Past-paper walk-through

Proteins ▪ 2.3

eXercise

Questions in this set

- 9700/11 N25 Q11 ▪ 1 mark
- 9700/12 N25 Q10 ▪ 1 mark
- 9700/12 N25 Q11 ▪ 1 mark
- 9700/12 N25 Q12 ▪ 1 mark
- 9700/14 N25 Q11 ▪ 1 mark
- 9700/14 N25 Q12 ▪ 1 mark
- 9700/23 N25 Q2 ▪ 14 marks

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 11

9700/11 N25 ▪ Q11 ▪ 1 mark

11 In some people a mutation can affect the beta chains in their haemoglobin molecules. As a result polar amino acids on the outer surfaces of the chains are replaced by non-polar amino acids.

What will be the effect on haemoglobin?

A Haemoglobin will become less soluble.

B Haemoglobin will become more soluble.

C Hydrophobic interactions between amino acids will decrease.

D More hydrogen bonds will form in the molecule.

Solution 11

Answer: **A**

Why

- Polar groups on the outside of a protein are what let it dissolve in the watery cytoplasm.
- Replacing them with non-polar groups removes those interactions with water.
- The haemoglobin therefore becomes less soluble – which is what makes sickle cells form.

Question 10

9700/12 N25 ▪ Q10 ▪ 1 mark

10 Which bonds between amino acids hold the shape of the secondary structure and also the tertiary structure of proteins?

A peptide bonds

B disulfide bonds

C hydrogen bonds

D ionic bonds

Solution 10

Answer: **C**

Why

- The secondary structure (α-helix and β-pleated sheet) is held by hydrogen bonds.
- Hydrogen bonds also help hold the tertiary structure, alongside ionic and disulfide bonds.
- Peptide bonds hold the primary sequence, and disulfide bonds appear only in the tertiary structure.

Question 11

9700/12 N25 ▪ Q11 ▪ 1 mark

11 Resilin is a protein found in the wings of insects. It is an elastic, fibrous protein and scientists have suggested that it may have an important role in allowing the wings of an insect to fold and unfold without damage.

Peptidyl transferase is an enzyme which catalyses the condensation of amino acids during translation to form resilin.

Which statements are correct?

1 Peptidyl transferase and resilin have structural roles in the insect.

2 Peptidyl transferase is a globular protein.

3 Peptidyl transferase is soluble in water.

A 1 and 2 **B** 1 and 3 **C** 1 only **D** 2 and 3

Solution 11

Answer: **D**

Why

- Peptidyl transferase catalyses condensation between amino acids on the ribosome.
- So it builds the primary structure of the polypeptide.
- The elasticity of resilin comes from its later folding, not from this enzyme.

Question 12

9700/12 N25 ▪ Q12 ▪ 1 mark

12 Collagen is a protein that helps to strengthen and increase the elasticity and hydration of the skin. Aging can lead to dry skin and the formation of wrinkles, due to the body producing less collagen.

Which row is correct for the structure of collagen in the skin?

	every fourth amino acid is glycine	fibrous protein
A	✗	✗
B	✓	✓
C	✗	✓
D	✓	✗

key

✓ = correct

✗ = **not** correct

Solution 12

Answer: **C**

Why

- Collagen is three polypeptides wound into a triple helix.
- Glycine is the smallest amino acid, and having it at every third position lets the chains pack tightly.
- Cross-links between the chains, and staggered ends between molecules, give the fibre its strength.

Question 11

9700/14 N25 ▪ Q11 ▪ 1 mark

11 Thermostable enzymes can maintain their tertiary structure at high temperatures.

Scientists studying the primary structure of a thermostable enzyme found that the enzyme contained:

- more charged amino acids
- fewer polar amino acids that are **not** charged
- more hydrophobic amino acids

than enzymes that are **not** thermostable.

Which row shows a correct comparison between this thermostable enzyme and an enzyme that is **not** thermostable?

	number of amino acids	number of ionic bonds

Question 11

	forming interactions at the centre of a thermostable enzyme compared to an enzyme that is **not** thermostable	number of ionic bonds in a thermostable enzyme compared to the number in an enzyme that is **not** thermostable
A	less than	more than
B	less than	less than
C	more than	less than
D	more than	more than

Solution 11

Answer: **D**

Why

- More charged and hydrophobic amino acids means more ionic bonds and more hydrophobic interactions.
- Those extra interactions hold the tertiary structure together more firmly.
- So a higher temperature is needed before the enzyme denatures.

Question 12

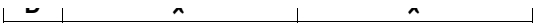
9700/14 N25 ▪ Q12 ▪ 1 mark

12 Collagen is a strong, elastic molecule that is often found in the connective tissues of animals. Glycine is an amino acid found at regular positions in the primary structure of a collagen polypeptide.

Which row shows features of collagen that contribute to its strength and elasticity?

	glycine is found on the outside of the helical polypeptides to allow them to lie closer together	disulfide bonds form between glycine amino acids to join the polypeptides together
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

Question 12



key

✓ = contributes to the strength and elasticity of collagen

✗ = does **not** contribute to the strength and elasticity of collagen

Solution 12

Answer: **D**

Why

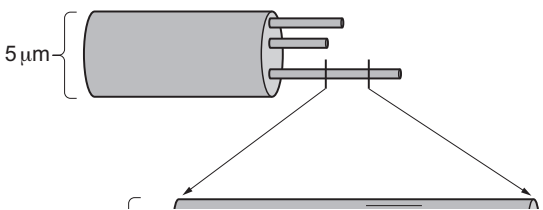
- Glycine is the smallest amino acid, so having it at every third position lets three chains wind tightly together.
- The chains form a triple helix held by hydrogen bonds.
- Covalent cross-links between neighbouring molecules, staggered along the fibre, give the strength.

Question 2

9700/23 N25 ▪ Q2 ▪ 14 marks

2 Collagen is a fibrous protein found in many tissues in animals.

Fig. 2.1 shows the composition of a collagen fibre.



collagen fibre
- a bundle of
collagen fibrils

Question 2

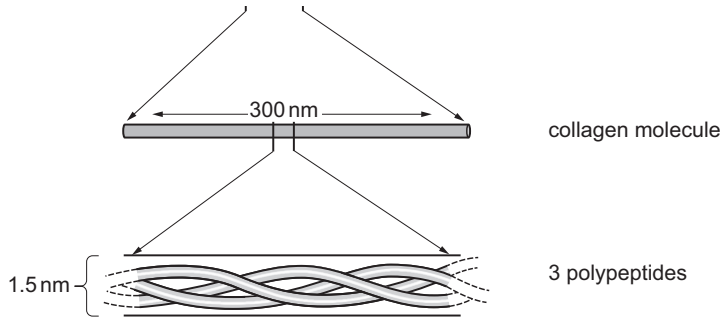


Fig. 2.1

(a) (i) Describe the arrangement of the 3 polypeptides in each molecule of collagen.

Question 2

(ii) With reference to Fig. 2.1, explain how the molecules of collagen are arranged **and** held together in a collagen fibril.

Question 2

[3]

(b) Collagen fibres and elastic fibres are found in the structures of the gas exchange system of mammals.

(i) Suggest **two** properties of collagen that contribute to the function of cartilage in the trachea in the gas exchange system.

Question 2

(ii) State the function of elastic fibres in the alveoli in the lungs.

Question 2

(c) Table 2.1 shows the DNA triplets in the two strands of DNA in part of a gene that codes for one of the polypeptides in collagen.

Table 2.1

non-transcribed strand	GGT	CCA	ATG	GGT	CCC	CGA	GGT	CCC	CCA	GGT
template strand	CCA	GGT	TAC	CCA	GGG	GCT	CCA	GGG	GGT	CCA
amino acid	gly									

Table 2.2 shows the triplets of bases in **DNA** and the amino acids for which they code.

The table can be used to determine the sequence of the amino acids in a polypeptide.

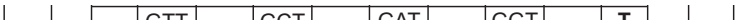
Question 2

Question 2

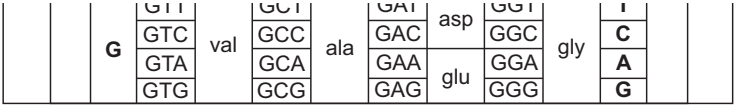
Table 2.2

first base	second base: T		second base: C		second base: A		second base: G		third base
T	TTT	phe	TCT	ser	TAT	tyr	TGT	cys	T
	TTC		TCC		TAC		TGC		C
	TTA	leu	TCA		TAA	stop	TGA	stop	A
	TTG		TCG		TAG		TGG	trp	G
C	CTT	leu	CCT	pro	CAT	his	CGT	arg	T
	CTC		CCC		CAC		CGC		C
	CTA		CCA		CAA	gln	CGA		A
	CTG		CCG		CAG		CGG		G
A	ATT	ile	ACT	thr	AAT	asn	AGT	ser	T
	ATC		ACC		AAC		AGC		C
	ATA		ACA		AAA	lys	AGA	arg	A
	ATG	met	ACG		AAG		AGG		G

Question 2



Question 2



(i) Complete Table 2.1 to show the amino acids coded by the DNA nucleotide sequence in Table 2.1. [1]

(ii) The sequence of amino acids that you have worked out is representative of the whole of the collagen polypeptide.

Explain how the sequence of amino acids makes the polypeptide suitable as a component of a collagen molecule.

Question 2

(iii) Two mutations, **P** and **Q**, can have an effect on the primary structure of the polypeptide.

- Mutation **P** is a deletion of the first nucleotide pair in the DNA nucleotide sequence shown in Table 2.1.
- Mutation **Q** is a substitution of G with T as the first base in the DNA nucleotide sequence shown in Table 2.1.

State the effects of the mutations, **P** and **Q**, on the primary structure of the polypeptide.

Question 2

[2]

[Total: 14]

Solution 2

(a)(i)

Mark scheme

- any two from
- each polypeptide is a (left-handed), helix / helical shape ; R alpha helix
- (three) polypeptides are tightly, coiled / wound (around each other) / AW ;
- (three polypeptides form a) triple helix ;
- I bonding
- 2

Solution 2

(a)(ii) Mark scheme

- any three from
- collagen molecules arranged
- 1
- in parallel ;
- 2
- staggered / ends are not aligned / AW ;
- molecules held together by – max 2/3 covalent, bonds / links ; I hydrogen bonds R if part of a list that includes other bonds in proteins

Solution 2

- 4
- between R-groups of amino acids on different molecules ; A side chains
- 5
- AVP ; e.g. covalent bonds between lysine / hydroxylysine (residues)
- 3

Solution 2

(b)(i)

Mark scheme

- provides (high tensile) strength to, help keep trachea open / support trachea ;
- A provides strength to prevent trachea collapsing
- allows flexibility for, breathing / change of diameter of trachea / bending of trachea / AW ;
- 2

Solution 2

(b)(ii)

Mark scheme

- any one from:
- (inhalation) allow, stretching / expansion, without, rupture / AW ; A prevent overstretching
- elastic fibres recoil to help, expel air / exhalation / expiration ; R to empty
- 1

Solution 2

(c)(i)

Mark scheme

- (gly)-pro-met-gly-pro-arg-gly-pro-pro-gly ;
- 1
- 9700/23
- October/November 2025

Solution 2

(c)(ii) Mark scheme

- any three from:
- allow gly for glycine
- 1
- glycine is every third amino acid ;
- 2
- glycine, allows tight folding for the polypeptides / makes it easy for polypeptides to fit closely together / AW ;
- A compactness A glycine allows the turning points (of the polypeptide)

Solution 2

- 3
- glycine has smallest R-group ;
- A glycine is the smallest (amino acid) / glycine has H as R-group or side chain
- 4
- NH in glycine can form hydrogen bonds (with carboxyl group on another amino acid residue)
- 5
- (so) allows many hydrogen bonds between polypeptides ;
- 6
- AVP ; ala / pro, also has a small R-group / AW

Solution 2

- 3

Solution 2

(c)(iii) Mark scheme

- P deletion of first nucleotide pair
- changes the, sequence / order, of amino acids (in primary structure) ; I shorter
- A (GTC CAA TGG GTC CCC GAG GTC CCC CAG GT_)
- val gln trp val pro glu val pro gln (val)
- Q substitution in first triplet
- (GGT to TGT in non-transcribed strand)
- cys (instead of gly) is first amino acid, and no change to the rest (of, sequence / order, of amino acids) ;

Solution 2

- A only first amino acid is different
- 2
- 9700/23
- October/November 2025