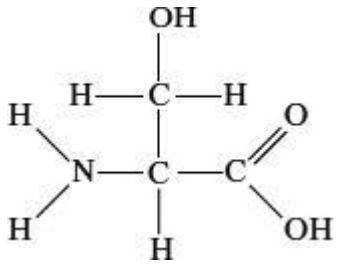
BIOLOGICAL MOLECULES

Proteins & Enzymes Part 3 EXAM Q&A

Q1.

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.

_____

_____

_____

_____

_____

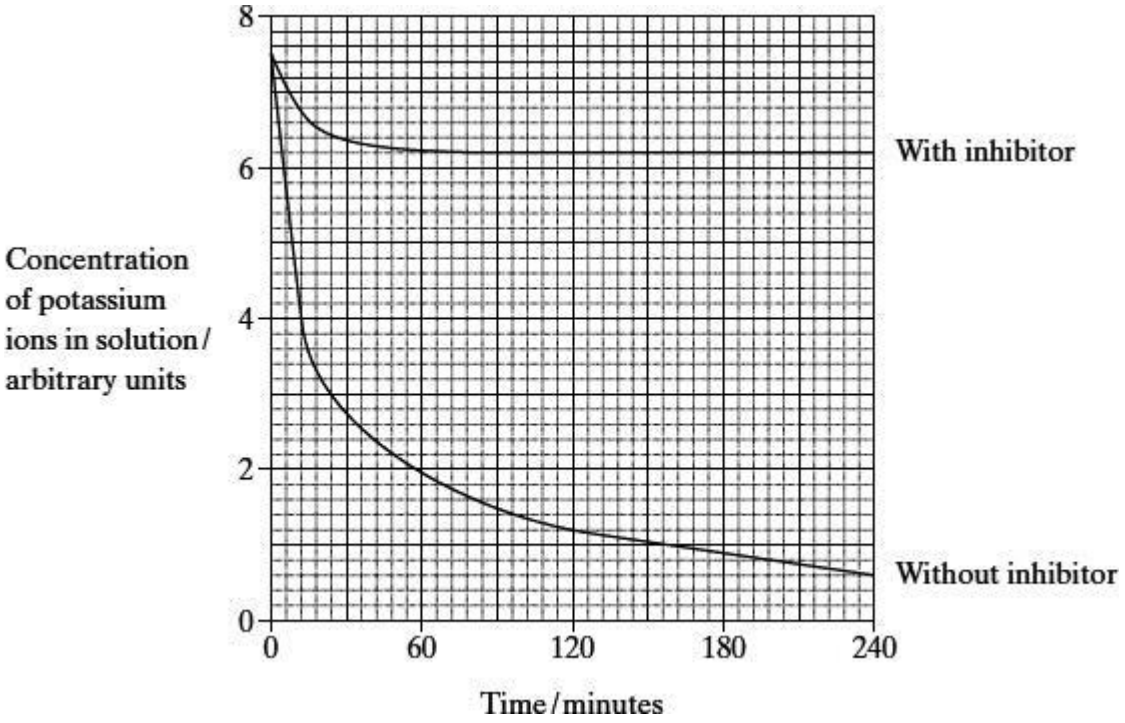
_____

(3)

(Total 7 marks)

Q2.

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)

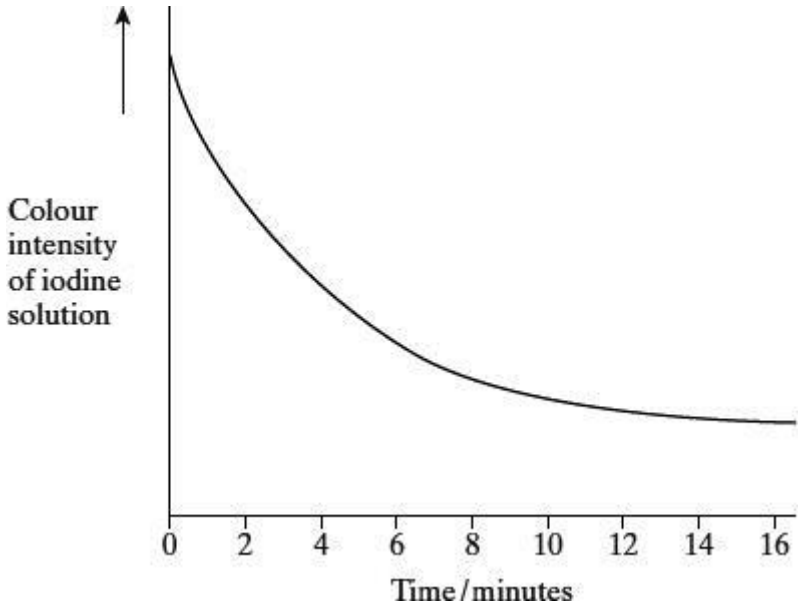
(c) The substance malonate is an inhibitor of respiration. It has a structure very similar to the substrate of an enzyme that catalyses one of the reactions of respiration. Explain how malonate inhibits respiration.

(2)

(Total 7 marks)

Q3.

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;

(ii) decreasing the pH affects carbohydrase activity.

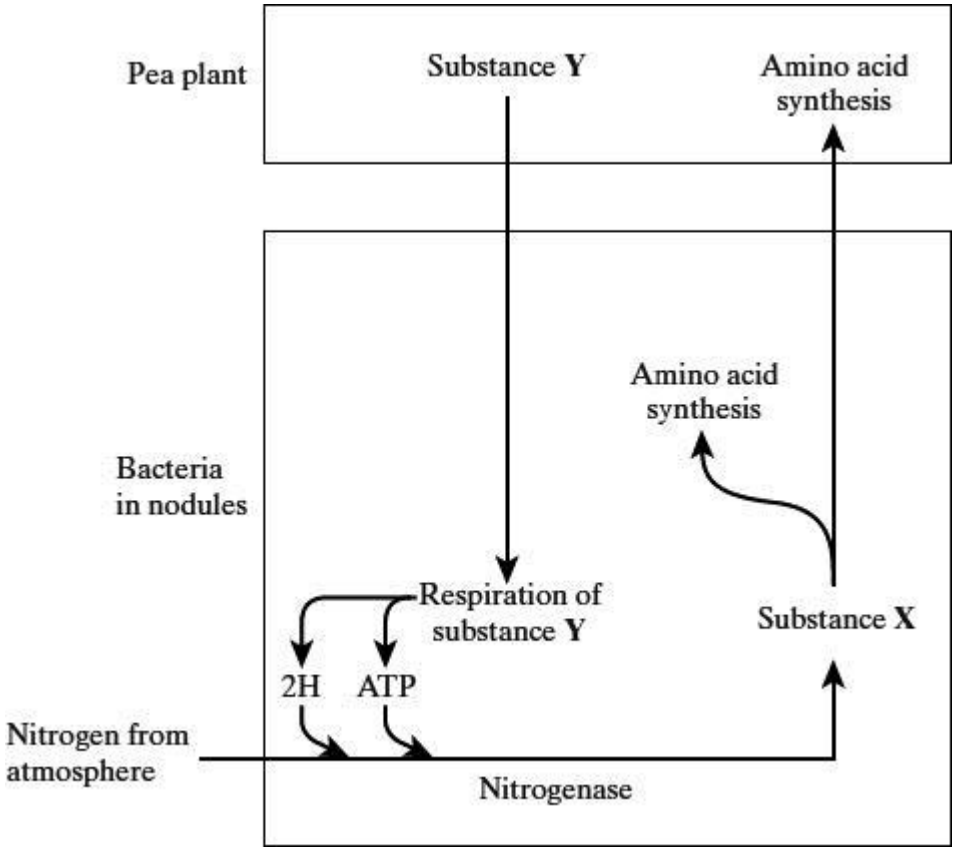
(7)

(Total 11 marks)

Q4.

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.

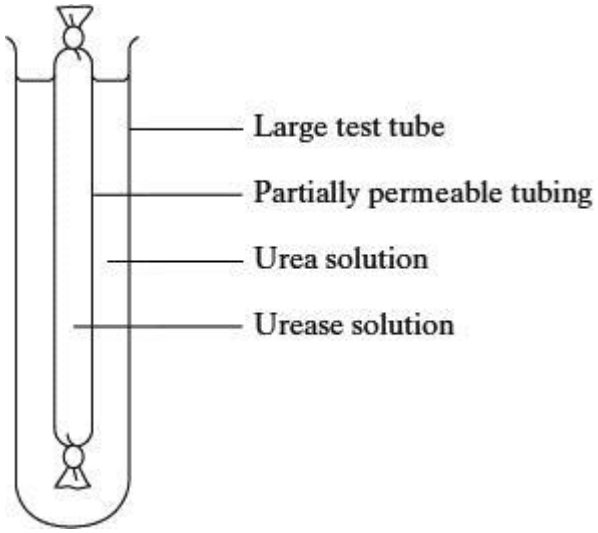
(3)

(Total 11 marks)

Q5.

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.

_____

_____

_____

_____

_____

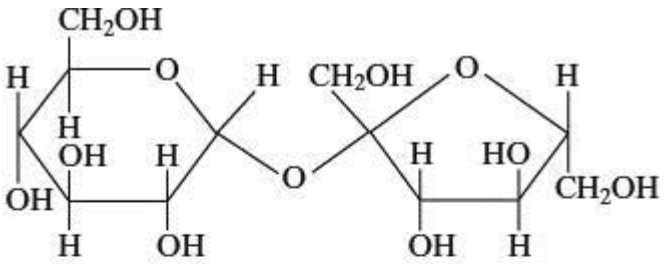
_____

(3)

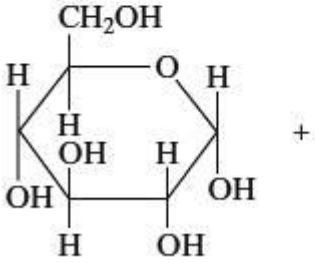
(Total 10 marks)

Q6.

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.

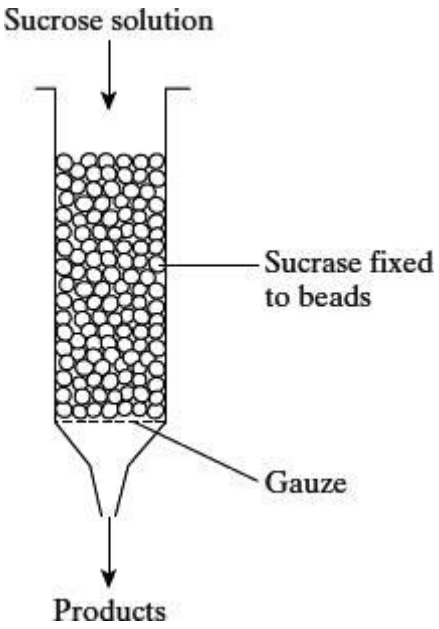
(1)

(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.

_____

_____

_____

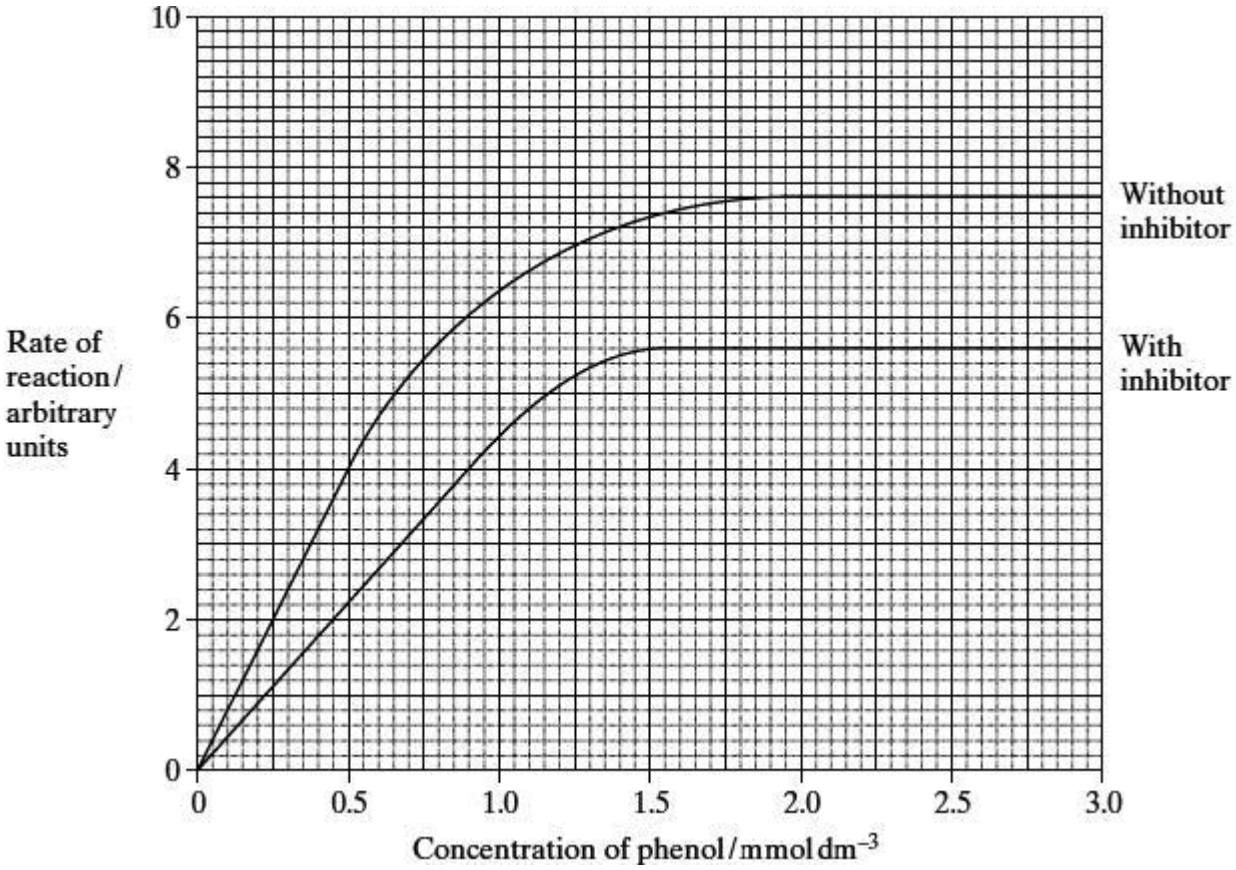
_____

(2)

(Total 7 marks)

Q7.

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.

(2)

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

(2)

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

Percentage decrease _____

(2)

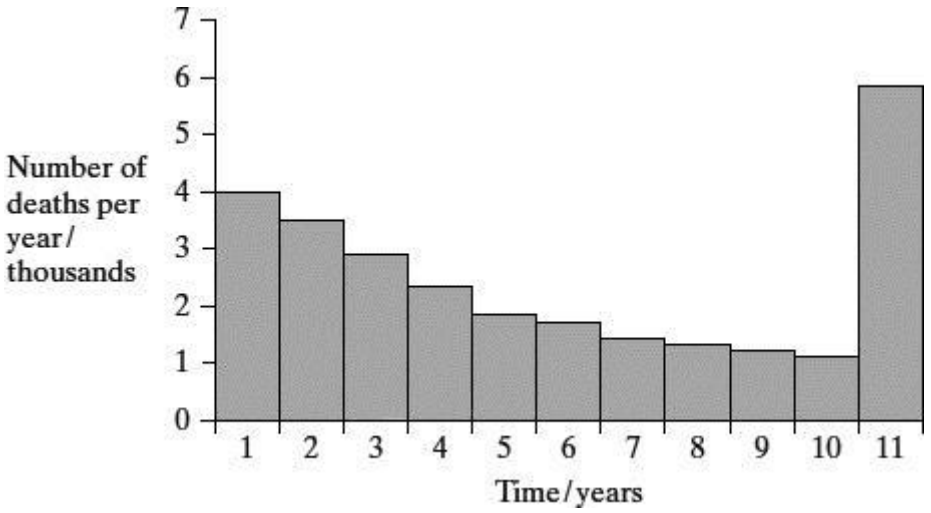
(d) Draw a curve on the graph to show the results expected if a competitive inhibitor instead of a non-competitive inhibitor had been used.

(1)

(Total 7 marks)

Q8.

(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.

_____

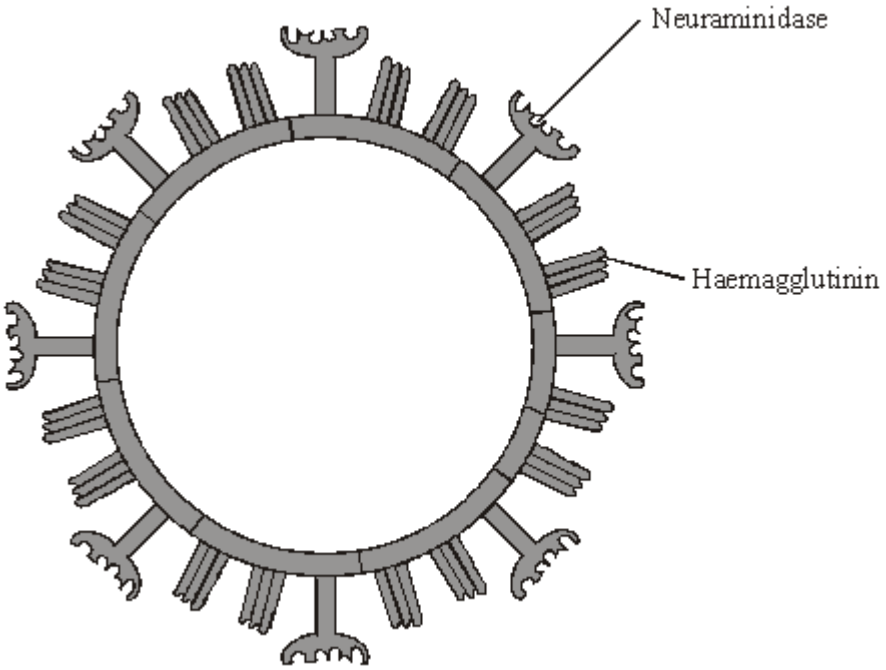
_____

_____

_____

(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.

_____

_____

_____

(2)

(Total 9 marks)

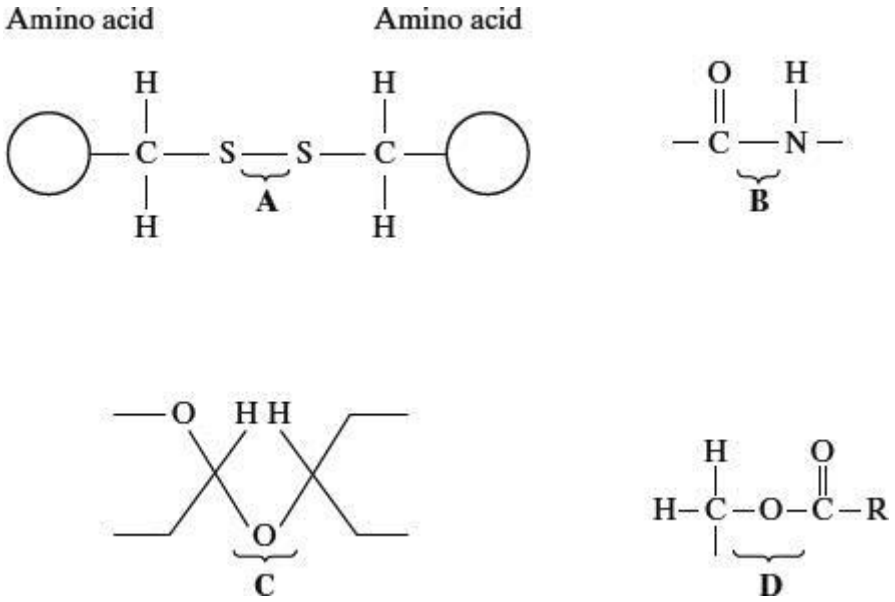
Q9.

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

(Total 25 marks)

Q10.

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)

Q11.

(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)

Q12.

(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 _____

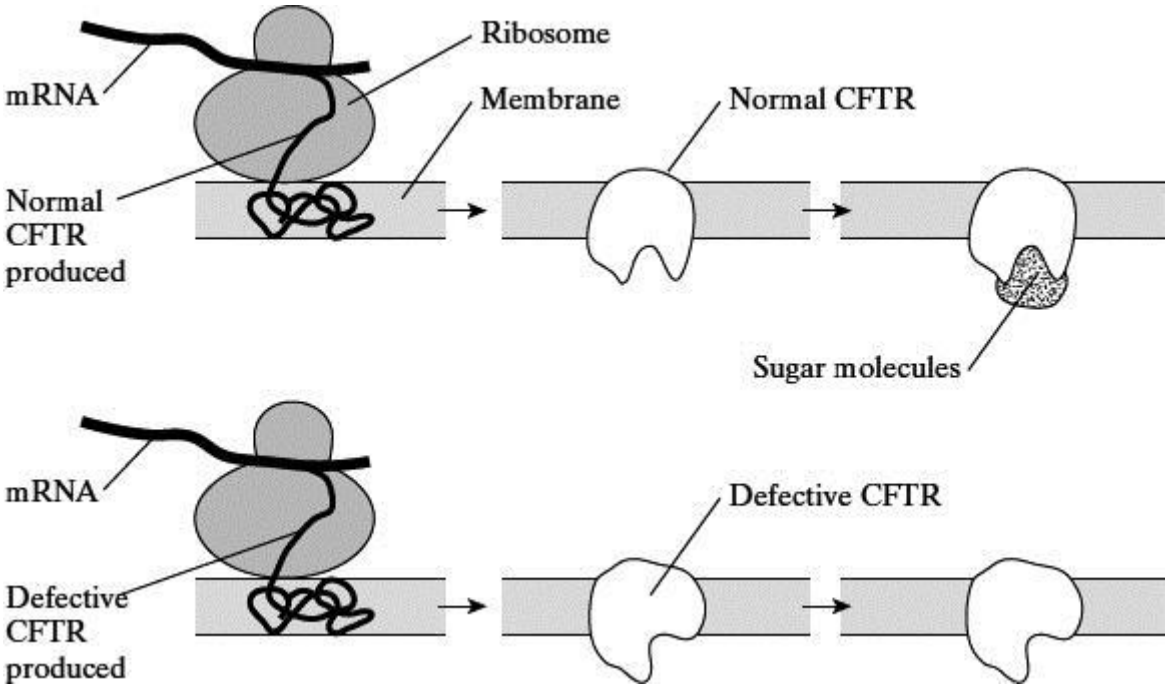
_____

(2)

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

(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.

(4)
(Total 8 marks)

Q13.

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)

Q14.

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.

_____

_____

_____

_____

(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.

_____

_____

_____

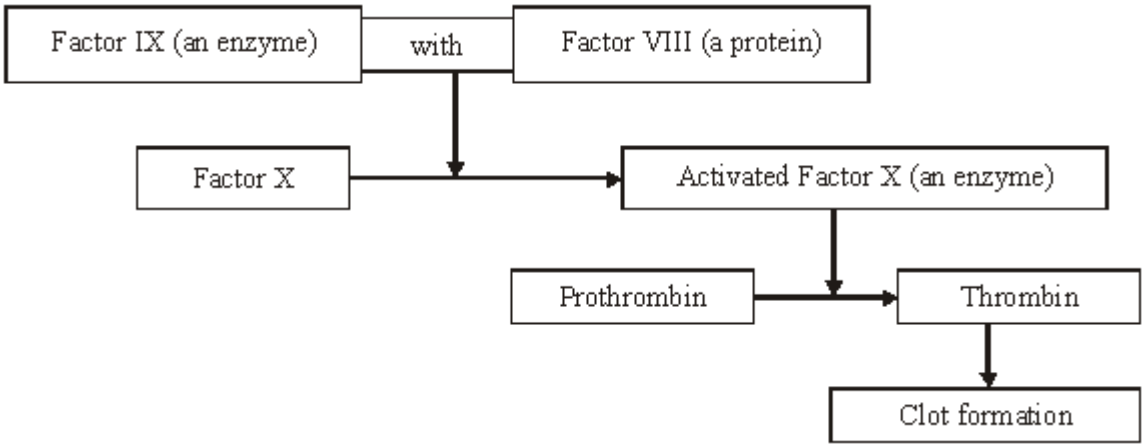
_____

(2)

(Total 6 marks)

Q15.

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.

(2)

(Total 6 marks)

Q16.

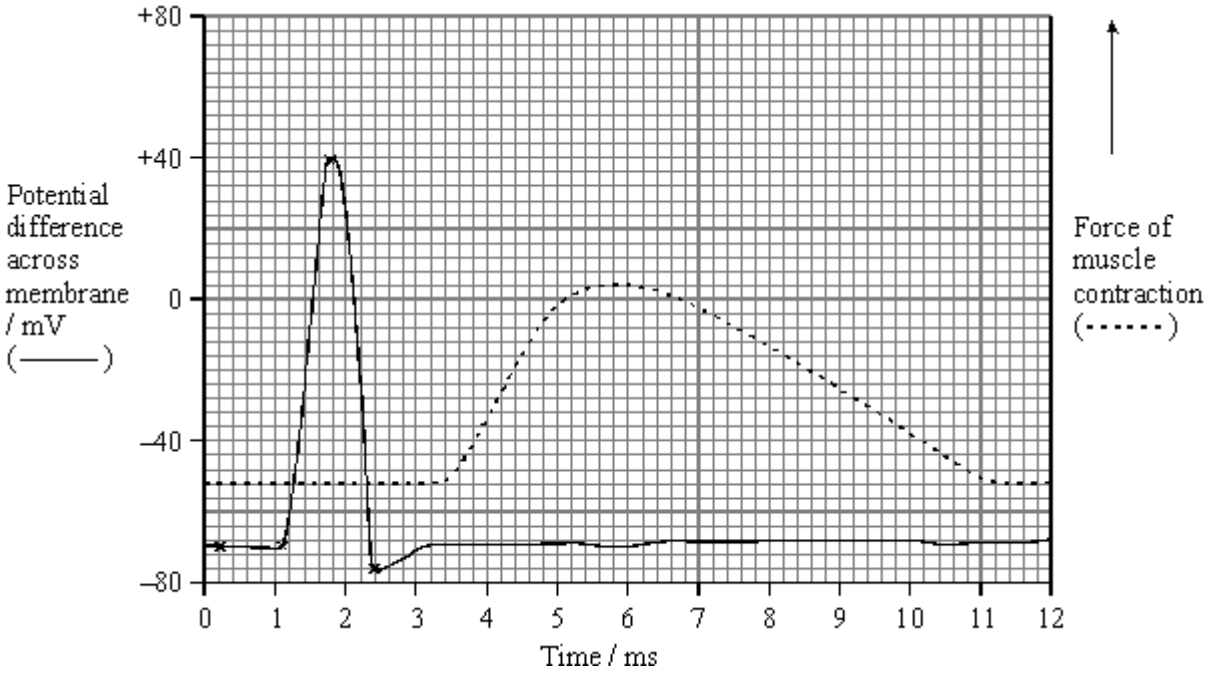
This question should be written in continuous prose, where appropriate.

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

(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)

Q17.

Write an essay on how the structure of proteins is related to their functions.

(Total 25 marks)

Q18.

Gelatine is a protein. When a warm gelatine solution cools, it sets to form a jelly.
Fresh pineapple juice contains an enzyme that digests protein.
A student investigated the effect of pineapple juice on the setting of jelly.
He set up three different tubes of warm gelatine solution and recorded which had set after three hours. The contents of each tube and his results are shown in the table.

Tube	Contents of tube	Jelly formed
A	6 cm^3 gelatine + 2 cm^3 pineapple juice + 2 cm^3 water	No
B	6 cm^3 gelatine + 2 cm^3 pineapple juice + 2 cm^3 hydrochloric acid	Yes
C	6 cm^3 gelatine + 2 cm^3 boiled pineapple juice + 2 cm^3 water	Yes

(a) Explain why 2 cm^3 of water was added to tubes **A** and **C**.

(2)

(b) Explain the results of

tube **A**

tube **B**

(4)

(c) What was the purpose of tube **C**?

(Extra space)

(3)
(Total 9 marks)

Q19.

(a) What is an enzyme?

_____

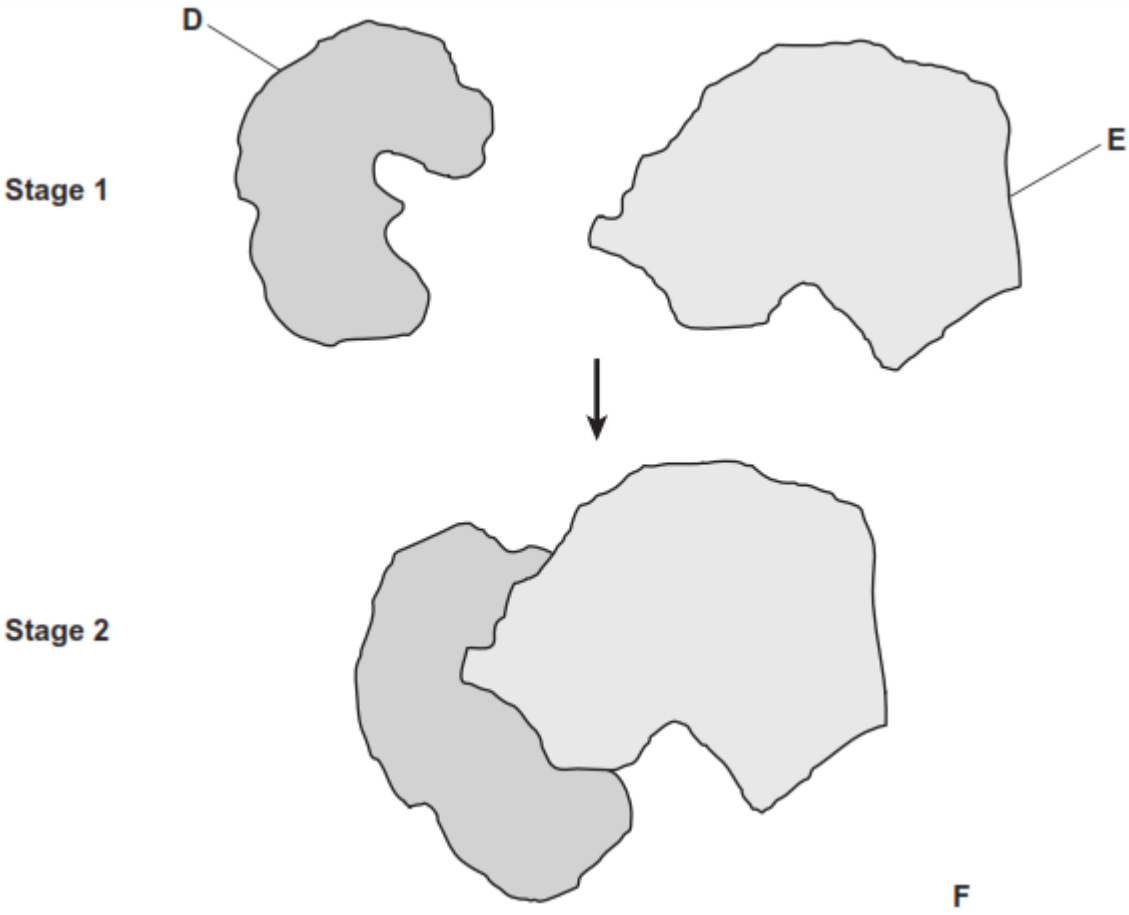
_____

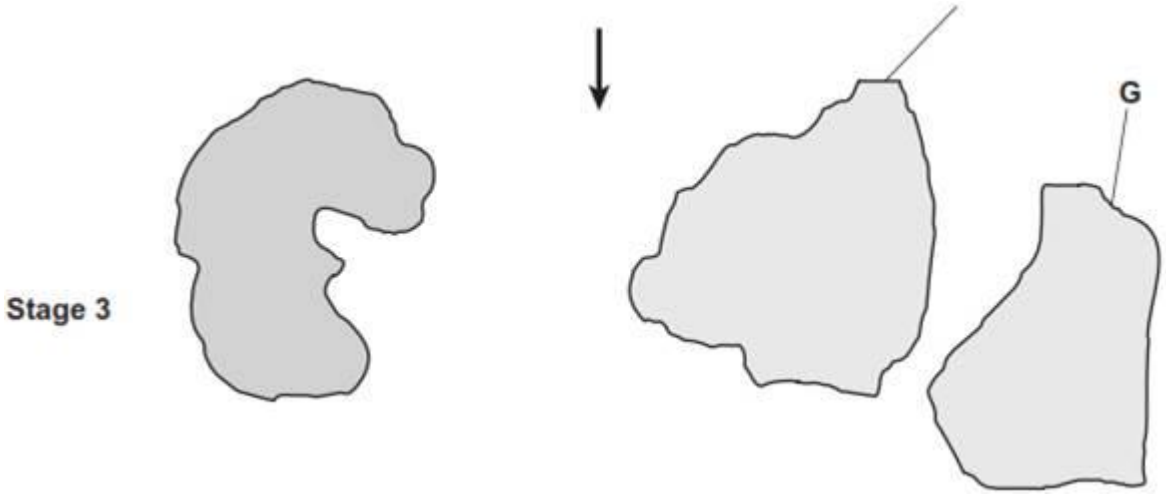
_____

_____

(2)

The diagram shows stages during an enzyme-catalysed reaction.





(b) Using the letters in the diagram, describe what is happening in this reaction.

_____

_____

_____

_____

_____

_____

(Extra space) _____

_____

_____

_____

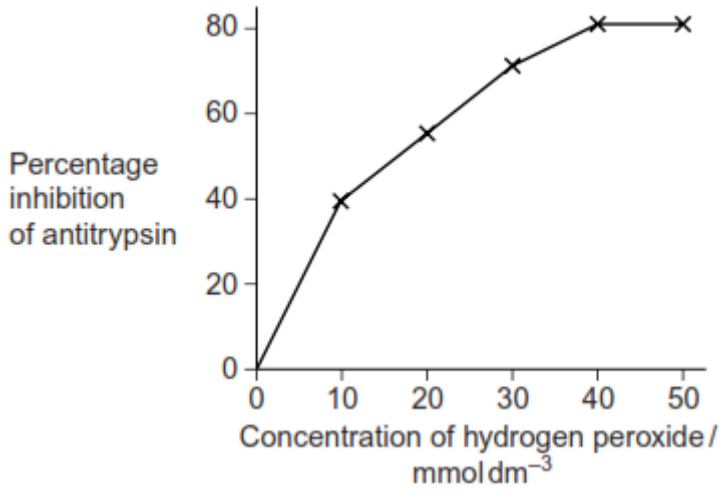
(3)

(Total 5 marks)

Q20.

Alpha-1-antitrypsin is a protein that reduces the activity of enzymes that can damage lung tissue.

Cigarette smoke contains hydrogen peroxide. Hydrogen peroxide reduces the activity of alpha-1-antitrypsin. Scientists investigated the effect of different concentrations of hydrogen peroxide on the activity of alpha-1-antitrypsin. The graph shows their results.



(a) (i) Hydrogen peroxide reacts with two amino acids in alpha-1-antitrypsin. Explain how this reduces activity of the protein.

_____

_____

_____

_____

(2)

(ii) Explain the results shown in the graph.

_____

_____

_____

_____

(2)

(b) Long-term smokers are often short of breath. Use this information to explain why.

_____

_____

_____

_____

(2)

(Total 6 marks)

Q21.

Antimicrobial proteins (AMPs), found in the skin of the African clawed frog, can kill bacteria. When AMPs are injected into humans, they are broken down by protease enzymes. Scientists have produced a number of AMPs that are not broken down by proteases. They did this by making these AMPs from man-made amino acids containing

fluorine. The AMPs containing fluorine were found to be more effective in killing bacteria than AMPs without fluorine.

(a) Name the type of reaction involved when a protease enzyme breaks down an AMP.

_____

(1)

(b) Suggest why protease enzymes cannot break down AMPs made from amino acids containing fluorine.

_____

_____

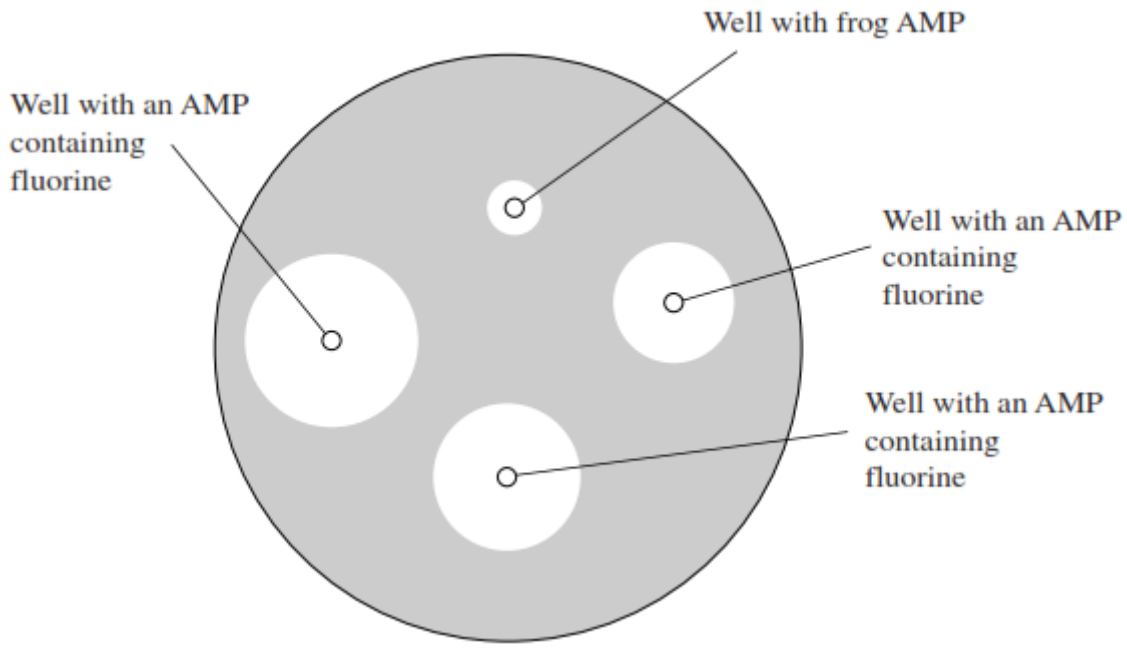
_____

_____

(2)

(c) Scientists carried out an investigation to compare the effectiveness of AMPs containing fluorine and a frog AMP. They inoculated an agar plate with a culture of one species of bacterium. They cut four wells in the agar. They placed a frog AMP in one well. They put three different man-made AMPs containing fluorine in the other three wells. They incubated the plate for 48 hours. After incubation, there were clear areas around each well where the bacteria had not grown.

The appearance of the plate after incubation is shown below.



(i) Give **one** example of aseptic technique that the scientists would have used during this investigation.

_____

_____

(1)

(ii) What conclusions could the scientists draw from these results?

_____

_____

_____

_____

_____

_____

(Extra space) _____

_____

_____

(3)

(Total 7 marks)

Q22.

Doctors investigated babies who were bottle-fed with baby-formula milk and suffered from colic. Colic is a condition that affects the gut and makes babies cry.

Each mother was given two solutions to add to her baby's milk. One solution contained the enzyme lactase, the other did not. The mother did not know which solution contained lactase. The mother added one of the solutions to her baby's milk for a week and recorded how long it cried each day. The mother then used the other solution for the second week.

The table shows the results.

	Mean crying time / hours day^{-1}
Milk with lactase	1.43
Milk without lactase	2.57

(a) Suggest an explanation for the results.

_____

_____

_____

_____

(2)

(b) The mothers were not told which solution contained lactase.

Suggest **one** reason why.

_____

_____

(1)

(c) Suggest **one** variable the doctors would have to control in this study to make it a fair test. Explain your answer.

Variable _____

Explanation _____

_____

_____

(2)

(d) The doctors concluded that adding lactase to milk was, '*A major breakthrough for babies with colic*.'

Evaluate the evidence for this conclusion.

_____

_____

_____

_____

_____

_____

(Extra space) _____

_____

_____

(3)

(Total 8 marks)

Q1.

(a) (i) box drawn around R group (i.e. CH_2OH group)
(allow circle if labelled R);

1

(ii) circle drawn around either of the Hs on NH_2 group and circle drawn around the OH;

1

(b) (i) (di)peptide and water;

1

(ii) peptide;

1

(c) sequence of amino acids changes;
tertiary structure changes / folds in a different way;
bonds form in different places;
(*Reject peptide bonds*)

3

[7]

Q2.

(a) (i) absorbed by diffusion;
no energy / ATP available / active transport requires energy / ATP;

2 max

(disqualify energy made)
(allow energy reference in either (i) or (ii))

(ii) absorbed by active transport;

1

(b) (absorption by) diffusion no longer occurs / diffusion / movement of ions equal in both directions;
because no concentration / diffusion gradient / reached equilibrium;

2

(c) malonate fits into / blocks active site of enzyme / complementary to active site;
(prevents fitting neutral)
competes with substrate / is a competitive inhibitor / prevents substrate forming enzyme-substrate complex;

2

[7]

Q3.

(a) colour results from starch-iodine reaction;
decrease due to breakdown of starch by carbohydrase / enzyme;

2

(b) (i) curve drawn below curve on graph and starting at same point;

1

(ii) curve drawn above curve on graph and starting at same point but finishing above;

(allow curve or horizontal line)

(allow alternative curve for pH if explanation in (ii) is consistent)

1

(c) (i) 1. increase in temperature increases kinetic energy;
2. increases collisions (between enzyme / active site and substrate) / increases formation of enzyme / substrate complexes;
3. increases rate of breakdown of starch / rate of reaction / carbohydrase activity;

(ii) 4. (decrease in pH) increases H^+ ions / protons which attach / attracted to amino acids;
5. hydrogen / ionic bonds disrupted / broken which denatures enzyme / changes tertiary structure;
6. changes <u>shape / charge</u> of active site so active site / enzyme unable to combine / fit with starch / enzyme-substrate complex no longer able to form;
7. decreases rate of breakdown of starch / rate of reaction / carbohydrase activity;

(allow alternative explanation for pH if consistent with line drawn in (ii))

7

[11]

Q4.

(a) (i) ammonia / ammonium ions / compound;

1

(ii) glucose;

1

(b) <u>final</u> acceptor for hydrogen:
to form water;

2

(c) glycolysis can continue;
NAD can accept more hydrogen;

2

(d) secondary / tertiary structure;
produces particular shape of active site;
or
(shape of) active site;
complementary to shape of substrate;

2

(e) sodium ions / non-competitive inhibitor binds to enzyme at a site other than active site;
resulting in change of shape of active site / no longer complementary;
substrate can no longer bind with the enzyme / enzyme-substrate complexes no longer formed;

3

[11]

Q5.

(a) urea diffused into / entered the tubing and was hydrolysed / broken down (inside tubing);
ammonia increases pH / makes (solution) more alkaline and indicator turns blue as pH above 8 / due to alkalinity / due to ammonia;
idea that outside stays yellow because urease does not pass out;

3

(b) (i) add biuret solution / add sodium hydroxide + copper sulphate (solution);

(disqualify heat / boil, but accept warm)

violet / lilac / purple colour;

2

(ii) inside: protein present, as enzyme is protein;
outside: no protein, as urease / enzyme / protein unable to pass through membrane / out;

(accept correct result of biuret test as indicator of protein)

2

(c) method to maintain range of temperatures, e.g. water baths;
method to measure rate of activity - e.g. time taken to turn indicator blue;

(principle - measure rate of activity over range of temperatures = 1 mark, if neither point)

other conditions kept constant / named examples,
e.g. volumes of solutions,
starting pH, sample time;
method of refining optimum, e.g. repeats at narrower range;

3 max

[10]

Q6.

(a) (i) fructose;

1

(ii) correctly drawn (OH group at bottom left);

1

(b) hydrolysis;

1

(c) (i) heat with Benedict's solution (*disqualify if HCl added*);
orange / brown / brick red / green / yellow colour or precipitate;

2

(ii) biuret test / NaOH + $CuSO_4$;
purple / violet / lilac / mauve;

2

[7]

Q7.

(a) maximum rate at which enzyme can combine with substrate / form enzyme-substrate complexes / substrate no longer limiting / enzyme is a limiting

factor;
(active site of) enzyme saturated with substrate (*disqualify active sites / enzymes* '*used up*');

2

(b) inhibitor attaches to enzyme away from the active site;
changes shape of active site and prevents formation of enzyme-substrate complex;

2

(c) $\frac{7.6 - 5.6}{7.6}$ × 100;
= 26.32%; *(accept 26% or 26.3%)*
(correct answer = 2 marks)
(principle – $\frac{\text{decrease in rate}}{\text{max rate}}$ *× 100 = 1 mark)*

2

(d) curve below top curve (without inhibitor) joining to top curve / continues to increase to end of *x*-axis
(*must not exceed or level out below 'without inhibitor curve' and must start from origin*);

1

[7]

Q8.

(a) (i) fall in deaths due to rise in number of people with immunity / better care / targeting vaccination at vulnerable;

1

(ii) mutation of virus / new strain;
mutant form not recognised by memory cells (*allow antibodies*);

2 max

(b) (i) T lymphocyte receptors recognise shape of haemagglutinin / neuraminidase / viral antigen;
clone (*once only*);
destroy virus;

2 max

(ii) clone (*once only*);
produce antibodies;
effect of antibody e.g. stimulation of phagocytosis / precipitation of toxins;

2

(c) alter shape of active site of neuraminidase / block active site;
virus unable to leave host cells;

2

[9]

Q9.

21 – 25	Extended abstract	Response shows holistic approach to the question with a fully integrated answer which makes clear links

	Generalised beyond specific context	between several different topics and the theme of the question. Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained. No significant errors or irrelevant material. For top marks in the band, the answer shows evidence of reading beyond specification requirements.
16 – 20	Relational Integrated into a whole	Response links several topics to the main theme of the question, to form a series of interrelated points which are clearly explained. Biology is fundamentally correct A-level content and contains some points which are detailed, though there may be some which are less well developed, with appropriate use of terminology. Perhaps one significant error and, or, one irrelevant topic which detracts from the overall quality of the answer.
11 – 15	Multistructural Several aspects covered but they are unrelated	Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question. Biology is usually correct A-level content, though it lacks detail. It is usually clearly explained and generally uses appropriate terminology. Some significant errors and, or, more than one irrelevant topic.
6 – 10	Unistructural Only one or few aspects covered	Response predominantly deals with only one or two topics that relate to the question. Biology presented shows some superficial A-level content that may be poorly explained, lacking in detail, or show limited use of appropriate terminology. May contain a number of significant errors and, or, irrelevant topics.
1 – 5	Unfocused	Response only indirectly addresses the theme of the question and merely presents a series of biological facts which are usually descriptive in nature or poorly explained and at times may be factually incorrect. Content and terminology is generally below A-level. May contain a large number of errors and, or, irrelevant topics.
0		Nothing of relevance or no response.

Commentary on terms and statements in the levels mark scheme

The levels mark scheme for the essay contains a number of words and statements that are open to different interpretations. This commentary defines the meanings of these words and statements in the context of marking the essay. Many words and statements are used in the descriptions of more than one level of response. The definitions of these remain the same throughout.

Levels mark scheme word/statement	Definition
Holistic	Synoptic, drawing from different topics (usually sections of the specification)
A fully integrated answer which makes clear links between several different topics and the theme of the question	All topics relate to the title and theme of the essay; for example, explaining the biological importance of a process. When considering, for example, the importance of a process, the explanation must be at A-level standard. 'Several' here is defined as at least four topic areas from the specification covered. This means some sentences, not just a word or two. It does not mean using many examples from one topic area.
Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained.	Detailed and comprehensive A-level content is the specification content. Terminology is that used in the specification. Well written and clearly explained refers mainly to biological content and use of terminology. Prose, handwriting and spelling are secondary considerations. Phonetic spelling is accepted, unless examiners are instructed not to do so for particular words; for example, glucagon, glucose and glycogen.
No significant errors or irrelevant material.	A significant error is one which significantly detracts from the biological accuracy or correctness of a described example. This will usually involve more than one word. Irrelevant material is several lines (or more) that clearly fails to address the title, or the theme of the title.
For top marks in the band, the answer shows evidence of reading beyond	An example that is relevant to the title and is not required in the specification content. The example must be used at

specification requirements.	A-level standard.
Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question.	Not addressing the biological theme of the essay (e.g. importance) at A-level standard.

Please note that to obtain full credit, students must use information to show **the importance of enzymes in plants and animals**.

Topics

1	principles of enzyme action (A) e.g. catalysis, protein structure, active site, activation energy, enzyme-substrate complex, specificity. good candidates relate protein structure to specificity / active site, catalysis to activation energy.
2	factors affecting enzyme action (F) e.g. temperature, pH, enzyme / substrate concentration, inhibition. good candidates – relate changes in activity to denaturing / tertiary structure; effects of concentration to active site availability, distinguish competitive / non-competitive inhibition.
3	enzyme synthesis (S) reference to protein synthesis; link to genes, gene expression, effects of mutation. good candidates – appreciation of connection between genes and enzyme production, e.g. 'one gene, one enzyme'. roles and functions of enzymes in different processes. In each case good candidates should specify enzyme and its function.
4	digestion (D) enzymes involved in mammalian digestive system, breakdown of polymers in other circumstances, e.g. saprophytic digestion / mobilisation of storage compounds. good candidates – range of enzymes giving source and action in sequence in mammalian digestion; reference to other breakdown.
5	metabolic pathways - photosynthesis (Ps) and respiration (R) e.g. light independent reaction, Krebs cycle, ATP formation. good candidates - reference to specific roles e.g. in l.i.r., distribution in mitochondria / chloroplasts.
6	other specific examples e.g. in nervous system (N), such as role of acetylcholinesterase in synapses,

	in homeostasis (H), such as in glycogenesis, in muscle action (M), such as role of ATPase, in fertilisation (Sp), such as enzymes in acrosome, in transcription / translation (T), such as role of polymerases. other specific examples e.g. in nervous system (N), such as role of acetylcholinesterase in synapses, in homeostasis (H), such as in glycogenesis, in muscle action (M), such as role of ATPase, in fertilisation (Sp), such as enzymes in acrosome, in transcription / translation (T), such as role of polymerases.

In order to fully address the question and reach the highest mark bands students must also include at least four topics in their answer, to demonstrate a synoptic approach to the essay.

Students may be able to show the relevance of other topics from the specification.

Note, other topics from beyond the specification can be used, providing they relate to the title and contain factually correct material of at least an A-level standard. Credit should not be given for topics beyond the specification which are below A-level standard.

[25]

Q10.

(a) (i) condensation;

1

(b) (i) **D**;

1

(ii) **C**;

1

(iii) **A**;

1

(c) absence of a double bond;
in the (hydrocarbon) chain;
unable to accept more <u>hydrogen</u> / saturated with hydrogen;

2 max

[6]

Q11.

(a) specific 3D tertiary structure / shape;
substrate complementary shape;

(reject same shape)

substrate (can bind) to <u>active site</u> / can fit into each <u>active site</u>;

3

(b) (bacterial) active site / enzymes / proteins denatured /
tertiary 3D structure disrupted / changed;
(ionic) bonds broken;

(reject peptide bonds)
(ignore other bonds)

no enzyme substrate complex formed / substrate no longer fits;

3

[6]

Q12.

(a) (i) number of bases = 4440

allow 4446 if they refer to start / stop

each amino acid coded for by triplet / three bases
(so three times more bases than amino acids);

2

(ii) deletion;
(deletion) of three bases;
because substitution / addition would change amino acid(s);

2 max

(b) codon on mRNA;
specific / complementary base pairing with;
<u>anti-codon</u> on tRNA;
specific tRNA for each amino acid;
protein formed by condensation reactions /
peptide bonds formed;

4 max

[8]

Q13.

(a) pioneers / suitable example colonise land;
example of change in environment;
enables change in species;
<u>conditions change further / example</u> to favour trees;

4

(b) stable community / no further succession / final community;

1

(c) <u>roots</u> unable to respire (aerobically);
active transport of minerals / other metabolic effect stops;

2

(d) action of bacteria / decomposers inhibited / fewer bacteria / decomposers;
acid conditions <u>inhibits</u> enzymes / enzymes denatured / changes active site;
H^+ ions affect active site;
anaerobic conditions;

3 max

[10]

Q14.

(a) C_{12} ; $H_{22}O_{11}$;

2

(b) (i) <u>heat</u> with Benedict's;

yellow / brown / orange / red;

2

(ii) (yes)

(may appear on second line)

more precipitate in sample **B**;
both sugars are reducing sugars / give a positive test;

2

[6]

Q15.

(a) mutation changes the amino acid sequence / primary structure of Factor VIII protein;
changes the tertiary structure / 3D shape;

2

(b) (mutant) Factor VIII protein is non-functional / does not work with Factor IX;
so no conversion of Factor X to active form and pathway blocked;

2

(c) boy's blood contains (active) Factor VIII;
Factor VIII haemophiliac's blood contains (active) Factor IX;
the mixture has both Factors and so the pathway can complete / blood clots;

2 max

[6]

Q16.

(a) membrane relatively impermeable / less permeable to sodium ions / gated channels are closed / fewer channels;
sodium ions pumped / actively transported <u>out</u>;
by sodium ion carrier / intrinsic proteins;
inside negative compared to outside / 3 sodium ions out for two potassium ions in;

(if sodium mentioned but not in context of ions, negate 1 mark)

4

(b) (i) 1.6;

1

(ii) 18 ÷ 1.6 = 11.25;
multiply by 1000 to convert from ms to s / 11 250;

(correct method = 1 mark, i.e. $\frac{distance}{time}$ *or × 1000)*
(correct answer based on (b)(i) = 2 marks)

2

(iii) time for transmission / diffusion across the neuromuscular junction / synapse;
time for muscle (fibrils) to contract;

1 max

(c) movement by diffusion;
binding to receptors on (post-synaptic) membrane;

causing sodium channels to open / sodium ions to move in to muscle (cell);

3

(d) (i) toxin binds to / competes for / blocks the acetylcholine receptors; acetylcholine can not depolarise the membrane / the toxin does not cause depolarisation;

(allow references to generating action potentials instead of depolarisation, do not allow references to impulses in muscles)

2

(ii) acetylcholinesterase is unable to breakdown acetylcholine; acetylcholine still available to depolarise the membrane / generate action potentials in the membrane;

2

[15]

Q17.

21 – 25	Extended abstract Generalised beyond specific context	Response shows holistic approach to the question with a fully integrated answer which makes clear links between several different topics and the theme of the question. Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained. No significant errors or irrelevant material. For top marks in the band, the answer shows evidence of reading beyond specification requirements.
16 – 20	Relational Integrated into a whole	Response links several topics to the main theme of the question, to form a series of interrelated points which are clearly explained. Biology is fundamentally correct A-level content and contains some points which are detailed, though there may be some which are less well developed, with appropriate use of terminology. Perhaps one significant error and, or, one irrelevant topic which detracts from the overall quality of the answer.
11 – 15	Multistructural Several aspects covered but they are unrelated	Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question. Biology is usually correct A-level content, though it lacks detail. It is usually clearly explained and generally uses appropriate terminology. Some significant errors and, or, more than one irrelevant topic.

6 – 10	Unistructural Only one or few aspects covered	Response predominantly deals with only one or two topics that relate to the question. Biology presented shows some superficial A-level content that may be poorly explained, lacking in detail, or show limited use of appropriate terminology. May contain a number of significant errors and, or, irrelevant topics.
1 – 5	Unfocused	Response only indirectly addresses the theme of the question and merely presents a series of biological facts which are usually descriptive in nature or poorly explained and at times may be factually incorrect. Content and terminology is generally below A-level. May contain a large number of errors and, or, irrelevant topics.
0		Nothing of relevance or no response.

Commentary on terms and statements in the levels mark scheme

The levels mark scheme for the essay contains a number of words and statements that are open to different interpretations. This commentary defines the meanings of these words and statements in the context of marking the essay. Many words and statements are used in the descriptions of more than one level of response. The definitions of these remain the same throughout.

Levels mark scheme word/statement	**Definition**
Holistic	Synoptic, drawing from different topics (usually sections of the specification)
A fully integrated answer which makes clear links between several different topics and the theme of the question	All topics relate to the title and theme of the essay; for example, explaining the biological importance of a process. When considering, for example, the importance of a process, the explanation must be at A-level standard. ‘Several’ here is defined as at least four topic areas from the specification covered. This means some sentences, not just a word or two. It does not mean using many examples from one topic area.
Biology is detailed and comprehensive A-level content, uses appropriate terminology, and is very well written and always clearly explained.	Detailed and comprehensive A-level content is the specification content. Terminology is that used in the specification.

	Well written and clearly explained refers mainly to biological content and use of terminology. Prose, handwriting and spelling are secondary considerations. Phonetic spelling is accepted, unless examiners are instructed not to do so for particular words; for example, glucagon, glucose and glycogen.
No significant errors or irrelevant material.	A significant error is one which significantly detracts from the biological accuracy or correctness of a described example. This will usually involve more than one word. Irrelevant material is several lines (or more) that clearly fails to address the title, or the theme of the title.
For top marks in the band, the answer shows evidence of reading beyond specification requirements.	An example that is relevant to the title and is not required in the specification content. The example must be used at A-level standard.
Response mostly deals with suitable topics but they are not interrelated and links are not made to the theme of the question.	Not addressing the biological theme of the essay (e.g. importance) at A-level standard.

Please note that to obtain full credit, students must use information to show **how the structure of proteins is related to their functions.**.

Topics

1	Structure (S) primary structure – peptide bond secondary structure tertiary structure. Globular - bonds between R groups give spherical shape – shape determines function – active sites and receptor sites (*allow quaternary structure – haemoglobin incorporates ions for oxygen transport*)
2	Structural proteins (ST) fibrous – regular pattern of hydrogen bonds – coiling, (*e.g. keratin coils twist together to form rope-like structures – flexible and strong*) (*e.g. collagen – coils more tightly bound – more rigid*)
3	Transport (T)

	channel – complementary shape – charges – gated carrier – complementary shape – can change shape active transport – phosphate group attached by energy from ATP – can change shape
4	Enzymes (E) active site, enzyme-substrate complex activation energy reduction - explanation e.g. brings molecules closer
5	Receptors (R) synapse insulin / glucagon ADH rhodopsin
6	Muscle (M) actin thin – binding site myosin thick - cross bridges tropomyosin – block binding sites

In order to fully address the question and reach the highest mark bands students must also include at least four topics in their answer, to demonstrate a synoptic approach to the essay.

Students may be able to show the relevance of other topics from the specification.

Note, other topics from beyond the specification can be used, providing they relate to the title and contain factually correct material of at least an A-level standard. Credit should not be given for topics beyond the specification which are below A-level standard.

[25]

Q18.

(a) To keep concentrations of gelatine constant;

Accept 'to keep concentration constant' for / mark if points 1 and 2 not made

To keep concentration of pineapple extract constant;
Tube 2 had HCI added / to give same volume as B;

2 max

(b) Tube A

Enzyme (in pineapple) has digested gelatine;

Allow enzyme 'breaks down' gelatine

So no gelatine / protein to form a jelly;

Tube B

Enzyme denatured / inhibited / reference to hydrogen bonds / change of tertiary structure;
By HCl / change of pH;

4

(c) For comparison / as a control;
To show that it is an <u>enzyme</u> in pineapple that digested gelatine / stopped gelatine setting in tube 1;
Boiling denatures enzyme / Can be described but must be permanent change;
Other components of pineapple still present;

3 max

[9]

Q19.

(a) Protein;

Catalyst;

Accept speeds up a reaction (but is not changed by the reaction)

(For reaction involving a) specific substrate;

Lowers activation energy;

2 max

(b) Enzyme D binds/collides with substrate E;

Ignore lock and key references

Active site forms/changes shape to fit substrate/E;

Max 2 if no reference to letters

(By) <u>induced fit</u>;

(As) enzyme-substrate complex forms;

(Breaks down to give) products F <u>and</u> G;

Enzyme is unchanged (at end);

3 max

[5]

Q20.

(a) (i) Changes shape of antitrypsin;
Reference to hydrogen/ionic/disulfide bonds;
No longer attaches to/interacts/ reacts with trypsin;

Accept protease

2

(ii) Higher the concentration of hydrogen peroxide, more amino acids/ proteins affected;

More antitrypsin molecules change shape;

2

(b) (Longterm smokers) inhale a lot of hydrogen peroxide;
Smokers have more active enzyme that damages lung tissue;
Reducing gas exchange surface;

2 max

[6]

Q21.

(a) Hydrolysis;

Accept breaking of peptide bonds

1

(b) Adding fluorine changes shape/different shape from other proteins;
Do not fit active site (of protease);
Induced fit not produced;

2 max

(c) (i) Suitable example;
e.g. Flaming spreader/ use lid of Petri dish as umbrella/ clean bench with disinfectant/ sterilise agar in autoclave;

Ignore references to wearing gloves, unless suitably qualified and unqualified references to 'clean'

1

(ii) All the AMPs killed/inhibited the bacteria/AMPs with fluorine more effective than frog AMP;
Not All fluorine AMPs are equally effective;
Diameter/area of clear zone indicates effectiveness;
Only used one kind of bacterium/need to repeat using other bacteria;
Need to repeat the investigation/only one plate used;
Credit suitable measurements or calculations;

3 max

[7]

Q22.

(a) Lactose intolerance in babies/babies don't make/have lactase;
Lactose (in milk) causes colic/crying/discomfort;
Lactase breaks down lactose/milk sugar;

2 max

(b) To avoid prejudice/bias from <u>mother</u> (when recording crying);

Accept for mother she/they/their

Accept to avoid mothers being concerned that their child has lactose intolerance.
Q - Reject vague ref. to fair test/avoid bias with no ref. to mothers.

1

(c) **One** variable; with explanation;
Example,
Type of milk used;
So same concentration of lactose;

Same age of children;
Change in enzyme production with age;

Same age of children;
Change in milk consumption with age;

Same volume of milk (per kg baby);

So same dosage (of lactose);

Accept ref. to controlling other factors in diet

Reject time in the context of duration of investigation, given in stem

Accept e.g. time of feeding each day

Accept temperature of milk, related to action of lactase enzyme

2 max

(d) There is a decrease in crying;
Could be other causes/symptoms of colic;
Babies might cry for reasons besides colic/might have colic and not cry/can't be sure they have colic, they can't talk;
Don't know number of babies in trial/need a larger study;
So don't know how reliable mean is;
Standard deviation not given/spread of data;
So don't know whether difference is significant;
Babies still crying (for 1.43 hours);
Recording by mothers might not be reliable;
Longer running study to make sure effect (of lactase) lasts;

3 max

[8]