

## Section 1.7: Enzymes

### Mini Investigation: Modelling Enzymes and Polymers, page 51

A. Answers may vary. Sample answer: In the paper enzyme, the two paper clips fit in specific positions on the paper. This changes the conformation of the enzyme.

### Research This: Researching Enzymes in Industry, page 56

A. Answers may vary. Sample answer: Starch is processed using various alpha-amylases, glucoamylase, and glucose isomerase.

B. Answers may vary. Sample answer: The glucose isomerase can further process glucose units into fructose.

C. Answers may vary. Sample answer: The sources for these enzymes include bacterial and fungal sources.

D. Answers may vary. Sample answer: The enzymes were isolated from their host organisms by filtration. The glucose isomerase was immobilized.

E. Answers may vary. Sample answer: Controlling the pH, temperature, and fermentation time regulates the enzymes.

F. Answers may vary. Sample answer: The organisms where the enzymes were produced contain a complex array of enzymes and unwanted organic molecules that may interfere with the manufacturing process if they are not removed.

G. Answers may vary. Sample answer: Careers associated with this industry include: chemical engineer, microbiologist, and biochemist.

### Section 1.7 Questions, page 57

1. (a) A substrate is a substance that is recognized and binds to an enzyme. An active site is the location on an enzyme where a substrate binds and is the location of the enzymatic reaction.

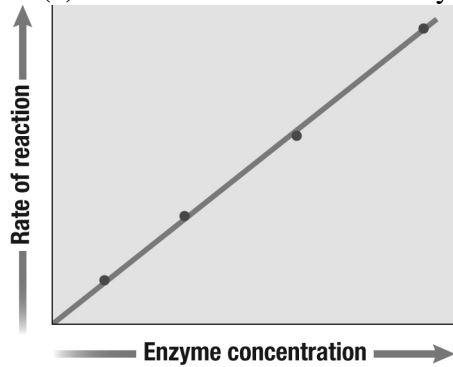
(b) Enzymes are considered biological catalysts because they can be used repeatedly and are not wasted after they catalyze a reaction.

2. In the induced-fit hypothesis, the conformation of the enzyme changes slightly to allow for a more precise binding of the substrate.

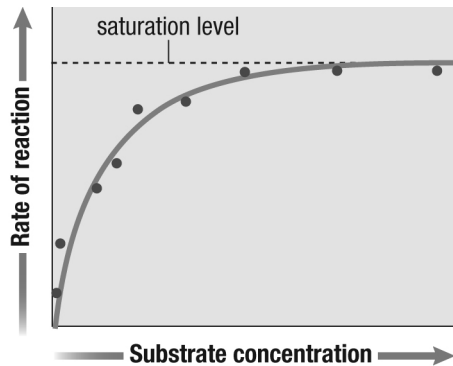
3. Coenzymes and cofactors are required for an enzyme to properly catalyze a reaction. Answers may vary. Sample answer: Pyruvate dehydrogenase requires the cofactor magnesium.

4. Vitamin C (ascorbic acid) is a water-soluble vitamin that requires regular replenishment through diet. Deficiencies in vitamin C result in scurvy, characterized by the following symptoms: anemia, bleeding gums, decreased infection resistance, decreased wound-healing, easy bruising, gingivitis, nosebleeds, rough/dry/scaly skin, inflamed joints, and weakened tooth enamel. Over-consumption of vitamin C, though rare because the body does not store the molecule, can lead to upset stomach and diarrhea.

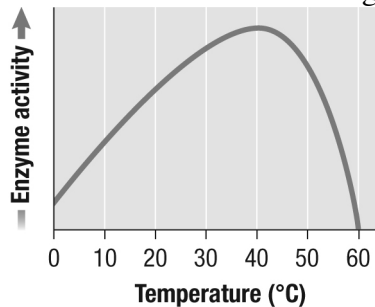
5. (a) As the concentration of enzyme increases, so does the rate of the reaction.



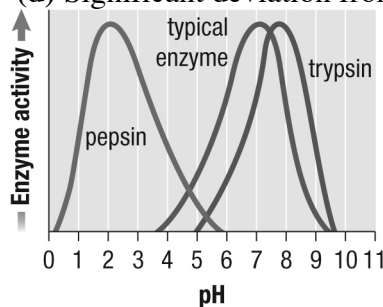
(b) The rate of a reaction will increase with increasing substrate concentration until the enzyme reaches its saturation level. At this point there is no change in the rate of the reaction.



(c) Temperature above the optimal point will slowly cause decrease of enzymatic activity and ultimately stop it at the point of denaturation; lower temperature will decrease the activity due to a decrease of available energy.



(d) Significant deviation from the optimal pH will cause enzyme denaturation.



6. A noncompetitive inhibitor binds to the enzyme at a site other than the active site. It changes the conformation of the enzyme so that it no longer binds its normal substrate. Answers may vary. Examples may vary. Sample answer: Alanine noncompetitively inhibits pyruvate kinase forming a feedback loop preventing more alanine production.

- 7.** Answers may vary. Sample answer: Since malonate is a competitive inhibitor, it binds to the active site of the enzyme and prevents the binding of the substrate, succinate.
- 8.** Answers may vary. Sample answer: The activator binds in such a way that it stabilizes the active conformation of the enzyme, and it is then able to better bind the substrate. An inhibitor stabilizes the inactive conformation of the enzyme, so it cannot bind to its normal substrate.
- 9.** The products of a reaction pathway inhibit the production of more products. Therefore, if there is too much product in the cell, the pathway is inhibited, and the resources needed for the intermediate steps in the pathway are not wasted.
- 10.** Maintenance of proper temperature and pH is important in providing optimal conditions for the body's enzymes to perform their activity.
- 11. (a)** A protease is an enzyme that begins protein catabolism by breaking the peptide bonds that link the amino acids in the polypeptide chain. This disrupts the gelatin and stops it from setting.
- (b)** Yes, you can use cooked or canned pineapple in gelatin because the cooking or canning process denatures and inactivates the proteases in the pineapple.
- 12.** As we age, it becomes harder to utilize the nutrients in our food due to loss of function of digestive enzymes. This can lead to malnutrition and/or digestive problems.
- 13.** Carbohydrates and proteins are broken down by hydrolysis into smaller subunits by the addition of water molecules. Without water, hydrolysis cannot happen, therefore, digestion cannot take place.