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VCE Biology ¾

Proteins, Protein Export & Enzymes [0.5]

Workshop

Section A: Multiple Choice Questions (21 Marks)

Question 1 (1 mark)

Following translation, the insulin peptide is activated when an enzyme cuts a linking peptide chain that connects insulin's A-chain to its B-chain. This suggests that insulin is a:

A. Primary structure peptide.

B. Secondary structure protein.

C. Tertiary structure protein.

D. Quaternary structure protein.

Question 2 (1 mark)

The primary structure of a protein is described as:

A. The sequence of amino acids in a peptide.

B. The three-dimensional arrangement of a polypeptide chain.

C. The closely packed arrangement of several polypeptide chains.

D. Containing the alpha helixes, beta pleated sheets and random coils.

Question 3 (1 mark)

The correct pathway for the production and secretion of a protein in a cell is:

A. Ribosome, endoplasmic reticulum, Golgi apparatus, exocytosis.

B. Endocytosis, ribosome, Golgi apparatus, endoplasmic reticulum.

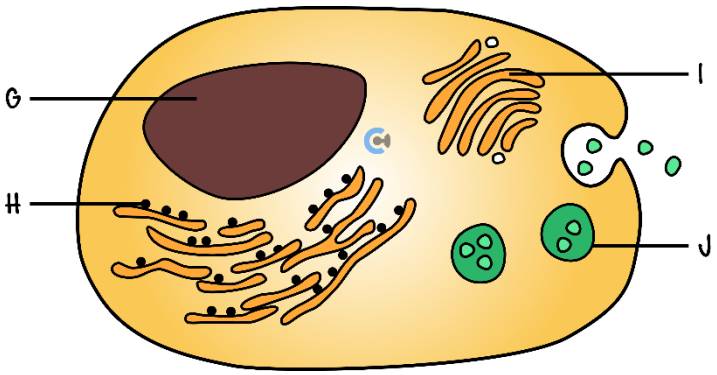
C. Endoplasmic reticulum, ribosome, Golgi apparatus, endocytosis.

D. Golgi apparatus, ribosome, endoplasmic reticulum, exocytosis.

Space for Personal Notes

Question 4 (1 mark)

The diagram below represents a cell secreting a protein into the extracellular environment. Structures G-J are part of this process.



In which order are structures G-J involved in the secretion of proteins?

A. G, H, I, J

B. J, I, H, G

C. H, J, G, I

D. I, G, J, H

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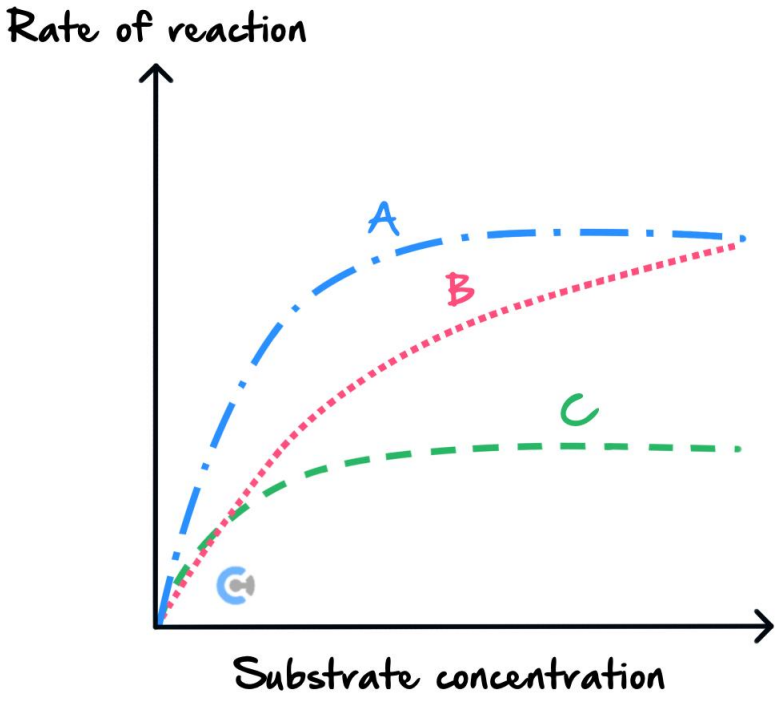
Question 5 (1 mark)

Enzyme CYP3A4 is responsible for metabolising the drug codeine, shown as *A* in the figure below. Grapefruit juice binds irreversibly with this enzyme, limiting the effectiveness of the drug.



Identify the correct statement from the options below.

A. Graph *B* represents the effect of grapefruit juice on codeine.

B. Graph *C* represents the effect of grapefruit juice on codeine.

C. Graph *B* represents the effect of grapefruit on CYP3A4.

D. Graph *C* represents the effect of grapefruit on CYP3A4.

Question 6 (1 mark)

The primary sequence of amino acids is bonded together by:

A. Hydrogen bonds.

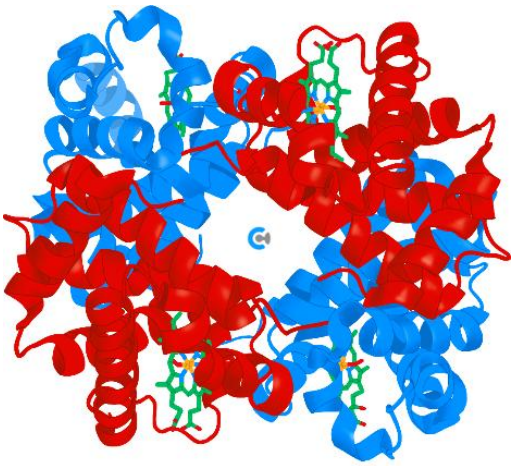
B. Ionic bonds.

C. Glycosidic bonds.

D. Peptide bonds.

Question 7 (1 mark)

Haemoglobin is a protein consisting of four peptide subunits.



The haemoglobin molecule

The protein structure can be described as a:

A. Primary structure.

B. Secondary structure.

C. Tertiary structure.

D. Quaternary structure.

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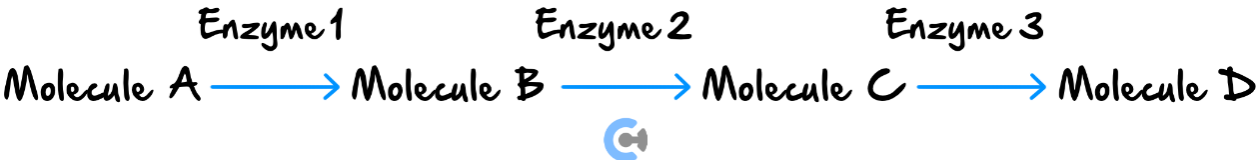
The following information applies to the two questions that follow.



Question 8 (1 mark)

Identify what would happen to the rate of production of molecule *D* if enzyme 1 was not present.

A. It would increase.

B. It would decrease.

C. It would stop.

D. It would be unchanged.

Question 9 (1 mark)

Identify how the rate of production of molecule *D* would be affected if the concentration of enzyme 1 was increased but the concentration of enzymes 2 and 3 remained unchanged.

A. It would increase.

B. It would decrease.

C. It would stop.

D. It would be unchanged.

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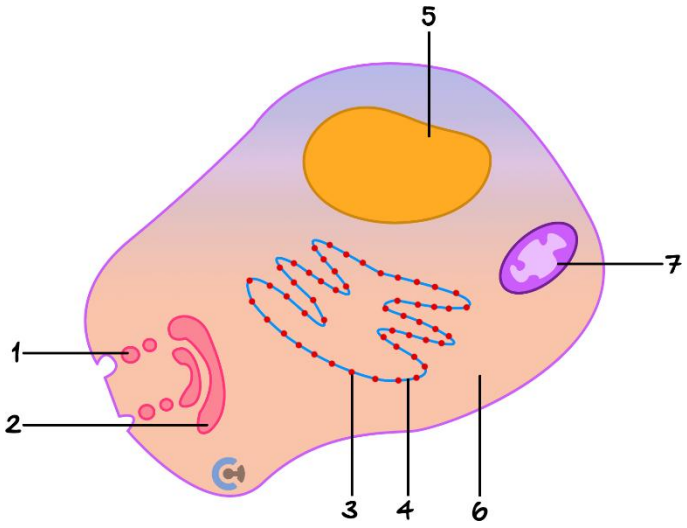
Question 10 (1 mark)

The following diagram shows a typical secretory cell, such as the β-cell that secretes the insulin protein and is found in the pancreas. The organelles labelled 1-7 in the diagram are the components of the cell that are involved in the synthesis, internal transport, modification, packaging and export of the substance being secreted from the cell.



In which order are the organelles directly involved in the synthesis, internal transport, modification, packaging and export of insulin?

A. 1, 2, 3, 4, 5

B. 3, 4, 2, 1

C. 7, 6, 5, 2, 1

D. 5, 3, 2, 1

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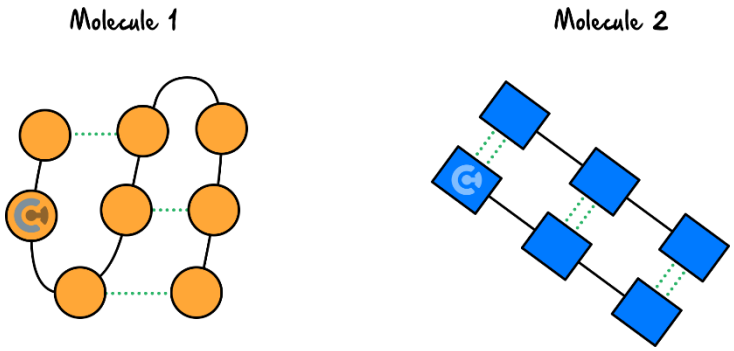
Question 11 (1 mark)

The diagram below shows two biomolecules.



Molecule 1 contains:

A. R-groups.

B. Complementary pairing.

C. Phosphate groups.

D. Antiparallel strands.

Question 12 (1 mark)

The primary structure of a protein is important because it:

A. Is the active, functional form of the protein.

B. Has a very specific three-dimensional shape.

C. Influences the way that the polypeptide folds.

D. Directly controls the way proteins are transported into a cell.

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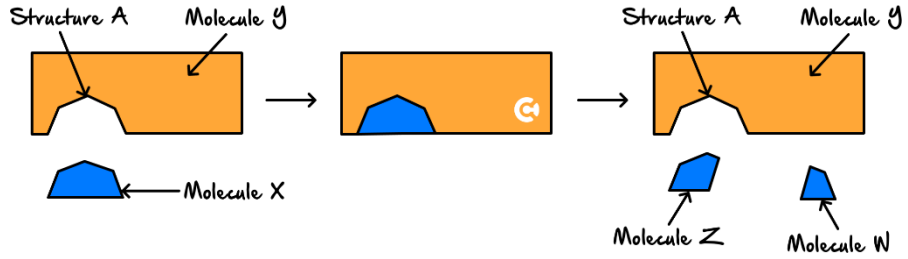
The following information applies to the two questions that follow.

The diagram below represents a generalised biochemical process.



Question 13 (1 mark)

Which one of the following statements is correct?

A. Molecule *Y* represents the substrate.

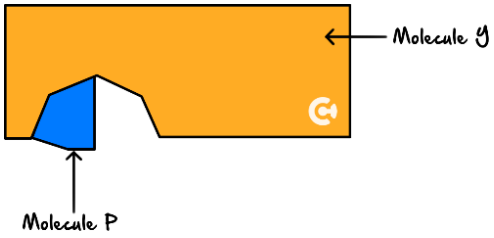
B. Molecule *X* represents an enzyme.

C. Structure *A* is an active site.

D. Molecule *Z* is a reactant.

Question 14 (1 mark)

Another molecule, Molecule *P*, can bind to part of the Structure *A* of Molecule *Y*, as shown below.



Consider a mixture containing molecules of *X*, molecules of *Y* and molecules of *P*. The rate of production of a molecule *Z* and molecule *W* is measured and found to change in the presence of a molecule *P*. In the presence of a molecule *P*, increasing the concentration of a molecule *X* increases the rate of production of a molecule *Z* and molecule *W*.

Which one of the following statements is correct?

A. Molecule *X* changes shape in the presence of Molecule *P*.

B. Molecule *P* is considered a reversible inhibitor.

C. Molecule *Y* is denatured by Molecule *P*.

D. Molecule *P* is made from monomers of nucleotides.

Question 15 (1 mark)

A condensation reaction between two amino acids will produce:

A. Monomers.

B. Water.

C. Energy.

D. DNA.

Question 16 (1 mark)

The proteome can best be described as:

A. All of the proteins that a cell can produce.

B. All of the genes in a cell.

C. Only the proteins that are needed by the organism.

D. The complete array of the gene pool.

Question 17 (1 mark)

When comparing the genome with the proteome of an organism, it is appropriate to say:

A. The genome and the proteome in a particular cell are the same.

B. The proteome controls the genome within the organism.

C. All of the instructions from the genome are transferred to the proteome at some stage within the organism.

D. The genome in each cell in a particular organism is the same but the proteome is different.

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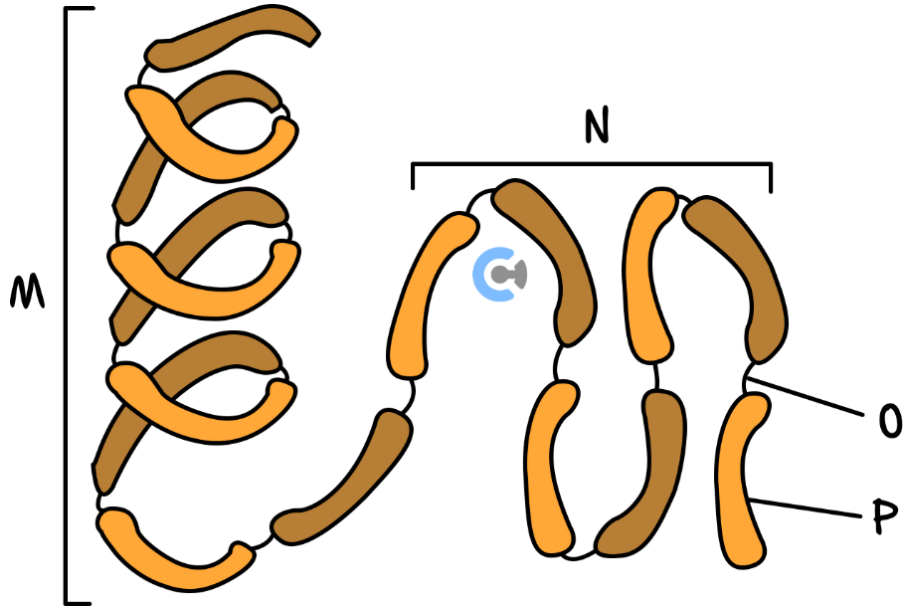
Question 18 (1 mark)

The diagram below shows a globular protein.



Which of the following correctly identifies structures M to P?

	M	N	O	P
A.	α-helix	β sheet	Peptide bond	Amino acid
B.	β sheet	α-helix	Hydrogen bond	Nucleotide
C.	β sheet	α-helix	Amino acid	Peptide bond
D.	α-helix	β sheet	Peptide bond	Nucleotide

Question 19 (1 mark)

Given the critical role of haemoglobin in oxygen transport, how might a mutation affecting the primary structure of haemoglobin impact its function?

A. It could change the protein's three-dimensional shape, impairing oxygen binding.

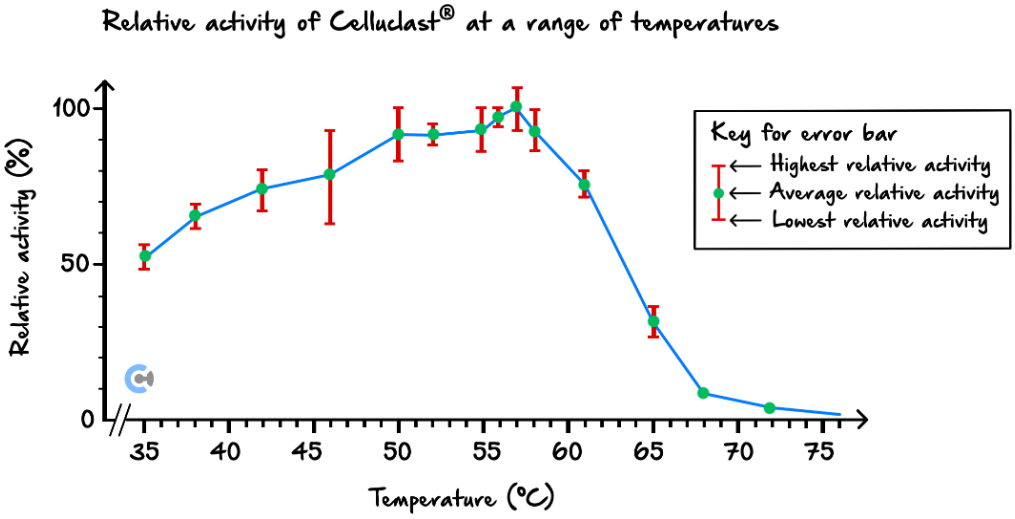
B. It would have no effect since primary structure does not affect function.

C. It could enhance oxygen transport by increasing haemoglobin flexibility.

D. It would prevent haemoglobin from being exported out of the cell.

Question 20 (1 mark)

Celluclast® is an enzyme. The activity of Celluclast® at a range of temperatures and at a pH of 5 was measured. The experiment was repeated five times. The relative activity (%) of Celluclast® was calculated and plotted on a graph, as shown below. The range of the calculated measurements at each temperature is shown as an error bar on the graph.



Source: J Herlet et al.,'A new method to evaluate temperature vs pH activity profiles for biotechnological relevant enzymes', Biotechnology for Biofuels,10,234(2017),<https://doi.org/10.1186/s13068.017-0923-9>

It is reasonable to conclude that:

A. Celluclast® is inactive at 61°C.

B. Celluclast® is denatured at 35°C.

C. The optimum pH for Celluclast® is pH 5.

D. The optimum temperature for Celluclast® is around 57°C.

Question 21 (1 mark)

The error bars on the graph shown above indicate that the measurements taken at:

A. 38°C were more valid than at 35°C.

B. 52°C were more precise than at 46°C.

C. 46°C were more accurate than at 55°C.

D. 58°C had more random errors than at 42°C.

Section B: Short Answer Questions (61 Marks)

Question 22 (2 marks)

Describe the difference between the tertiary and the quaternary structure of proteins.

Question 23 (2 marks)

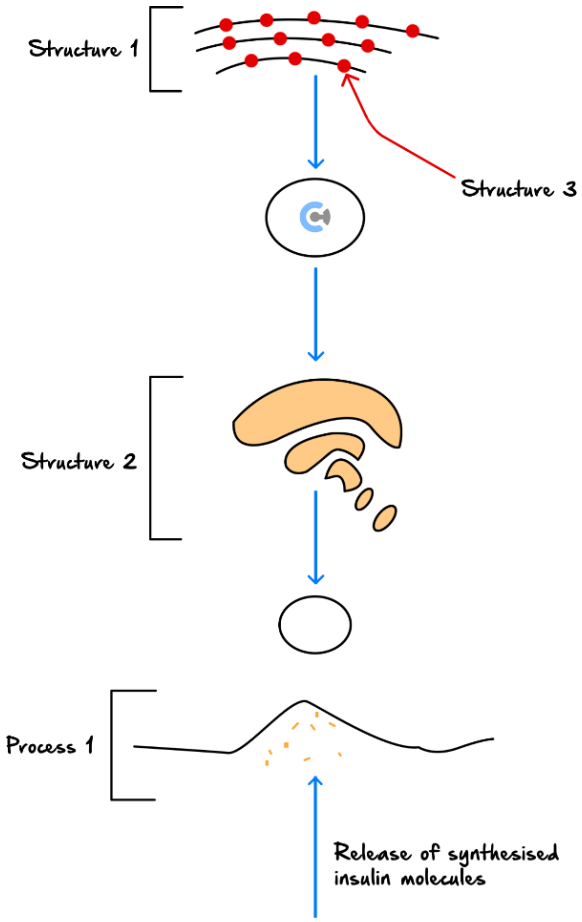
Explain what is meant by the 'proteome' and account for the functional diversity of proteins.

Question 24 (2 marks)

Will all cells within an organism have the same proteome? Explain your answer.

Question 25 (10 marks)

The human insulin protein is secreted by pancreatic cells and functions to enable the cellular uptake of glucose essential for the process of cellular respiration. The figure below is a simplified outline that shows the production of insulin in a cell.



a. Name and outline the role of Structures 1 and 2 in the process shown in **the figure.** (4 marks)

b. Name Process 1 in **the given figure.** (1 mark)

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_____

c.

i. Name Structure 3 in **the given figure.** (1 mark)

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_____

ii. Identify and briefly describe the process that occurs at this structure in relation to human insulin production. (4 marks)

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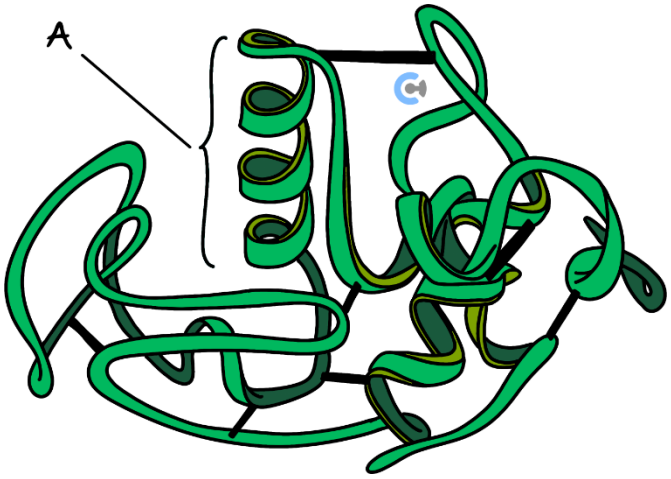
Question 26 (8 marks)

Lipase is an enzyme that catalyses the hydrolysis of triglycerides. It is a soluble globular protein. The function of an enzyme depends upon the precise nature of its tertiary structure. The diagram below represents the structure of an enzyme. The black strips represent the disulphide bonds that help to stabilise its tertiary structure.



a. What is this secondary structure called? (1 mark)

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b. Explain why the function of an enzyme depends upon the precise nature of its tertiary structure. (2 marks)

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c. Describe the effect of breaking the bonds between the R groups of the amino acids of the protein on lipase function. (2 marks)

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d. After being synthesised, lipase is released from mast cells via exocytosis.

Complete the table below by naming three different organelles directly associated with the transport of the synthesised lipase within or from mast cells and state the role of each organelle in this process. (3 marks)

Organelle	Role

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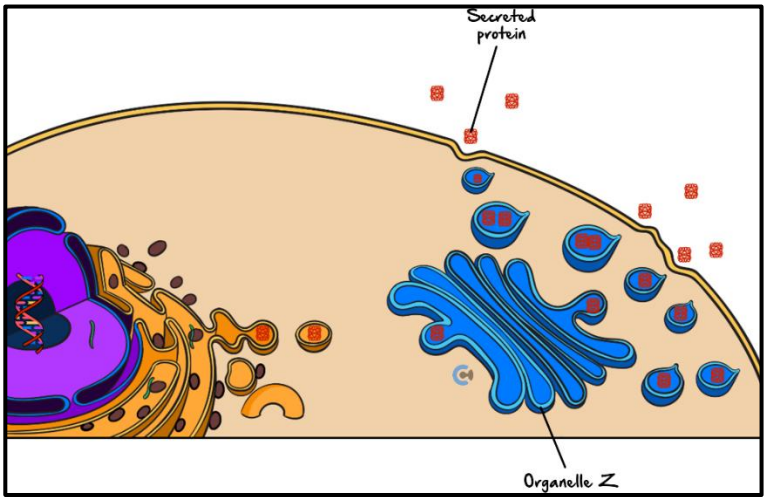
Question 27 (7 marks)

This diagram shows a human cell secreting a protein.



a. Where, specifically, is the polypeptide of this protein synthesised in this cell? (1 mark)

b. Briefly describe the process by which this polypeptide is synthesised. (3 marks)

c. What is an organelle Z? Describe its function in protein secretion. (2 marks)

d. By what process does the protein exit the cell? (1 mark)

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Question 28 (7 marks)

Baker's yeast (Saccharomyces cerevisiae) is a unicellular, eukaryotic organism. Biologists have studied its proteome. A single yeast cell contains approximately 100000 different proteins.

a. Consider the 100000 different proteins. The concentration of each protein may change with a change in environmental conditions.

Give **one** example of a **type** of protein within a yeast cell that may change in concentration and explain why this change is necessary. (3 marks)

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b. Explain how yeast could produce over 100,000 different proteins from 20,000 genes. (2 marks)

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c. What is the functional difference between a regulatory gene and a structural gene? (2 marks)

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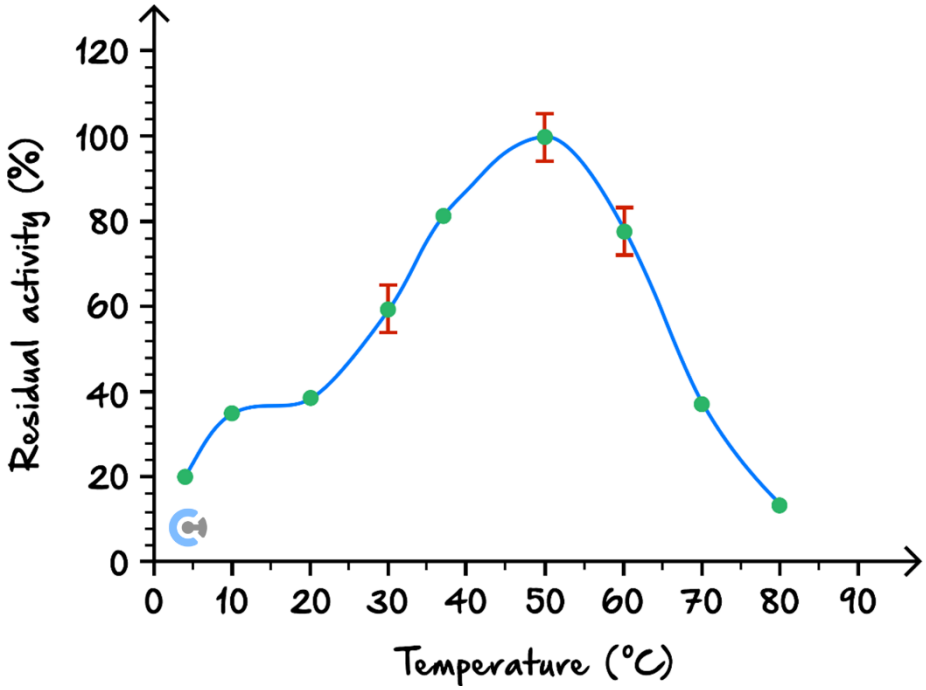
Question 29 (13 marks)

In the human body, the enzyme amylase is found in both saliva and the digestive tract, and is responsible for catalysing the hydrolysis of starch to maltose. This maltose is then broken down by the enzyme maltase to become glucose, which is the most common energy source for a cell in the body.

Some students, upon hearing about amylase being an enzyme, wanted to investigate the impact of different factors on the rate at which amylase hydrolyses starch.

The following results are achieved when comparing the activity of amylase at different temperatures.



a. Explain and compare how enzymes work to catalyse reactions using the lock and key model and induced fit model. Include diagrams in your answer. (4 marks)

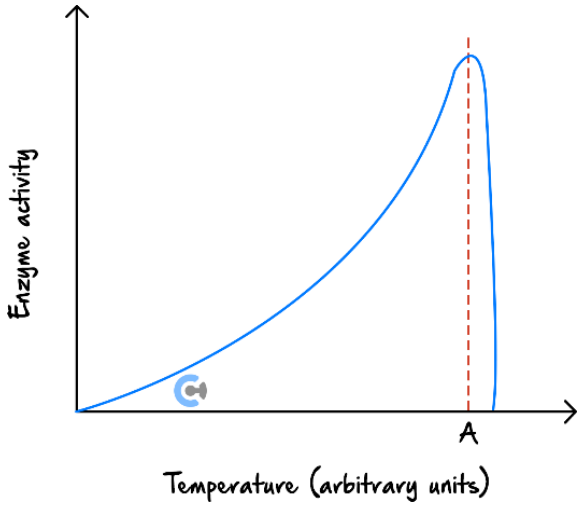
b. Explain the shape of the graph generated. (3 marks)

c. How might this graph look different if the students were investigating the impact of pH? Use a diagram in your response. (3 marks)

d. Describe how non-competitive inhibitors impact the rate of enzyme function. (3 marks)

Question 30 (7 marks)

Below is a graph showing how enzyme activity changes with temperature.



a. For most mammalian enzymes, what is the temperature at *A*? (1 mark)

b. Explain the shape of the graph. (2 marks)

c. Referring to the graph, explain how food is preserved by refrigeration. (2 marks)

d. In order to store vegetables, such as carrots, for long periods, they are first 'blanched' (boiled for a few seconds) and then deep frozen.

Referring to the graph, explain how this method works. (2 marks)

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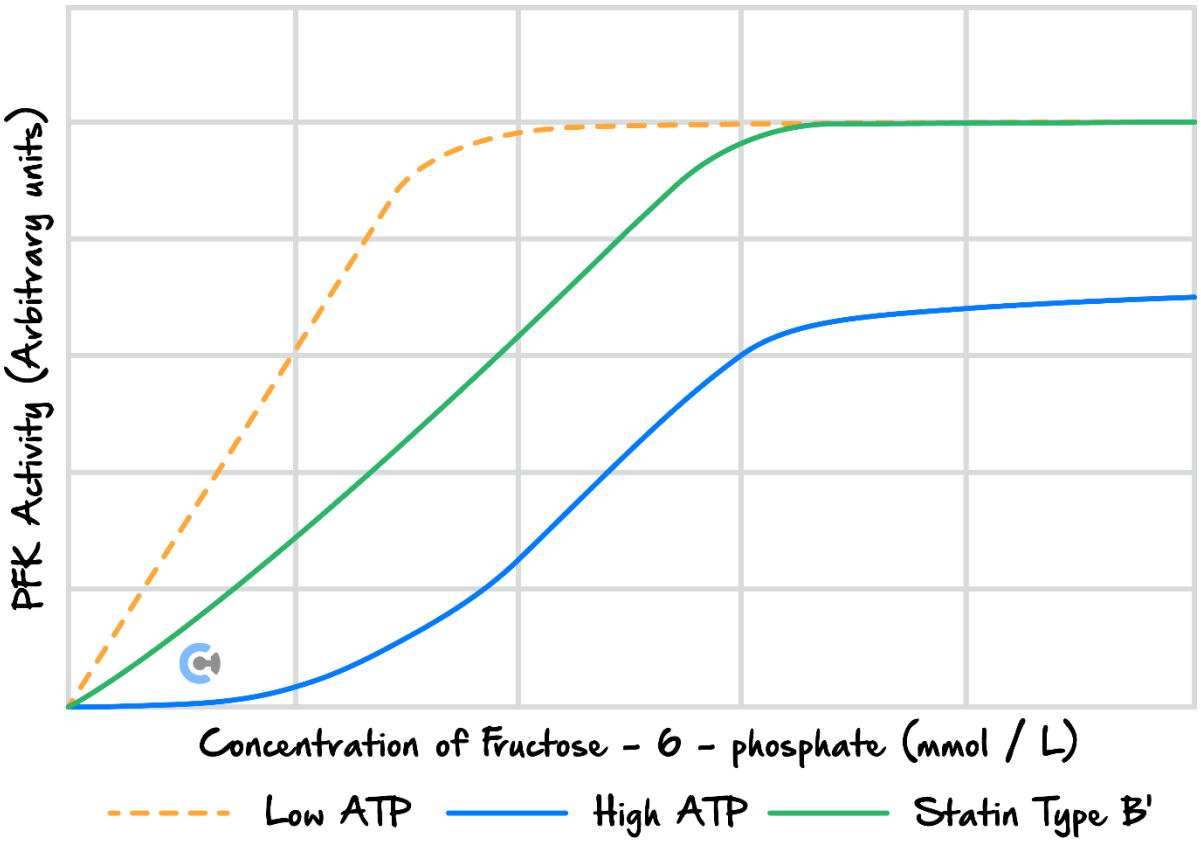
Question 31 (3 marks)

The diagram below shows one of the reactions that occur during the regulation of cholesterol synthesis. The enzyme **HMG-CoA reductase** is responsible for catalysing the conversion of HMG-CoA into mevalonate, a key step in the cholesterol biosynthesis pathway. ATP and statins both act as allosteric inhibitors of HMG-CoA reductase. Statins type B can act as active inhibitors of HMG-Coa reductase.

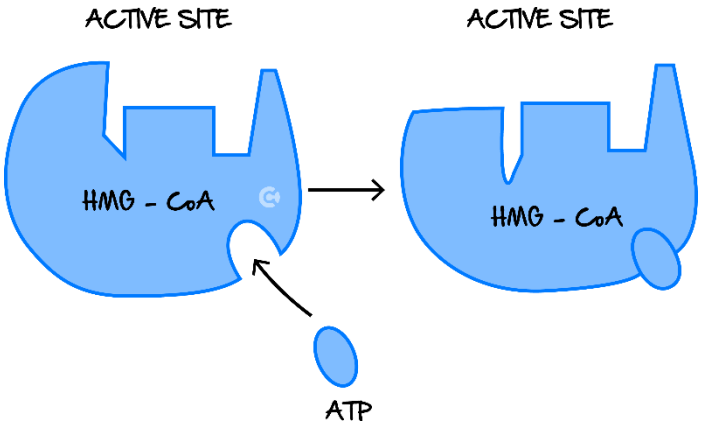
During cholesterol synthesis, the following reactions occur:

Acetyl-CoA → HMG-CoA → Mevalonate → Cholesterol

An experiment was conducted to determine the effect of ATP on HMG-CoA reductase activity and the results are shown on this graph.



A student draws the following diagrams to illustrate the effect of ATP on HMG-CoA reductase.



Does this diagram accurately convey the role of ATP in HMG-CoA reductase regulation?
Circle the correct answer: Yes / No.

Explain your answer:

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