Year 12 Science: Enzymes and the factors that affect them

Name: _____ Date: _____

Try these without your notes first, then check the answer key.

Practice

1. An enzyme reaction gives off 30 cm³ of oxygen in 2 minutes. What is the average rate?

2. An enzyme is kept at 5 °C for an hour, then warmed to 37 °C. What happens to its activity, and why?

3. The rate has levelled off at a high substrate concentration. What happens to the rate if you double the substrate concentration again?

4. Which kind of inhibitor can be overcome by adding more substrate?

5. In the class's catalase results, how many times faster was the rate at 30 °C than at 10 °C?

Exam-style question: kiwifruit in jelly

Mere makes two jellies with gelatine, which is a protein. She stirs fresh kiwifruit into the first and canned kiwifruit into the second. Canning heats the fruit to a high temperature. The jelly with canned fruit sets, but the jelly with fresh fruit stays runny.

6. Describe what an enzyme is.

7. Explain why the jelly with fresh kiwifruit does not set, using the idea of the active site.

8. Explain why the jelly with canned kiwifruit does set.

9. Mere keeps fresh kiwifruit in the fridge at 4 °C for a week, then puts it in a jelly. Discuss whether this jelly will set, comparing the effects of low and high temperature on the enzyme.

Fix the mistake

10. Correct this statement: "At low temperatures the enzyme is denatured, so it stops working."

11. Correct this statement: "The enzyme dies at high temperatures."

12. Correct this statement: "The enzyme is used up in the reaction, so the rate slows down."

13. Correct this statement: "The active site and the substrate are the same shape."

Answer key (for parents and tutors)

1. An enzyme reaction gives off 30 cm^3 of oxygen in 2 minutes. What is the average rate?
   Rate = 30 cm^3 ÷ 2 min = 15 cm^3/min.
2. An enzyme is kept at 5 °C for an hour, then warmed to 37 °C. What happens to its activity, and why?
   Its activity returns: low temperature only slowed the molecules down and did not change the active site's shape.
3. The rate has levelled off at a high substrate concentration. What happens to the rate if you double the substrate concentration again?
   No change, because every active site is already occupied, so the enzyme concentration is limiting.
4. Which kind of inhibitor can be overcome by adding more substrate?
   A competitive inhibitor, because more substrate molecules win more of the collisions with the active site.
5. In the class's catalase results, how many times faster was the rate at 30 °C than at 10 °C?
   14 ÷ 4 = 3.5 times faster.
6. Describe what an enzyme is.
   An enzyme is a protein that acts as a biological catalyst, speeding up a reaction by lowering its activation energy without being used up (Achieved).
7. Explain why the jelly with fresh kiwifruit does not set, using the idea of the active site.
   Fresh kiwifruit contains actinidin, an enzyme whose active site fits the gelatine protein; the gelatine binds to form an enzyme–substrate complex and is broken into smaller pieces that cannot form the network that sets the jelly (Merit).
8. Explain why the jelly with canned kiwifruit does set.
   The high temperature of canning broke the bonds holding actinidin's shape, so its active site changed shape and the gelatine can no longer fit; the enzyme is denatured, so the gelatine stays whole and sets (Merit).
9. Mere keeps fresh kiwifruit in the fridge at 4 °C for a week, then puts it in a jelly. Discuss whether this jelly will set, comparing the effects of low and high temperature on the enzyme.
   The jelly will not set (Excellence for linking the ideas). At 4 °C the enzyme molecules moved slowly and collided with substrate less often, but their shape was not changed, so actinidin was not denatured; once the fruit is in the warm jelly mixture, the molecules collide more often and the active site still fits the gelatine, so the gelatine is broken down. The canned fruit's enzyme is different: denaturing changed its active site permanently, so it cannot recover even when cooled.
10. Correct this statement: "At low temperatures the enzyme is denatured, so it stops working."
    Low temperature only slows the enzyme by reducing collisions; it is not denatured and works again once warmed.
11. Correct this statement: "The enzyme dies at high temperatures."
    Enzymes are proteins, not living things: they are denatured, meaning the active site changes shape so the substrate cannot fit.
12. Correct this statement: "The enzyme is used up in the reaction, so the rate slows down."
    The enzyme is unchanged and reused; the rate slows because the substrate is being used up.
13. Correct this statement: "The active site and the substrate are the same shape."
    They are complementary shapes that fit together, like a key and its lock, not identical ones.