1.

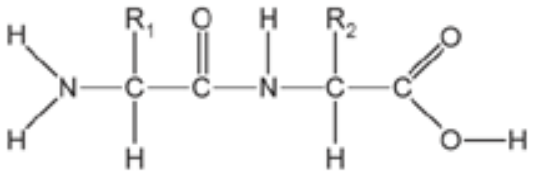
i. The general structure of an amino acid molecule has one R group and two other groups.

Name the **two** other groups in an amino acid molecule.

1 _____

2 _____ **[2]**

ii. Below is a diagram of a dipeptide.



Draw a circle around the peptide bond. Answer on the diagram.

[1]

iii. Name the type of reaction involved in breaking the peptide bond.

_____ **[1]**

2. The table lists some biological molecules

Complete the table by putting a tick (✓) in the appropriate box or boxes on each line to show whether the corresponding feature is present.

The first line has been completed for you.

Biological molecule	Is a monomer	Is a polymer	Contains glycosidic bond(s)
Amino acid	✓		
Amylopectin			
Glucose			
Sucrose			

[3]

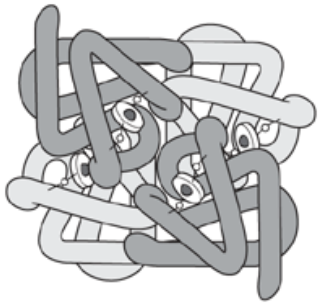
3. The table lists statements about a molecule of insulin.

Complete the table by stating the level of protein structure (primary, secondary, tertiary or quaternary) to which the statement relates.

Statement	**Level of protein structure**
It consists of two polypeptide chains (A and B) that are linked by disulfide bonds.	
Chain A consists of a sequence of 21 amino acids.	
Chain A contains a disulfide bond between cysteine amino acids.	
Chain B contains both α-helix and β-pleated sheet structures.	

[2]

4. The image shows the quaternary structure of a haemoglobin molecule.



i. In addition to having a quaternary structure, haemoglobin also has primary, secondary and tertiary structures.

The table below contains statements about the structure of haemoglobin.

Complete the table to show the level of protein structure described in each statement.

You can choose each level of protein structure **once**, **more than once** or **not at all**.

Statement	**Level of Protein Structure**
Disulfide bonds are formed when two cysteine amino acids in an α-globin chain come together after the alpha helix folds	
Haemoglobin is made up of two α-globin chains and two β-globin chains	
Each α-globin and β-globin chain is folded into a spherical shape	
The β-globin chain has 147 amino acids in a specific sequence	

[3]

ii. Name the enzyme in an erythrocyte that allows haemoglobinic acid to be formed.

_____ **[1]**

5. Thin layer chromatography (TLC) can be used to separate and identify amino acids.

Name **and** describe the reaction that produces amino acids from polypeptides.

_____

_____ [1]

6. Which statement is a correct description of polymers?

A A polymer is broken down by condensation reactions.
B A polymer is formed when two monomers bond together.
C All polymers are classified as either a carbohydrate or a protein.
D Some polymers are composed of several monomers that are similar in structure but **not** identical.

Your answer ☐ **[1]**

7. A scientist analysed and recorded **all** of the chemical elements in one particular amino acid.
Which elements did the scientist record?

A C, H, N, S
B C, H, O, N
C C, H, O, N, P
D C, H, O, N, S, P

Your answer ☐ **[1]**

8. Rheumatoid arthritis is an autoimmune disease that causes pain in skeletal joints.

i. Explain the meaning of the term **autoimmune disease**.

_____

_____ **[1]**

ii. Collagen is a protein found in ligaments. Ligaments attach bone to bone and stabilise joints.

State the properties of collagen that make it suitable for this function.

_____

_____

_____

_____

[2]

iii. Neutrophils are produced by stem cells.

State where in the body these stem cells are found.

[1]

iv. A student wrote the following passage about the immune system:

'T helper cells produce cell signalling molecules called perforins. These stimulate the activity of B cells which increase antibody production. Agglutinins cause pathogens with antigen-toxin complexes to clump together.'

Identify **two** errors in the statement and write a correction for each error.

1 _____

_____

2 _____

[2]

9. Which description of biological molecules is correct??

A DNA and RNA are both polymers of nucleotides.

B Hydrolysis of sucrose produces fructose and β-glucose.

C Proteins are polymers of amino acids and are broken down in condensation reactions.

D Starch is a polymer of the monosaccharide maltose.

Your answer ☐ **[1]**

10. Which statement about the structure of amino acids is **not** true?

A Amino acids contain amino and carboxyl groups.

B Amino acids contain the elements hydrogen, carbon and oxygen only.

C Each amino acid has a unique R group.

D The R groups in amino acids can be polar or non-polar.

Your answer ☐ **[1]**

11. Which of the options is a feature of collagen?

A It allows alveoli to recoil

B It dissolves in water

C It is flexible

D It is the main protein found in hair

Your answer ☐ **[1]**

12. Which statement about the secondary structure of a protein is correct?

A β-pleated sheets contain β-glucose.
B Disulfide bonds are not involved.
C Each single polypeptide is either an α-helix or a β-pleated sheet.
D Hydrogen bonds form between the R-groups of different amino acids.

Your answer ☐ **[1]**

13(a). Haemoglobin is a globular protein.

Fig. 16.1 shows the structure of haemoglobin.

Fig. 16.1

There are four levels of protein structure.

i. Name the bond present in the primary structure of a protein.

_____ **[1]**

ii. Name the structure labelled **X**.

_____ **[1]**

iii. State **one** feature, visible in **Fig. 16.1**, that shows that haemoglobin is a globular protein.

---------- **[1]**

(b). Sickle cell disease is a genetic disease that results from a substitution mutation in one of the genes that code for haemoglobin.

Fig. 16.2 below shows part of the mRNA sequence that codes for normal haemoglobin and the corresponding sequence of amino acids.

mRNA	ACU	CCU	GAG	GAG	AAG
Amino acids	1	2	glutamic acid	glutamic acid	lysine

Fig. 16.2

Fig. 16.3 is a representation of the genetic code.

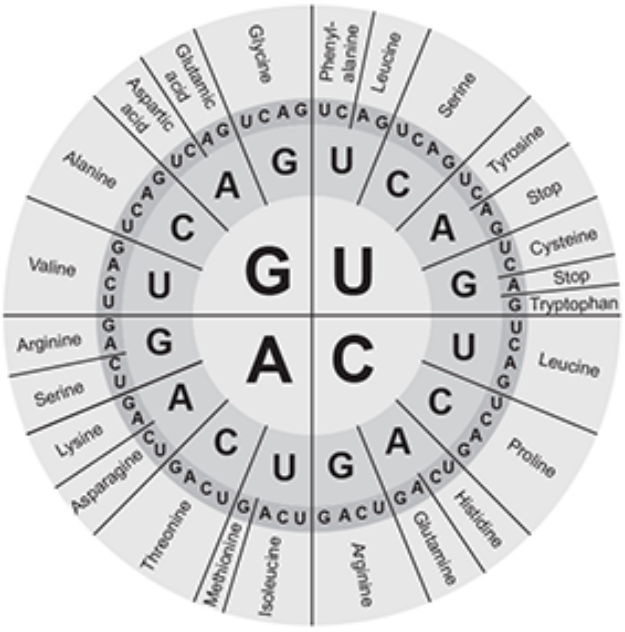


Fig. 16.3

i. Use **Fig. 16.3** to identify the missing amino acids 1 and 2 in **Fig. 16.2**.

1 _____

2 _____

[2]

ii. Outline the role of RNA polymerase in the production of the mRNA sequence in **Fig. 16.2**.

[2]

iii. In sickle cell disease, the haemoglobin contains the amino acid valine in one of the positions normally occupied by glutamic acid.

State the base sequence on the anticodon of a tRNA molecule that brings valine to the ribosome.

[1]

iv. *In sickle cell disease, the mutated haemoglobin has a reduced ability to carry oxygen.

Some gene mutations do not affect protein function.

Use **Fig. 16.3 and** levels of protein structure to explain why some gene mutations do **not** affect the function of a protein.

[6]

Additional answer space if required.

14(a). Human insulin is a globular protein with a quaternary structure. One insulin molecule has 51 amino acids.

Fig. 21.1 shows the sequence of amino acids in one molecule of human insulin.

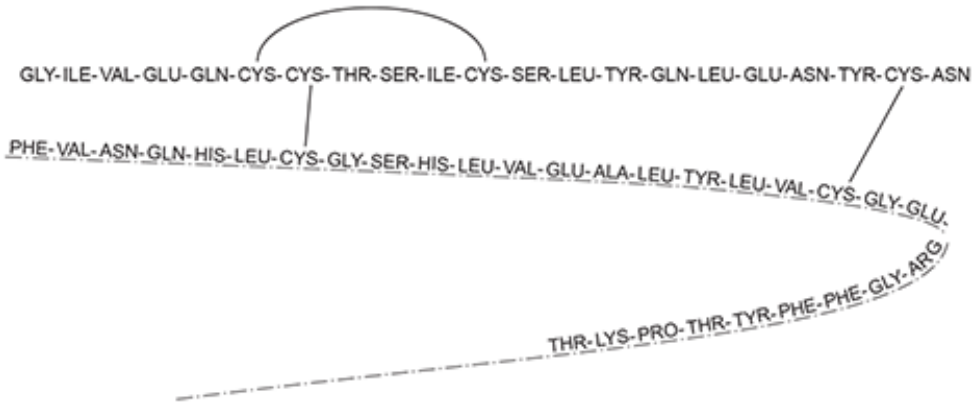


Fig. 21.1

The amino acid cysteine is abbreviated to 'CYS' in **Fig. 21.1**. The side chain (R group) found in cysteine is shown in **Fig. 21.2**.

Complete **Fig. 21.2** to show the structure of the amino acid cysteine.

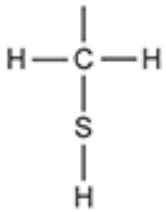


Fig. 21.2

[3]

(b). Explain how **Fig. 21.1** shows that insulin has a quaternary structure.

---**[2]**

(c). Insulin is a hormone that regulates blood glucose concentration. People with type 1 diabetes need to inject insulin, to reduce their blood glucose concentration, as they are unable to produce their own insulin.

Diabetics need to inject insulin before every meal as insulin has a short half-life. Enzymes in the liver cells break down insulin, which removes it from the blood.

Insulin glargine is a modified version of human insulin that lasts much longer in the blood.

Fig. 21.3 shows the sequence of amino acids in one molecule of human glargine with the modifications in **bold**.

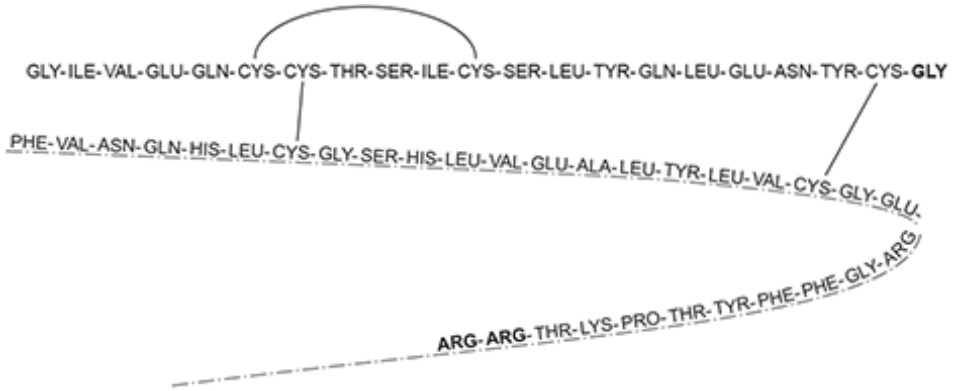


Fig. 21.3

i. Suggest why insulin glargine is long-lasting.

---**[1]**

ii. The table shows some of the DNA triplet codes for amino acids.

1st base of DNA triplet	2nd base of DNA triplet								3rd base of DNA triplet
	T		C		A		G		
A	ATT	(ILE) Isoleucine	ACT	(THR) Threonine	AAT	(ASN) Asparagine	AGT	(SER) Serine	T
	ATC		ACC		AAC		AGC		C
	ATA		ACA		AAA	(LYS) Lysine	AGA	(ARG) Arginine	A
	ATG	(MET) Methionine	ACG		AAG		AGG		G
G	GTT	(VAL) Valine	GCT	(ALA) Alanine	GAT	(ASP) Aspartic acid	GGT	(GLY) Glycine	T
	GTC		GCC		GAC		GGC		C
	GTA		GCA		GAA	(GLU) Glutamic acid	GGA		A
	GTG		GCG		GAG		GGG		G

In order to produce insulin glargine, the human insulin gene is modified by genetic engineering. This is a process which can change the genetic code of the gene. The genetic code of DNA triplet 21 is changed so that the amino acid it codes for is glycine instead of asparagine.

iii. With reference to the table, predict how the genetic code of DNA triplet 21 is changed so that it codes for the amino acid glycine instead of the amino acid asparagine.

---

[2]

iv. The modified polypeptides that form insulin glargine are made inside cells.

The process of making the modified polypeptides that form insulin glargine involves several steps. The process starts with the modified gene for insulin glargine.

Outline the steps involved in the process of making the modified polypeptides that form insulin glargine, starting with the gene for insulin glargine until when the modified polypeptides are made.

---

[4]

END OF QUESTION PAPER