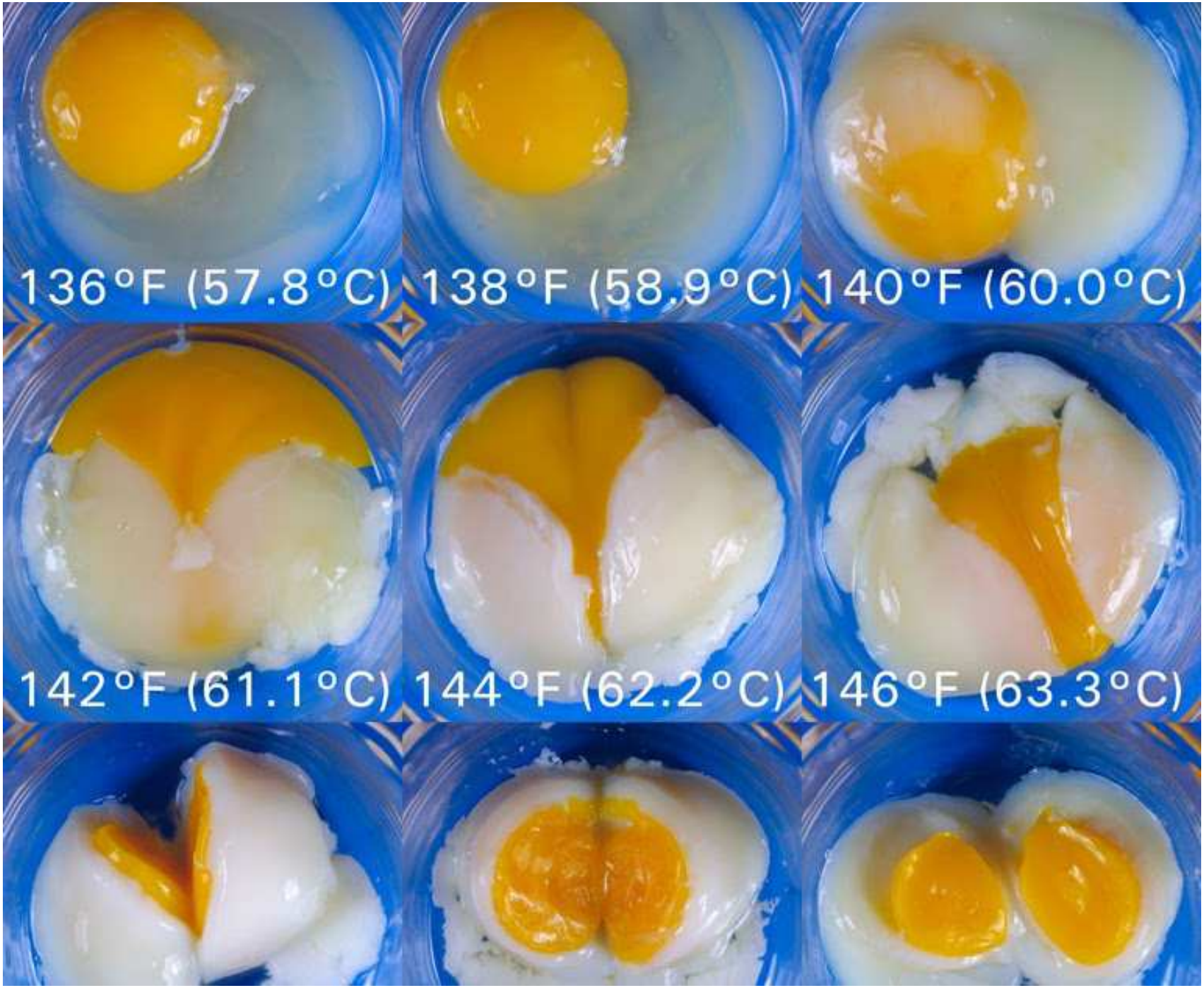
1. Although inorganic catalysts can accelerate many different reactions, enzymes are very specific, promoting only one or at most a few chemical reactions, for example, the enzyme amylase breaks down starch but leaves cellulose intact, despite the fact that both starch and cellulose are compounds of glucose subunits.

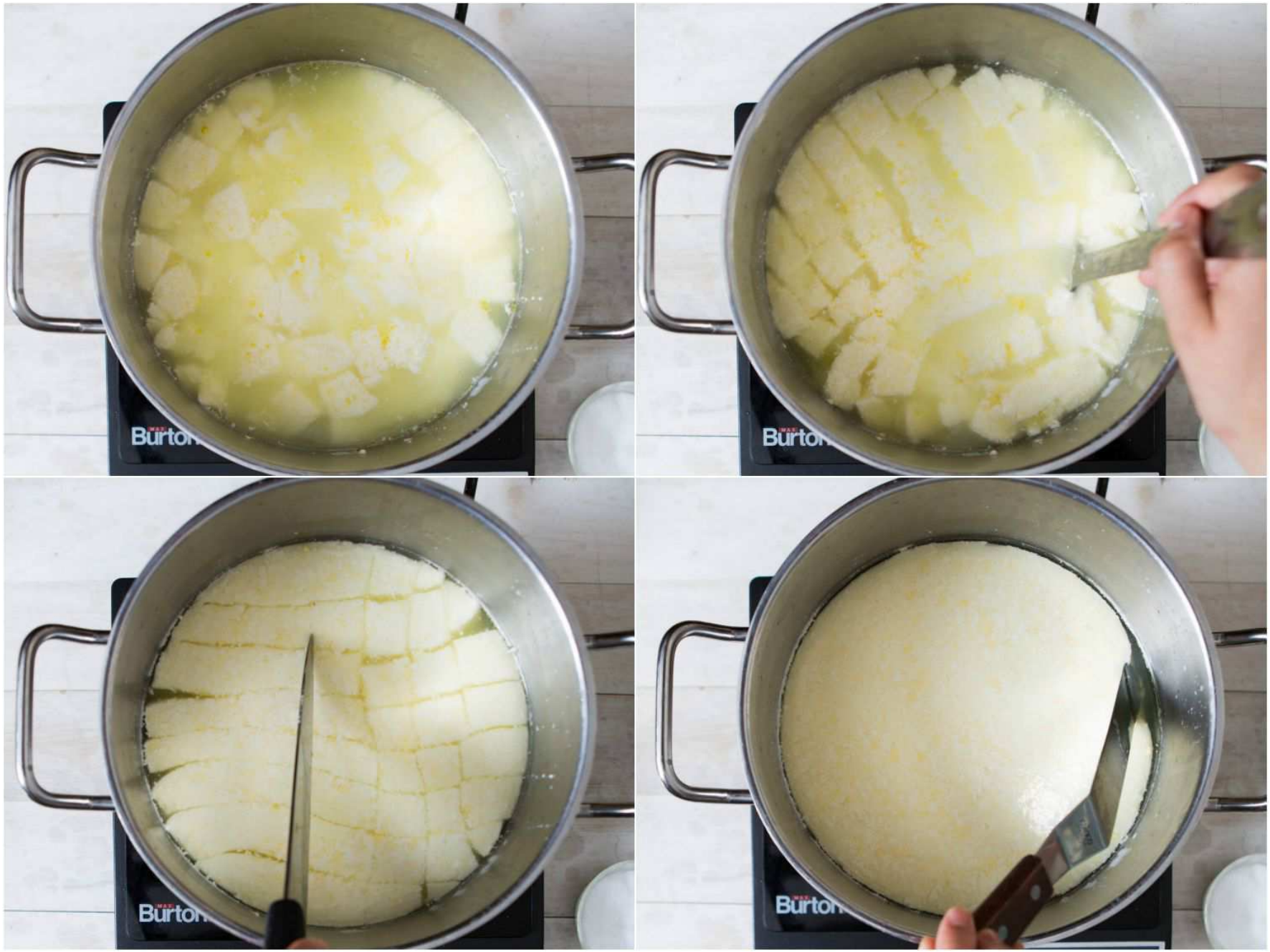

AMYLASE
Large
Insoluble
STARCH
Small
Soluble
GLUCOSE

2.-The second distinctive trait of enzymes is that their activity can be regulated, that is advanced or suppressed.

3. - Enzymes are sensitive to heat.

- Most enzyme-catalysed reactions are slowed down when the temperature is extremely low or is increased to 35 - 40°C, and are destroyed at temperatures between 60°-70°C.
- The reaction proceeds rapidly, when the temperature has been raised for 10° C.


136°F (57.8°C)
138°F (58.9°C)
140°F (60.0°C)
142°F (61.1°C)
144°F (62.2°C)
146°F (63.3°C)



4. Enzyme activity is influenced by hydrogen ion concentration (pH).

   For each enzyme there is an optimum pH at which the enzyme reaction proceeds most rapidly, usually at pH 7.

   Solutions that have hydrogen ion concentrations higher or lower than the optimum tend to destroy the enzyme.

# ENZYME REGULATION

Enzyme – assisted reactions may be regulated in the following ways :

1 . ***Limit the amount of enzyme present in the cell .***

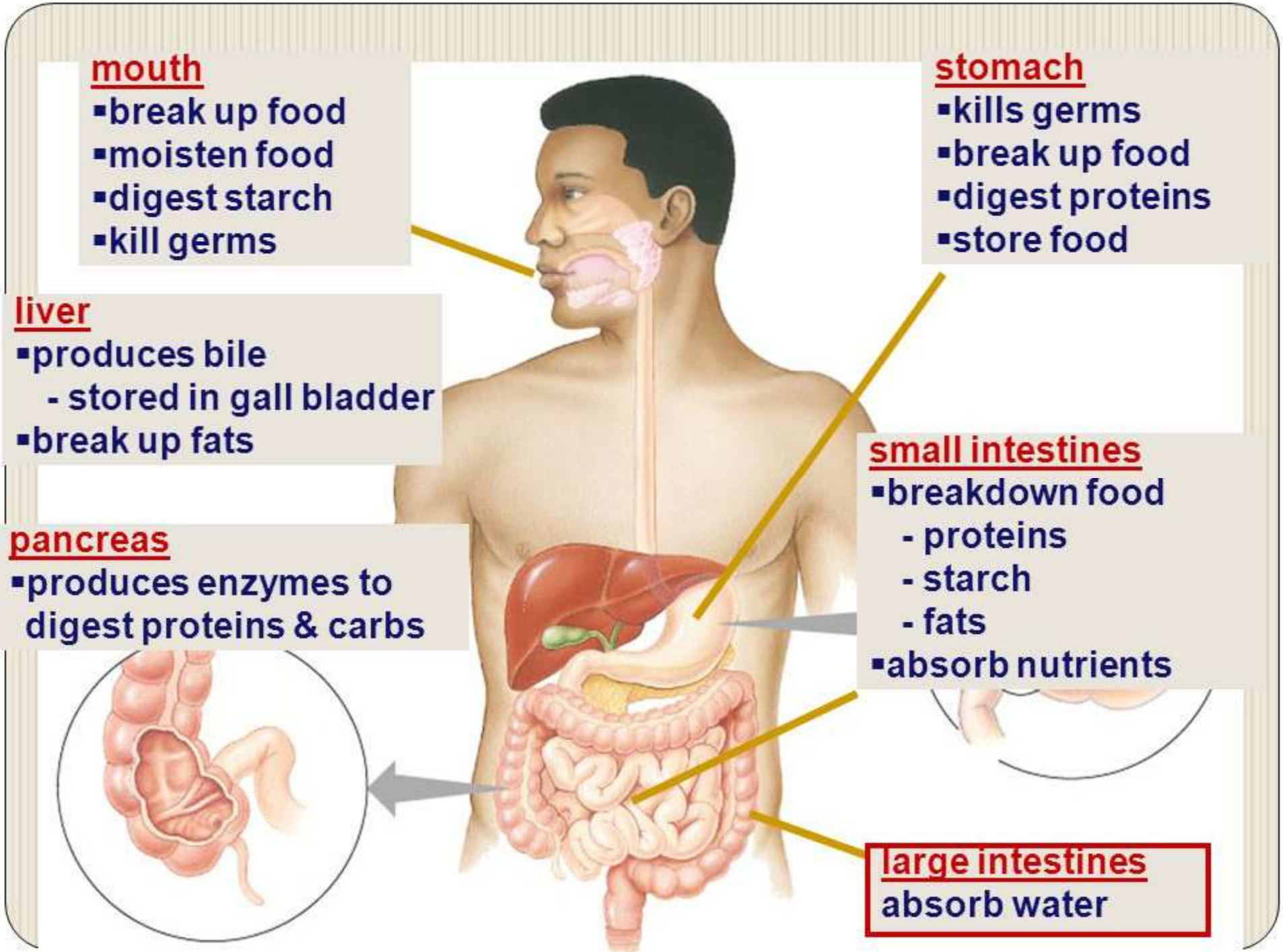
- If there is no enzyme , the reaction will not occur .
- Cells can regulate the synthesis of enzymes to meet their changing needs .

2 . ***Synthesize the enzyme initially in an inactive form and activate it only when needed*** **.**

- Certain cells in the stomach , pancreas and small intestine , for example, produce enzymes that digest food molecules such as proteins and lipids .

-These enzymes are synthesized in an inactive form , with the active site blocked off .

- In the digestive tract , the interfering parts are cut off , thus activating the enzyme.

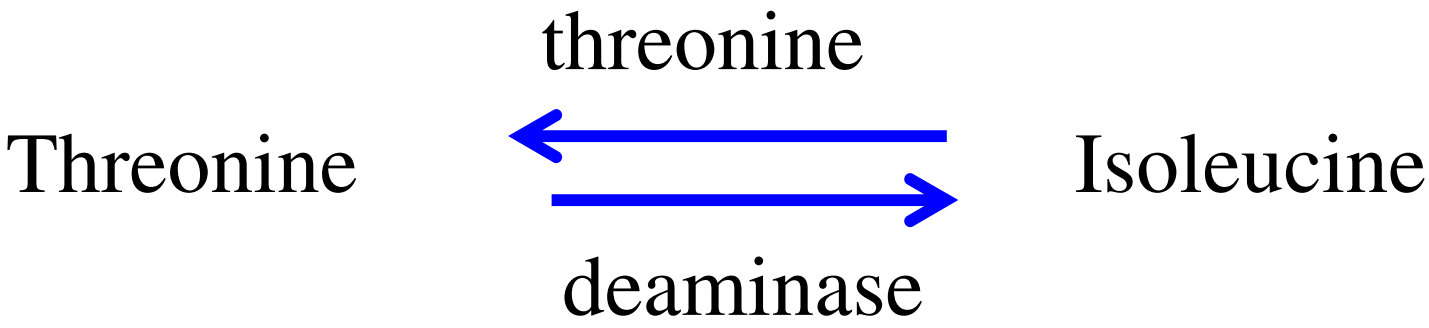

mouth
▪break up food
▪moisten food
▪digest starch
▪kill germs
stomach
▪kills germs
▪break up food
▪digest proteins
▪store food
liver
▪produces bile
- stored in gall bladder
▪break up fats
small intestines
▪breakdown food
- proteins
- starch
- fats
▪absorb nutrients
pancreas
▪produces enzymes to digest proteins & carbs
large intestines
absorb water

3. More flexible enzyme regulation can be ***achieved by temporarily activating and inactivating enzymes*** : depending on the conditions in the cell at any given time.

# a. End –Product Inhibition

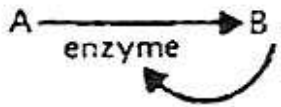
***- Enzyme activity is inhibited by the end – product of the reacaction catalyzed by the enzyme .***

- For example the enzyme threonine deaminase converts threonine to isoleucine .
- The cell needs both amino acids in suitable concentrations .
- If enough isoleucine is present , it inhibits the activity of threonine deaminase preventing further conversion of threonine .


threonine
Threonine
Isoleucine
deaminase

end product inhibition

( 1 )

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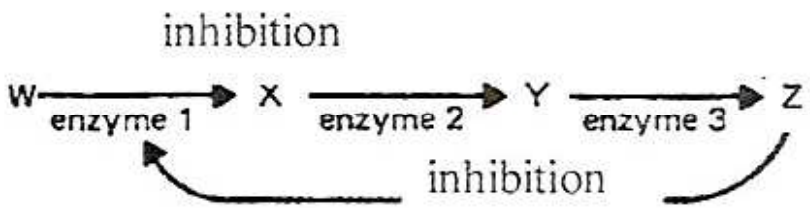
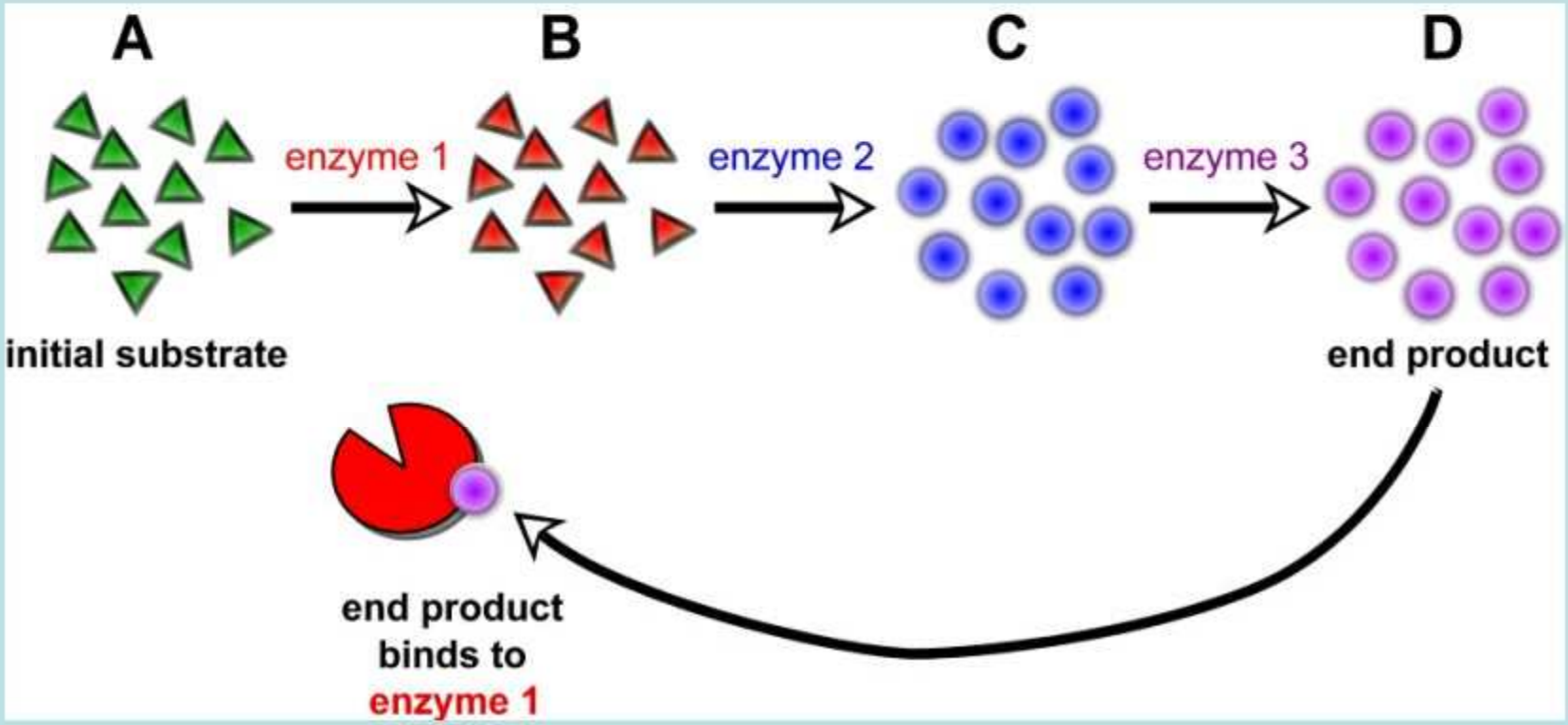


# End-product Inhibition



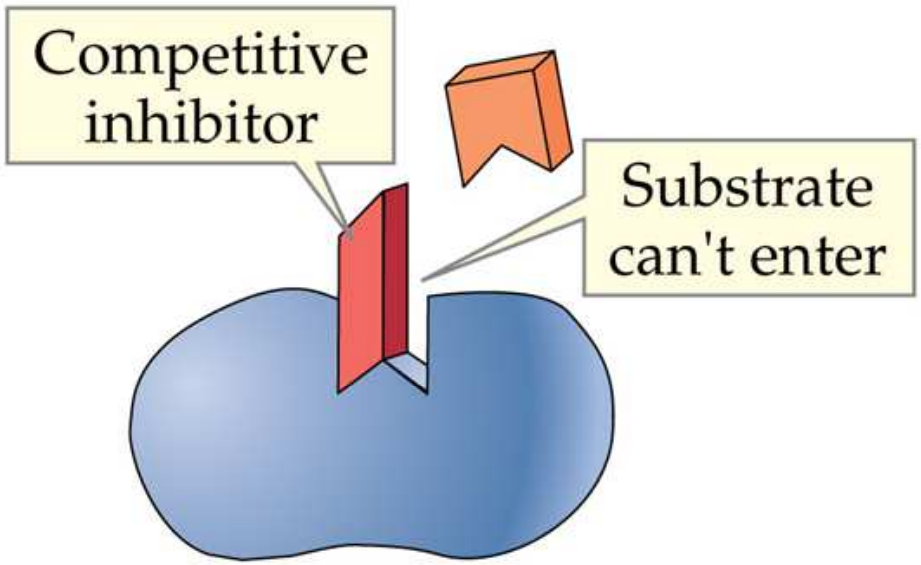

- When end product **D** increases in concentration, it can bind to the first enzyme in the pathway and reduce the efficiency of conversion of **A** to **B**.

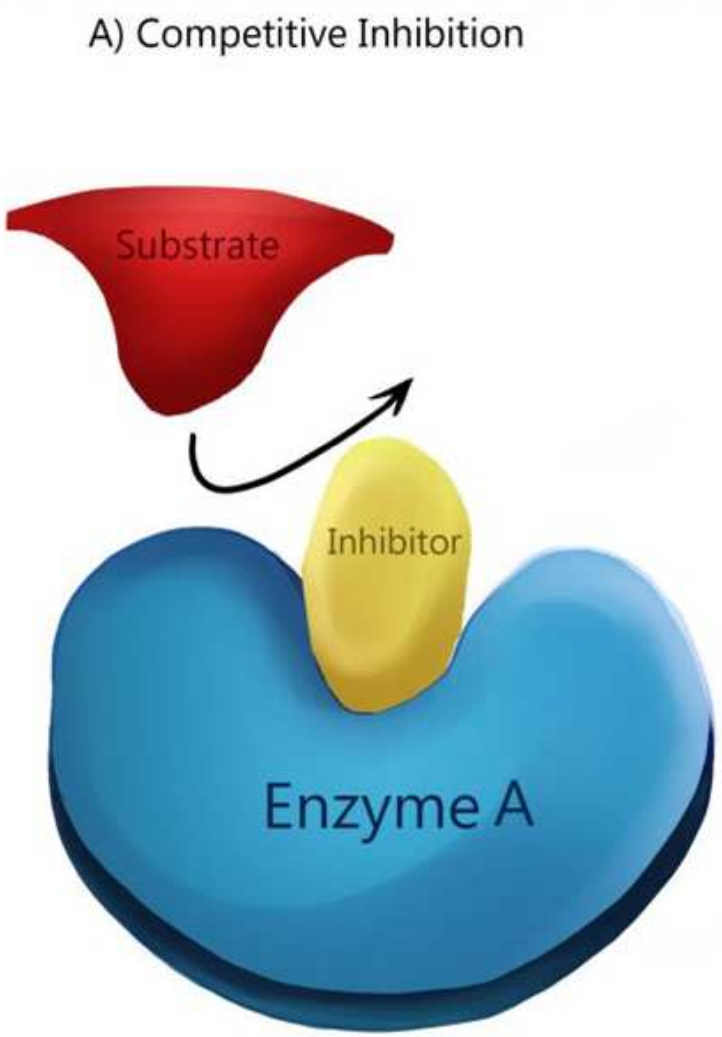
# b. Competitive Inhibition

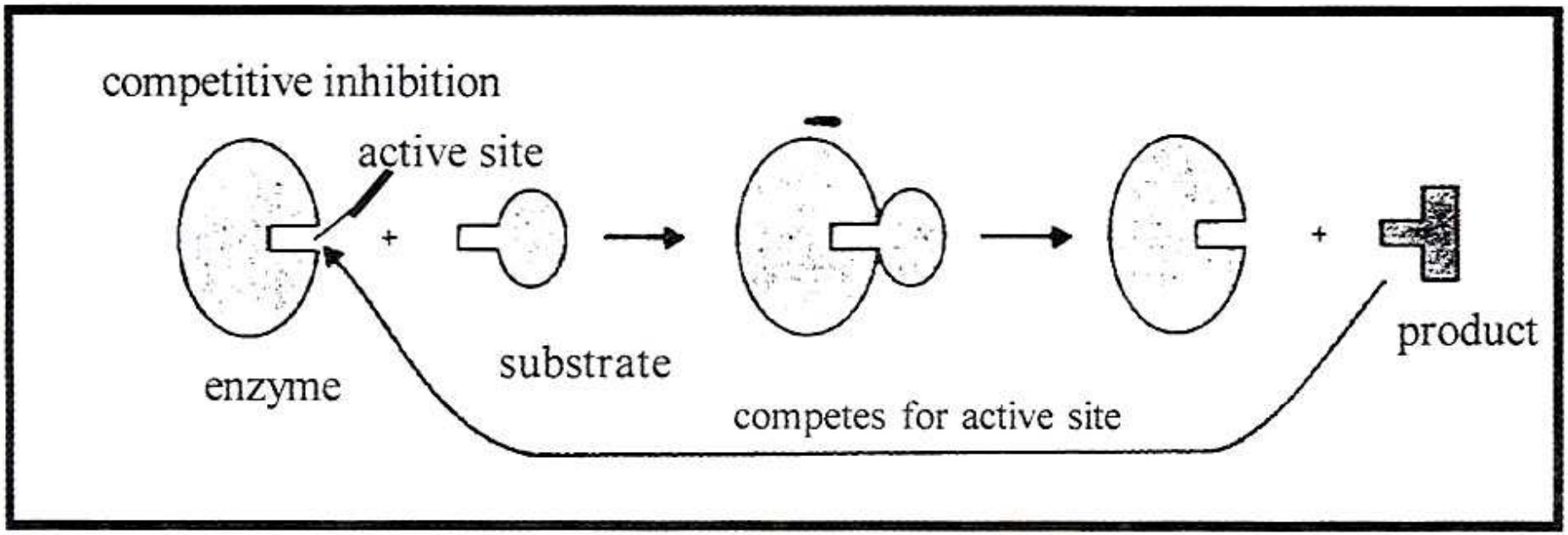
***- When two or more molecules complete for entry into the active site , only one molecule can occupy the active site .***

- If the product of a series of reactions can bind to the active site of one of the enzymes in the pathway , the rate of the reaction will be slowed down .

# *Competitive inhibition*




competitive inhibition
active site
enzyme
substrate
competes for active site
product

# c. Allosteric Inhibition

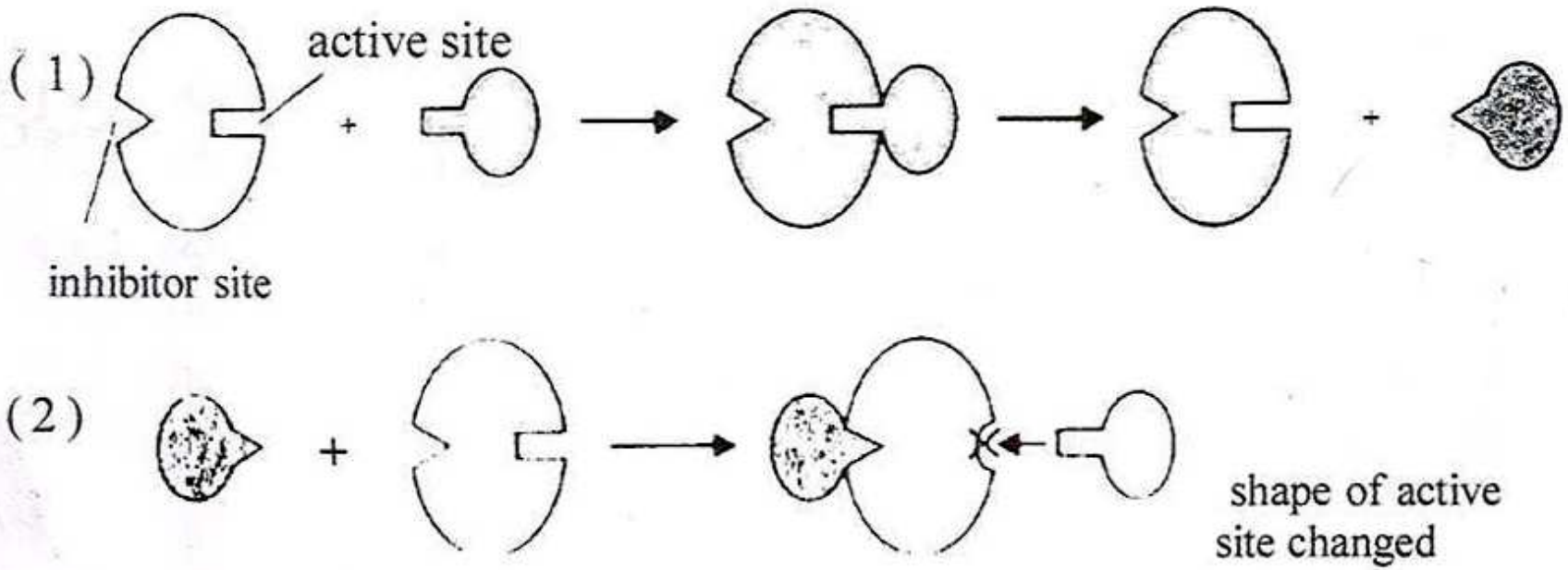
***- In which enzyme action is blocked by molecules binding to the enzyme , some place away from the active site .***

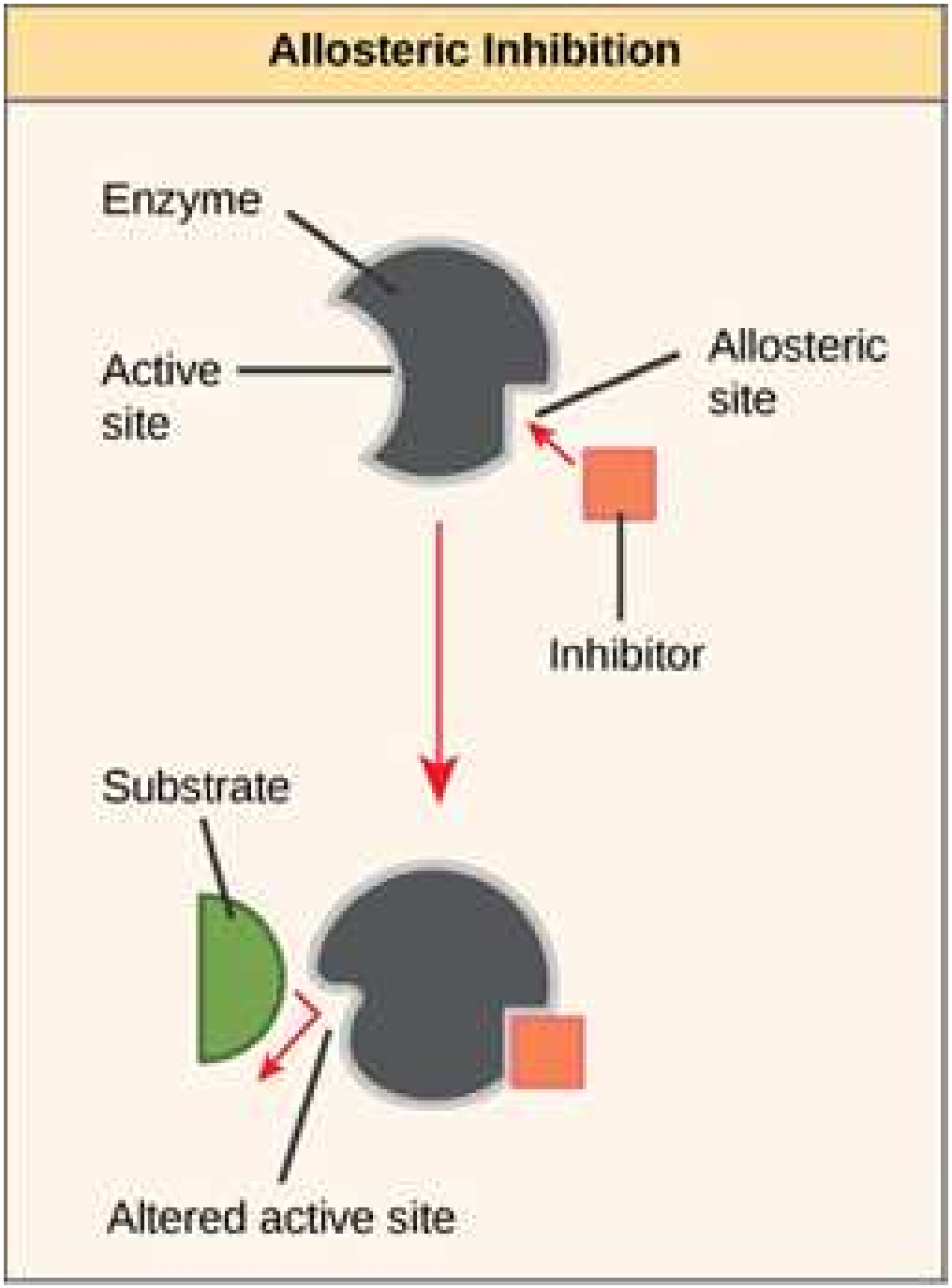
- Many enzymes have both an active site that catalyzes the reaction and an inhibitor site on a different part of the enzyme .
- When the inhibitor site is occupied the enzyme molecule changes shape ( “allosteric” means “ other shape “ ) .
- This distorts the active site there by keeping the substrate out ,so the reaction stops.

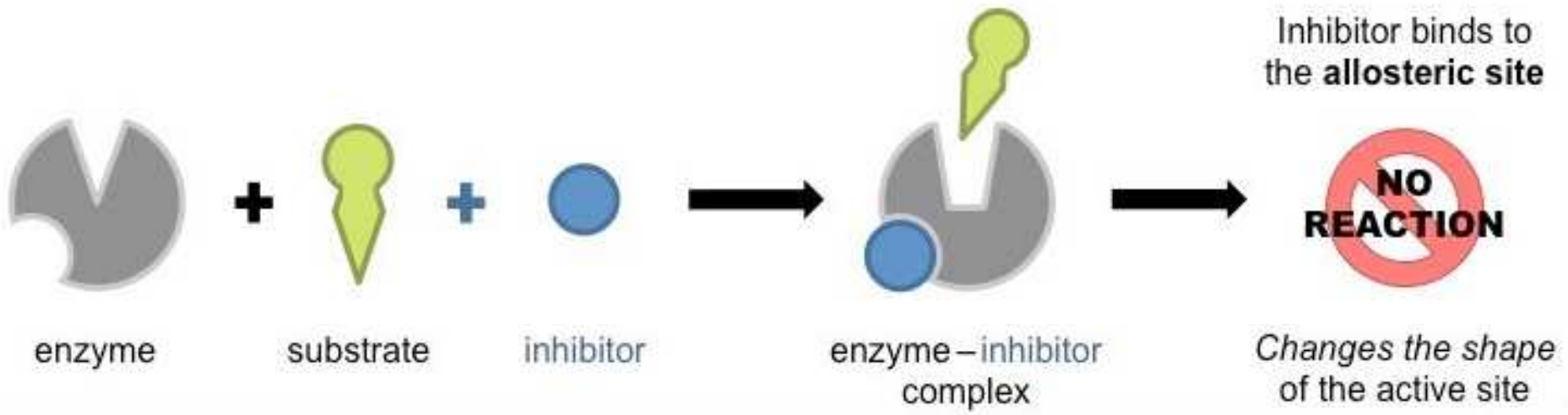
- Because enzyme- catalyzed reactions are reversible for any given enzyme, inhibitors are continuously binding and releasing .
- If inhibitors are scarce , it will be along while between binding and the enzyme will be active of the time .
- If the concentration of inhibitors is high ,as soon as one inhibitor leaves the enzyme ,another will take its place ,and the enzyme will be inactive most of the time.

- In end –product inhibition , this means that when there is very little product in the cell , there is very little enzyme inhibition ,therefore ,the enzyme will actively synthesize the product.
- As the product accumulates , it gradually shuts down the enzyme , preventing further depletion of substrate .
- ***Thus the activity of an enzyme is controlled by the concentration of inhibitors in the cell to maintain optimal concentrations of both substrate and products .***

allosteric inhibition




Allosteric Inhibition
Enzyme
Active site
Allosteric site
Inhibitor
Substrate
Altered active site


Inhibitor binds to
the **allosteric site**
NO
REACTION
enzyme
substrate
inhibitor
enzyme – inhibitor
complex
*Changes the shape*
of the active site

# THANK YOU