

PEARSON EDEXCEL A-LEVEL BIOLOGY B • 9B10

BIOLOGY



EXAM QUESTION PACK

TOPIC 1: BIOLOGICAL MOLECULES
PROTEINS

SCORE

/65

PERCENTAGE

%

STEMUP

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Q1.

Sickle cell anaemia is caused by a mutation in the β -globin gene which codes for part of haemoglobin.

The diagram shows the first 10 amino acids in this part of haemoglobin, in a healthy person and in a person with sickle cell anaemia.

Healthy person: val – his – leu – thr – pro – glu – glu – lys – ser – ala

Person with sickle cell anaemia: val – his – leu – thr – pro – val – glu – lys – ser – ala

Explain why the haemoglobin in a person with sickle cell anaemia will fold differently from the haemoglobin of a healthy person.

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Q2.

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 ☐.

Palm plants and cocoa plants are used to produce lipids for the food industry.

Palm oil is produced from palm plants. Cocoa butter is produced from cocoa plants.

The fatty acid compositions of palm oil and cocoa butter are shown in the table.

Fatty acid	Chemical formula of fatty acid	Percentage of fatty acid found in palm oil and cocoa butter (%)	
		Palm oil	Cocoa butter
palmitic acid	$C_{16}H_{32}O_2$	45	27
oleic acid	$C_{18}H_{34}O_2$	40	31
linoleic acid	$C_{18}H_{32}O_2$	10	3
myristic acid	$C_{14}H_{28}O_2$	1	1
stearic acid	$C_{18}H_{36}O_2$	4	38

(i) How many of the named fatty acids shown in the table are saturated?

(1)

☐ A 1

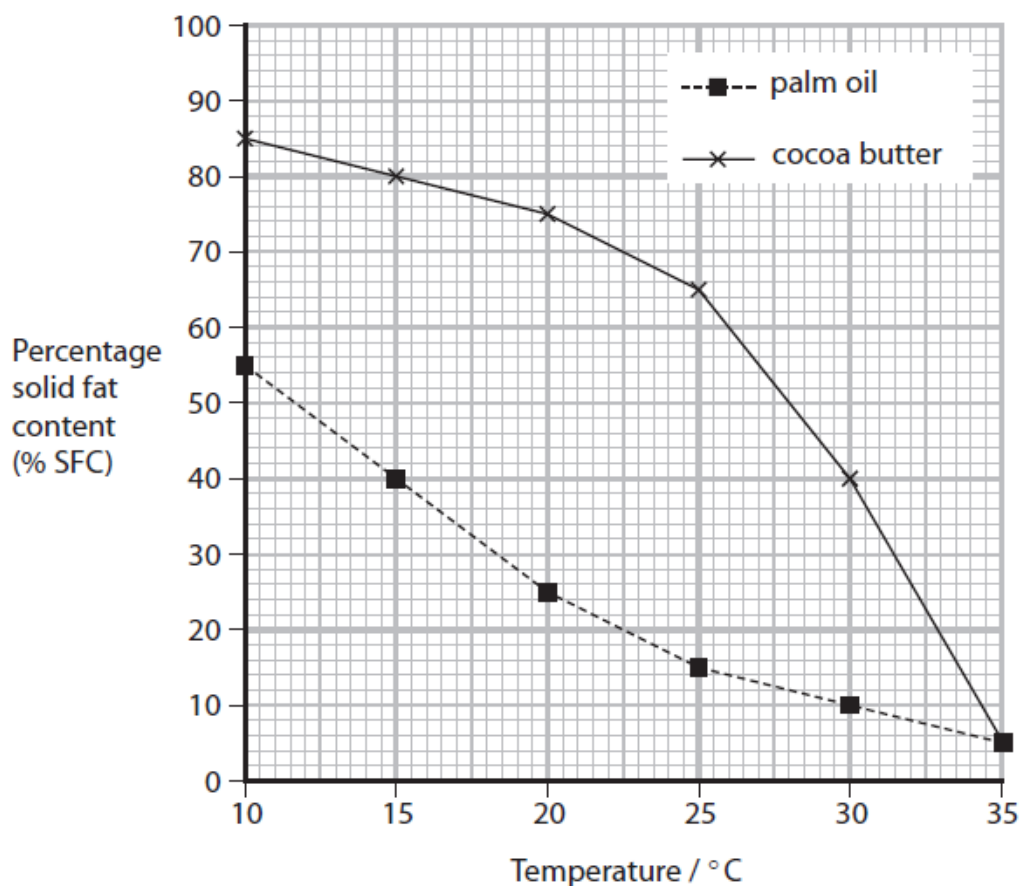
☐ B 2

☐ C 3

☐ D 4

(ii) The percentage solid fat content (% SFC) is a measure of how much of a lipid is solid at different temperatures.

The graph shows the effect of temperature on the % SFC for palm oil and for cocoa butter.



Comment on the effect of temperature on the % SFC of palm oil and of cocoa butter.

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(Total for question = 5 marks)

Q3.

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.

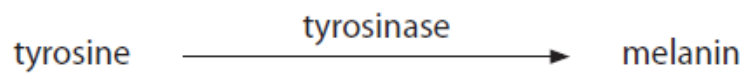


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The pigment melanin causes the fur to turn black.
This pigment is produced by tyrosinase, an enzyme coded by the TYR gene.



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)

Q4.

The order of bases in a section of DNA codes for a sequence of amino acids in a protein.

Draw a diagram to show the structure of an amino acid.

(2)

(Total for question = 2 marks)

Q5.

Doxorubicin (Dox) is a drug used to treat cancer.

Cancer is caused when cells divide uncontrollably.

This drug works in two ways:

- it becomes inserted into the DNA and holds the two strands together.
- it binds to an enzyme that repairs DNA.

Explain how Dox prevents cancer cells from dividing.

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(Total for question = 5 marks)

Q6.

Sickle cell anaemia is caused by a mutation in the β -globin gene which codes for part of haemoglobin.

The diagram shows the first 10 amino acids in this part of haemoglobin, in a healthy person and in a person with sickle cell anaemia.

Healthy person: val – his – leu – thr – pro – glu – glu – lys – ser – ala

Person with sickle cell anaemia: val – his – leu – thr – pro – val – glu – lys – ser – ala

The allele that leads to sickle cell anaemia is known as HbS.

From 1990 to 1996, all newborn infants in California were screened for the presence of the HbS allele.

The data in the table show the ratio of individuals with and without the HbS allele, in various ethnic groups.

Ethnic group	HbS allele : no HbS allele
African American	1:14
Asian	1:1336
Caucasian	1:625
Hispanic	1:183
Middle Eastern	1:360
Native American	1:176

A chi squared test was used to analyse the raw data.

The null hypothesis was: "There is no difference between the frequency of the HbS allele in African Americans and in all other ethnic groups combined."

The calculated value of chi squared was 450 615.

The table shows some critical values for the chi squared distribution, with one degree of freedom.

probability, p	0.005	0.010	0.025	0.050	0.100
critical value	7.879	6.635	5.024	3.841	2.706

Malaria is a major cause of death in Africa.

Assess the effect that this might have on the frequency of the HbS allele in African populations.

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Q7.

Many of the chemicals found in living organisms are polymers.

Which of the following molecules are all polymers?

(1)

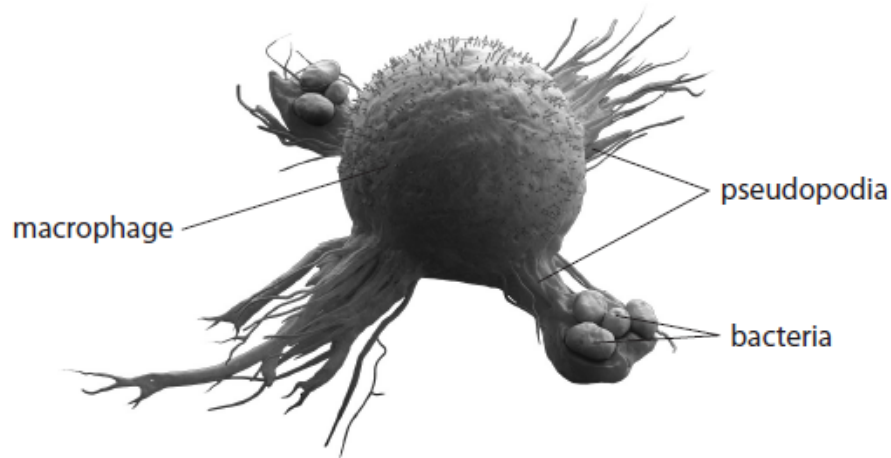
- ☐ **A** polypeptides, nucleotides, starch
- ☐ **B** polypeptides, starch, lipids
- ☐ **C** proteins, carbohydrates, lipids
- ☐ **D** proteins, nucleic acids, starch

Q8.

Macrophages are involved in response to infection.

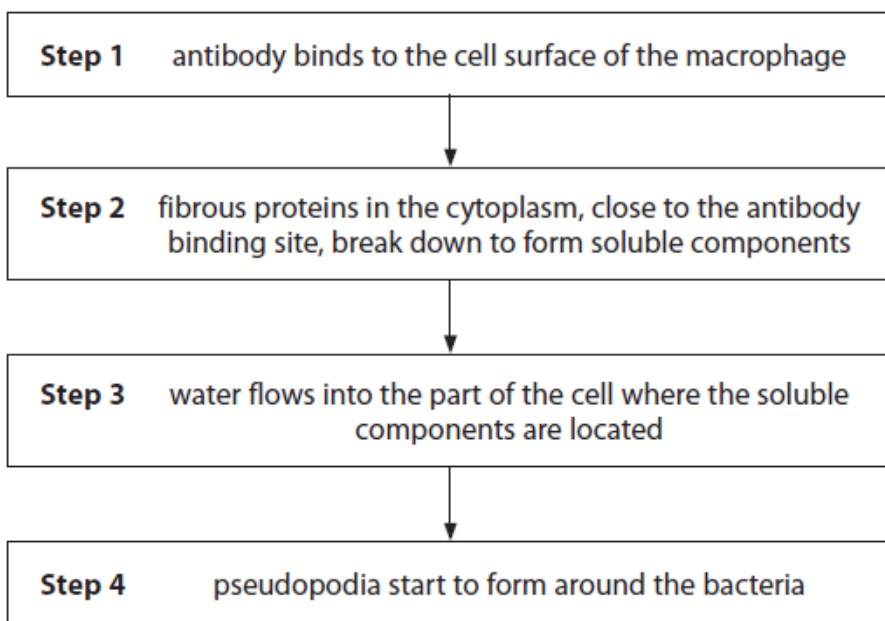
Macrophages engulf bacteria by surrounding the bacteria with pseudopodia.

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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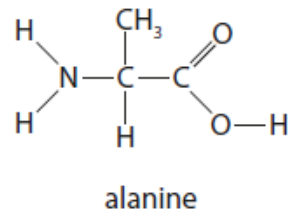
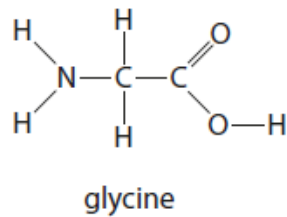
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Q9.

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.



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

(1)

- ☐ **A** CH₃
- ☒ **B** COOH
- ☐ **C** H
- ☐ **D** NH₂

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

(2)

(iii) Describe the structure of collagen.

(3)

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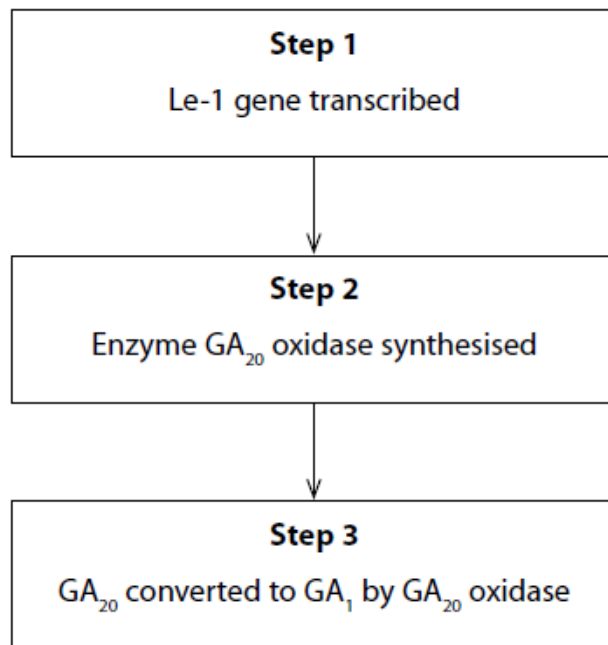
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(Total for question = 6 marks)

Q10.

'DELLA' proteins normally prevent transcription factors from binding to important growth-stimulating genes in the cells of plant stems.

The diagram below shows part of the biochemical pathway leading to the synthesis of an active plant growth substance called gibberellin (GA_1). GA_1 reduces the effect of 'DELLA' proteins.



(a) The Le-1 gene codes for the enzyme GA_{20} oxidase. A mutation of this gene forms a recessive allele which, when translated, leads to a single amino acid change in this enzyme. This change significantly reduces the activity of GA_{20} oxidase.

Explain how a single amino acid change can bring about a change in the structure and activity of GA_{20} oxidase.

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(b) (i) Explain why homozygous recessive plants will have short stems.

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(ii) An ecological survey of a stable population of one species of plant found that 36% had short stems.

Calculate the percentage of heterozygous individuals in this population.
Assume that there are only two alleles for this gene.

(4)

Answer

(Total for question = 12 marks)

Q11.

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.

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(Total for question = 5 marks)

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.

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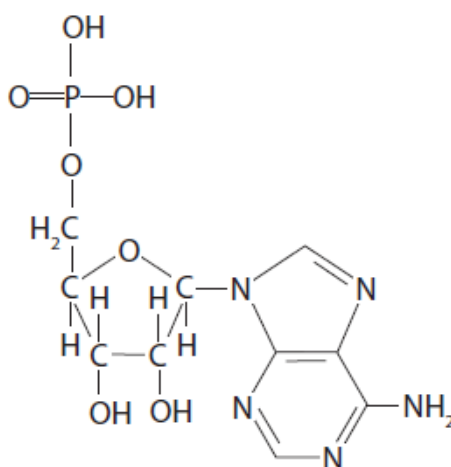
(Total for question = 2 marks)

Q13.

Many of the chemicals found in living organisms are polymers.

The diagram shows the structure of a monomer.

(1)



This monomer is found in

☒ **A** DNA

- ☐ **B** DNA polymerase
- ☐ **C** haemoglobin
- ☐ **D** mRNA

Q14.

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

Describe the tertiary structure of a globular protein.

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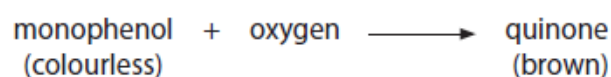
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(Total for question = 3 marks)

Q15.

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	Acceptable Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: - substitution of val for glu, which has a different { R / residual } group (1) - val (R-group) has no positive charge (1) - therefore ionic bond lost (1) - therefore tertiary structure changes (1)	Allow glu has a positive charge	(4)

Q2.

Question Number	Answer	Additional Guidance	Mark
(i)	C 3 <i>A is incorrect because palmitic, myristic and stearic acid are saturated fats</i> <i>B is incorrect because palmitic, myristic and stearic acid are saturated fats</i> <i>D is incorrect because palmitic, myristic and stearic acid are saturated fats</i>		1

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to four from the following: • %SFC for both decreases as temperature increases for both cocoa butter and palm oil / both have 5% SFC at 35 °C (1) • the % SFC of cocoa butter is higher at all temperatures (except 35 °C) (1) • because cocoa butter has higher percentage of / more saturated fat (1) • so fatty acid chains can associate with each other more easily (1) • the % SFC of cocoa butter decreases more steeply above 25 °C / larger decrease after 25°C (1)	Accept converse Accept converse Accept pack more tightly together / has straight chains/rods which pack tightly together higher density of intermolecular contacts/bonds	4

Q3.

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

Q4.

Question Number	Acceptable Answer	Additional guidance	Mark
	$ \begin{array}{c} \text{R} \\ \\ \text{NH}_2 - \text{C} - \text{COOH} \\ \\ \text{H} \end{array} $ • central carbon atom bonded to NH₂ and COOH group (1) • central carbon atom bonded to R group and H atom (1)	Allow opposite orientation with R group and R may be replaced with appropriate group	(2)

Q5.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to five of the following: • DNA synthesis is needed for {mitosis / cell division} (1) • Dox prevents {DNA synthesis / DNA strands separating / promoters binding} (1) • because the strands are not available (for nucleotides to align) (1) • Dox prevents {transcription / transcription factors from binding} (1) • so no proteins synthesised (1) • repair enzyme will not be able to remove the drug (1)	ACCEPT without DNA synthesis the cell will remain in interphase ACCEPT mRNA cannot be made ACCEPT {cell cycle stops / cells destroyed} if damaged DNA is not repaired	

Q6.

Question Number	Acceptable Answer	Additional Guidance	Mark
	An answer that makes reference to the following: • { selective pressure against / loss of } sickle cell alleles due to effects of sickle cell anaemia (1) • heterozygote advantage due to protection against malaria increases { HbS frequency / number of heterozygotes } (1) • heterozygote advantage increases with increased prevalence of malaria (1) • HbS frequency depends on whether malaria or sickle cell disease represents a greater risk to survival (1)		(4)

Q7.

Question Number	Acceptable Answer	Additional Guidance	Mark
	D (proteins, nucleic acids, starch)		(1)

Q8.

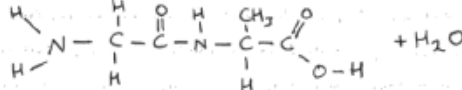
Question Number	Answer	Additional Guidance	Mark
(i)	The only correct answer is D A is incorrect because antibodies have two antigen binding sites B is incorrect because the two binding sites attach to the antigen and not the macrophage C is incorrect because there is only one macrophage binding site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

Q9.

Question Number	Answer	Additional Guidance	Mark
(i)	A CH₃ <i>B is incorrect because it is the carboxylic acid group</i> <i>C is incorrect because it is not the R group</i> <i>D is incorrect because it is the amino group</i>		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 helices joined together (1)	Allow repeating sequences of aminoacids / every third amino acid is glycine / lots of proline Allow triple helix	3

Q10.

Question Number	Correct Answer	Additional guidance	Mark
(a)	An explanation that makes reference to the following: • {Active site changes shape / not correctly formed} and no longer an efficient 'fit' to substrate (1) • because if one amino acid is changed then these bonds cannot form (1) • because only certain amino acids (e.g. cysteine needed for S –S bonding) can form disulphide bridges/hydrogen bonds/ionic bonds (1) • and these bonds are important in the formation of a tertiary/3D protein structure (1)		(4)

Question Number	Correct Answer	Additional guidance	Mark
(b)(i)	An explanation that makes reference to the following: • (reduced activity of GA₂₀ oxidase means) less active GA₂₀ is produced (1) • therefore less GA₂₀ means more DELLA proteins present (1) • hence more DELLA proteins means fewer transcription factors binding to growth regulator genes (1) • therefore resulting in growth regulator genes not expressed / growth less because transcription factors needed for expression of genes (1)	Less DELLA protein broken down	(4)

Question Number	Correct Answer	Additional guidance	Mark
(b)(ii)	• equation $p^2 + 2pq + q^2 = 1$ (1) • $p^2 = 0.36$ so $p = 0.6$ (1) • $q = 0.4$ so $2pq = 2 \times 0.6 \times 0.4$ (1) • correct answer 48% (1)		(4)

Q11.

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

Q12.

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)

Q13.

Question Number	Acceptable Answer	Additional Guidance	Mark
	D (mRNA)		(1)

Q14.

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)

Q15.

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)