

## Demonstrate understanding of life processes at the cellular level.

### ENZYMES

**(2013: 2)**

The rate of photosynthesis is directly related to the availability of light. Normally, an increase in light intensity also leads to an increase in temperature. However, if the temperature gets too high, the rate of photosynthesis may decrease or even stop completely. Experiments have shown that if light is kept constant but temperature is varied independently, then the rate of photosynthesis can still be seen to change.

- (a) With reference to the structure and function of enzymes, and the conditions that they are best suited to, explain why the rate of photosynthesis varies with changes in temperature.

*Enzymes are biological catalysts that speed up the rate of reactions or allow reactions to take place in conditions where it would not otherwise be possible.*

*Enzymes function in specific conditions. Outside of these conditions, the enzymes will not function as well. A temperature that is too low means that substrate / enzyme collisions and interaction will be lower and therefore so will the rate of photosynthesis. As heat increases, there will be an optimum temperature for the functioning of the enzymes associated with photosynthesis in that particular plant. This will be the temperature at which the peak rate of photosynthesis occurs. Beyond (above) this temperature, the enzymes may become denatured, which makes them inactive. This latter reaction is irreversible.*

*They are denatured because of a change in the shape / structure of the active site, which can no longer fit the substrate(s) involved in the process.*

*Once the active site begins to distort, the rate of photosynthesis will decrease, as not as many interactions will be able to take place. If the enzymes become denatured, the rate of photosynthesis would decrease rapidly, and may stop altogether.*

**(2012:3)**

DNA replication is the starting point for cell division. In common with other cellular processes, the replication of DNA is reliant on the presence of a number of enzymes and the rate at which they can carry out their function.

The rate of enzyme activity can be affected by factors such as temperature, pH, substrate, concentration, co-enzymes and enzyme poisons.

Discuss how any THREE of these factors can change the rate of enzyme activity, and why this would be important in the case of DNA replication.

*Enzymes are biological catalysts that speed up the rate of reactions or allow reactions to take place in conditions where it would not otherwise be possible.*

*Enzymes function in specific conditions. Outside of these conditions the enzymes will not function as well.*

*Enzymes are proteins.*

*All enzymes have an optimum temperature. At very low temperatures the enzyme action is slow and at high temperatures the enzyme may become denatured which makes them inactive.*

*Enzymes have an optimal pH.*

● BIOLOGY

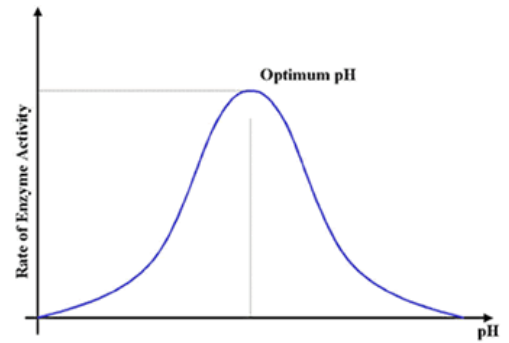
*DNA replication would occur at the greatest rate at the optimal pH.*

*Co-enzymes complete the active site and are therefore essential to enzyme action.*

*Poisons combine with the active site and prevent the enzyme functioning.*

*Substrate is the molecule on which an enzyme acts. The concentration of this will affect enzyme action – increase in substrate results in an increase in rate of reaction up to a maximum.*

*Enzymes are involved in each step of DNA replication and therefore the rate of DNA replication is dependent on the factors affecting enzyme action.*



**(2011: 2)**

- (a) Enzymes play an important role in most of the cellular functions that are carried out by organelles. Molecules can be broken down into smaller parts as well as the opposite process where molecules are joined together. These processes take place in organelles such as lysosomes and the Golgi body. Describe the function of these two organelles:
- (b) The term 'specific' can be used to describe the physical / chemical conditions in which an enzyme works, and the type of substrate on which it works. Explain this statement, with reference to one or more named examples.
- (c) Enzyme activity is rarely at a constant rate. The amount of enzyme available, the amount of substrate on which the enzymes can act, as well as the presence or absence of enzyme poisons or co-enzymes, are all factors that can change the rate of activity within a cell. Discuss the effect of any THREE of these factors on the rate of activity within animal or plant cells.

- (a) *Lysosomes are organelles that contain enzymes to break up / digest waste materials, cellular debris or food particles. Cells require lysosomes because they allow for digestion and then absorption of materials required by the cell and allows cells to remove wastes which may be toxic to the cell. Golgi bodies modify the newly synthesized proteins then process them and sort them for transportation. Cells need golgi bodies because the protein molecules made by the ribosomes are not ready for use by the cell and may require modification before they can carry out their function.*
- (b) *Enzymes can only work in certain conditions, such as the stomach enzymes working in a low pH. Enzymes only work on specific substrate(s), such as amylase only working on starch. Most enzymes only function on specific substrate(s) due to the precise nature of the active site. This is because the active site is a specific shape due to the arrangement of molecules. The shape is specific to the shape of the substrate molecule. Changes in condition such as pH, temperature etc. can change the nature of the active site, so that it will no longer 'fit' the target 'substrate'. Most enzymes only function on specific substrate(s) due to the precise nature of the molecular bond. The lock and key (may mention induced fit) nature of the active site is such that other 'non-target' molecules will not join with the enzyme and no catalytic action will be carried out.*
- (c)
- *Temperature – as the temperature increases the number of collisions between the enzymes and the substrate molecules will increase since both are moving more quickly. This results in an increased reaction rate since more collisions means more reactions are likely to occur.*

## ● BIOLOGY

- *Substrate – as more molecules collide, more can combine and this will increase the rate of reaction, until the available enzyme molecules become ‘saturated’ and the rate of reaction levels off (may use a diagram to show this).*
- *Enzyme – more availability of enzyme allows a greater number of reactions to take place so the overall rate of reaction increases. The actual enzyme activity does not increase (ie no change in product per unit time per unit mass of enzyme).*
- *Co-enzyme – these organic molecules alter the shape of the active site in such a way that it can effectively combine with the substrate(s). Without them the enzymes will not work, or do so at a very low rate of activity.*
- *Inhibitors are usually considered poisons because they alter or block the active site to prevent the enzyme-substrate complex forming. This results in decreased reaction rate within a cell.*

**(2010: 2)**

Discuss the structure and function of enzymes.

In your answer you should include:

- the reason(s) why the enzymes are important
- an explanation of TWO models of enzyme activity
- TWO factors that affect enzyme activity and how each factor is linked to the functioning of enzymes.

You may include diagrams to help you answer the question.

*Enzymes are biological catalysts which control the rate of reactions in organisms. They have an active site that can work in 2 ways. The lock and key model is where the substrate attaches to the enzyme at the active site. The reaction happens and the product(s) are released. However in the induced fit model, the active site changes slightly when combined with substrate. The enzyme returns to its ‘normal’ shape once the substrate / product is released.*

*How and why factors affect enzyme activity / active site:*

*Eg:*

- *Substrate – As there are more substrate molecules, more can combine with the enzyme and this will increase the rate of reaction. Until the available enzyme molecules become ‘saturated’ and the rate of reaction levels off.*
- *Co-enzyme – these organic molecules alter the shape of the active site in such a way that it can effectively combine with the substrate(s). Without them the enzymes will not work, or do so at a very low rate of activity.*
- *Enzyme – more availability of enzyme allows a greater number of reactions to take place /time so the overall rate of reaction increases. The actual enzyme activity does not increase (ie no change in product per unit time per unit mass of enzyme).*
- *Inhibitors are usually considered poisons because they alter or block the active site to prevent the substrate from binding to the active site.*
- *pH – which falls outside of the specific range / optimum pH of an enzyme can cause the active site to denature and change the shape of the active site.*
- *Temperature – as the temperature increases the enzyme activity also increases as more substrate bind to enzyme. Temperatures above the optimum temperature cause the enzyme to denature and change the shape of the active site.*

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**(2009: 2)**

Changes in temperature can alter the rate of activity of enzymes, which in turn affects the metabolic rate of an organism.

Discuss the reasons why enzyme activity is affected by temperature.

In your answer you should include:

- the structure of enzymes (you may use a labelled diagram to support your answer)
- the purpose of enzymes
- how enzymes work
- reasons for the different effects of temperature on enzymes.

**(2008: 2)**

Enzymes are found in both animals and plants, and have important roles in their metabolism.

- (a) Describe the general purpose of enzymes.
- (b) Explain the difference between the 'lock and key' and 'induced fit' models of enzyme activity. You may use diagrams in your answer if you wish.
- (c) Some of the factors that affect the rate of enzyme activity within cells include the amount of substrate, the enzyme concentration, coenzymes, and enzyme poisons (inhibitors).

Discuss how any THREE of these factors can change the rate of activity within cells.

**(2007: 2)**

Chemical reactions in living organisms are made possible by the action of enzymes. Enzymes are usually specific in terms of the conditions they operate in, and the substrates they act upon.

- (a) Use the structure of enzymes to explain why they are usually specific to the substrates they act upon.
- (b) Discuss the effect of temperature on the activity of an enzyme. (You may include a diagram in your answer if you wish.)

**(2006: 2)**

Bread can be made by mixing flour, water, salt, sugar and a small amount of yeast. Carbon dioxide is produced from the fermentation of simple sugars. Fermentation is controlled by enzymes from the yeast.

- (a) Explain why the shape of an enzyme is important for the way it functions. (You may use a diagram to help with your explanation.)
- (b) In relation to enzyme structure, describe why the enzyme will not function at 45°C.

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Researchers have investigated the effect of temperature on yeast activity. The following table is a summary of their results.

Temperature	Fermentation
-20°C	No fermentation
27°C–38°C	Optimum Fermentation range
35°C	Optimum fermentation temperature

Temperature	Cell division
Less than 20°C Greater than 40°C	Cell division significantly reduced
20°C–27°C	Most favourable range for yeast to multiply
26°C	Optimum temperature for multiplication of yeast
Greater than 60°C	Nil

Between two and three hours are needed for the yeast to ferment the dough before it is baked in an oven.

- (c) Discuss, with respect to the number of yeast cells and the fermentation rate, why it is important to have the temperature at:
- 26°C for the first hour and
  - 35°C for the next two hours, before the dough is baked.

If the concentration of simple sugars is greater than 6% of the flour, the rate of fermentation is slowed because there is less water inside the yeast cell.

- (d) Explain how the increase in concentration of sugar will slow the rate of fermentation in the yeast cell. (You may use a diagram to help with your explanation.)

Heavy metals, such as mercury and lead, are enzyme inhibitors.

- (e) Explain how an enzyme inhibitor affects enzyme activity. (You may use a diagram to help with your explanation.)