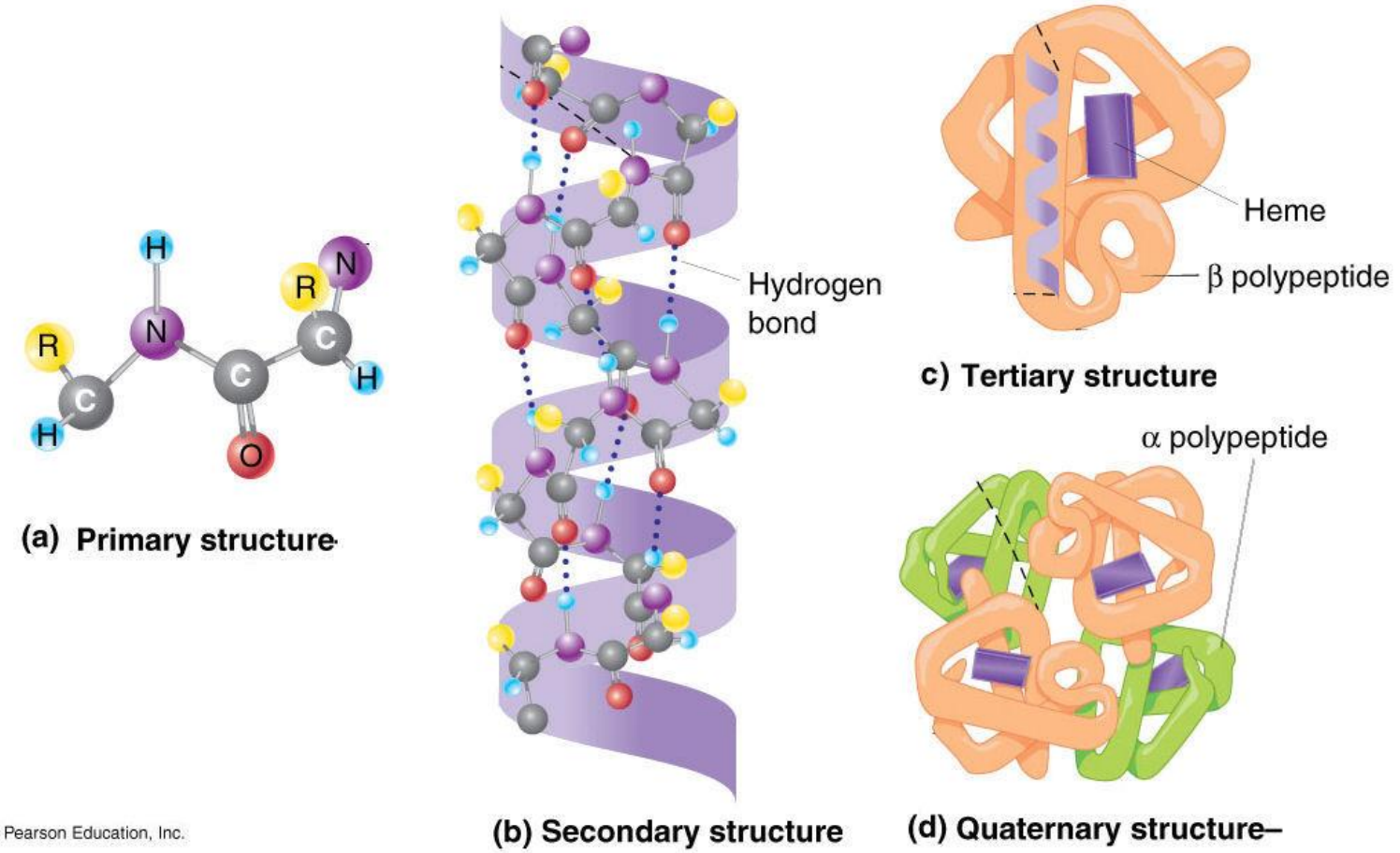
Enzymes

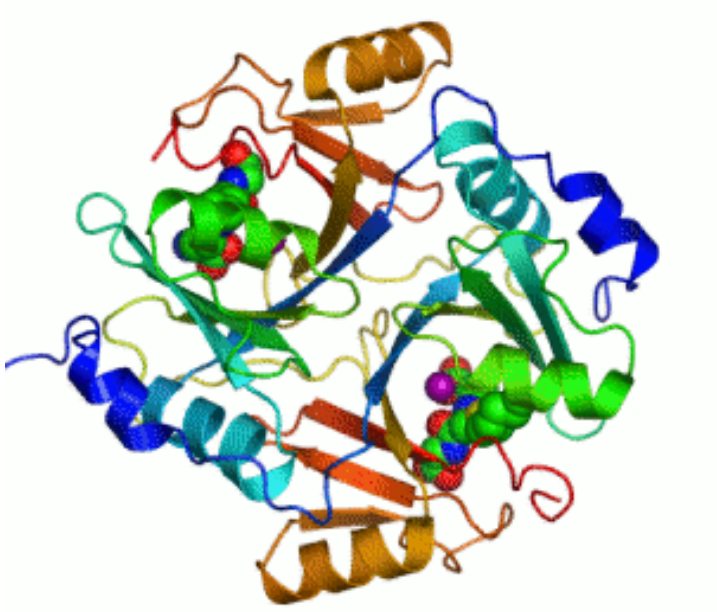
SBI4U

Recap



Enzymes and Biological Reactions

Enzymes are protein catalysts that regulate many metabolic reactions.



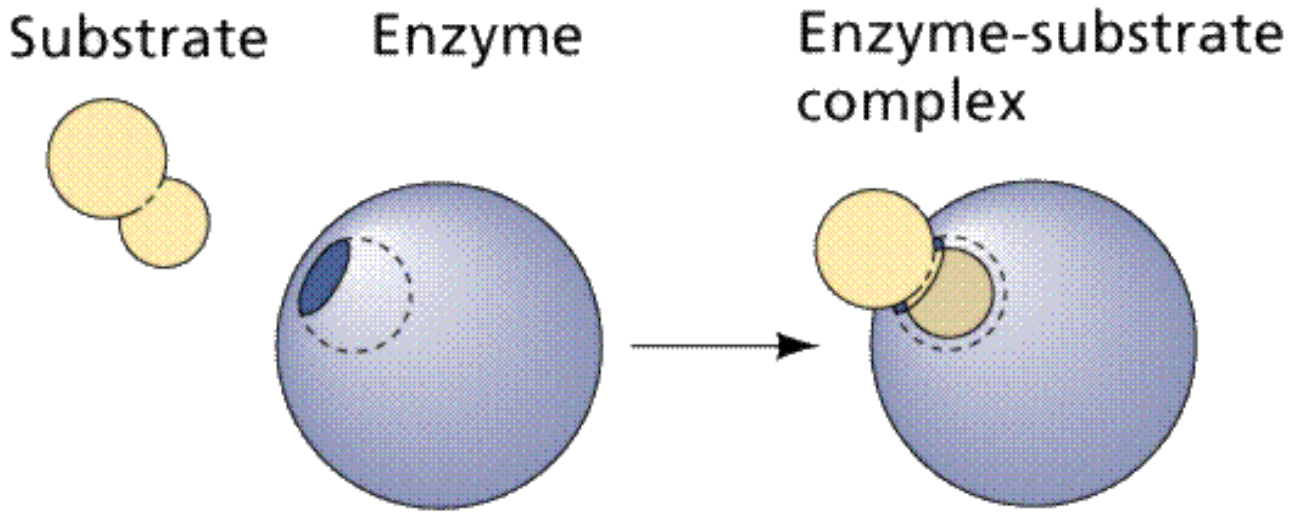
All catalysts increase the rate of a reaction.

Most enzymes are names after the reaction they catalyze and their names end in **'-ase'.**

e.g **amylase** – hydrolyzes starch

Enzyme Structure

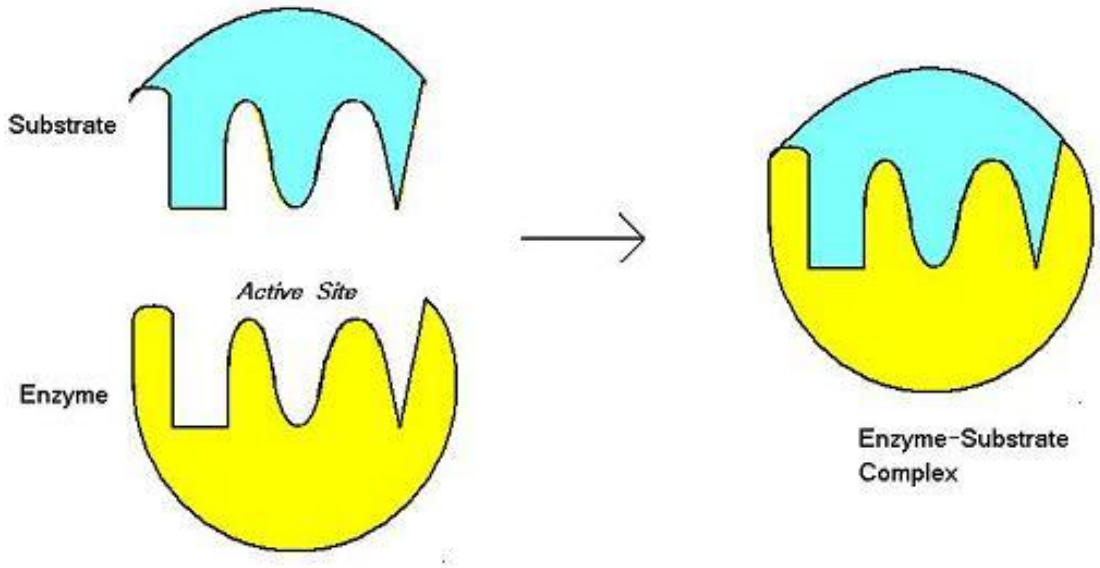
The ***substrate*** must fit precisely in the ***active site*** in order for the reaction to proceed. All enzymes are highly specific to only one substrate.



Attachment of the substrate to the active site forms an **'Enzyme-substrate complex'**

Enzyme Structure

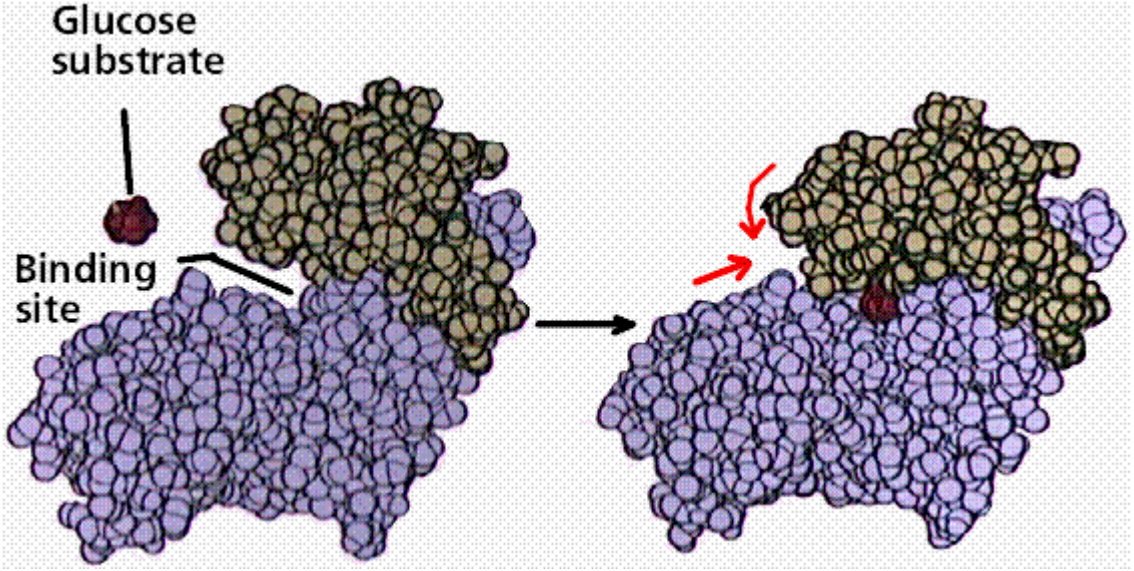
The active site of the enzyme has a specific 3-D structure that only allows it to bind to one specific substrate.



Each enzyme is involved in specific biochemical reactions within the cell. Each specialized for a particular function.

Induced Fit Model

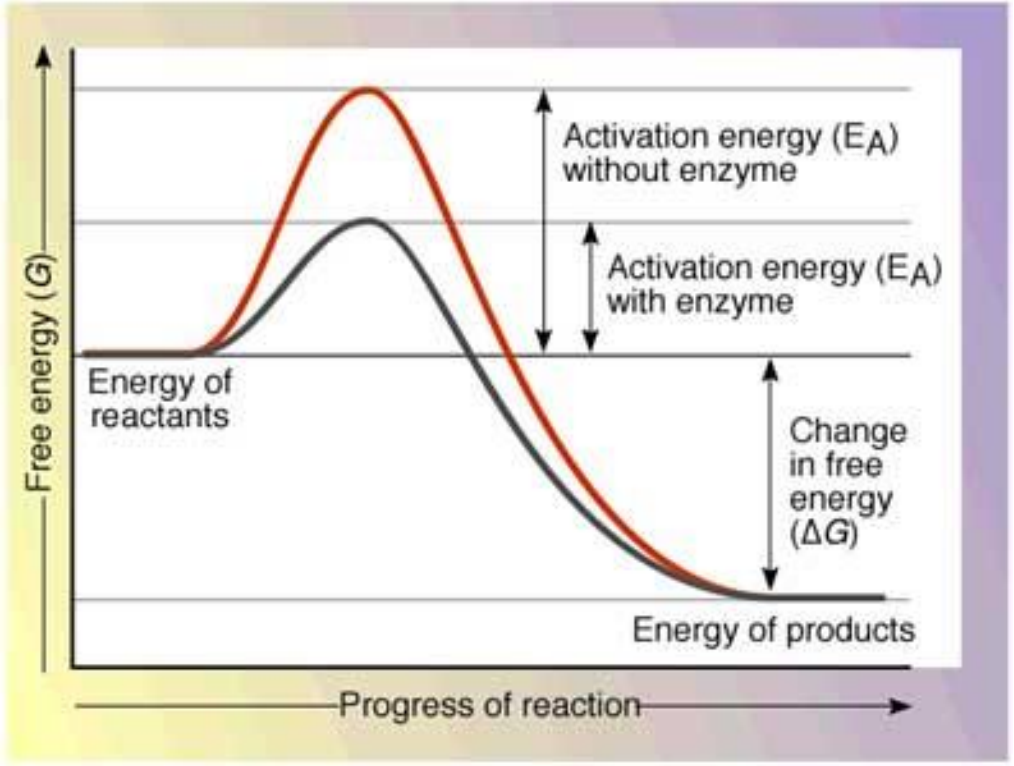
The substrates interact with the functional groups within the enzyme's active site. This helps to ***weaken the bonds*** in the substrate and increase the rate of reaction.



When the substrate and enzyme interact it causes the enzyme to change its shape and better fit the substrate.

Enzymes and Biological Reactionsc

The interactions within the enzyme-substrate complex allow the bonds to be weakened and easily broken without increasing the activation energy of the reaction.



Transition state: The enzyme changes conformation to better fit the substrate. At this state the bonds are weakened and the activation energy is lowered.

Enzymes and Biological Reactions

The enzyme can lower the activation energy by:

A) The R-group of the protein interferes with the molecule bonds in the substrate.

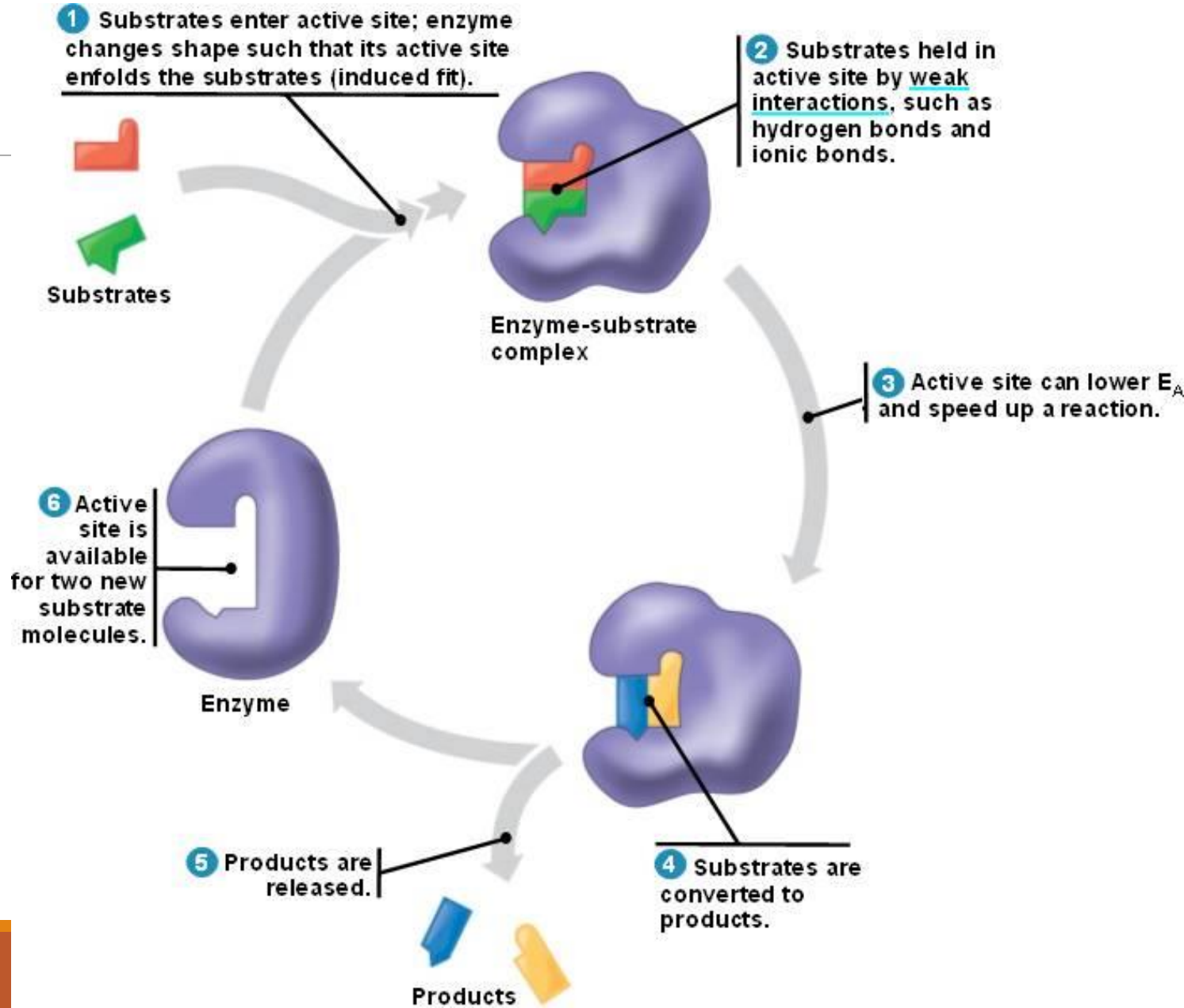
B) Transfer of electrons between the enzyme and substrate.

C) Add or remove hydrogen ions to or from the substrate.

Enzymatic Cycle

At the end of the reaction, only the substrate changes its shape permanently.

The enzyme remains the same and is recycled in the cytoplasm.

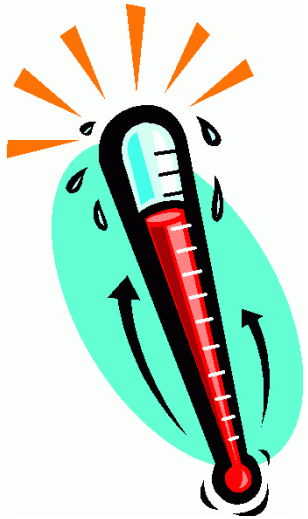


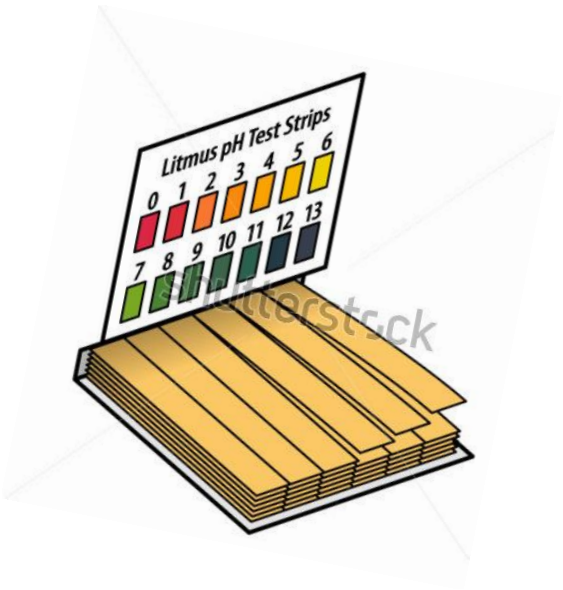
Enzymes and Biological Reactions

All enzymes function in an optimal environment. Any change to those conditions can alter the rate of reaction.

Factors affecting enzyme activity:

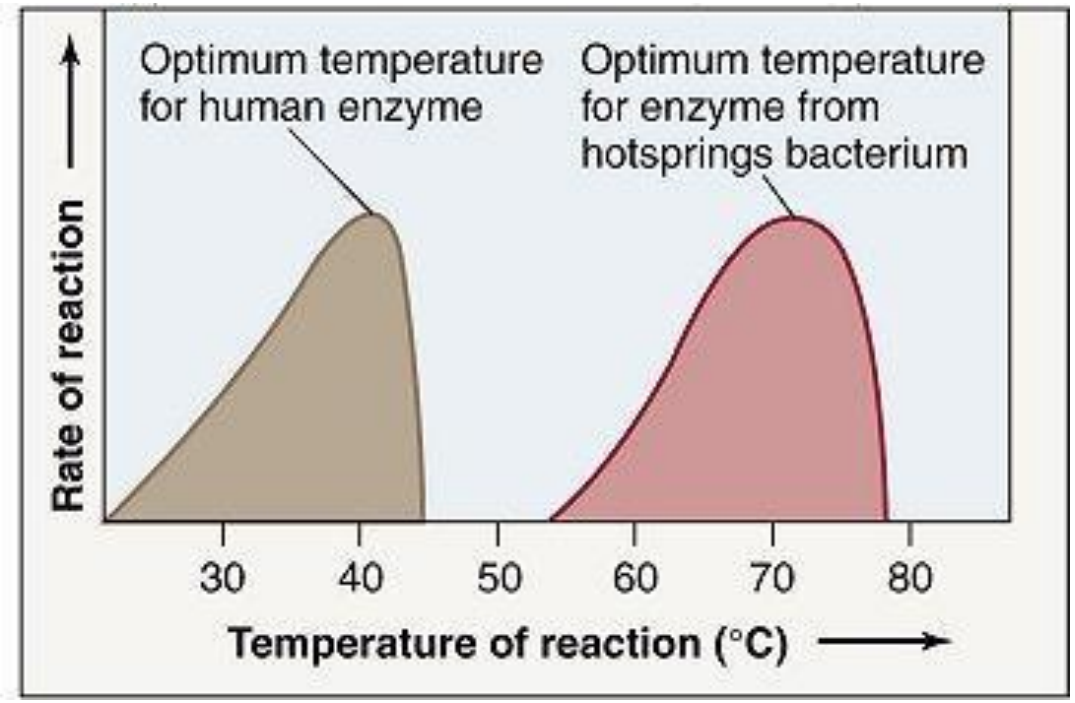
- Temperature
- pH
- Enzyme concentration
- Substrate concentration





Factors Affecting Enzyme Acitivty

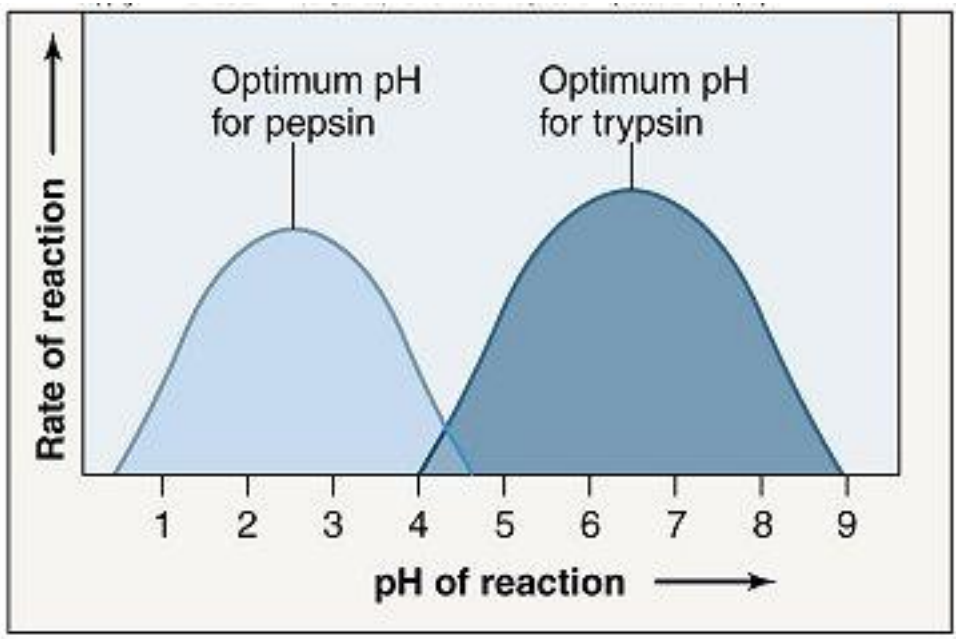
1) Temperature:



At high temperatures, the reaction rate increases, until the bonds are disrupted and the enzyme Is denatured (unravelled).

Factors Affecting Enzyme Acitivty

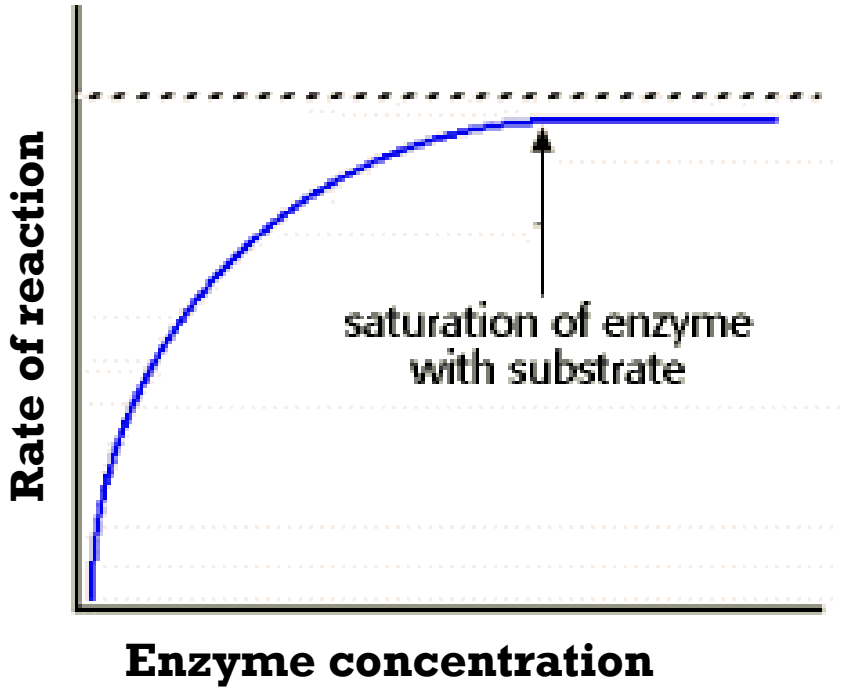
2) pH: bonds between the functional groups that hold the protein together are sensitive to H+ concentration.



The pH within the environment can denature the enzymes.

Factors Affecting Enzyme Acitivty

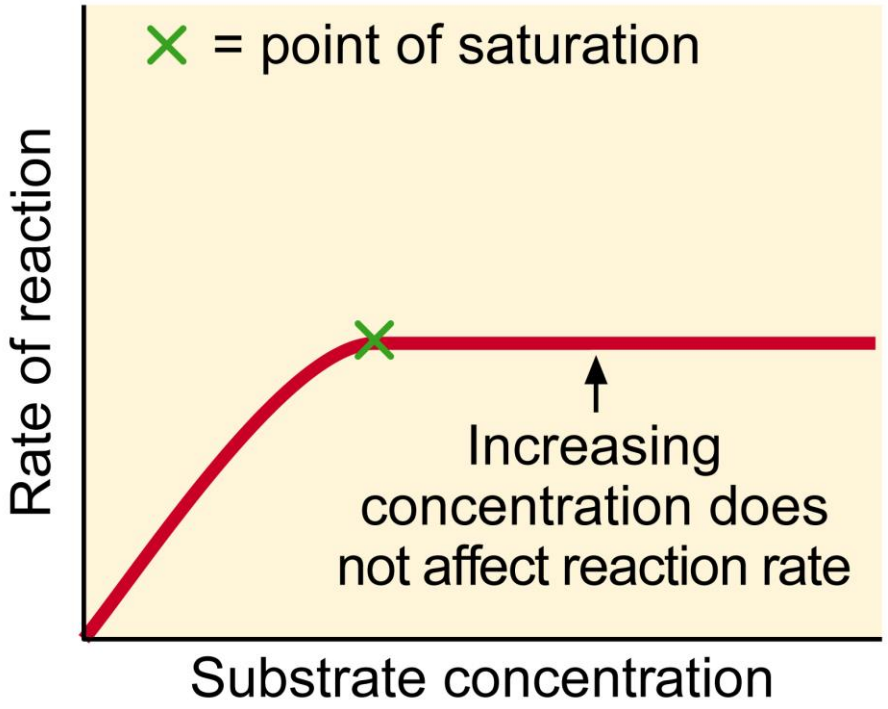
3) Enzyme Concentration: the more enzymes in the solution the more likely they are to collide with the substrate.



Increase in the enzyme concentration increases the rate of reaction until it reaches a point of saturation.

Factors Affecting Enzyme Acitivty

4) Substrate Concentration: the higher the substrate concentration, the faster the reaction until it reaches a point of saturation.



Saturation point *is the point whereby all of the active sites are full. By adding more substrate it will no longer have an effect on the rate of reaction because all of the enzymes are occupied.*

Enzymes and Biological Reactions

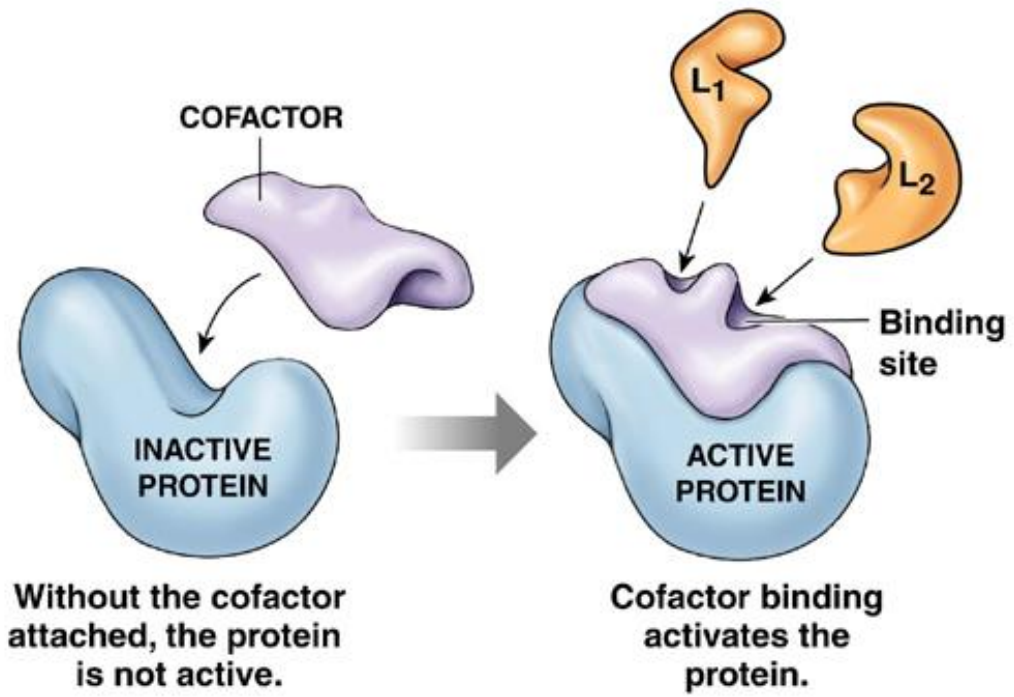
Enzyme activity can also be regulated by a variety of factors.

Regulation mechanisms:

- Cofactors/Coenzymes
- Competitive inhibitors
- Non-Competitive inhibitors
- Allosteric Changes
- Feedback Inhibition

1. Cofactors/Coenzymes

A cofactor is placed within the active site of the enzyme and helps to draw electrons from the substrate molecules.



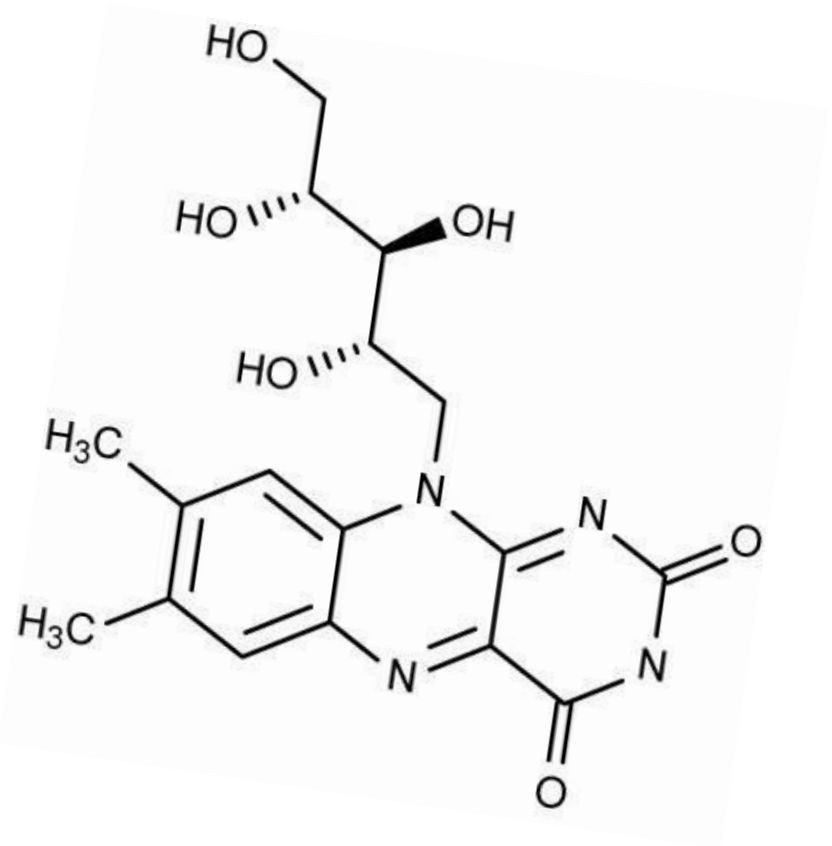
Example: Vitamin B_2 (Riboflavin)

Part of the coenzyme FAD and FMN.

Involved in energy metabolism (i.e metabolism of fat, carbohydrates and proteins)

Riboflavin deficiency: your body has difficulty metabolizing (fats, carbs and proteins)

Most common cause is dietary inadequacy.



Example: Vitamin B_2 (Riboflavin)

Can obtain riboflavin from meat, nuts, cheese, eggs.

Testing for riboflavin deficiency measures activity of the enzyme gluthathione.

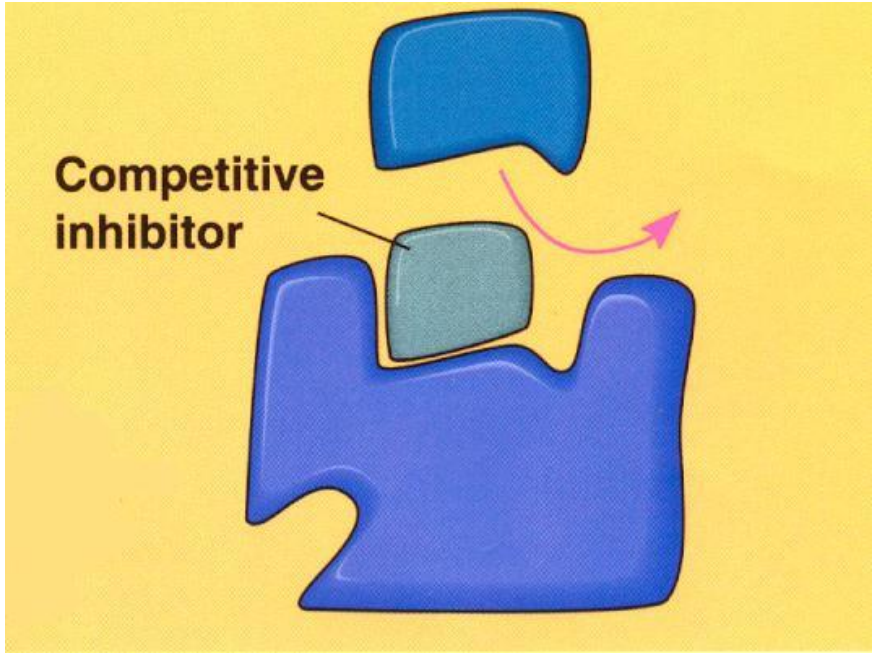
Symptoms: bloodshot eyes, mouth, inflammation, sores, burning tongue.

Not common because most countries fortify their breads and cereals with vitamin B_2.

2. Competitive Inhibitor

The inhibitor has a similar shape to the enzyme and binds to the active site

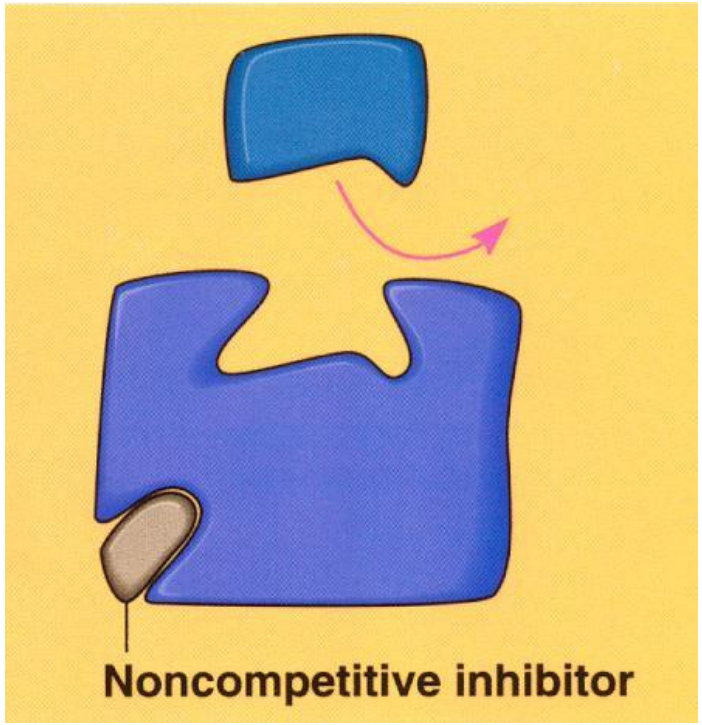
The greater the inhibitor concentration the less likely it is that a reaction will occur.



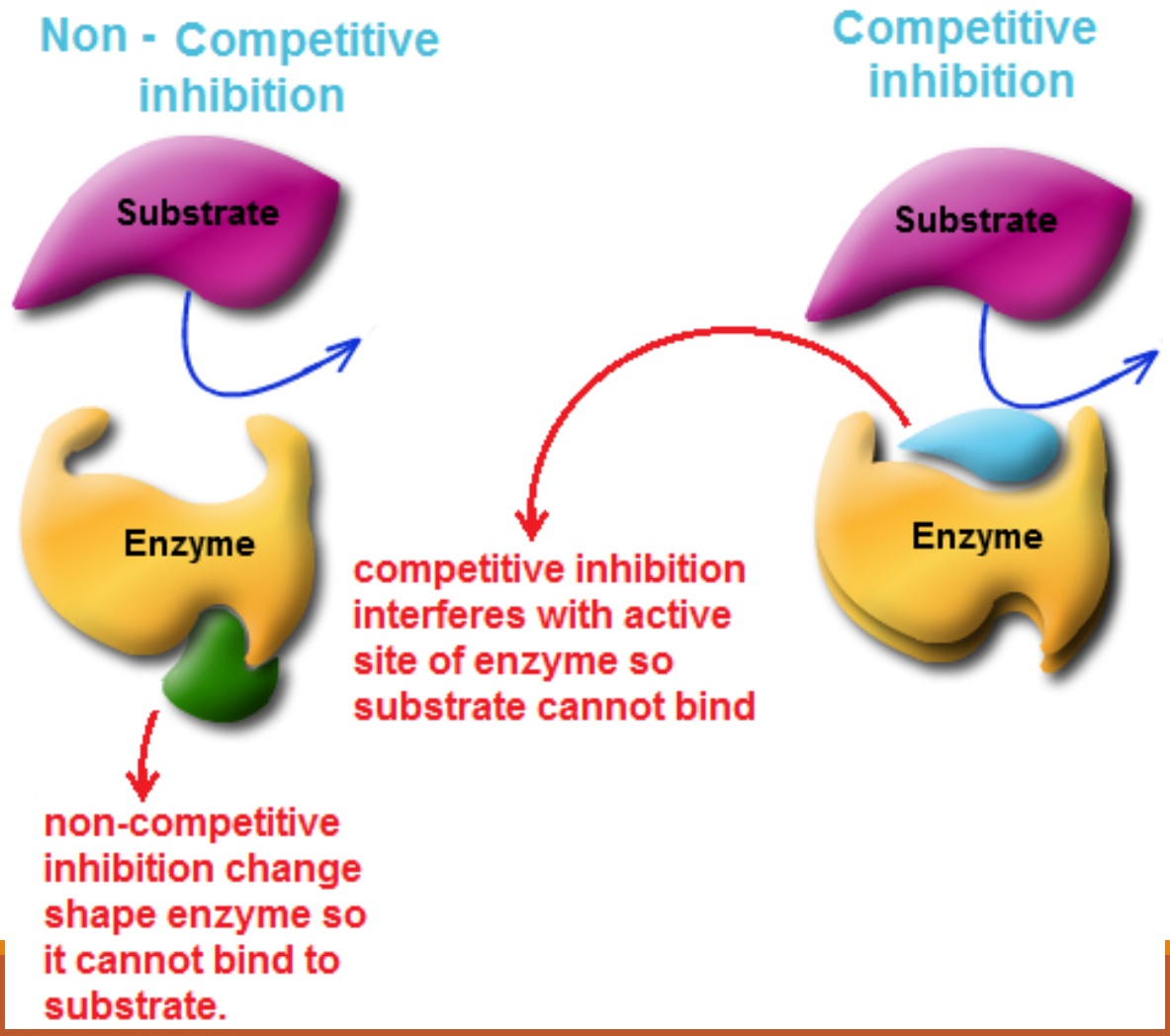
3. Non-Competitive Inhibitor

An inhibitor binds to another site ***(allosteric site)*** on the enzyme that changes its conformation and prevents the substrate from binding.

By increasing the substrate concentration, the reaction rate does not change because the shape has changed and therefore will not bind.

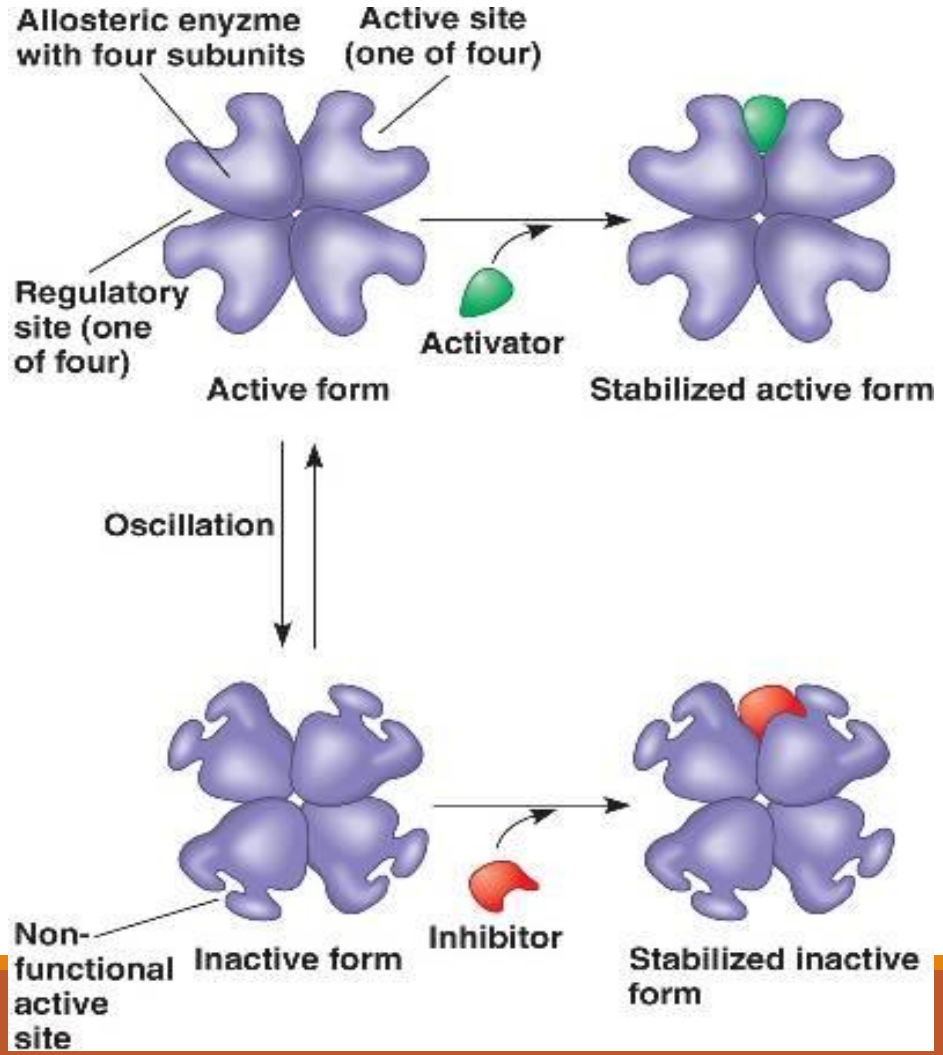


Competitive vs. Non-Competitive Inhibitor



4. Allosteric Changes

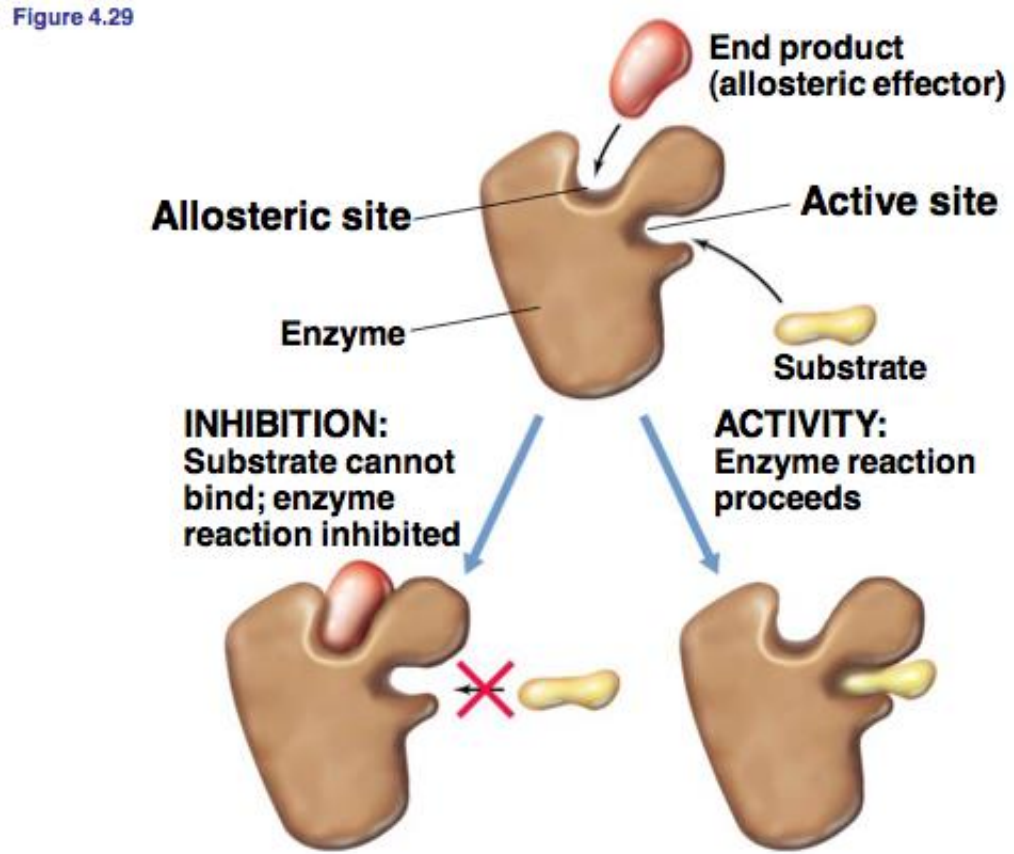
******Allosteric change*****:** *when the shape of an enzyme change when an activator/inhibitor binds to the allosteric site.*



When the activator binds: *all of the active site are open and the enzyme is in an active state.*

When the inhibitor binds*: all of the active site are closed and the enzyme in an inactive state.*

4. Allosteric Changes

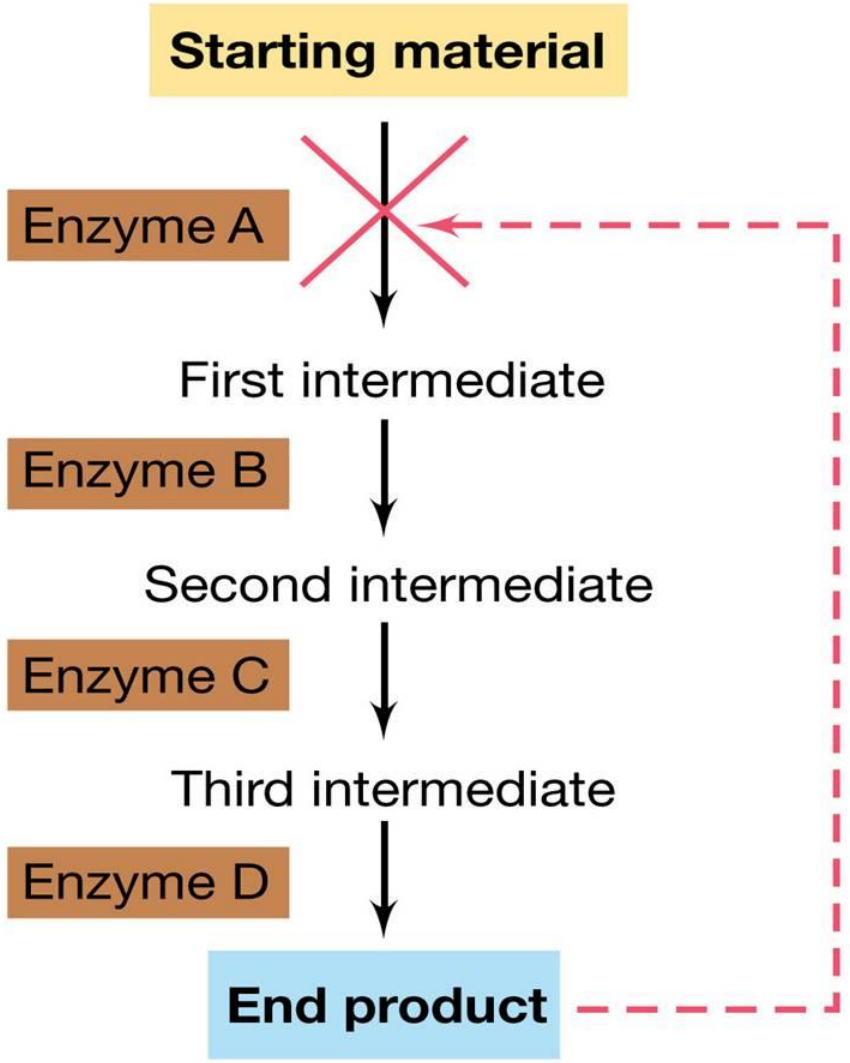


5. Feedback Inhibition

The product of one reaction becomes the substrate of another enzymatic reaction.

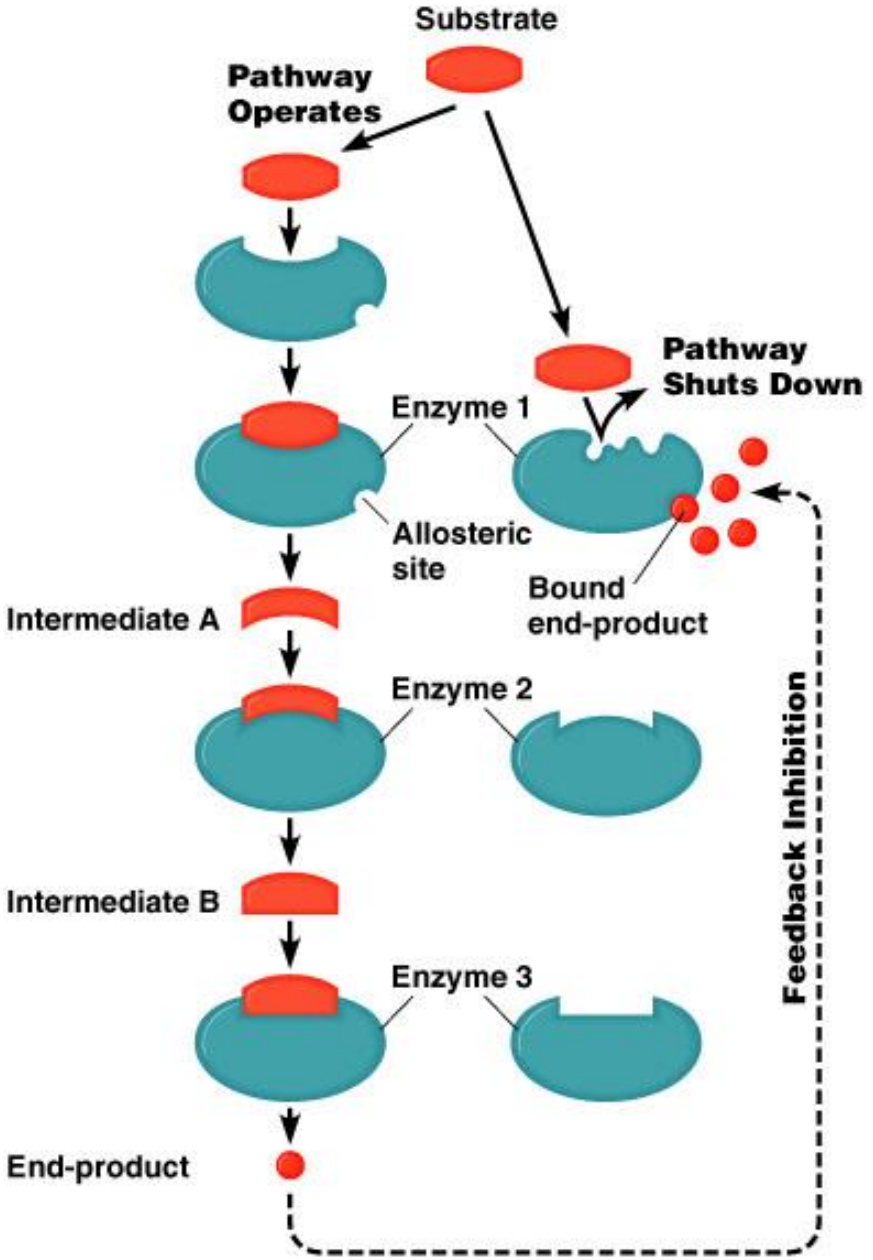
Each enzyme is highly specific to the new product in the pathway.

The product formed in the last step of the pathway can become an inhibitor.



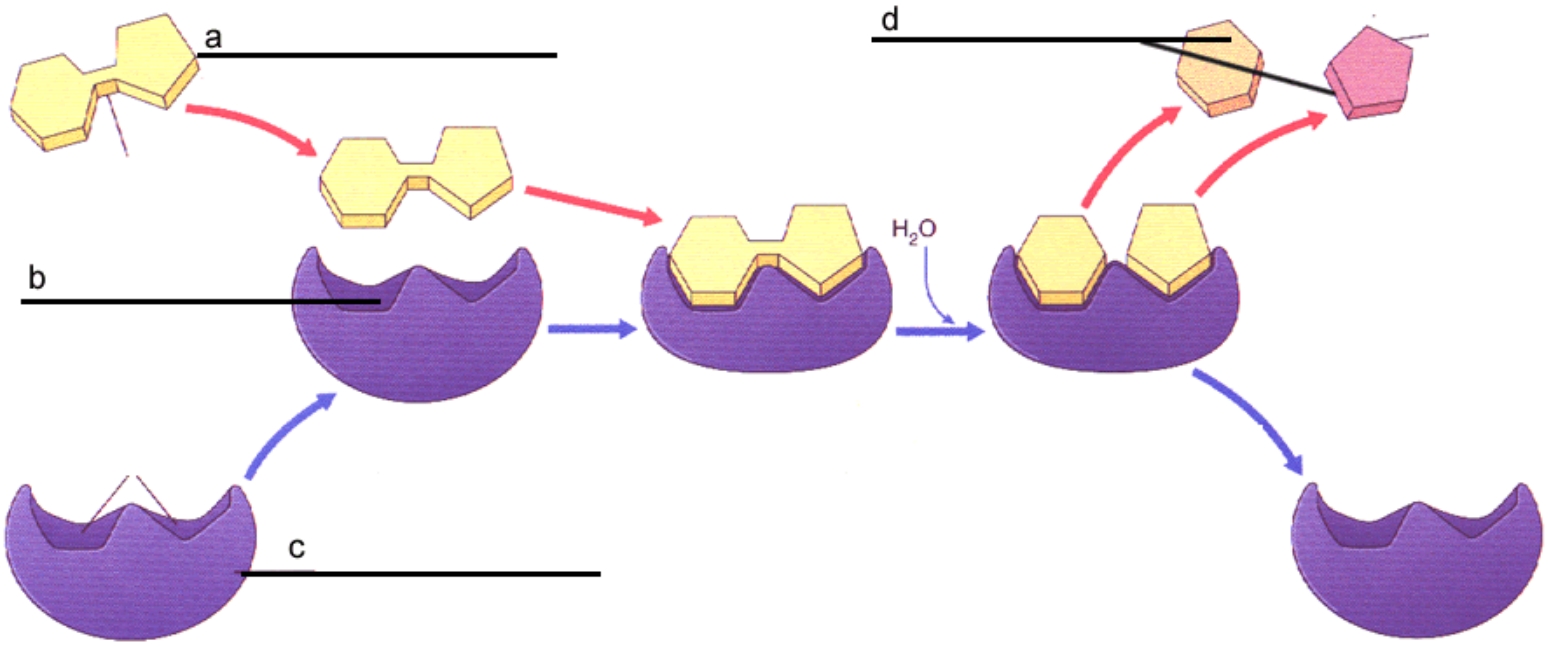
5. Feedback Inhibition

Our cells use this process t prevent an overproduction of a certain product. This is a mechanism used by humans to control how much of a substance is being produced.



Check-in point

Label the following diagram



Check-in point

Determine whether the following statements are true or false:

A) Enzymes interact with specific substrates

B) enzymes change shape after a reaction occurs

C) Enzymes speed up reactions

D) Adding more enzyme will decrease the rate of reaction.

E) Enzyme reactions can be slowed or halted using inhibitors.

F) All enzymes have an optimal pH of 8.

Homework

- Please read the Enzyme AP handout given in class.

- Textbook: p. 42 # 3, 9 & 11