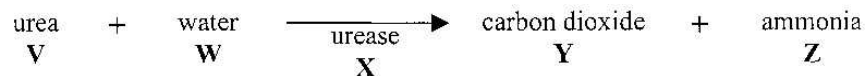


Enzymatics

Part A – Multiple Choice

- Which of the following is **TRUE** about a metabolic pathway?
 - ATP is required at each step.
 - A final end product is never produced.
 - The products become the next substrates.
 - The same enzyme is used each step in the pathway.
- Which of the following is **NOT TRUE** about enzymes?
 - Participants in reactions.
 - Stored in a cell's active site.
 - Very specific in their function.
 - Denatured by high temperatures.
- Which of the following is **NOT TRUE** about enzymes?
 - Protein substances.
 - Organic substances.
 - Regulate metabolism.
 - Consumed in reactions.
- Which part of a person's diet supplies them with co-enzymes?
 - Lipids.
 - Proteins.
 - Vitamins.
 - Carbohydrates.
- Which part of a person's diet supplies them with co-factors?
 - Fats.
 - Water.
 - Minerals.
 - Vitamins.
- Which of the following is **NOT TRUE** about enzymatic reactions?
 - Enzymes can be used repeatedly.
 - Enzymes each catalyze only one specific reaction.
 - Substrates temporarily bond onto enzymes for a reaction to occur.
 - The energy of activation required for a reaction is increased by the presence of enzymes.
- Which of the following factors will **NOT** denature an enzyme?
 - pH.
 - Temperature.
 - Concentration.
 - Heavy metal ions.

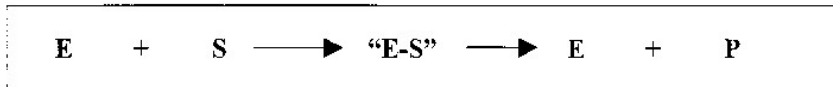
Use the following reaction to answer the next question.



- Which letter refers to the enzyme in this reaction?
 - V
 - W
 - X
 - Y

9. Which of the following steps occurs **FIRST** during a hydrolytic reaction?
- The substrate is broken.
 - The active site changes shape.
 - The substrate bonds to the active site.
 - Water molecules are broken and used.

Use the following reaction to answer the next two questions.



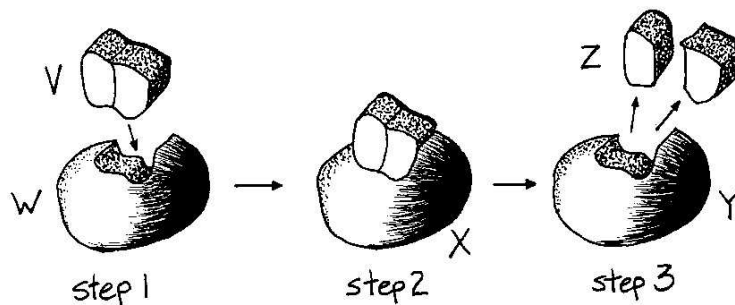
10. Which component is made at a cell's ribosomes?
- E
 - S
 - P
 - None of them are.
11. Which reaction component is temperature and pH sensitive?
- E
 - S
 - P
 - None of them are.
12. A particular reaction that occurs in the mouth was proceeding in a test tube at 45 degrees and at a pH of 2.5. Which of the following would likely cause the greatest **INCREASE** in the reaction rate?
- Drop 10 degrees and increase the pH.
 - Drop 10 degrees and maintain the pH.
 - Raise 10 degrees and maintain the pH.
 - Raise 10 degrees and decrease the pH.
13. Which of the following conditions for an enzyme-catalyzed reaction will produce the **LEAST** product?

	[Substrate]	[Enzyme]
A.	low	low
B.	low	high
C.	high	low
D.	high	high

14. Where does the energy for enzymatic reactions come from?
- ATP.
 - Enzymes.
 - Substrates.
 - Co-enzymes.
15. Consider the following statements and select the **BEST** order for an enzyme-catalyzed reaction.
- The chemical reaction occurs.
 - The enzyme is released unchanged.
 - The substrate pieces are combined to form a product.
 - The substrate pieces fit into the active site of the enzyme.
- 1, 4, 3, 2
 - 2, 1, 3, 4
 - 4, 1, 3, 2
 - 4, 2, 3, 1

16. One of the following factors affecting enzymatic activity will often allow the enzymes to “renature” when the condition is returned to normal. Which one is it?
- A pH much lower than optimum.
 - A pH much higher than optimum.
 - A temperature much lower than optimum.
 - A temperature much higher than optimum.
17. What level of structure is affected when an enzyme gets denatured?
- Primary.
 - Secondary.
 - Tertiary.
 - Quaternary.
18. Which of the following is the **LEAST** likely to affect the rate of enzymatic activity?
- pH.
 - Temperature.
 - Concentration.
 - Osmotic pressure.
19. An enzyme’s ability to “recognize” the appropriate substrate is based on
- mass.
 - shape.
 - reactivity.
 - glycoproteins on their surfaces.
20. Which of the following is **TRUE** about hydrolytic enzymes?
- They cannot be stored in cells.
 - They bond onto proteins to react.
 - They are denatured at very high temperatures.
 - Their function almost never involves co-enzymes.
21. Which of the following is **NOT TRUE** about enzymes?
- They lower activation energy.
 - They are environmentally sensitive.
 - Their shape is very specific to their function.
 - They are made out of repeating nucleotide units.

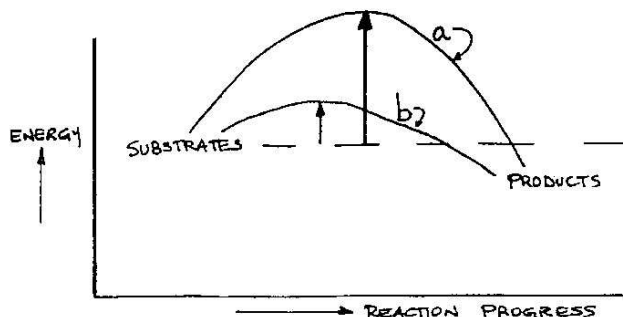
Use the following diagram to answer the next two questions.



22. At which step(s) in this reaction sequence are co-enzymes and co-factors the **MOST** involved?
- Step 1.
 - Step 2.
 - Step 3.
 - Step 1 or 2, but not Step 3.

23. Which of the following is the **MOST** probable identity of **V**?
- ATP.
 - Maltose.
 - Glucose.
 - Calcium.
24. Generally, increasing the enzyme concentration in an enzymatic reaction will cause the reaction to
- stop.
 - reverse.
 - speed up.
 - slow down.

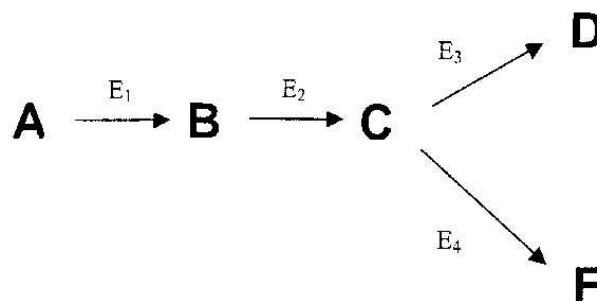
Use the following graph to answer the next question.



25. The difference between line “a” and line “b” represents the effect of
- adding enzymes.
 - establishing optimum pH.
 - establishing optimum temperature.
 - increasing the substrate concentration.
26. Which of the following is **NOT TRUE** for enzymes?
- They are produced by cells.
 - They can react only when inside cells.
 - They can be destroyed by high temperatures.
 - They are generally considered to be proteins.
27. Which of the following is **NOT TRUE** about enzymatic reactions?
- Substrates get consumed.
 - Once started they can’t be stopped.
 - Chemical bonds are either broken or formed.
 - The shape of the enzyme’s active sites is temporarily affected.
28. If a substrate concentration is increased, the amount of product formed normally should
- increase.
 - decrease.
 - decrease and stop.
 - remain unchanged.
29. Which of the following is **NOT TRUE** for enzymes?
- Their name ends with the suffix “ase.”
 - They each react with only one type of substrate.
 - They increase the amount of energy required to start a reaction.
 - They form an association with the substrate before the actual reaction.
30. Which of the following is **TRUE** for enzymes?
- They can be used repeatedly.
 - They increase the energy of activation.
 - They are often named after their solute.
 - They are not always specific in their function.

31. Which of the following will **NOT** change the shape of an active site?
- Altering the pH.
 - Adding heavy metal ions.
 - Increasing the temperature.
 - Adding competitive inhibitors.
32. Select the **FALSE** statement from the following choices.
- The Kinetic Molecular Theory applies to enzymatic activity.
 - Enzyme-catalyzed reactions rarely occur without the enzyme.
 - Enzymes work best when certain vitamins and minerals are present.
 - Some enzymes can react with several different shapes of substrates.
33. How does Hg^{2+} affect enzyme activity?
- It alters the pH, which affects the enzyme's ability to function.
 - It combines with the substrate preventing it from reaching the active site.
 - It combines with the active site to prevent the substrate from binding there.
 - It causes the redistribution of electrons in the enzyme which causes a distortion in its shape.

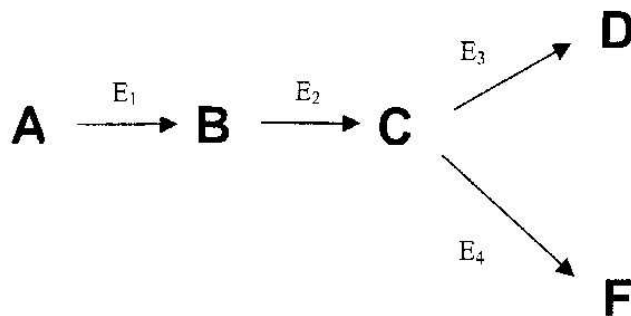
Use the following diagram to answer the next question



34. If substance **D** inhibits Enzyme 2 (**E₂**), this will in turn inhibit the production of
- Substance **D** only.
 - Substance **F** only.
 - both Substances **D** and **F**.
 - Enzymes 3 and 4 (**E₃** and **E₄**).
35. At which of the following conditions does the rate of enzymatic activity **DECREASE** as predicted by the Kinetic Molecular Theory?
- At a pH less than optimum.
 - At a pH greater than optimum.
 - At a temperature less than optimum.
 - At a temperature greater than optimum.

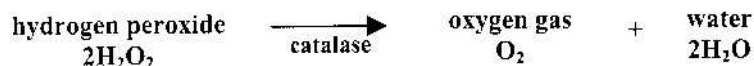
Part B – Written Answers

1. An experiment investigating enzyme activity is carried out. A test tube is prepared containing substrate solution **A** and enzyme solutions **1, 2, 3, and 4**. The reactions that occur in the test tube are summarized below.



- Describe two ways in which the rate of production of product **D** can be increased.
 - A substance is added to the test tube. As a result, no product **F** is formed, but product **D** is still formed. Explain why.
- Some bacteria thrive in hot springs where the temperature averages 85°C. Predict the shape of a graph illustrating their metabolic rate vs. temperature. Draw and label this graph.
 - An experiment designed to measure the effect of pH on enzyme activity was conducted using the following steps:
 - An equal volume of hydrogen peroxide (H₂O₂) was added to eight numbered test tubes at 20°C.
 - The contents of each test tube were maintained at a different pH.
 - An equal mass of liver was added to each test tube.

Liver contains the enzyme catalase, which catalyzes the following reaction:



- The time required to collect 10 mL of oxygen gas (O₂) from each test tube was measured and recorded as shown in the table below.

Test Tube	pH of Solution	Time to Collect 10mL of O ₂ (seconds)
1	5	120
2	6	90
3	7	50
4	8	30
5	9	40
6	10	60
7	11	90
8	12	140

- Draw a graph that compares the time to collect 10 mL of O₂ produced to the pH of the solution.
- Use your graph to estimate the time it would take to collect 10 mL of O₂ at a pH of 6.5
- Explain what causes the results observed between pH 8 and pH 12

4. With specific reference to the Lock and Key Analogy, describe the difference between substrates and competitive inhibitors.
5. During an experiment, it was discovered that doubling the amount of substrate did not speed up the reaction. Explain this observation.
6. An experiment was conducted to measure the effect of temperature on the metabolic activity of thyroxin. Two tissue samples were prepared as shown below.
 - Sample A: 50 grams of muscle tissue was added to a nutrient solution.
 - Sample B: 50 grams of muscle tissue was added to a thyroxin and nutrient solution.
 Oxygen consumption by the muscle tissue was used as an indicator of metabolic activity. It was measured over a range of temperatures. The results are shown below.

Temperature °C	Consumption of oxygen (mL/hour)	
	Sample A	Sample B
15°C	6	12
25°C	8	16
35°C	12	24
45°C	7	14
55°C	2	4

- a. Graph this data using separate lines for Sample A and Sample B.
- b. Based on your graph of the data for sample B, determine the amount of oxygen consumed per hour at 20°C.
- c. Explain the difference observed in the results for samples A and B.
- d. Explain the variations in the results for Sample B at each of the following temperatures.
 - i) 15°C
 - ii) 35°C
 - iii) 55°C