AQA A-LEVEL · 7402

BIOLOGY



EXAM QUESTION PACK

3.1.4 PROTEINS AND ENZYMES

SCORE	PERCENTAGE
/995	%

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Q1.

(a) Describe how a peptide bond is formed between two amino acids to form a dipeptide.

(2)

(b) The secondary structure of a polypeptide is produced by bonds between amino acids.

Describe how.

(2)

(c) Two proteins have the same number and type of amino acids but different tertiary structures.

Explain why.

(2)

(Total 6 marks)

Q2.

(a) What is digestion?

(2)

One species of fungus digests cellulose using two types of enzyme, endocellulases and exocellulases.

Endocellulases act in the middle of the cellulose molecule and exocellulases act at the ends of the cellulose molecule.

(b) Endocellulases and exocellulases act at different places on cellulose molecules.

Suggest why.

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(2)

A scientist prepared the following mixtures:

- 15 g cellulose with 0.2 mol dm^{-3} endocellulase
- 15 g cellulose with 0.2 mol dm^{-3} exocellulase
- 15 g cellulose with 0.2 mol dm^{-3} endocellulase and 0.2 mol dm−3 exocellulase.

The mixtures had identical total volumes. She determined the mass of cellulose remaining after 48 hours.

Her results are shown in the table.

Time / hours	**Mass of cellulose remaining / g**		
	Endocellulase	**Exocellulase**	**Endocellulase + exocellulase**
48	11.9	14.8	9.2

(c) Use information from the table to calculate the rate of digestion of cellulose when both enzymes are present.

Give your answer in g min^{-1} and in standard form.
Show your working.

Answer = _____ g min^{-1}

(2)

(d) The scientist used the same concentration of endocellulase and exocellulase in the mixtures. The rate of digestion of cellulose is greatest when both enzymes are present.

Suggest why.

(2)

(e) The scientist could have expressed her results as the percentage loss in mass of cellulose.

In the space, write the equation for calculating the percentage loss in mass.

(1)

(Total 9 marks)

Q3.

(a) Formation of an enzyme-substrate complex increases the rate of reaction.

Explain how.

(2)

(b) A scientist measured the rate of removal of amino acids from a polypeptide with and without an enzyme present. With the enzyme present, 578 amino acids were released per second. Without the enzyme, 3.0×10^{-9} amino acids were released per second.

Calculate by how many times the rate of reaction is greater with the enzyme present.
Give your answer in standard form.

Answer = _____ times faster

(2)

Another scientist investigated an enzyme that catalyses the following reaction.

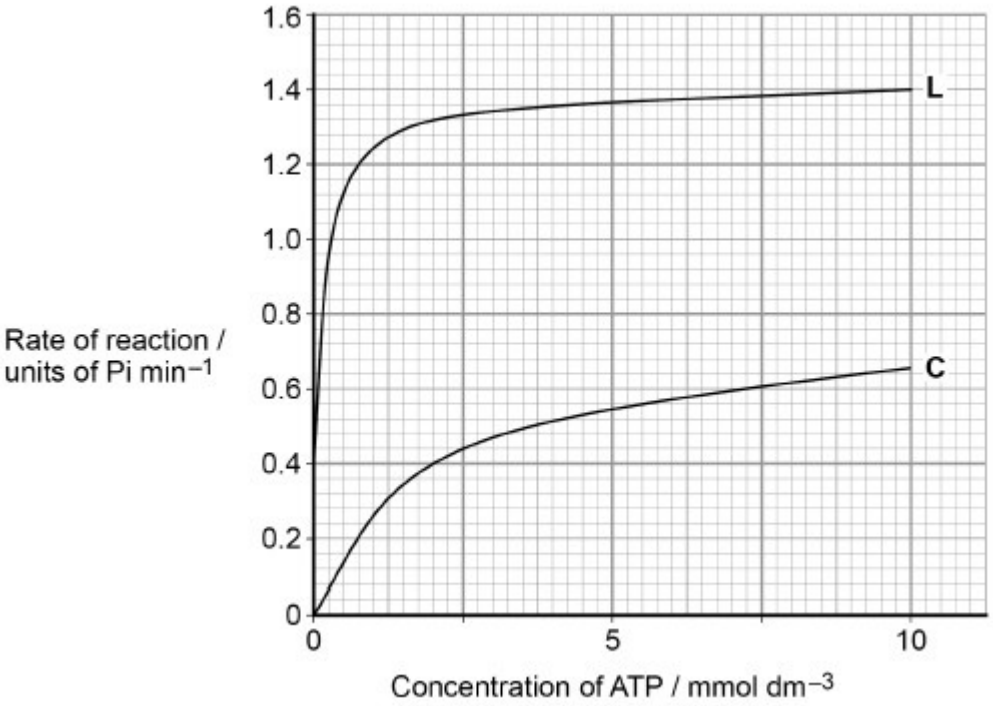
$$ATP \longrightarrow ADP + Pi$$

The scientists set up two experiments, **C** and **L**.

Experiment **C** used
- the enzyme
- different concentrations of ATP.

Experiment **L** used
- the enzyme
- different concentrations of ATP
- a sugar called lyxose.

The scientists measured the rate of reaction in each experiment. Their results are shown in the graph.



(c) Calculate the rate of reaction of the enzyme activity with no lyxose at 2.5 mmol dm^{-3} of ATP as a percentage of the maximum rate shown with lyxose.

Answer = _____ %

(2)

(d) Lyxose binds to the enzyme.

Suggest a reason for the difference in the results shown in the graph with and without lyxose.

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(3)

(Total 9 marks)

Q4.

(a) Draw the general structure of an amino acid.

(1)

Table 1 shows mRNA codons and the amino acids coded for by each codon. It also shows some properties of the R group of each amino acid.

Table 1

1st base	2nd base				3rd base
	U	C	A	G	
U	Phe	Ser	Tyr	Cys	U
					C
	Leu		Stop	Stop	A
				Trp	G
C	Leu	Pro	His	Arg	U
					C
			Gin		A
					G
A	Ile	Thr	Asn	Ser	U
					C
			Lys	Arg	A
	Met				G
G	Val	Ala	Asp	Gly	U
					C
			Glu		A
					G

Key to the properties of the R group of each amino acid

No overall change Positively charged Negatively charged

(b) The genetic code is described as degenerate.

What is meant by this? Use an example from **Table 1** to illustrate your answer.

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(2)

A scientist investigated changes in the amino acid sequence of a human enzyme resulting from mutations. All these amino acid changes result from single base substitution mutations.
This enzyme is a polypeptide 465 amino acids long.

Table 2 shows the result of three of the base substitutions.

Table 2

Amino acid number	Correct amino acid	Amino acid inserted as a result of mutation
203	Val	Ala
279	Glu	Lys
300	Glu	Lys

(c) What is the minimum number of bases in the gene coding for this polypeptide?

Answer = _____

(1)

(d) Use information from **Table 1** to tick (✔) one box that shows a single base substitution mutation in DNA that would result in a change from Val to Ala at amino acid number 203

CAA ⟶ CGA ☐

GUU ⟶ GCA ☐

GUU ⟶ GUC ☐

CAC ⟶ CGG ☐

(1)

(e) A change from Glu to Lys at amino acid 300 had no effect on the rate of reaction catalysed by the enzyme. The same change at amino acid 279 significantly reduced the rate of reaction catalysed by the enzyme.

Use all the information and your knowledge of protein structure to suggest reasons for the differences between the effects of these two changes.

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(3)

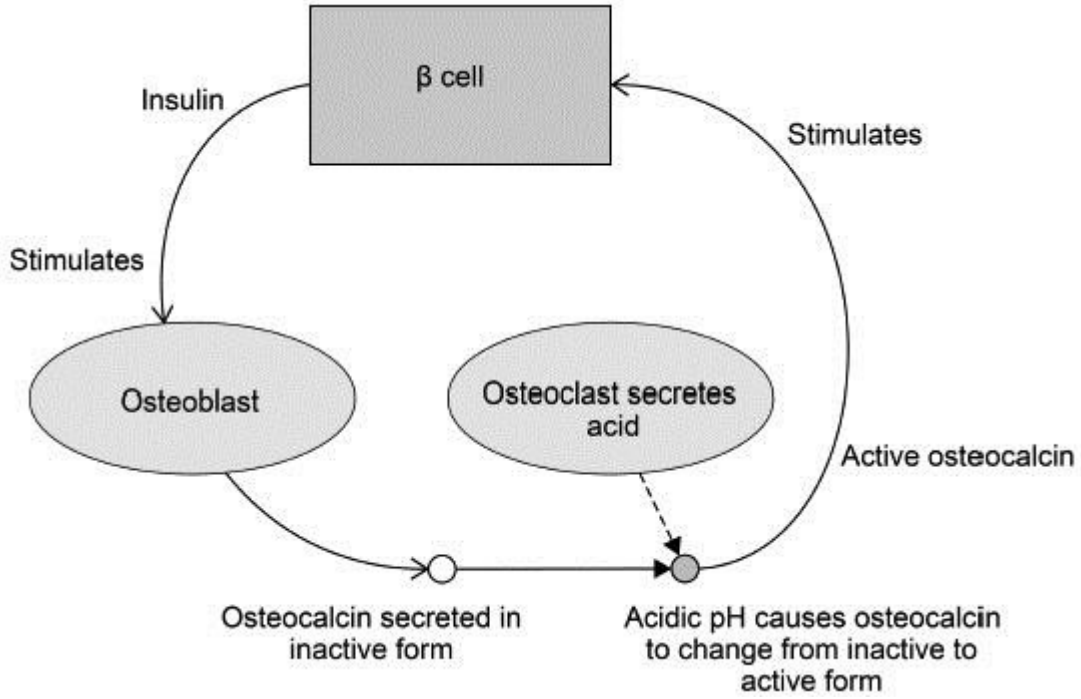
(Total 8 marks)

Q5.

Broken bones are repaired by cells called osteoclasts and osteoblasts.

Osteoblasts secrete a hormone called osteocalcin in an inactive form. Osteocalcin is a protein. The active form of osteocalcin binds to a receptor on beta (β) cells in the pancreas, stimulating them to release insulin. Osteoblasts have receptors for insulin.

The diagram shows how the production of osteocalcin by osteoblasts is controlled by positive feedback.



(a) The secretion of osteocalcin (in an inactive form) by osteoblasts is controlled by positive feedback.

Use information from the diagram to explain why this is positive feedback.

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(2)

(b) The acidic pH conditions created by osteoclasts cause the inactive form of the protein osteocalcin to change into the active form of osteocalcin.

Suggest how.

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(2)

(c) Binding of insulin leads to an increase in the rate of respiration in cells such as osteoblasts.

Explain how.

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(2)

(Total 6 marks)

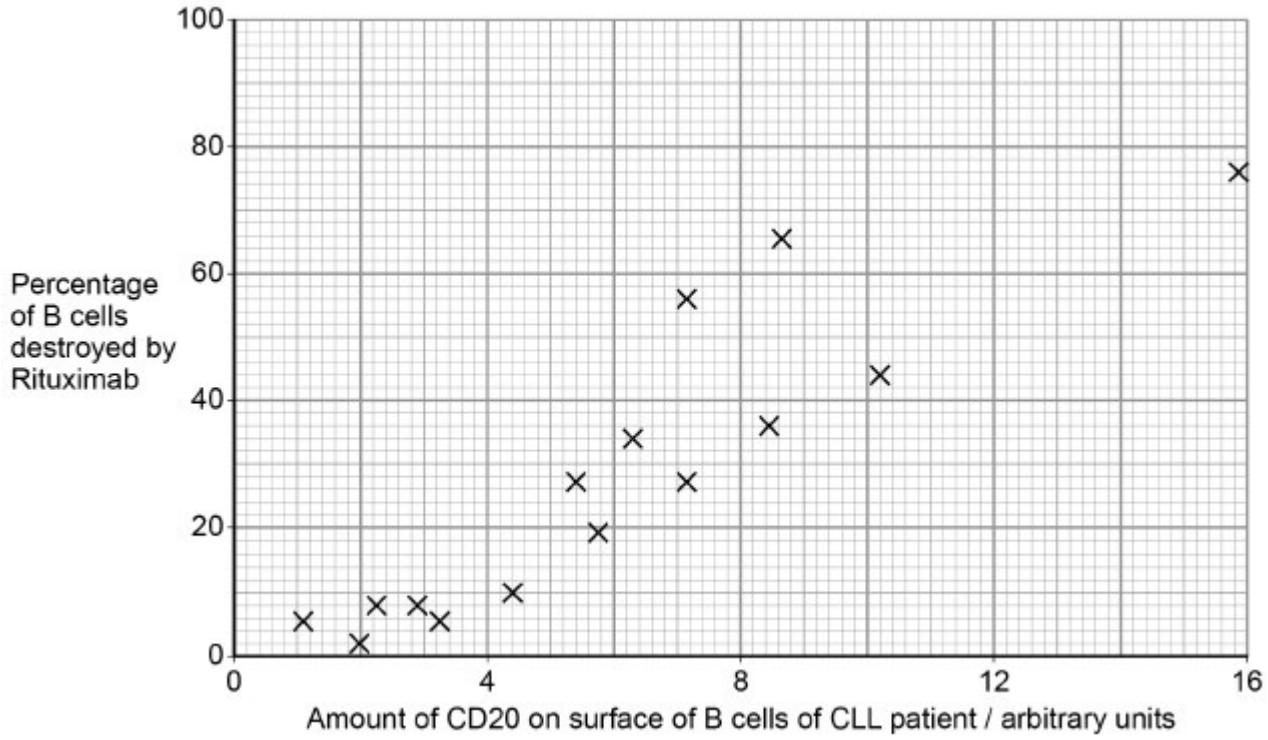
Q6.

Chronic lymphocytic leukaemia (CLL) is a cancer that affects some B cells of a person's immune system.

Rituximab is a drug used to treat CLL. It binds to a protein called CD20 on the surface of B cells. If enough Rituximab binds to a B cell, it can kill the cell. Rituximab kills **both** healthy **and** cancerous B cells. The body then produces new B cells.

The amount of CD20 on the surface of B cells varies from one person to another. Doctors investigated the relationship between the amount of CD20 on the B cells of a patient and the percentage of B cells destroyed by Rituximab.

The graph shows the doctors' results. Each cross is the result for one patient.



(a) What statistical test could the scientists have used to determine whether there was a significant relationship between the amount of CD20 on the surface of B cells and the percentage of B cells destroyed by Rituximab?
Give a reason for your answer.

Name of test _____

Reason _____

_____

_____

_____

(1)

(b) From these data, what can you conclude about the effectiveness of Rituximab in treating patients with CLL?

Do **not** include considerations of statistical analyses in your answer.

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(3)

Approximately 11 percent of people with CLL also have mutations of a gene called *NOTCH1*. This leads to production of a non-functional transcription factor associated with CD20 production.

The doctors determined the median percentage of B cells destroyed by Rituximab in people with CLL who had the *NOTCH1* mutation and those who did not.

The doctors' results are shown in the table.

	Median percentage of B cell destroyed by Rituximab
In people with CLL who had the *NOTCH1* mutation	**4**
In people with CLL who did **not** have *NOTCH1* mutation	**22**

(c) Human blood contains (approximately) 1.0×10^9 B cells per dm^3.

Use the median values in the table to calculate the difference between the number of B cells per dm^3 in the blood of people treated with Rituximab with the *NOTCH1* mutation and people without the *NOTCH1* mutation.

Express your answer in standard form. Show your working.

_____ cells per dm^3

(2)

(d) Use all of the information to suggest how the mutation of *NOTCH1* led to the difference in the percentage of B cells destroyed by Rituximab.

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(3)

(Total 9 marks)

Q7.

Scientists measured the mean amino acid concentration in white wines made from grapes grown organically and white wines made from grapes that were not grown organically.

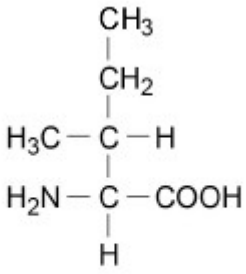
(a) Which test could the scientists have used to identify that there are amino acids in white wine?

_____

(1)

(b) All amino acids have the same general structure. The image below shows the structure of the amino acid isoleucine.

Draw a box around the part of the molecule that would be the same in all amino acids.



Isoleucine

(1)

(c) Name the chemical element found in all amino acids that is **not** found in triglycerides.

_____

(1)

(d) The scientists used a statistical test to determine whether there was a significant difference in the amino acid concentration in the two types of white wine. They obtained a value for P of 0.04.

Name the statistical test the scientists used and give a reason for your answer.

Was the difference significant? Give a reason for your answer.

Name of statistical test _____

Reason for choice _____

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Explanation of test result _____

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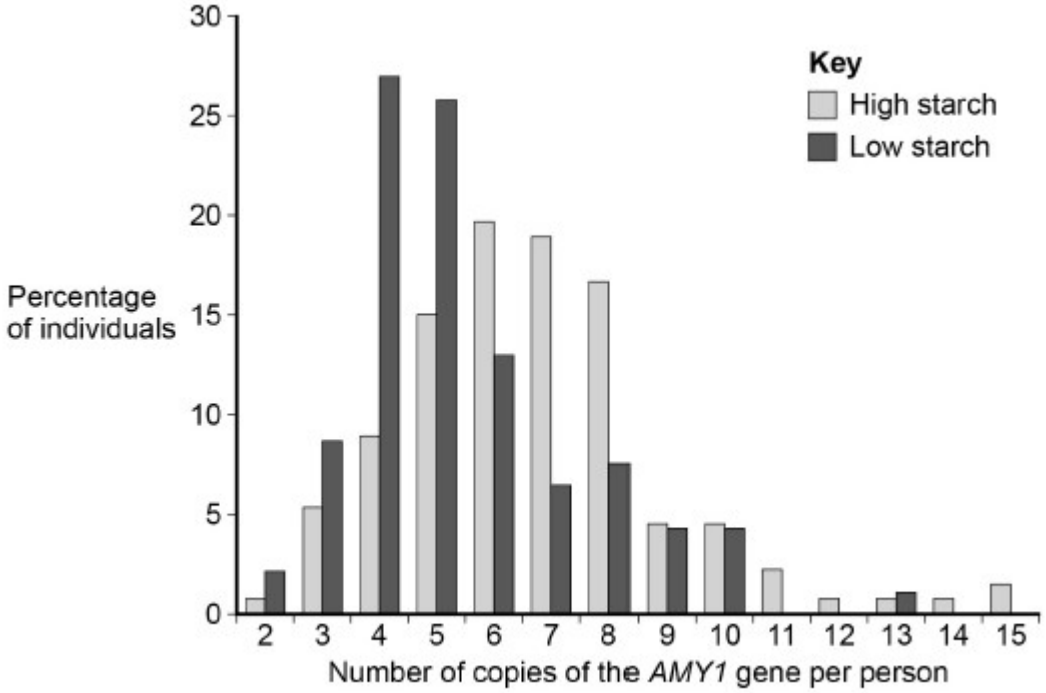
(3)

(Total 6 marks)

Q8.

(a) Most human cells contain two copies of each gene. However, there might be up to 15 copies of the gene for amylase (*AMY1*). Scientists investigated the number of copies of the *AMY1* gene in individual people in two populations. One population had a high-starch diet and the other population had a low-starch diet.

The graph below shows their results.



Describe what their results show.

(3)

(b) Multiple copies of the *AMY1* gene is an adaptation to a high-starch diet.

Use your knowledge of protein synthesis and enzyme action to explain the advantage of this adaptation.

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(3)

(c) Multiple copies of the *AMY1* gene is an adaptation to a high-starch diet.

Suggest how this evolved through natural selection.

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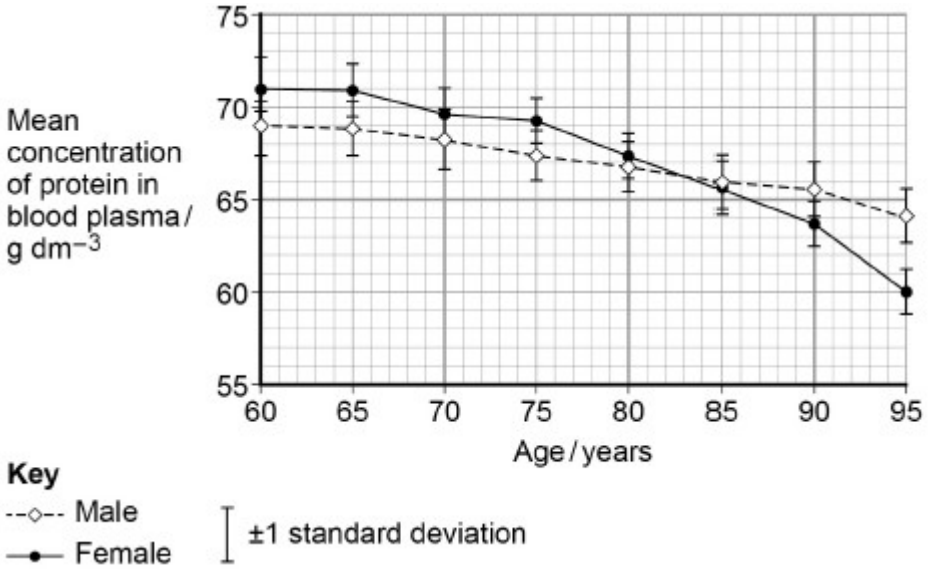
(3)

(Total 9 marks)

Q9.

Scientists investigated how the concentration of protein in blood plasma changes in people between the ages of 60 and 95.

The graph shows the scientists' results. The bars show ±1 standard deviation.



(a) What is the difference between males and females in the fall in mean concentration of protein in blood plasma between 60 and 95 years?

Answer = _____ g dm^{-3}

(1)

(b) Use the graph above to calculate the rate of change of the mean concentration of protein in the blood plasma of males between the ages of 60 and 95.

Show your working.

Answer = _____ g dm^{-3} year^{-1}

(2)

(c) What can you conclude from the graph above about the effect of ageing on the mean concentration of protein in the blood plasma in males and females?

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(2)

(d) The scientists measured the absorption of each sample of blood plasma using a colorimeter. They used a calibration curve to find the concentration of protein in samples of blood plasma.

Describe how the scientists could obtain data to produce a calibration curve and how they would use the calibration curve to find the concentration of protein in a sample of blood plasma.

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(3)

(e) Older people are more likely to suffer from infectious diseases.

Suggest how this may be linked to the decrease in the mean concentration of protein in the blood as people get older.

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(1)

(Total 9 marks)

Q10.

(a) Bacteria are often used in industry as a source of enzymes. One reason is because bacteria divide rapidly, producing a large number of them in a short time.

Describe how bacteria divide.

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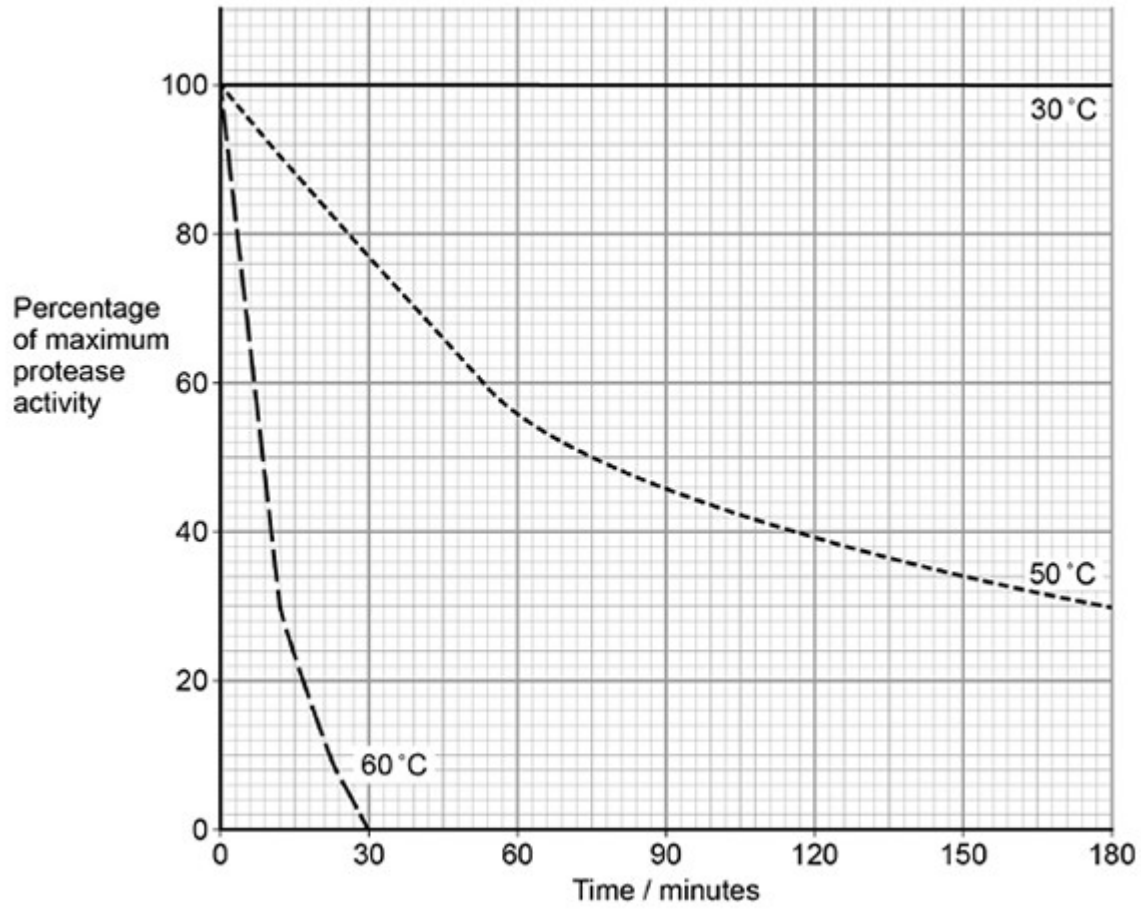
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(2)

(b) Washing powders often contain enzymes from bacteria. These enzymes include proteases that hydrolyse proteins in clothing stains.

The graph shows the effect of temperature on a protease that could be used in washing powder.



Explain the shape of the curves at 50 °C and 60 °C.

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(4)

(c) Some proteases are secreted as extracellular enzymes by bacteria.

Suggest **one** advantage to a bacterium of secreting an extracellular protease in its natural environment.

Explain your answer.

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(2)

(d) Mammals have some cells that produce extracellular proteases. They also have cells with membrane-bound dipeptidases.

Describe the action of these membrane-bound dipeptidases and explain their importance.

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(2)

(Total 10 marks)

Q11.

(a) Name **two** enzymes involved in the semi-conservative replication of DNA.

1. _____

2. _____

(2)

(b) Sometimes, damage occurs during DNA replication. One enzyme involved in repairing damage to DNA is called ATR.

ATR works as follows.

- ATR phosphorylates other enzymes involved in repairing DNA.
- ATR **also** phosphorylates substrates required to repair DNA.

When ATR phosphorylates other enzymes, these enzymes become able to bind to their substrates.

Use your knowledge of enzyme structure to suggest why.

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(2)

(c) The enzyme-catalysed reactions activated by ATR only occur if the substrates have been phosphorylated.

Use your knowledge of energy changes in enzyme-catalysed reactions to suggest why.

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(1)

(d) Sometimes, a mutagenic agent causes DNA to break. A different enzyme called ATM binds to the broken DNA. This leads to the activation of a protein coded for by a tumour suppressor gene. The effect of ATM binding is to stop cell division until DNA is repaired.

A mutation could result in a person having non-functional forms of the gene that produces ATM.

What can you predict about the possible effects of having a non-functional form of ATM?

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(3)

(Total 8 marks)

Q12.

(a) Cells lining the ileum of mammals absorb the monosaccharide glucose by co-transport with sodium ions. Explain how.

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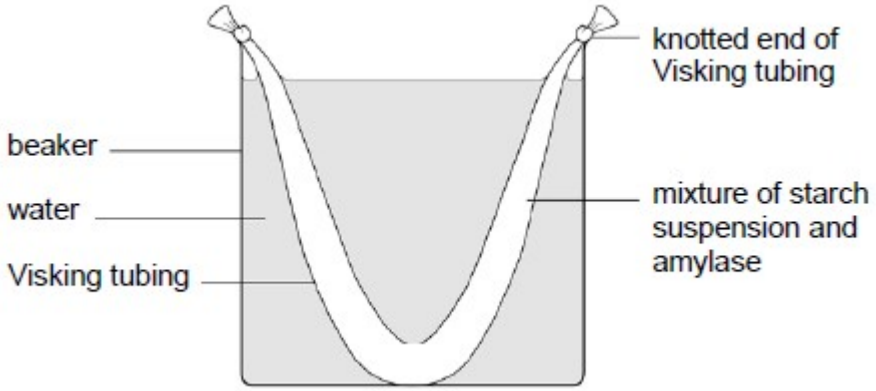
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(3)

A student set up the experiment shown in the diagram below.



The material from which Visking tubing is made is partially permeable.

After 15 minutes, the student removed samples from the liquid in the beaker and from the liquid inside the Visking tubing. She carried out biochemical tests on these samples. She drew the table below to record her results.

(b) Complete the table by placing a tick (✔) in each box that you expect to have shown a positive result.

Biochemical test	**Liquid from beaker**	**Liquid inside Visking tubing**
Biuret reagent		
Iodine in potassium iodide		
Benedict's solution		

(3)

(c) Justify your answers to part **(b)**.

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(3)

(Total 9 marks)

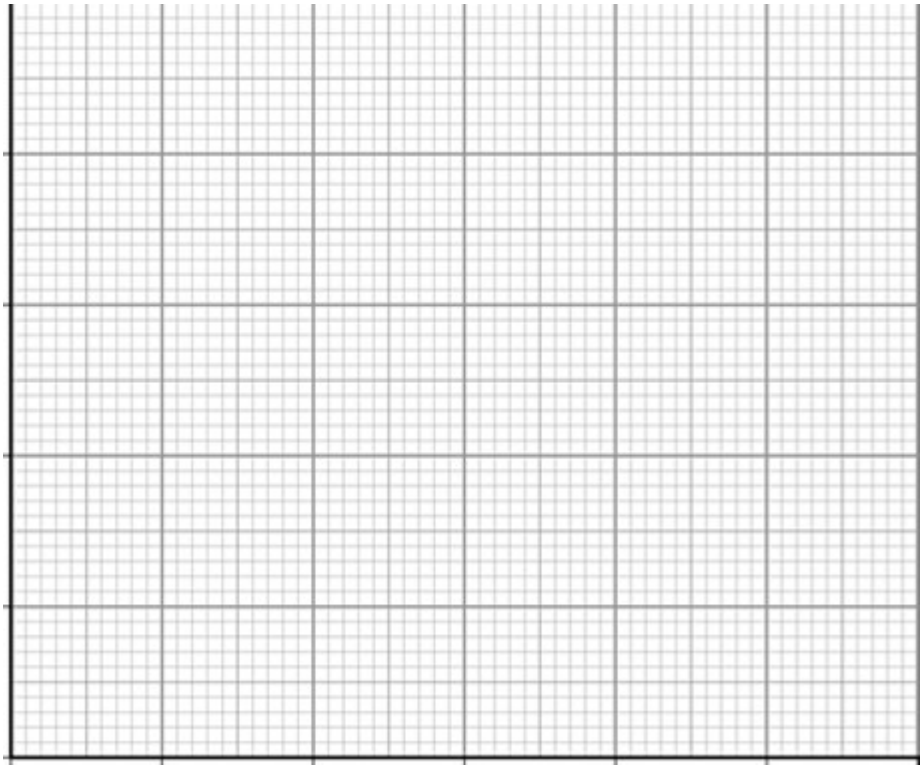
Q13.

A biochemist isolated a protease from a bacterium. He investigated the effect of temperature on the rate of hydrolysis of a protein by this protease. He measured the mass of protein hydrolysed in **5 minutes** at each temperature.

The results are shown in the table below.

Temperature / °C	**Mass of protein hydrolysed / g**	**Rate of hydrolysis / _____**
5	0.48	
10	1.11	
15	1.23	
20	1.05	
30	0.78	
45	0.12	

(a) Process the data in the table. Plot the processed data on the graph paper.



(4)

(b) A student concluded from a graph of the data in the table that the bacterium lives at 15 °C.

Does the data support the student's conclusion? Give reasons for your answer.

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(4)

(c) Suggest **two** variables the biochemist controlled when investigating the effect of temperature on the rate of breakdown of a protein by the protease.

1. _____

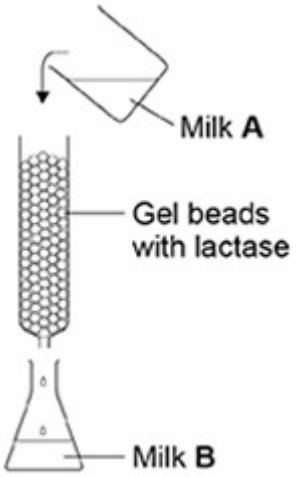
2. _____

(1)

(Total 9 marks)

Q14.

Many humans are unable to digest lactose. A scientist investigated the production of lactose-free milk. He produced gel beads containing the enzyme lactase and placed the beads in a column. He poured milk (Milk **A**) into the column and collected the milk (Milk **B**) after it had moved through the column over the beads. This is shown in the diagram below.



(a) Milk **A** contains no glucose. Milk **B** contains glucose. Explain why Milk **B** contains glucose.

_____

_____

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(1)

(b) The enzyme was trapped within the gel beads. Suggest **one** advantage of trapping the enzyme within the gel beads.

_____

_____

_____

(1)

The scientist varied the flow rate of the milk through the column. The effect of flow rate on the concentration of glucose in Milk **B** is shown in the table below.

Flow rate of milk through the column / cm^3 $minute^{-1}$	**Concentration of glucose in Milk B / arbitrary units**
50	45
100	6

(c) Explain the difference in the results in the table.

_____

_____

_____

(1)

(d) The gel beads were all similar sizes. Use the formula below to calculate the volume of one of the beads with a 3.0 mm diameter.

Volume of sphere = $\frac{4}{3}\pi r^3$

Volume = _____ mm^3

(1)

(e) Galactose has a similar structure to part of the lactose molecule.
Explain how galactose inhibits lactase.

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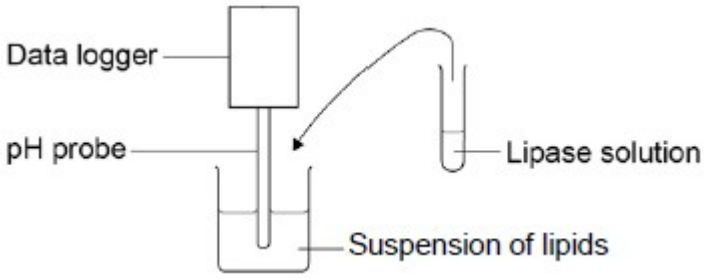
(2)

(Total 6 marks)

Q15.

A student investigated the effect of lipase concentration on the hydrolysis of lipids.

He took a beaker containing a suspension of lipids. He placed a pH probe attached to a data logger into the beaker. After 5 minutes, he added the lipase solution. The data logger recorded the pH. The apparatus used is shown in the diagram below.



(a) The student did **not** add a buffer to the lipase solution.

Explain why.

_____

_____

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(1)

(b) Give **two** variables the student would have controlled in this investigation.

1. _____

2. _____

(2)

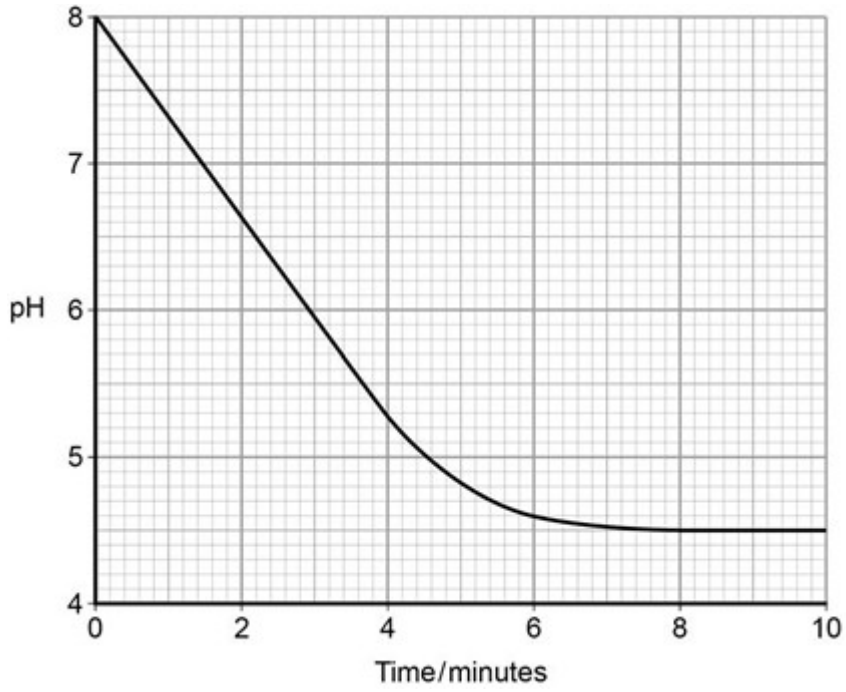
(c) Give the suitable control for this investigation.

_____

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(1)

The data logger recorded the pH. The graph below shows what happened after he added the lipase solution.



(d) Draw a tangent on the graph and use it to calculate the rate of change at 5 minutes.

Rate of change at 5 minutes = _____ pH minute^{-1}

(2)

(e) Explain the results shown in the graph.

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(2)

(f) The student repeated the experiment with a higher concentration of lipase solution. Describe and explain the results you would expect him to get.

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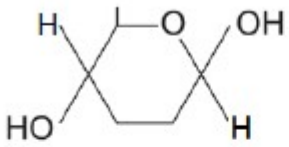
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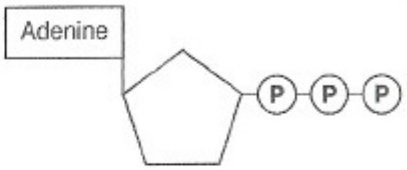
Q16.

The diagram shows four biological molecules.

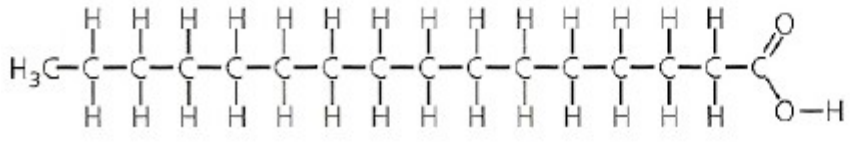
Molecule **A**



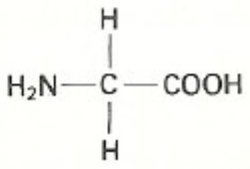
Molecule **B**



Molecule **C**



Glycine



(a) Give the **full** name of:

Molecule **A** _____

Molecule **B** _____

(2)

(b) What type of molecule is molecule **C**?

_____

(2)

(c) Glycine, shown in the diagram, is an amino acid.

In the space below, draw a diagram to show the dipeptide produced when two molecules of glycine are joined together.

(2)

(d) Name the other molecule formed when two molecules of glycine are joined together.

_____

(1)

(Total 7 marks)

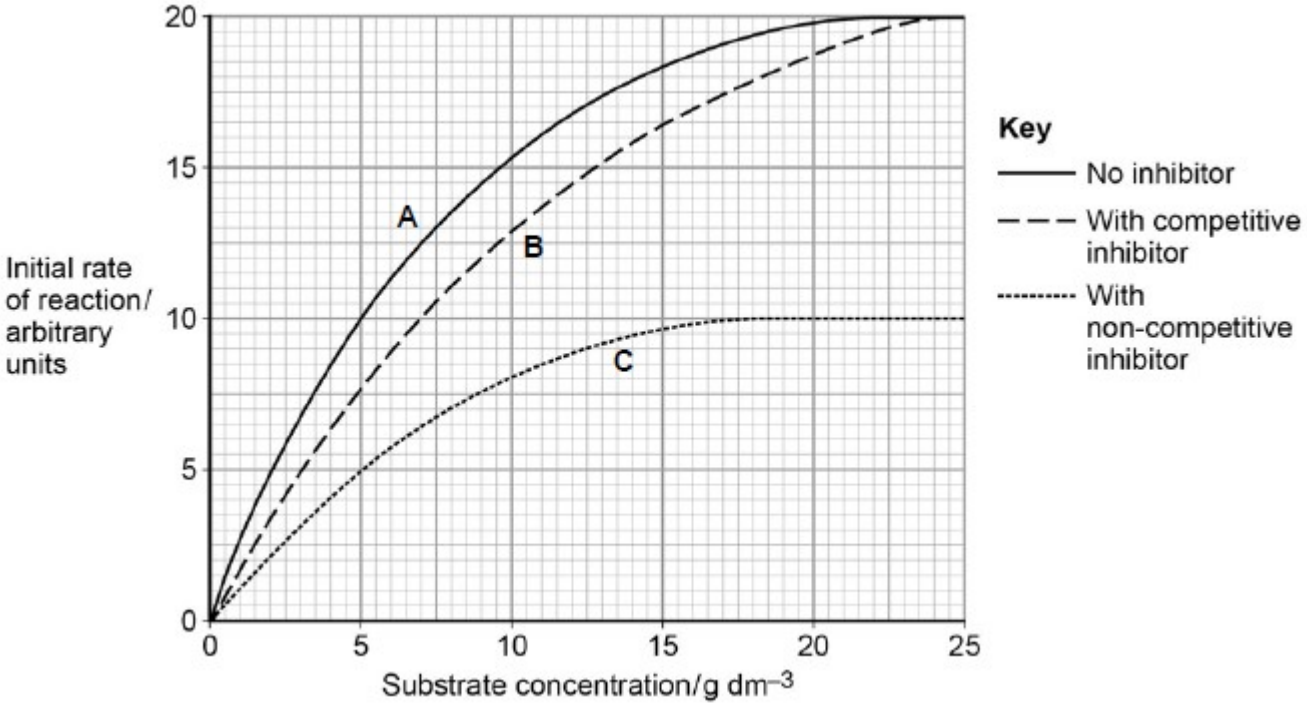
Q17.

A student investigated the effect of substrate concentration on the initial rate of an enzyme-catalysed reaction.

She added 10 cm^3 of an enzyme solution to 10 cm^3 of substrate solutions of different concentrations. At 30-second intervals, she tested samples of each mixture for the presence of substrate.

- **A** – in the absence of an inhibitor.
- **B** – with a competitive inhibitor added to the substrate solution.
- **C** – with a non-competitive inhibitor added to the substrate solution.

Her results are shown in the graph below.



(a) Explain the results **without** inhibitor (curve **A**) shown in the graph.

_____

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(2)

(b) The graph shows that the maximum initial rate of reaction (V_{max}) when a competitive inhibitor was present (curve **B**) is different from that when a non-competitive inhibitor was present (curve **C**).

Explain this difference.

_____

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(4)

(c) The Michaelis constant (K_m) is the substrate concentration at which the initial rate of reaction is half its maximum value (V_{max}).

How could you use the Michaelis constant to determine the type of inhibition occurring in an enzyme-catalysed reaction?

Use information from the graph to support your answer.

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(1)

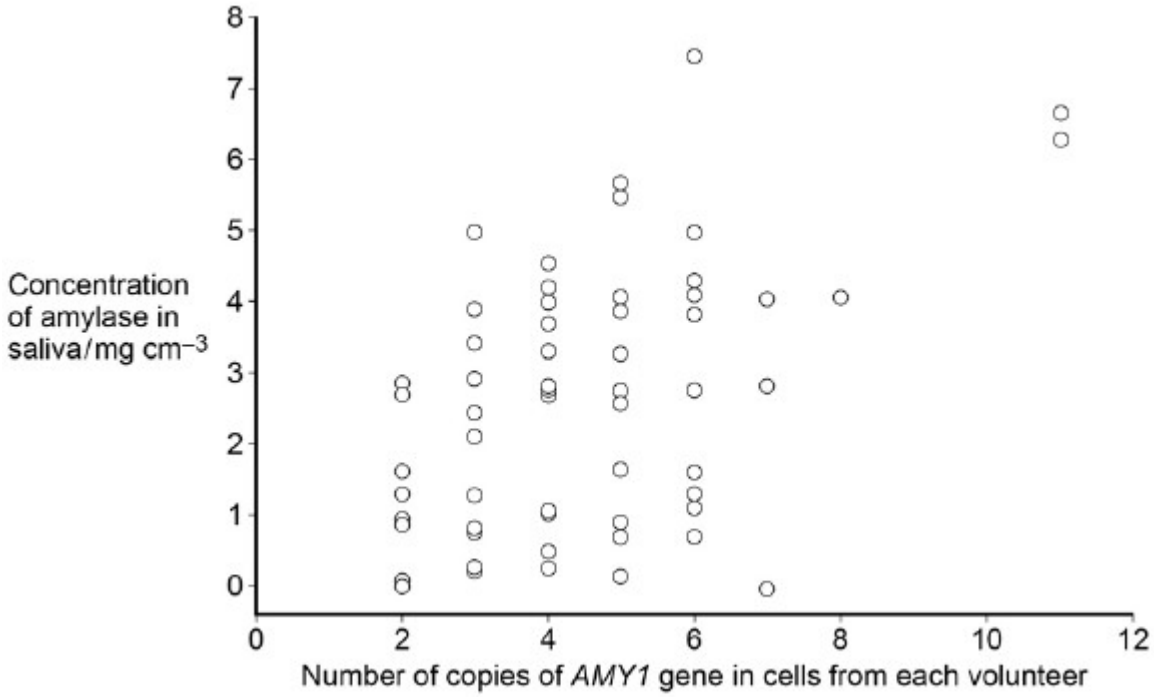
(Total 7 marks)

Q18.

The saliva of most humans contains α-amylase. The gene encoding α-amylase is called *AMY1;* it is located on chromosome 1.

As a result of mutation, humans might have more than one copy of the *AMY1* gene on one, or both, of their copies of chromosome 1. A team of scientists investigated whether the number of copies of the *AMY1* gene was associated with the concentration of α-amylase in the saliva of 58 human volunteers.

The graph shows their results. Each circle represents one volunteer.



(a) What was the range in the number of copies of the *AMY1* gene?

_____

(1)

(b) The scientists found the mean number of copies of gene *AMY1* was 4.4 genes per person.

Four values of the standard deviation of this mean are given below.
Estimate which of the four values for the standard deviation is most likely for this mean.
Indicate your choice by placing a tick in the appropriate box.

Use evidence from the graph to justify your answer.

☐ ± 0.002 ☐ ± 0.02 ☐ ± 0.20 ☐ ± 2.00

Justification_____

_____

_____

_____

(2)

(c) The scientists calculated a correlation coefficient, R, from their data.
They found R = 0.50, with P <0.0001

Explain the meaning of the result of their calculations.

_____

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(3)

(d) The number of copies of the *AMY1* gene is unlikely to affect people's ability to digest starch.

Explain why.

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(3)

(Total 9 marks)

Q19.

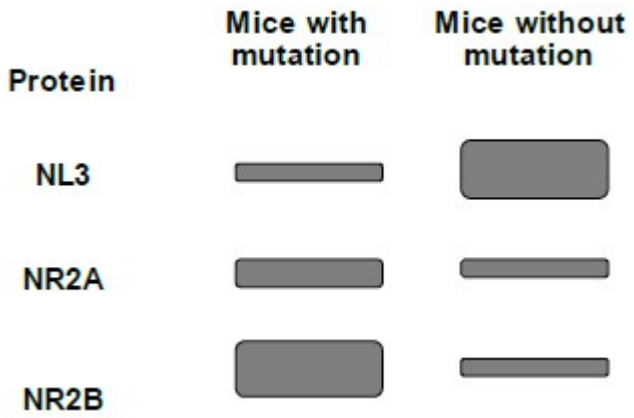
Some autism spectrum disorders (ASDs) are associated with a mutation affecting the neuroligin-3 gene. This gene codes for a protein called NL3, that is found in synapses.

Scientists investigated the effects of a mutation affecting NL3 in mice. They obtained brains from mice with the mutation and from mice without the mutation. For each type of mouse they:

- obtained a solution containing all of the proteins from synapses in one part of the brain
- separated these proteins using gel electrophoresis
- identified and measured the amount of three proteins from the solution using three different labelled antibodies.

The three proteins are parts of a postsynaptic membrane receptor.

The diagram below shows the scientists' results. Each band shows the presence of a protein. The size of a band shows the amount of the protein present.



(a) The mutation affecting NL3 in these mice was a substitution in the neuroligin-3 gene.

What is a substitution mutation?

_____

_____

_____

(1)

(b) Suggest how gel electrophoresis separated the proteins obtained from the synapses.

(2)

(c) Each type of labelled antibody binds specifically to one of the proteins.

Explain why.

(3)

(d) What do these data show about the effects of the mutation on the proteins?

(2)

(e) These proteins are part of a receptor found in synapses in the part of the brain called the hippocampus. A high ratio of NR2B to NR2A protein in this receptor has been associated with good memory.

Using all of the information, suggest how the mutation affecting the NL3 protein may affect a mouse.

_____

_____

(2)

(Total 10 marks)

Q20.

Scientists have investigated the use of different types of stem cell to treat damage to the heart after a myocardial infarction. During a myocardial infarction, a number of different cell types in the heart die. This includes cardiomyocytes which are heart-muscle cells.

Embryonic pluripotent stem cells (ESCs) can divide and differentiate into a wide range of different cell types.

(a) Using the information given, suggest **one** reason why ESCs might be suitable to treat damage to the heart.

_____

_____

_____

(1)

(b) ESCs have not yet been used to treat people who have had a myocardial infarction. This is because of concern that the use of ESCs might lead to more harm to the person. One way that ESCs might lead to more harm is by differentiating into the wrong types of cells.

Suggest **one** other way that putting ESCs into a person's heart might lead to more harm to the person.

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(2)

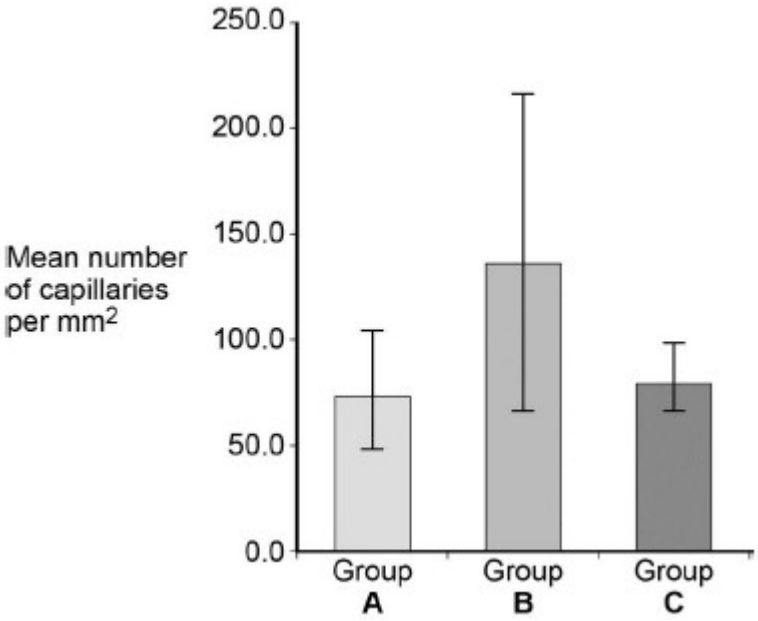
(c) Transplants of cardiomyocytes have been shown to increase the repair of heart tissue damaged by myocardial infarction.

One group of scientists investigated the hypothesis that these transplants work by stimulating growth of new blood vessels into damaged heart tissues. They obtained three groups of mice, **A**, **B** and **C** that had suffered myocardial infarctions.

- **Group A** were operated on but no transplant was given.
- **Group B** were operated on and given transplants containing cardiomyocytes and two other types of heart cell.
- **Group C** were operated on and given transplants containing the two other types of heart cells but no cardiomyocytes.

After a suitable time, the scientists measured the mean number of capillaries per mm^2 in sections taken from areas of the hearts of the mice affected by myocardial infarction.

Their results are shown in the graph below. The bars show ±2 standard deviations, which includes 95.4% of the data.



Group **A** was a control group. Explain **two** ways in which Group **A** acts as a control.

1. _____

_____

_____

2. _____

_____

_____

(2)

(d) What can you conclude from these data about the stimulation by cardiomyocytes on growth of new blood vessels into damaged heart tissues?

_____

_____

_____

_____

_____

_____

_____

(3)

(e) Suggest how the growth of new blood vessels into damaged heart tissues could increase the rate of repair of tissues.

_____

_____

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(3)

(f) The scientists used an optical microscope to measure the number of capillaries in thin sections cut from samples of heart muscle.

Describe the method they would have used to find the mean number of capillaries per mm^2.

_____

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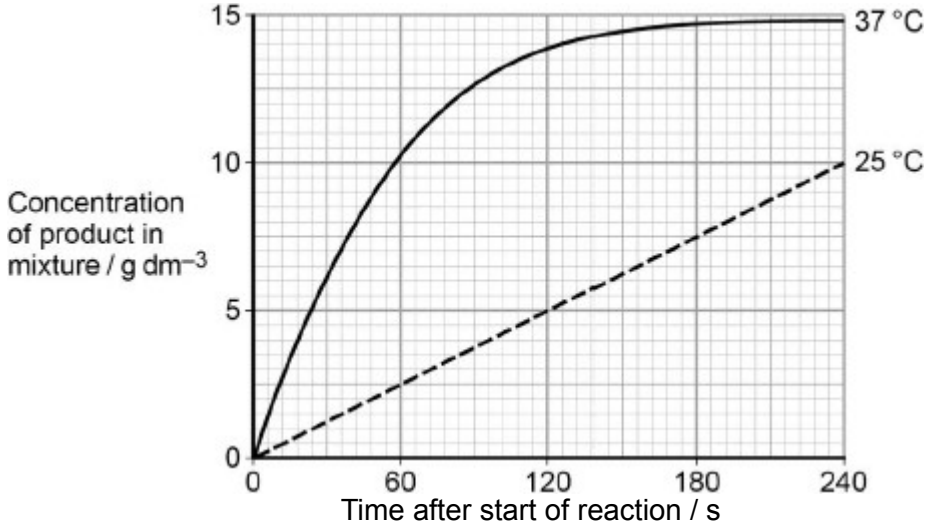
(4)

(Total 15 marks)

Q21.

A technician investigated the effect of temperature on the rate of an enzyme-controlled reaction. At each temperature, he started the reaction using the same volume of substrate solution and the same volume of enzyme solution.

The figure below shows his results.



(a) Give **one** other factor the technician would have controlled.

_____

_____

(1)

(b) Calculate the rate of reaction at 25 °C.

Answer _____

(2)

(c) Describe and explain the differences between the two curves.

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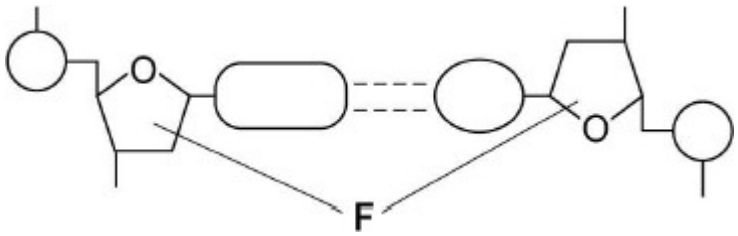
(5)

(Total 8 marks)

Q22.

Figure 1 shows one base pair of a DNA molecule.

Figure 1



(a) Name part **F** of each nucleotide.

_____

(1)

(b) Scientists determined that a sample of DNA contained 18% adenine.

What were the percentages of thymine and guanine in this sample of DNA?

Percentage of thymine ☐

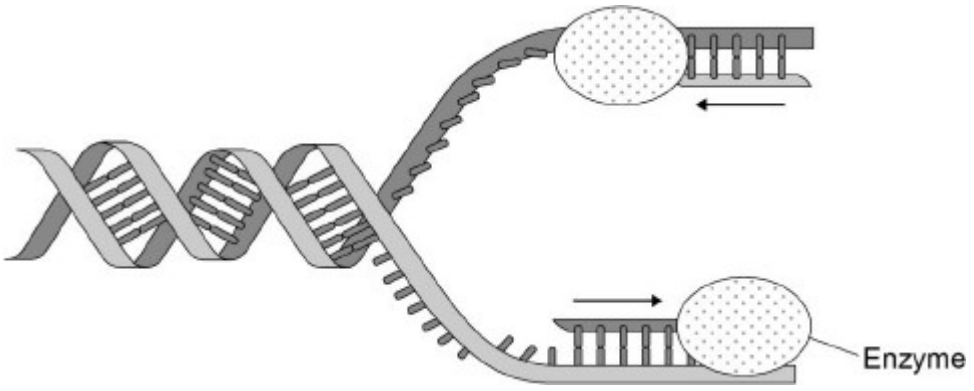
Percentage of guanine ☐

(2)

During replication, the two strands of a DNA molecule separate and each acts as a template for the production of a new strand.

Figure 2 represents DNA replication.

Figure 2



(c) Name the enzyme shown in **Figure 2**.

_____

(1)

The arrows in **Figure 2** show the directions in which each new DNA strand is being produced.

(d) Use **Figure 1, Figure 2** and your knowledge of enzyme action to explain why the arrows point in opposite directions.

_____

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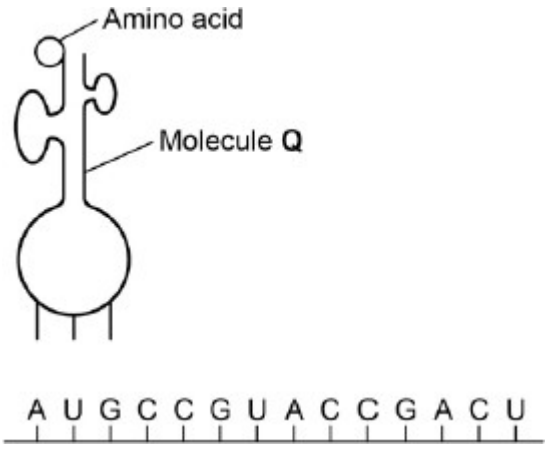
_____

(4)

(Total 8 marks)

Q23.

The diagram below represents one process that occurs during protein synthesis.



(a) Name the process shown.

_____

(1)

(b) Identify the molecule labelled **Q**.

_____

(1)

(c) In the diagram above, the first codon is AUG. Give the base sequence of:

the complementary DNA base sequence _____

the missing anticodon _____

(2)

The table below shows the base triplets that code for two amino acids.

Amino acid	Encoding base triplet
Aspartic acid	GAC, GAU
Proline	CCA, CCG, CCC, CCU

(d) Aspartic acid and proline are both amino acids. Describe how two amino acids differ from one another. You may use a diagram to help your description.

_____

_____

_____

(1)

(e) Deletion of the sixth base (G) in the sequence shown in the diagram above would change the nature of the protein produced but substitution of the same base would not. Use the information in the table and your own knowledge to explain why.

_____

_____

_____

_____

_____

_____

(3)

(Total 8 marks)

Q24.

Newborn babies can be fed with breast milk or with formula milk. Both types of milk contain carbohydrates, lipids and proteins.

- Human breast milk also contains a bile-activated lipase. This enzyme is thought to be inactive in milk but activated by bile in the small intestine of the newborn baby.
- Formula milk does not contain a bile-activated lipase.

Scientists investigated the benefits of breast milk compared with formula milk.

(a) The scientists used kittens (newborn cats) as model organisms in their laboratory investigation.

Other than ethical reasons, suggest **two** reasons why they chose to use cats as

model organisms.

1. _____

_____

2. _____

_____

(2)

(b) Before starting their experiments, the scientists confirmed that, like human breast milk, cat's milk also contained bile-activated lipase.

To do this, they added bile to cat's milk and monitored the pH of the mixture.

Explain why monitoring the pH of the mixture could show whether the cat's milk contained lipase.

_____

_____

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_____

(2)

The scientists then took 18 kittens. Each kitten had been breastfed by its mother for the previous 48 hours.

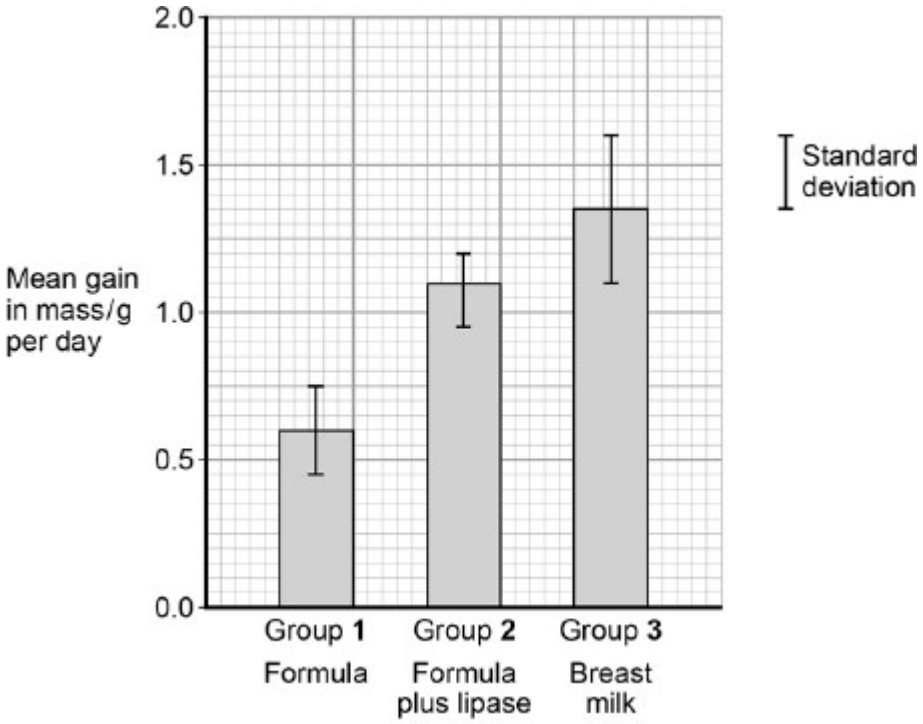
The scientists divided the kittens randomly into three groups of six.

- The kittens in group **1** were fed formula milk.
- The kittens in group **2** were fed formula milk plus a supplement containing bile-activated lipase.
- The kittens in group **3** were fed breast milk taken from their mothers.

Each kitten was fed 2 cm^3 of milk each hour for 5 days.

The scientists weighed the kittens at the start of the investigation and on each day for 5 days.

The figure below shows the scientists' results.



Type of milk given to kittens

(c) What can you conclude from the figure about the importance of bile-activated lipase in breast milk?

_____

_____

_____

_____

_____

_____

(3)

(Total 7 marks)

Q25.

A technician investigated the effect of temperature on the rate of an enzyme-controlled reaction. At each temperature, he started the reaction using the same concentration of substrate.

The following graph shows his results.



(a) Give **two** other factors the technician would have controlled.

1. _____

2. _____

(1)

(b) Draw a tangent on each curve to find the initial rates of reaction.
Use these values to calculate the ratio of the initial rates of reaction at 60 °C : 37 °C.
Show your working.

Ratio = _____ :1

(2)

(c) Explain the difference in the initial rate of reaction at 60 °C and 37 °C.

_____

_____

_____

_____

(2)

(d) Explain the difference in the rates of reaction at 60 °C and 37 °C between 20 and 40 minutes.

_____

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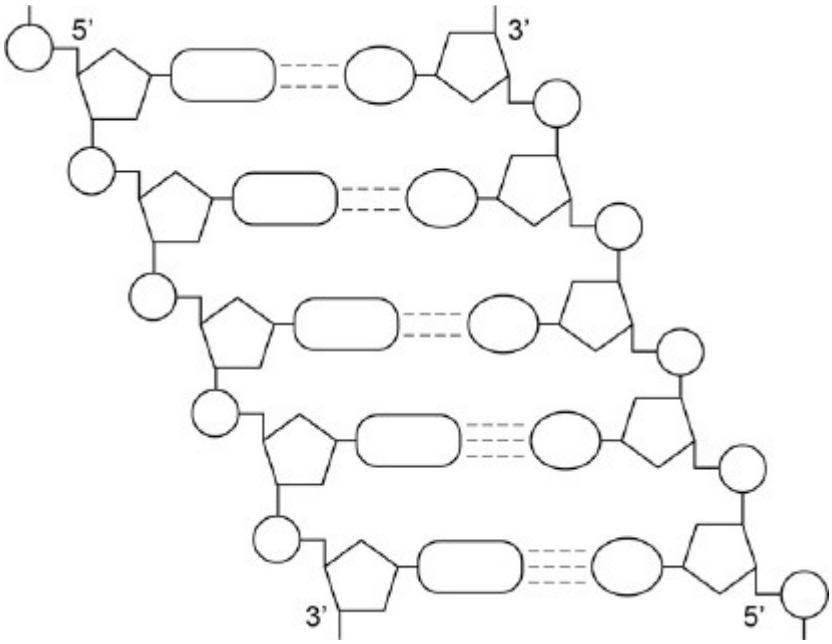
_____

(4)

(Total 9 marks)

Q26.

The following figure represents part of a DNA molecule.



(a) Draw a box around a single nucleotide.

(1)

The table below shows the percentage of bases in each of the strands of a DNA molecule.

DNA strand	**Percentage of each base**			
	A	**C**	**G**	**T**
Strand **1**	16			
Strand **2**		21	34	

(b) Complete the table by adding the missing values.

(2)

(c) During replication, the two DNA strands separate and each acts as a template for the production of a new strand. As new DNA strands are produced, nucleotides can only be added in the 5' to 3' direction.

Use the figure in part **(a)** and your knowledge of enzyme action and DNA replication

to explain why new nucleotides can only be added in a 5' to 3' direction.

(4)

(Total 7 marks)

Q27.

(a) Messenger RNA (mRNA) is used during translation to form polypeptides. Describe how mRNA is produced in the nucleus of a cell.

(6)

(b) Describe the structure of proteins.

_____

_____

_____

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_____

_____

(5)

(c) Describe how proteins are digested in the human gut.

_____

_____

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(4)

(Total 15 marks)

Q28.

A student investigated the effect of chewing on the digestion of starch in cooked wheat.

He devised a laboratory model of starch digestion in the human gut. This is the method he used.

1. Volunteers chewed cooked wheat for a set time. The wheat had been cooked in boiling water.
2. This chewed wheat was mixed with water, hydrochloric acid and a protein-digesting enzyme and left at 37 °C for 30 minutes.
3. A buffer was then added to bring the pH to 6.0 and pancreatic amylase was added. This mixture was then left at 37 °C for 120 minutes.
4. Samples of the mixture were removed at 0, 10, 20, 40, 60 and 120 minutes, and the concentration of reducing sugar in each sample was measured.
5. Control experiments were carried out using cooked wheat that had been chopped up in a blender, not chewed.

(a) What reducing sugar, or sugars, would you expect to be produced during chewing? Give a reason for your answer.

_____

_____

_____

_____

(2)

(b) In this model of digestion in the human gut, what other enzyme is required for the complete digestion of starch?

_____

(1)

(c) What was the purpose of step 2, in which samples were mixed with water, hydrochloric acid and pepsin?

_____

_____

(1)

(d) In the control experiments, cooked wheat was chopped up to copy the effect of chewing.

Suggest a more appropriate control experiment. Explain your suggestion.

_____

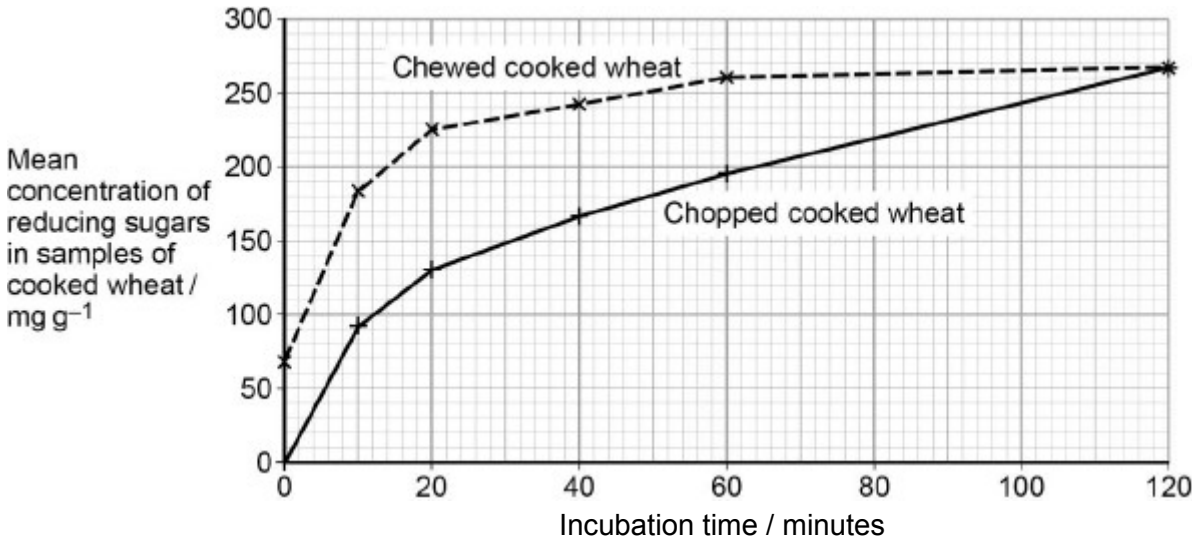
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(2)

(e) The figure below shows the student's results.



Explain what these results suggest about the effect of chewing on the digestion of starch in wheat.

_____

_____

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_____

(3)

(Total 9 marks)

Q29.

(a) Describe the difference between the structure of a triglyceride molecule and the structure of a phospholipid molecule.

_____

_____

_____

(1)

(b) Describe how you would test for the presence of a lipid in a sample of food.

_____

_____

_____

_____

(2)

(c) Animal fats contain triglycerides with a high proportion of saturated fatty acids. If people have too much fat in their diet, absorption of the products of fat digestion can increase the risk of obesity. To help people lose weight, fat substitutes can be used to replace triglycerides in food.

Describe how a saturated fatty acid is different from an unsaturated fatty acid.

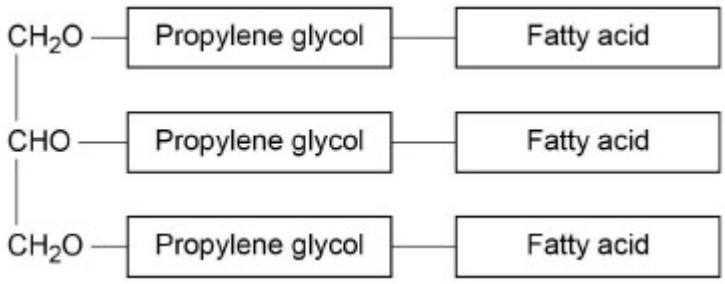
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(1)

The diagram shows the structure of a fat substitute.



(d) This fat substitute **cannot** be digested in the gut by lipase.

Suggest why.

_____

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_____

_____

(2)

(e) This fat substitute is a lipid. Despite being a lipid, it cannot cross the cell-surface membranes of cells lining the gut.

Suggest why it **cannot** cross cell-surface membranes.

_____

_____

_____

(1)

(Total 7 marks)

Q30.

(a) Describe the induced-fit model of enzyme action.

_____

_____

_____

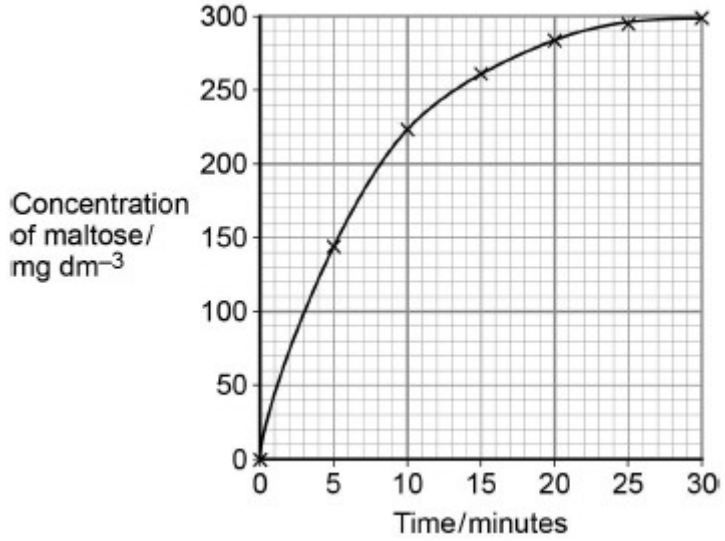
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_____

(2)

(b) A scientist investigated the hydrolysis of starch.
He added amylase to a suspension of starch and measured the concentration of maltose in the reaction mixture at regular intervals.

His results are shown in the graph below.



Determine the rate of the reaction **at** 10 minutes.
Show how you obtained your answer.

Rate of reaction _____ mg dm^{-3} min^{-1}

(2)

(c) Explain the results shown in the graph.

_____

_____

_____

_____

_____

(2)

(d) A quantitative Benedict's test produces a colour whose intensity depends on the concentration of reducing sugar in a solution. A colorimeter can be used to measure the intensity of this colour.

The scientist used quantitative Benedict's tests to produce a calibration curve of colorimeter reading against concentration of maltose.

Describe how the scientist would have produced the calibration curve and used it to obtain the results in the graph.

Do **not** include details of how to perform a Benedict's test in your answer.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 9 marks)

Q31.

Read the following passage.

Alzheimer's disease leads to dementia. This involves small β-amyloid proteins binding together to form structures called plaques in the brain.

Nerve cells in the brain produce a large protein called amyloid-precursor protein that has a complex shape. This protein is the substrate of two different enzymes, α-secretase and β-secretase. These enzymes are normally produced in the brain. One product of the reaction catalysed by β-secretase is a smaller protein that can lead to β-amyloid protein formation. Many people with Alzheimer's disease have mutations that decrease α-secretase production, or increase β-secretase production.

One possible type of drug for treating Alzheimer's disease is a competitive inhibitor of β-secretase. When some of these types of drugs were trialled on patients, the trials had to be stopped because some patients developed serious side effects.

Use information from the passage and your own knowledge to answer the following questions.

(a) Suggest how amyloid-precursor protein can be the substrate of two different enzymes, α-secretase and β-secretase (lines 3–5).

_____

_____

_____

_____

_____

(2)

(b) One product of the reaction catalysed by β-secretase is a smaller protein (lines 6–7).

Describe what happens in the hydrolysis reaction that produces the smaller protein from amyloid-precursor protein.

_____

_____

_____

_____

_____

(2)

(c) Many people with Alzheimer's disease have mutations that decrease α-secretase production, or increase β-secretase production (lines 8–9).

Use the information provided to explain how these mutations can lead to Alzheimer's disease.

_____

_____

_____

_____

_____

_____

(3)

(d) One possible type of drug for treating Alzheimer's disease is a competitive inhibitor of β-secretase (lines 10–11).

Explain how this type of drug could prevent Alzheimer's disease becoming worse.

_____

_____

_____

_____

_____

(2)

(e) When some of these types of drugs were trialled on patients, the trials were stopped because some patients developed serious side effects (lines 11–13).

Using the information provided, suggest why some patients developed serious side effects.

_____

_____

_____

(1)

(Total 10 marks)

Q32.

(a) HIV attaches to a specific protein receptor on helper T cells. A low percentage of people have a mutation of the *CCR5* gene which codes for this protein receptor. This mutation results in a non-functional protein receptor.

Explain how this mutation can result in the production of a non-functional protein receptor.

_____

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(4)

(b) People with the *CCR5* mutation show a greater resistance to developing AIDS.

Explain why.

_____

_____

_____

_____

_____

(2)

(c) The frequency of the *CCR5* mutation is highest in Europe. Scientists have collected data on the history and number of HIV infections in Europe. Using these data, scientists have concluded that the high frequency of the *CCR5* mutation is not due to natural selection in response to HIV.

Suggest **two** reasons why scientists reached this conclusion.

1. _____

_____

2. _____

_____

(2)

(Total 8 marks)

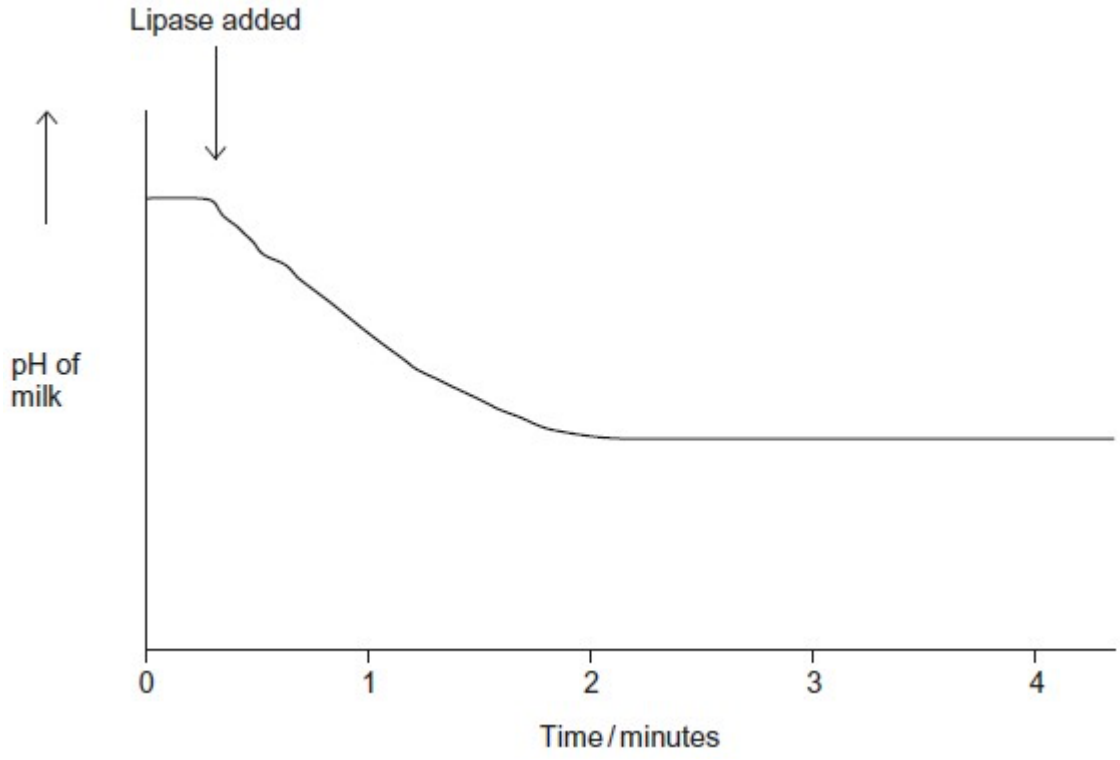
Q33.

Lipase is an enzyme that hydrolyses triglycerides.

A student investigated the hydrolysis of triglycerides in milk by human lipase at 20 °C.

He recorded the pH of a sample of milk before and after adding lipase. He used a pH meter to record pH.

His results are shown in the graph.



(a) Suggest **one** advantage of using a pH meter rather than a pH indicator in this experiment.

_____

_____

_____

(1)

(b) Explain why the pH decreases when the lipase is added to the milk.

_____

_____

_____

(1)

(c) Suggest why the pH remained constant after 2 minutes.

_____

_____

_____

_____

_____

(2)

(d) The student carried out his experiment at 20 °C. He then repeated the experiment at 15 °C.
Draw a line on the graph to show the results you would expect at 15 °C.

(2)

(Total 6 marks)

Q34.

Trypsin is a protease. It is produced in an inactive form inside some of the cells of the pancreas.

(a) Name the part of a pancreatic cell that produces the inactive form of trypsin.

_____

(1)

(b) Suggest the advantage of producing trypsin in an inactive form inside cells in the pancreas.

_____

_____

_____

_____

_____

(2)

(c) After the inactive form of trypsin enters the small intestine, another enzyme removes a short chain of amino acids from the end of the inactive trypsin molecules. This leads to the formation of the active form of trypsin.

(i) Name the type of bond hydrolysed when the short chain of amino acids is removed.

_____

(1)

(ii) Sometimes trypsin can become activated inside a pancreatic cell. A competitive inhibitor in the cell then binds to the trypsin and stops it working. Explain how the competitive inhibitor stops trypsin working.

_____

_____

_____

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_____

(3)

(Total 7 marks)

Q35.

Haemoglobin is a protein. It is made of two alpha polypeptides and two beta polypeptides. Each alpha polypeptide has 141 amino acids and each beta polypeptide has 146 amino acids.

(a) What term is used to describe the structure of a protein made of two or more polypeptides?

_____

(1)

(b) Calculate the minimum number of DNA bases needed to code for the number of amino acids in one alpha polypeptide.

Answer = _____

(1)

(c) Describe the role of haemoglobin in supplying oxygen to the tissues of the body.

_____

_____

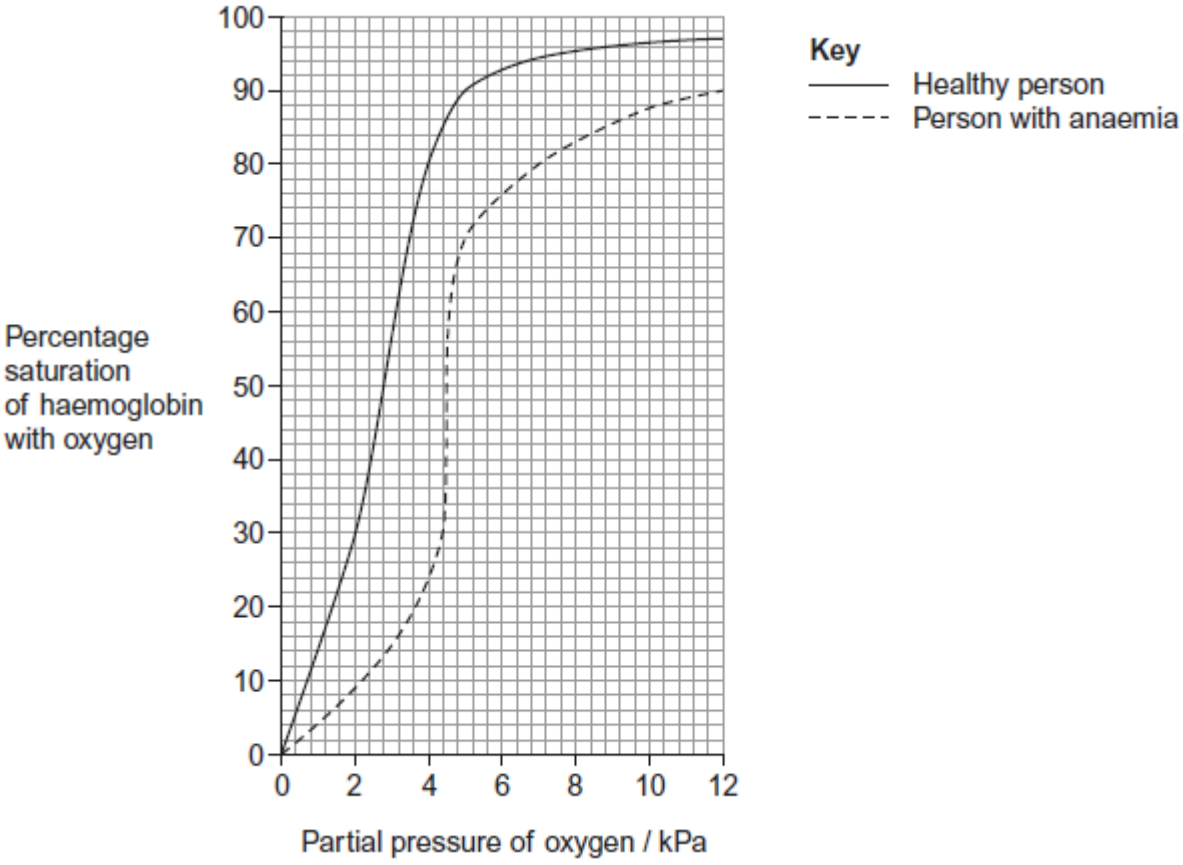
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(2)

Anaemia is a condition in which there is a decrease in the concentration of haemoglobin in blood. In some people with anaemia, substances are produced which change the oxygen dissociation curve of haemoglobin.

The graph shows the effect of these substances on the oxygen dissociation curve of haemoglobin.



(d) (i) Use information in the graph to find the difference in the percentage saturation of haemoglobin with oxygen between a healthy person and a person with anaemia at a partial pressure of oxygen of 4 kPa.

Answer = _____

(1)

(ii) Explain the advantage to a person with anaemia of the change shown in the oxygen dissociation curve.

_____

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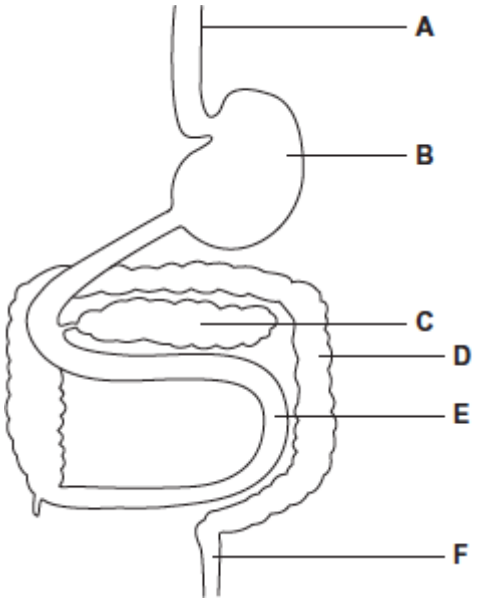
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(3)

(Total 8 marks)

Q36.

The diagram represents part of the human digestive system. The organs are labelled **A–F**.



(a) Give the letter of the organ that produces amylase.

(1)

(b) Give the letter of the organ that produces maltase.

(1)

(c) Maltose is hydrolysed by the enzyme maltase.

Explain why maltase catalyses only this reaction.

_____

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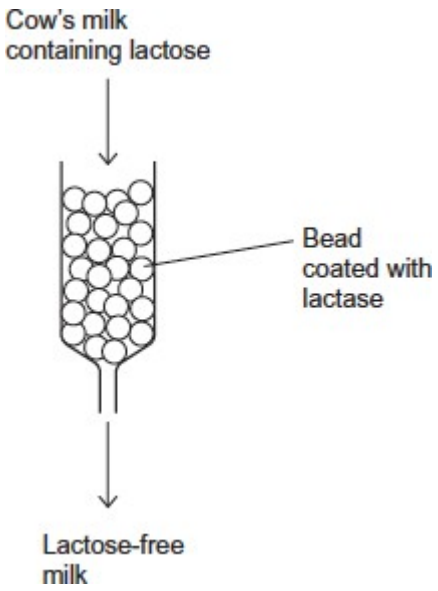
(3)

(Total 5 marks)

Q37.

Cow's milk contains the sugar lactose. Many cats are unable to digest cow's milk because they are lactose intolerant.

Cow's milk can be made suitable for these cats by treating it with the enzyme lactase to hydrolyse lactose. This makes the cow's milk lactose-free. Beads are coated with lactase and placed in a tube, as shown in the diagram below. Cow's milk flows over the beads and the lactose is hydrolysed.



(a) Attaching lactase to the beads is a more efficient use of lactase than adding the lactase directly to cow's milk.

Suggest **three** reasons why it is more efficient to attach lactase to the beads.

1. _____

_____

2. _____

_____

3. _____

_____

(3)

(b) Monosaccharides and disaccharides taste sweet.
The lactose-free milk made after hydrolysis with lactase tastes sweeter than the cow's milk containing lactose.
Suggest why.

_____

_____

_____

_____

_____

(2)

(Total 5 marks)

Q38.

A stomach ulcer is caused by damage to the cells of the stomach lining. People with stomach ulcers often have the bacterium *Helicobacter pylori* in their stomachs.

A group of scientists was interested in trying to determine how infection by *H. pylori* results in the formation of stomach ulcers.

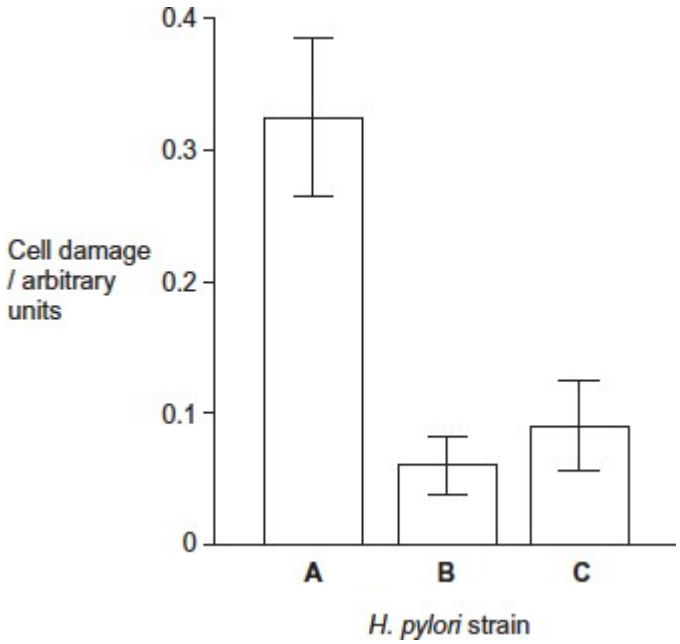
The scientists grew different strains of *H. pylori* in liquid culture.

The table below shows the substances released by each of these strains.

***H. pylori* strain**	**Substances released by the *H. pylori* cells**	
	Toxin	**Enzyme that neutralises acid**
A	✓	✓
B	×	✓
C	✓	×

The scientists centrifuged the cultures of each strain to obtain cell-free liquids. They added each liquid to a culture of human cells. They then recorded the amount of damage to the human cells.

Their results are shown below. The error bars show ± 1 standard deviation.



(a) Describe and explain how centrifuging the culture allowed the scientists to obtain a cell-free liquid.

(3)

(b) The scientists measured cell damage by measuring the activity of lysosomes.
Give **one** function of lysosomes.

(1)

(c) *H. pylori* cells produce an enzyme that neutralises acid.
Suggest **one** advantage to the *H. pylori* of producing this enzyme.

_____

(2)

(d) What do these data suggest about the damage caused to human cells by the toxin and by the enzyme that neutralises acid?
Explain your answer.

_____

_____

_____

_____

_____

_____

(3)

(e) The scientists carried out a further investigation. They treated the liquid from **strain A** with a protein-digesting enzyme before adding it to a culture of human cells. No cell damage was recorded.
Suggest why there was no damage to the cells.

_____

_____

_____

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(3)

(Total 12 marks)

Q39.

A principle of homeostasis is the maintenance of a constant internal environment. An increase in the concentration of carbon dioxide would change the internal environment and blood pH.
Explain the importance of maintaining a constant blood pH.

_____

_____

_____

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_____

_____

(Total 3 marks)

Q40.

Cyanide is poisonous. Cyanide binds to cytochrome oxidase, which is an enzyme in the electron transport chain in mitochondria. This stops the movement of electrons to oxygen. As a result, ATP cannot be made via aerobic respiration. If a person or animal is exposed to cyanide, a substance that acts as an antidote can reduce or prevent poisoning. This substance binds to cyanide.

Scientists investigated the effect of cyanide on the rate of respiration of cells in different animal organs and in organs from different animals. They extracted organs from animals that had just been killed. For each animal organ they set up 3 dishes. Each dish contained:

- phosphate solution
- saline (sodium chloride) solution
- cyanide solution of known concentration.

They measured the mean amount of oxygen used by the slices of organs in one hour. Their results are shown in **Table 1**.

Table 1

Trial	Animal organ	Mean amount of oxygen used, in the absence or presence of cyanide, per hour / arbitrary units		
		No cyanide	10^{-4} mol dm^{-3} cyanide	10^{-2} mol dm^{-3} cyanide
A	Sheep liver	2.7	2.5	0.7
B	Sheep kidney	14.1	9.9	1.9
C	Ox liver	1.9	1.5	0.8
D	Rat kidney	20.7	18.8	2.3
E	Rat liver	10.5	10.0	1.9
F	Guinea pig kidney	16.8	14.4	1.9

(a) Suggest how binding of cyanide to cytochrome oxidase affects the enzyme.

_____

_____

_____

_____

_____

_____

(3)

(b) Suggest how the antidote can reduce poisoning by cyanide.

_____

_____

_____

(1)

(c) **Table 1** shows the scientists' results for different trials. The trials could be put into groups to allow comparisons to be made within each group.

(i) As an example of how trials could be grouped, **Group 1** has been completed in **Table 2** below. Complete **Table 2** to show **three** other possible ways that the scientists' trials could be grouped.

Table 2

Group	Trials allowing comparisons to be made
1	**A** with **B**
2	
3	
4	

(2)

(ii) What is the effect of cyanide on **Group 1** trials in **Table 2**? Use evidence from **Table 1** to support your answer.

_____

_____

_____

_____

_____

_____

(3)

(iii) Calculate the percentage difference in oxygen use for 'rat liver' (**Trial E**) between a cyanide concentration of 10^{-4} and 10^{-2} mol dm^{-3}.

Percentage difference = _____

(2)

(Total 11 marks)

Q41.

(a) In humans, the enzyme maltase breaks down maltose to glucose.
This takes place at normal body temperature.

Explain why maltase:
- only breaks down maltose
- allows this reaction to take place at normal body temperature.

_____

_____

_____

_____

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_____

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_____

_____

_____

(5)

(b) Scientists have investigated the effects of competitive and non-competitive inhibitors of the enzyme maltase.

Describe competitive and non-competitive inhibition of an enzyme.

_____

_____

_____

_____

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(5)

(Total 10 marks)

Q42.

(a) An enzyme catalyses only one reaction. Explain why.

_____

_____

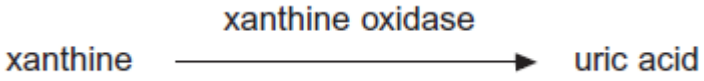
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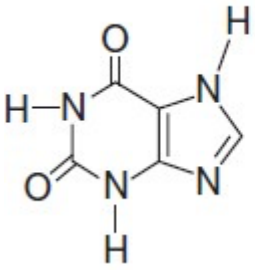
(2)

(b) Gout is a disease caused by the build-up of uric acid crystals in joints. Uric acid is produced from xanthine in a reaction catalysed by the enzyme xanthine oxidase.

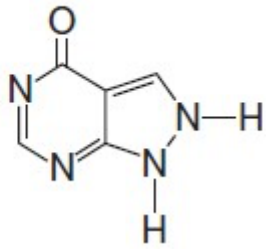


Allopurinol is a drug used to treat gout. The diagram shows the structures of xanthine and allopurinol.

Xanthine



Allopurinal



Use this information to suggest how allopurinol can be used to treat gout.

_____

_____

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_____

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(3)
(Total 5 marks)

Q43.

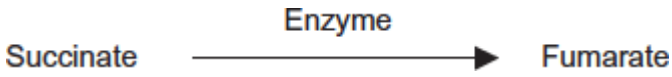
(a) The table contains statements about three stages of respiration.

Complete the table with a tick if the statement in the first column is true for each stage of respiration in an animal.

	Glycolysis	Link reaction	Krebs cycle
Occurs in mitochondria			
Carbon dioxide produced			
NAD is reduced			

(3)

(b) The following reaction occurs in the Krebs cycle.



A scientist investigated the effect of the enzyme inhibitor malonate on this reaction. The structure of malonate is very similar to the structure of succinate. The scientist added malonate and the respiratory substrate, pyruvate, to a suspension of isolated mitochondria. She also bubbled oxygen through the suspension.

(i) Explain why the scientist did not use glucose as the respiratory substrate for these isolated mitochondria.

_____

_____

_____

_____

_____

(2)

(ii) Explain how malonate inhibits the formation of fumarate from succinate.

_____

_____

_____

_____

_____

(2)

(iii) The scientist measured the uptake of oxygen by the mitochondria during the investigation. The uptake of oxygen decreased when malonate was added. Explain why.

_____

_____

_____

_____

_____

(2)

(Total 9 marks)

Q44.

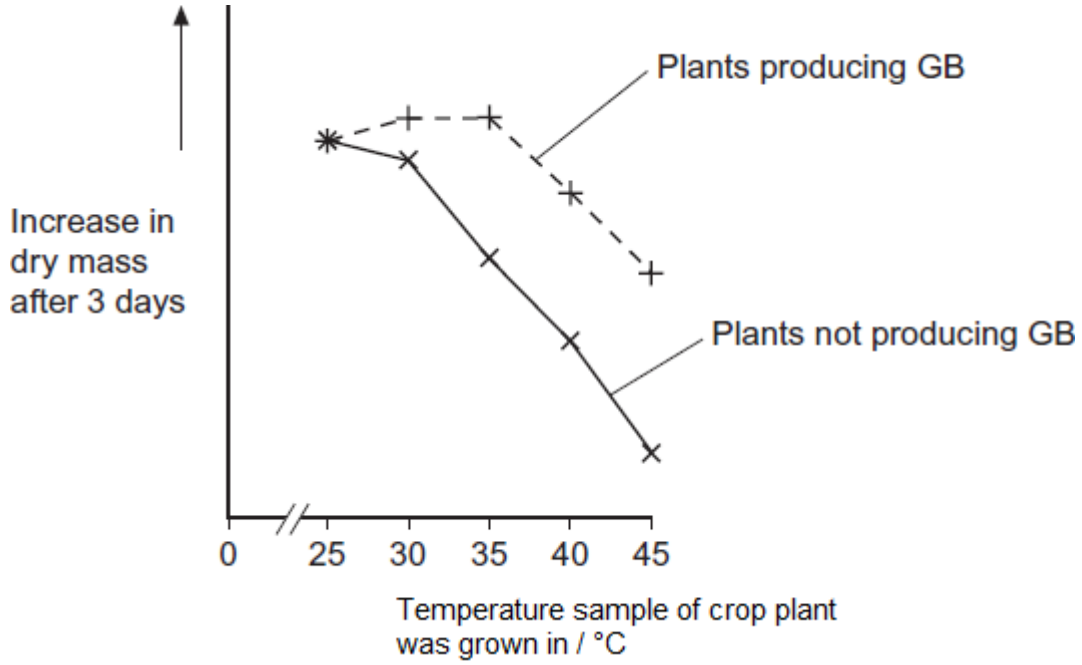
Some species of crop plant produce a substance called glycinebetaine (GB).

Scientists transferred the gene for GB into a species of crop plant that does not normally produce GB. These genetically modified plants then produced GB.

The scientists grew large numbers of the same crop plant with and without the gene at different temperatures. After 3 days, they found the increase in dry mass of the plants.

Figure 1 shows their results.

Figure 1



(a) Describe the effect on growth of transferring the gene for GB into this plant.

_____

_____

_____

_____

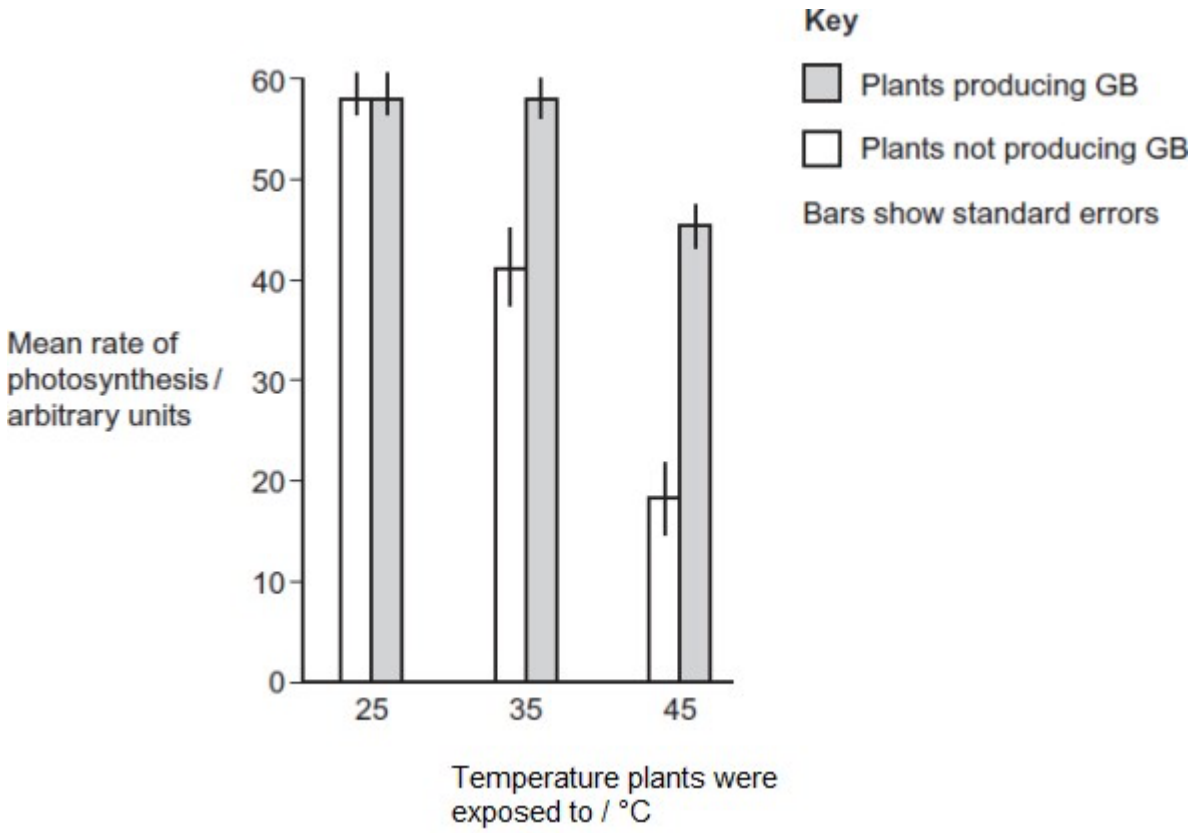
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(2)

(b) The scientists measured the rate of photosynthesis in plants that produce GB and plants that do not produce GB at 25°C, 35°C and 45°C.

Figure 2 shows their results.

Figure 2



(i) The scientists concluded that the production of GB protects photosynthesis from damage by high temperatures.

Use these data to support this conclusion.

_____

_____

_____

(1)

(ii) Use the data from **Figure 2** for plants that do not produce GB to explain the effect of temperature on changes in dry mass of the plants shown in **Figure 1.**

_____

_____

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_____

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_____

(4)

Rubisco activase is an enzyme found in chloroplasts. It activates the light-independent reaction of photosynthesis.

The scientists discovered that, as temperature increased from 25°C to 45°C, rubisco activase began attaching to thylakoid membranes in chloroplasts and this stopped it working.

(c) Rubisco activase stops working when it attaches to a thylakoid.

Use your knowledge of protein structure to explain why.

_____

_____

_____

_____

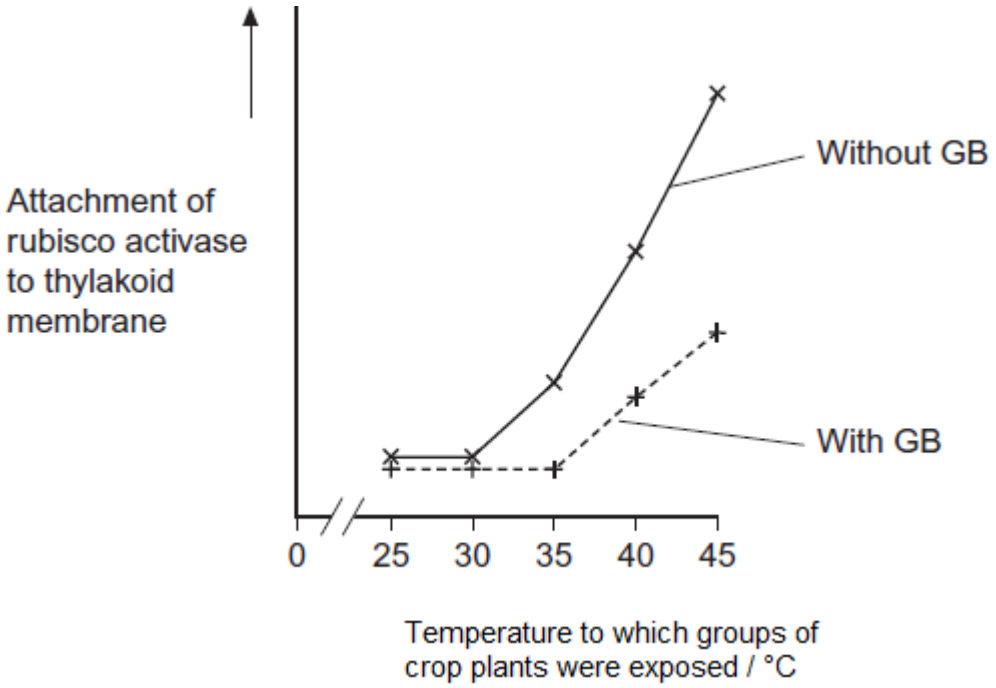
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(2)

(d) The scientists investigated the effect of GB on attachment of rubisco activase to thylakoid membranes at different temperatures.

Figure 3 shows their results.

Figure 3



Use information from **Figure 2** and **Figure 3** to suggest how GB protects the crop plant from high temperatures.

(4)

(e) The scientists' hypothesis at the start of the investigation was that crop plants genetically engineered to produce GB would become more resistant to high environmental temperatures.
The scientists developed this hypothesis on the basis of previous research on crops that are grown in hot climates.

Suggest how the scientists arrived at their hypothesis.

(2)

(Total 15 marks)

Q45.

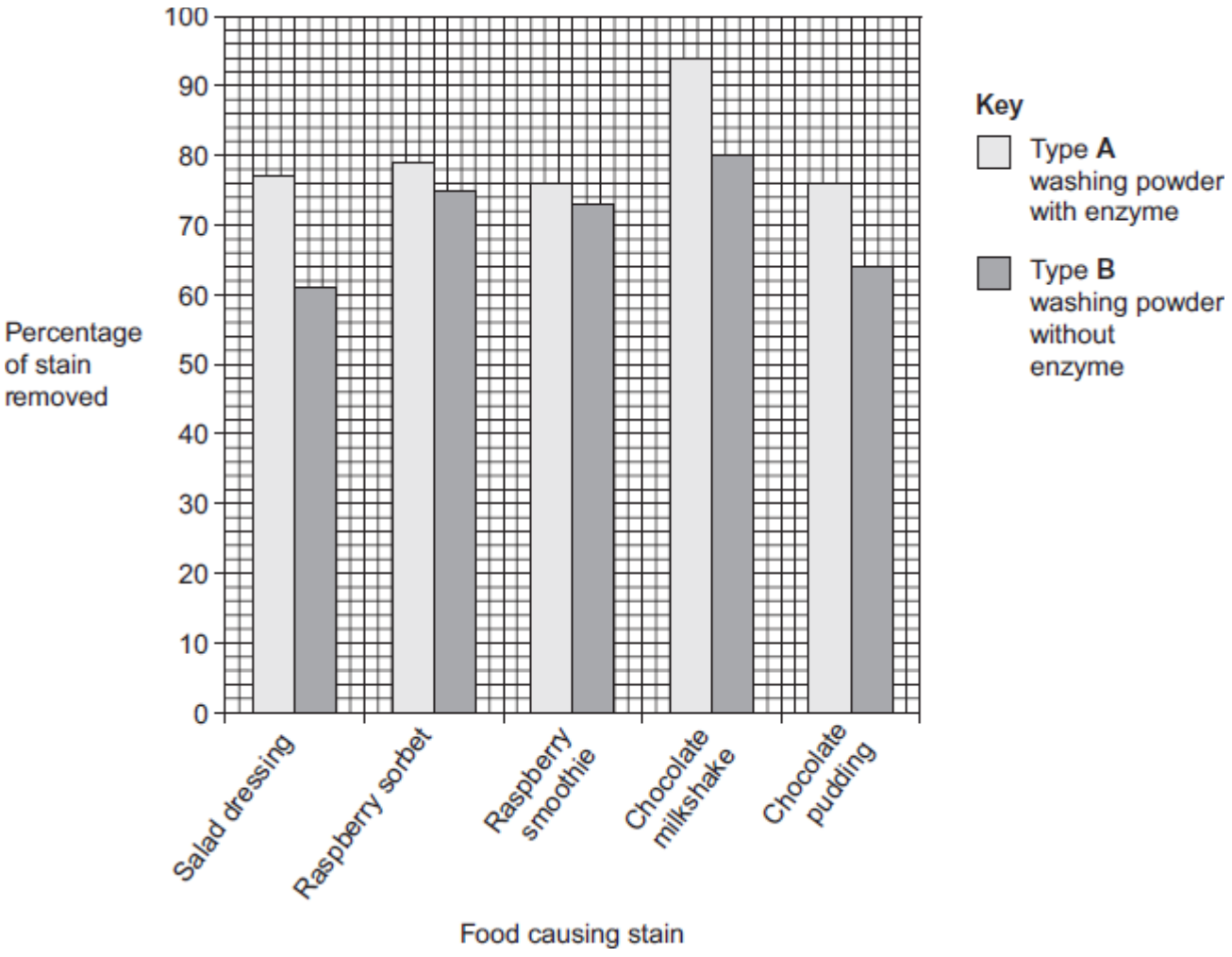
Biological washing powders contain enzymes which hydrolyse substances that cause stains on clothes.

A manufacturer tested the ability of two types of the same brand of washing powder to remove different food substances that stain clothes.

- Type **A** contained an enzyme.
- Type **B** was identical to **A** except it did **not** contain the enzyme.

Figure 1 shows the results.

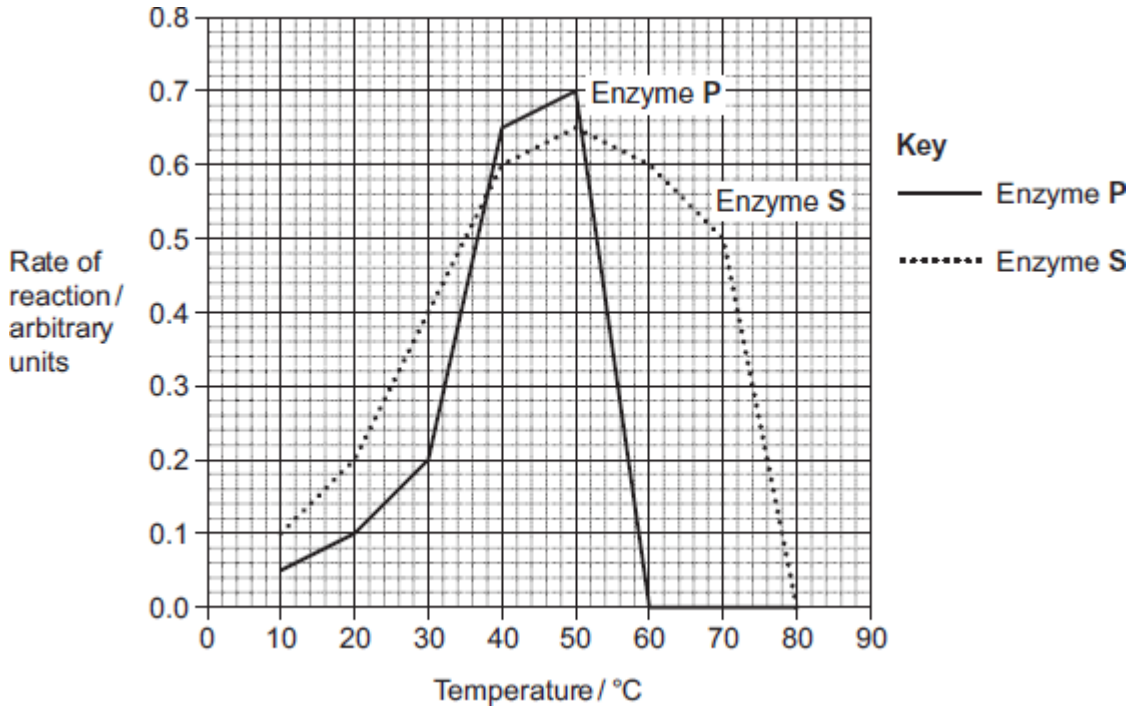
Figure 1



A scientist worked for a company that wanted to develop a biological washing powder that was effective over a range of temperatures. He investigated the effect of temperature on the rates of the reaction catalysed by two enzymes, **P** and **S** used in biological washing powders.

Figure 2 shows his results.

Figure 2



(a) Many of the substances causing the food stains are large, insoluble proteins. Suggest how a biological washing powder removes this type of stain.

(2)

(b) The manufacturer of type **A** and type **B** washing powder claimed that these results showed that biological washing powders are better at removing stains from clothes.

Use the information in **Figure 1** to evaluate this claim.

(4)

(c) Most customers want a washing powder which removes stains from clothes over a range of temperatures. After obtaining the results shown in **Figure 2**, which enzyme should the scientist recommend for use in a biological powder?

Give reasons for your answer.

_____

_____

_____

_____

_____

_____

(3)

(d) Biological washing powders often contain a number of different enzymes. This enables them to remove a wider range of stains from clothes.
Explain why a number of enzymes are required to remove a wider range of stains.

_____

_____

_____

_____

_____

_____

(3)

(Total 12 marks)

Q46.

(a) Name the monosaccharides of which the following disaccharides are composed.

(i) Sucrose

monosaccharides_____and_____

(1)

(ii) Lactose

monosaccharides_____and_____

(1)

(b) Amylase and maltase are involved in the digestion of starch in the small intestine.

Complete the table by identifying where these enzymes are produced and the product of the reaction they catalyse.

Name of enzyme	Where the enzyme is produced	Product of the reaction catalysed by the enzyme
Amylase		
Maltase		

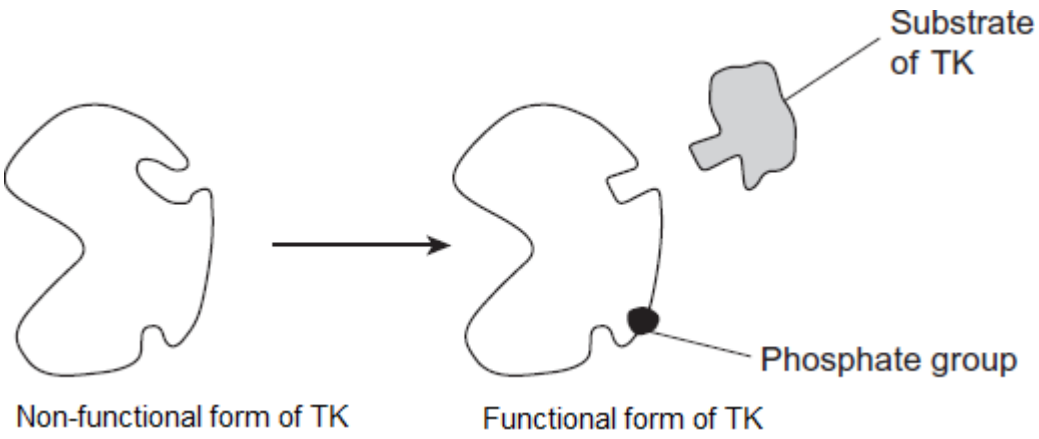
(2)
(Total 4 marks)

Q47.

The enzyme tyrosine kinase (TK) is found in human cells. TK can exist in a non-functional and a functional form. The functional form of TK is only produced when a phosphate group is added to TK.

This is shown in **Figure 1.**

Figure 1



(a) Addition of a phosphate group to the non-functional form of TK leads to production of the functional form of TK.

Explain how.

_____

_____

_____

_____

_____

(2)

(b) The binding of the functional form of TK to its substrate leads to cell division. Chronic myeloid leukaemia is a cancer caused by a faulty form of TK. Cancer involves uncontrolled cell division.

Figure 2 shows the faulty form of TK.

Figure 2



Faulty form of TK

Suggest how faulty TK leads to chronic myeloid leukaemia.

_____

_____

_____

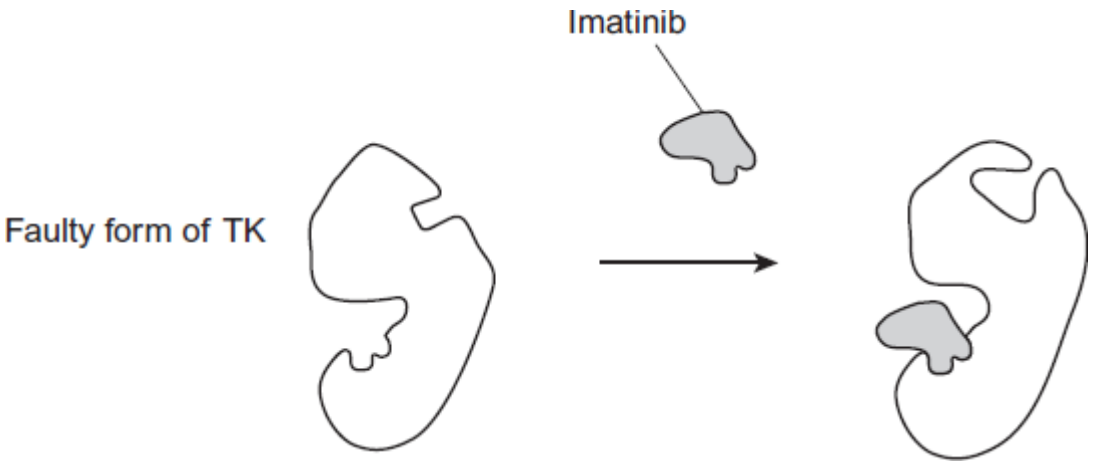
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(2)

(c) Imatinib is a drug used to treat chronic myeloid leukaemia. **Figure 3** shows how imatinib inhibits faulty TK.

Figure 3



Using all of the information, describe how imatinib stops the development of chronic myeloid leukaemia.

_____

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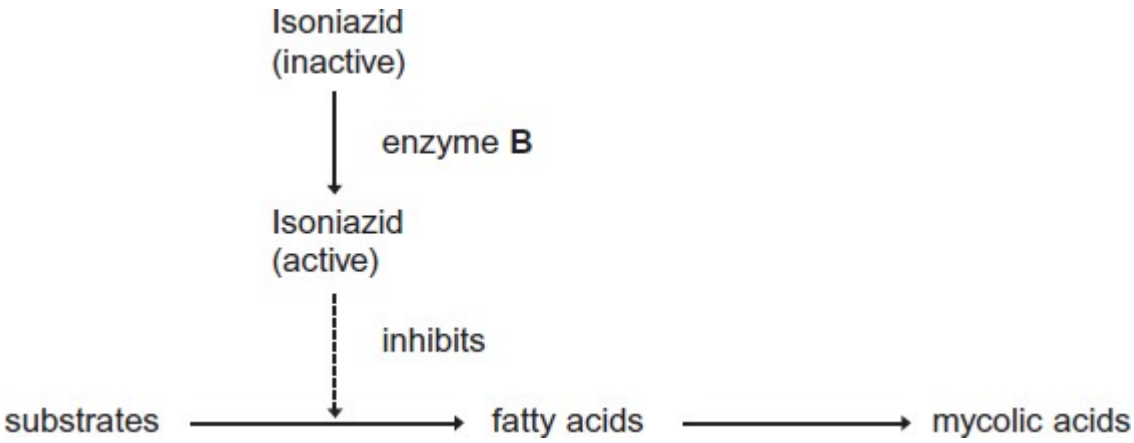
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(2)

(Total 6 marks)

Q48.

Mycolic acids are substances that form part of the cell wall of the bacterium that causes tuberculosis. Mycolic acids are made from fatty acids. Isoniazid is an antibioticthat is used to treat tuberculosis. The diagram shows how this antibiotic inhibits the production of mycolic acids in this bacterium.



(a) Treatment with isoniazid leads to the osmotic lysis of this bacterium. Use information in the diagram to suggest how.

_____

_____

_____

_____

_____

(2)

(b) Human cells also produce fatty acids. Isoniazid does not affect the production of these fatty acids.

Use information in the diagram to suggest **one** reason why isoniazid does **not** affect the production of fatty acids in human cells.

_____

_____

_____

(1)

(c) A mutation in the gene coding for enzyme **B** could lead to the production of a non-functional enzyme. Explain how.

_____

_____

_____

_____

_____

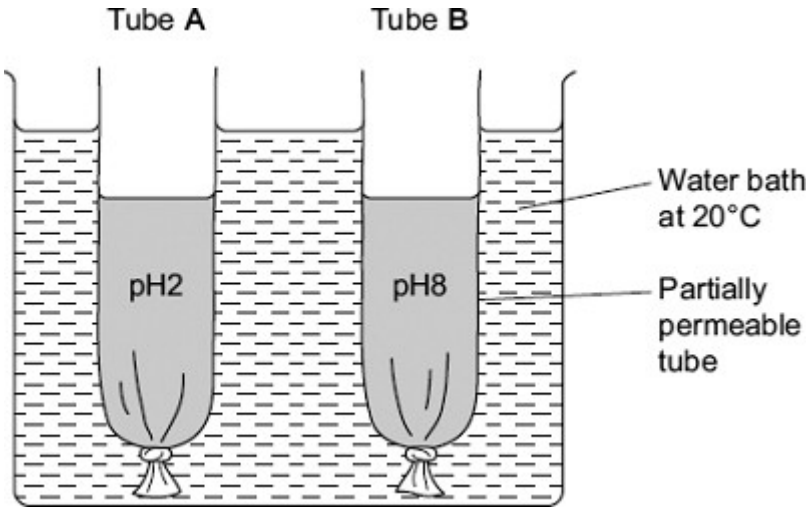
_____

(3)

(Total 6 marks)

Q49.

(a) A student investigated the effect of pH on the activity of the enzyme amylase. She set up the apparatus shown in the diagram.



The tubes were made from Visking tubing. Visking tubing is partially permeable. She added an equal volume of amylase solution and starch to each tube.

- She added a buffer solution at pH2 to tube **A**.
- She added an equal volume of buffer solution at pH8 to tube **B**.

After 30 minutes, she measured the height of the solutions in both tubes.
She then tested the solutions in tubes **A** and **B** for the presence of reducing sugars.

Describe how the student would show that reducing sugars were present in a solution.

_____

_____

_____

_____

_____

_____

(3)

(b) After 30 minutes, the solution in tube **B** was higher than the solution in tube **A**.

(i) Explain why the solution in tube **B** was higher.

_____

_____

_____

_____

_____

_____

(3)

(ii) The student concluded from her investigation that the optimum pH of amylase was pH8. Is this conclusion valid? Explain your answer.

_____

_____

_____

(1)

(Total 7 marks)

Q50.

Read the following passage.

Gluten is a protein found in wheat. When gluten is digested in the small intestine, the products include peptides. Peptides are short chains of amino acids. These peptides cannot be absorbed by facilitated diffusion and leave the gut in faeces

Some people have coeliac disease. The epithelial cells of people with coeliac disease do not absorb the products of digestion very well. In these people, some of the

peptides from gluten can pass between the epithelial cells lining the small intestine and enter the intestine wall. Here, the peptides cause an immune response that leads to the destruction of microvilli on the epithelial cells.

Scientists have identified a drug which might help people with coeliac disease. It reduces the movement of peptides between epithelial cells. They have carried out trials of the drug with patients with coeliac disease.

Use the information in the passage and your own knowledge to answer the following questions.

(a) Name the type of chemical reaction which produces amino acids from proteins.

_____

(1)

(b) The peptides released when gluten is digested cannot be absorbed by facilitated diffusion (lines 2 – 3). Suggest why.

_____

_____

_____

_____

_____

_____

(3)

(c) Explain why the peptides cause an immune response (lines 7 – 8).

_____

_____

_____

(1)

(d) Scientists have carried out trials of a drug to treat coeliac disease (lines 10 – 11). Suggest **two** factors that should be considered before the drug can be used on patients with the disease.

1. _____

_____

2. _____

_____

(2)

(Total 7 marks)

Q51.

Catalase is used in a number of industrial processes. It is normally obtained from a fungus called *Aspergillus niger*. Scientists produced a mutant strain of *A*. *niger* called K30. They wanted to know if this mutant strain produced more catalase than the normal strain of *A*. *niger*.

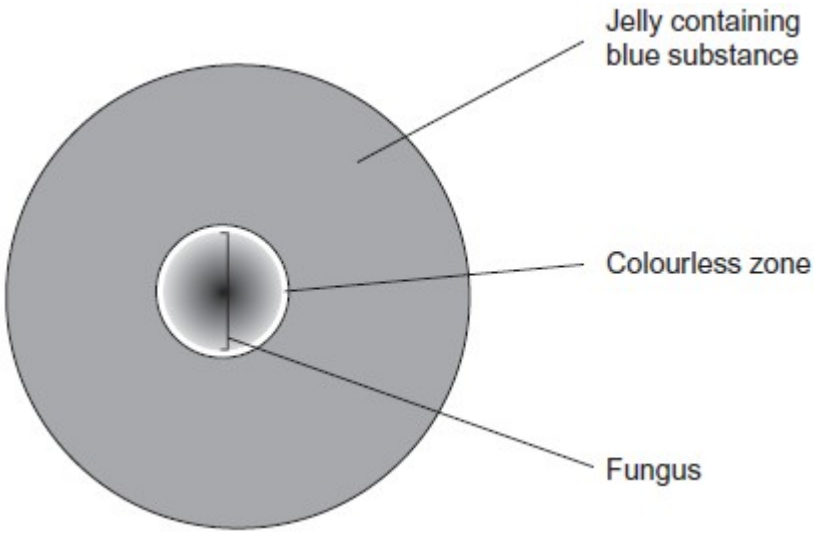
- The scientists grew samples of the normal strain of the fungus and of the K30 strain on jelly in separate Petri dishes. The jelly contained a blue substance which is turned colourless by catalase.

- They incubated the dishes for 3 days then measured the diameter of the colourless zone around the fungus.

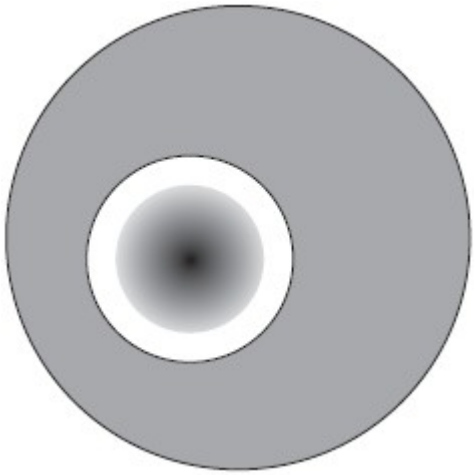
- They calculated the ratio of the diameter of the colourless zone to the diameter of the fungus.

The diagram shows the dishes after incubation.

Normal strain



K30 strain



(a) The scientists grew both strains of fungi on dishes kept at 30 °C. Keeping the dishes at a temperature of 15 °C would affect the results. Use your knowledge of kinetic energy to explain why.

_____

_____

_____

_____

_____

(2)

(b) (i) The scientists gave their results as ratios. Explain the advantage of giving the results of this investigation as a ratio.

_____

_____

_____

_____

_____

(2)

(ii) For the normal strain the ratio of the diameter of the colourless zone to the diameter of the fungus was 1.1 : 1.

Calculate the ratio of the diameter of the colourless zone to the diameter of the fungus for the K30 strain. Show your working.

Ratio = _____

(2)

(c) The catalase produced by the K30 strain of the fungus is mainly an extracellular enzyme. This means that the fungus secretes catalase from its cells into the jelly in the Petri dish.

Describe and explain the evidence from the investigation which shows that the catalase is an extracellular enzyme.

_____

_____

_____

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_____

(2)

(Total 8 marks)

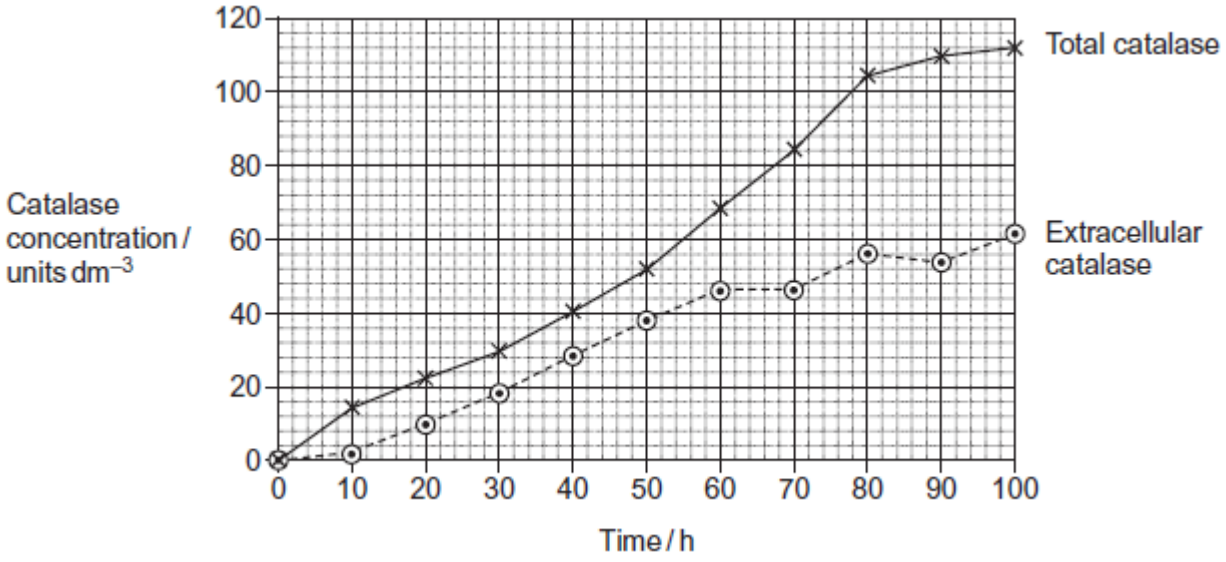
Q52.

Some of the catalase produced by *Aspergillus niger* is intracellular and some is extracellular.
Intracellular enzymes stay inside the cells that produce them. Extracellular enzymes are secreted from the cells that produce them.

Another group of scientists grew a different strain of *A. niger*.

- *A. niger* grows from tiny structures called spores. The scientists kept the spores in an isotonic medium at a low temperature until they needed them.
- They put spores of *A. niger* into a 500 cm^3 flask containing a sterile medium. The medium contained starch.
- They measured the total amount of catalase and the amount of extracellular catalase produced by the fungus over a period of 100 hours.

The graph shows their results.



(a) (i) The scientists kept the spores in an isotonic medium until they were needed. Suggest why it was important that the medium was isotonic.

_____

_____

_____

_____

_____

(2)

(ii) The scientists kept the spores at a low temperature until they were needed. Suggest why.

_____

_____

_____

(1)

(b) Starch is a source of carbon, hydrogen and oxygen for the fungus. Name one other chemical element that must be in the culture medium before *A. niger* can synthesise catalase. Give the reason for your answer.

Chemical element _____

Reason _____

_____

_____

_____

(2)

(c) To get reliable results in this investigation, the medium must be sterile.
Explain why.

_____

_____

_____

_____

_____

(2)

(d) (i) At what time was the concentration of intracellular catalase highest?

_____

(1)

(ii) Between what times was the rate of total catalase production highest?

_____

(1)

(e) Technologists prefer to manufacture extracellular enzymes rather than intracellular enzymes. This is because intracellular enzymes are more expensive to purify than extracellular enzymes. Suggest why intracellular enzymes are more expensive to purify.

_____

_____

_____

_____

_____

(2)

(Total 11 marks)

Q53.

Read the following passage.

Aspirin is a very useful drug. One of its uses is to reduce fever and inflammation. Aspirin does this by preventing cells from producing substances called prostaglandins. Prostaglandins are produced by an enzyme-controlled pathway. Aspirin works by inhibiting one of the enzymes in this pathway. Aspirin attaches permanently to a chemical group on one of the monomers that make up the active site of this enzyme.

The enzyme that is involved in the pathway leading to the production of prostaglandins is also involved in the pathway leading to the production of thromboxane. This is a substance that promotes blood clotting. A small daily dose of aspirin may reduce the risk of myocardial infarction (heart attack).

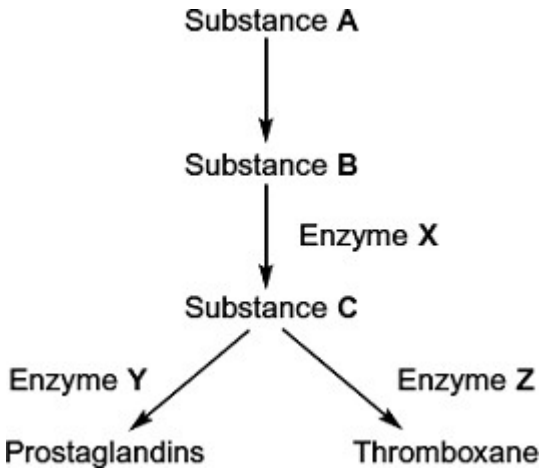
Use information from the passage and your own knowledge to answer the following questions.

(a) Name the monomers that make up the active site of the enzyme (lines 6 – 7).

_____

(1)

(b) The diagram shows the pathways by which prostaglandins and thromboxane are formed.



(i) Aspirin only affects one of the enzymes in this pathway. Use information in lines 5 - 7 to explain why aspirin does **not** affect the other enzymes.

_____

_____

_____

_____

_____

(2)

(ii) Which enzyme, **X**, **Y** or **Z**, is inhibited by aspirin? Explain the evidence from the passage that supports your answer.

Enzyme _____

Explanation _____

_____

_____

(2)

(c) Aspirin is an enzyme inhibitor. Explain how aspirin prevents substrate molecules being converted to product molecules.

_____

_____

_____

_____

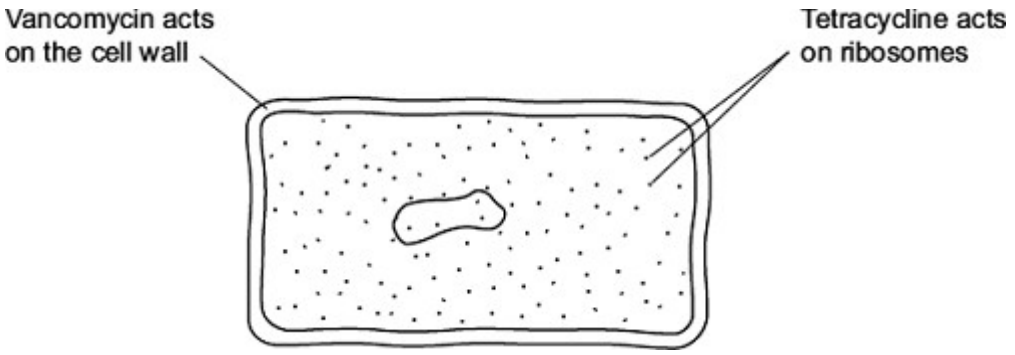
_____

(2)

(Total 7 marks)

Q54.

The diagram shows the structure of a bacterium and the sites of action of two antibiotics.



(a) (i) Use information in the diagram to explain why vancomycin does **not** affect human cells.

_____

_____

(1)

(ii) Use information in the diagram to explain how tetracycline prevents bacterial growth.

_____

_____

(1)

(b) Frequent treatment with vancomycin can result in resistant strains of bacteria. Explain how.

_____

_____

_____

_____

_____

_____

(2)

(Total 4 marks)

Q55.

The equation shows the breakdown of lactose by the enzyme lactase.



(a) (i) Name the type of reaction catalysed by the enzyme lactase.

_____

(1)

(ii) Name monosaccharide **X**.

_____

(1)

(b) (i) Describe how you would use a biochemical test to show that a reducing sugar is present.

_____

_____

_____

_____

_____

(2)

(ii) Lactose, galactose and monosaccharide **X** are all reducing sugars. After the lactose has been broken down there is a higher concentration of reducing sugar. Explain why.

_____

(1)

(c) A high concentration of galactose slows down the breakdown of lactose by lactase. Use your knowledge of competitive inhibition to suggest why.

_____

_____

_____

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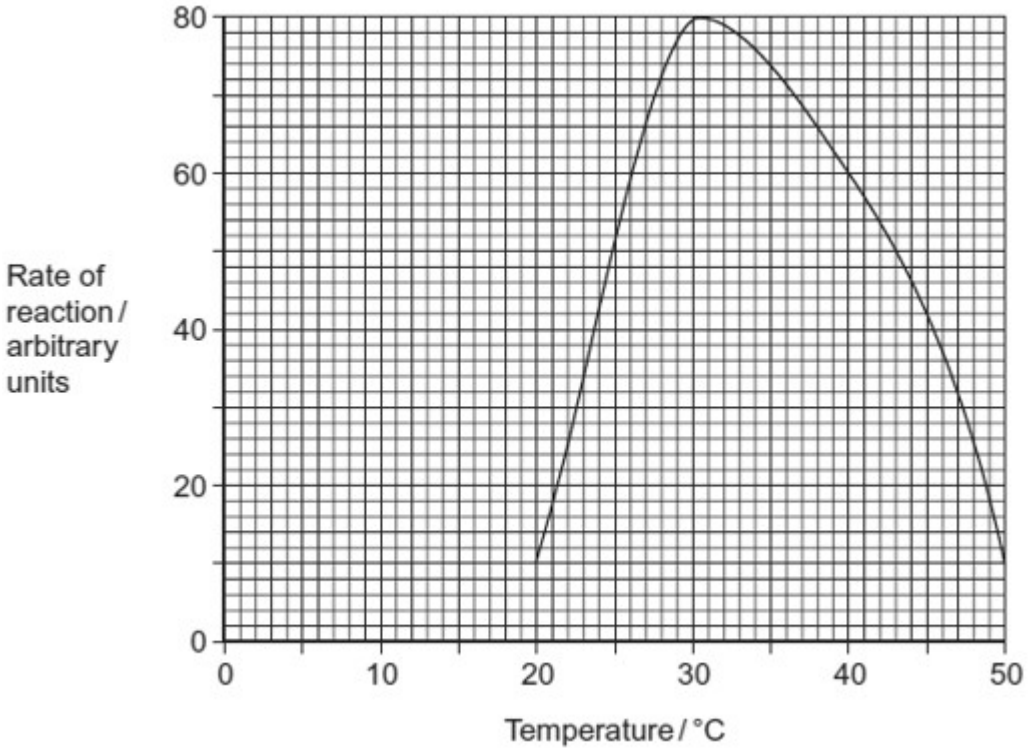
_____

(2)

(Total 7 marks)

Q56.

A protease is an enzyme that digests protein. The graph shows how the activity of a protease varies with temperature.



(a) (i) Describe what the graph shows about the effect of temperature on the rate of reaction.

_____

_____

_____

(1)

(ii) Explain the shape of the curve between 30 °C and 50 °C.

_____

_____

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_____

_____

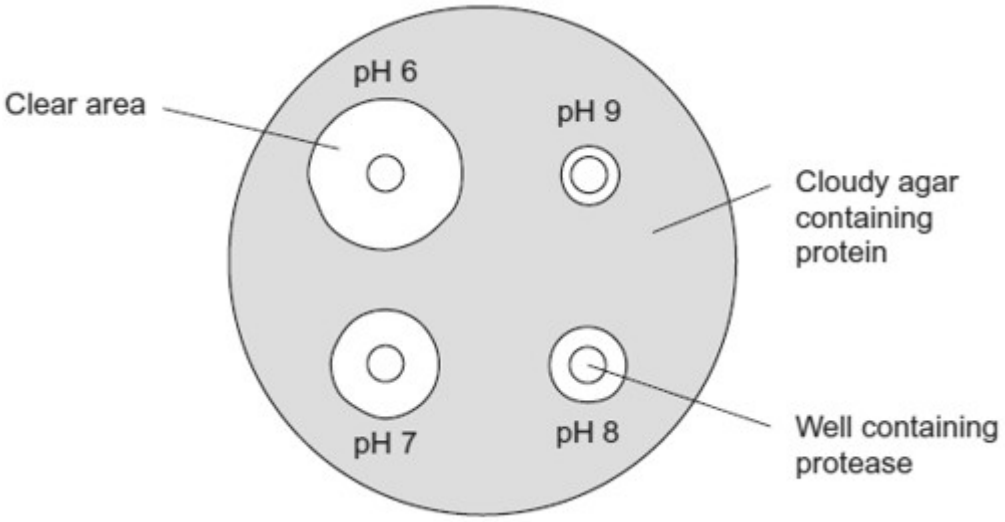
_____

(3)

(b) Students investigated the effect of pH on the activity of the protease.

- The students used agar plates containing protein. The protein made the agar cloudy.
- They made four wells of equal size in the agar of each plate.
- They added a drop of protease solution to each of the wells. The protease solution in each well was at a different pH.
- The students incubated the agar plates for 4 hours at a constant temperature.

The diagram shows the agar plates after they were incubated and the pH of the protease solution in each well.



(i) How should the students make sure that the pH of the protease solution did **not** change?

_____

(1)

(ii) Use the graph to suggest a suitable temperature for incubating the agar plates.

Explain your answer.

_____

_____

_____

(1)

(iii) Use the diagram to describe the effect of pH on the activity of this protease.

_____

_____

_____

(1)

(Total 7 marks)

Q57.

(a) *Clostridium difficile* is a bacterium that is present in the gut of up to 3% of healthy adults and 66% of healthy infants.

(i) *C. difficile* rarely causes problems, either in healthy adults or in infants. This is because its numbers are kept low by competition with harmless bacteria that normally live in the intestine.

Use this information to explain why some patients treated with antibiotics can be affected by *C. difficile*.

_____

_____

_____

_____

_____

(2)

(ii) Suggest why older people are more likely to be affected by *C. difficile*.

_____

_____

_____

(1)

(b) The antibiotic methicillin inhibits the enzyme transpeptidase. This enzyme is used by some bacteria to join monomers together during cell wall formation. Methicillin has a similar structure to these monomers. Use this information to explain how methicillin inhibits the enzyme transpeptidase.

_____

_____

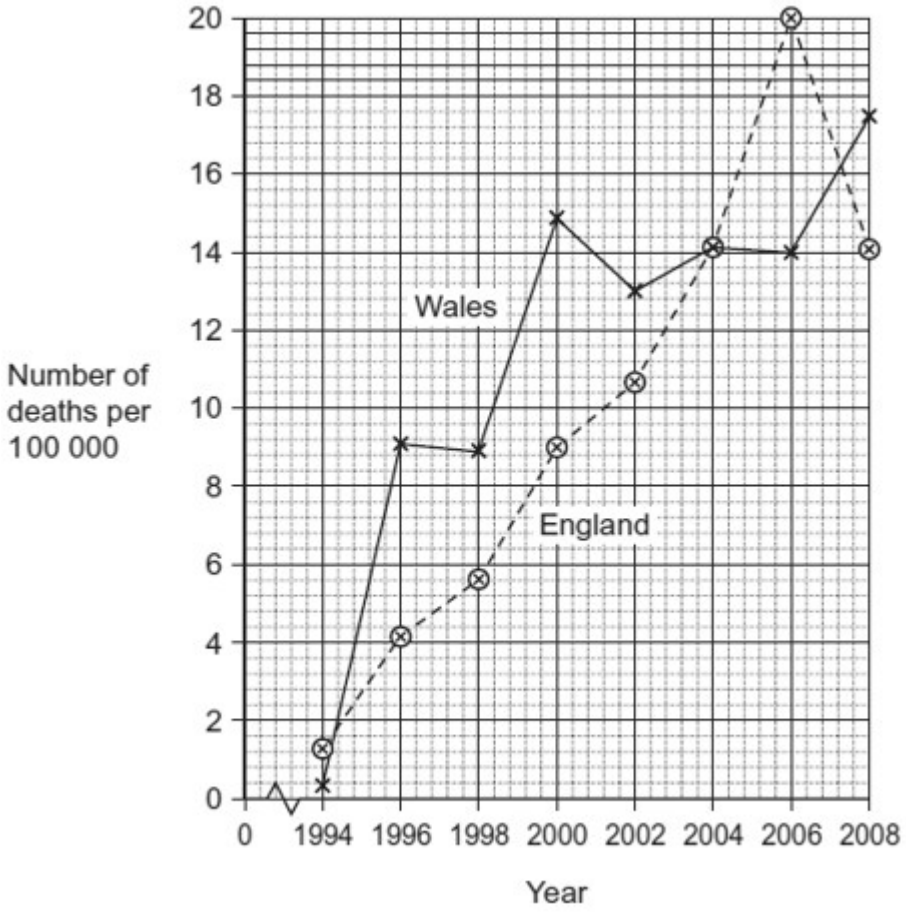
_____

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(2)

(c) MRSA is a variety of *Staphylococcus aureus*. It is difficult to treat infections caused by this bacterium because it is resistant to methicillin and to some other antibiotics. As a result, some patients who are already very ill may die if they become infected with MRSA. The graph shows the number of deaths in England and Wales between 1994 and 2008 caused by MRSA.



(i) It may be difficult to identify MRSA as the actual cause of death. Explain why.

_____

_____

_____

(1)

(ii) Describe the change in the number of deaths caused by MRSA in England in the period shown in the graph.

_____

_____

_____

(1)

(iii) Calculate the percentage increase in the number of deaths caused by MRSA in Wales from 1996 to 2006. Show your working.

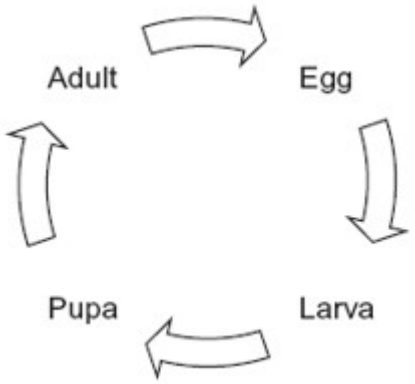
Answer _____

(2)

(Total 9 marks)

Q58.

The diagram shows the life cycle of a fly.



When the larva is fully grown, it changes into a pupa. The pupa does not feed. In the pupa, the tissues that made up the body of the larva are broken down. New adult tissues are formed from substances obtained from these broken-down tissues and from substances that were stored in the body of the larva.

(a) Hydrolysis and condensation are important in the formation of new adult proteins. Explain how.

_____

_____

_____

_____

(2)

(b) Most of the protein stored in the body of a fly larva is a protein called calliphorin. Explain why different adult proteins can be made using calliphorin.

_____

_____

(1)

The table shows the mean concentration of RNA in fly pupae at different ages.

Age of pupa as percentage of total time spent as a pupa	Mean concentration of RNA / µg per pupa
0	20
20	15
40	12
60	17
80	33
100	20

(c) Describe how the concentration of RNA changes during the time spent as a pupa.

_____

_____

_____

_____

(2)

(d) (i) Describe how you would expect the number of lysosomes in a pupa to change with the age of the pupa. Give a reason for your answer.

_____

_____

_____

_____

(2)

(ii) Suggest an explanation for the change in RNA concentration in the first 40% of the time spent as a pupa.

_____

_____

_____

_____

_____

(2)

(e) Suggest an explanation for the change in RNA concentration between 60 and 80% of the time spent as a pupa.

_____

_____

_____

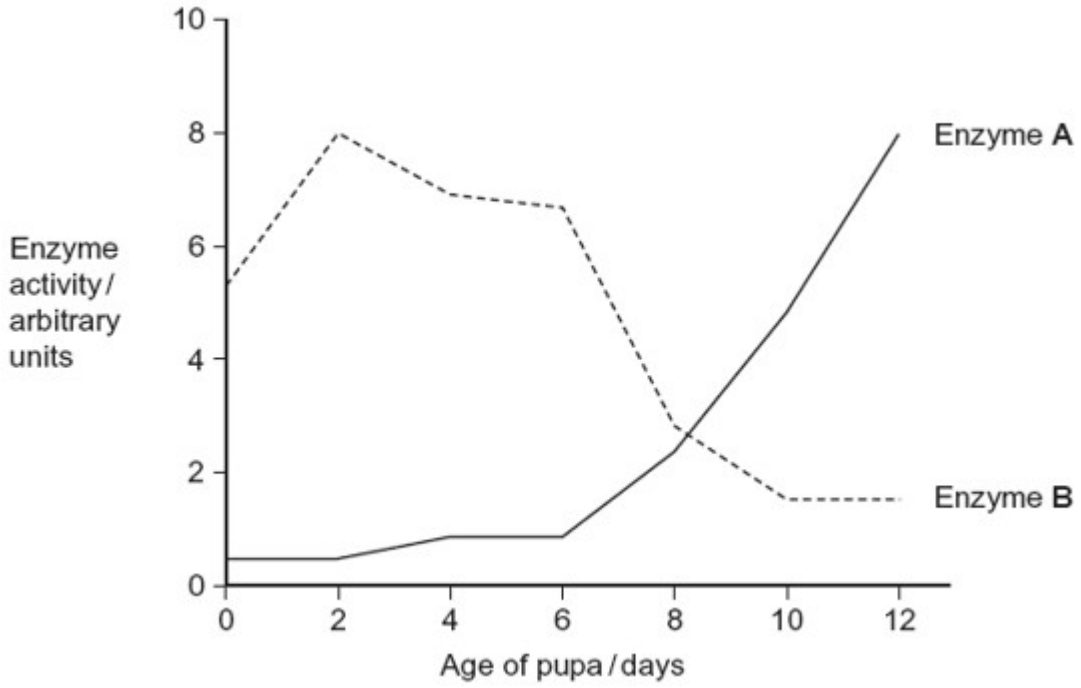
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_____

(2)

(f) The graph shows changes in the activity of two respiratory enzymes in a fly pupa.

- Enzyme **A** catalyses a reaction in the Krebs cycle
- Enzyme **B** catalyses the formation of lactate from pyruvate



During the first 6 days as a pupa, the tracheae break down. New tracheae are formed after 6 days. Use this information to explain the change in activity of the two enzymes.

_____

_____

_____

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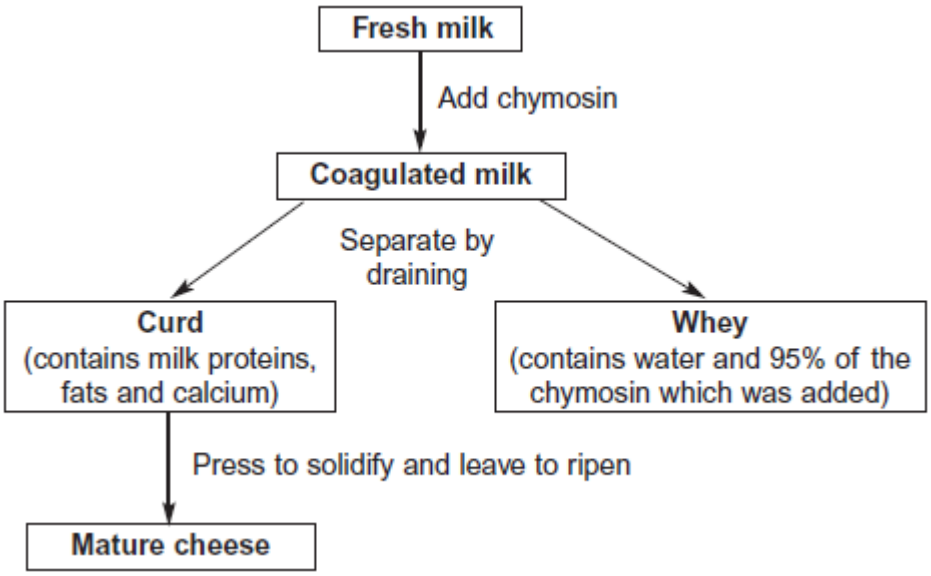
_____

(4)

(Total 15 marks)

Q59.

The figure below summarises the way in which cheese is made.



(a) A student carried out a biuret test on a sample of whey. The sample turned purple. Use the flowchart to explain why.

_____

_____

_____

_____

_____

(2)

(b) The percentage of protein in mature cheese is greater than the percentage of protein in coagulated milk. Use the flow chart to explain why.

_____

_____

_____

(1)

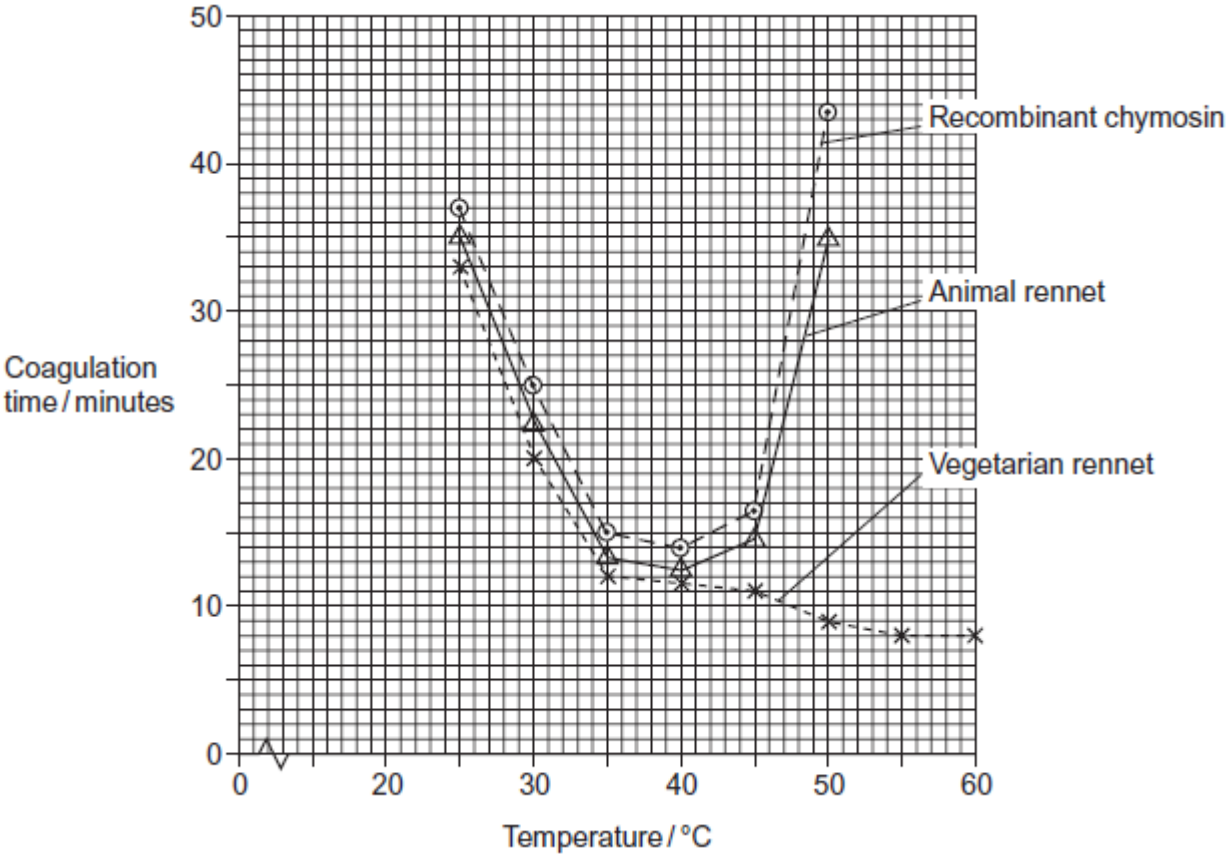
(Total 3 marks)

Q60.

Different extracts may be added to milk to make cheese. All of these extracts contain chymosin.

- Animal rennet comes from calves and lambs. Rennet from these young animals contains between 80 and 95% chymosin. It also contains between 5 and 20% of another protein-digesting enzyme called pepsin.
- Vegetarian rennet comes from fungi. It contains 100% chymosin.
- Recombinant chymosin comes from bacteria which have had an animal gene for chymosin inserted in them. It contains 100% chymosin.

Scientists investigated the effect of temperature on the time these different extracts took to coagulate milk. Their results are shown below.



(a) Suggest **two** disadvantages of using animal rennet rather than recombinant chymosin as a source of chymosin for making cheese.

1. _____

_____

2. _____

_____

(2)

(b) The shape of the curve for recombinant chymosin is similar to the shape of the curve for animal rennet. Suggest why.

_____

_____

_____

(1)

(c) (i) Describe how the coagulation time for vegetarian rennet is different from that for animal rennet.

_____

_____

_____

(1)

(ii) Calculate the percentage reduction in coagulation time between 45 °C and 60 °C for vegetarian rennet. Show your working.

Answer _____%

(2)

(d) Explain the shape of the curve for animal rennet above 45 °C.

_____

_____

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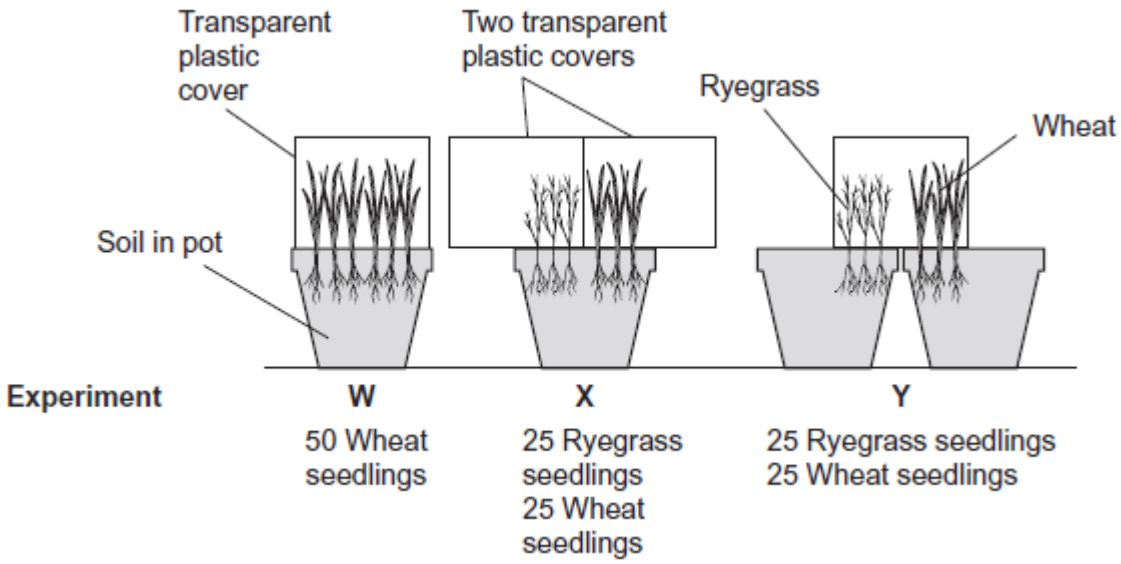
(3)

(Total 9 marks)

Q61.

Wheat is an important cereal crop. Ryegrass is a weed in wheat fields. Wheat and ryegrass belong to the grass family.

Scientists investigated competition between wheat and ryegrass seedlings. They set up three experiments **W, X**, and **Y** as shown in the diagram.



The table shows the mean dry mass of the wheat seedlings as a percentage of their dry mass when grown alone.

	Experiment		
	W	**X**	**Y**
Mean dry mass of wheat seedlings as a percentage of their dry mass when grown alone	100	76	46

(a) Experiment **W** was a control experiment. Explain the purpose of the control experiment in this investigation.

_____

_____

_____

_____

_____

(2)

(b) What can you conclude from this investigation about competition between wheat and ryegrass? Use the data in the table to support your answer.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(c) Explain how a decrease in temperature could affect the outcome of this investigation.

_____

_____

_____

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_____

(2)

(Total 8 marks)

Q62.

In the early 1980s, before DNA analysis had been developed, scientists investigated the genetic variation of cheetahs living in captivity. They used skin grafts to do this. They carried out skin grafts on anaesthetised animals by

- removing a small piece of skin from one animal. This animal was the recipient.
- replacing the removed skin by a piece of skin taken from another animal. This animal was the donor.
- attaching the new piece of skin with stitches.

A graft may be accepted by the recipient. It will be rejected if the recipient's immune system recognises the antigens on the skin as foreign.

Scientists carried out skin grafts between cheetahs living in captivity and domestic cats. The table shows the data that they obtained.

Recipient of skin graft	Donor of skin graft	Relationship	Time taken for the graft to be rejected / days
Domestic cat 1	Domestic cat 2	Unrelated	13
Cheetah 1	Domestic cat 3	Unrelated	12
Cheetah 1	Cheetah 2	Sisters	No rejection after 52 days
Cheetah 3	Cheetah 4	Unrelated	49
Cheetah 5	Cheetah 6	Unrelated	No rejection after 78 days
Cheetah 7	Cheetah 8	Unrelated	No rejection after 41 days
Cheetah 9	Cheetah 10	Unrelated	No rejection after 24 days

Cheetah 11	Cheetah 12	Unrelated	No rejection after 14 days
Cheetah 13	Cheetah 14	Unrelated	No rejection after 44 days

The scientists also grafted skin from one area to another on the same animal. These grafts were not rejected.

(a) (i) The scientists grafted skin from a domestic cat to a cheetah. Suggest why.

_____

_____

(1)

(ii) They also grafted skin from one area to another on the same animal. Explain why.

_____

_____

(1)

(b) (i) Give **three** conclusions that you can make from the data in the table above about the time taken for rejection.

1. _____

_____

2. _____

_____

3. _____

_____

(3)

(ii) Give **one** reason why these conclusions may **not** be reliable.

_____

_____

(1)

(iii) There are proteins on the skin of cheetahs that act as antigens. What do the data in the table suggest about these cheetah antigens?

_____

_____

(1)

(iv) Antigens are proteins. Explain why a knowledge of antigens can show that animals are genetically similar.

_____

_____

_____

_____

(2)

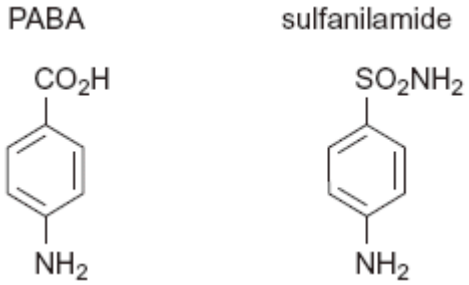
(Total 9 marks)

Q63.

Folic acid is a substance required by bacteria for cell growth. Bacteria produce folic acid by the following reaction.



The diagram shows the structure of a molecule of PABA. It also shows the structure of a molecule of a drug called sulfanilamide, which can be used to treat bacterial infections. Sulfanilamide prevents bacteria producing folic acid.



Use the diagram and your knowledge of enzymes to explain how sulphanilamide prevents bacteria producing folic acid.

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(Total 3 marks)

Q64.

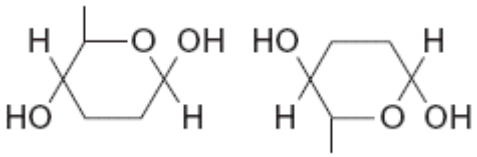
(a) The table shows some substances found in cells. Complete the table to show the properties of these substances. Put a tick in the box if the statement is correct.

Statement	**Substance**			
	Starch	Glycogen	Deoxyribose	DNA

				helicase
Substance contains only the elements carbon, hydrogen and oxygen				
Substance is made from amino acid monomers				
Substance is found in both animal cells and plant cells				

(4)

(b) The diagram shows two molecules of β-glucose.



On the diagram, draw a box around the atoms that are removed when the two β-glucose molecules are joined by condensation.

(2)

(c) (i) Hydrogen bonds are important in cellulose molecules. Explain why.

_____

_____

_____

_____

(2)

(ii) A starch molecule has a spiral shape. Explain why this shape is important to its function in cells.

_____

_____

_____

(1)

(Total 9 marks)

Q65.

Gangliosides are lipids found in the cell surface membranes of nerve cells. Hexosaminidase is an enzyme present in blood that breaks down gangliosides. If gangliosides are not broken down, they damage nerve cells.

(a) Hexosaminidase only breaks down gangliosides. It does not break down other lipids.

Explain why this enzyme only breaks down gangliosides.

_____

_____

_____

_____

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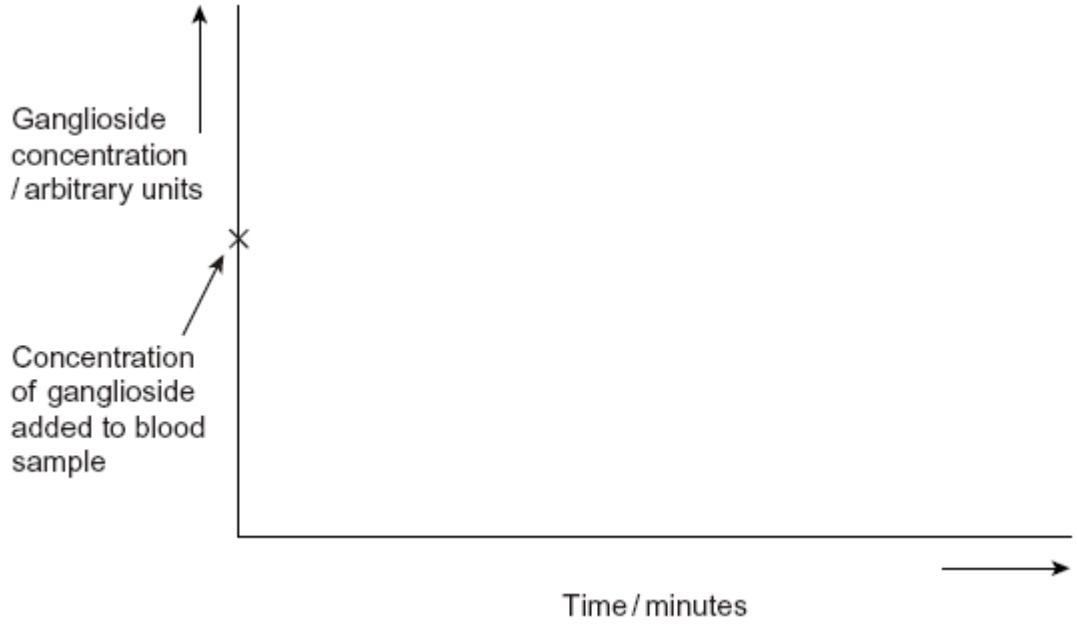
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(3)

(b) Hexosaminidase is found in the blood of healthy people. People with Tay Sachs disease do not have this enzyme in their blood.

Doctors confirm Tay Sachs disease by using a blood test. The technician carrying out the test adds a solution containing a high concentration of gangliosides to a sample of blood from the person being tested. The technician then measures the concentration of gangliosides in the person's blood at regular intervals.

(i) Complete the graph below by sketching a curve to show the results you would expect for a person with Tay Sachs disease. Label this curve **T**.



(1)

(ii) Sketch a curve on the same graph to show the results you would expect for a healthy person who does **not** have Tay Sachs disease. Label this curve **H**.

(1)

(c) Scientists are trying to find a way to give the missing enzyme to people with Tay Sachs disease. Suggest why they cannot give the enzyme as a tablet that is swallowed.

_____

_____

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_____

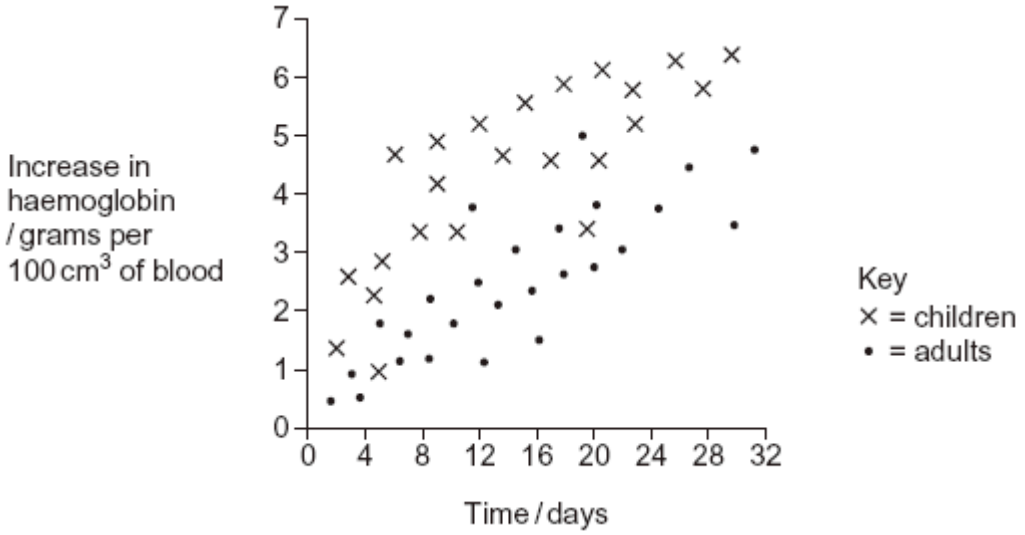
(2)

(Total 7 marks)

Q66.

(a) Haemoglobin contains iron. One type of anaemia is caused by a lack of iron. This type of anaemia can be treated by taking tablets containing iron. A number of patients were given a daily dose of 120 mg of iron. **Figure 1** shows the effect of this treatment on the increase in the concentration of haemoglobin in their red blood cells.

Figure 1



(i) Give **one** difference in the response of adults and children to this treatment.

_____

_____

(1)

(ii) You could use the graph to predict the effect of this treatment on the increase in haemoglobin content of an adult after 40 days. Explain how.

_____

_____

_____

_____

(2)

(iii) Haemoglobin has a quaternary structure. Explain what is meant by a quaternary structure.

_____

_____

(1)

(b) (i) Pernicious anaemia is another type of anaemia. One method of identifying pernicious anaemia is to measure the diameter of the red blood cells in a sample of blood that has been diluted with an isotonic salt solution. Explain why an isotonic salt solution is used to dilute the blood sample.

_____

_____

_____

_____

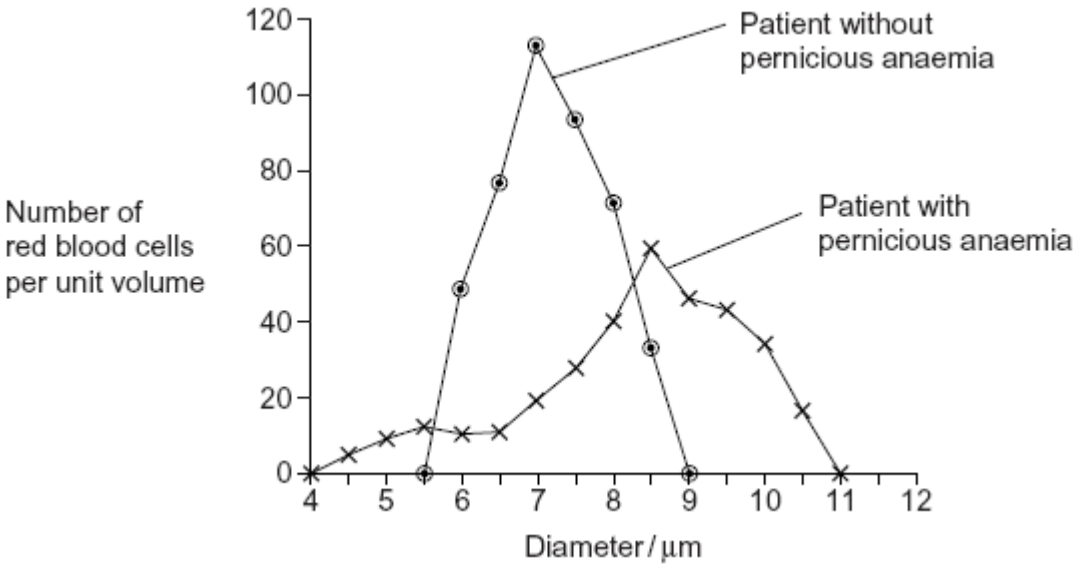
_____

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(3)

(ii) A technician compared the red blood cells in two blood samples of equal volume. One sample was from a patient with pernicious anaemia, the other was from a patient who did not have pernicious anaemia. **Figure 2** shows some of the results she obtained.

Figure 2



Describe **two** differences between the blood samples.

1. _____

_____

2. _____

_____

(2)
(Total 9 marks)

Q67.

Nitrogenase catalyses the reduction of nitrogen during nitrogen fixation. The reaction requires 16 molecules of ATP for each molecule of nitrogen that is reduced.

(a) Nitrogen gas is the usual substrate for this enzyme. Name the product.

_____

(1)

(b) Nitrogenase also catalyses reactions involving other substances. Explain what this suggests about the shapes of the molecules of these other substances.

_____

_____

_____

_____

_____

(2)

(c) (i) *Azotobacter* is a nitrogen-fixing bacterium. It produces the enzyme nitrogenase. The enzyme only works in the absence of oxygen.

Azotobacter has a very high rate of aerobic respiration compared with bacteria that do not fix nitrogen. Suggest **two** advantages of the very high rate of aerobic respiration.

_____

_____

_____

_____

_____

(2)

(ii) If scientists could transfer the gene that codes for nitrogenase to cereal plants, these cereal plants would be able to fix nitrogen. However, the scientists would expect these genetically engineered cereal plants to grow more slowly than cereal plants that get their nitrogen from fertiliser. Explain why they would grow more slowly.

_____

_____

_____

_____

_____

(2)

(Total 7 marks)

Q68.

Lettuce growers investigated the best conditions for germinating lettuce seeds. They soaked lettuce seeds for 8 hours in distilled water at different temperatures. They then germinated some of the seeds at 20°C and some at 35°C. The table shows their results.

Temperature at which seeds were soaked / ?C	Percentage of seeds which germinated	
	at 20°C	at 35°C
20	100	89
25	100	43
30	41	1
35	21	0

(a) Use the information above to describe and explain the effect of temperature on lettuce seed germination.

_____

_____

_____

_____

_____

_____

(3)

(b) Explain why the lettuce growers measured germination as a percentage.

_____

_____

(1)

(Total 4 marks)

Q69.

Doctors compared two tests for lactase deficiency.

Doctors investigated three groups of people. The people in all three groups were not allowed to eat or drink for 8 hours before the test. They each then drank a solution

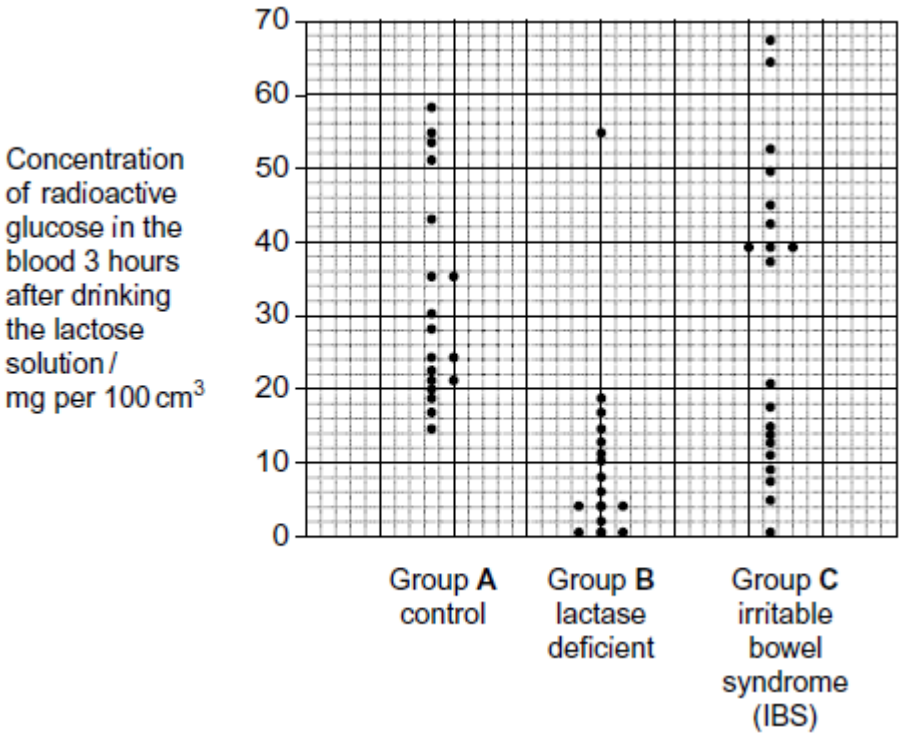
containing 50 g of lactose made with a radioactive form of carbon called ^{14}C.

- Group **A** were the control group
- Group **B** were lactase deficient
- Group **C** had irritable bowel syndrome (IBS)

Both lactase deficiency and irritable bowel syndrome have similar symptoms.

The lactose tolerance test

The doctors measured the concentration of radioactive glucose in the blood of each person. The figure below shows the results. Each point shows the result for one person 3 hours after drinking the lactose solution.



(a) (i) Give the range of results for the control group (group **A**)

_____

(1)

(ii) Each person in the control group was given 50 g of lactose containing the same amount of radioactive carbon. All the products of lactose digestion were absorbed into their blood. The concentration of glucose was measured in mg per 100 cm^3 of blood.

Explain why the variation in the results may be due to differences in body mass.

_____

_____

_____

_____

(2)

(b) In the test the doctors obtained different results for the three groups.

Would this test be useful to identify people who were lactase deficient? Use the data from all three groups to explain your answer.

_____

_____

_____

_____

_____

_____

(3)

(Total 6 marks)

Q70.

Doctors compared two tests for lactase deficiency.

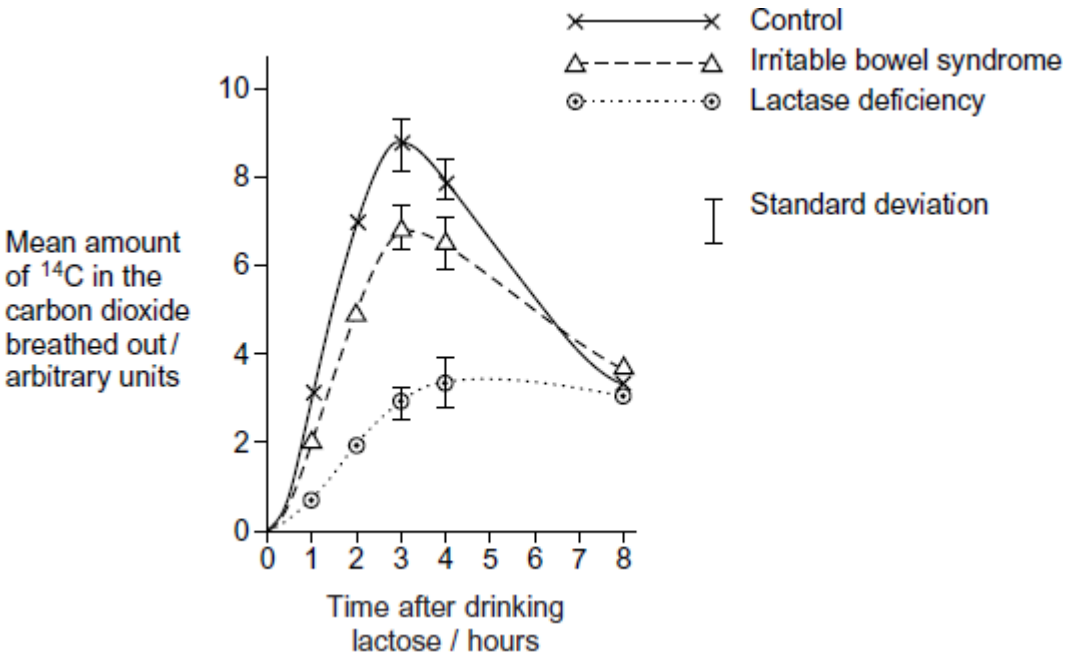
Doctors investigated three groups of people. The people in all three groups were not allowed to eat or drink for 8 hours before the test. They each then drank a solution containing 50 g of lactose made with a radioactive form of carbon called ^{14}C.

- Group **A** were the control group
- Group **B** were lactase deficient
- Group **C** had irritable bowel syndrome (IBS)

Both lactase deficiency and irritable bowel syndrome have similar symptoms.

The carbon dioxide breath test

In this test the doctors measured the amount of ^{14}C in the carbon dioxide breathed out. The doctors took measurements at intervals for 8 hours after each volunteer had drunk the lactose solution. The following figure shows the mean results for each group.



(a) Describe the common trend shown by **all** the curves in the figure.

_____

_____

_____

(1)

(b) Explain why the doctors stopped measuring the amounts of ^{14}C in the carbon dioxide breathed out after 8 hours.

_____

_____

_____

_____

(2)

(c) Carbon dioxide in the breath contained the radioactive form of carbon, ^{14}C. Explain how ^{14}C in carbon dioxide came from ^{14}C in glucose in the blood.

_____

_____

_____

_____

(2)

(d) The doctors concluded that measuring the amount of ^{14}C in the carbon dioxide in the breath after 3 hours was a better way of diagnosing lactase deficiency than the lactose tolerance test. Do you agree with the doctors' conclusion? Give the reasons for your answer.

_____

_____

_____

_____

_____

(2)

(Total 7 marks)

Q71.

Biologists divided new-born rats randomly into four groups.

They fed the rats in each group on a standard diet which only differed in the carbohydrate content. When these rats were adult, the biologists measured the activity of lactase in the digestive system of the rats. The following table shows the mean results for each group.

Diet	Mean lactase activity / μ mol of lactose digested per hour (± standard deviation)
Low sucrose	57.9 (± 14.5)
High sucrose	184.2 (± 30.8)
Low starch	86.9 (± 13.3)
High starch	221.4 (± 25.4)

(a) Give **one** piece of evidence from the table that indicates lactase activity is affected by diet.

_____

_____

(1)

(b) Some students suggested from these data that increasing starch in the diet was the most effective way to increase lactase activity in lactase deficient people. Is this conclusion valid? Explain your answer.

_____

_____

_____

_____

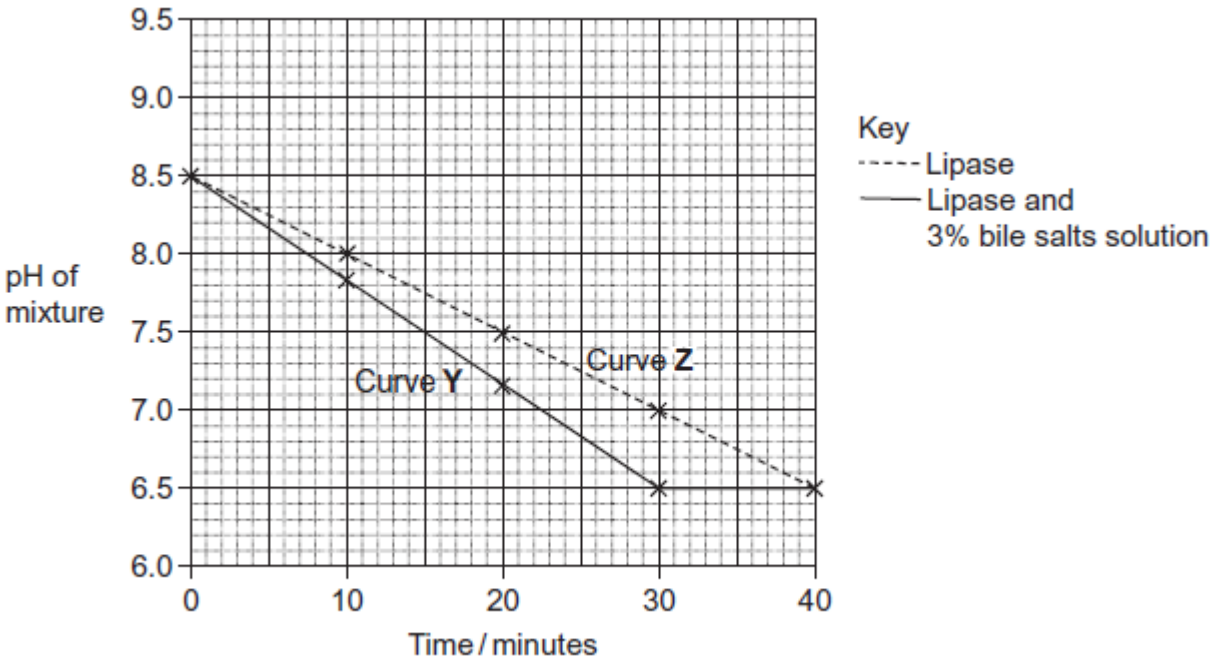
_____

(2)

(Total 3 marks)

Q72.

Scientists investigated the effect of lipase and a 3% bile salts solution on the digestion of triglycerides. The graph below shows their results.



The scientists also incubated triglycerides with different concentrations of bile salts. After 30 minutes they measured the diameter of the triglyceride droplets. They used the results to calculate the mean radius of the droplets at each concentration. The table below shows their results.

Concentration of bile salts /%	0	1	2	3	4	5
Mean radius of triglyceride droplet / μm	6	5	4	3	2	1

(a) Describe how you would use a microscope to find the mean diameter of triglyceride droplets on a slide.

_____

_____

_____

_____

_____

_____

(3)

(b) (i) The ratio of mean radius of triglyceride droplets in bile salts at a concentration of 0% to the mean radius in bile salts at a concentration of 3% is 2 : 1.

What is the ratio of their surface areas? Show your working.

You can calculate the surface area of a droplet from the formula

$$A = 4\pi r^2$$

Where A = surface area
r = radius
π = 3.14

(2)

(ii) Use the data in the table to explain the difference between curves **Y** and **Z** in the graph.

_____

_____

_____

_____

_____

_____

(3)

(Total 8 marks)

Q73.

(a) (i) The equation shows the reaction catalysed by the enzyme lactase. Complete this equation.

Lactose + _____ ⟶ Glucose + _____

(2)

(ii) Name the type of chemical reaction shown in this equation.

_____

(1)

(b) Lactase is an enzyme. Lactose is a reducing sugar.

(i) Describe how you could use the biuret test to distinguish a solution of the enzyme, lactase from a solution of lactose.

_____

_____

(1)

(ii) Explain the result you would expect with the enzyme.

_____

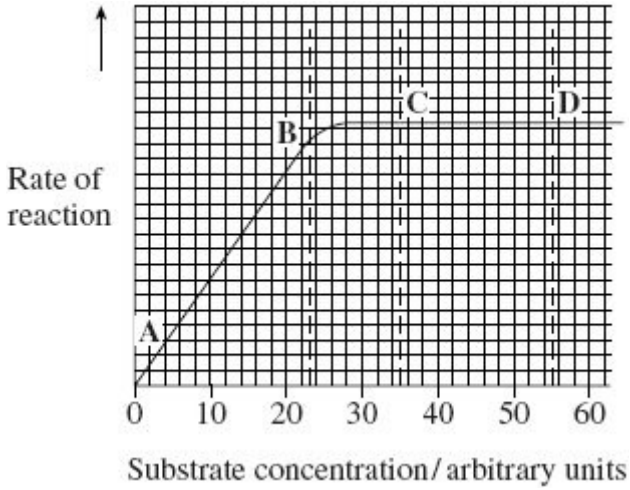
_____

(1)

(Total 5 marks)

Q74.

The graph shows the effect of substrate concentration on the rate of an enzyme-controlled reaction.



(a) (i) Describe what the graph shows about the effect of substrate concentration on the rate of this enzyme-controlled reaction.

_____

_____

_____

_____

(2)

(ii) What limits the rate of this reaction between points **A** and **B**? Give the evidence from the graph for this.

_____

_____

_____

_____

(2)

(iii) Suggest a reason for the shape of the curve between points **C** and **D**.

_____

_____

(1)

(b) Sketch a curve on the graph to show the rate of this reaction in the presence of a competitive inhibitor.

(1)

(c) Methotrexate is a drug used in the treatment of cancer. It is a competitive inhibitor and affects the enzyme folate reductase.

(i) Explain how the drug lowers the rate of reaction controlled by folate reductase.

_____

_____

_____

_____

_____

(2)

(ii) Methotrexate only affects the rate of the reaction controlled by folate reductase.

Explain why this drug does not affect other enzymes.

_____

_____

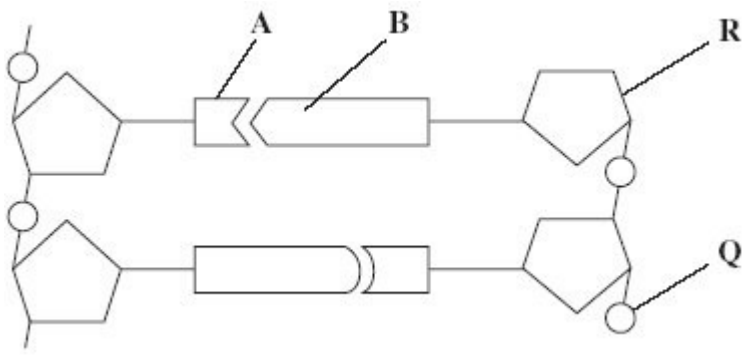
(1)

(Total 9 marks)

Q75.

Figure 1 shows a short section of a DNA molecule.

Figure 1



(a) Name parts **R** and **Q**.

(i) **R** _____

(ii) **Q** _____

(2)

(b) Name the bonds that join **A** and **B**.

_____

(1)

(c) Ribonuclease is an enzyme. It is 127 amino acids long.

What is the minimum number of DNA bases needed to code for ribonuclease?

(1)

(d) **Figure 2** shows the sequence of DNA bases coding for seven amino acids in the enzyme ribonuclease.

Figure 2

G T T T A C T A C T C T T C T T C T T T A

The number of each type of amino acid coded for by this sequence of DNA bases is shown in the table.

Amino acid	Number present
Arg	3
Met	2
Gln	1
Asn	1

Use the table and **Figure 2** to work out the sequence of amino acids in this part of the enzyme. Write your answer in the boxes below.

Gln						

(1)

(e) Explain how a change in a sequence of DNA bases could result in a non-functional enzyme.

_____

_____

_____

_____

_____

_____

(3)

(Total 8 marks)

Q76.

A glucose biosensor is an instrument used to measure glucose concentration. It contains an enzyme called glucose oxidase.

(a) A glucose biosensor detects only glucose. Use your knowledge of the way in which enzymes work to explain why.

_____

_____

_____

_____

_____

_____

(3)

(b) It is better to use a biosensor than the Benedict's test to measure the concentration of glucose in a sample of blood. Suggest **two** reasons why.

1. _____

_____

2. _____

_____

(2)

(c) (i) Diabetes mellitus is a disease that can lead to an increase in blood glucose concentration. Some diabetics need insulin injections. Insulin is a protein so it cannot be taken orally. Suggest why insulin cannot be taken orally.

_____

_____

_____

(1)

(ii) A drug company produced a new type of insulin. Scientists from the company carried out a trial in which they gave this new type of insulin to rats. They reported that the results of this trial on rats were positive. A newspaper stated that diabetics would benefit from this new drug. Suggest **two** reasons why this statement should be viewed with caution.

1. _____

_____

2. _____

_____

(2)

(Total 8 marks)

Q77.

(a) Describe the role of the enzymes of the digestive system in the complete breakdown of starch.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(5)

(b) Describe the processes involved in the absorption of the products of starch digestion.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(5)

(Total 10 marks)

Q78.

Bromelain is a protein-digesting enzyme found in pineapples. Some people claim that bromelain tablets have benefitial effect on health. These effects include reducing swelling and pain after surgery and reducing growth of cancers.

Bromelain is absorbed from the gut into the blood. Scientists gave a group of volunteers 3 g of bromelain in tablets each day for three days. They then measured the maximum mass of bromelain in the blood of each volunteer. The mean value for the maximum mass of bromelain in the blood of the volunteers was 0.025 mg.

(a) There is a difference between the mass of bromelain that the volunteers were given and the maximum mass of bromelain in their blood. Suggest **one** explanation for this difference.

_____

_____

(1)

(b) The scientists measured the concentration of bromelain in the blood. What else did they need to measure to calculate the total mass of the bromelain in the blood of a volunteer?

_____

_____

(1)

(Total 2 marks)

Q79.

(a) Sucrose, maltose and lactose are disaccharides.

(i) Sucrase is an enzyme. It hydrolyses sucrose during digestion. Name the products of this reaction.

_____ and _____

(2)

(ii) Sucrase does **not** hydrolyse lactose. Use your knowledge of the way in which enzymes work to explain why.

_____

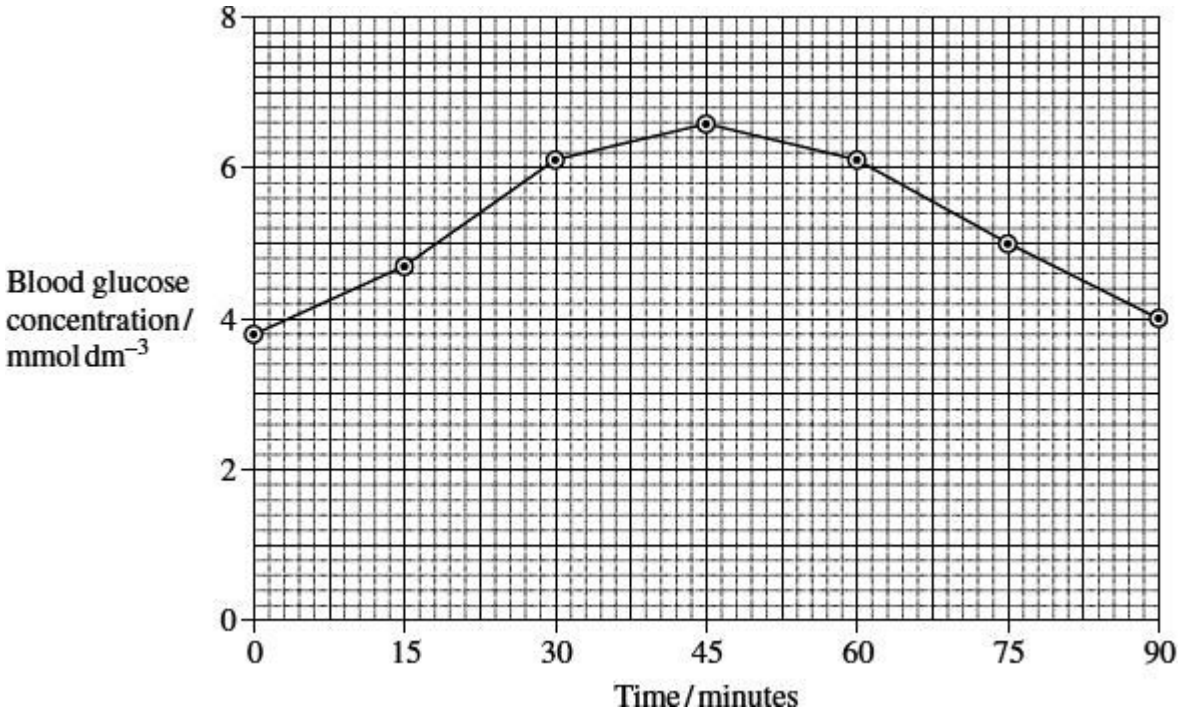
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_____

_____

(2)

(b) A woman was given a solution of sucrose to drink. Her blood glucose concentration was measured over the next 90 minutes. The results are shown on the graph.



(i) Describe how the woman's blood glucose concentration changed in the period shown in the graph.

_____

_____

_____

_____

(2)

(ii) Explain the results shown on the graph.

_____

_____

_____

_____

(2)

(Total 8 marks)

Q80.

Some enymes digest protein. They hydrolyse the peptide bonds between amino acids. The extent to which a protein is digested is called the degree of hydrolysis (DH). The DH value may be calculated from the equation:

$$DH = \frac{100 \times \text{Number of peptide bonds hydrolysed}}{\text{Total number of peptide bonds present}}$$

(a) (i) A protein molecule contains 151 amino acids. What is the total number of peptide bonds in this molecule?

_____

(1)

(ii) A molecule of this protein is digested. The DH value of the digested protein is 18. Calculate the number of peptide bonds that have been hydrolysed.

Answer _____

(1)

(b) What would be the DH value of a protein if it were completely hydrolysed to amino acids? Explain how you arrived at your answer.

DH value _____

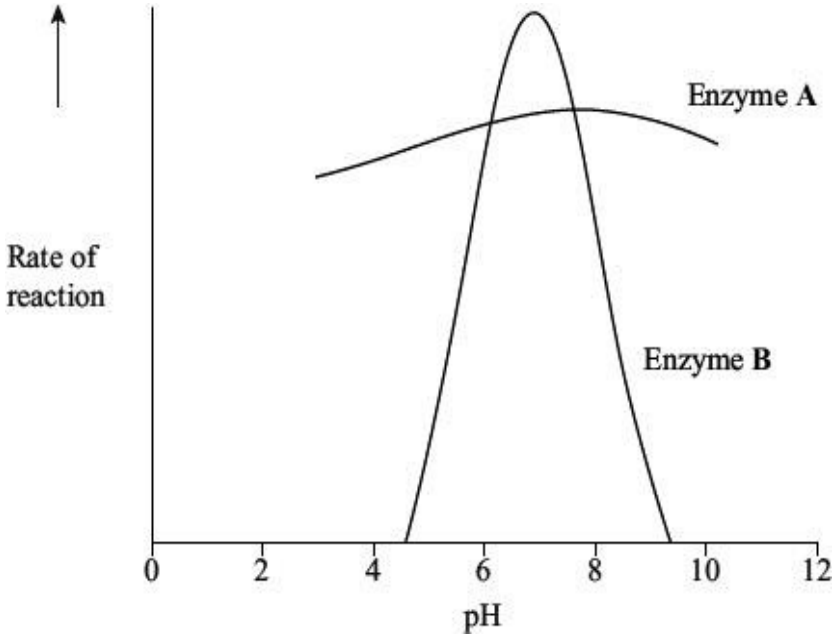
Explanation _____

_____

_____

(2)

Enzymes **A** and **B** digest protein. The graph shows the effect of pH on the rates of reaction of these enzymes.



(c) Pepsin is a protein-digesting enzyme found in the stomach. It has an optimum pH of 2 and is fully denatured at pH 6. Sketch a curve on the graph to show the effect of pH on the rate of reaction of pepsin.

(1)

(d) Explain why the rate of reaction of enzyme **B** is low at pH 5.

(3)

(e) Enzyme **A** is present in some washing powders used for cleaning clothes. Use the graph to suggest why enzyme **A** would be of more use in washing clothes than enzyme **B**.

(1)

(f) Use your knowledge of protein structure to explain why enzymes are specific and may be affected by non-competitive inhibitors.

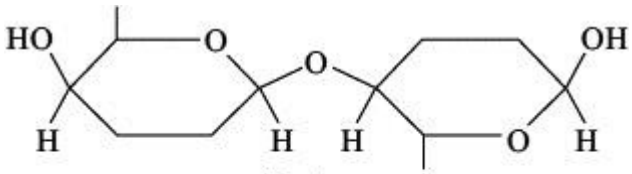
(6)

(Total 15 marks)

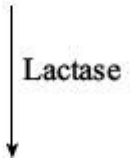
Q81.

Lactose is a disaccharide found in milk. In the human small intestine, the enzyme lactase catalyses the hydrolysis of lactose to the monosaccharides, galactose and glucose. These monosaccharides are then absorbed into the blood.

Complete the diagram to show the hydrolysis of lactose to galactose and glucose.



Lactose



(Total 2 marks)

Q82.

Uric acid is produced in the body. One of the reactions involved in the production of uric acid is catalysed by xanthine oxidase.

$$\text{xanthine} \xrightarrow{\text{xanthine oxidase}} \text{uric acid}$$

(a) A sample of xanthine oxidase was tested by mixing with biuret reagent. Describe and explain the result of this test.

_____

_____

_____

_____

(2)

(b) Explain why xanthine oxidase is able to catalyse this reaction but it is not able to catalyse other reactions.

_____

_____

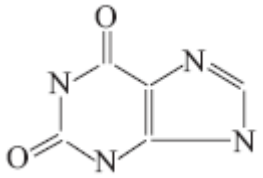
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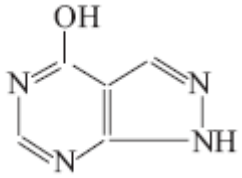
(2)

(c) Gout is a painful condition caused by uric acid crystals in the joints. It is often treated with a drug that inhibits xanthine oxidase. The diagram shows a molecule of xanthine and a molecule of this drug.

Xanthine



Drug used to treat gout



Use the diagram to explain why this drug is effective in the treatment of gout.

_____

_____

_____

_____

_____

_____

(3)

(Total 7 marks)

Q83.

Read the following passage.

During the course of a day, we come into contact with many poisonous substances. These include industrial and household chemicals. The skin acts as a barrier and prevents many of these substances entering and harming the body.

The skin is one of the largest organs in the body. It is composed of several layers of tissue. The outer layer consists of dead cells packed with keratins. Keratins are a group of proteins that differ from each other in their primary structure. Each keratin molecule consists of several polypeptide chains, each individual chain wound into a spiral or helix. The polypeptide chains include many sulphur-containing amino acids and these help to give the keratin molecules their characteristic strength.

Use information from the passage and your own knowledge to answer the questions.

(a) What is the evidence from the passage that keratin molecules have a quaternary structure?

_____

_____

(1)

(b) Explain how sulphur-containing amino acids help to give keratin molecules their characteristic strength (lines 8–9).

_____

_____

_____

_____

(2)

(c) Explain why differences in primary structure result in keratins with different properties
(line 6).

_____

_____

_____

_____

(2)

(d) The skin prevents poisonous substances entering and harming the body (line 3). Explain why these substances are unable to pass through the outer layer of skin cells by active transport.

_____

_____

_____

_____

_____

_____

(3)

(e) Skin cells may be studied with a transmission electron microscope or an optical microscope. Explain the advantages and limitations of using a transmission electron microscope to study cells.

_____

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(6)

(Total 14 marks)

Q84.

The box jellyfish produces a poison (venom) which enters the blood when a person is stung. A person who has been stung can be treated with an injection of antivenom. This antivenom is produced by injecting small amounts of venom from box jellyfish into sheep, then extracting antibodies from the sheeps' blood. These antibodies are then injected into the person who has been stung.

(a) If a sheep is injected with the box jellyfish venom on more than one occasion a higher yield of antivenom is obtained. Explain why.

_____

_____

_____

_____

(2)

(b) Injecting antivenom does not give a person lasting protection against the venom of box jellyfish. Explain why.

_____

_____

_____

_____

(2)

(c) Suggest **one** possible problem in injecting people with antivenom made in this way.

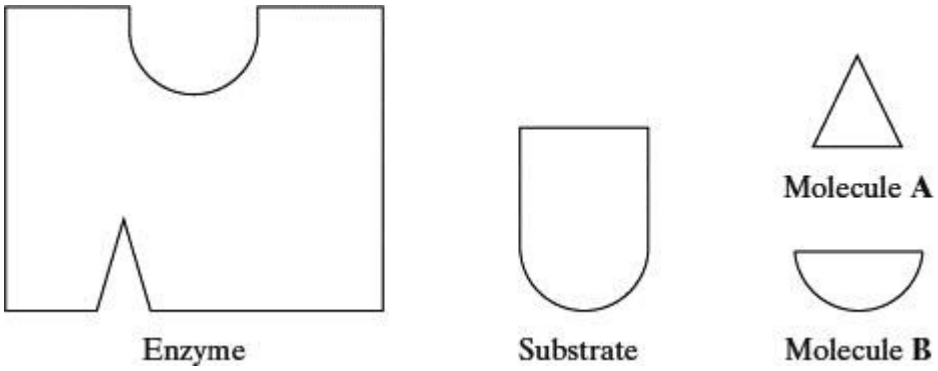
_____

_____

(1)
(Total 5 marks)

Q85.

(a) The diagrams represent an enzyme, its substrate and two other molecules, **A** and **B**.



The addition of a non-competitive inhibitor will prevent the formation of an enzyme-substrate complex. Draw a labelled diagram based on relevant molecules selected from the diagram above to explain how this occurs.

(2)

(b) A decrease in temperature decreases the kinetic energy of molecules in a solution. Explain how a decrease in temperature decreases the rate of an enzyme-controlled reaction.

_____

_____

_____

_____

(2)

(c) Urea breaks hydrogen bonds. Explain how the addition of urea would affect the rate of an enzyme-controlled reaction.

_____

_____

_____

_____

_____

_____

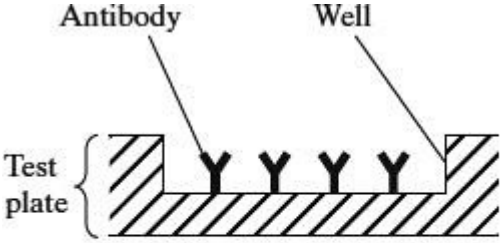
(3)

(Total 7 marks)

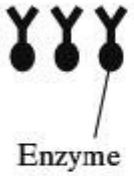
Q86.

A test has been developed to determine if a person is infected with variant CJD (vCJD), the human form of BSE (mad cow disease). The test detects the protein which causes vCJD in a urine sample.

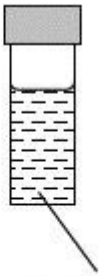
The test kit contains the following components.



A test plate with wells containing antibodies to the protein which causes vCJD

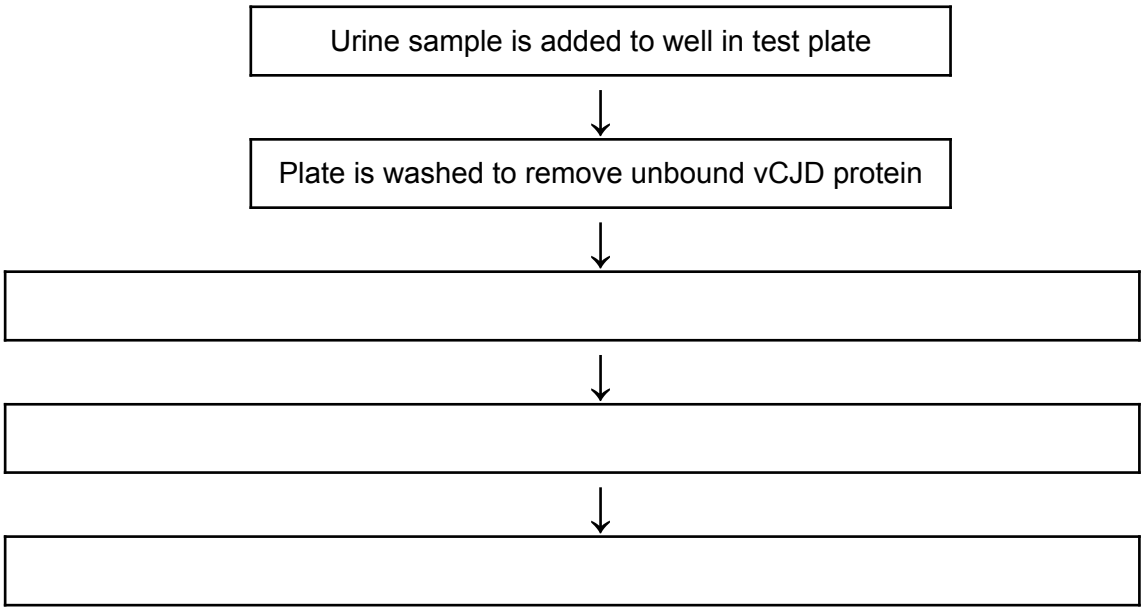


Antibodies to the protein which causes vCJD. These antibodies have an enzyme attached to them



Colourless solution which turns blue if the enzyme is present

(a) Complete the flow chart to describe how this test would be used.



(3)

(b) Explain why this test would detect vCJD, but not other antigens in the urine.

_____

_____

_____

_____

(2)

(Total 5 marks)

Q87.

Catalase is an enzyme. It catalyses the breakdown of hydrogen peroxide in the reaction:

$$\underset{\text{hydrogen peroxide}}{2H_2O_2} \rightarrow \underset{\text{water}}{2H_2O} + \underset{\text{oxygen}}{O_2}$$

In an investigation, samples of different substances were added to hydrogen peroxide in a series of test tubes. The rate of reaction was measured by recording the rate at which bubbles of oxygen were produced. A scale going from 0 for no bubbles to 5 for the maximum rate of bubbling was used to measure this. The results are shown in the table.

Tube	Substance added	Rate at which bubbles of oxygen were produced
A	Piece of liver	4
B	Ground liver and sand	5
C	Sand	0
D	Piece of cooled, boiled liver	0

(a) Explain the difference between the rate at which bubbles were produced in.

(i) tubes **A** and **B**;

_____

_____

_____

_____

(2)

(ii) tubes **A** and **D**.

_____

_____

_____

_____

_____

_____

(3)

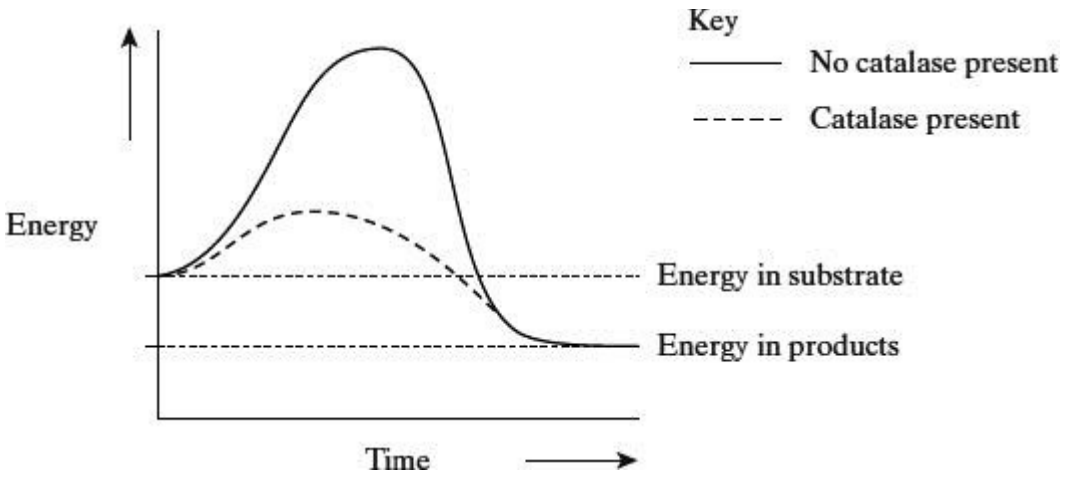
(b) Explain the purpose of tube **C**.

_____

_____

(1)

(c) The graph shows the energy changes which take place during the reaction in which hydrogen peroxide is converted to water and oxygen.



Use the graph to explain why

(i) hydrogen peroxide breaks down at a lower temperature when catalase is present than when it is not present;

_____

_____

(1)

(ii) test tubes **A** and **B** became warmer when the reaction was taking place.

_____

_____

_____

_____

(2)

(Total 9 marks)

Q88.

(a) Starch and protein are biologically important polymers.

(i) Explain what is meant by a polymer.

_____

_____

(1)

(ii) Give **one** example of a biologically important polymer other than starch or protein.

_____

(1)

(b) In an investigation, the enzyme amylase was mixed in a test tube with a buffer solution and a suspension of starch. The amylase broke down the starch to maltose. When all the starch had been broken down, a sample was removed from the test tube and tested with biuret reagent.

(i) Explain why a buffer solution was added to the amylase-starch mixture.

_____

_____

_____

(2)

(ii) What colour would you expect the sample to go when tested with biuret reagent?

_____

(1)

(iii) Give an explanation for your answer to part (ii)

_____

_____

_____

(2)

(Total 7 marks)

Q89.

Read the following passage.

The plasma membrane plays a vital role in microorganisms. It forms a barrier between the cell and its environment, controlling the entry and exit of solutes.
This makes bacteria vulnerable to a range of antiseptics and antibiotics.

When bacteria are treated with antiseptics, the antiseptics bind to the proteins in the membrane and create tiny holes. Bacteria contain potassium ions at a concentration many times that outside the cell. Because of the small size of these ions and their concentration in the cell, the first observable sign of antiseptic damage to the plasma membrane is the leaking of potassium ions from the cell. Some antibiotics damage the

plasma membrane in a similar way. One of these is tyrocidin. This is a cyclic polypeptide consisting of a ring of ten amino acids. Tyrocidin and other polypeptide antibiotics are of little use in medicine.

Other antibiotics also increase the rate of potassium movement from cells. It is thought that potassium ions are very important in energy release and protein synthesis, and a loss of potassium ions would lead to cell death. Gramicidin A coils to form a permanent pore passing through the plasma membrane. This pore enables potassium ions to be conducted from the inside of the cell into the surrounding medium. Vanilomycin also facilitates the passage of potassium ions from the cell.
A molecule of vanilomycin forms a complex with a potassium ion and transports it across the membrane. The potassium ion is released on the outside and the vanilomycin is free to return and pick up another potassium ion. Vanilomycin depends on the fluid nature of the plasma membrane in order to function.

Polyene antibiotics have flattened ring-shaped molecules. The two sides of the ring differ from each other. One side consists of an unsaturated carbon chain. This part is strongly hydrophobic and rigid. The opposite side is a flexible, strongly hydrophilic region. It has been shown that polyene antibiotics bind only to sterols. Sterols are lipids found in the membranes of eukaryotes but not in the membranes of prokaryotic organisms. It is thought that several sterol-polyene complexes come together.
The plasma membranes of eukaryotic cells treated with these polyene antibiotics lose the ability to act as selective barriers and small ions and molecules rapidly leak out.

Use information in the passage and your own knowledge to answer the questions.

(a) By what process do potassium ions normally enter a bacterial cell? Explain the evidence for your answer.

_____

_____

_____

_____

(2)

(b) (i) Draw a peptide bond showing how the COOH group of one amino acid joins to the NH_2 group of another.

(1)

(ii) How many peptide bonds are there in a molecule of tyrocidin (lines 9 - 10)?

_____

(1)

(c) Experiments have shown that vanilomycin is unable to transport potassium ions across a membrane when it is cooled. Gramicidin A continues to facilitate the movement of potassium ions at these low temperatures. Explain these results.

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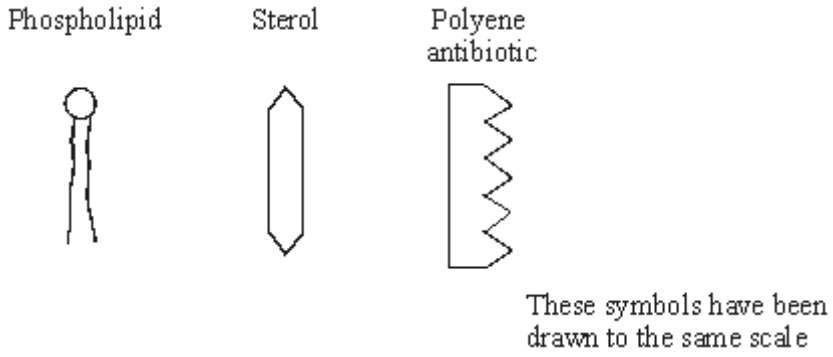
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(3)

(d) Draw a simple diagram of one of the phospholipid layers to show how polyene antibiotics allow small ions and molecules to leak rapidly through a plasma membrane. Use the following symbols to represent the different molecules.

Note that the zigzag line on the symbol for the polyene antibiotic represents its hydrophobic region.



(2)

(Total 9 marks)

Q90.

(a) Describe how you would use a biochemical test to show that a solution contained protein.

_____

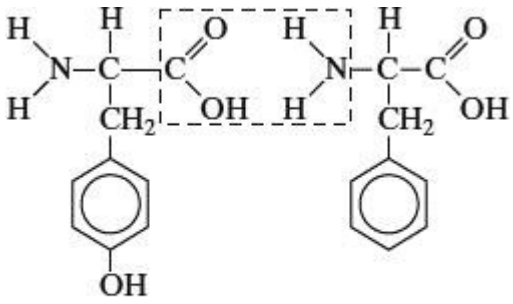
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(2)

The diagram shows the structure of two amino acid molecules, tyrosine and phenylalanine.



Tyrosine Phenylalanine

(b) Copy from the diagram the R group in the phenylalanine molecule.

(1)

(c) (i) In the space below, draw the chemical bond formed when these two amino acids are joined by condensation. You need only draw the parts of the molecules shown in the box.

(2)

(ii) Name this bond.

_____

(1)

(d) Tyrosine can be made in the body by hydroxylating phenylalanine. Use the diagram to explain the meaning of *hydroxylating*.

_____

_____

(1)

(Total 7 marks)

Q91.

Read the following passage.

Job's Tears is a cereal plant which grows in the tropics. An unusual protein has been found in its grains. This protein is unusual because it has two functions. It acts as both an enzyme inhibitor and as an enzyme. As an inhibitor, the protein reduces the activity of starch-digesting enzymes. The protein acts as an enzyme by breaking down chitin, a polysaccharide found in the walls of many fungi, to its monomers. Because of the resulting more negative water potential in the cytoplasm of the fungus, this effectively leads to "death by osmosis" of any fungus attacking the grain.

Our knowledge of the relationship between protein structure and function has led to the development of the new technology of protein engineering. This involves changing the amino acid sequence of a protein and altering its tertiary structure. Altering the tertiary structure changes the protein's properties. So far, we have been unable to produce a protein with more than one function such as that found in Job's Tears. We have had success, though, in making some enzymes more stable and less prone to heat denaturation. We have done this by substituting amino acids and allowing the formation of additional chemical bonds.

Use information from the passage and your own knowledge to answer the following questions.

(a) (i) The protein found in Job's Tears breaks down chitin (line 4). What type of chemical reaction is involved in breaking down chitin?

_____

(1)

(ii) Breakdown of chitin leads to "death by osmosis" of fungi attacking the grain (lines 6 - 7). Explain how.

_____

_____

_____

_____

(2)

(iii) This protein does not break down the cell walls of the Job's Tears plant. Explain why.

_____

_____

(1)

(b) Explain what is meant by the tertiary structure of a protein (line 10).

_____

_____

(1)

(c) (i) Explain how heating an enzyme leads to it being denatured.

_____

_____

_____

_____

(2)

(ii) How can protein engineering make enzymes more stable and less prone to heat denaturation (line 13)?

_____

_____

_____

_____

(2)

(d) Describe how the sequence of amino acids in part of the protein from Job's Tears could enable this protein to act as an enzyme inhibitor.

_____

_____

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_____

(6)

(Total 15 marks)

Q92.

(a) Haemoglobin is a protein with a quaternary structure. What is meant by a *quaternary* structure?

_____

_____

(1)

(b) Explain how oxygen in a red blood cell is made available for respiration in active tissues.

_____

_____

_____

_____

_____

_____

(3)

(c) Haemoglobin is broken down in the liver. One product of this breakdown is amino acids. Give **one** use in the body of these amino acids.

_____

_____

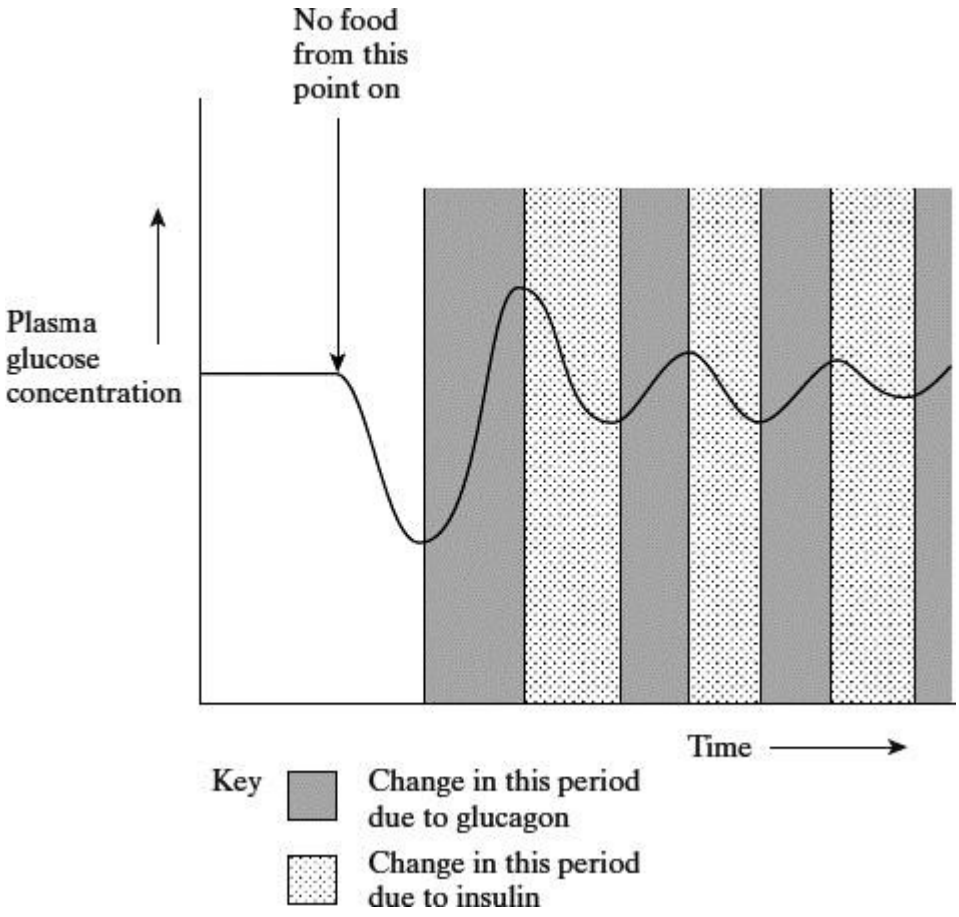
(1)

(Total 5 marks)

Q93.

Homeostatic mechanisms maintain a constant environment in the body.

(a) The graph shows changes in plasma glucose concentration that occurred in a person who went without food for some time.



Use evidence from the graph to explain the role of negative feedback in the control of plasma glucose concentration.

(5)

(b) How does maintaining a constant body temperature allow metabolic reactions in cells to proceed with maximum efficiency?

_____

_____

_____

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(5)

(Total 10 marks)

Q94.

Lactose is a disaccharide found in milk. In the small intestine, it is digested into glucose and galactose by the enzyme lactase. Molecules of lactase are located in the plasma membranes of cells lining the small intestine.

(a) What evidence in the paragraph suggests that galactose is a monosaccharide?

_____

_____

(1)

(b) (i) Name **one** other digestive enzyme that is located in the plasma membranes of cells lining the small intestine.

_____

(1)

(ii) Give an advantage of lactase and other digestive enzymes being located in the plasma membranes of cells lining the small intestine, rather than being secreted into the lumen of the small intestine.

_____

_____

(1)

(c) The absorption of galactose from the small intestine is reduced if the absorbing cells are treated with a respiratory inhibitor, such as cyanide. Suggest an explanation for this.

_____

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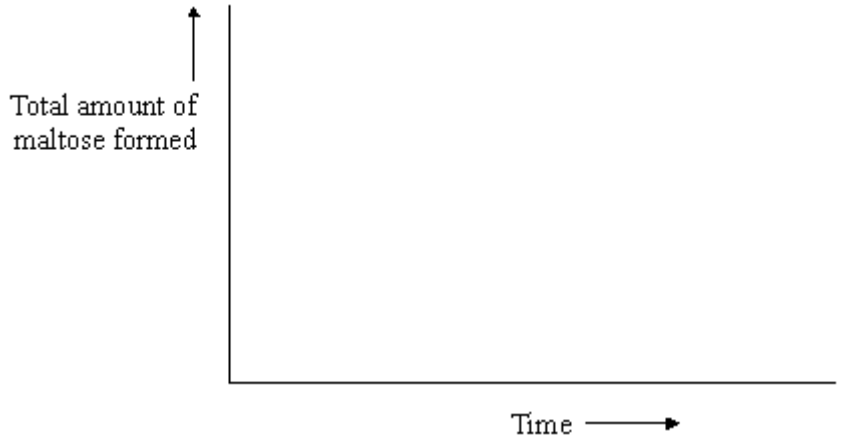
(2)

(Total 5 marks)

Q95.

(a) Amylase is an enzyme which hydrolyses starch to maltose. Some amylase and starch were mixed and the mixture incubated at 37 °C until the reaction was complete.

(i) Sketch a curve on the axes below to show the progress of this reaction.



(1)

(ii) Explain why the rate of the reaction decreases as the reaction progresses.

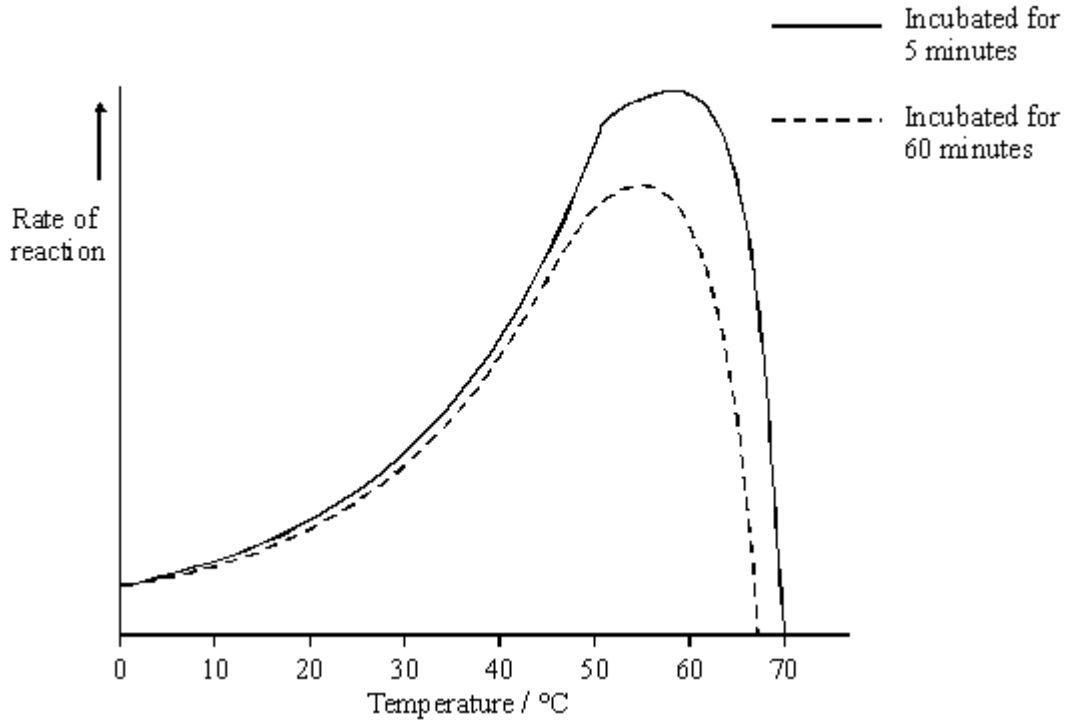
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(2)

The effect of temperature on the rate of reaction of an enzyme was investigated. A test tube containing the enzyme and a test tube containing the substrate were incubated separately at each of the temperatures being investigated. After 5 minutes, they were mixed and the rate of reaction was determined. The experiment was repeated but, this time, the enzyme and the substrate were left for 60 minutes before they were mixed. The results of the investigation are shown in the graph.



(b) The enzyme solution used in this investigation was made by dissolving a known mass of enzyme in a buffer solution. Explain why a buffer solution was used.

_____

_____

(1)

(c) (i) Use the graph to describe how incubation time affects the rate of the reaction.

_____

_____

_____

_____

(2)

(ii) The maximum rate of reaction with an incubation time of 60 minutes is less than the maximum rate of reaction with an incubation time of 5 minutes. Explain why.

_____

_____

_____

_____

_____

_____

(3)

(d) Explain how inhibitors affect the rate of enzyme-controlled reactions.

_____

_____

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_____

_____

(6)

(Total 15 marks)

Q96.

Mammals and fish remove nitrogenous waste from their bodies in different forms.

(a) Name **two** polymers present in mammals and fish that contain nitrogen.

1. _____

2. _____

(2)

(b) In a mammal urea is removed from the blood by the kidneys and concentrated in the filtrate.

(i) Describe how urea is removed from the blood.

_____

_____

_____

_____

(2)

(ii) Explain how urea is concentrated in the filtrate.

_____

_____

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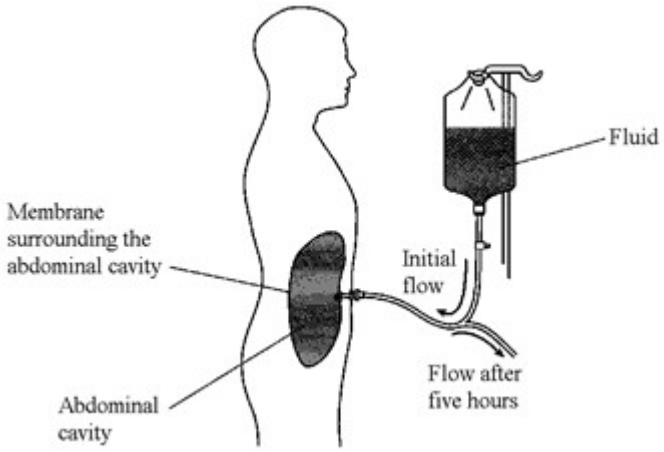
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(4)

(c) The diagram shows one way in which a person who has kidney disease can have the condition managed. In the process a fluid is put into the abdominal cavity. Exchange of materials takes place across the membrane that surrounds the abdominal cavity. This removes waste products from the blood. After five hours the fluid is drained out of the cavity and discarded. The cavity is then refilled with fresh fluid.



The table shows the concentration of solutes in the fresh fluid.

Solute	Concentration / mmol dm^{-3}
Sodium ions (Na^+)	132
Chloride ions (Cl^-)	96
Calcium ions (Ca^{2+})	1.25
Magnesium ions (Mg^{2+})	0.25
Glucose	76
Urea	0

(i) By what process does urea enter the fluid in the abdominal cavity from the blood?

_____

(1)

(ii) Explain why the fluid is changed every five hours.

_____

_____

(1)

(iii) Fluid of the composition shown in the table is used instead of distilled water. Explain why.

_____

_____

_____

_____

(2)

(Total 12 marks)

Q97.

When coal is mined by open-cast mining, the top layer of soil is first scraped off and stored in a large heap. Once mining has finished, the area can be reclaimed. Soil from this store is then spread back over the surface.

Some of the bacteria living in the soil store respire aerobically and some respire anaerobically. **Table 1** shows the numbers of aerobic and anaerobic bacteria found at different depths in a soil store.

Depth / cm	**Mean number of bacteria per gram of soil (× 10^7)**			
	Aerobic bacteria		Anaerobic bacteria	
	after 1 month	after 6 months	after 1 month	after 6 months
0	12.0	12.1	0.6	0.8
50	10.4	8.6	0.8	1.3
100	10.1	6.1	0.7	4.1
150	10.0	3.2	0.7	7.9
200	11.6	0.8	0.7	8.4
250	11.9	0.7	0.8	8.8
300	11.0	0.8	0.6	9.1

Table 1

(a) Some of the soil used to determine bacterial numbers was collected from the surface of the soil store. Describe how you would ensure that this soil was collected at random.

_____

_____

_____

_____

(2)

(b) (i) Describe how the numbers of aerobic bacteria after 6 months change with depth.

_____

_____

_____

_____

(2)

(ii) Explain the difference in the numbers of aerobic bacteria at a depth of 300 cm between 1 and 6 months.

_____

_____

_____

_____

(2)

(c) Explain how the changes in bacterial numbers which take place at 150 cm illustrate the process of succession.

_____

_____

_____

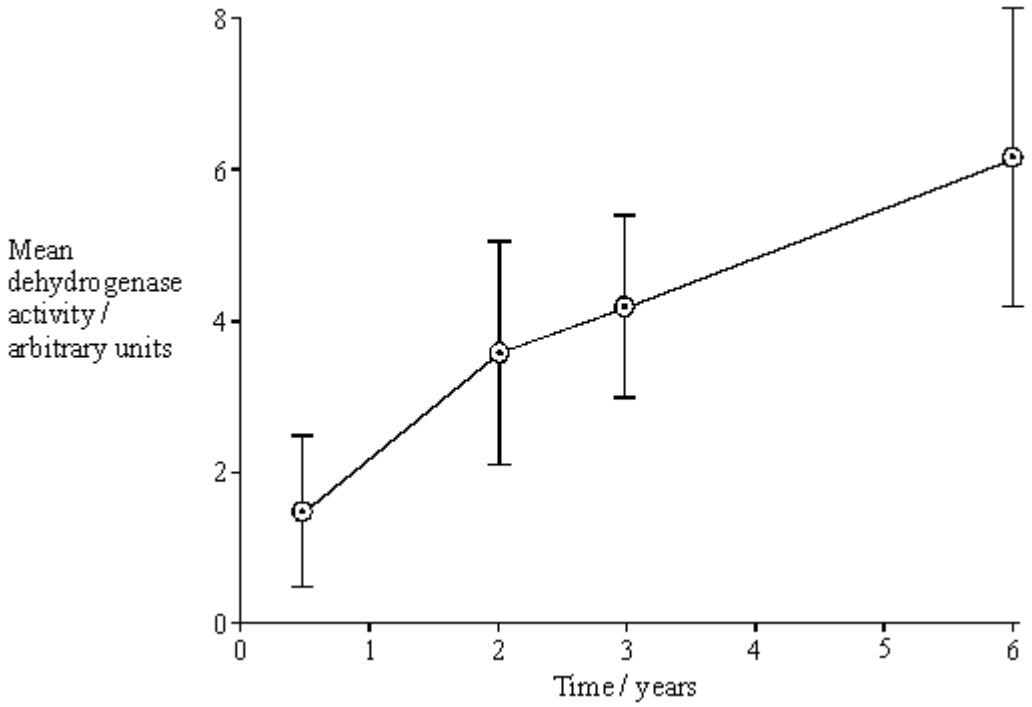
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(3)

Dehydrogenase is an enzyme involved in aerobic respiration. Dehydrogenase activity in a soil sample can be used as a measure of the activity of aerobic bacteria. The graph shows the mean dehydrogenase activity of soil samples taken from the same depth in a soil store at different times. The bars on the graph represent two standard errors above and below the mean.



(d) (i) From what depth in the soil store would you expect these soil samples to have been taken? Use information from **Table 1** to explain your answer.

_____

_____

_____

_____

(2)

(ii) How would you expect dehydrogenase activity to vary with depth after 6 months?

Use information from **Table 1** to explain your answer.

_____

_____

_____

_____

_____

_____

(3)

(e) What do the error bars tell you about the difference between the mean dehydrogenase activity at 6 months and 3 years? Explain your answer in terms of probability and chance.

_____

_____

_____

_____

_____

_____

(3)

(f) **Table 2** shows the dehydrogenase activity and the number of aerobic bacteria present in some soil samples.

Dehydrogenase activity / arbitrary units	Number of aerobic bacteria per gram of soil ($\times 10^7$)
13.1	12.0
9.2	8.7
5.5	6.5
3.0	4.6
2.2	2.7
0.4	0.6

Table 2

A sample of soil was found to have dehydrogenase activity of 8.7 arbitrary units. Explain how you would use the data in **Table 2** to predict the likely number of aerobic bacteria in 1 g of this soil sample.

_____

_____

_____

_____

_____

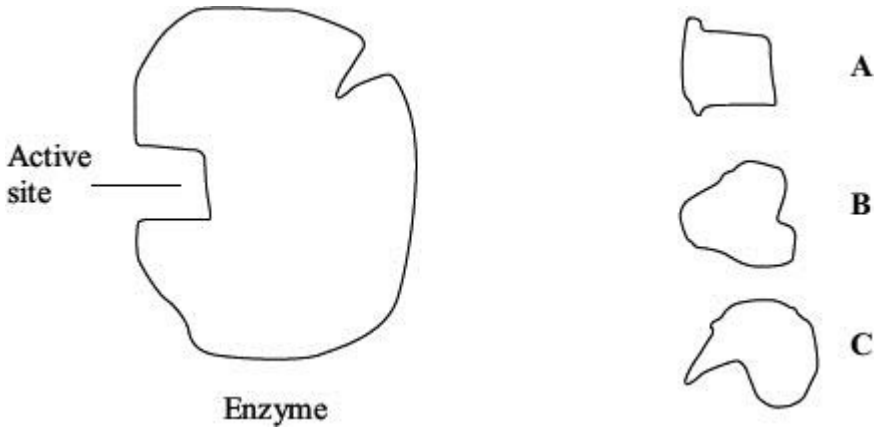
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(3)

(Total 20 marks)

Q98.

The diagram represents an enzyme molecule and three other molecules that could combine with it.



(a) Which molecule is the substrate for the enzyme? Give a reason for your answer.

_____

_____

_____

(1)

(b) Use the diagram to explain how a **non-competitive** inhibitor would decrease the rate of the reaction catalysed by this enzyme.

_____

_____

_____

_____

_____

_____

(3)

(c) Lysozyme is an enzyme. A molecule of lysozyme is made up of 129 amino acid molecules joined together. In the formation of its active site, the two amino acids that are at positions 35 and 52 in the amino acid sequence need to be close together.

(i) Name the bonds that join amino acids in the primary structure.

_____

(1)

(ii) Suggest how the amino acids at positions 35 and 52 are held close together to form the active site.

_____

_____

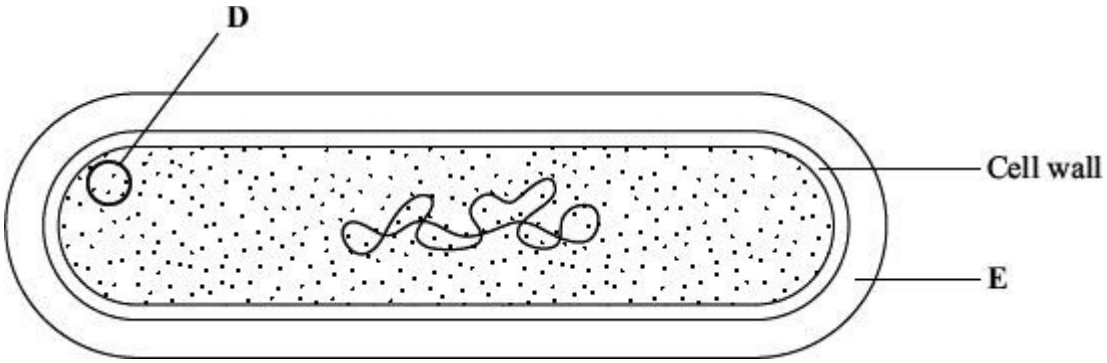
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(2)
(Total 7 marks)

Q99.

(a) The diagram shows a bacterial cell.



(i) Name the parts labelled **D** and **E.**

D _____

E _____

(2)

(ii) Give **one** function of the cell wall.

_____

_____

(1)

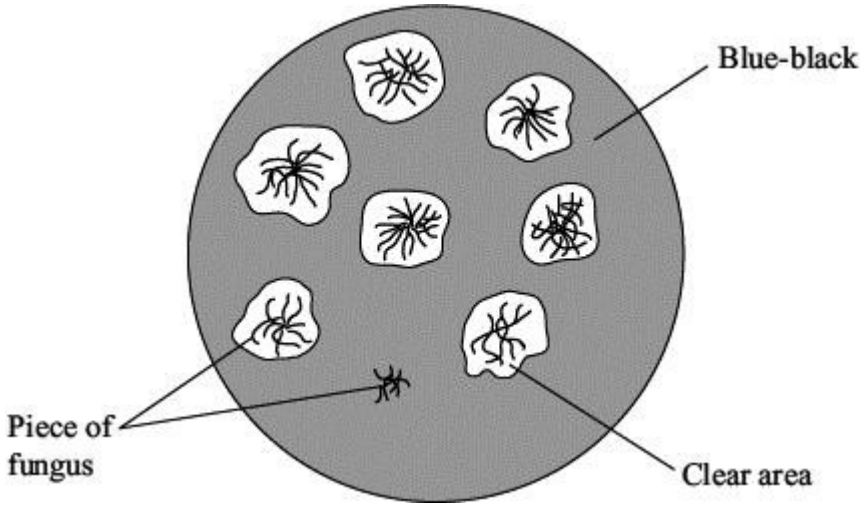
(b) Name **two** structures present in eukaryotic cells that are not present in the cells of prokaryotes.

1. _____

2. _____

(2)

(c) Several small pieces of a saprophytic fungus were placed on a starch agar plate. After 48 hours the iodine solution was poured over the starch agar. The result is shown in the diagram below.



(i) Explain why there is a clear area around most of the pieces of fungus.

_____

_____

_____

_____

(2)

(ii) Suggest why one piece of fungus has no clear area round it.

_____

_____

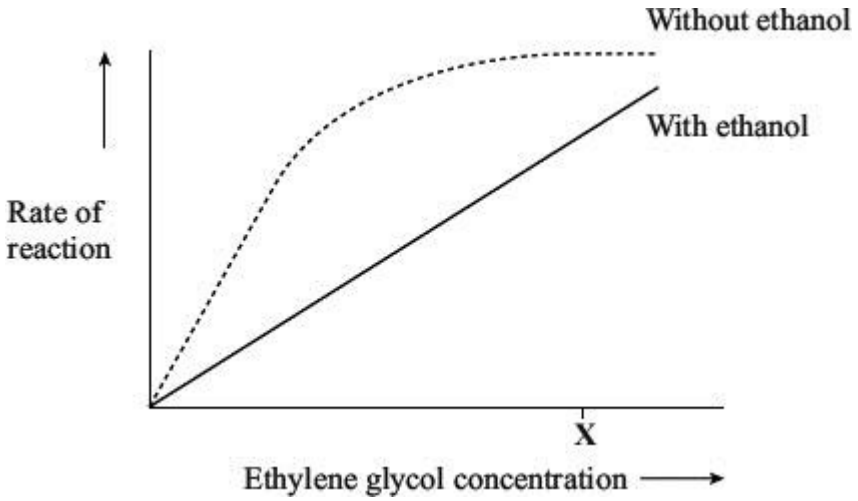
(1)

(Total 8 marks)

Q100.

Ethylene glycol is a substance used in car anti-freeze. If it is accidentally swallowed it enters the liver cells where it is converted to poisonous oxalic acid. Ethanol inhibits the production of oxalic acid and can be used to treat patients who have swallowed anti-freeze.

In an investigation, the rate of reaction of an enzyme that makes oxalic acid was measured with and without ethanol present. The graph shows the results.



(i) Increasing the concentration of ethylene glycol above **X** without ethanol present does not increase the rate of the reaction. Explain why.

_____

_____

_____

_____

(2)

(ii) Use the information in the graph to explain how ethanol prevents oxalic acid production.

_____

_____

_____

_____

(2)

(Total 4 marks)

Q101.

Yarrow is a herbaceous plant which grows in California at altitudes from 1500 m to 3000 m. The mean height of the stems of plants growing at 3000 m is smaller than that of plants growing at 1500 m.

(a) The higher the altitude, the lower the mean temperature. Explain how the lower temperature at high altitude reduces the growth of plants.

_____

_____

_____

_____

_____

(4)

(b) The relative contribution of environmental and genetic factors on the growth of the plants was investigated. Samples of young plants were taken and grown outdoors in prepared plots at altitudes of 1500 m and 3000 m.

Altitude at which young plants were collected / m	Mean maximum height of stems of plants / cm	
	Grown at 1500 m	Grown at 3000 m
1500	80.4	35.3
3000	31.5	24.7

Describe the evidence from the table that the variation in height is

(i) partly genetically determined;

_____

_____

(1)

(ii) partly environmentally determined.

_____

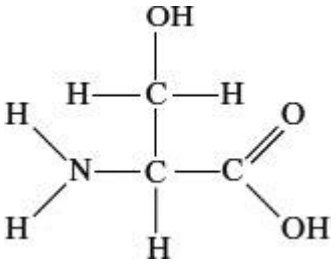
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(1)

(Total 6 marks)

Q102.

The diagram shows the structure of the amino acid serine.



(a) (i) Draw a box on the diagram around the R group of serine and label the box with the letter **R**.

(1)

(ii) Draw a circle around each of the parts of the serine molecule which would be removed when **two** other amino acid molecules join directly to it.

(1)

(b) (i) Which **two** substances are formed when two amino acid molecules join together?

1. _____

2. _____

(1)

(ii) Name the type of bond formed between the joined pair of amino acid molecules.

_____

(1)

(c) Explain how a change in the primary structure of a globular protein may result in a different three-dimensional structure.

_____

_____

_____

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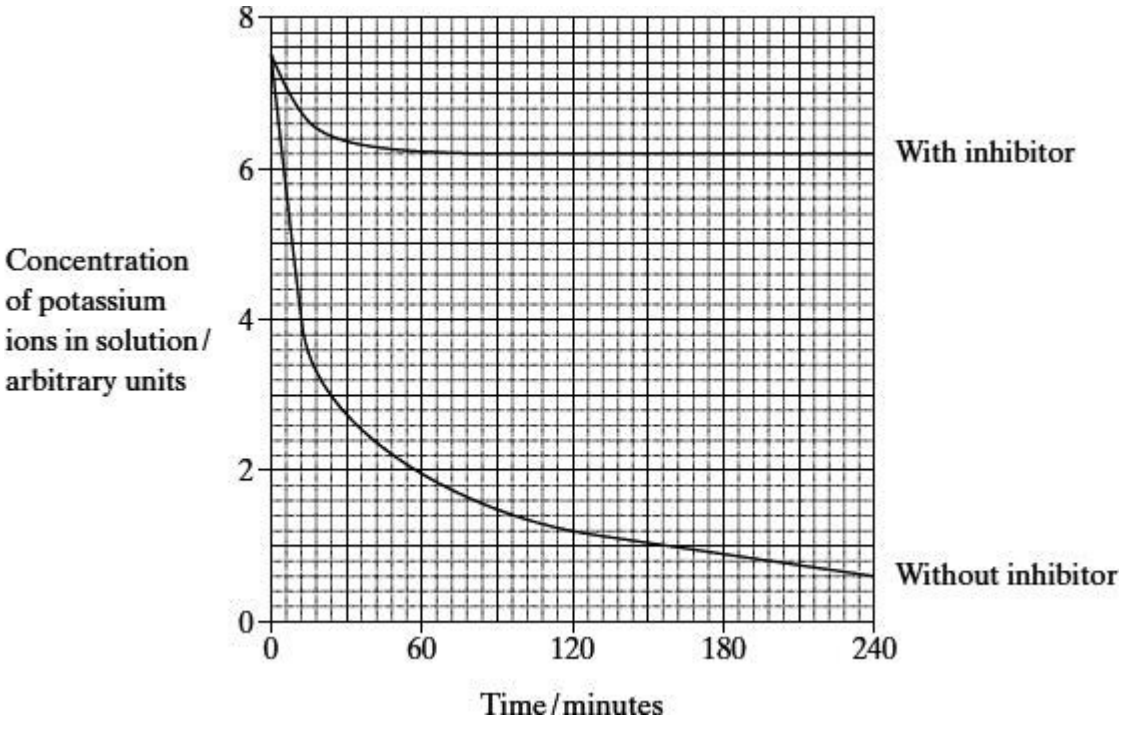
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(3)

(Total 7 marks)

Q103.

Two samples of the roots of pea plants were placed in solutions containing potassium ions. An inhibitor to prevent respiration was added to one solution. The concentrations of potassium ions in the two solutions were measured at regular intervals. The graph shows the results.



(a) Explain the decrease in the concentrations of potassium ions in the two solutions between 0 and 30 minutes.

(i) With inhibitor

_____

_____

_____

_____

(2)

(ii) Without inhibitor

_____

_____

(1)

(b) Explain why there is no further decrease in the concentration of potassium ions in the solution with the inhibitor after 60 minutes.

_____

_____

_____

_____

(2)

(c) The substance malonate is an inhibitor of respiration. It has a structure very similar to the substrate of an enzyme that catalyses one of the reactions of respiration. Explain how malonate inhibits respiration.

_____

_____

_____

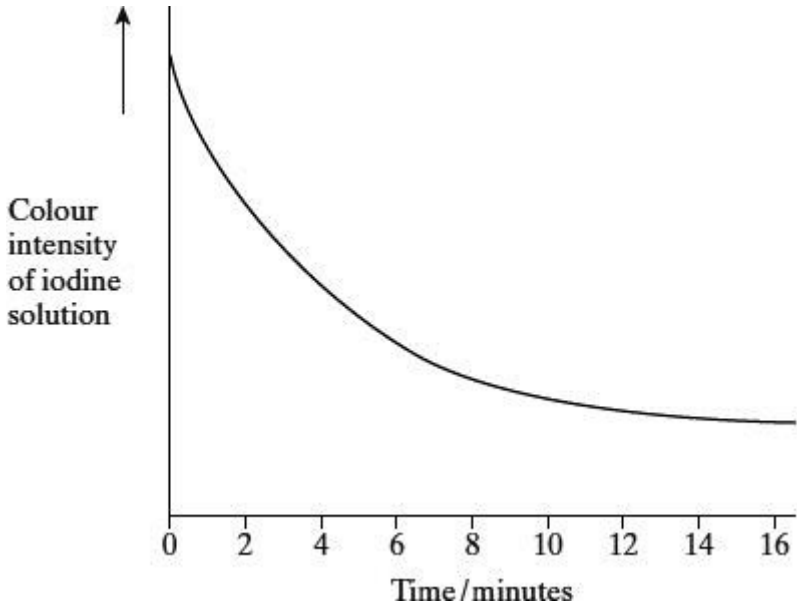
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(2)

(Total 7 marks)

Q104.

In an investigation into carbohydrase activity, the contents from part of the gut of a small animal were collected. The contents were added to starch solution at pH 7 and kept in a water bath at 25°C. At one-minute intervals, samples were removed and added to different test tubes containing dilute iodine solution. The colour intensity of each sample was determined. The graph shows the results.



(a) Explain the change in colour intensity.

_____

_____

_____

_____

(2)

(b) Draw clearly labelled curves on the graph to show the expected result if the experiment was repeated

(i) at 35 °C;

(ii) at pH 2.

(2)

(c) Explain how

(i) raising the temperature to 35 °C affects carbohydrase activity;

_____

_____

_____

_____

_____

_____

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_____

(ii) decreasing the pH affects carbohydrase activity.

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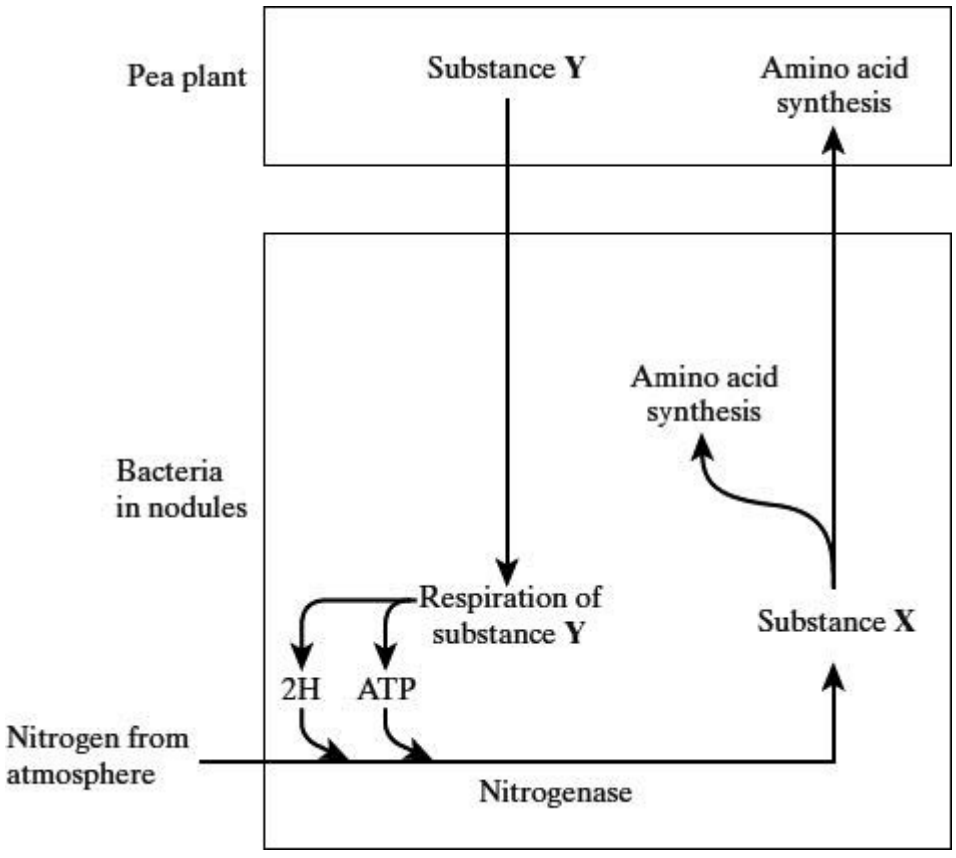
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(7)

(Total 11 marks)

Q105.

Pea plants are leguminous and have nodules on their roots which contain bacteria that are able to fix nitrogen. The diagram shows some of the processes involved in nitrogen fixation by these bacteria.



(a) Name

(i) substance **X**;

_____

(1)

(ii) substance **Y**.

_____

(1)

(b) Pea plants respire aerobically, producing ATP which can be used for amino acid synthesis. Describe the role of oxygen in aerobic respiration.

_____

_____

_____

_____

(2)

(c) The bacteria respire anaerobically. This produces hydrogen and ATP used in nitrogen fixation. The hydrogen comes from reduced NAD. Explain how the regeneration of NAD in this way allows ATP production to continue.

_____

_____

_____

_____

(2)

(d) The enzyme nitrogenase is specific to the reaction shown. Explain how **one** feature of the enzyme would contribute to this specificity.

Feature

_____

Explanation

_____

_____

_____

(2)

(e) Sodium ions act as a non-competitive inhibitor of the enzyme nitrogenase. Explain how the presence of a non-competitive inhibitor can alter the rate of the reaction catalysed by nitrogenase.

_____

_____

_____

_____

_____

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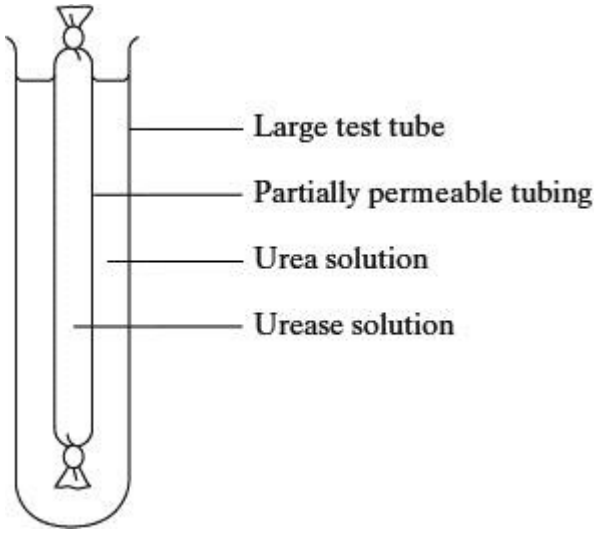
(3)

(Total 11 marks)

Q106.

Urease is an enzyme which hydrolyses urea to ammonia and carbon dioxide. The ammonia produces an alkaline solution.

In an experiment, a solution of urease was placed in tubing made from a partially permeable membrane. This tubing was put into a large test tube containing urea solution, as shown in the diagram. A control was set up with urease solution in the tubing and water outside.



After 5 minutes, samples were taken from inside and outside the tubing in each of the test tubes. The samples were tested with an indicator that is yellow below pH 8.0 and blue above pH 8.0. The results are shown in the table.

Tube	Contents		Colour with indicator after 5 minutes	
	Inside tubing	Outside tubing	Inside tubing	Outside tubing
A	Urease solution	Urea solution	Blue	Yellow
B	Urease solution	Water	Yellow	Yellow

(a) Explain the result for tube **A**.

_____

_____

_____

_____

_____

_____

(3)

(b) The solutions inside and outside the tubing in tube **B** were tested after 30 minutes for the presence of protein.

(i) Describe how the presence of protein in a sample of a solution could be detected.

_____

_____

_____

_____

(2)

(ii) What results of the tests for protein would you expect for tube **B**? In each case explain your answer.

Inside the tubing

_____

_____

_____

Outside the tubing

_____

_____

_____

(2)

(c) Describe how you would carry out an investigation to find the optimum temperature for the activity of urease.

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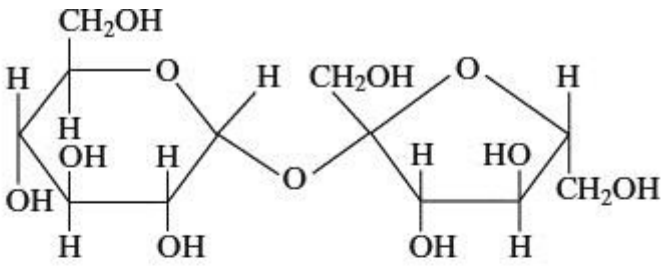
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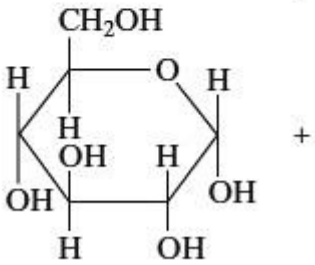
(3)
(Total 10 marks)

Q107.

Sucrose is a disaccharide. It is formed from two monosaccharides **P** and **Q**. The diagram shows the structure of molecules of sucrose and monosaccharide **P**.



Sucrose



Monosaccharide **P**

Monosaccharide **Q**

(a) (i) Name monosaccharide **Q**.

_____

(1)

(ii) Draw the structure of a molecule of monosaccharide **Q** in the space above.

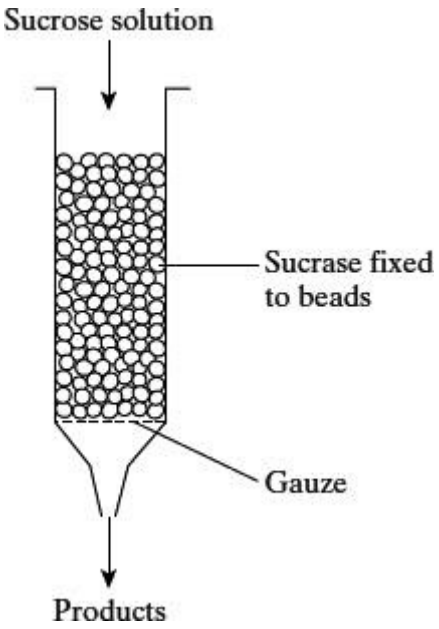
(1)

(b) The enzyme sucrase catalyses the breakdown of sucrose into monosaccharides. What type of reaction is this breakdown?

_____

(1)

(c) The diagram shows apparatus used in breaking down sucrose. The enzyme sucrase is fixed to inert beads. Sucrose solution is then passed through the column.



Describe a biochemical test to find out if the solution collected from the apparatus contains

(i) the products;

_____

_____

_____

_____

(2)

(ii) the enzyme.

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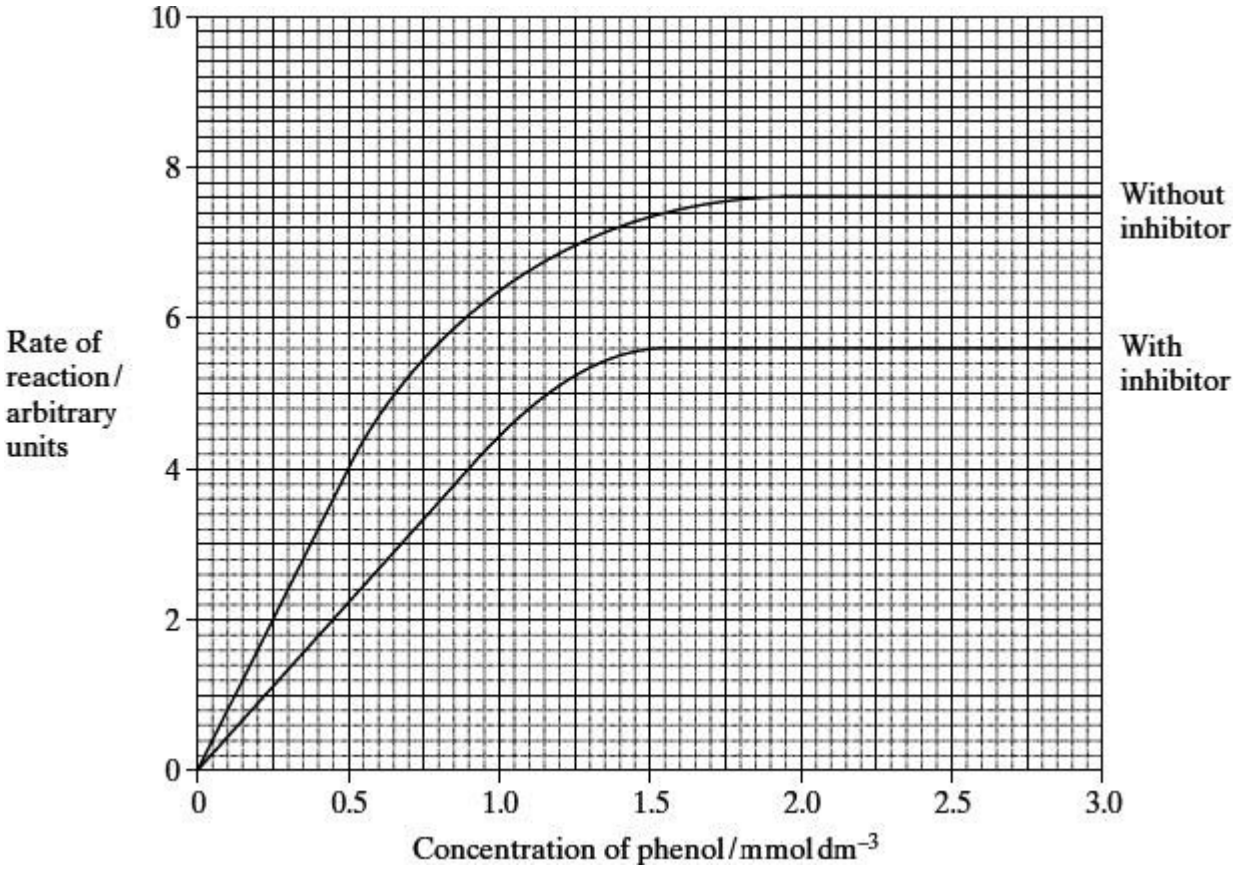
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(2)

(Total 7 marks)

Q108.

In an investigation, the rate at which phenol was broken down by the enzyme phenol oxidase was measured in solutions with different concentrations of phenol. The experiment was then repeated with a non-competitive inhibitor added to the phenol solutions. The graph shows the results.



(a) Explain why an increase in concentration of phenol solution from 2.0 to 2.5 mmol dm^{-3} has no effect on the rate of the reaction without inhibitor.

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_____

_____

_____

(2)

(b) Explain the effect of the non-competitive inhibitor.

_____

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_____

(2)

(c) Calculate the percentage decrease in the maximum rate of the reaction when the inhibitor was added. Show your working.

Percentage decrease _____

(2)

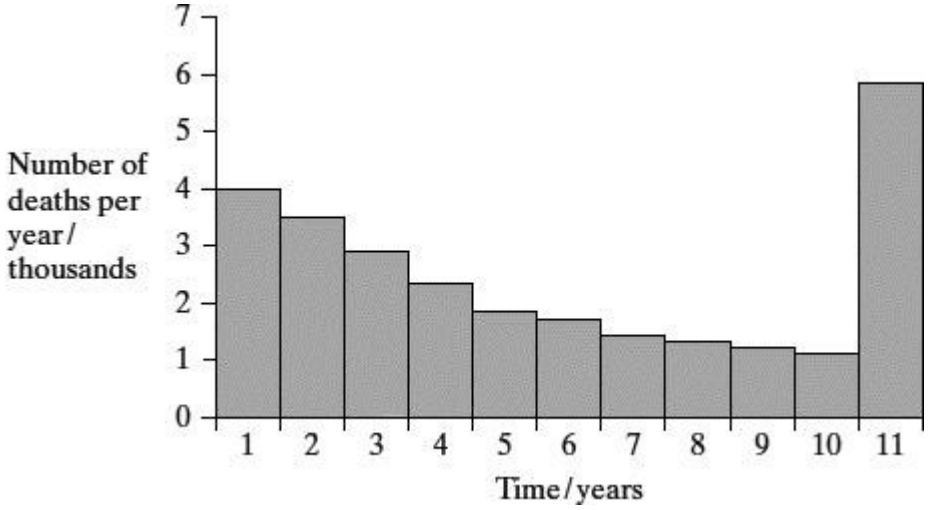
(d) Draw a curve on the graph to show the results expected if a competitive inhibitor instead of a non-competitive inhibitor had been used.

(1)

(Total 7 marks)

Q109.

(a) The graph shows the number of deaths from influenza per year in a developed country.



(i) Suggest an explanation for the change in the number of deaths from influenza during the first 10 years.

_____

_____

(1)

(ii) Suggest an explanation for the large increase in the number of deaths from influenza in year 11.

_____

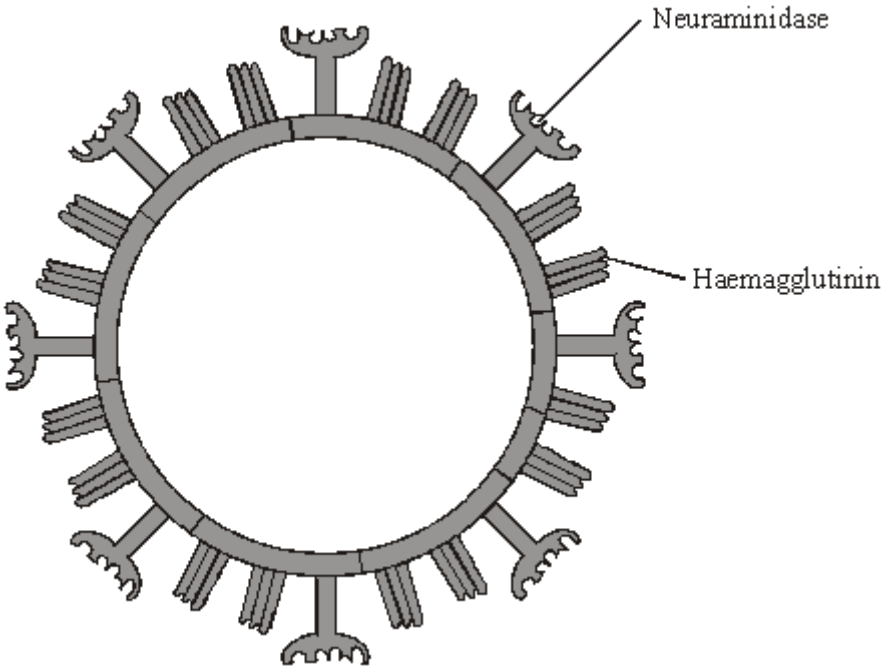
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(2)

(b) The diagram shows some of the structures on the outside of an influenza virus.



Haemagglutinin and neuraminidase are protein molecules. Haemagglutinin binds to receptor molecules on the surface of epithelial cells in the breathing system. Neuraminidase is an enzyme which breaks down molecules in the surface membrane of epithelial cells and allows the viruses to be released from the cells.

(i) Describe how T lymphocytes recognise and respond to the influenza virus.

_____

_____

_____

_____

(2)

(ii) Describe how B lymphocytes respond to the influenza virus.

_____

_____

_____

_____

(2)

(c) New drugs have recently become available for treating influenza. One type is a neuraminidase inhibitor. Explain how this type of drug would act as a treatment for influenza.

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(2)

(Total 9 marks)

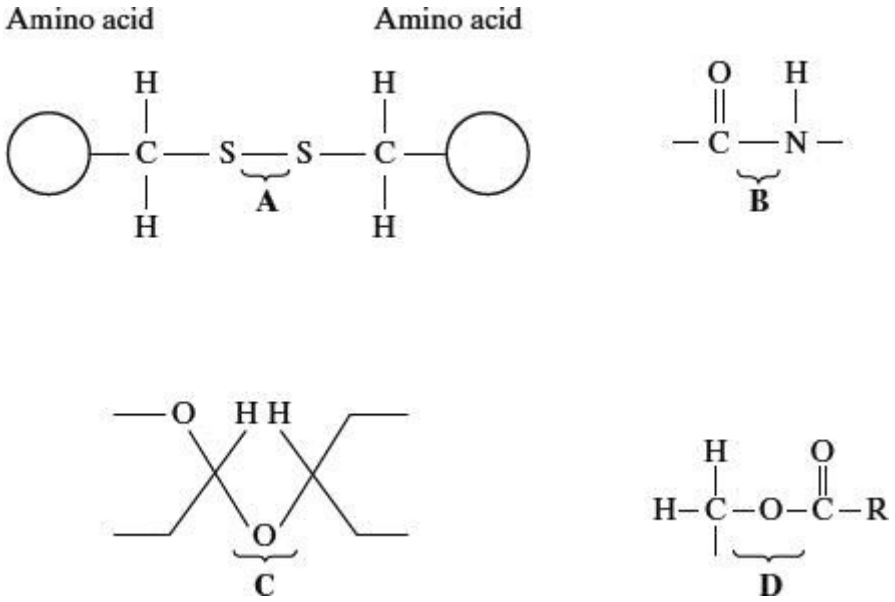
Q110.

Write an essay on the importance of enzymes in plants and animals.

(Total 25 marks)

Q111.

The diagrams show four types of linkage, **A** to **D**, which occur in biological molecules.



(a) Name the chemical process involved in the formation of linkage **B**.

_____

(1)

(b) Give the letter of the linkage which

(i) occurs in a triglyceride molecule;

_____

(1)

(ii) might be broken down by the enzyme amylase;

_____

(1)

(iii) may occur in the tertiary, but not the primary structure of protein.

_____

(1)

(c) Describe how a saturated fatty acid differs in molecular structure from an unsaturated fatty acid.

_____

_____

_____

_____

(2)

(Total 6 marks)

Q112.

(a) Explain how the shape of an enzyme molecule is related to its function.

_____

_____

_____

_____

_____

_____

(3)

(b) Bacteria produce enzymes which cause food to decay. Explain how vinegar, which is acidic, can prevent the action of bacterial enzymes in some preserved foods.

_____

_____

_____

_____

_____

_____

(3)

(Total 6 marks)

Q113.

(a) CFTR is a transmembrane regulator protein. Its molecules have 1480 amino acids. People with cystic fibrosis produce defective CFTR protein which is missing one amino acid from its structure.

(i) What is the minimum number of bases on DNA which would code for the normal CFTR protein? Explain your answer.

Number of bases _____

_____

_____

_____

_____

(2)

(ii) Which type of gene mutation produced the cystic fibrosis allele?
Explain your answer.

_____

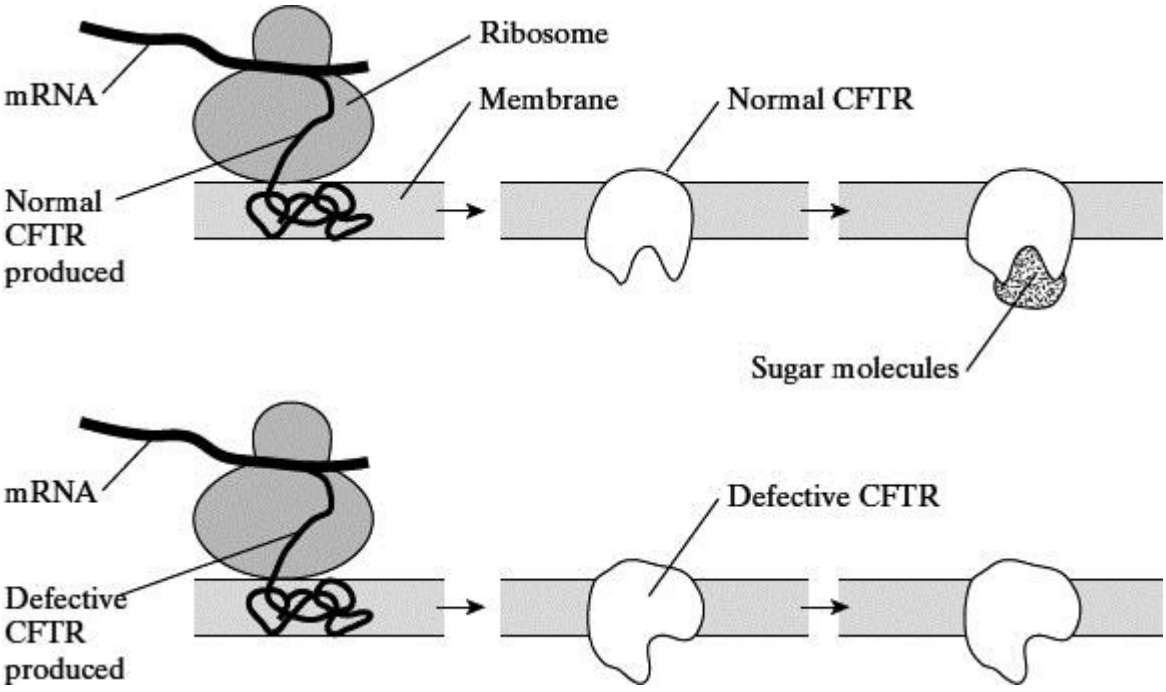
_____

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(2)

(b) The diagram shows part of the process of making normal and defective CFTR in a cell. A normal CFTR protein molecule has sugar molecules attached to it which make it functional.



Describe how the information on mRNA is translated into CFTR at the ribosome.

_____

_____

_____

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(4)

(Total 8 marks)

Q114.

Glaciers are masses of moving ice. When glaciers shrink, the thick covering of ice gradually disappears to leave behind bare land. Land exposed by a shrinking glacier in Alaska became covered by dense forest in 150 years.

(a) Explain how succession resulted in the formation of the forest.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) In areas of poor drainage the soil is waterlogged. In these areas the climax community is bog dominated by the moss, *Sphagnum*. Explain why bog is described as the climax community.

_____

_____

(1)

(c) Waterlogged soils lack oxygen. Suggest why trees are unable to survive in waterlogged soils.

_____

_____

_____

_____

(2)

(d) The water and soil in *Sphagnum* bogs are usually acidic. Suggest why *Sphagnum* is not fully decomposed after it dies.

_____

_____

_____

_____

_____

_____

_____

(3)

(Total 10 marks)

Q115.

Lactose is a disaccharide sugar which can be broken down by the enzyme lactase into two monosaccharides, glucose and galactose.

$$\text{lactose + water} \xrightarrow{\text{lactase}} \text{glucose + galactose}$$

(a) The formula for galactose is $C_6H_{12}O_6$. What is the formula for lactose?

_____

(2)

(b) A solution containing the enzyme lactase was added to a lactose solution. The solution was incubated at 40 °C for one hour. Sample **A** was removed from the tube before incubation. Sample **B** was removed after one hour.

(i) Describe a chemical test you could carry out on sample **A** to show that lactose is a reducing sugar.

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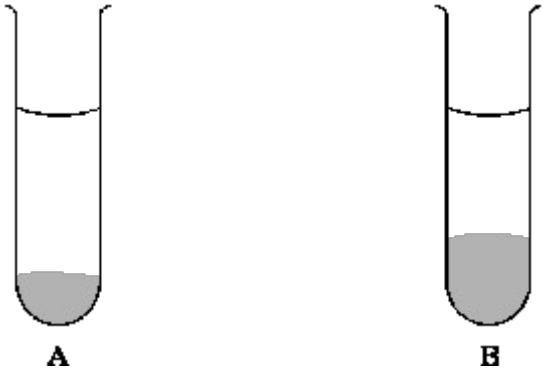
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(2)

(ii) This chemical test was carried out on samples **A** and **B**. All experimental variables were the same in the testing of the two samples. Both tubes were left for ten minutes to allow the precipitate to settle. The diagram shows the result.



Is galactose a reducing sugar? _____

Explain how the results in the diagram support your answer.

_____

_____

_____

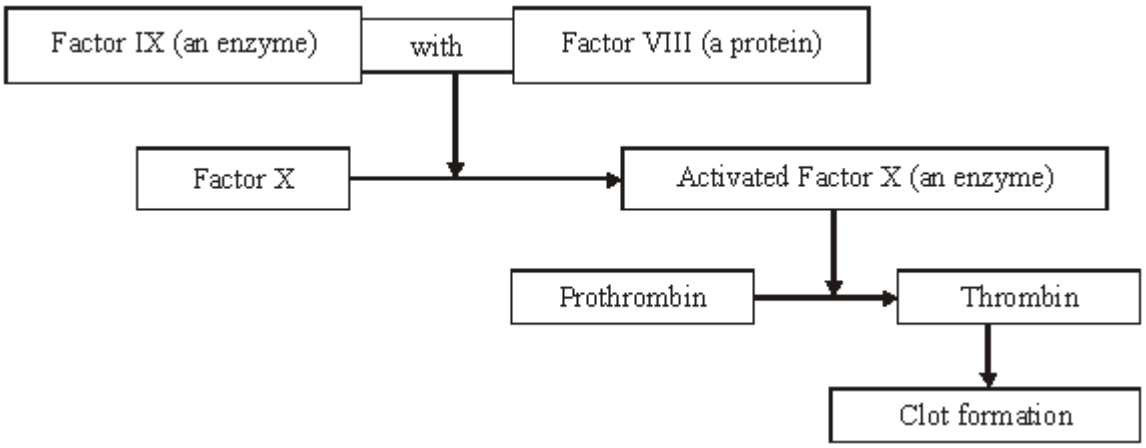
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(2)

(Total 6 marks)

Q116.

The diagram shows part of the metabolic pathway involved in the clotting of blood in response to an injury.



Haemophilia is a condition in which blood fails to clot. This is usually because of a mutant allele of the gene for Factor VIII.

(a) Explain how mutation could lead to faulty Factor VIII.

_____

_____

_____

_____

(2)

(b) Use information in the diagram to explain how faulty Factor VIII causes haemophilia.

_____

_____

_____

_____

(2)

(c) A boy had haemophilia caused by faulty Factor IX. When his blood was mixed with blood from a haemophiliac with faulty Factor VIII, the mixture clotted. Suggest an explanation for clotting of the mixture.

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(2)

(Total 6 marks)

Q117.

This question should be written in continuous prose, where appropriate.

(a) Explain how a resting potential is maintained in a neurone.

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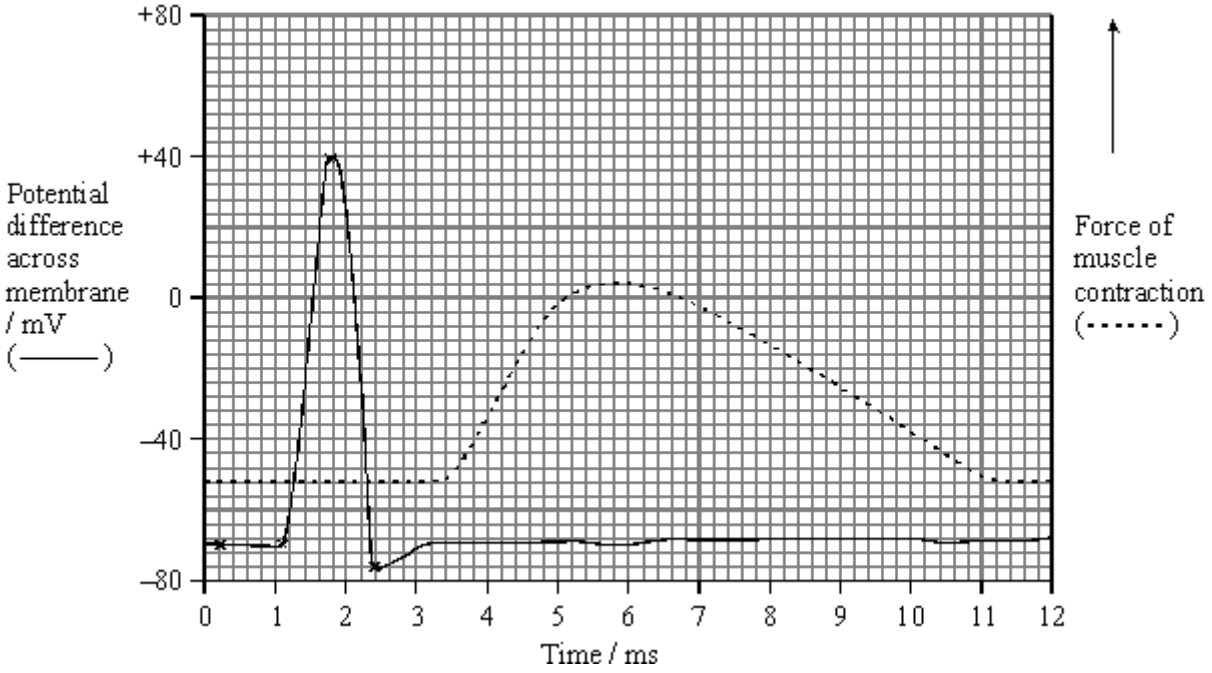
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(4)

(b) In an investigation, an impulse was generated in a neurone using electrodes. During transmission along the neurone, an action potential was recorded at one point on the neurone. When the impulse reached the neuromuscular junction, it stimulated a muscle cell to contract. The force generated by the contraction was measured. The results are shown in the graph.

The distance between the point on the neurone where the action potential was

measured and the neuromuscular junction was exactly 18 mm.



(i) Use the graph to estimate the time between the maximum depolarisation and the start of contraction by the muscle cell.

Time _____ ms

(1)

(ii) Use your answer to part (i) to calculate the speed of transmission along this neurone to the muscle cell. Give your answer in mm per second.

Show your working.

Speed _____ mm s^{-1}

(2)

(iii) Give **one** reason why the value calculated in part (ii) would be an underestimate of the speed of transmission of an impulse along a neurone.

_____

_____

(1)

Acetylcholine is the neurotransmitter at neuromuscular junctions.

(c) Describe how the release of acetylcholine into a neuromuscular junction causes the cell membrane of a muscle fibre to depolarise.

_____

_____

_____

_____

_____

_____

(3)

(d) Use your knowledge of the processes occurring at a neuromuscular junction to explain each of the following.

(i) The cobra is a very poisonous snake. The molecular structure of cobra toxin is similar to the molecular structure of acetylcholine. The toxin permanently prevents muscle contraction.

_____

_____

_____

_____

(2)

(ii) The insecticide DFP combines with the active site of the enzyme acetylcholinesterase. The muscles stay contracted until the insecticide is lost from the neuromuscular junction.

_____

_____

_____

_____

(2)

(Total 15 marks)

Q118.

Write an essay on how the structure of proteins is related to their functions.

(Total 25 marks)