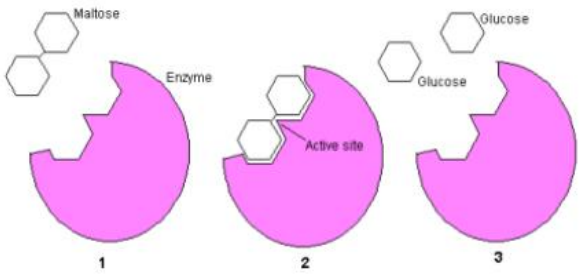
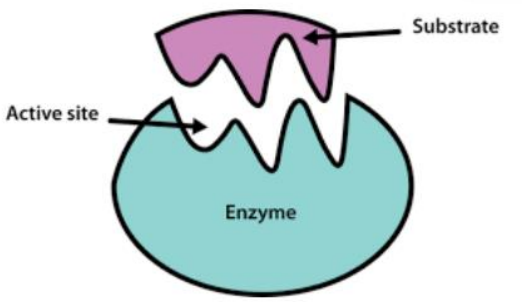


ENZYMES

Name: _____

Block: _____



Homework: Due _____

Watch the video link below and fill in the accompanying worksheet:

https://www.youtube.com/watch?v=qgVFkRn8f10

1. Enzymes look a lot like _____
2. P for _____ and P for _____
3. Enzymes have _____ _____ where a _____ can bind.
4. The _____ _____ is specifically shaped to fit the _____
5. The active site can change its shape by what is called _____ _____
6. Enzymes can _____ _____or _____ _____the substrate to make products.
7. Enzymes have the ability to _____ _____ reactions.
8. Enzymes often end in _____
9. Sugars often end in _____
10. Lactose is a _____
11. The enzyme _____ can break _____ down into _____ and _____
12. People who are lactose intolerant don't make enough _____ so they cannot break down _____ in milk
13. Enzymes are called _____ because they can be used _____ and _____ again
14. _____ breaks down lipids.

15. _____ breaks down starch.

16. _____ breaks down proteins

17. _____ and _____ help enzymes do their job.

18. Enzymes have _____ conditions.

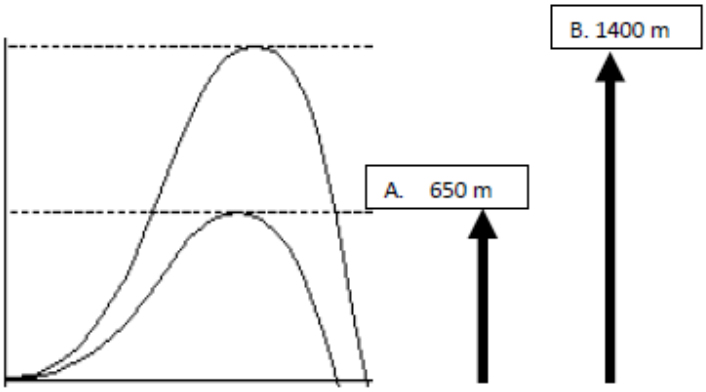
19. Enzymes become _____ if their environment changes.

20. When an enzyme becomes denatured, it can no longer _____ to it substrate.

Enzyme POGIL

How does an enzyme influence chemical reactions?
What roles do enzymes play in living things?

Figure 1



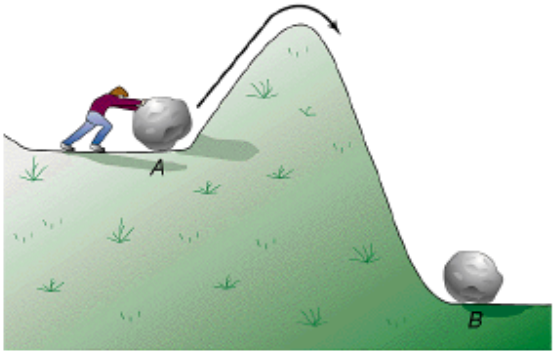
INTRODUCTORY SITUATION QUESTIONS:

1. If you're going hiking this weekend and you have the option of hiking a mountain that is 1400 meters in height and a mountain that is 650 meters in height, BUT you know that you have limited time because of other plans – which mountain would you choose to hike, A or B?

2. If you are hiking at the same pace, which of these mountains would require MORE energy to hike up (A or B)?

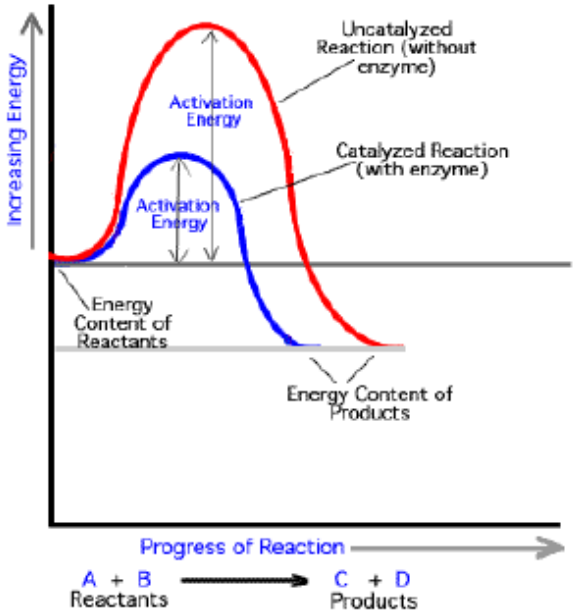
INFORMATION SECTION 1: ACTIVATION ENERGY

Figure 2



The picture above shows someone trying to push a boulder up a hill. In order for the boulder to reach its final destination at point B, it must be pushed to the top of the hill because once it reaches the top of the hill it will roll down the rest of the way. A similar scenario exists in chemistry, before a chemical reaction will take place, energy must be put into the system. The energy needed for a chemical reaction to move from point A to the top of the hill is known as *activation energy*, also written as E_a

Figure 3



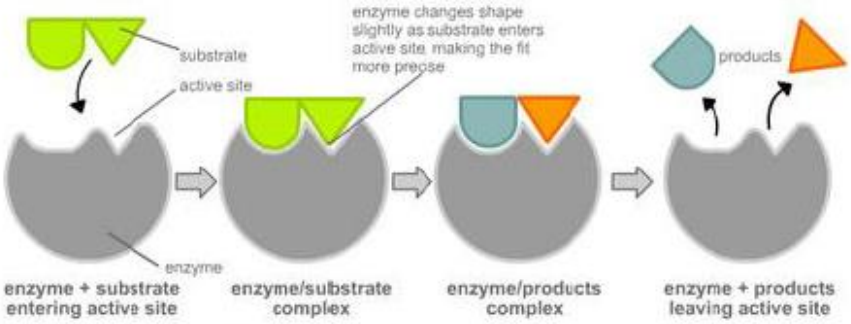
3. Comparing Figure 3 above to the figure 1 (comparing the heights of 2 mountains), how does using an enzyme in a chemical reaction impact the reaction?
   a. Does it speed up or slow down the reaction?
   b. How does the enzyme impact activation energy?
   c. Based on your answers to questions a and b, what do you think the term "catalyzed" means?
   d. Do you know of any other examples of things that "catalyze" chemical reactions?

INFORMATION SECTION 2: LOCK AND KEY THEORY

Figure 4

4. What do you know about keys?
   a. What are the characteristics that distinguish one key from another?
   b. Where are some places that you use keys?
   c. Can a key from one place open the lock of a different key?
   d. If you had to choose from the word "specific" or "general" to describe a key, which would you choose?

Figure 5



5. Looking at Figure 5 above, how is the enzyme similar to a lock and a key?
6. What terms are used in the picture of the enzyme that could be used in the following analogy. lock:key as ....what:what in the picture above?
7. If the substrate in the first image in the left of the series is a disaccharide such as sucrose, that is the enzyme doing to the disaccharide?
8. The picture above is showing what is known in biochemistry as the "***lock and key theory***." Explain why you think this theory is used to describe enzymes.
9. What are some examples from biology/chemistry class or from other areas of your life where the specific shape of something is important for it to work correctly.

INFORMATION SECTION 3: FUNCTION AND ENVIRONMENTAL CONDITIONS

Image A: Before

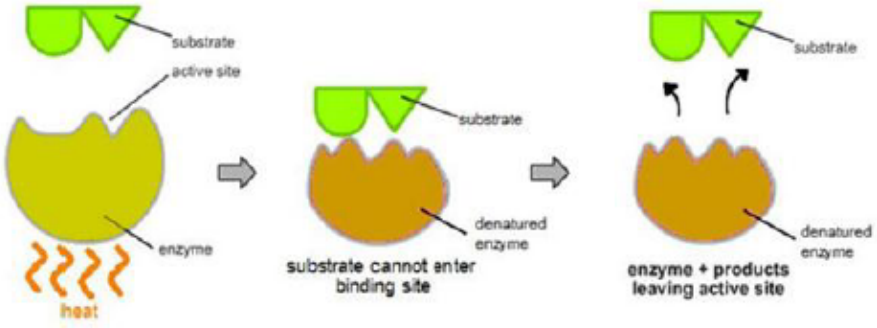
Image B: After

Figure 6

The other day I was really excited about my new coloring book, so I bought a new pack of Crayola crayons and forgot that I left them in my pocket. When I went to do my laundry later in the week, you can see what happened to the stack of crayons after they were put through the dryer.

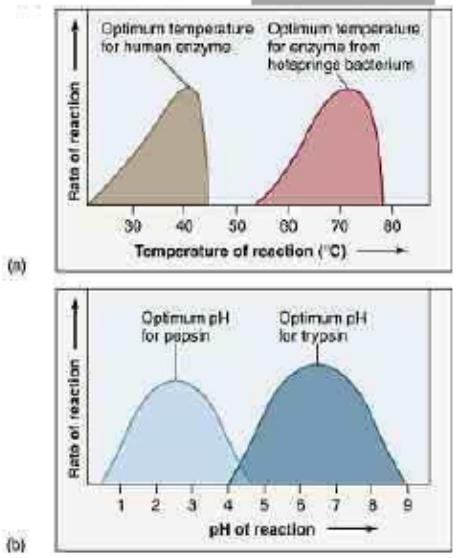
10. How would you describe what happened to my crayons between image A to image B?
11. Will I be able to accurately color my coloring book if the crayons are like this? Explain.
12. What caused my crayons to be changed?
13. What are some other things that you have seen "melted" or change shape which impacted their ability to work correctly. Come up with *at least* 3 other examples.

Figure 7



14. Figure 7 above shows what happens to an enzyme when exposed to heat. How is this similar to what happened to my crayons?
15. What term is used to describe when the shape of the enzyme has been altered?
16. Predict how this alteration will affect the enzyme's ability to function properly.

Figure 8



Conditions Affecting Enzyme Function

17. Using Figure 8(a) and 8(b): What are two conditions that affect enzyme function?
18. Provide an explanation for why human enzymes function best at 40 °C but enzymes from hotsprings bacterium works best at 70 °C.
19. What do you think happens to the human enzyme when the temperature increases to 45 °C.
20. In figure 8(b) you can see two different enzymes, why do you think they work best at different pH levels?

Information Section 4: Enzyme Uses

Enzymes are complex proteins produced by all living thing. Enzymes are substances that help carry out a number of the body's function like transforming food and chemical elements into other needed substances. Enzymes help eliminate toxins in the colon, kidneys, liver, lungs and skin. Your body has millions of enzymes controlling millions of tiny reactions. Under normal circumstances, each enzyme is able to catalyze many reactions before they stop working.

Like all proteins, enzymes consist of chains of amino acids linked together. The amino acids within each kind of enzyme have a characteristic arrangement. The bonds between the different amino acids in the chains are weak and may be broken by such conditions as high temperature or changes in pH. When the bonds are broken, the enzymes become non-functional, sometimes this results from diseases.

The most well known and important enzymes are the digestive enzymes:

1. **Amylase - contained in saliva. Splits the carbohydrates in order to be assimilated by the intestine.**
2. **Protease - contained in the gastric juices. Splits proteins so they can be digested.**
3. **Lipase - secreted by the pancreas. Split fats into fatty acids so that it can be digested.**

21. What are some uses for enzymes?
22. Can you think of things that enzymes would be used for in living things that are not listed in the examples above?
23. Low grade fevers are healthy because they help our body get rid of harmful bacteria/viruses, but when fevers reach of temperature of 105 degrees Fahrenheit it is extremely dangerous – using your knowledge of enzymes explain why. (*note: be sure to use the scientific terms throughout to help explain what happens)
24. Do you feel you understand the role of enzymes in living things and how they work? What questions do you still have about enzymes?

Enzymes and Cellular Regulation

What are the factors that regulate the rate at which enzymes catalyze reactions?

Why?

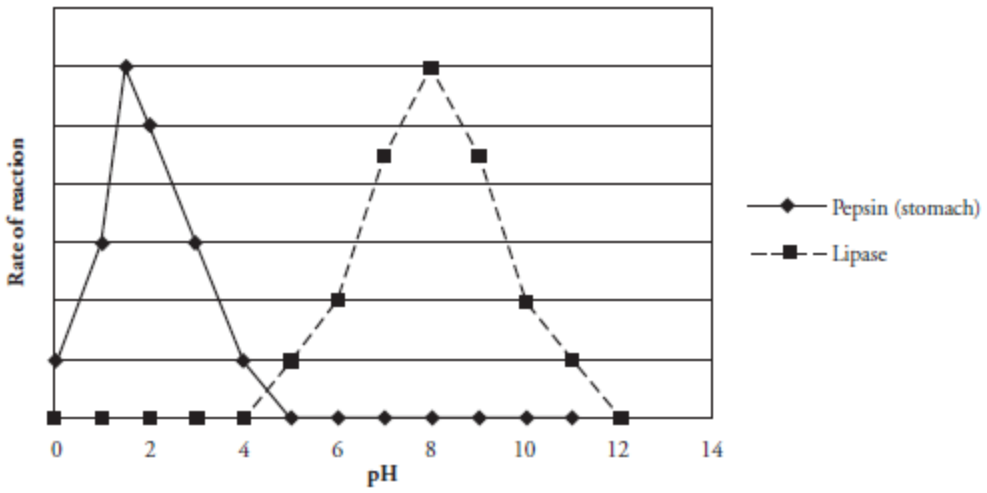
Digestive enzymes are protein-based biological catalysts that play important roles in our lives. They help remove stains from our shirts, turn milk into cheese, and are responsible for turning our dinner into useable fuel for our bodies. Enzymes however do not work well universally. Some are meant to work at high temperatures, others at low temperatures. They may work best in acidic conditions or neutral conditions. In this activity we will look at the optimal conditions for two different enzymes. The digestive enzyme lipase is made in the pancreas and breaks down lipids in the small intestine, while pepsin breaks down proteins in the stomach.

Model 1 – Two Digestive Enzymes

$$\text{Triglycerides} \xrightarrow{\text{lipase}} \text{glycerol + fatty acids}$$

$$\text{Large polypeptides} \xrightarrow{\text{pepsin}} \text{smaller polypeptides + amino acids}$$

Effect of pH on Enzyme Activity



1. Name the two enzymes illustrated in Model 1.

2. Consider the information provided in the *Why?* box and in Model 1 about these proteins.
   a. In which body organ is pepsin active?

   b. In which body organ is pancreatic lipase active?

3. For each enzyme in Model 1, circle the pH that best represents the environment in which the enzyme is most active.

Pepsin	1.5	8	10.4
Lipase	1.5	8	10.4

4. Compare the rate of the pepsin-catalyzed reaction at pH 1.5 with the rate of the lipase-catalyzed reaction at pH 1.5.

5. Compare the rate of the pepsin-catalyzed reaction at pH 8 with the rate of the lipase-catalyzed reaction at pH 8.

6. Using your knowledge of protein structure, explain in detail the effect of exposing an enzyme to a pH outside of its optimal range. Include the effect on both enzyme structure and function.

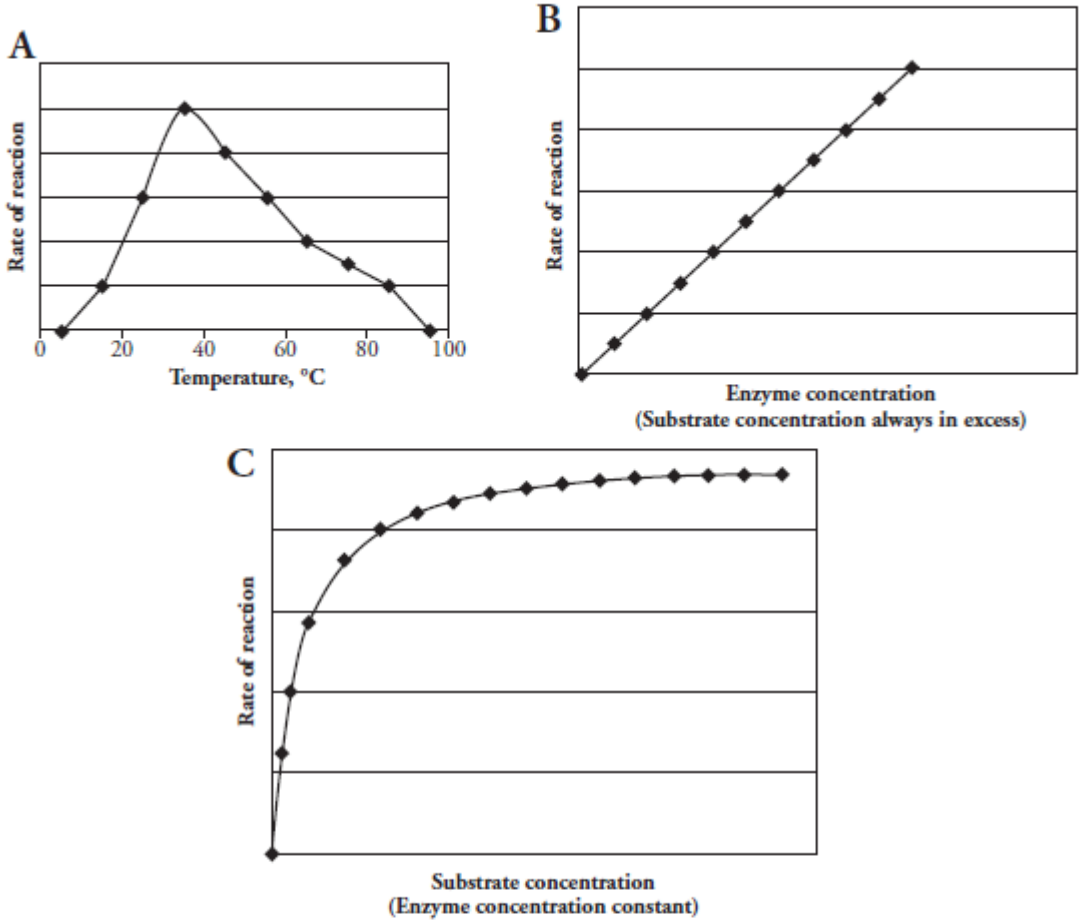
7. At what pH values is lipase likely to be denatured? Justify your answer.

8. At what pH values is pepsin likely to be denatured? Justify your answer.

9. In addition to being produced in the pancreas, lipase is also produced in the stomach. Is the structure of pancreatic lipase the same as gastric (produced in the stomach) lipase? Justify your reasoning.

10. Add a line to the graph in Model 1 that shows a prediction for gastric lipase activity.
11. Antacids work by neutralizing acids, bringing the pH of the stomach to a range of 6–7. What is the effect of taking an antacid on a person's ability to digest proteins?

Model 2 – Amylase Rate of Reaction



12. Amylase is an enzyme that catalyzes the digestion of carbohydrates. The graphs in Model 2 provide data on several factors that affect the function of amylase in the body.
    a. The relationship of which two variables is illustrated in graph A of Model 2?

    b. The relationship of which two variables is illustrated in graph B or Model 2?

    c. The relationship of which two variables is illustrated in graph C or Model 2?

13. Refer to Model 2.
    a. What is the optimum temperature for amylase?

    b. What is the biological significance of the temperature at which the amylase-catalyzed reaction is fastest?

14. Predict what causes a decrease in enzyme activity at temperatures above 37 °C.

15. A young child runs a fever of 40 °C for 24 hours. Explain what effect this may have on his digestion.

16. Consider the data in graph B of Model 2.

a. Describe the relationship between enzyme concentration and reaction rate.

b. Propose an explanation for this relationship.

17. Consider the data in graph C of Model 2.

a. What is the relationship between substrate concentration and the reaction rate?

b. Propose an explanation for why a maximum reaction rate is reached in graph C.

18. As a group, develop an analogy for the function of an enzyme that will explain the concentration graphs in Model 2 (graphs B and C).

19. Would the reaction rate on graph B of Model 2 ever reach a maximum level? Justify your answer.

Extension Questions

20. Thermophilic bacteria, such as *Thermus aquaticus,* live in hot springs where the temperature is greater then 70 °C. Draw a graph similar to graph A in Model 2 representing the optimal temperature of *T. aquaticus*.

21. DNA polymerase from *T. aquaticus (Taq)* is used in PCR (polymerase chain reaction). PCR is a technique where millions of copies of DNA can be made from one original copy. In this method, the target DNA molecule is subjected to temperatures over 95 °C to make the double-stranded DNA separate. The temperature is then lowered slightly to allow primers to anneal before the *Taq* polymerase catalyzes the reactions to incorporate new nucleotides into the complementary strands. The cycle is then repeated over and over until there are millions of copies of the target DNA.

    a. Predict why this bacterial polymerase is used instead of a human polymerase.

    b. What would happen if you used a human polymerase in a series of PCR reactions?

Read This!

The rate of an enzyme-catalyzed reaction can also be affected by the presence of other molecules that can bind to the enzyme, changing its shape. In some reactions a **coenzyme** is necessary. This molecule binds to the protein strands of the enzyme, changing its shape so that is ready to receive the substrate molecule. Without the coenzyme, the enzyme would not be able to attach to the substrate. Other molecules can reduce the rate of reaction for enzymes by binding to the protein and either blocking the spot where the substrate will bind or by making the enzyme's shape incompatible with the substrate. These molecules are called **inhibitors**.

22. Sketch a graph that shows the relationship between the rate of an enzyme reaction and the concentration of coenzyme necessary for the enzyme to function properly.

23. Add a line to graph C of Model 2 that shows the rate of an enzyme reaction in the presence of inhibitor molecules.

Lab - Enzyme Catalysis

Lab Report Due: _____

Objective: The enzyme pectinase converts applesauce in to apple juice. Using all of the materials listed create an experiment which demonstrates one of the following concepts:

a. Enzymes lower the activation energy for reactions and help them occur faster than reactions without enzymes
   OR
b. Enzymes denature at high temperatures

Applesauce	Funnels
Pectinase	A timing device
Graduated cylinders	Cheesecloth

Rules:

1. You must use all of the materials listed
2. You must collect quantitative data
3. You may only have one independent variable
4. You must have a control that serves as a basis for comparison

Your lab report should have the following sections:

1. Introduction: (10 pts)
   - Start with a statement that explains concisely what the question was the you were attempting to answer. Be as precise as possible.
   - Provide background information that relates to the question being studied. All background information must be cited from a reference.
   - Define key terms.
   - Explain why you chose to set up your experiment as you did.
   - Conclude this section with a prediction that includes all parts of your experiment.
2. Materials and Procedure (5pts)
   - In paragraph form describe the materials you used and the steps you followed in past tense.
   - Identify controls in the experiment.
3. Results: table (10 pts)
   - Display your data in well labeled table.
4. Results: graph (10pts)
   - Display your data in a well labeled graph

5. Conclusion (10pts)
    - Summarize your results in your data table and graph
    - What did you expect to find and why?
    - How do your results compare with your expectations?
    - How might you explain unexpected results?
    - How might you test these potential explanations?
    - What were your sources of error? How might they have affected your results?
6. References (5pts)
    - List all the sources you consulted and cited

Things to never say in a conclusion:

We had no sources of error
Our experiment worked
We liked the experiment/It was fun
We proved our hypothesis
We measured wrong, we counted wrong etc. – this is not what sources of error means