



ANSWER BOOK

Factors affecting enzyme rate: temperature, pH and concentration

Enzymes and metabolic control · Unit B03

AQA 3.1.4.2 · OCR A 2.1.4 (e)–(h) · Edexcel A Topic 1.8 · CAIE 3.2

6 questions · 19 marks

NAVY EDITION

SECTION A · Short, 1 to 2 marks

- A1** **B1** pepsin has an optimum of about pH 2 and works in the stomach. **B1** trypsin has an optimum of about pH 8 and works in the small intestine. [2]
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SECTION B · Standard, 3 to 5 marks

- B1** **B1** raising the temperature gives the molecules more kinetic energy, so substrate and active site collide more often and with more energy. **B1** more of those collisions are successful, so more enzyme-substrate complexes form and the rate roughly doubles for each 10 °C rise. **B1** above the optimum the increased vibration breaks the hydrogen bonds and ionic bonds holding the tertiary structure, so the enzyme denatures. **B1** the active site is then no longer complementary to the substrate, and denaturation proceeds far faster than a doubling per 10 °C, which is why the fall is steeper than the climb. [4]
- B2** **B1** substrate is being used up, so collisions between hydrogen peroxide and active sites become less frequent. **B1** product accumulates, and for many enzymes it competes for the active site or binds elsewhere and slows the reaction. **B1** a fraction of the enzyme denatures over a long warm run. **B1** she should compare initial rates, taken from the gradient of the tangent at time zero or from 1/time to a fixed early end point. [4]
- B3** **B1** a change in hydrogen ion concentration protonates or deprotonates the side chains, altering the charge they carry. **B1** ionic bonds between those side chains fail and hydrogen bonds are disrupted, so the tertiary structure shifts. **B1** the active site is a product of that structure, so its shape changes and the substrate is no longer complementary to it. [3]
- B4** **M1** Q10 is the rate at one temperature divided by the rate ten degrees lower, so 1.8 divided by 0.8. **A1** a Q10 of 2.25. **A1** a predicted rate of $1.8 \times 2.25 = 4.05$ μmol per minute at 30 °C. [3]
- B5** **B1** the rate climbs steeply from the origin and the climb then eases, before the curve levels off at a plateau. **B1** on the rising part the limiting factor is substrate concentration, because active sites are sitting empty and each extra substrate molecule finds one. **B1** at the plateau every active site is occupied, so the limiting factor is the number of active sites, set by the enzyme concentration. [3]
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