Questions

Q1.

There are three different types of haemoglobin in the blood of an adult human. Each haemoglobin molecule is composed of four polypeptide chains.

The table shows information about these types of haemoglobin.

Type of haemoglobin	Percentage present in the blood (%)	Types of polypeptide chain present
HbA_1	96	2α and 2β
HbA_2	3	2α and 2δ
HbF	1	2α and 2γ

Calculate the ratio of polypeptide chains present in the blood of an adult human.

(3)

Answer .....

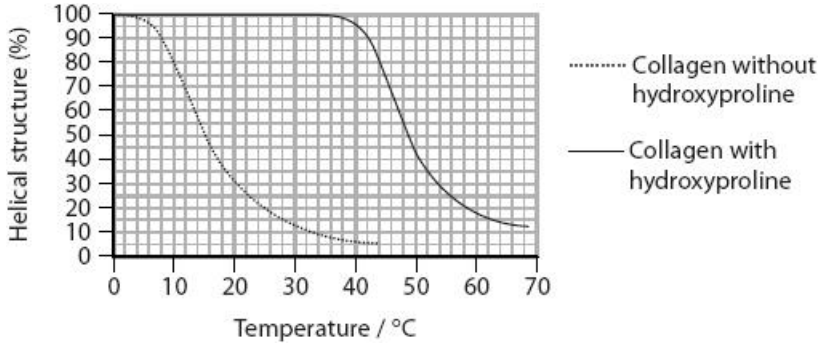
(Total for question = 3 marks)

Q2.

Collagen is a structural protein found in connective tissue.

Hydroxyproline and proline are components of collagen.

The graph shows the effect of temperature on the helical structure of collagen with hydroxyproline and collagen without hydroxyproline.



(i) Analyse the data to explain the importance of hydroxyproline in the structure of collagen.

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(ii) The table shows information about the skin collagen of three animals and the body temperature of each animal.

Animal	Percentage of proline and hydroxyproline in skin collagen (%)	Body temperature / °C
Calf	23.2	37
Shark	19.1	24 to 28
Cod	15.5	10 to 14

The thermal stability of collagen is described by its shrinkage temperature (T_s). This is the temperature at which 50% of the helical structure is lost.
Analyse the data in the graph and the table to comment on the stability of collagen in these animals.

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(Total for question = 6 marks)

Q3.

During mitosis, microtubules form the spindle.

These microtubules are made of a protein called tubulin.

Individual tubulin molecules are globular with a diameter of 25 nm.

Thousands of tubulin molecules are assembled together to form long, hollow microtubules.

(i) Describe the differences between a fibrous protein and an individual tubulin molecule.

(2)

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(ii) A microtubule is 40 μm in length.

Calculate how many times longer this microtubule is than a single tubulin molecule.

(2)

Answer .....

(Total for question = 4 marks)

Q4.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The photographs show a black cat and a Siamese cat.

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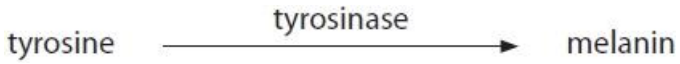
The pigment melanin causes the fur to turn black.
This pigment is produced by tyrosinase, an enzyme coded by the TYR gene.



Siamese cats have a mutation in their TYR gene.
This changes the secondary and tertiary structures of tyrosinase.

(i) Which of the following shows the type of bonding involved in both the secondary and tertiary structures of a protein?

(1)

- ☒ **A** hydrogen only
- ☒ **B** hydrogen and ionic
- ☒ **C** ionic and disulfide
- ☒ **D** ionic only

(ii) Explain why the cooler regions of a Siamese cat have dark coloured fur and the warmer regions have lighter coloured fur.

(3)

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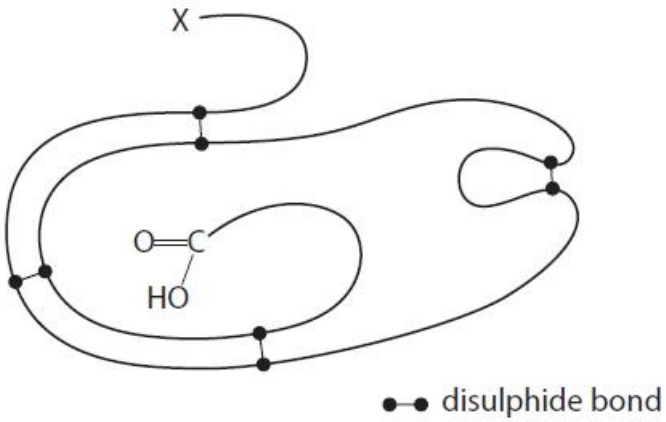
(Total for question = 4 marks)

Q5.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The diagram shows the tertiary structure of a molecule of the enzyme RNase.



(i) Which chemical group is found at position X?

(1)

- ☒ **A** amino
- ☒ **B** carboxyl
- ☒ **C** hydroxyl
- ☒ **D** nitrate

(ii) Give the meaning of the term tertiary structure of a protein.

(2)

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(Total for question = 3 marks)

Q6.

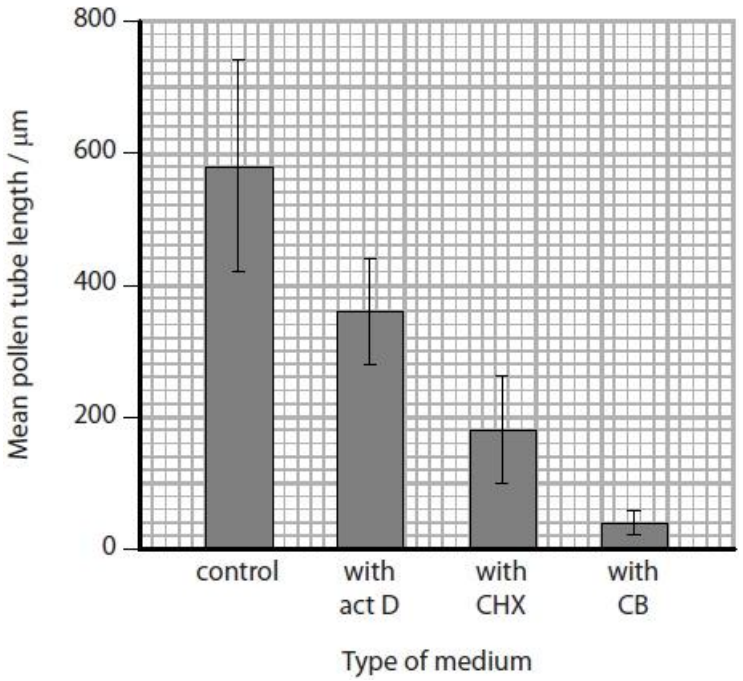
A student investigated the effect of three inhibitors on the growth of pollen tubes.

Pollen grains were incubated in a control medium.

In addition, some pollen grains were also incubated in three media, each containing one inhibitor.

The inhibitors used were actinomycin D (act D), cycloheximide (CHX) and cytochalasin B (CB).

The results of this investigation are shown in the graph.



The student made the following conclusions from these results:

Conclusion 1: all three inhibitors affected pollen tube growth

Conclusion 2: pollen grown in CB grew the slowest

Conclusion 3: the control result was the least repeatable

Conclusion 4: more pollen grains germinated in the control group

(i) Actinomycin D (act D) inhibits transcription.

Explain why pollen tubes could still grow in the presence of act D.

(2)

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(ii) Cycloheximide inhibits translation.
Describe the process of translation.

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(iii) Cytochalasin B prevents the addition of monomers in the synthesis of the protein actin.
Describe how monomers are bonded to a polypeptide chain during the synthesis of actin.

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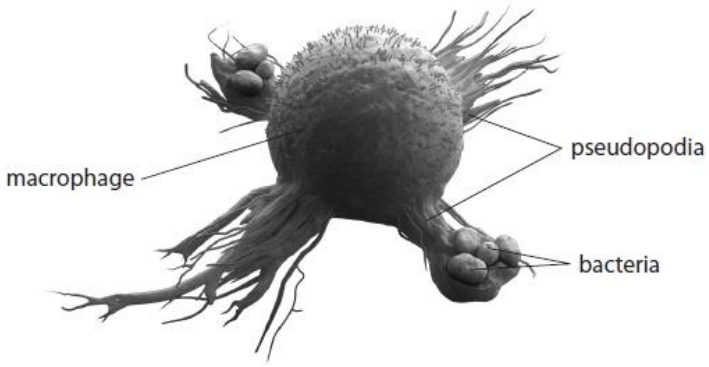
(Total for question = 8 marks)

Q7.

Macrophages are involved in response to infection.

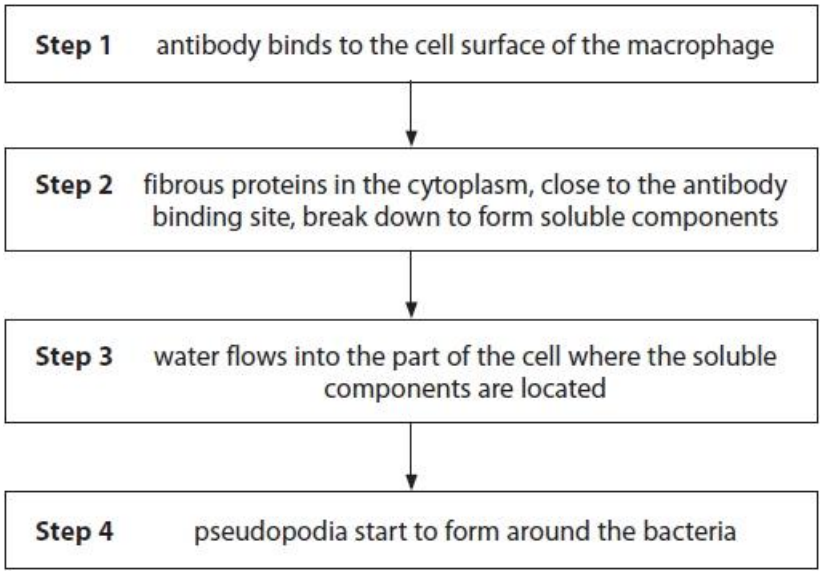
Macrophages engulf bacteria by surrounding the bacteria with pseudopodia.

The image shows a macrophage forming pseudopodia around some bacteria.



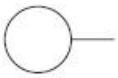
(Source: © urfin/Shutterstock)

The flow chart shows one theory for the formation of pseudopodia.

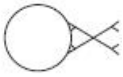


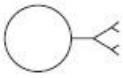
(i) Which diagram shows one antibody binding to the surface of a macrophage (**Step 1**)?

(1)

☒ **A** 

☒ **B** 

☒ **C** 

☒ **D** 

(ii) Actin is a fibrous protein.

Which row of the table describes the breakdown of actin (**Step 2**)?

(1)

		monomer formed	process by which bond is broken
☐	**A**	amino acid	condensation
☐	**B**	amino acid	hydrolysis
☐	**C**	nucleotide	condensation
☐	**D**	nucleotide	hydrolysis

(iii) Explain why water flows into the part of the cell where the soluble components are located (**Step 3**).

(2)

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(iv) Describe the events that take place resulting in T helper cell activation, following the formation of pseudopodia by the macrophages (**Step 4**).

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(Total for question = 7 marks)

Q8.

Cattle with bovine spongiform encephalopathy (BSE) have microscopic holes in their brain tissue.

This disease involves the misfolding of proteins which then form clumps.

Clumps of misfolded proteins can be seen with an electron microscope.

The misfolded proteins have a changed secondary structure. Therefore they cannot be digested by some protease enzymes.

(i) Describe what is meant by the secondary structure of a protein.

(2)

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(ii) Explain why the misfolded protein cannot be digested by some protease enzymes.

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(Total for question = 5 marks)

Q9.

Peptide hormones and steroid hormones are synthesised by endocrine glands.

Peptide hormones are transported dissolved in blood plasma. They bind to specific receptor molecules on the cell surface membranes of their target organs.

Explain how the primary structure of a peptide hormone determines its properties.

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(Total for question = 4 marks)

Q10.

Peptide hormones and steroid hormones are synthesised by endocrine glands.

Peptide hormones are transported dissolved in blood plasma. They bind to specific receptor molecules on the cell surface membranes of their target organs.

Some peptide hormones are nonapeptides.

The table shows the amino acid sequences of three types of nonapeptide: A, B and C.

Type	Position of amino acid in the nonapeptide								
	1	2	3	4	5	6	7	8	9
A	cys	tyr	ile	gln	asn	cys	pro	arg	gly
B	cys	tyr	phe	gln	asn	cys	pro	arg	gly
C	cys	tyr	phe	gln	asn	cys	pro	lys	gly

(i) Compare and contrast the amino acid sequence of these three nonapeptides.

(3)

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(ii) Explain why the DNA base sequences coding for these three nonapeptides are more variable than their amino acid sequences.

(3)

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(Total for question = 6 marks)

Q11.

Leeches are parasites that feed by sucking blood. When they bite, they secrete saliva into the wound. The saliva contains a globular protein called hirudin.

Explain why this protein is soluble in water.

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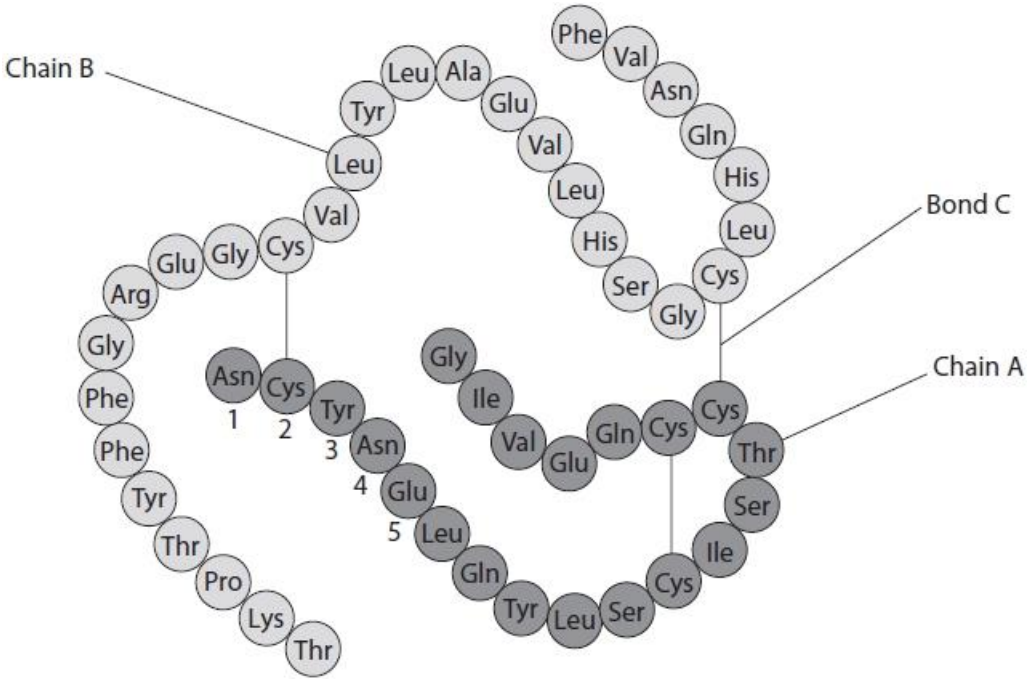
(Total for question = 3 marks)

Q12.

Insulin is a protein that is composed of two polypeptide chains, chain A and chain B.

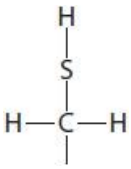
The diagram shows the amino acid sequence of these two polypeptide chains and some of the bonds involved in the folding of this protein.



Cysteine (Cys) is one type of amino acid found in insulin.

The presence of cysteine in insulin is important in determining the structure of this protein.

The R group of cysteine is:



(i) Draw a diagram to show the structure of the amino acid cysteine.

(3)

(ii) Name the covalent bond labelled C in the diagram.

(1)

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(Total for question = 5 marks)

Q13.

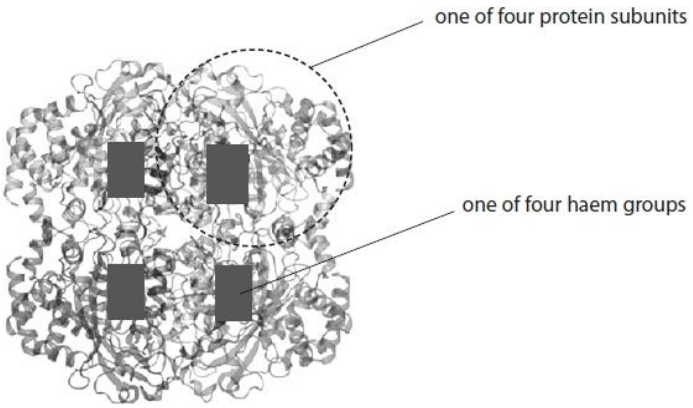
The photograph shows sweet red peppers growing on a plant.

Unripe sweet red peppers contain the enzyme catalase. As these peppers ripen, the activity of catalase decreases.

The equation summarises the reaction catalysed by catalase.

hydrogen peroxide ⟶ water + oxygen

The diagram shows the structure of catalase.



Explain why the enzyme catalase is described as having a tertiary and quaternary structure.

(3)

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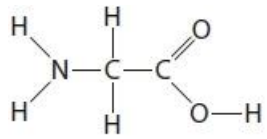
(Total for question = 3 marks)

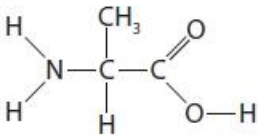
Q14.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The diagram shows two amino acids found in the primary sequence of collagen.



glycine



alanine

(i) Which is the R-group for alanine?

(1)

- ☒ **A** CH_3
- ☒ **B** COOH
- ☒ **C** H
- ☒ **D** NH_2

(ii) Draw the products of a condensation reaction between glycine and alanine.

(2)

(iii) Describe the structure of collagen.

(3)

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(Total for question = 6 marks)

Q15.

Antibiotics can affect bacteria.

The table describes the mode of action of four antibiotics.

Antibiotic	Mode of action
benzylpenicillin	disrupts peptidoglycan structure
streptomycin	binds to 70S ribosomes
ciprofloxacin	inhibits enzymes involved in prokaryotic DNA replication
rifamycin	inhibits prokaryotic RNA polymerase

Mutations in the DNA of bacteria can enable them to be resistant to antibiotics.

(i) A single bacterium can produce 2×10^{10} new cells per day by cell division.

The mean mutation rate in one day is 1 in 10 million new cells produced.
Calculate the mean number of bacteria with mutations that could be produced in one day from a single bacterium.

(2)

Answer .....

(ii) Explain how bacteria may become resistant to streptomycin if a mutation changes the primary structure of a protein.

(3)

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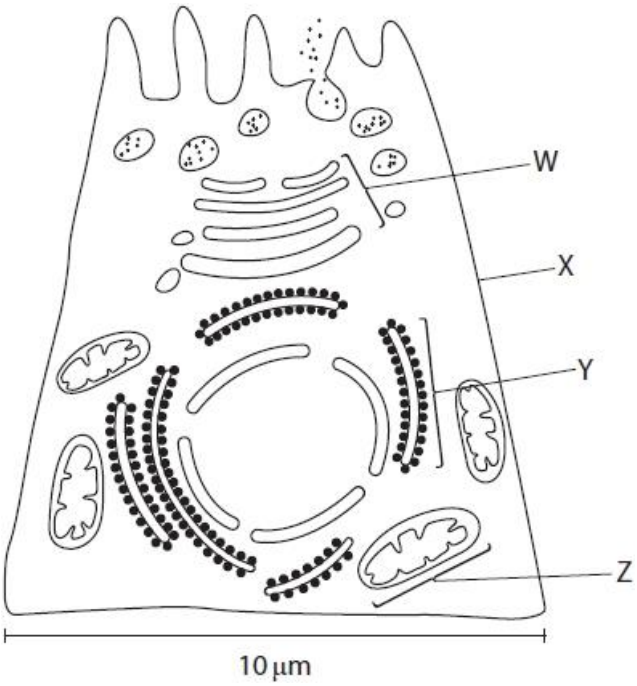
(Total for question = 5 marks)

Q16.

Some of the cells in the pancreas secrete proteins.

The diagram represents a pancreatic cell.



The secreted proteins are made from amino acids.

Two amino acids join together to form a dipeptide.

Draw a diagram to show the structure of a dipeptide.

(3)

(Total for question = 3 marks)

Q17.

Mitochondria can be extracted from liver cells.

In order to monitor the purification of a sample of mitochondria,
a protein concentration : enzyme activity ratio can be determined.

Describe the structure of a globular protein.

(2)

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(Total for question = 2 marks)

Q18.

The egg of a hen contains albumin, a globular protein.

Describe the tertiary structure of a globular protein.

(3)

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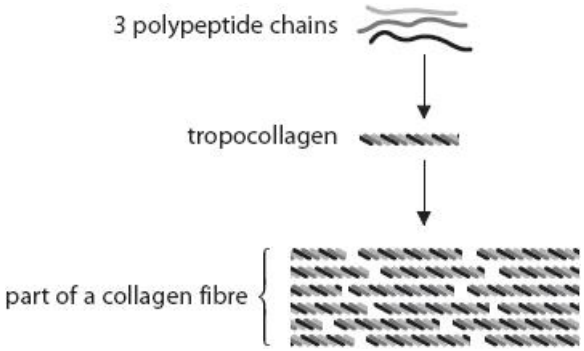
(Total for question = 3 marks)

Q19.

Collagen is a structural protein found in connective tissue.

The diagram shows the components of a typical collagen fibre.



(i) Explain the significance of repeating sequences of amino acids in the formation of tropocollagen.

(2)

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(ii) Which of the following bonds holds the 3 polypeptide chains together in the tropocollagen?

(1)

☒ **A** ester

☒ **B** glycosidic

☒ **C** hydrogen

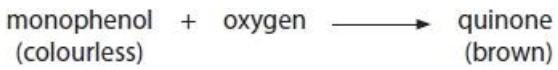
☒ **D** peptide

(Total for question = 3 marks)

Q20.

Polyphenol oxidase is an enzyme found in many plant cells.

This enzyme catalyses the following reaction



This reaction causes cut fruit to turn brown when exposed to air.

Plant breeders have developed a grape variety that produces inactive polyphenol oxidase.

The bonding in this enzyme is changed and this prevents the juice from turning brown.

(i) Which of the following bonds are used to form the tertiary structure of enzymes?

(1)

- ☒ **A** hydrogen, glycosidic and ester
- ☒ **B** hydrogen, ionic and disulfide
- ☒ **C** ionic, glycosidic and disulfide
- ☒ **D** ionic, disulfide and ester

(ii) The base sequence of this polyphenol oxidase gene is different in this grape variety. Explain how this leads to the production of inactive enzyme.

(3)

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(Total for question = 4 marks)

Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
	• percentage of each polypeptide in each type of haemoglobin **(1)**	Example of calculation HbA_1: α = 48 β = 48 HbA_2: α = 1.5 δ = 1.5 HbF : α = 0.5 γ= 0.5	
	• total percentage of α chains given **(1)**	α = 48 + 1.5 + 0.5 = 50	
	• ratio calculated **(1)**	α : β : δ : γ = 100 : 96 : 3 : 1 Correct answer with no working gains full marks Award 2 marks for 200 :192: 6: 2 OR 50: 48: 1.5 : 0.5	**(3)**

Q2.

Question Number	Answer	Additional Guidance	Mark
(i)	A response that makes reference to the following:		
	• the collagen with hydroxyproline has more helix present than collagen without hydroxyproline (at higher temperatures) **(1)**	**ACCEPT** collagen without hydroxyproline loses helical structure at lower temperature	
	• therefore hydroxyproline must be responsible for holding the helix together **(1)**	**ACCEPT** hydroxyproline maintains strength of collagen	**(2)**

Question Number	Answer	Additional Guidance	Mark
(ii)	A response that makes reference to the following: • the T_s values for collagen with hydroxyproline is 49°C / collagen without hydroxyproline is 15°C **(1)** • therefore presence of hydroxyproline increases the thermal stability of collagen **(1)** • calves will have the most stable collagen **(1)** • which is necessary as calves have the highest body temperature **(1)**	**ACCEPT** prevents helical structure breaking down **ACCEPT** converse **ACCEPT** converse / correlation between the two variables e.g. calf has the highest % of hydroxyproline and highest body temperature	**(4)**

Q3.

Question Number	Answer	Additional Guidance	Mark
(i)	A description that makes reference to two of the following: • fibrous proteins have little or no tertiary structure unlike tubulin (1) • fibrous proteins are insoluble whereas tubulin can be (semi) soluble (in water) (1) • fibrous proteins are made of long polypeptide chains (with cross-linkages) whereas tubulin is folded into a globular shape (1)	ACCEPT fibrous proteins have hydrophobic groups on the outside / converse ACCEPT fibrous proteins are {longer / tougher}	**(2)**

Question Number	Answer	Additional Guidance	Mark
(ii)	A calculation that shows: • µm converted to nm (1) • And divided by 25 (1)	Example of calculation • 40 µm = 40000 nm / 25 nm = 0.025 µm ACCEPT correct standard form • 40000/ 25 = 1600 correct answer gains both marks	(2)

Q4.

Question Number	Answer	Mark
(i)	The only correct answer is A hydrogen only *B is incorrect because ionic bonds are not involved in the secondary structure* *C is incorrect because disulfide bonds are not involved in the secondary structure* *D is incorrect because ionic bonds are not involved in the secondary structure*	1

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to three of the following: • {tyrosinase active / melanin made} in cooler regions (1) • tyrosinase denatures / {hydrogen / ionic} bonds break (in warm / light regions) (1) • active site changes shape / tertiary structure changes (1) • no enzyme substrate complexes form / tyrosine does not bind (to tyrosinase / enzyme) (1)	**ACCEPT** converse throughout **ACCEPT** enzyme for tyrosinase for all mark points **ACCEPT** optimum temperature is cool / low	3

Q5.

Question Number	Answer	Mark
(i)	**The only correct answer is A** ***B*** *is not correct because the carboxyl group is drawn at the other end of the polypeptide chain* ***C*** *is not correct because a hydroxyl group would be on a side chain or part of the carboxyl group at the other end of the molecule* ***D*** *is not correct because there is no oxygen in the functional group at the nitrogen side of an amino acid*	**(1)**

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to the following: • 3 dimensional {shape / folding} of protein (1) • held together by bonds between R groups (1)	ACCEPT suitable named bonds involved	**(2)**

Q6.

Question Number	Acceptable Answers	Additional Guidance	Mark
(i)	An explanation that makes reference to the following: • because there was some mRNA in the pollen grain (1) • so some {translation / protein synthesis} can take place (1)	Allow some mRNA can still be made e.g. if act D was a competitive inhibitor or transcription not completely inhibited Allow pollen tubes may already have the proteins they need for growth	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	A description that makes reference to four of the following: • mRNA attached to the ribosome (1) • tRNA is attached to a (specific) amino acid (1) • tRNA anticodon binds to mRNA codon (1) • peptide bonds form between amino acids (1) • process involves {start / stop} codons (1)	Reject amino acids Allow {complementary base pairing / hydrogen bonds} between tRNA and mRNA	(4)

Question Number	Acceptable Answer	Additional Guidance	Mark
(iii)	A description that makes reference to two of the following: • formation of a peptide bond (1) • between an amino group and carboxyl group (1) • by a condensation reaction (1)	Allow amine and carboxylic acid and formulae Allow release of a water molecule	(2)

Q7.

Question Number	Answer	Additional Guidance	Mark
(i)	**The only correct answer is D** **A** is incorrect because antibodies have two antigen binding sites **B** is incorrect because the two binding sites attach to the antigen and not the macrophage **C** is incorrect because there is only one macrophage binding site		(1) COMP

Question Number	Answer	Additional Guidance	Mark
(ii)	**The only correct answer is B** **A** is incorrect because hydrolysis reactions breakdown molecules **C** is incorrect because nucleotides are the monomers of polynucleotides not proteins **D** is incorrect because nucleotides are the monomers of polynucleotides not proteins		(1) COMP

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to the following: • (because water enters part of cell) by osmosis (1) • from a high water potential to a low water potential / because the osmotic potential inside the cell is lower / from a low solute concentration to a higher solute concentration (1)	**ACCEPT** more concentrated cytoplasm solute potential for osmotic potential **IGNORE** concentration gradient unqualified water concentration	(2) EXP

Question Number	Answer	Additional Guidance	Mark
(iv)	A description that makes reference to three of the following: • bacteria engulfed and {digested / broken down} (1) • antigen attached to MHC antigen (1) • macrophage becomes an antigen-presenting cell (to the T helper cell) (1) • CD4 (antigen) of T (helper) cell binds to {antigen / macrophage} (1)	**ACCEPT** macrophage presents the antigen (to the T helper cell) **NB** CD4 (antigen) of T (helper) cell binds to {antigen-MHC complex = 2 marks	(3) EXP

Q8.

Question Number	Answer	Additional Guidance	Mark
i	A description that makes reference to two of the following: • folding of the {primary structure / polypeptide chain } (1) • into α-helix or β pleated sheet (1) • due to formation of hydrogen bonds (1)		(2)

Question Number	Answer	Additional Guidance	Mark
ii	An explanation that makes reference to the following: • protease enzymes have an active site specific to certain amino acid sequences (1) • so the misfolded protein will not fit in the active site (of the protease enzyme) (1) • therefore enzyme is unable to hydrolyse peptide bond (1)		(3)

Q9.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: • (primary structure is) sequence of amino acids that determines the tertiary structure (1) • because the {amino acids / R groups} determine the {type / position} of the bonds (1) • credit named bond (that forms between the R groups) (1) • polar {amino acids / R groups} need to be on the outside of the hormone so that it can dissolve in the (blood) plasma (1) • (part of) the (final structure of) molecule has to be of a specific shape to {be complementary / bind} to the receptor molecules (on the target cells) (1)	**ACCEPT** shape / folding / 3D structure **IGNORE** quaternary e.g. hydrogen, ionic, disulfide, van der waals **ACCEPT** hydrophillic **ACCEPT** active site in either context of hormone or receptor, unless clearly talking about enzymes **IGNORE** quaternary	(4) EXP

Q10.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to the following: Similarities: • all three types have the same amino acids in positions 1, 2, 4, 5, 6, 7 and 9 (1) Differences: • type A has ile in position 3 whereas types B and C have phe (1) • type C has lys in position 7 whereas types A and B have arg (1)	**ACCEPT** they all have cys, tyr, gln, asn, (cys), pro, gly they all have one amino acid different **ACCEPT** instead of phe **ACCEPT** instead of arg	(3) EXP

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: • there are more (triplet) codes than there are amino acids (1) • so the code is degenerate (1) • therefore the same amino acids may have a different code (1) • this helps to maintain the same {structure / function} of the {nonapeptide / protein} (1)	**ACCEPT** this helps to prevent a mutation from changing the {structure / function}	(3) EXP

Q11.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to three of the following: • this protein is folded so that hydrophilic groups are on the outside (and hydrophobic on the inside) (1) • these exposed R groups are { polar / ionic } (1) • therefore they form hydrogen bonds with water (1) • because water is a polar solvent (1)	accept description of dipolar nature of water / ability to form hydrogen bonds with {charged / polar} molecules	**(3)**

Q12.

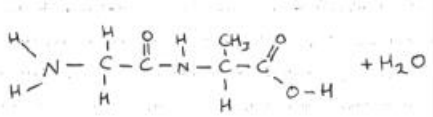
Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to the following: • COOH and NH_2 group shown (1) • cysteine R group and H shown (1) • attached to central C (1)	**ACCEPT** charged groupings	(3) **EXP**

Question Number	Answer	Additional Guidance	Mark
(ii)	• disulfide (bond / bridge)	**ACCEPT** disulphide	(1) **GRAD**

Q13.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: • enzymes are made of polypeptide chains with bonds between (R groups) to form a 3D tertiary structure (1) • catalase has four subunits so has quaternary structure (1) • because proteins with {non-protein / haem} groupshave quaternary structure (1)	**ACCEPT** are (semi) soluble so fold into a {3D shape / globular structure} in water **ACCEPT** more than one polypeptide chain	(3) **EXP**

Q14.

Question Number	Answer	Additional Guidance	Mark
(i)	**A** CH_3 *B is incorrect because it is the carboxylic acid group* *C is incorrect because it is not the R group* *D is incorrect because it is the amino group*		**1**
(ii)	*An answer that makes reference to:* • correct peptide bond between the amino acids(1) • a water molecule (1)		**2**
(iii)	*An answer that makes reference to three from:* • three polypeptide chains (1) • that are (left hand) helices joined together (1) • (helices are held together) by hydrogen bonds (1) • many tropocollagen molecules / triple helicesjoined together (1)	**Allow** repeating sequences of aminoacids / every third amino acid is glycine / lots of proline **Allow** triple helix	**3**

Q15.

Question Number	Answer	Additional Guidance	Mark
(i)	• multiplication (1) • division (1)	2×10^{10} divisions per day x 10^{-7} mutations per division / 2×10^{10} = 20 000 000 000 ÷ 10 000 000 / = 2 000 / 2×10^{3} Correct answer gains full marks, with no working shown ALLOW one mark for 20 000 000 000 / ÷ 10 000 000 / 10×10^{6} / 1×10^{7}	**(2)**

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to three of the following: • different {R groups / disulphide bonds / hydrogen bonds / ionic bonds} (1) • therefore different secondary / tertiary structure (1) • therefore different shaped ribosome (1) • therefore streptomycin cannot bind (to ribosome) (1)		**(3)**

Q16.

Question Number	Answer	Additional Guidance	Mark
	A diagram that includes the following: • amino group and carboxyl group shown (1) • a carbon attached to H and R on each side of (1) • a peptide bond shown (1)	accept reasonable example of an R group	**(3)**

Q17.

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to two of the following: • has a {tertiary structure / three dimensional structure (and quaternary structure)} (1) • held by named bond (1) • hydrophilic on the outside of the molecule (1)	**ACCEPT** hydrophobic R groups in the centre of the structure	**(2)**

Q18.

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to three of the following: • (folded into) {spherical / rounded / 3D} shape (1) • {polar / hydrophilic} {R groups / amino acids} on outside (1) • {non polar / hydrophobic} {R groups / amino acids} on inside (1) • ionic / hydrogen / disulfide bonds (1)	Accept disulfide bridges	(3)

Q19.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following: • glycine is very small so the collagen fibres are very close together **(1)** • so this allows the formation of bonds that hold the polypeptide chains together **(1)**	**ACCEPT** amino acids have small R groups which enables the proteins to be close together	**(2)**

Question Number	Answer	Mark
(ii)	**The only correct answer is C** ***A*** *is not correct because ester bonds are involved in bonding carboxyl and OH groups* ***B*** *is not correct because glycosidic bonds are found in carbohydrates* ***D*** *is not correct because peptide bonds join the amino acids in the individual polypeptide chains, not between the chains as there are no free carboxyl and amino groups along the length of the chain*	**(1)**

Q20.

Question Number	Answer	Additional Guidance	Mark
(i)	The only correct answer is **B** (hydrogen, ionic and disulfide) **A** is not correct because glycosidic and ester bonds are not tertiary structure bonds **C** is not correct because glycosidic bonds are not tertiary structure bonds **D** is not correct because ester bonds are not tertiary structure bonds		**(1)**

Question Number	Answer	Additional Guidance	Mark
(ii)	A explanation that makes reference to three of the following: • different {sequence of amino acids / primary structure} (1) • so there will be different R groups (1) • therefore {secondary / tertiary / quaternary} structure is different (1) • {active site is not complementary to monophenol / active site has different shape} so {monophenol cannot bind / enzyme substrate complexes cannot form} (1)	**Accept** insertion of a stop codon leads to shorter polypeptide (1) **Accept** different hydrogen bonds / disulfide bonds / ionic bonds **Accept** correct references to α-helix and β-sheet **Accept** references to substrate for monophenol	**(3)**