

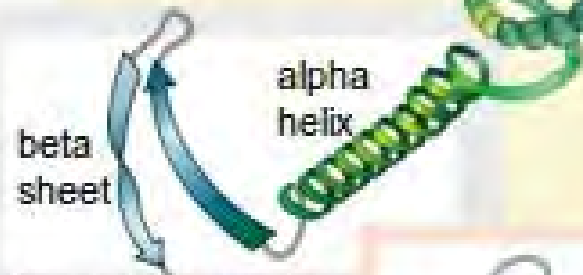
# *Enzymes*

# Terminology-Amino Acids

- Primary Structure: is a polypeptide (large number of amino-acid residues bonded together in a chain) chain of amino acids linked with peptide bonds.
- Secondary Structure- are polypeptide chains folded into one of two configurations: alpha helix or beta pleated sheet.
- Tertiary Structure: is the next step up, precise 3D configurations of the polypeptide chain formed through forces like hydrogen bonds. A tertiary structure corresponds to a specific protein.
- Quaternary Structure: A structural level wherein several proteins interact through non-covalent bonds to form one functional protein complex (complex biological macromolecules, i.e. hemoglobin, DNA polymerases)



Primary structure  
amino acid sequence



Secondary structure  
regular sub-structures



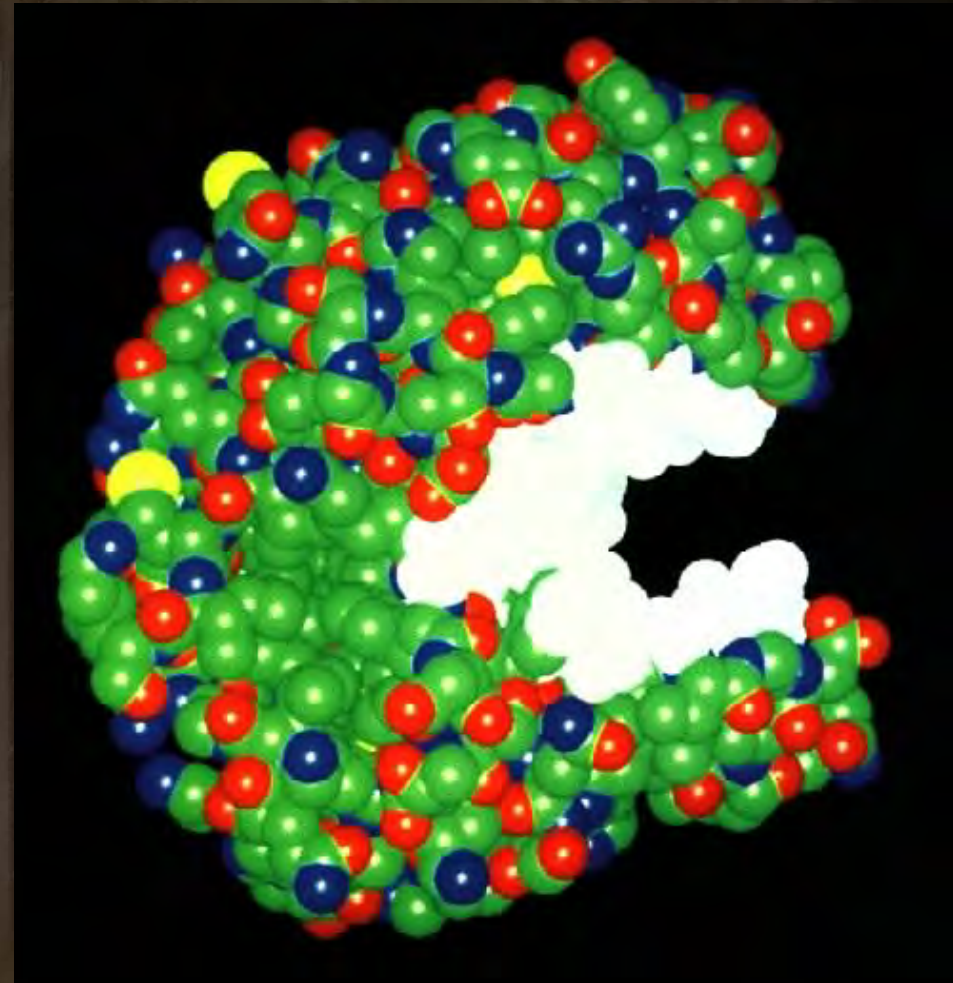
Quaternary structure  
complex of protein molecules



Tertiary structure  
three-dimensional  
structure

# What Are Enzymes?

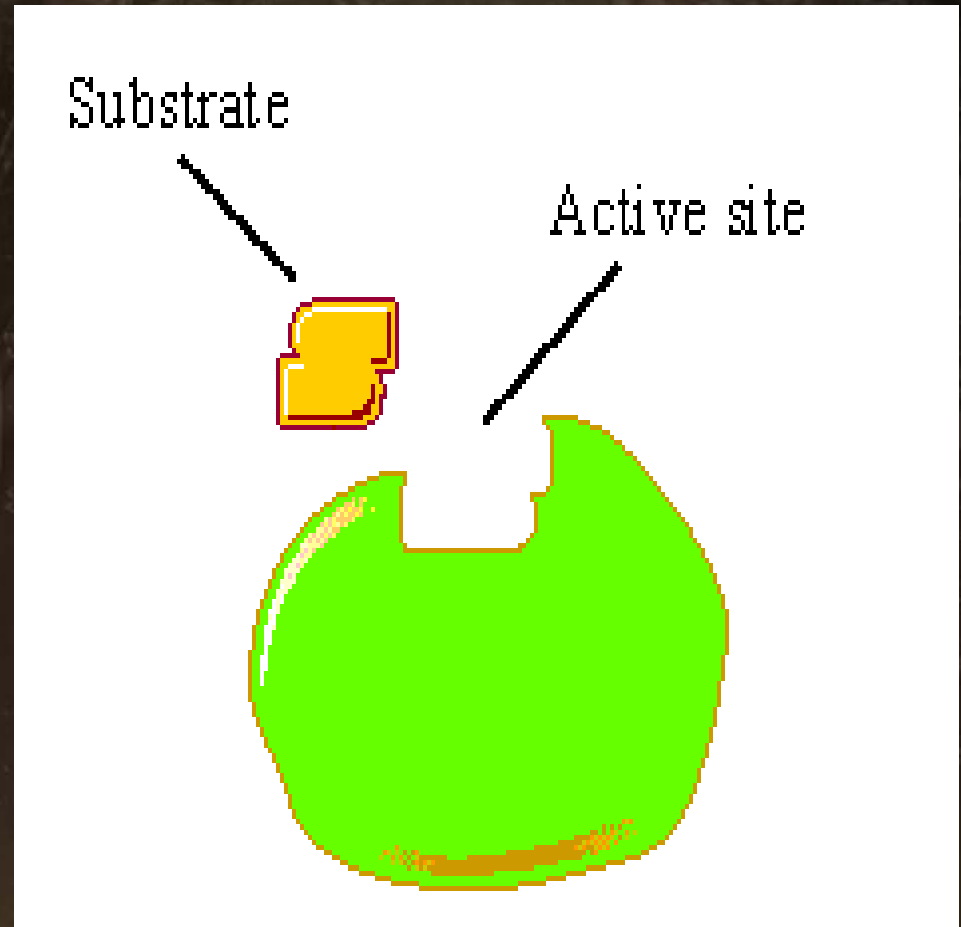
- Enzymes are **Proteins** (tertiary and quaternary structures)
- Known as a BIOLOGICAL CATALYST
- **Catalyst** is something that speeds up a chemical reaction.





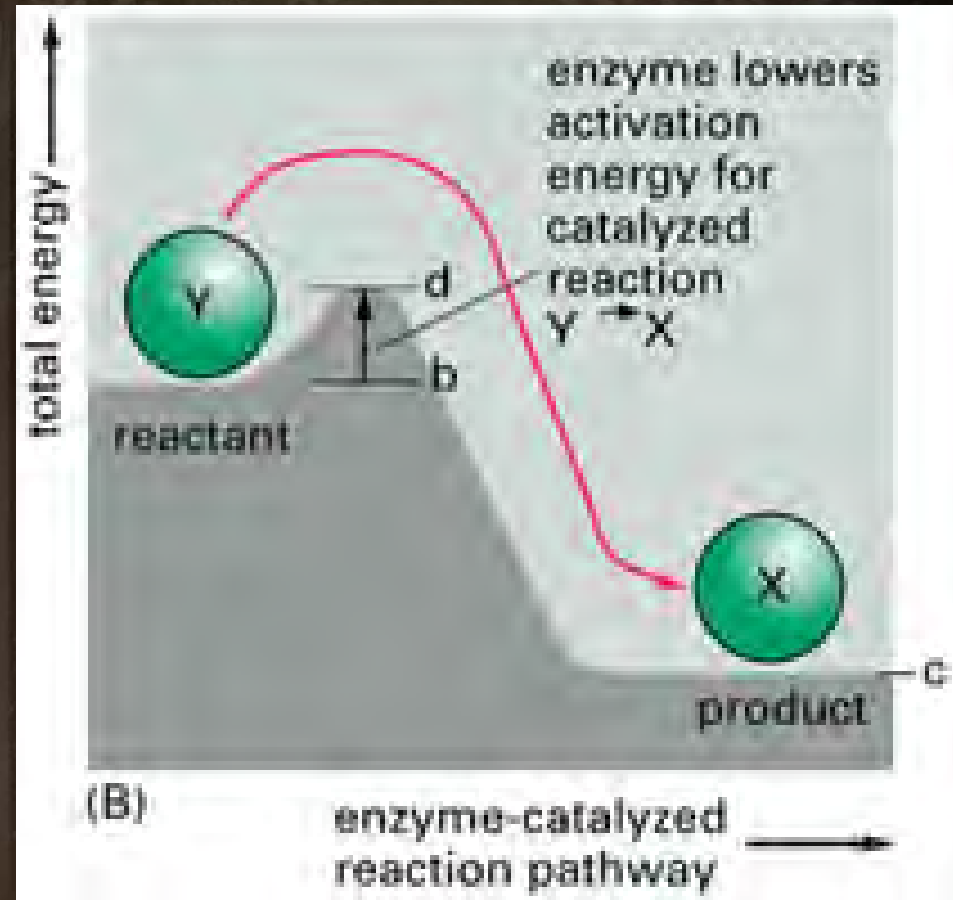
# Enzymes

- Are specific for what they will **catalyze**
- Are **Reusable**
- End in **-ase**
  - *Sucrase*
  - *Lactase*
  - *Maltase*

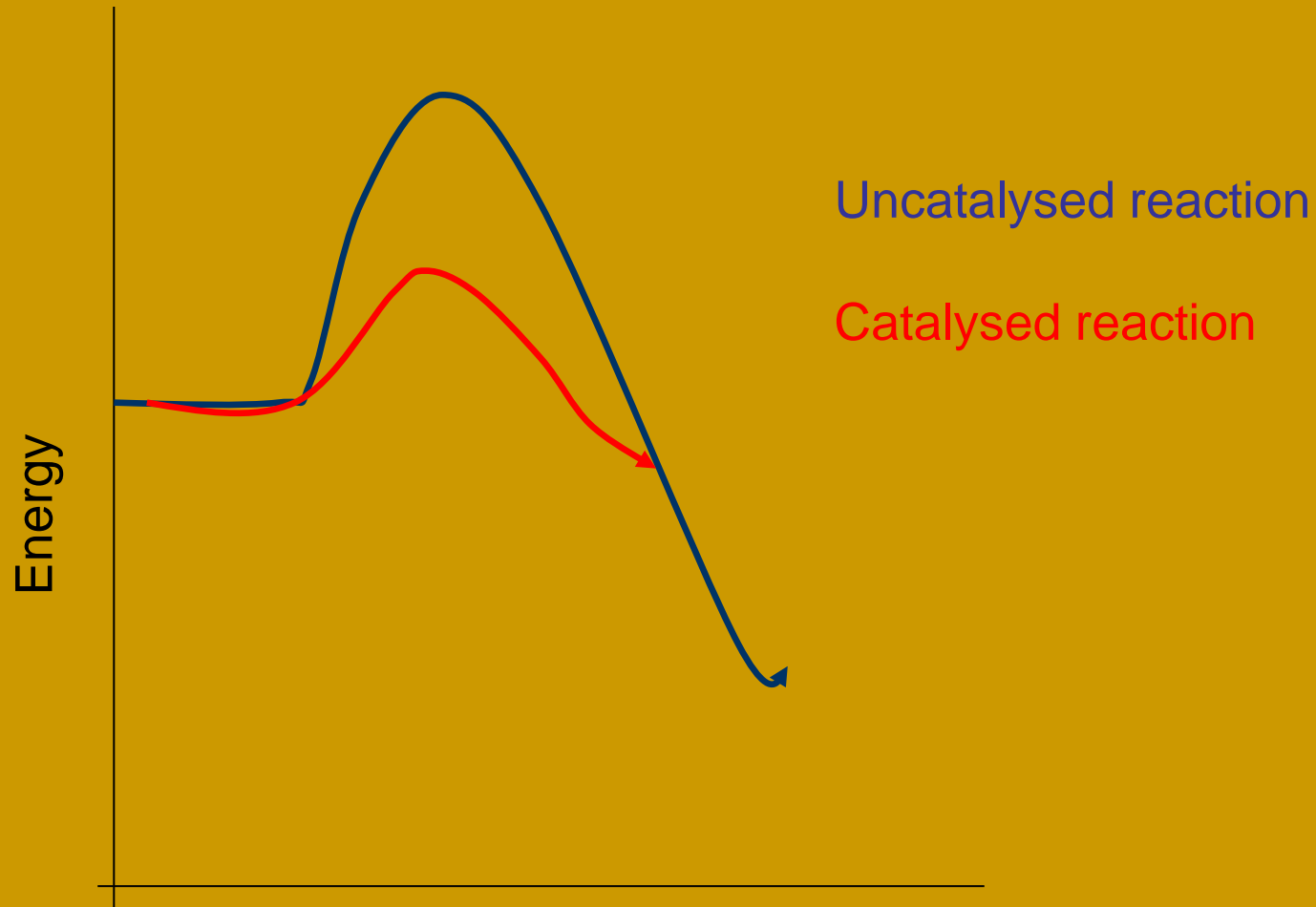


# How do enzymes Work?

Enzymes work by **weakening bonds** which **lowers activation energy**

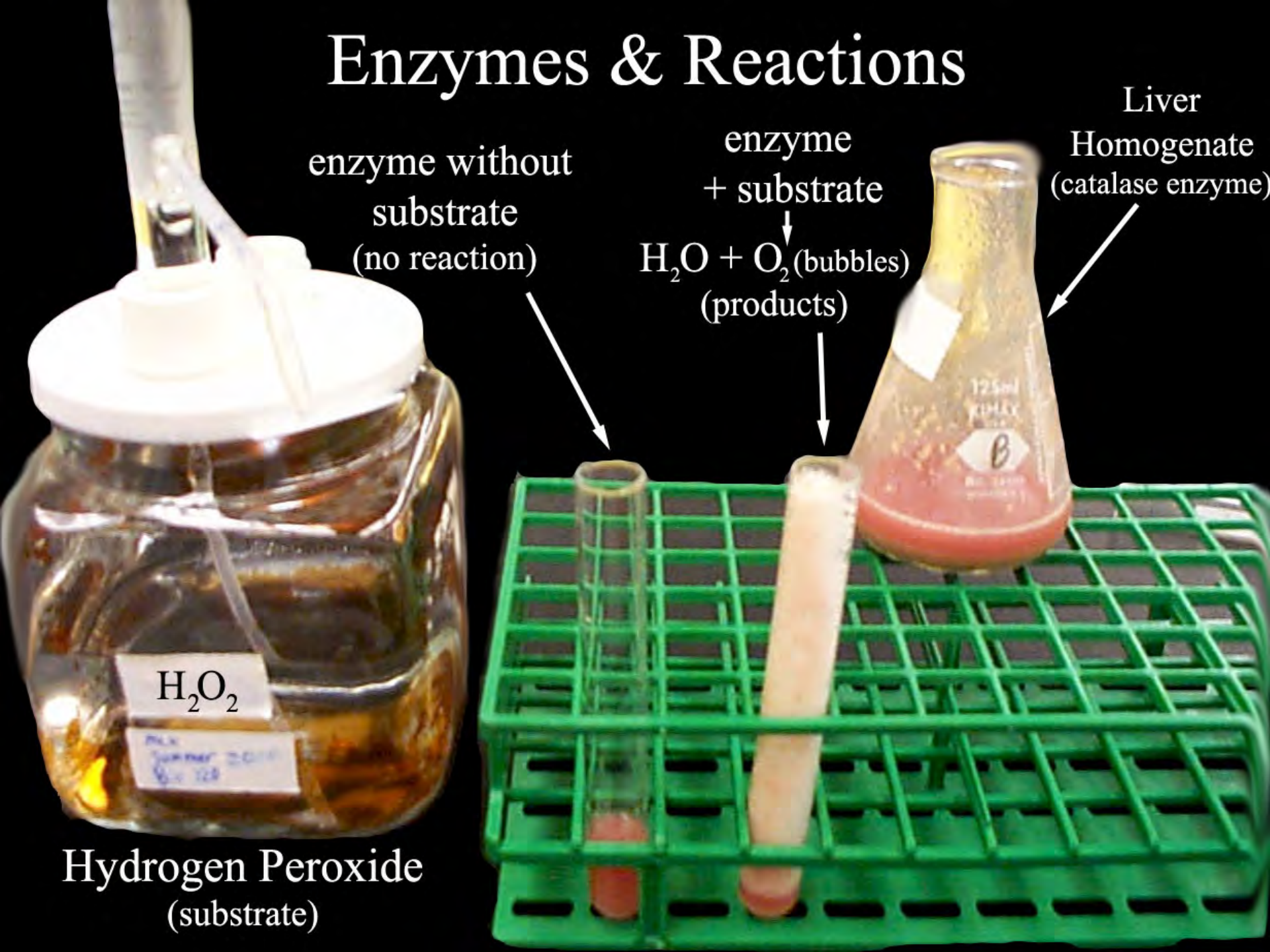


# Enzymes





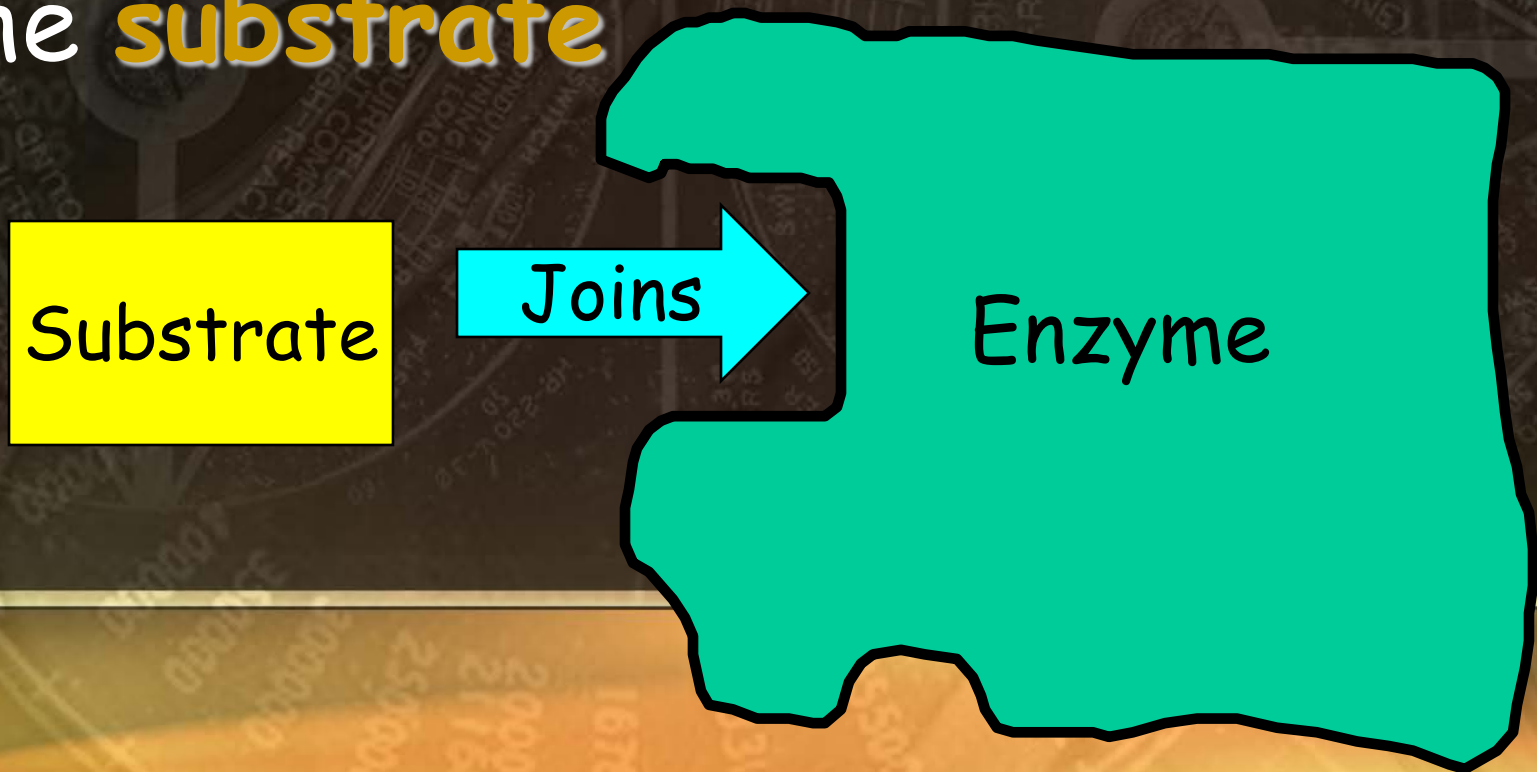
# Enzymes & Reactions





# Enzyme-Substrate Complex

The substance  
(reactant) an  
enzyme acts on  
is the **substrate**



# Active Site

- A **restricted region** of an enzyme molecule which **binds** to the substrate.

Active  
Site

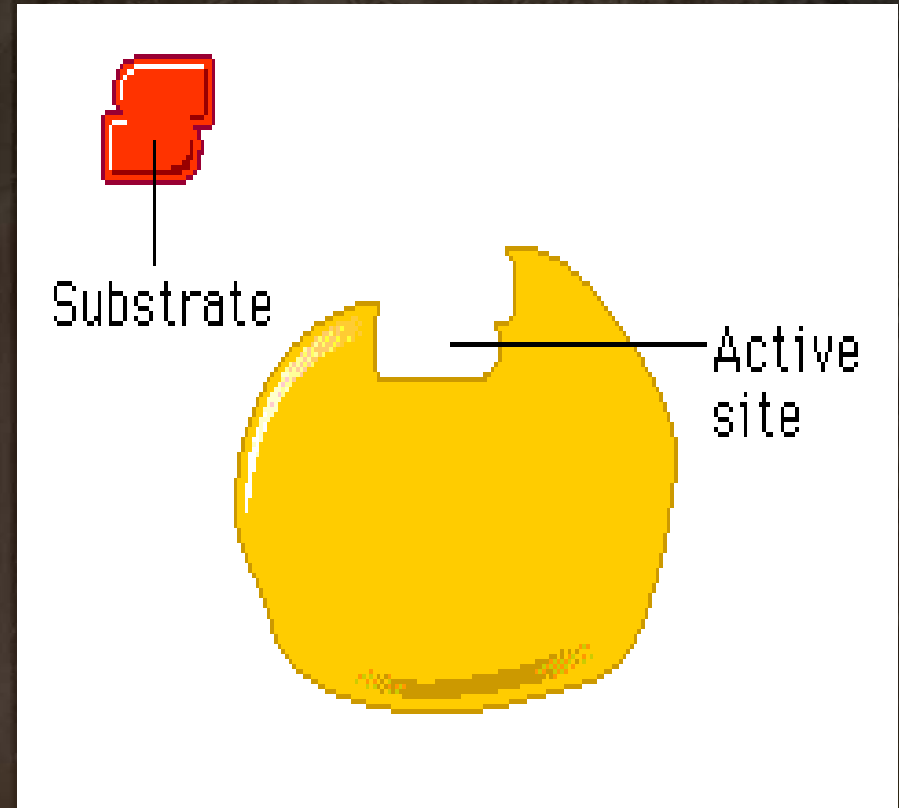
Substrate

Enzyme



# Induced Fit

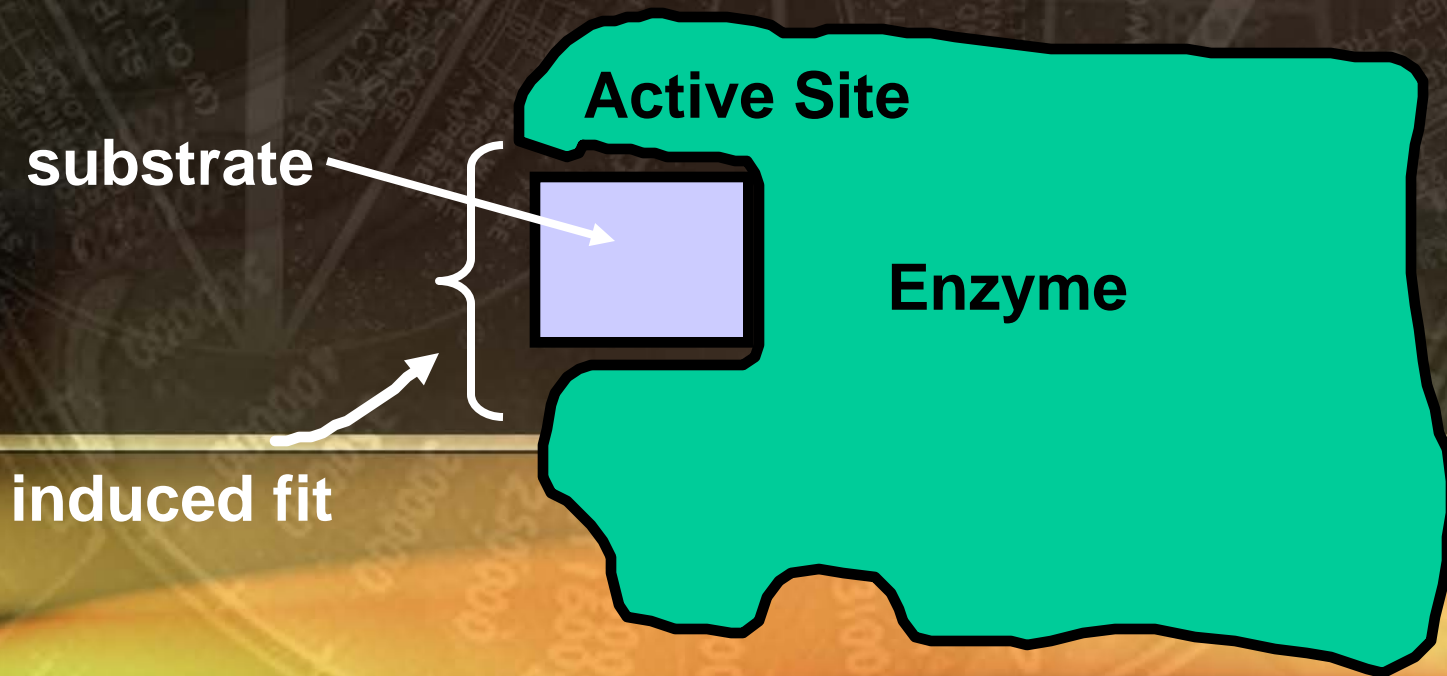
- A change in the **shape** of an enzyme's active site. **Induced** by the substrate.





# Induced Fit

- A change in the **configuration** of an **enzyme's active site**.
- Induced by the **substrate**.



# What Affects Enzyme Activity?

- Three factors:

1. Environmental Conditions

2. Cofactors and Coenzymes

3. Enzyme Inhibitors



# 1. Environmental Conditions

1. Extreme **Temperature** are the most dangerous

- **high temps** may denature (unfold) the enzyme.

2. **pH** (most like 6 - 8 pH near neutral)

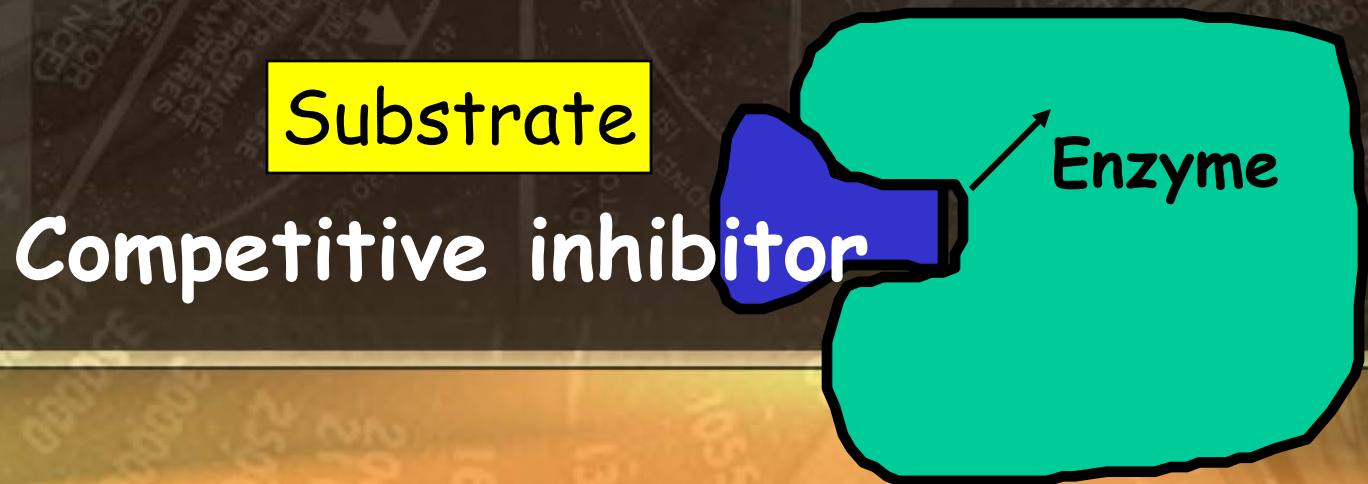


## 2. Cofactors and Coenzymes

- Inorganic substances (**zinc, iron**) and **vitamins** (respectively) are sometimes needed for proper enzymatic activity.
- Example:
  - Iron** must be present in the quaternary structure - **hemoglobin** in order for it to **pick up oxygen**.

# Two examples of Enzyme Inhibitors

- a. Competitive inhibitors: are chemicals that resemble an enzyme's normal substrate and compete with it for the active site.

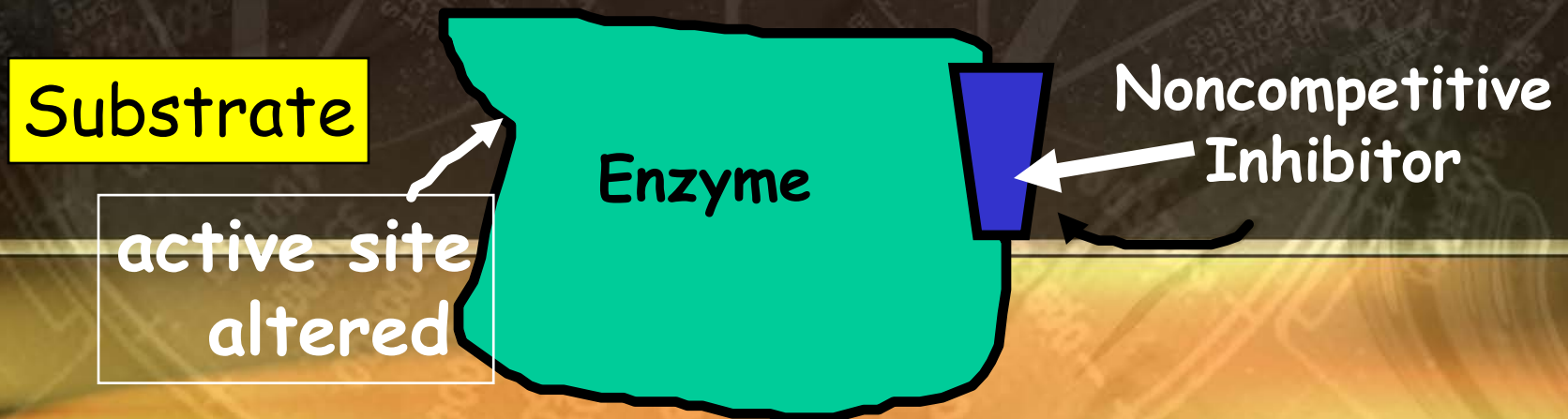




# Inhibitors

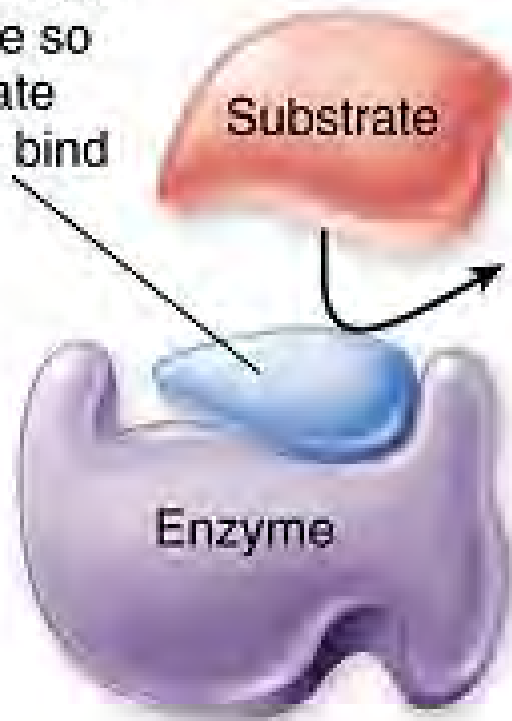
## b. Noncompetitive inhibitors:

Inhibitors that do not enter the active site, but bind to another part of the enzyme causing the enzyme to change its shape, which in turn alters the active site.

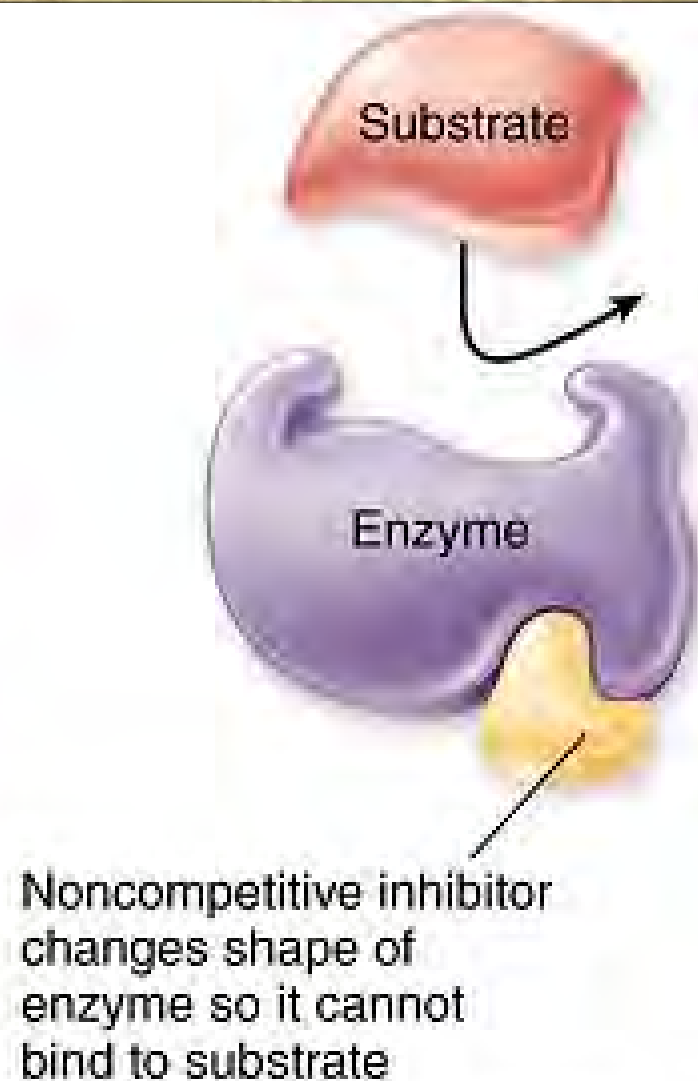




Competitive inhibitor interferes with active site of enzyme so substrate cannot bind

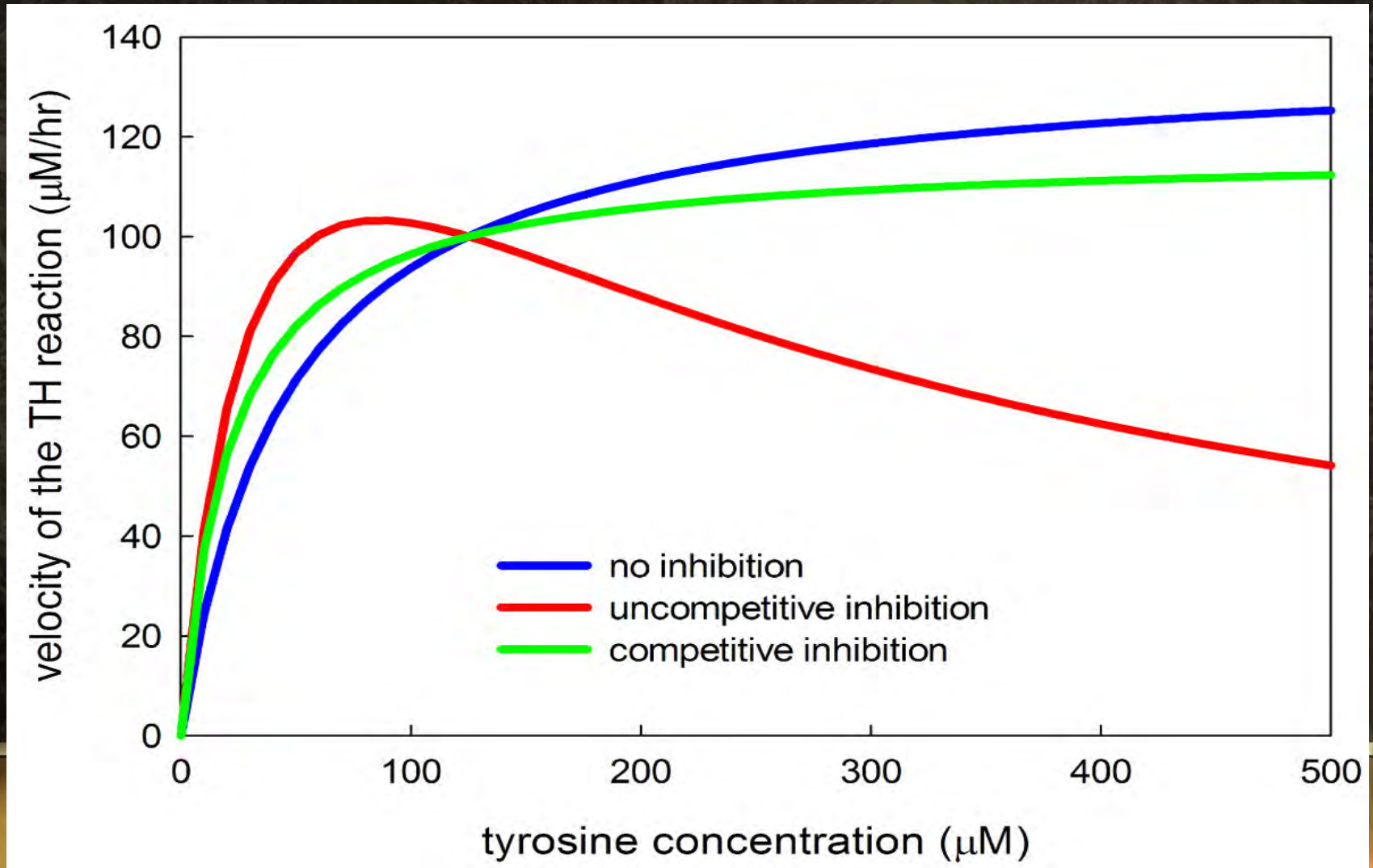


(a) Competitive inhibition



(b) Noncompetitive inhibition

# Michaelis Menten Studies (Saturation Curve)



# Summary

- Enzymes are made of proteins.
- They reduce the activation energy needed for a reaction to proceed and produce products.
- Enzymes have a region called an active site. Site is the "lock" into which a substrate "key" fits.
- Enzyme activity is affected by substrate type, temperature, pH and substrate concentration.
- Enzyme activity can be inhibited by adding inhibitors (inhibitors can be competitive and non-competitive).



# Enzyme's Quiz

- What are enzymes made off?
- What are the four types of protein structures? (hint they are made of amino acids) What type of structure is the hemoglobin protein?
- What is the definition to induce fit? How is this concept important?
- What does the "lock" and "key" model describe?
- Why are enzymes important? How do they alter "activation energies" ?
- How are enzymes denatured?
- Draw a energy diagram that shows a catalyzed reaction vs. uncatalyzed reaction?
- Describe the two type of inhibitors and how they work?

## Honors Biology

## Enzymology: Catalase and Hydrogen Peroxide

In this activity, you will carry out basic Michaelis Menten studies using the enzyme, Catalase. Catalase is found in all living organisms that are exposed to oxygen. It catalyzes the decomposition of hydrogen peroxide to oxygen and water. The importance of this enzyme is to protect cellular systems from oxidative damage by reactive oxygen species (you don't want these in your body). Catalase is found in almost all organs in the Human body but it has a high concentration in the liver. The ideal pH for catalase to function is between 7.0-7.5. In this lab, your group will test the affects of different concentrations of substrate (the Hydrogen Peroxide) have on activity (activity will be measured using oxygen gas sensor probe). Also, we will be determining how enzyme activity is affected by temperature. Record all data and observations.

### Materials needed:

- Catalase
- Hydrogen Peroxide (3% concentrated, found OTC)
- Graduated Cylinder
- Cups X5
- Test tubes X2
- 250mL beaker
- Oxygen gas sensor probe
- Refrigerator
- Hotplate

### Procedure (For determination of enzymatic activity):

1. Using a graduating cylinder measure out the hydrogen peroxide (in 20mL increments and add to each cup, stop at 100mL).
2. Add 2 mL of the Catalase to each cup and measure the activity using the oxygen gas sensor probe (record highest reading for each cup).
3. Record all your data and clean up.
4. Graph your readings obtained from the oxygen gas sensor probe.

### Procedure (For effect of temperature on enzyme activity):

1. Add water to a beaker and place it on a hotplate.
2. Add 2mL of Catalase to a test tube and place the test tube in the beaker that is on the hotplate (boil for ~5-6 minutes).
3. Add 2mL of Catalase and place it into a freezer for at least 30 minutes.
4. Add the Catalase that was warmed up into a test tube containing hydrogen peroxide. Observe and record your result.



5. Add the 2mL of Catalase that was cooled in the freezer into a cup containing hydrogen peroxide. Observe and record your result.
6. Clean up.

## Results

<b>Test Tube#1</b>	<b>10mL of Substrate</b>	
<b>Test Tube#2</b>	<b>20mL of Substrate</b>	
<b>Test Tube#3</b>	<b>30mL of Substrate</b>	
<b>Test Tube#4</b>	<b>40mL of Substrate</b>	
<b>Test Tube#5</b>	<b>50mL of Substrate</b>	
<b>Test Tube#6</b>	<b>Hot Temperature</b>	
<b>Test Tube#7</b>	<b>Cold Temperature</b>	

## Questions:

1. Why are enzymes important to biological systems? Describe the “Lock” and “Key” model.
2. Going by your graph generated by using enzyme activity experiment (Michaelis Menten studies), at what point is the enzyme considered saturated? What does this mean?
3. What did you observe with the reaction that had Catalase that was heated and cooled? Explain.
4. What cofactors affect enzyme activity? Why?
5. You have learned that Catalase is found in the human body, lets say that all the catalase suddenly disappeared from the body (use your imagination as to how this happened), what impact would this have on humans? Why?
6. Define competitive and noncompetitive inhibitors. In this experiment, if we were to add a competitive inhibitor, how would that affect the reaction? How would a noncompetitive inhibitor affect the reaction?