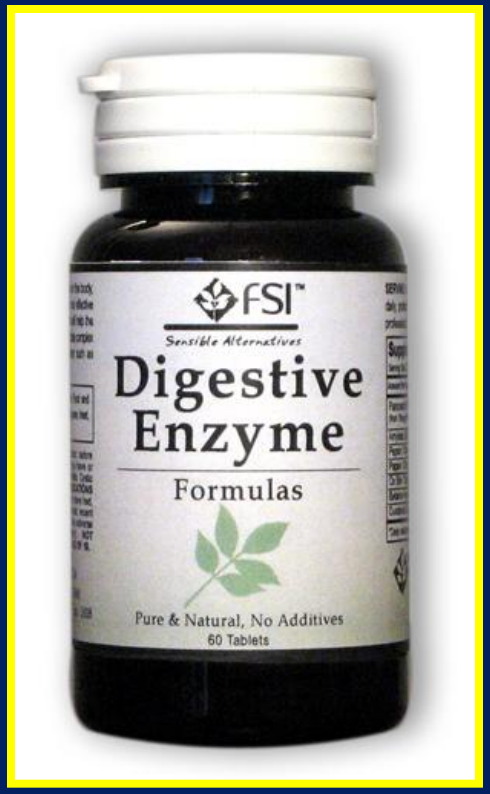
Cellular Reactions

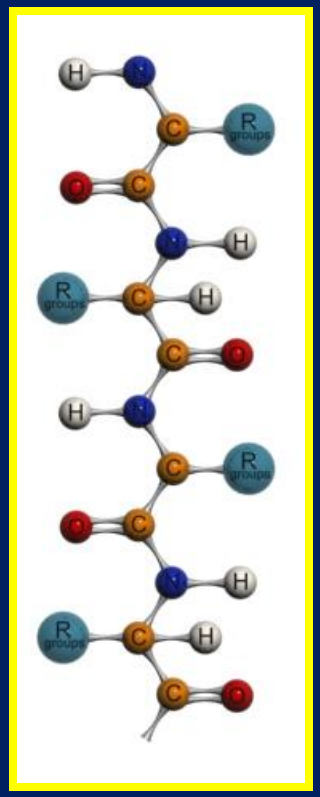


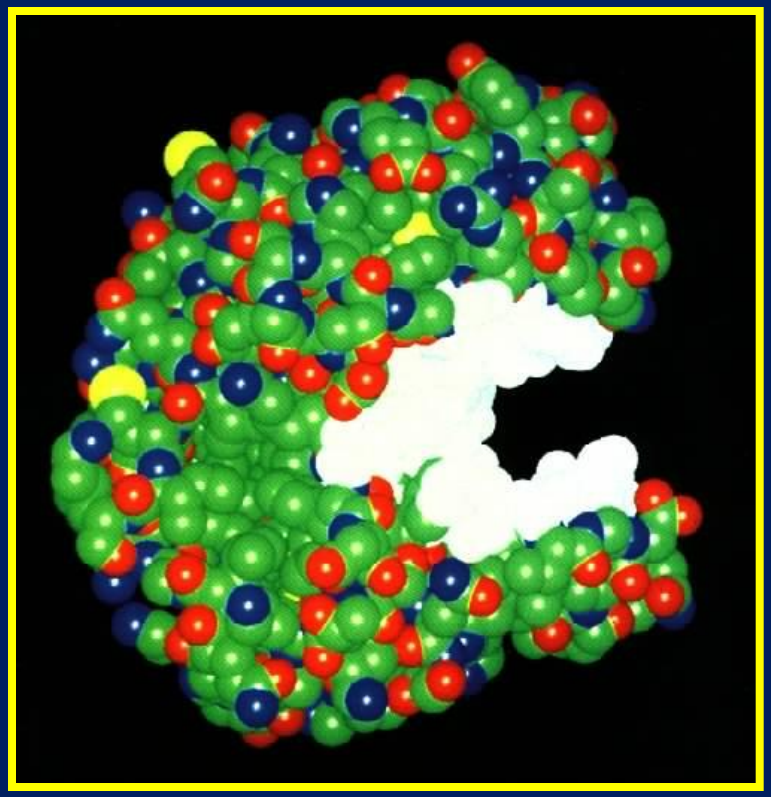
Clarifying Objective 4.1.3
Explain how enzymes act as catalysts for biological reactions

Metabolism is the sum of all chemical reactions within an organism for growth and activity

Each of those chemical reactions require help in order to occur at a rate fast enough to keep organisms alive

Enzymes are proteins that act as catalysts to increase the rate of biological reactions

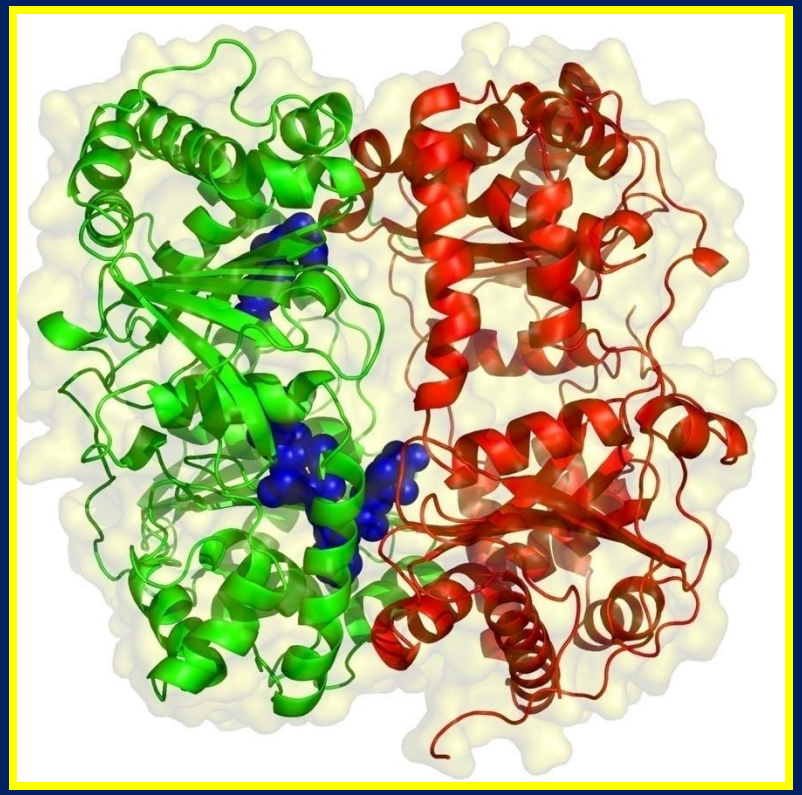


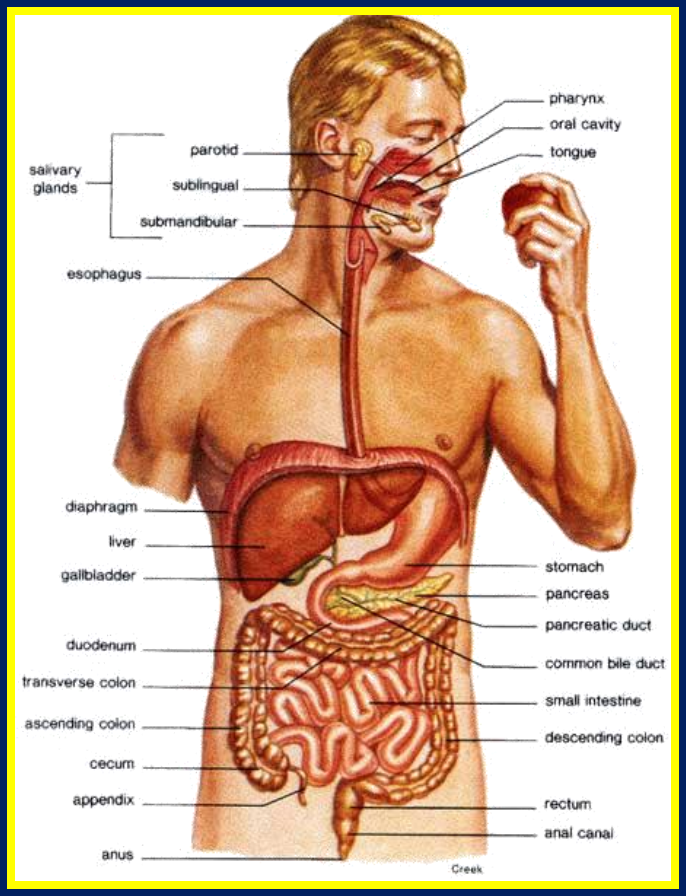


Enzymes are involved in nearly all metabolic processes

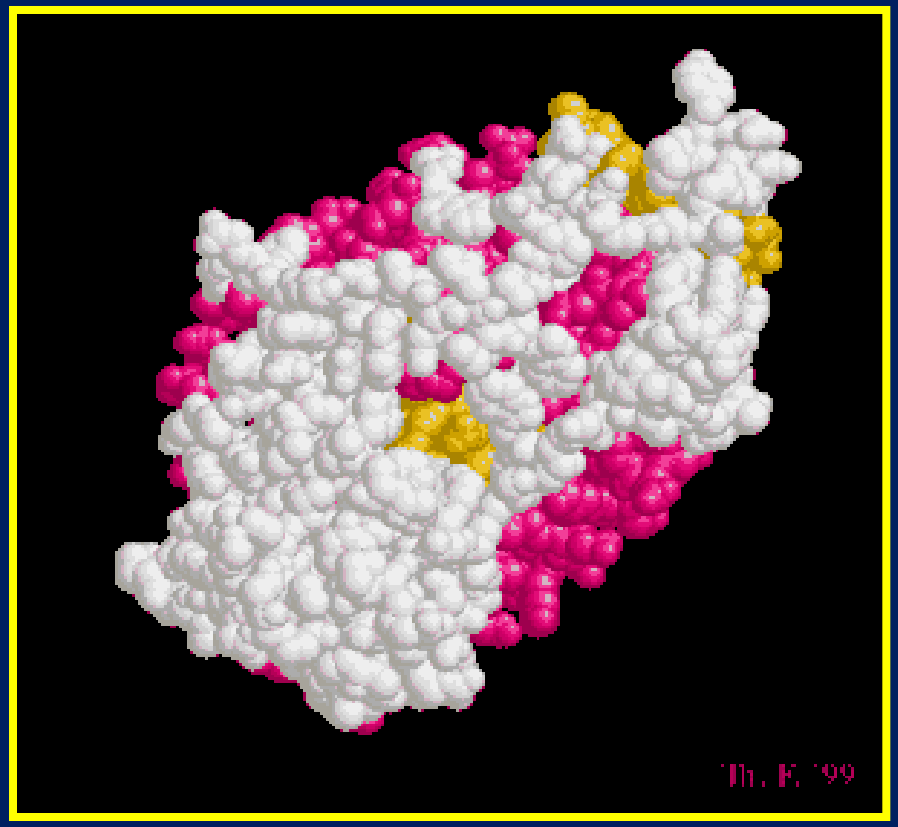
Examples of Enzymes

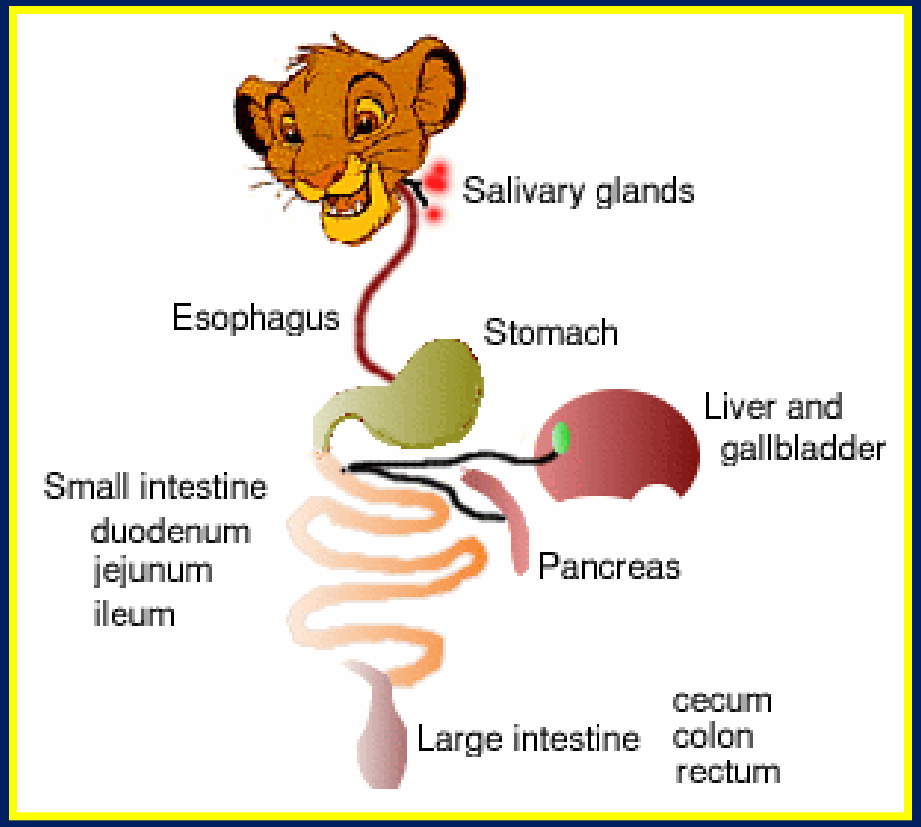
Sucrase is an enzyme, found in the smaller intestine, that breaks sucrose down into glucose and fructose so they can be more easily digested



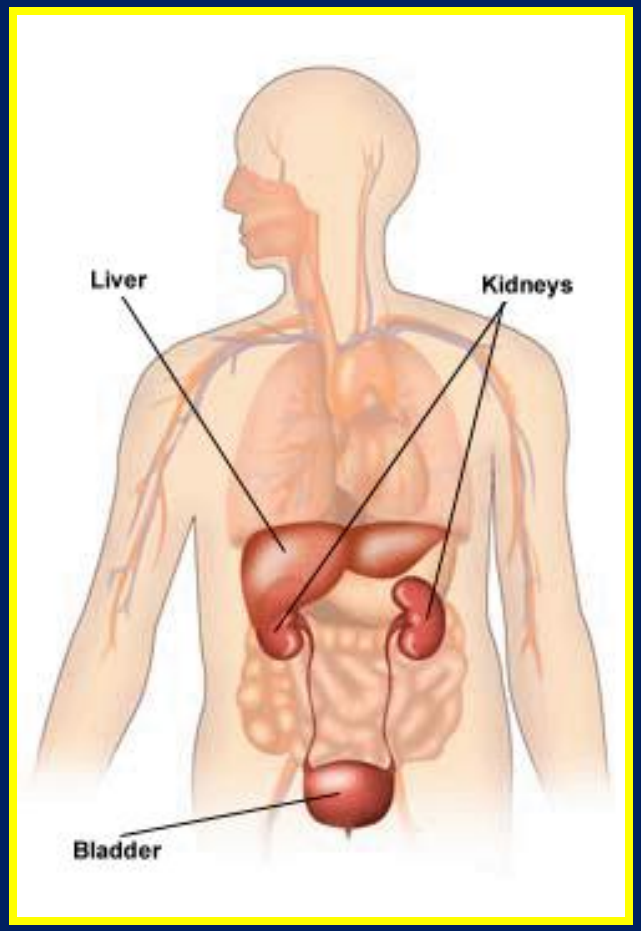


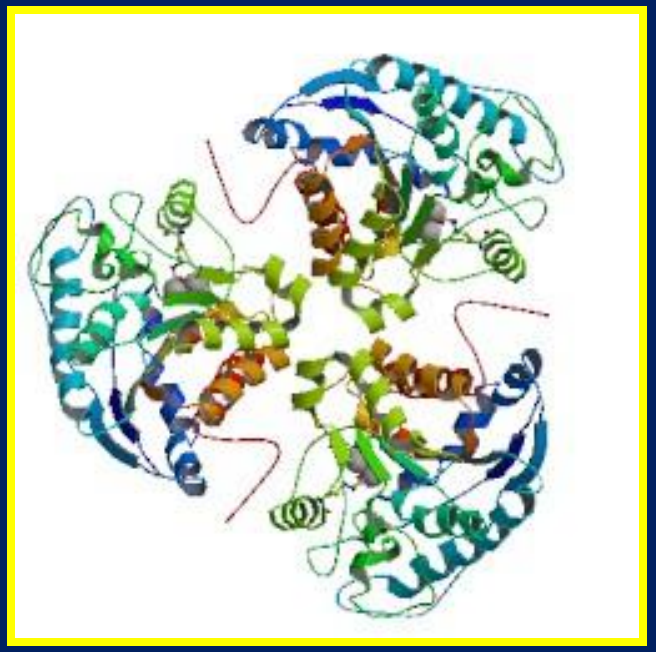
Amylase enzymes are found in saliva and break starch down into simple sugars so they can be easily digested





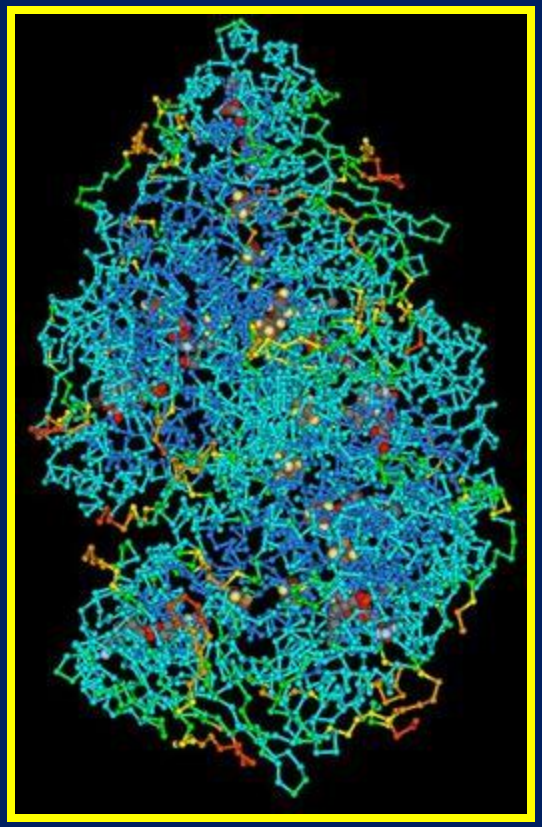
Arginase enzymes are found in the liver and kidneys and rid the body of nitrogen, a waste product of protein metabolism.

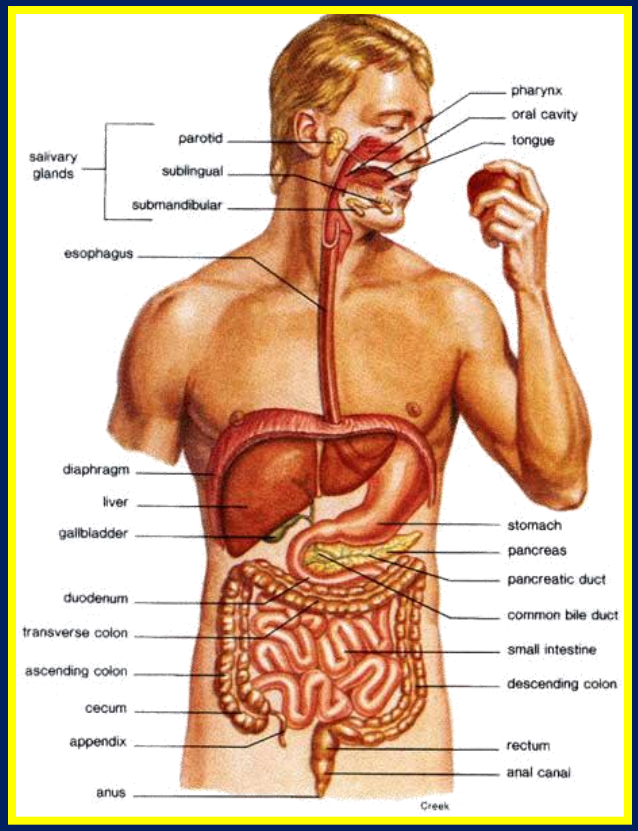




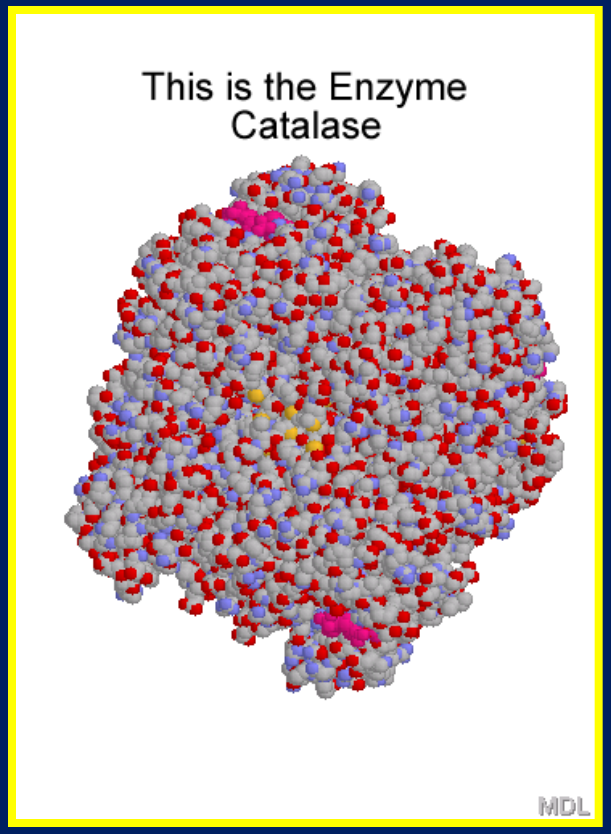
Without arginase, ammonia would build up in the blood

Pepsin enzymes are found in the stomach and help break down proteins into amino acids so they can be more easily digested





Catalase enzymes are found inside every cell and break down hydrogen peroxide, a toxic byproduct of cellular respiration, into water and oxygen

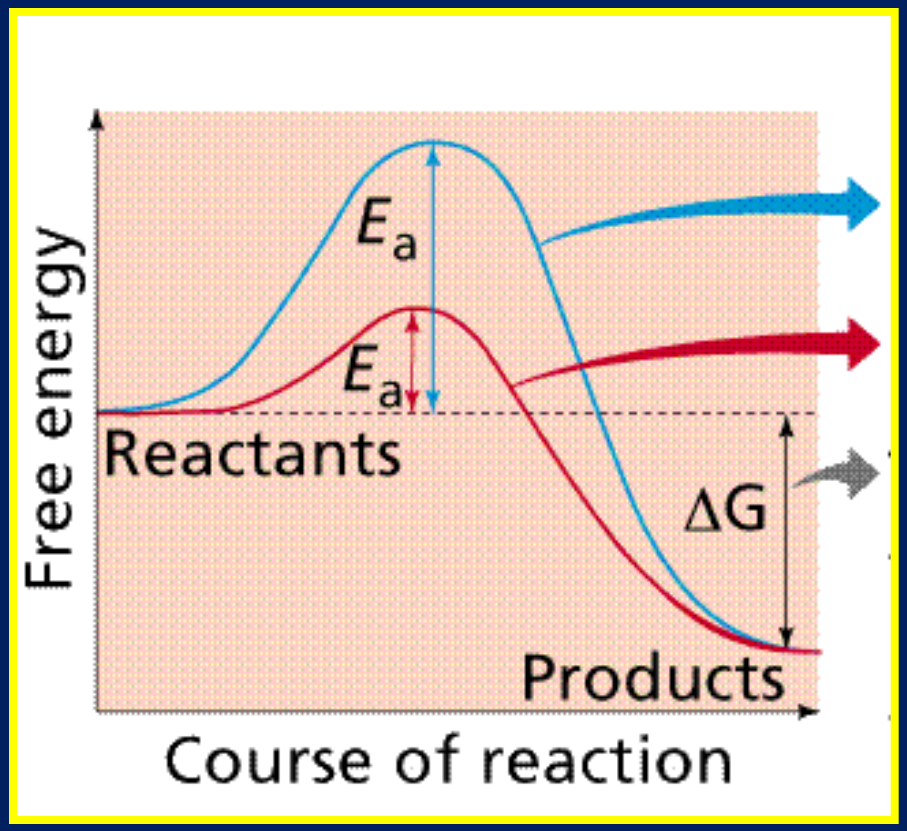


How Enzymes Work

Every chemical reaction requires both bonds breaking and bonds forming. In order to break or form bonds, the reactants must be contorted to an unstable state.

Like the ring on a keychain has to be contorted to slide a key onto the ring

To reach a contorted state where bonds can change, reactants must absorb energy. After the bonds form, energy is released as heat and the molecules return to stable states but have less energy.

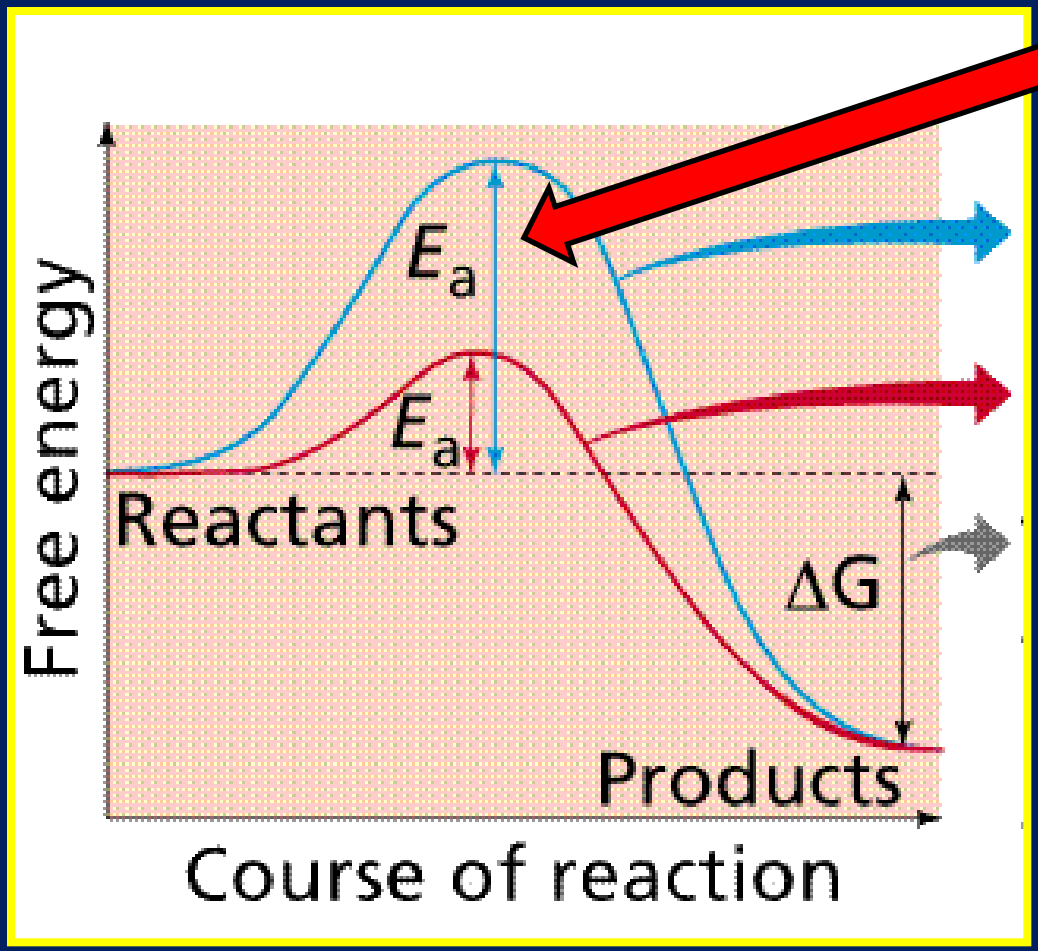


Amount of energy absorbed in order for reaction to occur

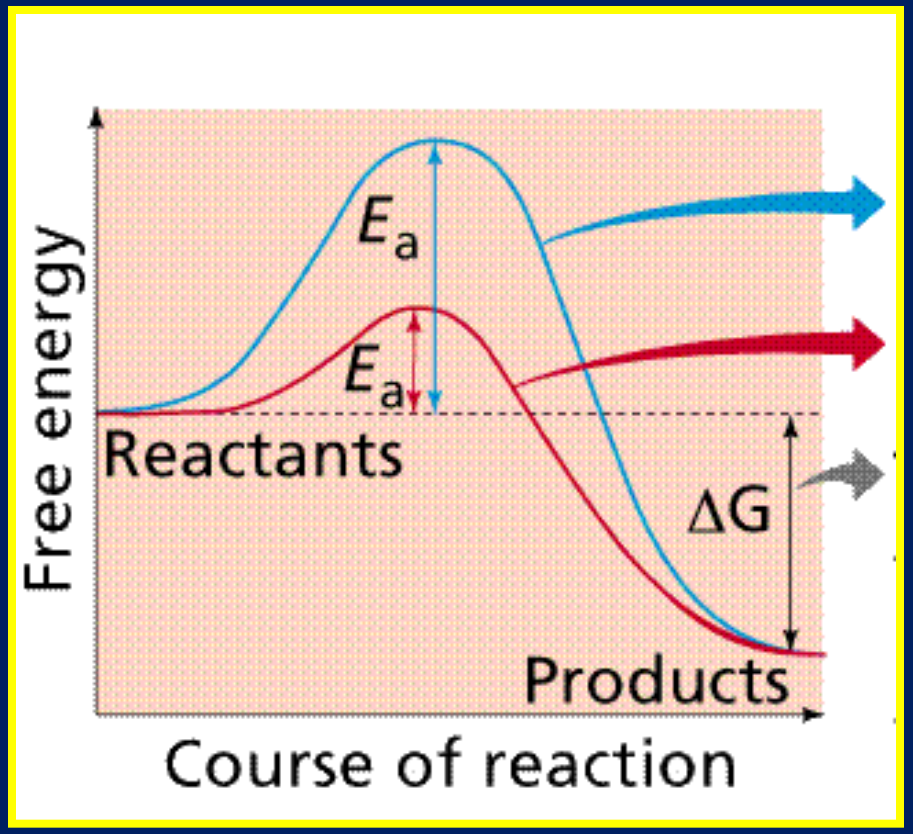
Amount of energy left after reaction takes place

The initial energy investment for starting a reaction is called the activation energy (Ea)

Activation Energy



Enzymes work by lowering the activation energy or the amount of energy needed for a reaction to take place

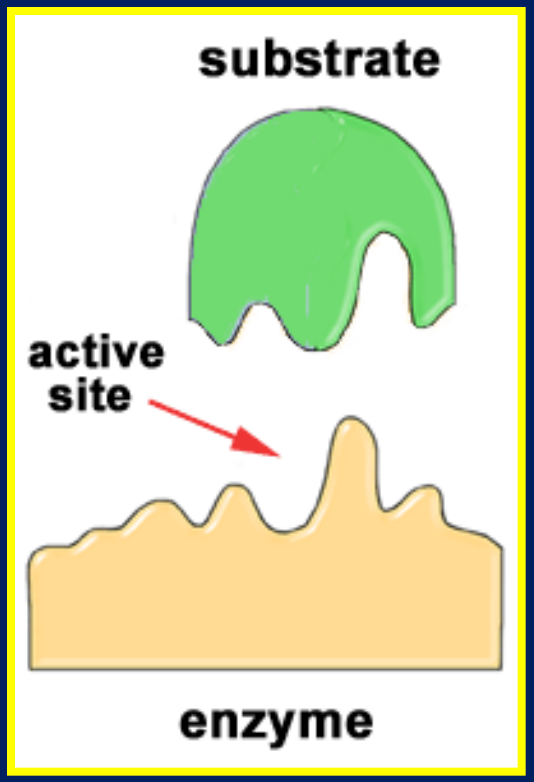


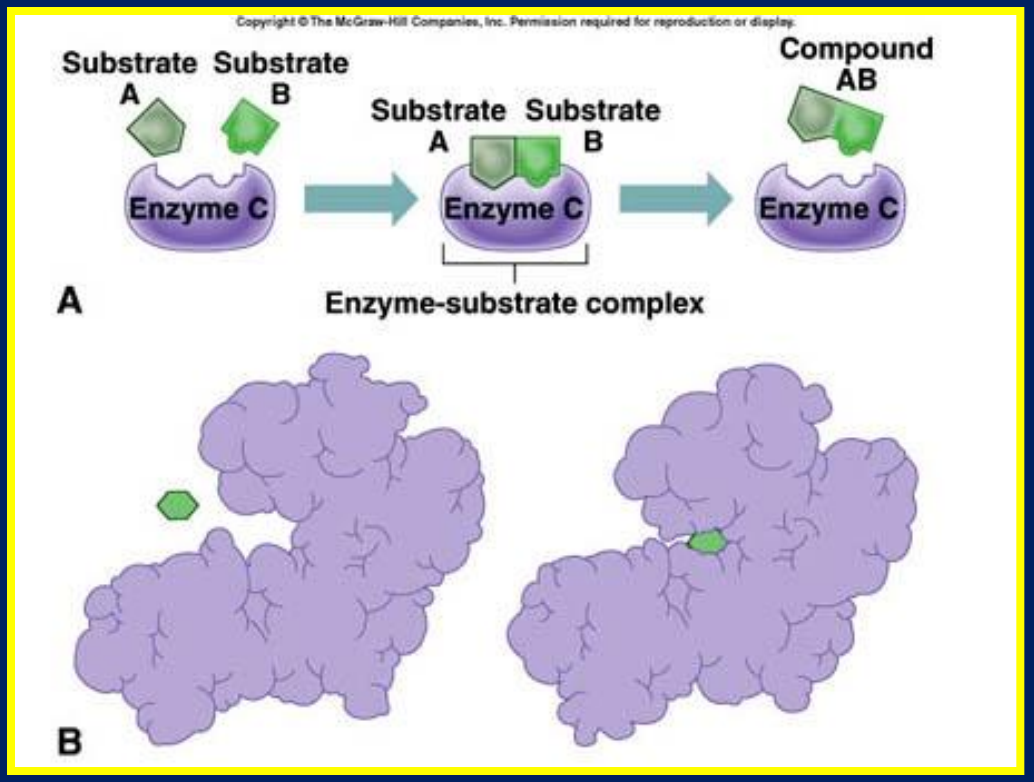
Reaction without an enzyme

Reaction with an enzyme

Characteristics of Enzymes

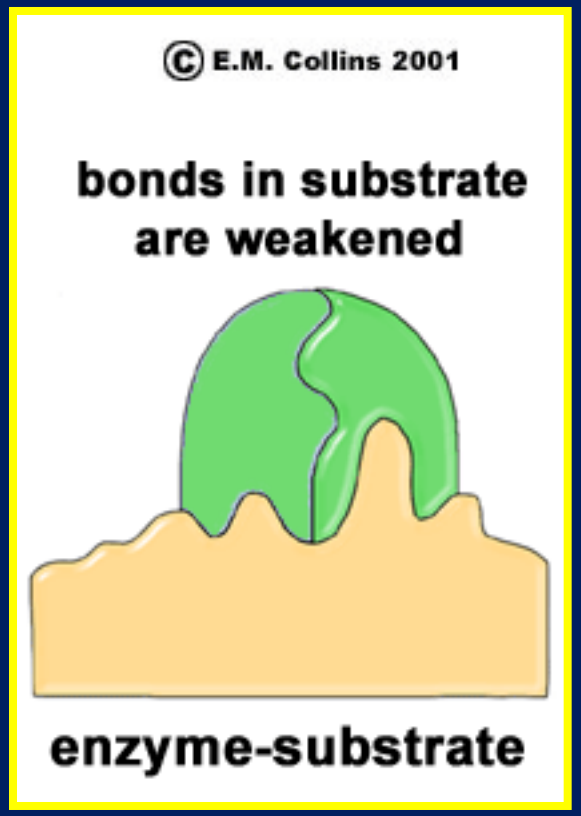
Reactants in an Enzyme reaction are called Substrates

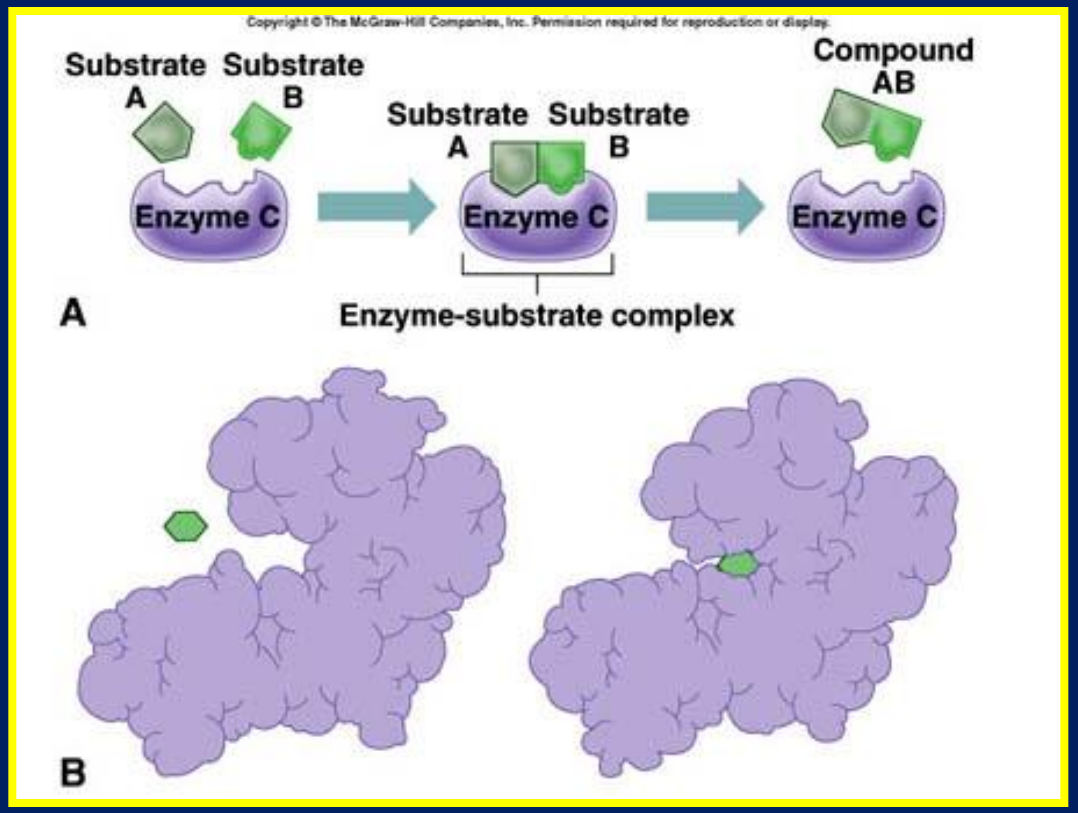




Substrates bind to enzymes at the active site

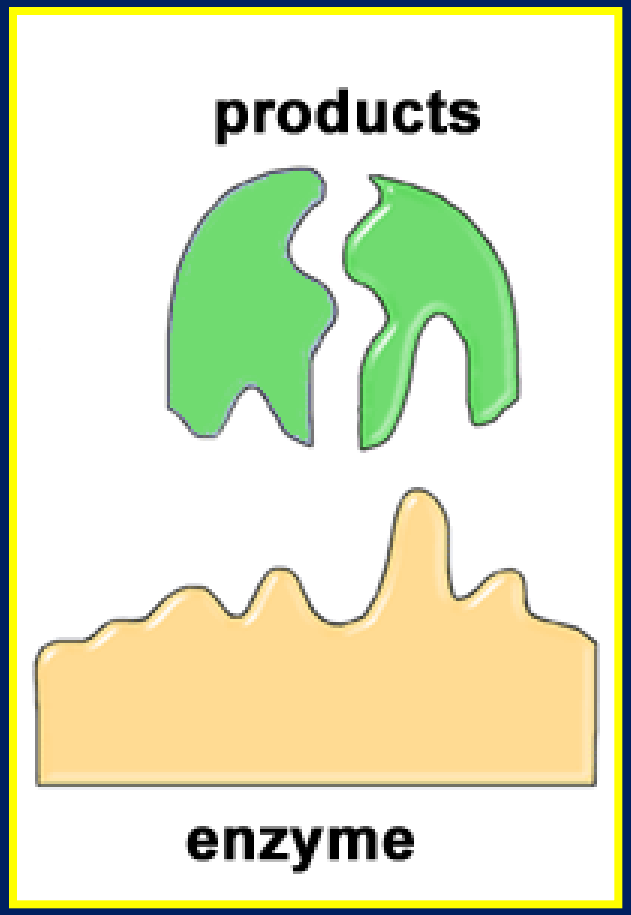
The enzyme helps weaken the bonds in the substrate

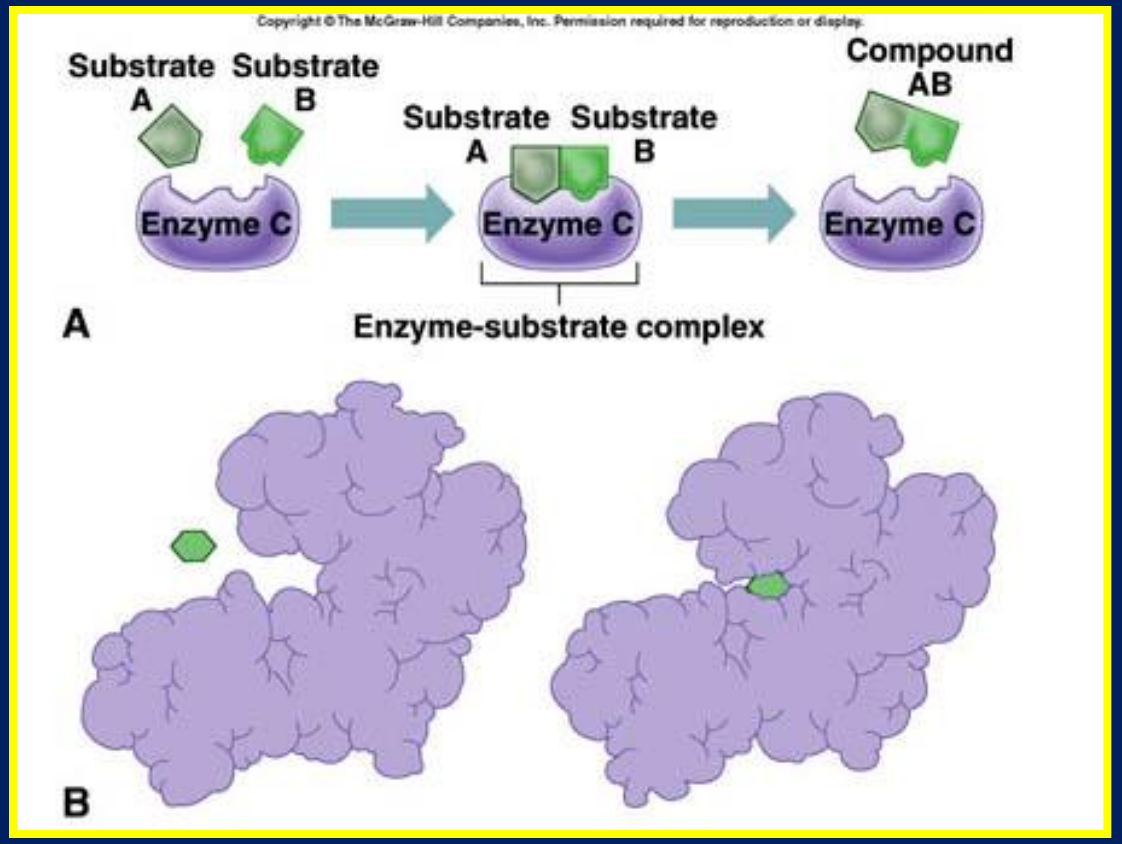




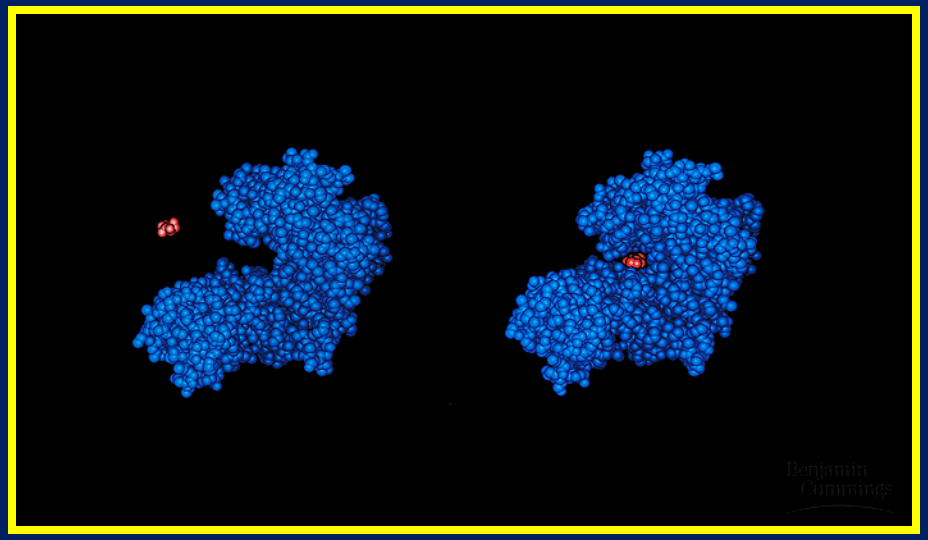
Sometimes the enzyme help form bonds in the substrate

The products of the enzyme reaction are then released and the enzyme retains its shape and is free to be used again or are reusable

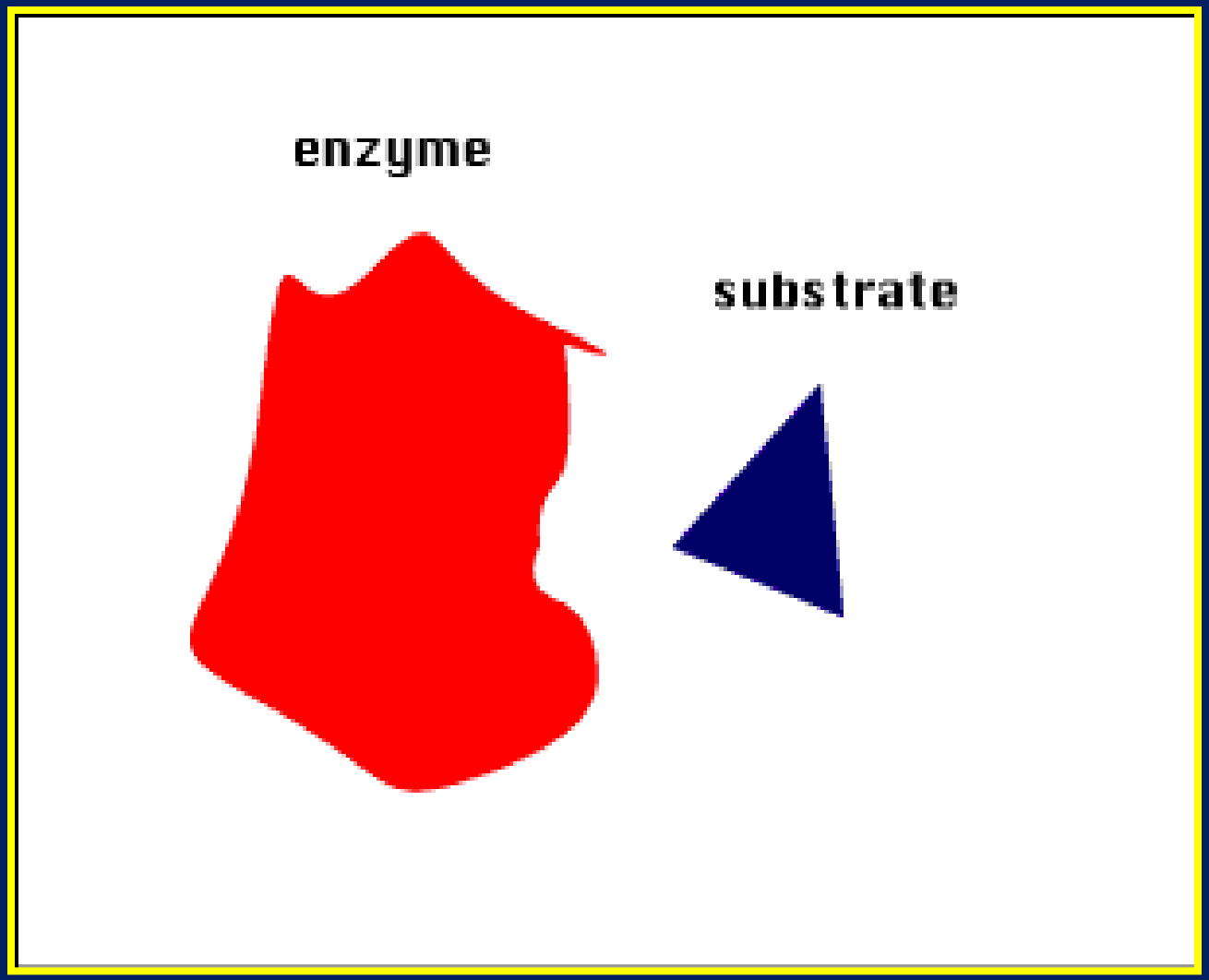




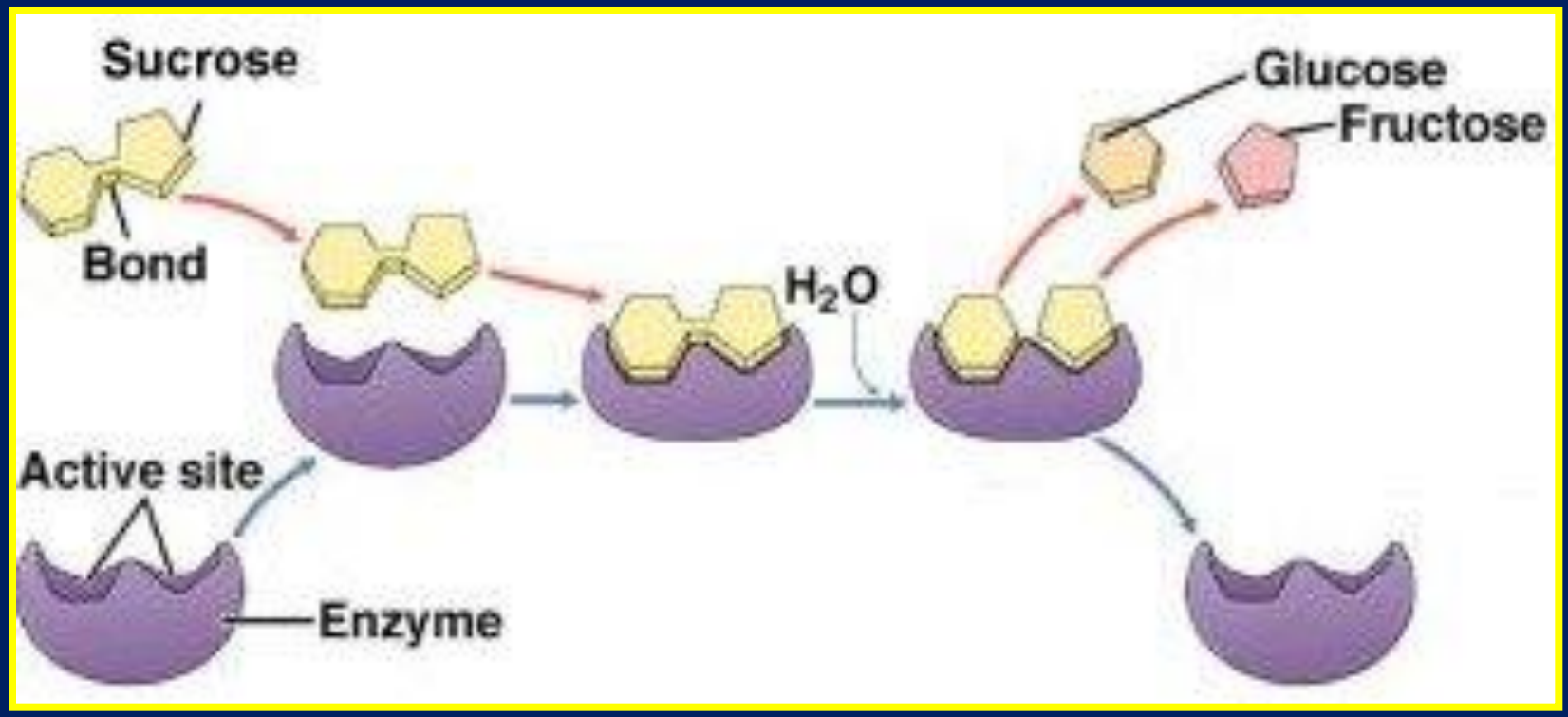
Enzymes are very specific and each enzyme can only be used for one type of reaction



Enzymes fit together with the substrate like a lock and key (one key for one lock)

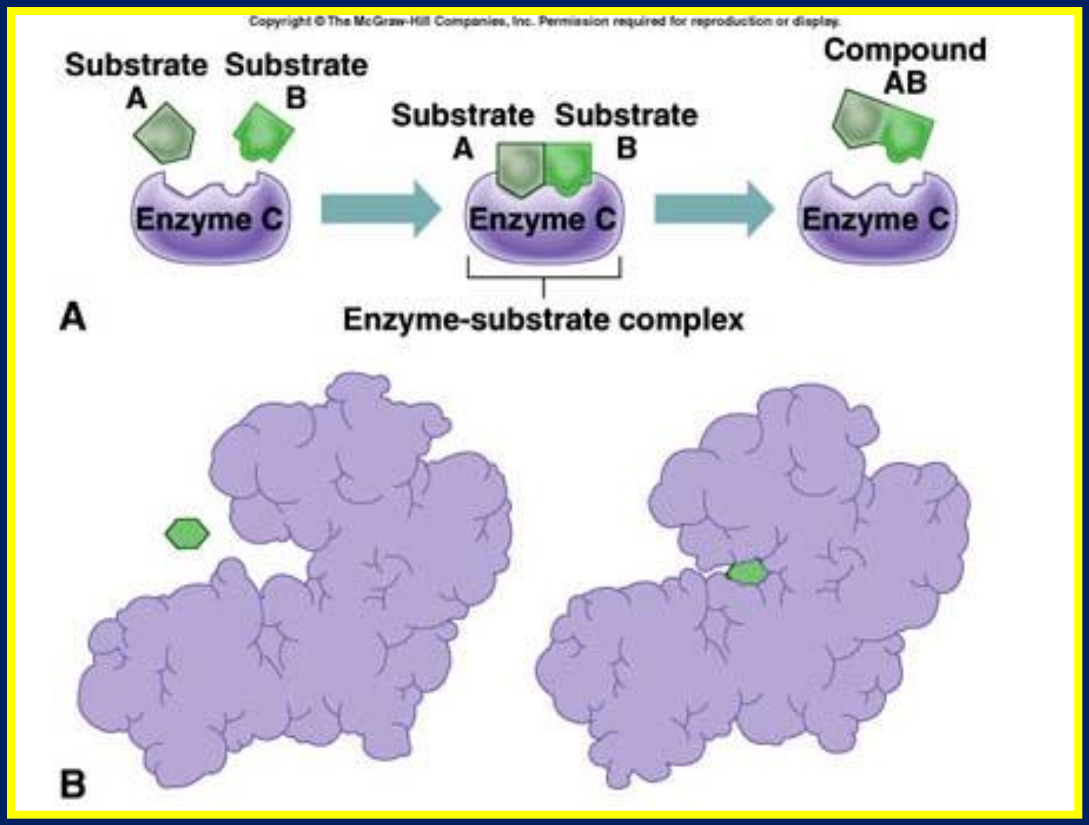

enzyme
substrate

Sucrase breaks down sucrose into glucose and fructose



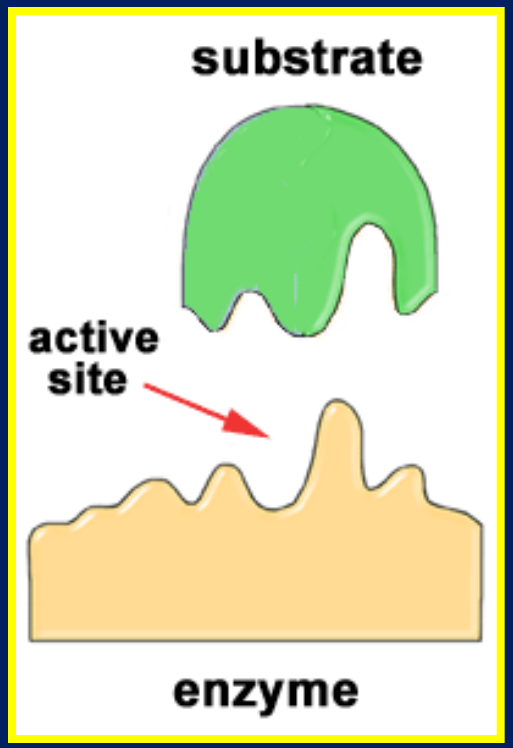
Sucrase would not work on starch which contains just glucose molecules

Enzymes act as catalysts, they speed up reactions, by allowing the reactants to absorb energy without destroying the reactants and are very selective so that only necessary reactions take place.

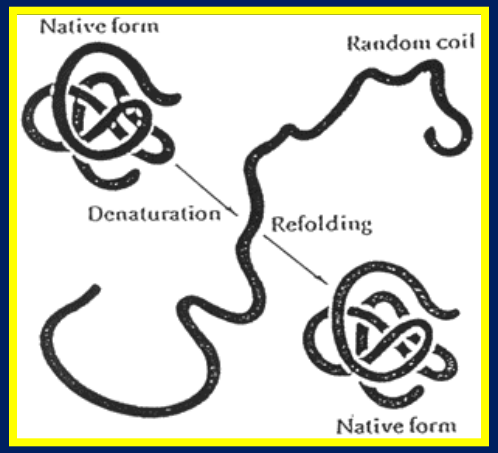


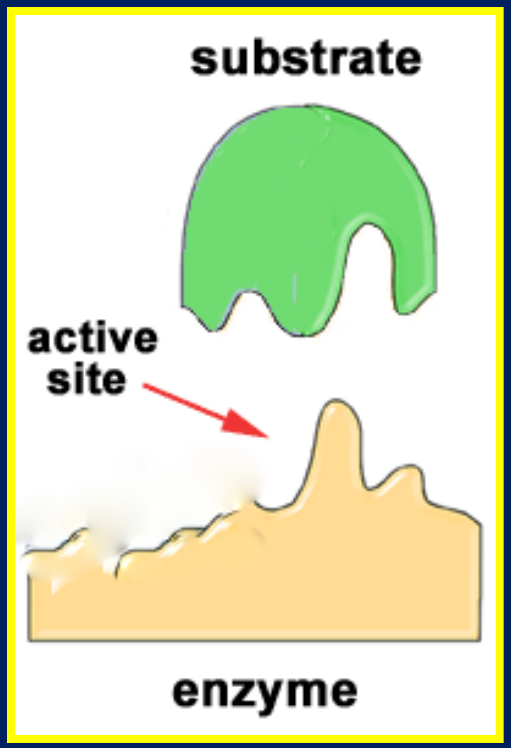
Denaturing Enzymes

If the enzymes shape is changed or denatured, it will no longer fit the substrate and the biological reaction will not take place

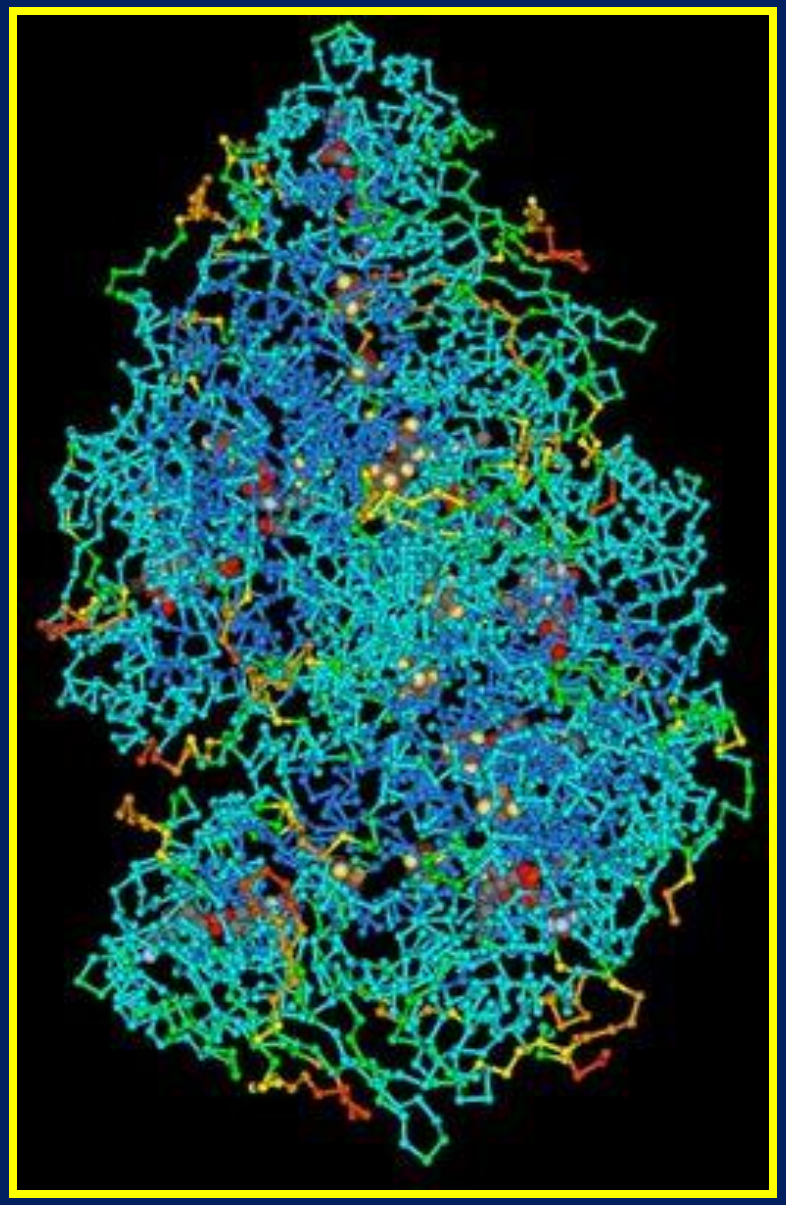


Normal

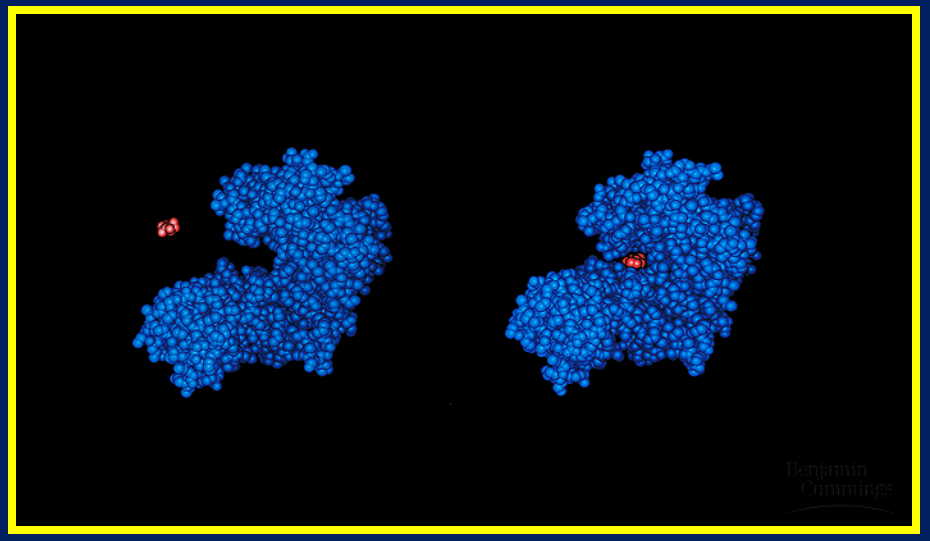




Denatured

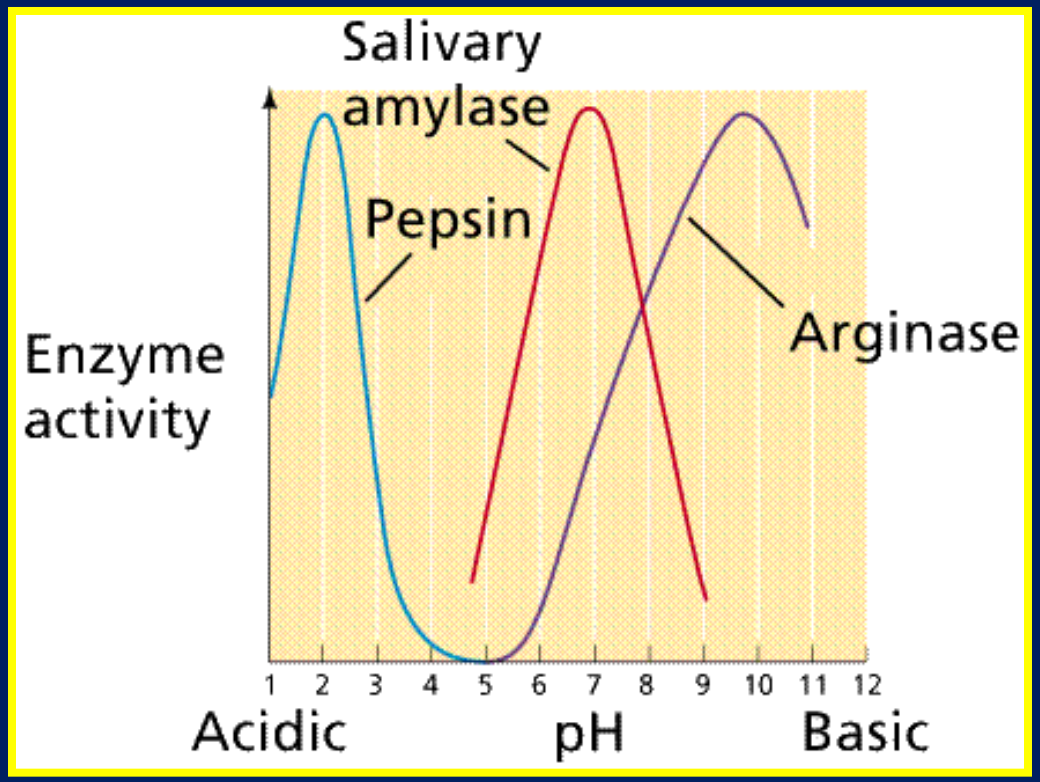


Denature



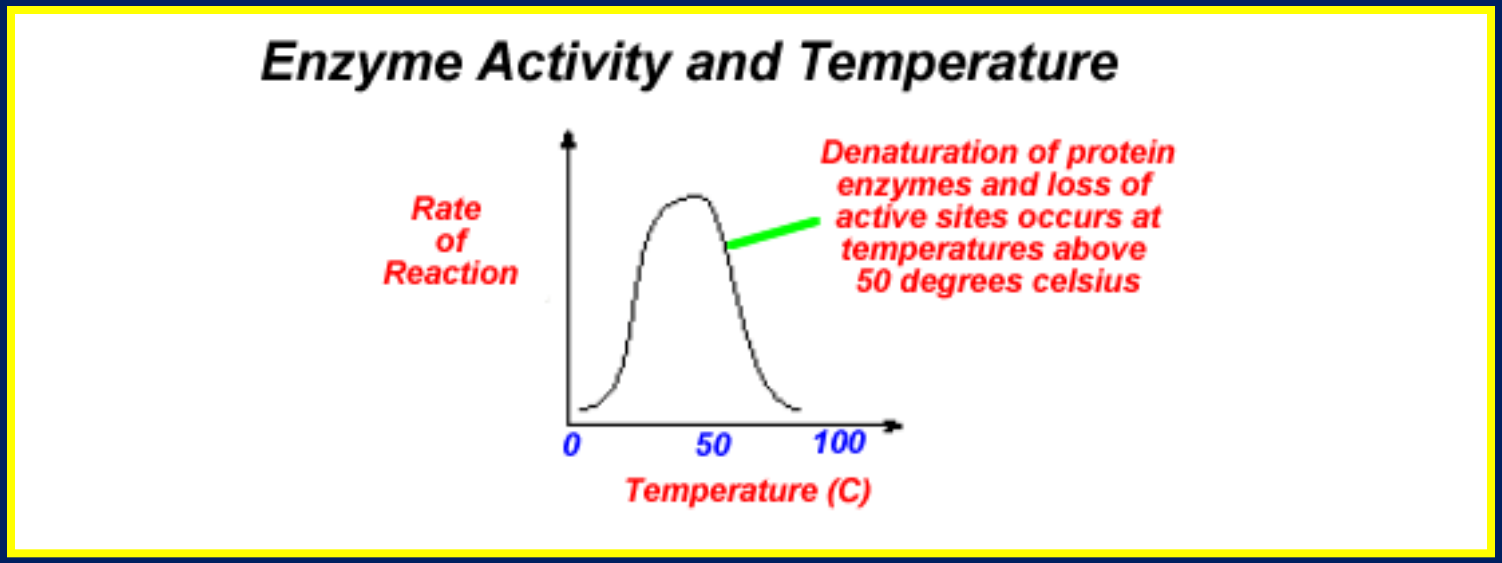
Changes its shape

Enzymes can only work in very specific pH ranges and can be denatured by changes in pH



Different enzymes have different optimal pH levels, depending upon their location in the body

Enzymes can also be denatured by changes in <u>temperature</u>

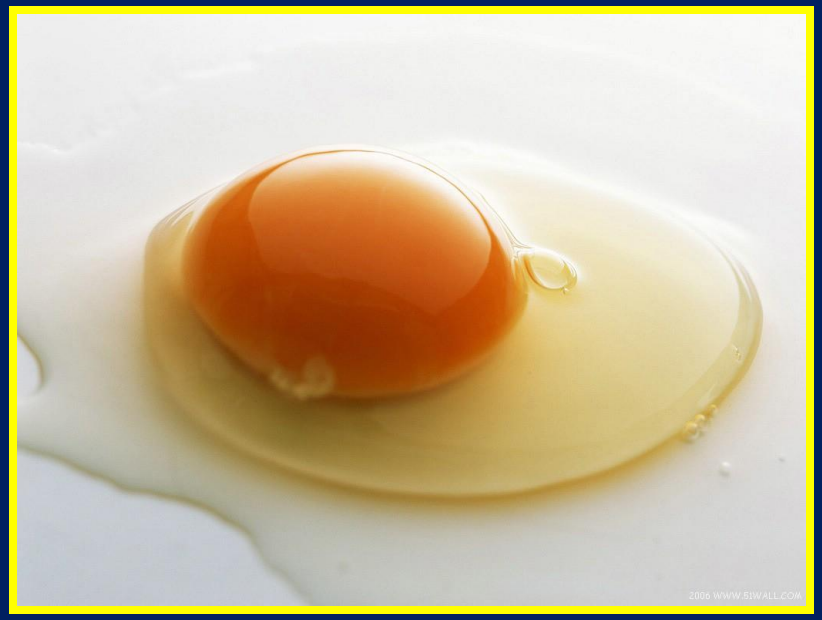


Enzymes work best at the normal <u>body temperature</u> of the organism

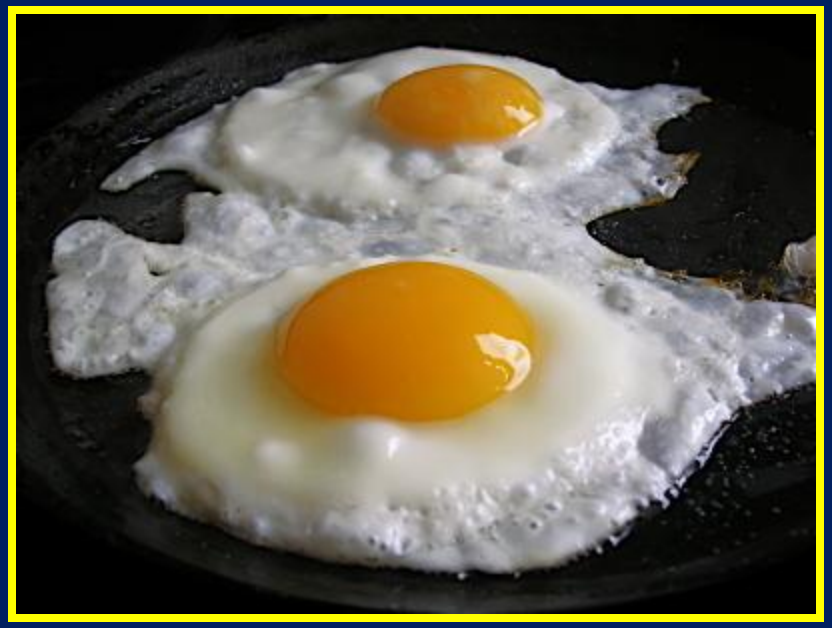
Our bodies try to fight pathogens by raising its body temperature, fever, so that the enzymes in the pathogens are denatured resulting in the pathogen's death.

Fevers also affect our own body's enzymes, which is why we feel so sick when we have a fever

We also cook our food in order to denature the enzymes of pathogens that may be in the food

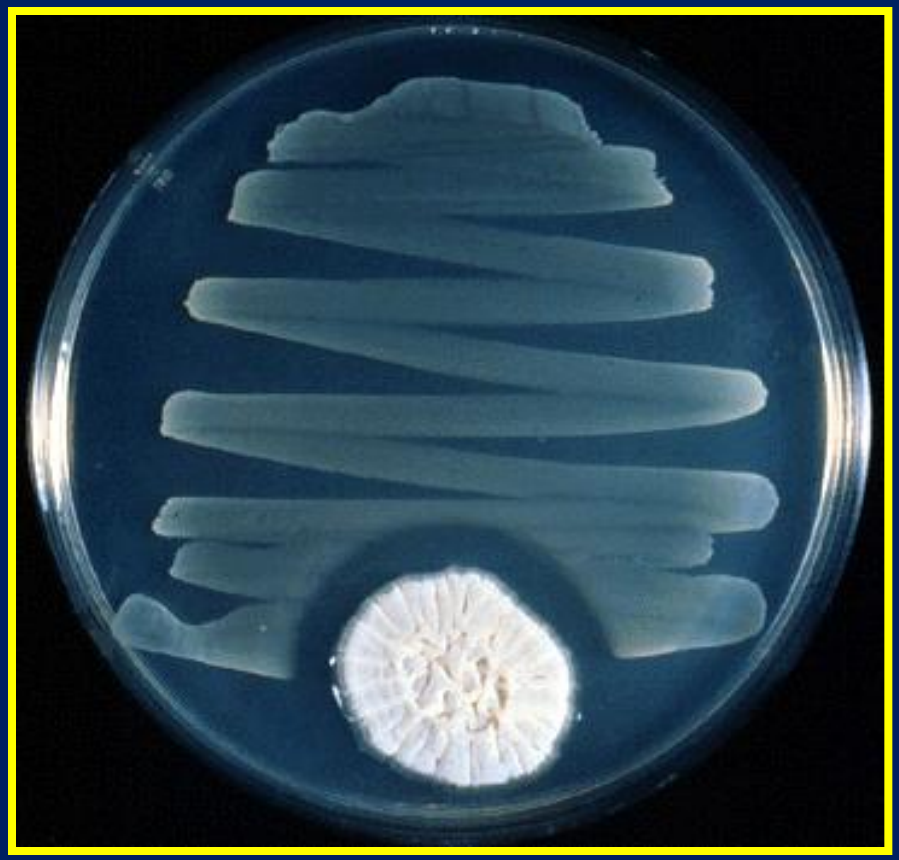


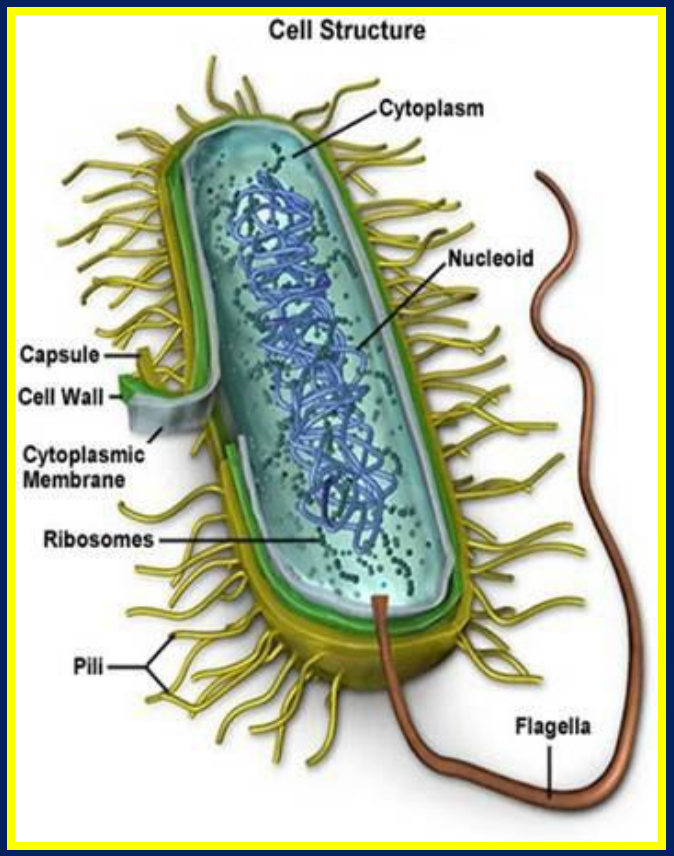
Egg white is full of protein and is usually clear



Cooking denatures the enzymes and turns them white

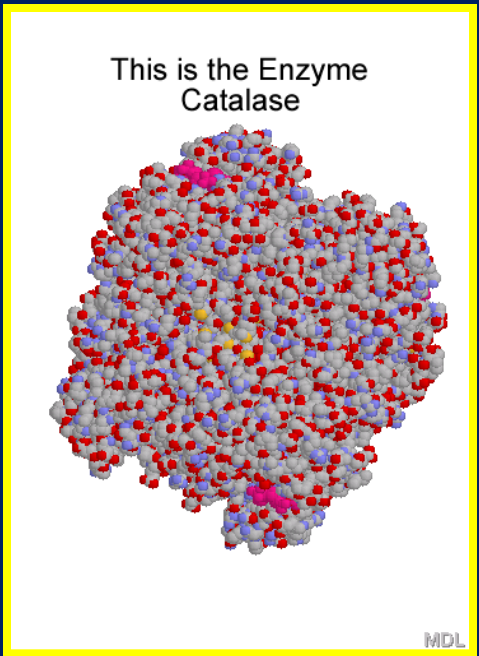
Some antibiotics inhibit the enzymes in bacteria. Penicillin blocks the active site on the enzymes used to create cell walls in bacteria resulting in cell death





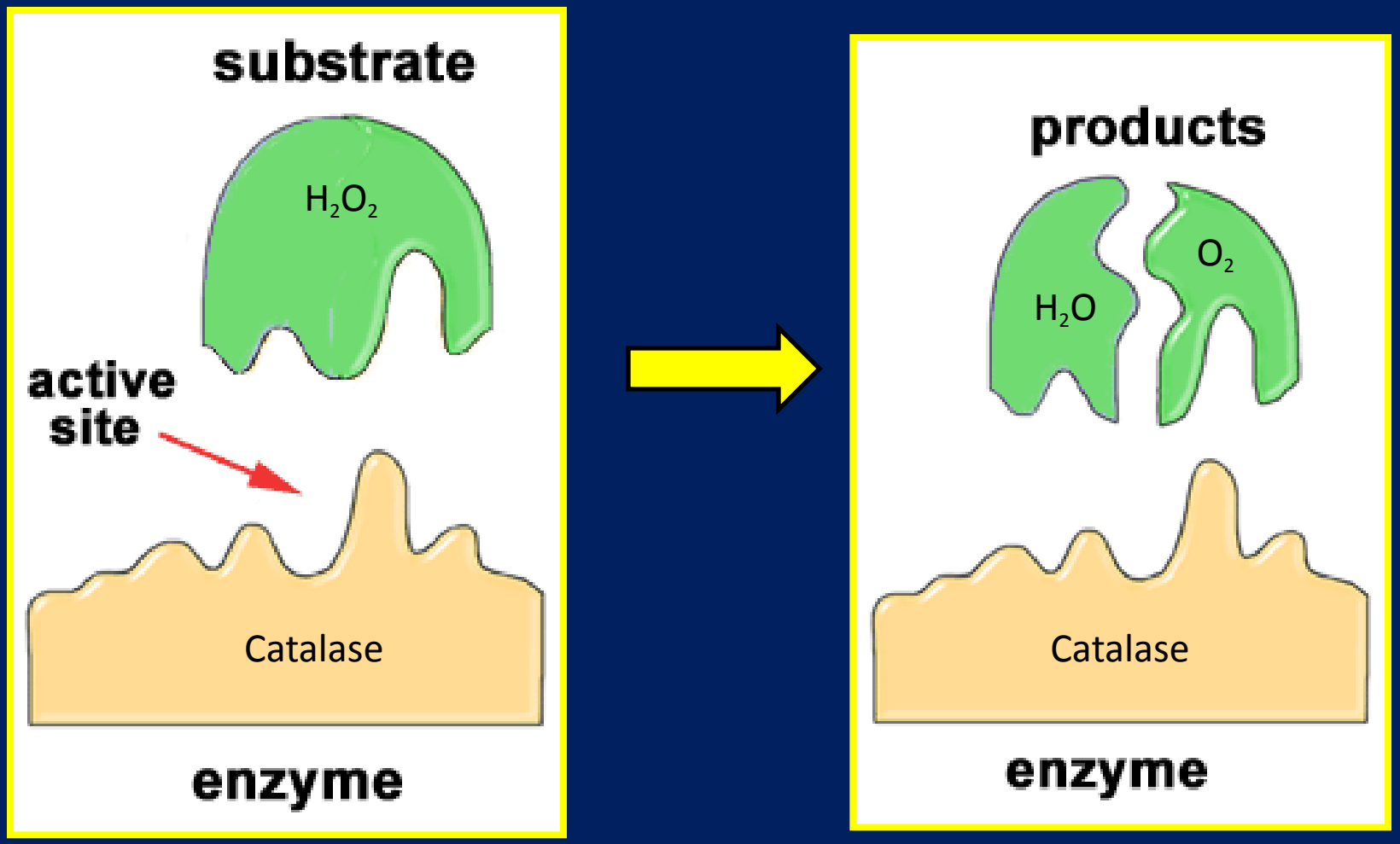
Enzyme Lab

In lab, we will test the effects of changes in temperature and pH on the catalase enzyme, found in liver cells, that breaks down hydrogen peroxide that is created in our cells as a byproduct of respiration.

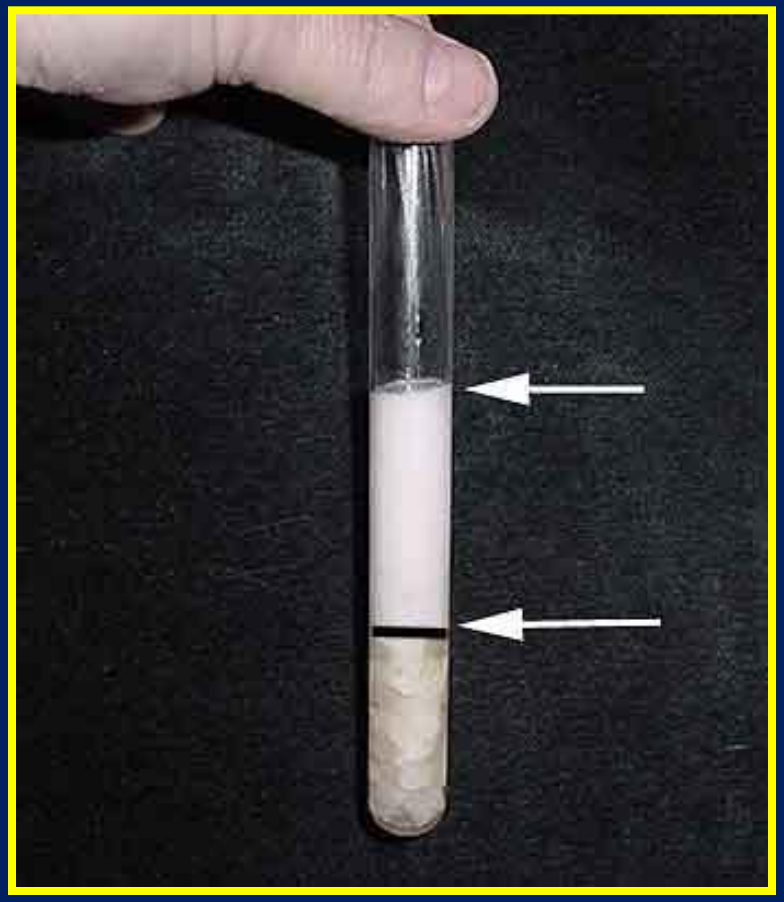


$$\text{Catalase} + H_2O_2 \rightarrow H_2O + O_2$$

Catalase + H_2O_2 → H_2O + O_2



We will add hydrogen peroxide to beef liver and measure the rate of the reaction by the amount of oxygen bubbles



Test the same reaction under different temperature conditions

0^0C
Freezing

25^0C
Room
Temp.

100^0C
Boiling

We could also test the same reaction under different pH conditions

Acid	Neutral	Base
Below 7	pH 7	Above 7

The End